Aspects of the ecology of the black-headed gull (larus ridibundus) with comparative data on the common gull (L. canus)

Gabriela Elisabeth MacKinnon

ABSTRACT

Between 1982 and 1984, 893 Black-headed and 117 Common Gulls were trapped outside the breeding season in northeast England, and individually marked with wingtags or colour-rings. About 40% of marked adult Black-headed and Common Gulls returned to the study area in subsequent years, although adult Black-headed Gulls marked at the coast in the 1982-83 season returned in considerably higher proportions. Proportionately fewer second-year and first-year birds returned than adults. These percentages are considerably lower than the estimated annual survival rate for Black-headed Gulls, showing that some of the birds probably spent subsequent winters outside the study area. Some of the birds which did not return to the study area were recovered or seen elsewhere, mainly in eastern parts of Britain: few moved to the west coast. Foreign Black-headed Gulls which overwintered in the British Isles were most numerous compared to British birds in the south and east of the British Isles. A small proportion of Continental Black-headed Gulls remained in Britain during the breeding season: the consequences of these birds joining the British breeding population are discussed. Overwintering Black-headed Gulls in the study area were observed feeding inland on fields and refuse tips, and at the coast. First-years were uncommon compared to adults at the coast, less so on tips, and were relatively most common on fields. Females made up similar proportions of flocks at the coast and on inland fields, but were excluded to some extent from tips. Neither the survival rates of adult and first-year British Black-headed Gulls, nor the weights of adult Black-headed Gulls caught in northeast England, were usually affected by the severity of weather in winter. The migrations and movements of Black-headed Gulls are discussed and compared to those of other species.

ASPECTS OF THE ECOLOGY OF THE BLACK-HEADED GULL (Larus ridibundus) WITH COMPARATIVE DATA ON THE COMMON GULL (L. canus)

Gabriela Elisabeth MacKinnon, B.Sc. (Glasgow)

A thesis presented in candidature for the degree of Doctor of Philosophy in the University of Durham, 1986.

I certify that all material in this thesis which is not my own work has been identified and that no material is included for which a degree has previously been conferred upon me.

For J.C.M. and B.J.M.

ACKNOWLEDGEMENTS

I should like to thank my supervisor, Dr. J. C. Coulson for his unfailing enthusiasm, invaluable advice, and for catching Black-headed Gulls in the cold light of dawn. I am grateful to members of Durham University Zoology Department for help with catching and processing gulls, including D. Baines, Dr. S. A. Greig, D. Jackson, Dr. J. M. Porter, Dr. P. Shaw and Dr. C. S. Thomas, and especially Dr. J. E. L. Butterfield. My study of colour-marked gulls was helped considerably by the many people who sent in sightings of marked birds, especially J. Strowger, D. Turner, F. Grey, K. Ferry, and members of the Teesmouth and Tyneside Bird Clubs. W. Grainger, J. Richardson and G. Wall were most helpful in locating Black-headed Gull colonies in County Durham. The Durham University Zoology Department supplied facilities. I would like to thank technicians M. Bone, D. Hutchinson, J. Richardson, D. Young, and especially E. Henderson for all their help during my stay in Durham. My thanks are due to Dr. N. J. Aebischer for generous help with computing, statistics and artwork, to J. Gregory for proof-reading and to S. Coulson for helping with the figures. The British Trust for Ornithology supplied me with ringing recoveries of British Black-headed Gulls, and recoveries in Britain of foreign-ringed birds. Weather data were obtained from the Newcastle Weather Centre, and from Durham University Geography Department. This research was supported by a grant from the Natural Environmental Research Council. I am grateful to everyone who gave me permission to pursue gulls on private property. I would finally like to thank my parents and friends for their moral support throughout the last four years.

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Chapter 1 GENERAL INTRODUCTION

Throughout the 20th century, there have been marked increases in both the breeding range and numbers of gulls (Laridae) in Europe, and summaries are given by species in Cramp & Simmons (1983). The Herring Gull has spread inland in France and Germany from mainly coastal breeding sites, and has colonised Iceland (1920-30), Switzerland (1968) and Yugoslavia (1979). There are reported to have been marked increases in the numbers of breeding pairs in Fennoscandia, the Netherlands, France and Britain during the 20th century, especially over the last 30 years. For example, the annual rate of increase in the Netherlands was 13% per annum during the period 1968-77 (Cramp & Simmons 1983). In West Germany, numbers are still increasing, despite control measures. There has also been an expansion of the breeding range of the Lesser Black-backed Gull this century, with colonisation of Iceland, France, the Netherlands and West Germany during the 1920s, and colonisation of the Iberian peninsula during the 1970s. Although there have been recent declines in the Danish (Møller 1978) and Finnish (Cramp & Simmons 1983) breeding populations, increases have been reported for Iceland, the British Isles and Northwest Europe. During the 1920s, the Great Black-backed Gull colonised Bear Island, France, Denmark and Spitzbergen, but there has been little expansion of the breeding range since. Nonetheless, there have been marked increases in the population during this century, e.g. Iceland (Ingolfsson 1976 (in Cramp & Simmons 1983)), Scotland (Cramp, Bourne & Saunders 1974) and Denmark (Møller 1978). The breeding range of the Kittiwake has spread this century to Helgoland (1938), Denmark (1941), Sweden (1967), Spain (1971) and Portugal (1973). In the British Isles, the population increased by 3-4% per annum between 1920 and 1969, but the rate of increase slowed to 2% per annum for the period

1969-1979 (Coulson 1983), probably due to food shortage in the western parts of the British Isles, where the decline occurred. Increases are reported from France, Spain, Portugal and Norway (Cramp & Simmons 1983), the USSR (e.g. Shklyarevitch 1977 (in Cramp & Simmons 1983)) and Bear Island, with 12,000 pairs in 1932 (Bertram & Lack 1933 (in Cramp & Simmons 1983)) increasing to ca. 200,000 pairs in 1980 (Cramp & Simmons 1983). There have been local declines in numbers in Denmark since 1970 (Møller 1978), and in the Faeroes (Cramp & Simmons 1983) in recent years.

The Common Gull has also increased its breeding range this century, colonising Iceland in 1955 or earlier (Gardarsson 1956 (in Cramp & Simmons 1983)), Belgium (1924) and Switzerland (1966), and recolonising the Netherlands in 1908 (Braaksma 1964 (in Cramp & Simmons 1983)). A spread in the breeding range has also occurred in Ireland (Cramp _et al_. 1974), West Germany (Tricot 1971 (in Cramp & Simmons 1983)), Denmark (Møller 1978) and Poland (Tomialojć 1976 (in Cramp & Simmons 1983)). Marked increases in numbers have occurred this century over most of the Common Gull's range. In the Netherlands, numbers have increased from less than 10 pairs (1908-23) to 7,000 pairs (1978) (Cramp & Simmons 1983). Cramp & Simmons also record large increases in West Germany (4,200 pairs in 1961 to ca. 7,500 pairs in 1969-1970), Finland, and Estonia (17,000 pairs in 1966 to 40,000 pairs in 1976). In Denmark, there were increases in numbers during the 19th century, but after the 1930s and 40s, numbers declined (Møller 1978). In the British Isles, Common Gulls mainly breed in Scotland (including Orkney and Shetland) and Ireland. Alexander & Lack (1944) state that marked increases in numbers occurred during the 19th century, continuing into this century, when some extension of breeding range also occurred. Common Gulls colonised the Ulster coast in 1934, and have bred sporadically in northern England since the 1920s (Sharrock 1976). Sharrock suggest that a well-established colony at Dungeness (Kent), founded in 1919, may have been started by incoming Continental Common Gulls. There are no overall figures for numbers breeding in the British Isles, but Sharrock (1976) suggests a total British and Irish population of around 50,000 pairs.

The Black-headed Gull has also increased in numbers and spread its breeding range this century. Voous (1960) described the breeding distribution of this species as transpalaearctic, extending across Europe and Asia from Iceland and the British Isles in the west, to Sakhalin Island and the Kamchatka peninsula (USSR) in the east. The present breeding range has been greatly extended this century: Black-headed Gulls first bred in Iceland in 1911 (Gudmundsson 1951), on the North Sea coast of West Germany in 1931 (Goethe 1969 (in Cramp & Simmons 1983)), in Italy in 1960 (Schenk 1976 (in Cramp & Simmons 1983)) and in Spain in 1960 (Maluquer Maluquer 1971 (in Cramp & Simmons 1983)). There is evidence that Black-headed Gulls are extending their breeding range across the Atlantic, having first bred in Greenland in 1969 and 1973, and in Newfoundland in 1977 (Cramp & Simmons 1983). Despite declines in Denmark (Møller 1978), Silesia and Bulgaria, the European population has increased greatly this century, with rapid increases in Iceland since 1930 (Gudmundsson 1951), and increases in Ireland, France, Belgium, the Netherlands, parts of West Germany, Sweden, Finland in the 1920s and 30s, Austria, Switzerland and the Baltic states of the USSR (Cramp & Simmons 1983). In the British Isles during the 19th century, Black-headed Gull numbers declined to such an extent that it was feared the species would disappear as a British breeding bird (Gurney 1919 (in Cramp & Simmons 1983)). After 1884, the population recovered, and has continued to increase this century. Surveys of colonies of Black-headed Gulls in England and Wales were carried out in 1938, 1958 and 1973. In 1938, there were 41,000 pairs breeding in England and Wales (Hollom 1940, and Marchant 1952). An increase in numbers was recorded for the 1958 survey (Gribble 1962), with an estimated 46,000-51,450 pairs breeding that year, an average annual increase of 1.1%. The 1973 survey estimated that 100,000-110,000 thousand pairs of Black-headed Gulls were breeding in England and Wales that year (Gribble 1976), an average annual increase of 5.2% since 1958. From the estimated total populations of Black-headed Gulls for individual countries in the mid-1970s (Cramp & Simmons 1983), the total European population has been taken as 1.14-1.26 million pairs, of which 8-10% breed in England and Wales. This is certainly an underestimate of the European population, as totals were not available for some regions, including Scotland and Ireland.

Whilst in some areas, declines in gull numbers have occurred (notably in Denmark, where gulls are shot by sportsmen, and Common Gulls have declined since the 1930s, Black-headed Gulls have declined since the 1940s, and there has been an average annual decline of 0.9% in Lesser Black-backed Gull numbers), the general trend during the 20th century has been for gulls breeding in Europe to expand their breeding ranges, and to increase in numbers throughout their range. In spite of these increases in gull numbers, and the establishment of many new colonies (e.g. Gribble 1976), it is notable that many colonies have declined and been abandoned. The 1958 survey of breeding Black-headed Gulls in England and Wales (Gribble 1962) showed that 122 (66%) of the colonies present in 1938 had been abandoned by 1958. The colony at Ravenglass, Cumbria, once famous as the largest Black-headed Gull colony in the British Isles, declined from ca. 10,000 pairs in 1938 to 1,514 pairs in 1984, when no chicks were fledged. In 1985, there were no breeding attempts (N. Anderson pers. comm.).

Large increases in the numbers of gulls overwintering in the British Isles have been observed in recent years, reflecting the increase in the European populations. Attempts have been made since the 1950s to survey roosting gulls in Britain during winter. Unfortunately, coverage has never been complete, with especially poor coverage of Ireland and Scotland. A survey of inland-roosting gulls in England in the winter of 1952-3 resulted in estimates of 250,000 Black-headed Gulls, 50,000 Common Gulls, 34,000 Herring Gulls, 2,000 Great Black-backed Gulls and 165 Lesser Black-backed Gulls (Hickling 1954). A comparable survey was carried out in the winter of 1963-64 (Hickling 1967), but cover of England was reduced, with no reports of roosts from most of the southwest, south and southeast of England. Nonetheless, there had been increases in the totals obtained for each species; Black-headed Gulls showed an average annual increase of 2% since 1952-3, with 310,000 roosting inland in England. Common Gulls had increased by 9% per annum to 124,000, Herring Gulls by 5% per annum to 56,000, Great Black-backed Gulls by 12% per annum to 7,000, and Lesser Black-backed Gulls by 41% per annum to 7,000. Another survey of inland-wintering gulls in England and Wales took place in 1973, and has been described by Hickling (1977). In England alone, the following totals were obtained: 576,600 Black-headed Gulls, 139,500 Common Gulls, 110,600 Herring Gulls, 13,700 Great Black-backed Gulls and 17,500 Lesser Black-backed Gulls, representing annual average increases of 7% (Black-headed Gulls), 1% (Common Gulls), 8% (Herring Gulls and Great Black-backed Gulls) and 11% (Lesser Black-backed Gulls). The most recent survey of wintering gulls was in January 1983 (Bowes, Lack & Fletcher 1984), in which coverage of England and Wales was claimed to be good. The total numbers of gulls in England and Wales, at coastal and inland roosts, were 1,701,000 Black-headed Gulls, 332,000 Common Gulls, 159,000 Herring Gulls, 58,000 Lesser Black-backed Gulls, and 29,0000 Great Black-backed Gulls, a total of over two and a quarter million gulls of British and Continental origin.

After the breeding season, Black-headed Gulls disperse from the colonies. Those belonging to the British and Irish breeding populations typically remain within the British Isles over the winter period, and only 2% of ringing recoveries have been from abroad, mainly France and Iberia, with a few from north-west Africa (Radford 1962). Flegg & Cox (1972) found that British Black-headed Gulls from different regions did not have well defined wintering areas within the British Isles. Black-headed Gulls breeding in countries surrounding the Baltic Sea overwinter in North Sea countries (including the British Isles, the Netherlands and Belgium), and Cramp & Simmons (1983) claim that some also cross the Continent to overwinter in the Mediterranean Sea area. Norwegian birds winter mainly in the British Isles, the Low Countries and Denmark. Black-headed Gulls from colonies in the Low Countries migrate to the west, and winter in the British Isles, France, Iberia and a few reach north-west Africa. French Black-headed Gulls display different dispersion patterns according to the region of origin (Faure 1969), and are found during the winter in the Bay of Biscay area, Iberia and the Mediterranean; few migrate north to reach Britain.

In their analysis of foreign-ringed Black-headed Gulls recovered in the British Isles, Horton et al. (1984) found that recoveries were chiefly from Scandinavia, the Baltic states of the USSR, and the Netherlands. Black-headed Gulls of Belgian and Dutch origin were recovered mainly in the south of Britain. The main concentrations of Danish birds were recovered in eastern counties from Yorkshire to Kent, whilst Black-headed Gulls of German and Czechoslovakian origin were mainly recovered in the south-east. Most recoveries in Britain of Black-headed Gulls from the Baltic states, Sweden and Finland occurred in south east and the east of Britain; Norwegian birds were recovered throughout the British Isles, but most recoveries were from eastern areas. Icelandic Black-headed Gulls have been recovered in northern

Scotland and in Ireland. Foreign Black-headed Gulls wintering in Britain are thus concentrated in the south and in eastern counties.

British Common Gulls remain in the British Isles for the winter, either remaining near their breeding areas, or moving to the south and southwest (Radford 1960). A study of Estonian Common Gulls found that they migrated southwest, mainly to overwinter around Denmark, with small numbers remaining in the Eastern Baltic, and some reaching Britain and Northern France (Jõgi 1958 (in Cramp & Simmons 1983)). Finnish and Swedish Common Gulls overwinter in the western Baltic and North Sea areas, with higher proportions of Swedish birds recovered in Britain (Cramp & Simmons 1983), whilst the main wintering area of Norwegian Common Gulls is Great Britain and Ireland. Danish birds leave Denmark to overwinter in North Sea and English Channel countries, with West German birds having a similar winter distribution. Common Gulls from the Netherlands usually stay in the southern North Sea countries, including eastern England (Braaksma 1964). Foreign Common Gulls overwintering in Britain have been shown by analysis of recoveries (Radford 1960) to be mainly of Scandinavian origin, and Vernon (1969) suggests that observations and radar studies on migrating Common Gulls support this conclusion.

Overwintering gulls in the British Isles exploit a wide range of foods, some of which are available seasonally. In a study on the feeding ecology of gulls in the five counties surrounding the inner Bristol Channel area, Mudge & Ferns (1982) found that there were marked differences in the use of different types of feeding area between five gull species in winter. Herring Gulls depended mainly on refuse tips for food, with 75% of the total number of Herring Gulls known to be roosting in the area being seen at tips. Similar proportions of Lesser Black-backed Gulls fed at refuse tips (42%) and on fields (50%), whilst Common Gulls fed almost exclusively on fields

(94%). Black-headed Gulls also fed mainly on fields (71%), with substantial proportions also feeding in littoral and inshore areas (12%) and at sewage outfalls (12%). Few Great Black-backed Gulls were present in the area; none were seen feeding in fields, 15 individuals were seen at tips (47.5%), 15 in littoral and inshore areas, and one (5.7%) at a sewage outflow. Black-headed Gulls were the most numerous species in the Bristol Channel area (45,000), more than twice as numerous as Herring Gulls (21,000), but at tips Herring Gulls outnumbered Black-headed Gulls by a factor of seven. By contrast, in a study by Horton, Brough & Rochard (1983) in the area south-west of London, the total number of Black-headed Gulls at all tips in the area outnumbered Herring Gulls in each month of the study, suggesting that the relative importance of different types of feeding area may vary between regions. Vernon (1970 & 1972) discussed the results of a nationwide survey into habitat choice and choice of food of overwintering Black-headed Gulls and Common Gulls. A total of 1,336 flocks of predominantly Black-headed Gulls, and 479 flocks of predominantly Common Gulls, were observed throughout the British Isles. Of flocks observed inland, Vernon (1970) found that 37% of Black-headed Gull flocks and 65% of Common Gull flocks were seen on grassland. Common Gulls preferred well-drained upland fields, with 40% of flocks on fields occurring above 300 feet, compared with only 10% of Black-headed Gull flocks. Black-headed Gulls were more common in urban habitats (refuse tips, sewage-works, parks, docks etc.) than Common Gulls, with 13% of inland Black-headed Gull flocks observed in urban habitats, compared to 3% of Common Gull flocks. There were also marked differences in habitat preferences of flocks at the coast with 106 (54%) Black-headed Gull flocks observed on muddy areas, and 24 (80%) Common Gull flocks observed on sandy shores. Vernon (1972) discussed the types of food exploited by Common Gulls and Black-headed Gulls. Earthworms were a major component of the diet of gulls feeding on fields, varying in availabilty according to the weather (e.g. Gerard 1967), and were mainly available early in the morning. Gulls also feed on tipulid larvae, and on the adults when they emerge in early autumn. Both species take cereal grains from stubble fields in autumn, but records of gulls feeding on hedgerow trees are of Black-headed Gulls only, which are recorded to have fed on acorns (Gregory 1970), birch catkins (Holyoak & Sager 1970), caterpillars and hawthorn berries. In winter, Black-headed Gulls commonly feed at sewage works, taking solids floating on the surface of the tanks. At refuse tips, household refuse (e.g. meat and fish scraps and bread) is taken. Black-headed Gulls are less shy of people than Common Gulls and consequently, Black-headed Gulls are more often seen scavenging at bird tables, in parks and in other urban areas. Types of food taken at the coast include the worm Nereis diversicolor and the bivalve Hydrobia ulvae from muddy shores (Mudge & Ferns 1982), sewage from offshore outfalls (Vernon 1972), and fish offal from fish quays.

There are age-related differences in both feeding efficiency of gulls (e.g. Herring Gull, Greig, Coulson & Monaghan 1983) and in daily dispersal patterns. Van de Weghe (1971) and Vernon (1970) found that the proportions of first-year Black-headed Gulls were higher inland than at the coast in Belgium and Great Britain respectively.

The increases in gull numbers have had effects both on man and his animals. Gulls feeding on airstrips are a considerable hazard to aircraft. Gulls frequently form nocturnal roosts on reservoirs, and, particularly on small bodies of water, the consequent quantities of excrement in the water cause measurable increases in levels of bacteria. Although there is thought to be little risk to human populations from the fouling of drinking water before chlorination, efforts have been made to discourage gulls from roosting on certain reservoirs by scaring them with recorded gull distress-calls. Another source of concern is the increasing number of gulls which nest on buildings in towns, where the noise of the birds, and fouling of the buildings cause a considerable nuisance. Monaghan & Coulson (1977) found that town-nesting Herring Gulls in Britain increased by 17% per annum between 1969 and 1976, with the highest rate of increase (29% per annum) occurring in southeast Scotland and northeast England, probably owing to surplus young birds being produced at natural colonies in the area. Culls of Herring Gulls have been carried out in some places (e.g. Scarborough) in an attempt to reduce this problem.

Breeding gulls are considered by some to be pests. Colonies of gulls on grouse moors may be persecuted, on the grounds that they prey on grouse chicks (e.g. Brough 1969), and shooting and egg-collecting may both be employed in attempts to reduce the colonies. The presence of gulls may adversely affect breeding seabirds and waders through direct predation on eggs, young and adults, e.g. Great Black-backed Gulls prey on auks and shearwaters, and in some places young Sandwich Terns are known to suffer high mortality rates as adults are kleptoparasitised by Black-headed Gulls (Thomas 1972). Competition by gulls for nesting space can also reduce colonies of seabirds. On the Isle of May, a National Nature Reserve in the Firth of Forth, the breeding population of Herring Gulls was reduced from 29,700 in 1972 to 5,872 in 1981 by annual culls of breeding adults (Coulson, Duncan & Thomas 1982). It was hoped that this management policy would encourage terns to spread on the Isle of May. Coulson and his co-workers found that as numbers of breeding gulls declined, the density of the colony decreased, but the area used for breeding was little altered.

The five species of gull which feed and roost inland in Britain are known to carry salmonella, and Butterfield _et al_. (1983) found that the range of salmonella serotypes carried by town-living Herring Gulls was similar to those causing infection in man, and suggested that gulls become infected by feeding on untreated sewage from offshore outfalls. Herring Gulls were implicated in outbreaks of Salmonella montevideo in sheep and cattle, as the gulls migrated from their wintering area in northeast England to their breeding grounds in east Scotland (Coulson et al. 1983a). The disease causes abortion in the livestock, and an outbreak may cause considerable financial loss to farmers.

Concern over the possible harm caused to man, his livestock and to wildlife by increasing populations of gulls has led to great interest in gull ecology, both during the breeding season and in winter. It is well known that gulls have a strong attachment to their breeding areas, returning year after year to the same colony, and ringing studies of overwintering gulls have suggested that similar attachments to wintering areas occur. In studies of individually colour-marked Herring Gulls, it was found that although some birds returned to the same wintering area each year, they did not stay for the whole winter, but moved elsewhere after an average period of a month (J. C. Coulson pers. comm.). This tendency for Herring Gulls to move about during the winter is thought to have implications for the spread of disease. It was noticed that despite regular ringing of Black-headed Gulls in Durham City each winter, very few recaptures of ringed birds occurred, suggesting that Black-headed Gulls, like Herring Gulls, do not remain at the same nocturnal roost throughout the non-breeding season, exploiting the same feeding area daily, but move about within some larger area.

This thesis contains six chapters of results. Chapter 3 considers the survival-rates of Black-headed Gulls ringed in the British Isles as chicks. Chapter 4 concerns the origin of overwintering Black-headed Gulls in the

British Isles, and their distribution. Chapter 5 examines the seasonal changes in weight of Black-headed Gulls, and Chapter 6 considers the use of different feeding areas and sites by birds of different ages and of each sex. Chapter 7 is concerned with the daily and seasonal movements of individually marked Black-headed Gulls and Chapter 8 presents comparative data on Common Gulls.

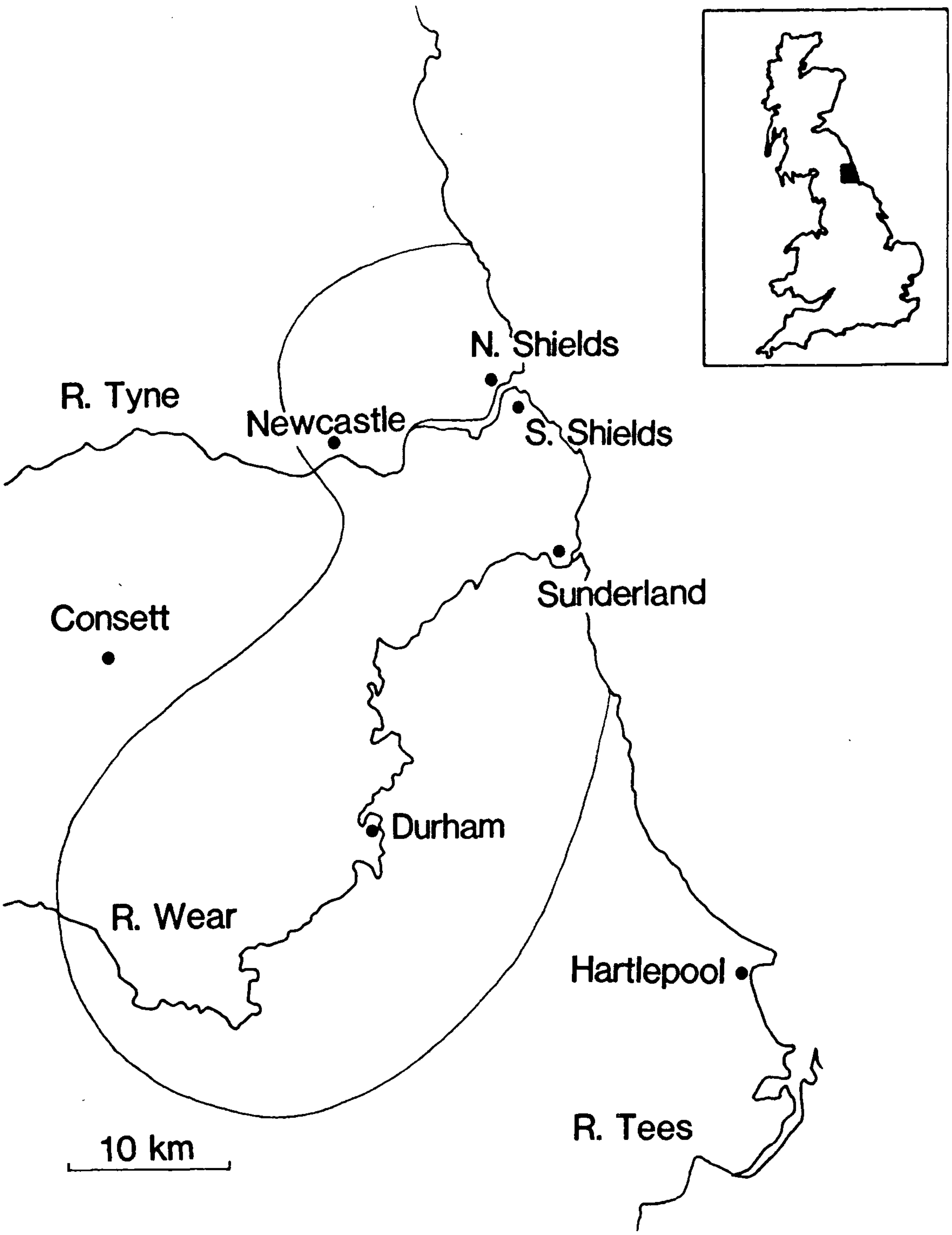
Chapter 2 METHODS

Details of the methods used are given at the beginning of the appropriate chapters. The study area covers about 550 square kilometres of Tyne & Wear and County Durham (Fig. 2:1), and includes two major rivers, the Tyne and the Wear. Descriptions of individual sites are given in the appropriate chapters. Several types of habitat occur inside the study area: sandy shore, muddy shore, pasture and playing fields, arable fields, refuse tips, sewage works and built-up areas. The study area extends up to 20km from the coast, and most of it lies under 200m above sea level.

Samples of 1867 Black-headed Gulls and 128 Common Gulls were trapped during the course of this study (September 1982 to March 1986), and 632 Black-headed Gulls were trapped before the start of the study. Each bird had measurements of head-and-bill length, wing length and weight recorded, and were aged according to plumage and bare part characteristics. First-year Black-headed Gulls are readily distinguished from older birds both in the hand and in the field by their brown carpal bar, black secondary bar and tail band, and by their dull flesh coloured beak and legs. Second-year Black-headed Gulls closely resemble adults, but birds apparently in adult plumage having pale red or orange bill and legs are probably second-years. Dark markings on the 11th primary (bastard primary), and/or the presence of one or more brown-marked coverts also indicate second-year birds (J. C. Coulson pers. comm.). Whilst the majority of second-year birds can be recognised, it is not certain that every second-year individual differs in these respects from adults (also see Grant 1982). Second-year and adult Black-headed Gulls are indistinguishable in the field. Common Gulls are aged as first-year, second-year and adult on obvious plumage differences.

Figure 2:1

Map showing the study area. The solid line encloses the area where most of the field work was carried out.



Most of the Common Gulls and 893 of the Black-headed Gulls trapped during the course of this study were marked so they could be individually recognised in the field. Either a combination of Darvic plastic colour-rings, or a pair of wing-tags engraved with a letter and number combination were used. Tags were made from four different colours of Darvic plastic, the material being made in three layers. Letter and number combinations were engraved by removing the top layer of plastic to reveal the middle, contrasting layer. A tag was attached to the patagium of each wing with either one or two nylon pins and plastic washers (Fig. 2:2), and the weight of a pair of tags together with the necessary pins and washers was about 5g. These tags were usually easy to read on birds seen in the field with the aid of binoculars or a telescope, except when light was failing or when strong winds shook the telescope.

Although male and female gulls are indistinguishable on plumage, males are generally larger and heavier than females. Using samples of Herring Gulls, Lesser Black-backed Gulls and Kittiwakes of known sex (by dissection or behavioural differences), Coulson _et al_. (1983b) found the most accurate single measurement for differentiating the sexes was the combined length of head and bill. In the case of Herring Gulls, 95.8$\pm$0.9% of individuals were correctly sexed on this measurement, using the discriminant value of 118mm.

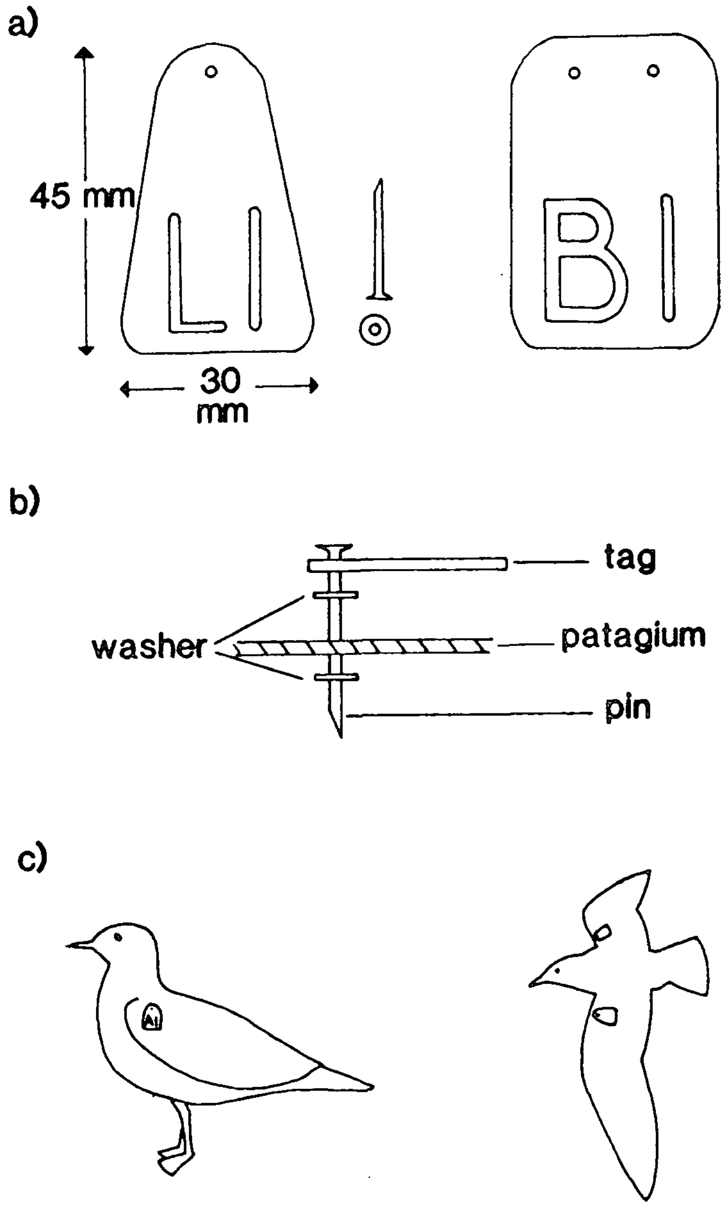
In the absence of a large sample of Black-headed Gulls of known sex, the discriminant head-and-bill length was found using arithmetic probability paper (Lewis & Taylor 1967). There being no significant difference in the variances of the head-and-bill lengths of adult, second-year and first-year Black-headed Gulls (F=2.118, 2 and 1399 d.f.), the three age classes were combined to give a sample of 1402 birds, and a discriminant value of 81mm was found. Fully grown Black-headed Gulls with a head-and-bill length greater than 81mm are classed as male, and those with a head-and-bill length

Figure 2:2

a) Two designs of wingtag are used, the first being secured by one pin, and the second by two pins. Two washers are used with each pin to prevent excessive wear of the tag and pin.

b) The nylon pin is passed through the tag and the first washer, then pushed through the skin of the leading edge of the wing (the patagium). The pin is passed over the second washer, then clipped short. The end of the pin is then melted with a cigarette lighter, and butted flat.

c) Wingtags are attached to each wing of the bird.



of 81mm or less are classed as female. The accuracy of this value was partly confirmed by sexing four dead Black-headed Gulls by dissection. Two of the birds were males, and their head-and-bill lengths were greater than the discriminant value (82mm and 89.5mm); the two females had head-and-bill lengths less than the discriminant value (76mm and 80mm). The mean head-and-bill lengths of males and females were 84.5mm (s.d.=2.0) and 78.5mm (s.d.=2.0) respectively. The mean values for the sexes were close to those found by Coulson et al. (1983b), who used a sample of 684 individuals, and the discriminant value was identical. They also estimated that 96.7% of females and 93.6% of males were correctly identified by this method. All the Black-headed Gulls and Common Gulls caught during this study were sexed on head-and-bill length. The discriminant value used for sexing Common Gulls was 88mm (Coulson et al. 1983b).

CHAPTER 3 SURVIVAL RATES OF BLACK-HEADED GULLS

3:1 Introduction

Annual survival-rates based on recoveries of birds ringed as nestlings may be calculated using either complete data (all birds originally ringed are assumed to be dead (Lack 1943)) or incomplete data (some of the birds originally ringed have still to die (Haldane 1955)). Murton (1962) gives a clear explanation of these two methods. Lack and Haldane both demonstrated that after the low rate of survivorship in the first few months following fledging, survival-rates are constant with age, but Botkin & Miller (1974) argued that this is probably incorrect. In a long-term study of a colony of individually colour-marked Kittiwakes, Coulson & Wooller (1976) showed that survival-rates of breeding birds decreased with age. Flegg & Cox (1975) found some evidence of age-dependent annual survival-rates in Black-headed Gulls, ranging from 79% for third-year birds to 56% for 10th year birds, but they did not provide sufficient information to calculate whether these differences were significant. The average annual survival-rate of British Black-headed Gulls ringed as chicks between 1909 and 1972 was estimated by Flegg & Cox to be 76% for the first five years of reproductive life. The survival-rate of first-year birds up to 31 December of the first year of life was estimated at 62%. There was a considerable difference in the monthly pattern of recoveries of first-year and adult birds, with most first-year recoveries occurring soon after fledging, and most adult recoveries during the breeding months, May to July.

Aluminium rings are known to wear so severely on certain species, e.g. Kittiwakes (Coulson & White 1959), Manx Shearwaters (Harris 1964a), that they are rendered illegible or lost long before some of the birds die.

Poulding (1954) found that Herring Gulls were able to remove aluminium rings. Survival-rates of species in which ring-wear or loss is severe will be greatly underestimated, since few old birds will be recovered. Concern over the limitations of aluminium led to the use of monel for rings, a hard-wearing alloy of copper and nickel. Coulson (1976) examined a sample of 871 monel rings which had been on Herring Gulls and Lesser Black-backed Gulls for between five and eight years, and found an annual weight loss of 3.8% and 2.2% respectively. He suggested that owing to variability in rates of weight loss, monel rings on Herring Gulls are not fully effective in producing recoveries after eight years. Black-headed Gulls were first marked with monel rings in 1957. Between 1957 and 1972 inclusive, either aluminium or monel rings were used on Black-headed Gull chicks, and after 1972 monel was used exclusively. In this chapter, a strict comparison of the reliability of the two types of ring has been made over the period 1957-1965. Average annual survival-rates of adult and first-year Black-headed Gulls have been estimated for birds ringed between 1949 and 1980 inclusive, and regional variation in survival-rates considered. Yearly survival-rates have been considered in the light of the severity of winter weather, and the monthly variation in number of recoveries has been compared between different age classes.

3:2 Methods

3:2.1 Description of data set

Ringing of Black-headed Gulls in Great Britain and Eire began in 1909, but the total number of recoveries of Black-headed Gulls ringed before 1949 was low. This analysis is concerned only with birds ringed as chicks from

1949 onwards, and recovered by the end of July 1982. For a recovery to be included in this analysis, all the following criteria had to be satisfied:

i. The bird was ringed as a nestling.

ii. The bird was found dead, or can be assumed to have been found dead.

iii. The date of recovery is accurate to within 30 days each way.

Birds reported as shot were excluded. Juveniles recovered on, or within 6km of the colony were assumed to be unfledged, and omitted.

3:2.2 Description of terms

The first year of life of Black-headed Gulls is taken as the period from hatching to 31 July in the following year. The second year of life is taken from 1 August of the year after hatching to the following 31 July. The "year" of recovery spans two calendar years (August to July), and so gulls recovered between 1 August 1970 and 31 July 1971 are recorded as having died in 1970. "Adult" survival-rate estimates include second-year recoveries.

3:2.3 Survival-rate estimates

The oldest British Black-headed Gulls were recovered in their 22nd year of life, and so recovery data are assumed to be complete for birds ringed up to and including 1960. The recoveries of Black-headed Gulls ringed from 1961 onwards are incomplete, so Haldane's method (1955) has been used to estimate survival-rates and the joint method has been used where both complete and incomplete data are available. Year-specific survival-rates, i.e. the proportion of birds dying out of the total number at risk in any given year, have been estimated (for method see Aebischer (in press)). To estimate survival-rates by region, recoveries have been divided according to the place of ringing, since British Black-headed Gulls do not generally move more than a few hundred kilometres from their natal areas in winter (Flegg & Cox 1972), and show a high degree of return in summer.

3:2.4 Index of weather severity

Five representative meteorological stations were chosen: Bath (southwest), Kew (southeast), Sutton Bonnington (midlands), Morecambe (northwest) and Acclington (northeast). In cases where data were missing, data from the nearest alternative station were substituted. For each year from 1949-1978 (August-July), the number of days when snow lay was averaged between the stations to give an index of weather severity.

3:2.5 Comparison of survival-rates of aluminium-ringed and monel-ringed Black-headed Gulls

The joint method was used to estimate average annual survival-rates for aluminium-ringed and monel-ringed Black-headed Gulls over a period for which substantial numbers of recoveries of both types of ring were available (1957-65) (Table 3:1). The estimated annual adult survival-rates of aluminium-ringed gulls (80.3±0.8%) and monel-ringed gulls (82.3±1.2%) were not significantly different (t=1.39), and it is concluded that on Black-headed Gulls, aluminium and monel rings are equally effective in producing recoveries.

As the ring wears, the legibility of the inscription deteriorates, sometimes before the ring itself drops off the bird. The rate of wear of aluminium and monel rings has been compared, using samples of 30 aluminium

Table 3:1

Recoveries up to July 1982 of second-year and older Black-headed Gulls which were ringed as chicks from 1957-65 inclusive with a) aluminium rings and b) Monel rings, and survival-rates (± 1 s.e.) estimated using Haldane's (1955) method.

a) Aluminium rings

Year	Total	Year of life at recovery																				
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1957	117	25	15	10	18	17	4	10	4	2	3	1	2	0	1	2	0	1	0	0	1	1
1958	88	21	13	10	15	5	2	4	2	4	3	4	1	2	0	1	1	0	0	0	0	0
1959	51	5	9	12	5	4	1	2	4	0	1	2	0	1	0	0	0	2	0	0	2	1
1960	60	12	11	3	7	4	4	7	1	1	3	3	3	0	0	0	1	0	0	0	0	0
1961	81	21	5	9	6	3	5	8	6	9	2	3	0	0	1	1	2	0	0	0	0	-
1962	35	6	5	7	3	1	3	1	4	0	4	0	1	0	0	0	0	0	0	0	-	-
1963	28	8	2	2	4	5	2	2	1	1	0	1	0	0	0	0	0	0	0	-	-	-
1964	23	4	3	1	3	1	0	1	1	3	2	1	0	1	1	1	0	0	-	-	-	-
1965	25	4	6	2	1	1	1	1	3	3	0	2	1	0	0	0	0	-	-	-	-	-

Total 508

Survival-rate=80.3±0.8%

b) Monel rings

Year	Total	Year of life at recovery																				
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1957	19	2	3	2	3	4	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	3	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	40	20	3	5	2	3	1	1	3	0	0	1	1	0	0	0	0	0	0	0	0	-
1962	47	12	2	2	5	4	3	8	4	2	1	0	0	0	3	0	0	0	0	1	-	-
1963	70	14	4	8	8	1	12	6	2	3	0	3	3	3	0	1	1	1	0	-	-	-
1964	37	5	2	5	0	5	1	5	4	1	2	0	1	1	3	0	2	0	-	-	-	-
1965	92	18	11	11	12	6	7	4	5	5	3	5	1	2	2	0	0	-	-	-	-	-

Total 311

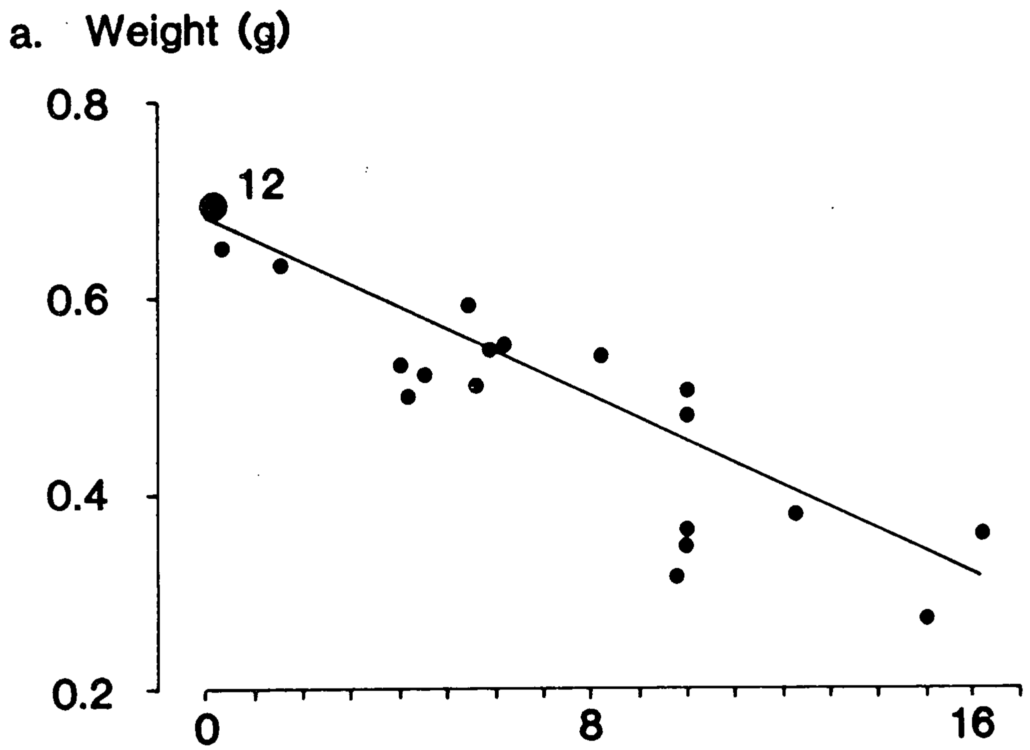
Survival-rate=82.3±1.2%

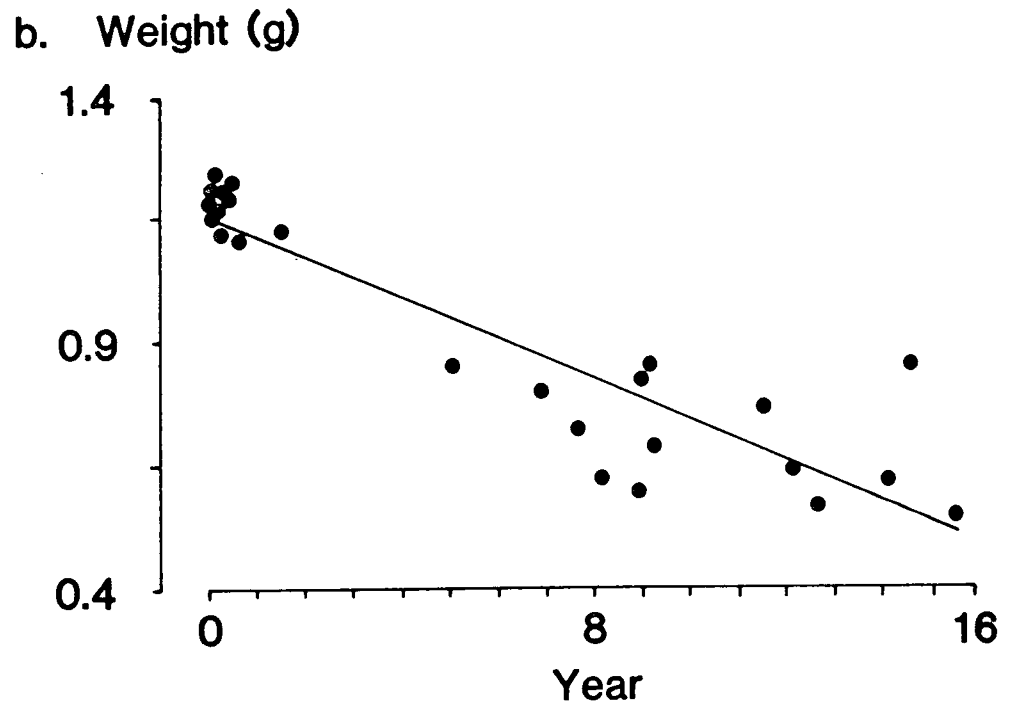
and 25 monel rings, recovered from dead birds after periods varying from a few weeks to 16 years after ringing. The relationship between ring weight and time was linear for both aluminium and monel rings (Fig. 3:1). It is noticable that whilst rings that were recovered after a short period were very similar in weight, variability in weight increased in older rings, suggesting that ring-wear was partly dependent on the activities of individual birds. Although the rate of weight loss is significantly greater for the heavier monel rings, the percentage weight loss per year is almost identical for monel and aluminium ($3.8 \pm 0.29\%$ and $3.5 \pm 0.34\%$ respectively), and it is concluded that monel rings are as likely as aluminium to be rendered illegible or lost before the death of the bird.

Inspection of inscriptions on a sample of rings (nine aluminium and nine monel) which had been on Black-headed Gulls for between one to nine years showed that all were easy to read, although wear had occurred in the older rings, mostly along the bottom margin. Out of a further sample of rings (four aluminium and ten monel) which had been on for ten to sixteen years, 11 were easily read, whilst wear had reduced the legibility of three. All 14 rings were worn to some degree, and it seems unlikely that many could have remained legible had the bird lived to be 20 years old, although the recovery data show that both types of ring may last 20 years or more on this species. Rings returned to the B.T.O. tend to be those which retain the major part of the inscription, whilst those which are unreadable are more likely to be ignored by finders of ringed birds, or may drop off before the bird's death. Further studies are necessary to determine whether any birds outlive the length of life of the rings. If this occurs, survival-rate estimates calculated by conventional methods will be too low. Since no difference in the effectiveness of monel and aluminium rings was found, recoveries of the two have been combined for analysis.

Figure 3:1

The weight (g) of rings recovered at intervals ranging from a few days to 16 years after being put onto Black-headed Gulls. The relationship between time and weight was linear for both a) aluminium rings: r_{28}=-0.94, P<0.001, y=-0.025x+0.685, and b) Monel rings: r_{23}=-0.92, P<0.001, y=-0.041x+1.160. Note different scales in a) and b).





3:3 Results

3:3.1 Survival-rate estimates for adults

Recoveries of Black-headed Gulls ringed from 1949-1960 inclusive are assumed to be complete, and the average annual adult survival-rate for Black-headed Gulls (after the first year of life) was 79.2±0.6% (Table 3:2). A survivorship curve was drawn from the data (Fig. 3:2), and the solid line in Fig. 3:2 represents the theoretical curve obtained if the survival-rate was constant throughout life. However, it is clear that the survival-rate declines in older birds, and a chi-square goodness-of-fit test (Table 3:2) shows that the annual adult survival-rate is not constant with age (chi-square=31.2, 16 d.f., $P<0.05$). Since the deviation from the expected curve in Fig. 3:2 begins around the eleventh year of life, survival-rates have been estimated separately for years 2-10 (82.5±1.2%) and years 11-22 (72.0±2.3%) (Table 3:3), and these estimates are significantly different ($t=4.05$, $P<0.001$). The expected number of recoveries has been estimated for each year of life, and the observed values do not differ significantly from the expected either for years 2-10 (chi-square=11.8, 8 d.f.) or for years 11-22 (chi-square=11.1, 7 d.f.) indicating that the average annual survival-rate for Black-headed Gulls is constant at 82.5% until about the 10th year, after which it abruptly declines to 72.0%. The attribution of such an abrupt change in survival-rates to biological factors is unacceptable. In the light of examination of a sample of rings from dead Black-headed Gulls (see section 3:2.5), it is very likely that loss and wear of rings causes bias in the number of recoveries of older birds, although this does not rule out the possibility of age-dependent survivorship. In the rest of the analysis, it is assumed that survival-rates of birds between

Table 3:2

Complete recoveries by year-of-life of Black-headed Gulls ringed in the British Isles from 1949-60 inclusive, and the expected number of recoveries for each year-of-life assuming a constant annual adult survival-rate of 79.2%.

Year of life	Number alive at start of year	No. of recoveries	Expected number of recoveries	Difference	Chi-square
1	1441	557	-	-	-
2	884	164	183.7	19.7	2.11
3	720	131	145.5	-14.5	1.45
4	589	104	115.3	-11.3	1.11
5	485	114	91.3	22.7	5.64
6	371	85	72.4	12.6	2.19
7	286	50	57.3	-7.3	0.93
8	236	55	45.4	9.6	2.03
9	181	49	36.0	13.0	4.69
10	132	28	28.5	-0.5	0.01
11	104	34	22.6	11.4	5.75
12	70	19	17.9	1.1	0.07
13	51	12	14.2	-2.2	0.34
14	39	9	11.2	-2.2	0.43
15	30	3	8.9	-5.9	3.91
16	27	8	7.0	1.0	0.14
17	19	6	5.6	0.4	0.03
18	13	7 }	4.4 }	0.1	0.00
19	6	1 }	3.5 }		
20	5	0 }	2.8 }		
21	5	3 }	2.2 }	1.7	0.43
22	2	2 }	1.7 }		

The annual rate of survival is not constant with age :

chi-square=31.3 16 d.f. P<0.05

Figure 3:2

The number ($\log_{10}$) of Black-headed Gulls, ringed from 1949-60 inclusive and recovered dead, which were alive at the beginning of each year of life, and the theoretical curve obtained if the estimated average annual survival rate (79.2%) remained constant from the second year of life onwards (data from Table 3:2, column 2).

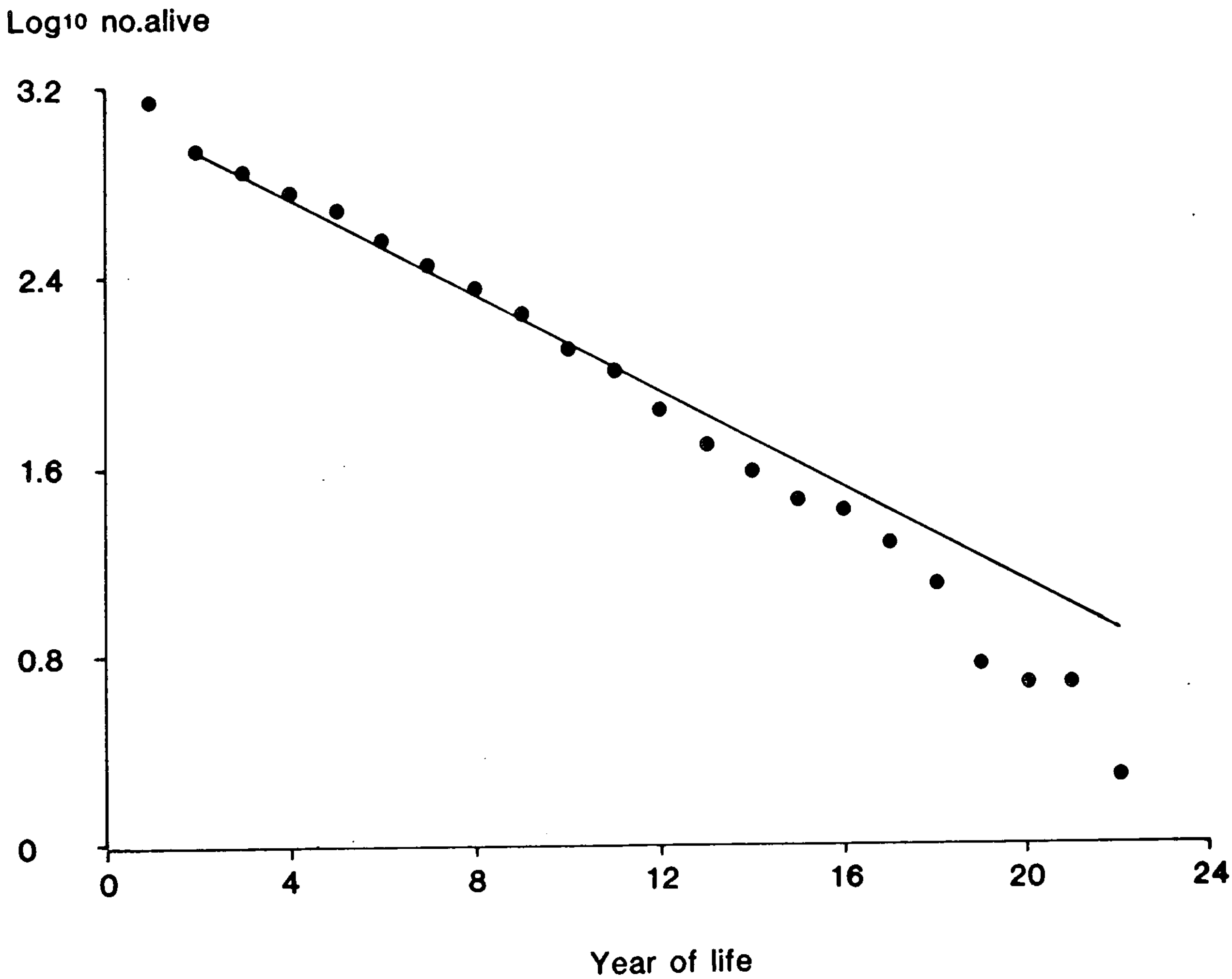


Table 3:3

The observed number of recoveries of Black-headed Gulls by year-of-life compared to the expected number a) recovered between the 2nd and 10th years of life (chi-square=11.9, 8 d.f., n.s.) and b) recovered between the 11th and 22nd years of life (chi-square=11.6, 7 d.f., n.s.), assuming constant annual survival-rates of 82.5% and 72.0% respectively.

a) Survival rate = 82.5% (s.e.=1.2%)

Year of life	Number recovered	Expected number	Difference	Chi-square
2	164	165.8	-1.8	0.02
3	131	136.8	-5.8	0.25
4	104	112.9	-8.9	0.70
5	114	93.1	20.9	4.69
6	85	76.9	8.1	0.85
7	50	63.4	-13.1	2.83
8	55	52.3	2.7	0.14
9	49	43.2	5.8	0.78
10	28	35.6	-7.6	1.62
Total	780			

b) Survival rate = 72.0% (s.e.=2.3%)

Year of life	Number recovered	Expected number	Difference	Chi-square
11	34	29.2	4.8	0.79
12	19	21.0	-2.0	0.19
13	12	15.1	-3.1	0.64
14	9	10.9	-1.9	0.33
15	3	7.8	-4.8	2.95
16	8	5.6	2.4	1.03
17-18	13	7.0	6.0	5.14
19-22	6	5.5	0.5	0.55
Total	104			

the 2nd and 10th years of life are representative of the pattern of survival for each cohort, and survival-rates of the small proportion of individuals over ten years of age are considered no further.

3:3.2 Regional variation in average annual survival-rates

Mean survival-rates (Table 3:4) were estimated for Black-headed Gulls ringed as chicks between 1949 and 1972 (i.e. years for which recoveries were complete to the tenth year of life) in Scotland, Ireland and England and Wales. England and Wales were divided separately into both eastern and western areas (by the line of longitude 1 30' W), and into northern and southern areas. Northern England included: Northumberland, Tyne and Wear, Cleveland, Durham, Humberside, Cumbria, Isle of Man, Lancashire, Cheshire, Merseyside, Greater Manchester and North, South and East Yorkshire. The southern region included all of Wales and the remaining English counties.

Survival-rates of adult Black-headed Gulls (i.e. over one year old) ringed in east England (84.6±1.3%) and west England and Wales (82.4±1.2%) were not significantly different, but the survival-rate of birds ringed in Ireland (77.8±2.8%) was significantly lower than in eastern England. Survival-rates of adults ringed in northern England (82.9±1.2%), southern England and Wales (83.7±1.2%) and Ireland were not significantly different from one another, but survival-rates of Scottish birds (88.9±1.2%) were significantly higher than in any other region (Table 3:4).

Survival-rates of first-year Black-headed Gulls were significantly higher in eastern England (66.5±1.7%) than in either western England and Wales (61.1±1.5%) or Ireland (57.6±3.3%) (Table 3:4). There were no significant differences in survival-rates between Scotland (59.7±3.3%), northern England (61.5±1.7%) and southern England and Wales (65.4±1.7%), but

Table 3:4

Regional differences in the average annual survival-rates (s%) of Black-headed Gulls ringed in the British Isles between 1949 and 1972, and recovered as first-years and as adults between their 2nd and 10th years of life inclusive.

Region of ringing	First-years		Adults	
	N	s% (1 s.e.)	N	s% (1 s.e.)
Scotland	303	59.7 (3.3)	292	88.9 (1.2)
North England	478	61.5 (1.7)	623	82.9 (1.2)
South England & Wales	393	65.4 (1.7)	593	83.7 (1.2)
East England	336	66.6 (1.7)	521	84.6 (1.3)
West England & Wales	535	61.1 (1.5)	695	82.4 (1.2)
Ireland	107	57.6 (3.3)	130	77.8 (2.8)

Significance Tests

Regions compared	First-years		Adults	
	t	P	t	P
E England/ W England & Wales	2.43	<0.05	1.24	n.s.
Scotland/ N England	0.48	n.s.	3.54	<0.001
Scotland/ S England & Wales	1.54	n.s.	3.06	<0.01
Scotland/ Ireland	0.45	n.s.	3.64	<0.001
Ireland/ E England	2.42	<0.05	2.20	<0.05
Ireland/ S England & Wales	2.10	<0.05	1.94	n.s.

Differences between other pairs of regions are not significant.

first-years ringed in Ireland had a significantly lower survival-rate than those from southern England and Wales. There was no significant correlation between regional survival-rates of first-years and older birds.

3:3.3 Year-specific survival-rates of Black-headed Gulls

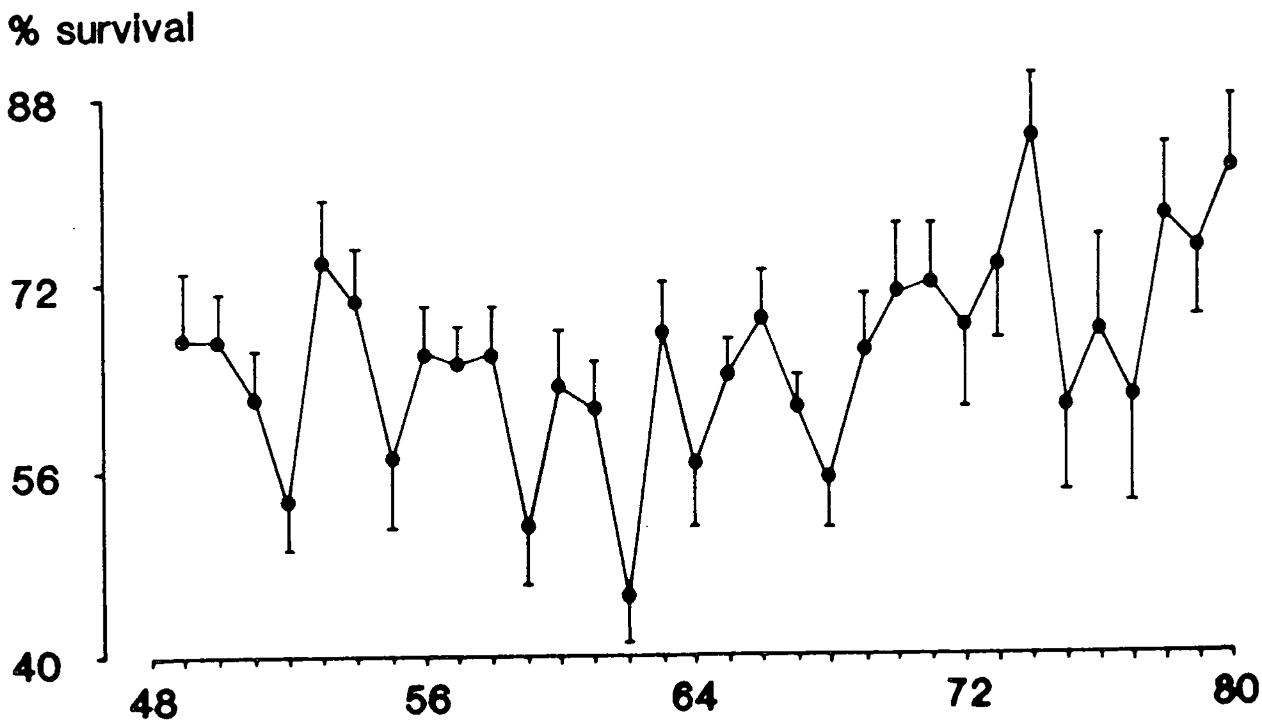
Year-specific survival-rates of 2nd-10th year adult and first-year Black-headed Gulls have been determined for the years 1949-1980 inclusive. (N.b. Owing to the skewed distribution of survival-rates, estimated standard errors are unreliable, probably underestimating the true values.) There are considerable and significant differences in the estimated yearly survival-rates (likelihood ratio tests: chi-square=100, 30 d.f., $P<0.001$, and chi-square=88.7, 31 d.f., $P<0.001$ for adults and first-years respectively), but there is no evidence that survival rates tended to increase or decrease in either first-years or adults over this period (Fig. 3:3). The mean survival-rates for the period 1949-1980 were 84.4±0.4% for adults (2nd to 10th years) and 65.7±0.9% for first-years, and these were significantly different ($t=19.0$, $P<0.001$).

Although there was a significant correlation between weather severity and survival-rate in adult Black-headed Gulls (Fig. 3:4), the significance is due to the unusually low survival-rate in 1962-63 (71.4±2.4%, i.e. mortality 83% higher than average) when the winter was exceptionally hard. There was no significant correlation between weather and first-year survival-rates (Fig. 3:4), although first-years also had an unusually low survival-rate in 1962-63 (45.2±3.8%, i.e. mortality 60% higher than average). Despite a winter nearly as severe as in 1962-63, survival-rates in 1978-79 were relatively high (82.9±2.9% and 77.8±6.3% for adults and first-years respectively), suggesting that Black-headed Gulls can

Figure 3:3

Estimated year-specific survival-rates of a) first-year and b) 2nd-10th year Black-headed Gulls (ringed from 1949-80) which were alive at the start of each year from 1949-80. Note different scales in a) and b).

a.



b.

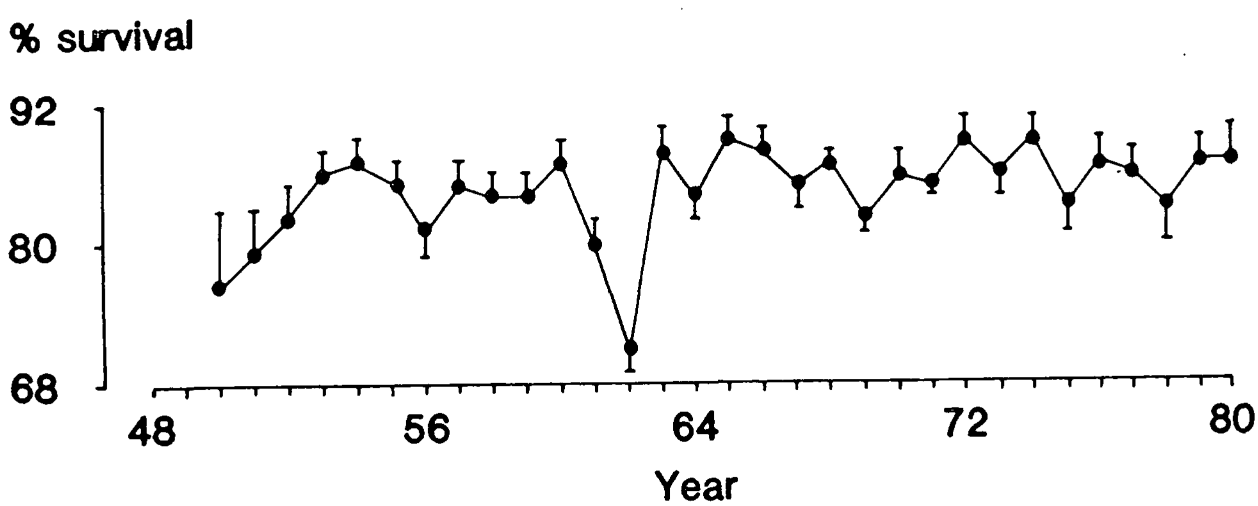
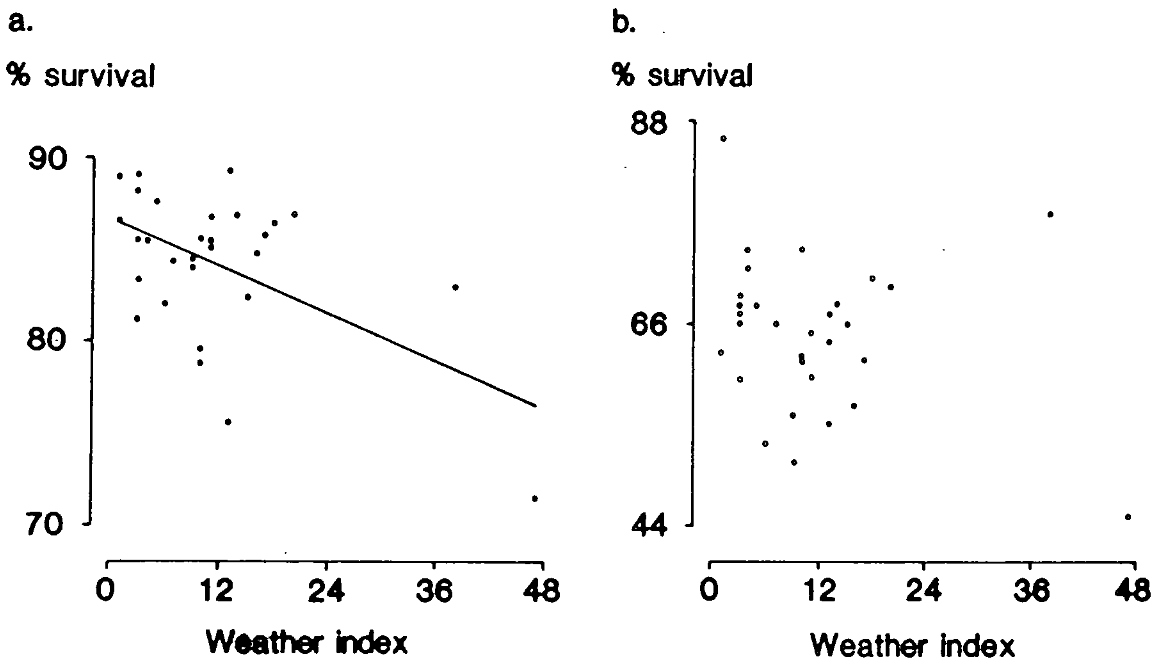


Figure 3:4

The correlation between year-specific survival-rates of Black-headed Gulls and the index of weather severity for that year: a) 2nd-10th years (r_{27}=-0.534, P<0.01), and b) 1st years (r_{28}=-0.269 n.s.). Note different scales in a) and b).



successfully cope with all but the most unusually severe weather.

3:3.4 Month of recovery

There is considerable seasonal variation in numbers of Black-headed Gulls recovered, and the changes in monthly proportions of recoveries have been compared for birds belonging to different age-classes. Both adults and second-years were recovered in the greatest proportions during the main breeding months (May and June), with a smaller winter peak of recoveries in February and January respectively (Table 3:5). The monthly proportions of recoveries of young adults (3rd to 10th year) and older adults (11th to 22nd year) were not significantly different (chi-square=6.0, 11 d.f.) (Table 3:5a), so all adult recoveries were pooled for comparison with second years (Table 3:5b). Overall, the monthly patterns of adult and second-year recoveries were not significantly different (chi-square=16.0, 11 d.f.), but during one month alone (July) there was a significant difference in the proportion of adults (11.8%) and second-years (6.5%) recovered (chi-square=9.37, 1 d.f., P<0.01). Not all second-summer Black-headed Gulls breed, and since non-breeders avoid some of the stresses associated with breeding (e.g. defence of territory, chick-rearing), this may account for the unexpectedly low percentage of recoveries at the end of the breeding season in July.

The survival-rate of first-year Black-headed Gulls is markedly lower than that of adults for the first few months after fledging, but usually increases to the level of adults by the first January of life (Lack 1943). Assuming that adult and second-year survival-rates are similar, the month in which first-year survival-rates become comparable to those of older birds was found by examining the monthly proportions of recovered first-year and

Table 3:5

Number and percentage of recoveries, by month, of Black-headed Gulls belonging to different age-classes: a) young (3rd-10th year) and old adults (11th-22nd year) and b) second-years and adults (3rd-22nd year).

a)

Month	Young adults: Number of recoveries	%	Old adults: Number of recoveries	%
Aug	132	9.5	19	9.0
Sep	92	6.6	19	9.0
Oct	66	4.8	12	5.7
Nov	70	5.1	6	2.9
Dec	69	5.0	14	6.7
Jan	89	6.4	13	6.2
Feb	117	8.5	15	7.1
Mar	81	5.9	14	6.7
Apr	117	8.5	19	9.0
May	207	15.0	28	13.3
Jun	182	13.2	25	11.9
Jul	162	11.7	26	12.4
Total	1384		210	

Chi-square=6.0 11 d.f. n.s.

b)

Month	Second-years: Number of recoveries	%	Adults: Number of recoveries	%
Aug	50	11.6	151	9.5
Sep	30	7.0	111	7.0
Oct	22	5.1	78	4.9
Nov	23	5.3	76	4.8
Dec	29	6.7	83	5.2
Jan	38	8.8	102	6.4
Feb	32	7.4	132	8.3
Mar	29	6.7	95	6.0
Apr	33	7.7	136	8.5
May	62	14.4	235	14.7
Jun	54	12.6	207	13.0
Jul	28	6.5	188	11.8
Total	430		1594	

Chi-square=16.0 11 d.f. n.s.

second-year Black-headed Gulls in relation to those of older birds (Table 3:6). The proportion of recoveries of first-year to older birds (including second-years) was compared to the proportion of recoveries of second-year to older birds for each month from August to July. First-years made up a significantly higher proportion of recoveries from August to February (except December), indicating that first-year survival-rates were lower than second-year survival-rates over this period. From March to July (except May), proportions of first-year recoveries were not significantly different to those of second-years, indicating that by March the survival-rates of first-years and second-years were comparable. In May, first-years comprised only 13% of recoveries, whilst 21% of recoveries of older birds were second-years. The difference was significant, and since there is no difference in the percentages of second-years and third-year and older adults recovered in May (Table 3:5b), this strongly suggests that first-years survive better than older birds in May.

3:4 Discussion

Monel rings have proved to be no more effective on Black-headed Gulls than aluminium rings, and so despite their use since 1957, ring-wear is still a problem in estimating survival-rates in the long-lived Black-headed Gull. Loss of rings is probably the main cause of the decline in survival-rate estimates after the 10th year of life, although the possibility of an age-related decline, as in the Kittiwake (Coulson & Wooller 1976), cannot be discounted.

The mean survival-rate of adults between the second and tenth years of life from 1949 to 1980 has been estimated at 84.4±0.4%, which is similar to the estimate of 84% for Black-headed Gulls in the Camargue (Lebreton &

Table 3:6

Recoveries by month of a) first-year Black-headed Gulls, expressed as percentages of all recoveries for each month, and b) second-year Black-headed Gulls, expressed as percentages of all second-year and older recoveries for each month. Recoveries of first-year birds during June and July of the year of hatching have been ignored.

Month	Total recoveries	1st-year recoveries	% (1 s.e.)	Total adult & 2nd year recoveries	2nd year recoveries	% (1 s.e.)	t	P
Aug	544	343	63.1 (2.1)	201	50	24.9 (3.1)	10.20	***
Sep	296	155	52.4 (2.9)	141	30	21.3 (3.4)	6.96	***
Oct	208	108	51.9 (3.4)	100	22	22.0 (4.1)	5.55	***
Nov	164	65	39.6 (3.8)	99	23	23.2 (4.2)	2.90	**
Dec	174	62	35.6 (3.6)	112	29	25.9 (4.1)	1.78	n.s.
Jan	236	96	40.7 (3.2)	140	38	27.1 (3.8)	2.74	**
Feb	244	80	32.8 (3.0)	164	32	19.5 (3.1)	3.08	**
Mar	173	49	28.3 (3.4)	124	29	23.4 (3.8)	0.96	n.s.
Apr	212	43	20.3 (2.8)	169	33	19.5 (3.0)	0.19	n.s.
May	341	44	12.9 (1.8)	297	62	20.9 (2.4)	2.67	**
Jun	313	52	16.6 (2.1)	261	54	20.7 (2.5)	1.26	n.s.
Jul	261	45	17.2 (2.3)	216	28	13.0 (2.3)	1.29	n.s.

** $P < 0.01$

*** $P < 0.001$

Isenmann 1976). The estimate given in Flegg & Cox (1975) for the first five years of reproductive life (76%) was for birds ringed between 1908 and 1972, and may reflect a lower survival-rate in birds ringed before 1949. The average post-fledging first-year survival-rate from 1949 to 1980 has been estimated at 65.7$\pm$0.9%, nearly twice that estimated by Lebreton & Isenmann (35% up to 31 May in the year after fledging). This low estimate for the Camargue birds was probably due to the inclusion of chicks found dead in the colony, and is thus a combined estimate of pre-fledging and post-fledging survival. Flegg & Cox's estimate of 62% was for the period from fledging to 31 December. Using the formula: mean age=2-mortality rate/2 x mortality rate, the mean age of adult birds is 5.9 years, if the adult survival rate is constant at 84.4%.

There was little regional variation in adult survival-rates, although Scottish-ringed adults had a significantly higher survival-rate than those ringed elsewhere in the British Isles. First-year survival-rates were significantly lower in west England and Wales than in east England, and those in Ireland were lower still, suggesting that survival-rates of first-year Black-headed Gulls may increase from west to east in Britain. There was no indication that variations in adult and first-year survival-rates were consistent between regions.

Comparing the proportions of adult birds dying each month, older birds (over 10 years of age) do not differ significantly from younger birds (2nd to 10th year). The proportions of second-year Black-headed Gulls recovered each month are similar to those of adults, except in July when fewer second-years are recovered than expected. This may be associated with the proportion of non-breeding second-years (50% in the Camargue (Lebreton & Isenmann 1976)) which have avoided the stresses of breeding. The first-year survival-rates gradually increase from the time of fledging until March of the following year, when they become comparable with those of older birds, and even become greater than those of older birds in May.

The greatest proportion of deaths occur during the breeding season in adults, and during the post-fledging period in first-years. The severity of winter weather had little effect on the survival-rates of either adult or first-year Black-headed Gulls, except during the unusually cold winter of 1962-63. Clearly, Black-headed Gulls have little difficulty in finding food during cold weather, even when fields are frozen or snow-covered. Although Mudge & Ferns (1982) found that Black-headed Gulls in the Bristol Channel area prefer feeding on fields (71%), with refuse-tips (5%), sewage outfalls (12%) and littoral and inshore areas (12%) of relatively low importance during the winter (October-February), no doubt the proportions at the less favoured feeding sites increase considerably during periods of severe weather. Horton _et al_. (1983) found that numbers of Black-headed Gulls and Common Gulls increased on tips during a severe cold spell. The opportunistic feeding habits of Black-headed Gulls enable them to exploit alternative food sources when severe weather occurs, so this species is well able to withstand a British winter.

Chapter 4 THE TEMPORAL AND GEOGRAPHICAL DISTRIBUTION OF CONTINENTAL BLACK-HEADED GULLS IN THE BRITISH ISLES

4:1 Introduction

Large increases in the number of gulls overwintering in the British Isles have occurred in recent decades, reflecting the increase in European breeding populations (Cramp & Simmons, 1983, Hickling 1954, 1977, Bowes, Lack & Fletcher 1984). Except for Lesser Black-backed Gulls, many of which migrate to Iberia and North Africa to overwinter (Harris 1962a), Larus gulls that breed in the British Isles usually remain there over the winter (Herring Gulls, Harris 1964b; Black-headed Gulls, Flegg & Cox 1972; Great Black-backed Gulls, Harris 1962b; Common Gulls, Radford 1960). Incoming gulls from Continental Europe increase the over-wintering populations, e.g. Great Black-backed Gulls from Norway (Coulson et al. 1984a), Herring Gulls from Arctic Norway (Stanley et al. 1981, Coulson et al. 1984b) and Black-headed Gulls from Scandinavia and the Baltic Sea countries (Horton et al. 1984).

In their analysis of recoveries in Britain of Black-headed Gulls ringed abroad, Horton et al. (1984) found that the great majority of foreign gulls overwintering in the British Isles were from the Netherlands, Finland, the Baltic States of the USSR, Sweden, Denmark, Germany and Norway. They examined the regional distribution in the British Isles of Black-headed Gulls from each Continental country separately and expressed the number of recoveries in each county as a percentage of the total recoveries in the British Isles from that country. However, no correction was made for the area or human population of each county concerned, differences which introduce major difficulties into the interpretation of their results. For example, Yorkshire is about five times larger than County Durham and has appreciably more recoveries. They showed that recoveries of Black-headed Gulls ringed on the Continent were mainly concentrated in southeast England. The exceptions were those from Norway, which were mainly recovered in northern England, and those ringed in Iceland, which were recovered only in Ireland, northern Scotland and the Orkney and Shetland Isles. (Since their study there have been two recoveries of Icelandic-ringed birds in southern England).

There have been few recoveries abroad of Black-headed Gulls ringed in the British Isles as chicks (ca. 2% of recoveries), and most of these were first-year and second-year birds overwintering in France and Iberia (Radford 1962). The dispersal of British Black-headed Gulls within the British Isles has been analysed by Flegg & Cox (1972). The directional component of dispersing adult and first winter birds was not usually marked and varied according to region, but there was an overall trend to move inland. On average, the birds were furthest from their natal colonies by October and did not show clear evidence of a return until March. Most adult birds moved less than 200 km, but on average first-year and second-year birds moved about twice this distance. This dispersion is sufficient to ensure that British-ringed Black-headed Gulls spread into regions where few chicks have been ringed.

In this chapter, the distribution of Continental Black-headed Gulls in the British Isles is interpreted by examining the proportion of all winter recoveries in each region that was made up of birds ringed on the Continent. This method is unaffected by differences in the size or human population of each region and gives a somewhat different picture of the distribution of Continental Black-headed Gulls to that reported by Horton et al. (1984). In addition, we use the timing of recoveries of Continental-ringed birds to draw conclusions about the times of their arrival and departure.

4:2 Methods

Details of all Black-headed Gulls ringed as chicks, both in the British Isles and abroad, and recovered dead in the British Isles up to and including July 1982, were used. A few recoveries were excluded because the birds were long dead, or other inaccuracies were present in the data. The analysis is based on the recoveries in the British Isles of 3468 British and 3976 Continental Black-headed Gulls which were ringed as chicks. The few recoveries of birds ringed in Iceland were not considered. A sample of Black-headed Gulls ringed in the British Isles as adults during the winter, and recovered either alive or dead, was used in the section on the timing of the spring departure. Recoveries of first-year, second-year and adult birds were considered separately, taking the first year of life to be from hatching to 30 June of the following year.

The monthly pattern of arrival from the Continent was considered for Black-headed Gulls from 10 countries or groups of countries. Since there were less than 20 recoveries each from birds ringed in France, Switzerland, Austria and the USSR (excluding the Baltic States), these areas were excluded from this part of the analysis. There were less than 50 recoveries each from Belgium and Lithuania, so these countries were grouped with the Netherlands and Poland respectively. Starting from 1 July, the date by which the first 25% of recoveries in the British Isles from each country occurred has been used as a comparative index of the time of arrival of birds from that country. The distance between the centres of chick-ringing in each Continental country and the overwintering area in the British Isles has been measured.

Mainland Britain has been divided into nine regions. They consist of three pairs of adjacent eastern and western regions, and because of the greater east-west width of southern England and south Wales, this area has been divided into three regions (Fig. 4:1). Ireland has been treated as a single region because of the relatively small number of recoveries there. These groups of regions have been used to compare the relative proportions of Continental and British Black-headed Gulls on an east-west axis. The proportion in Ireland has been compared with regions C, E and G combined, which cover the same latitudinal range. Similarly, adjacent regions have been used to examine the proportions of Continental and British Black-headed Gulls on a north-south axis. The use of adjacent regions reduces any possible errors arising from variation in the winter distribution of ringed British Black-headed Gulls. The numbers of ringed Continental gulls recovered in the British Isles are, of course, influenced by the extent of ringing abroad. The proportions of recoveries in the British Isles of birds originating from different countries do not necessarily indicate the true proportions of wintering birds from those countries.

4:3 Results

4:3.1 Monthly variations in the proportions of Continental Black-headed Gulls in the recoveries reported in the British Isles

The number of recoveries each month of Continental Black-headed Gulls in the British Isles has been expressed as a percentage of the total number of recoveries (Continental and British) for each month (Fig. 4:2). The percentage of adult Black-headed Gulls from the Continent gradually increased from July (41%) to November (69%), then remained stable until

Figure 4:1

Division of the British Isles into 10 regions, A-K, and the percentage of recoveries which were of Continental origin found in each. The differences between adjacent regions were all significant (P<0.01), except those between A and C and between H and J; the difference between Ireland (K) and the combined figure for C, E, and G was also highly significant (P<0.001). Sample sizes were: A 115, B 198, C 264, D 236, E 646, F 367, G 372, H 971, J 1060 and K 381.

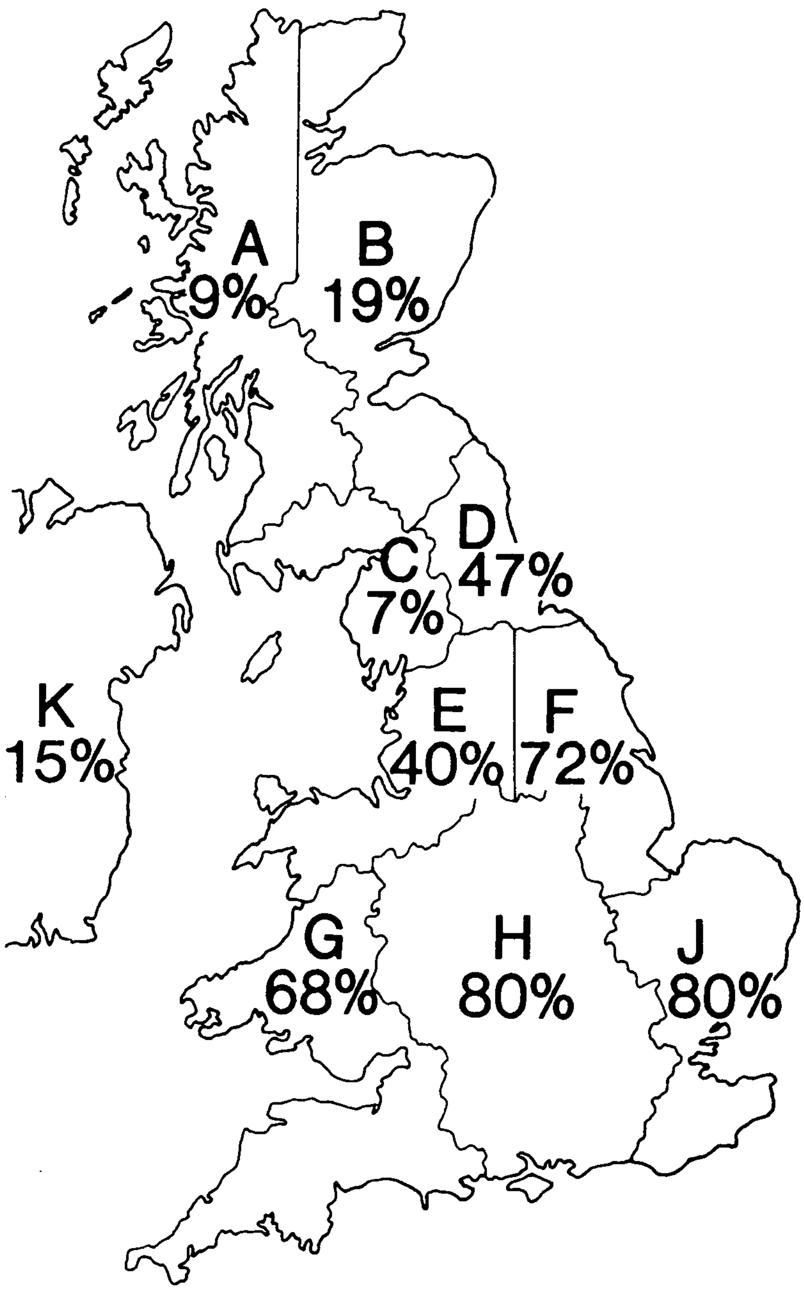
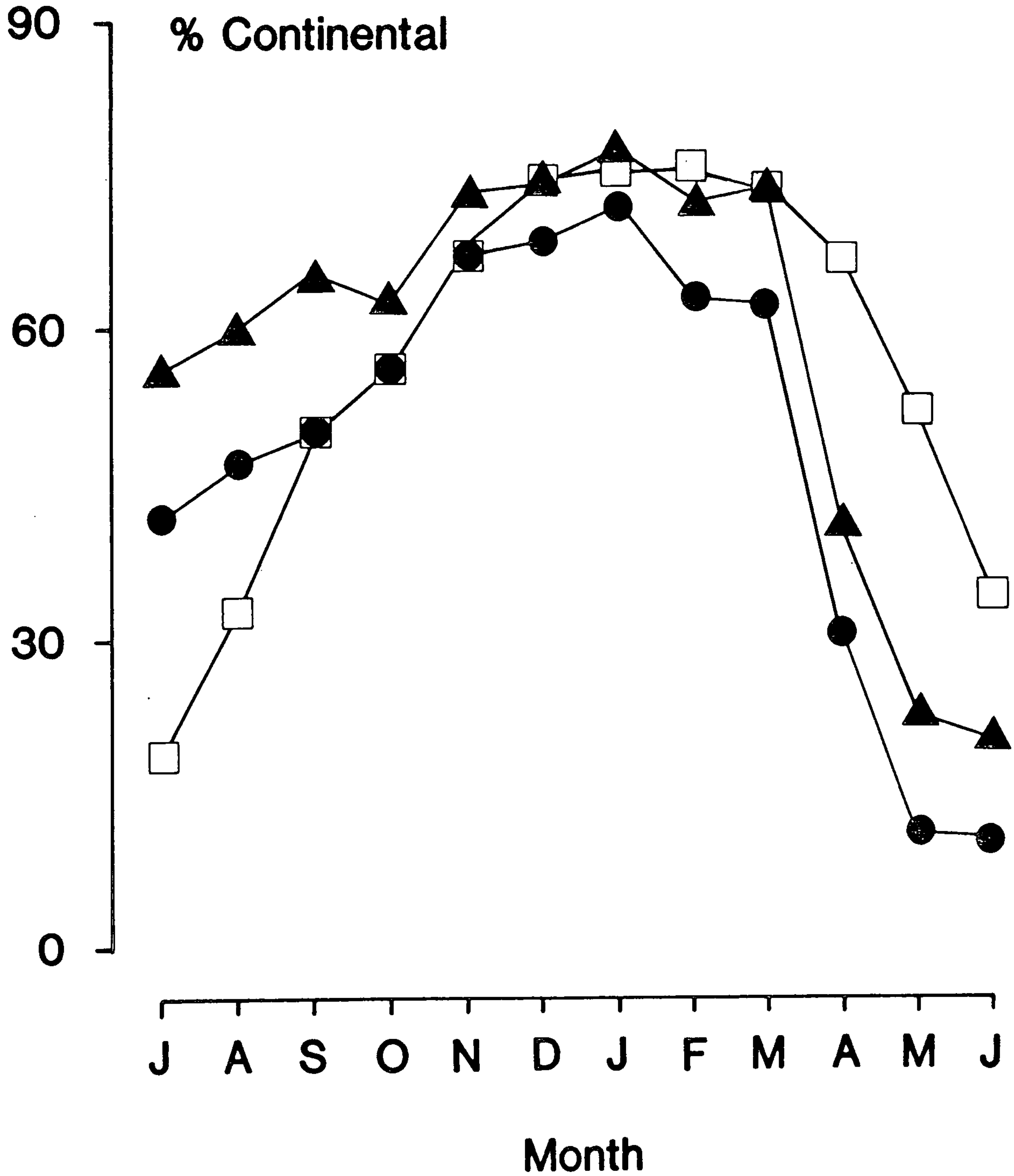


Figure 4:2

Percentage of recoveries of first-year, second-year and adult Black-headed Gulls in the British Isles each month which were of Continental origin. First-years shown by □ , second-years by ▲ , and adults by ●.



March and then declined to 31% in April. As the birds left for their natal areas, the percentage of Continental adults further declined to 11% in May and 10% in June, then increased abruptly in July indicating the start of the post-breeding migration of Black-headed Gulls back to the British Isles. A similar pattern occurred in second-years, with the percentage of Continental birds stable from November to March. The percentage of first-year Black-headed Gulls from the Continent increased each month from July (19%) until December (75%), and then remained stable from December to March (74%). The period during which the numbers of Continental birds present in the British Isles is assumed to remain unchanged thus begins a month later in first-years than in adults and second-years. The percentage of Continental birds began to decline in March in all age-groups, but inspection of Fig. 4:2 shows that the decline in the percentage of recoveries of Continental birds was less rapid for first-years than for older birds.

Taking December-February as representative of the period when Continental Black-headed Gulls are all present in the British Isles, the ratio:

Number of recoveries occurring from December to February /

Number of recoveries occurring in month X

(where month x is any month under consideration) is expected to be the same for Continental and British birds if all Continental and British birds remained in the British Isles throughout the year. It reflects both the variation in mortality that may occur between months, and any difference in the probability of recovery in winter and summer. Application of this relationship predicts the expected number of recoveries of Continental birds each month if none of those present from December to February left the British Isles to breed. For each month, the actual number of recoveries reported has been expressed as a percentage of this expected number

(Fig. 4:3), thus estimating the proportion of the December-February numbers of Continental birds present in other months.

4:3.2 Continental Black-headed Gulls recovered in the British Isles during the breeding season (May-June)

Using the method given above, it is estimated that 5.7±0.8% of the overwintering adult Continental Black-headed Gulls and 8.9±1.5% of second-years remain in the British Isles during May and June (average for the two months). The difference between adults and second-years is not significant. Significantly greater percentages ($P<0.001$) of first-year than older Black-headed Gulls still remain in May (36±4.2) and in June (17±3.0%). The percentage of recoveries that occurred in May and June out of the total number of recoveries in the British Isles of birds ringed in 10 areas of Continental Europe (all ages pooled) varied from 2.2% to 5.1%, but none of the differences were significant (Table 4:1); foreign Black-headed Gulls which summer in the British Isles are not predominantly from any particular area of Europe within the normal breeding range of Black-headed Gulls which winter here.

4:3.3 Arrival of Continental Black-headed Gulls into the British Isles

The first arrivals of newly fledged Black-headed Gulls from the Continent begin in July (except for one recovery of a Dutch first-year in June), mostly from the Netherlands and Belgium. By the end of July, 8% of the ultimate overwintering population have arrived (Fig. 4:3). Arrivals of first-years continue each month, with especially large increases from October to November (29%) and November to December (29%). There are

Figure 4:3

The number of Black-headed Gulls ringed on the Continent and recovered in the British Isles each month, expressed as percentages of the expected number for each month had all Continental birds remained in the British Isles throughout the year. First-years shown by □, second-years by ▲ and adults by ● .

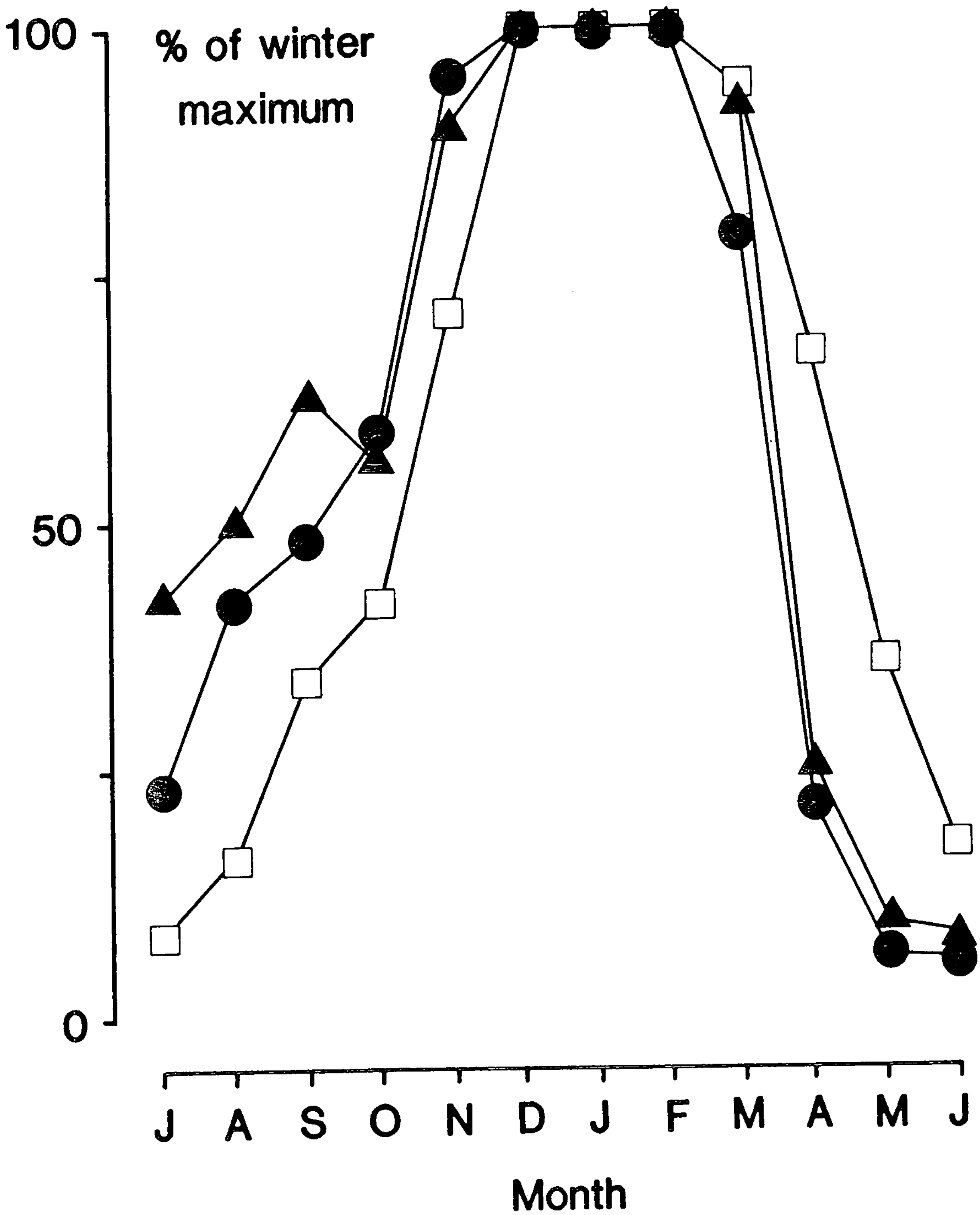


Table 4:1

The percentages of Black-headed Gulls ringed as chicks in 10 areas of Continental Europe and recovered in the British Isles during May and June (all age classes pooled).

Natal area	Total recoveries	Recoveries in May & June	Percentage
Netherlands/Belgium	684	28	4.1
Denmark	456	18	3.9
Germany	356	13	3.7
Czechoslovakia	114	4	3.5
Poland/Lithuania	276	6	2.2
Latvia	222	8	3.6
Estonia	294	13	4.4
Finland	711	29	4.1
Sweden	373	19	5.1
Norway	436	21	4.8
Total	3931	159	4.0

There is no significant difference between the percentages:

chi-square = 4.7, 9 d.f.

significantly higher percentages of both adults and second-years than first-years present each month from July to November.

In the previous section, we showed that 17% of the overwintering first-years were still present in June. By the end of July this had increased to 42% (the birds having changed age-class to become second-years on 1 July). The increase of 25% of second-year birds between June and July is comparable with the 18% increase in the adults over the same two months. Adults and second-years increase at similar rates from July to November, both age classes having practically reached maximum numbers by the latter month (95% and 90% present respectively). Significantly higher proportions of both adults and second-years are present compared to first-years in each month from July to November ($P<0.001$), with the exception of October for second-year birds. Thus first-years arrive later than older birds, and complete their period of arrival about a month later.

Comparative indices of arrival time, shown by the date by which the first 25% of recoveries of birds from each Continental region occurred are shown in Table 4:2. Although there was considerable variation between countries, adults showed no significant relationship between the distance moved from the natal colony to the British Isles and the index of arrival time. However both first-years and second-years arrived earlier from near than from distant countries. For every increment of 100 km, first-years took 5.8 ± 1.4 days longer to arrive in the British Isles and second-years 4.3 ± 1.0 days, values which do not differ significantly.

First-year Black-headed Gulls have markedly higher mortality rates than older birds in the autumn (Flegg & Cox 1975), so one would expect a higher proportion of first-year recoveries to occur from July to October. For this reason it is not possible to strictly compare the date of arrival of first-years with older birds, although cases where first-years are shown to

Table 4:2

Index of arrival of Black-headed Gulls ringed as chicks in 10 areas of the Continent, measured by the date by which the first 25% of recoveries occur in the British Isles (after 1 July). Note that these dates indicate the order of arrival, not the mean date of arrival.

Natal area	Distance to wintering area (km)	Recovered as: Adults		Second-years		First-years	
		Total recoveries	Date of first 25%	Total recoveries	Date of first 25%	Total recoveries	Date of first 25%
Belgium/Netherlands	300	279	16 Sep	103	23 Aug	302	18 Aug
East & West Germany	680	150	5 Nov	57	3 Oct	149	7 Oct
Denmark	740	187	18 Oct	80	6 Oct	198	12 Oct
Norway	900	149	6 Oct	95	14 Sep	192	27 Sep
Czechoslovakia	980	48	20 Nov	19	*	47	16 Sep
Sweden	1080	167	28 Nov	73	24 Sep	133	30 Oct
Poland/Lithuania	1360	111	26 Aug	51	6 Oct	114	21 Sep
Latvia	1600	108	24 Oct	35	28 Oct	79	17 Nov
Estonia	1600	108	19 Oct	63	13 Nov	123	20 Nov
Finland	1720	231	28 Sep	141	4 Nov	339	1 Dec

* Sample size too small for a meaningful estimate.

Correlations between arrival times are non-significant for adults and second-years (r_7=0.14) and for adults and first-years (r_8=0.27) but significant for first-years and second-years (r_7=0.89, $P<0.001$).

arrive later are probably genuine since this would be in the opposite direction to the bias. First-years arrive later than adults from the four areas furthest from the British Isles (Table 4:2). Similarly, second-years from the four furthest areas arrive later than the adults, and this comparison is not biassed by differences in mortality rates. The indices of arrival of first-year and second-year birds were significantly correlated but neither were correlated with adult indices (Table 4:2). It appears that first-year and second-year birds are behaving similarly to each other but that both are behaving differently to adults.

4:3.4 Time of departure of Continental Black-headed Gulls overwintering in the British Isles

There is little decline in the percentage of first-winter Black-headed Gulls present from February (100%) to March (94%) (Fig. 4:3). Between March and April, 27% of the first-years leave the British Isles, and numbers continue to decline throughout the spring and summer with 36% of the overwintering population still present during May and 17% during June. This gradual decline from March to June occurs only in first-years. Numbers of second-year birds decline rapidly from March (92%) to April (25%) followed by a further decline in May to 8%. Between the period of stability in numbers (December-February) and March, 21% of the overwintering population of adult Continental Black-headed Gulls leave the British Isles. Another 58% of the adults have left by the end of April, and a smaller percentage (15%) leaves between April and May. First-year birds leave the British Isles from March until June, but there is an abrupt departure of older Black-headed Gulls between late March and the end of April.

Evidence of the time of departure of Black-headed Gulls to different areas of the Continent can be obtained in two ways. The first is from the decline in the numbers of recoveries of Continental-ringed birds recovered in the British Isles in each month when the departure is likely to occur. The second is from recoveries abroad of Black-headed Gulls which were ringed in winter in the British Isles.

Detailed examination of the recoveries in the British Isles of Continental Black-headed Gulls shows that there is some variation in the time of departure according to the natal area. Significantly fewer Black-headed Gulls breeding in Germany and Denmark are recovered in the British Isles in April than those from other Continental countries, including the closer Low Countries and the eastern Baltic countries (Table 4:3). These results suggest that most German and Danish birds leave in the first few days of April, the other Continental birds leaving, perhaps, a week later.

Confirmation of these conclusions comes from the examination of the dates of recovery of adult birds ringed in Britain in winter and recovered abroad during the same winter or in the following spring and summer (Table 4:4). We have used a sample of 174 recoveries in natal areas B and C (described in Table 4:3; Belgium and the Netherlands were excluded as only 9 recoveries were available). Apart from one in Denmark in January, all of the recoveries occurred after February. Recoveries in area B were significantly higher in March than in area C ($P<0.001$), confirming the earlier departure from Britain of Danish and German birds. These results suggest that the return to Germany and Denmark is probably slightly earlier than that suggested by the first method, with appreciable numbers leaving the British Isles in late March.

Table 4:3

The number of recoveries of Black-headed Gulls ringed as chicks in 3 areas of Continental Europe and recovered as adults in the British Isles in February, March and April. The number of recoveries in each month is given as a percentage of the total recoveries from each area in the 3 months considered.

Natal area*	Number of recoveries in the British Isles						
	February		March		April		Total
	Number	%	Number	%	Number	%	
A	39	54	18	25	15	21	72
B	52	50	46	45	5	5	103
C	134	50	96	35	40	15	270
Total	225		160		60		445

The difference between the percentages was significant:

chi-square = 13.7 4 d.f. $P<0.01$

* A: Belgium, Netherlands

B: Denmark, Germany

C: Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Czechoslovakia

Table 4:4

The number of second-year or older Black-headed Gulls ringed in the British Isles during the winter (October-March) and recovered abroad during the same winter or in the following spring or summer. The number of recoveries in each time period is given as a percentage of the total recoveries from each area from March to July inclusive.

Area of recovery*	Number of recoveries abroad						
	March**		April		May-July		Total
	Number	%	Number	%	Number	%	
B	11	18	10	17	39	65	60
C	1	1	15	13	98	86	114

The difference between the percentages was significant:

chi-square = 19.9 2 d.f. $P<0.001$

* Areas B and C as in Table 4

** Includes one recovery in Denmark during January.

4:3.5 Regional differences in proportions of British and Continental gulls present between September and February inclusive

It is clear from the patterns in Fig. 4:1, and from the statistical significance of the differences between adjacent regions, that a higher proportion of the Black-headed Gulls wintering in the south and east of the British Isles are of Continental than of British origin, whilst in the north and west there is a higher proportion of British than of Continental birds. In England and Wales together, 71% of recoveries were of Continental Black-headed Gulls.

The actual proportions are dependent upon the relative ringing rates here and on the Continent. However, the wide regional variation (7%-80%) in the proportion of winter recoveries in the British Isles which were of Continental gulls suggests that they are probably reasonable estimates of the true values, since it is only possible for them to range between 0% and 100%.

4:4 Discussion

The arrival in the British Isles of Black-headed Gulls of all age classes from the Continent begins in July. Most of the first-years recovered in July originate from the Low Countries, although recently-fledged birds from Scandinavia, the Baltic and Poland have been recovered in the British Isles before the start of August. Whilst this has been known for some time (e.g. Dementiev & Gladkov 1969, Horton *et al*. 1984), this early movement of Continental Black-headed Gulls is not generally appreciated in the British literature.

The timing of arrival of first and second-year Black-headed Gulls from different areas of Europe is related to the distance travelled which agrees with the findings of Ritter & Fuchs (1980) for Black-headed Gulls overwintering in Switzerland. However, this is not the case with adult birds, whose timing of arrival in the British Isles bears no relation to the distance travelled. Adult Black-headed Gulls arrive earlier than younger birds from Finland, the Baltic States and Poland, i.e. the countries most distant from Britain. One possibility is that some adult birds leave the colonies earlier than second-year and first-year birds, but there is no obvious reason why second-year birds should leave later than adults. Alternatively, the younger birds may break their journey into stages and spend some weeks in areas between the breeding grounds and Britain, but again there is no obvious reason for the difference in behaviour of adult and second-year birds.

Maximum numbers of Continental Black-headed Gulls in the British Isles are probably reached in November, and thereafter their numbers remain relatively stable until the end of March. Recoveries of birds ringed in the British Isles also suggest that few leave before the second half of March. The departure of Black-headed Gulls to Denmark and Germany probably takes place in the second half of March and the peak departure to the rest of Europe in early April. The main departure to each country appears to be synchronised over a few weeks. Thus some Black-headed Gulls breeding on the Continent spend up to 9 months 'wintering' in the British Isles.

Observations made by Prüter (1982) of the passage of Black-headed Gulls through Helgoland from 1976-81 confirm that the spring migration of adults takes place over the period described above. Numbers of Black-headed Gulls passing through Helgoland were high from mid-March to mid-April, and reached a peak during the last days of March. Most of the birds observed during the spring passage were flying due east, suggesting that these birds had come from north England. Prüter also comments that the autumn passage is more protracted than in the spring.

Great Black-backed Gulls overwintering in northeast England originate from Norway and northwest Russia, and like Black-headed Gulls, the arrival of adult birds begins in July, peak numbers being reached early in the autumn (Coulson et al. 1984a). Most of the birds depart during the last two weeks in February, and this abrupt departure is about six weeks earlier than Black-headed Gulls. In contrast, the arrival in southern Scotland and northern England of Herring Gulls from north Norway does not begin until late September and continues until January; departures occur mainly in February (Coulson et al. 1984b). The departure of Common Gulls from Britain appears to be mainly in April (Bourne & Patterson 1962), at a similar time to Black-headed Gulls.

A small proportion of both adult (6%) and second-year (9%) Black-headed Gulls of Continental origin remain in the British Isles during the breeding season (May to June). Some of the recoveries could represent long-dead birds, but such recoveries were excluded from the analysis wherever possible, and there are many records of freshly dead birds. A significantly greater proportion of first-year Black-headed Gulls remain in the British Isles during May (36%) and June (17%) than older birds. Ritter & Fuchs (1980) suggest that all Swiss first-years spent their first summer in the area in which they overwintered, so considerably fewer Continental first-years remain in the British Isles than the Swiss study would predict. It is not known whether most of the adults amongst the Continental birds summering in the British Isles miss breeding, or whether they breed in Britain. It is possible that some of those Continental-ringed first-years which remained in Britain during their first summer join the British breeding population. If so, the immigration is considerable and originates from the whole breeding range of the Black-headed Gulls that winter in the British Isles. Such considerable mixing of breeding sub-populations may be associated with Black-headed Gulls being monotypic, unlike most Larus species (Cramp & Simmons 1983). Establishment of breeding colonies of Black-headed Gulls in the wintering area in Newfoundland (Cramp & Simmons 1983) also supports this idea.

Appreciable numbers of adult, second-year and first-year Black-headed Gulls arrive in the British Isles from the Continent as early as July. Thus many of these adults have spent less than four months away from their 'wintering' area, and many young birds of the year are arriving from the Baltic countries before there has been much dispersal of young reared in the British Isles. These early and rapid movements suggest that many of the birds find the areas bordering the Baltic Sea to be unsuitable during the summer. The most likely reason is food shortage but it is difficult to envisage why invertebrate food should be short during the summer. One advantage of leaving the Baltic is that the birds move into areas of greater tidal range, allowing much more extensive feeding on mudflats. During summer in the British Isles, many Black-headed Gulls feed in pastures on worms and leatherjackets, particularly in the early hours of the day (pers. obs.). Thus a further possibility is that the cooler, wetter oceanic climate in the British Isles makes earthworms more readily available. In the more Continental climate surrounding the Baltic there is more likelihood of worms aestivating.

Horton et al. (1984) considered the distribution of foreign Black-headed Gulls in the British Isles by country of origin, and noted the areas in which the greatest percentage of birds from each country were recovered. They noted that Scandinavian and east Baltic birds had a more pronounced northerly distribution in Britain than birds from other regions of Europe but that Continental birds generally were concentrated south of the Wash. In our study, we have compared the number of recoveries of Continental birds to British birds by region and found that Continental birds were significantly more common in the east and south than in the west and north. A similar effect has been observed in Continental Herring Gulls overwintering in southern Scotland and northern England, few of which penetrate to the west of the area (Coulson et al. 1984b). Whilst agreeing with Horton et al. (1984) that more were present south of the Wash, the proportion of Continental Black-headed Gulls is high in Yorkshire, Humberside and Lincolnshire and appreciable proportions occur in northern England (except Cumbria) though not in Scotland and Ireland.

In this chapter, it was estimated that about 71% of the birds wintering in England and Wales are of Continental origin. This means that of the 1.7 million Black-headed Gulls estimated to be overwintering in England and Wales during January 1983 (Bowes et al. 1984) about 1.2 million were of Continental and 500,000 of British origin. It is possible to estimate the total Black-headed Gull population of England and Wales from the census of breeding pairs in 1973. Gribble (1976) estimated that there were about 100,000 pairs breeding in England and Wales in 1973, representing an average annual increase of 5.2% since 1958, when there were about 46,000 pairs (Gribble 1962). If the population continued to increase at the same rate, the 1983 breeding population would have been 166,000 pairs (332,000 individuals). Assuming that around 20% of the total Black-headed Gull population are immatures and non-breeders (taken from life table, Chapter 3), the total population in 1983 would have been about 415,000 individuals. This figure is reasonably close to the figure of 500,000 British birds estimated here to have been present in January 1983, suggesting that the estimate of 71% Continental birds in England and Wales in winter is acceptable. With a high proportion of Continental birds in England and Wales during the winter (and indeed throughout the non-breeding season July to March), consideration should be given to the possibility that these birds are competitors of the British population. It is possible that competition, occurring at any time during the nine month non-breeding season, has, or could in the future, contribute to the decline of the British population of Black-headed Gulls. The extent of competition between Continental and British Black-headed Gulls in Britain requires detailed investigation.

Chapter 5 WEIGHT VARIATION IN BLACK-HEADED GULLS

5:1 Introduction

Both seasonal and daily cycles of weight change occur in birds. In diurnal birds, body weight is lowest early in the morning before feeding begins, due to the overnight emptying of the gut and depletion of food reserves. Increases in weight during the day are about 5-10% of the early morning minimum weight (King 1972). In temperate regions, seasonal increases in weight occur in winter, and are insurance against possible restrictions in food supply, or weather conditions which preclude feeding (e.g. Dugan et al. 1981). Davidson, Evans & Uttley (1986) found that pectoral muscle size in Dunlin was greater in birds overwintering at cold sites in Britain than at warm sites. Throughout this chapter, the term 'fattening' refers to gains in weight, as increases in carbohydrate and protein cannot be distinguished simply by weighing the birds. This chapter is concerned with seasonal changes in the weights of Black-headed Gulls, sex-related and age-related differences in weight, and with the effects of severe winter weather on weights.

5:2 Methods

Black-headed Gulls were mainly weighed on an electronic balance to the nearest 1g, but some were weighed on a pessola balance to the nearest 5g. Fully grown Black-headed Gulls were trapped and weighed at the following sites between November 1978 and July 1985:

i) Playing fields in Durham City (July-February)

ii) The coast at the mouths of the Rivers Tyne and Tees (July-March)

iii) Refuse tips in County Durham and County Cleveland (July-March)

iv) Colony at Sunbiggin Tarn, Cumbria (June and July)

v) Near the colony at Ravenglass, Cumbria (March)

The birds were divided into three age classes (first-year, second-year and adult), the age class changing on 1 July, and were sexed on their head-and-bill measurements (see Chapter 2). Weather data were supplied from the Durham University Observatory in Durham City, observations all being made at 0900 hours GMT.

5:3 Results

5:3.1 Variation in weight according to time of day

Overnight weight loss is expected to be more pronounced as the period of darkness lengthens, and is likely to be greatest in midwinter. This possibility was investigated by comparing mean weights of Black-headed Gulls caught at dawn and after noon. The mean weights of birds caught at the coast and at refuse tips (i.e. both caught after noon) were compared, but the mean difference was small (5.2g) and did not show a consistent pattern: birds were not consistently heavier at either site. Accordingly, no attempt has been made to correct for the difference (if any) between these two sites. The mean difference in weight between Black-headed Gulls caught late (at the coast and at tips) and early in the day (in fields) has been calculated for each age and sex category in every month (Table 5:1) (cases where the sample size is less than five have been excluded). In each month from July to October, differences in the mean weights of Black-headed Gulls caught early and late in the day were small and all but one were non-significant. Although none of the individual differences in November

Table 5:1

The mean monthly weights (g) (±1 s.e.) of Black-headed Gulls belonging to each age and sex category caught in the afternoon and at dawn, the differences between those caught at either time of day, and the mean monthly differences. Samples of less than 5 were not included. AM = adult male, AF = adult female, 2M = second-year male, 2F = second-year female, 1M = first-year male and 1F = first-year female.

Month	Age & sex	Afternoon N	Afternoon Weight	(s.e.)	Dawn N	Dawn Weight	(s.e.)	Difference	s.e. of difference	t	P
Jul	AM	45	274.0	3.2	28	277.7	5.0	- 3.7	5.9	0.62	n.s.
	AF	80	240.2	2.8	24	231.9	3.1	8.3	4.2	1.98	<0.05
	2M	41	259.6	4.3	22	265.4	3.8	- 5.8	5.7	1.01	n.s.
	2F	39	230.2	4.0	15	225.4	4.3	4.8	5.9	0.82	n.s.
	Mean							1.7	2.6	0.65	n.s.
Aug	AM	13	281.9	6.9	47	280.4	2.7	1.5	7.4	0.20	n.s.
	AF	12	254.8	4.4	20	243.9	4.3	10.9	6.2	1.77	n.s.
	2M	7	282.1	9.3	9	270.7	17.6	11.4	12.0	0.95	n.s.
	Mean							5.8	4.8	1.20	n.s.
Sep	AM	24	274.4	3.2	23	275.8	3.4	- 1.4	4.7	0.30	n.s.
	AF	12	240.2	4.4	14	245.7	3.8	- 5.5	5.8	0.95	n.s.
	2M	14	283.1	6.6	14	288.5	3.9	- 5.4	7.7	0.70	n.s.
	Mean							- 3.6	3.4	1.06	n.s.
Oct	AM	9	283.3	7.1	26	277.6	4.3	5.7	8.3	0.69	n.s.
	1M	7	278.4	4.5	29	271.9	4.2	6.5	6.2	1.02	n.s.
	Mean							6.1	5.2	1.17	n.s.
Nov	AM	69	306.7	2.5	32	298.4	4.9	8.7	5.5	0.96	n.s.
	AF	29	274.7	3.4	10	262.5	5.8	12.2	6.7	1.81	n.s.
	2M	22	303.8	3.8	11	294.3	8.2	9.5	9.0	1.05	n.s.
	2F	6	259.8	5.7	8	275.3	6.8	-15.5	8.9	1.75	n.s.
	1M	37	307.9	4.3	34	302.9	5.1	5.0	6.7	0.75	n.s.
	1F	27	277.9	5.7	22	268.6	3.8	9.3	6.9	1.36	n.s.
	Mean							7.4	3.0	2.47	<0.05
Dec	AM	144	321.5	2.4	19	304.3	5.0	17.2	5.5	3.10	<0.01
	AF	76	286.1	2.1	20	262.4	4.1	23.7	4.6	5.15	<0.001
	2F	20	278.8	5.3	8	260.8	5.3	18.0	7.6	2.40	n.s.
	1M	29	318.8	3.8	25	287.2	4.6	31.6	5.9	5.30	<0.001
	1F	15	276.7	7.1	38	261.5	3.6	15.2	8.0	1.91	n.s.
	Mean							20.8	2.9	7.17	<0.001
Jan	AM	100	312.6	2.9	11	289.8	4.7	22.8	5.5	4.19	<0.001
	1M	21	291.5	7.6	14	291.2	16.6	0.3	10.1	0.03	n.s.
	Mean							16.0	5.2	3.08	<0.01

were significant, the mean difference for that month (7.2±3.2g) was significant ($P<0.05$). The mean differences in December and January were both highly significant, (20.6±3.1g, $P<0.001$ and 17.4±5.8g, $P<0.01$ respectively).

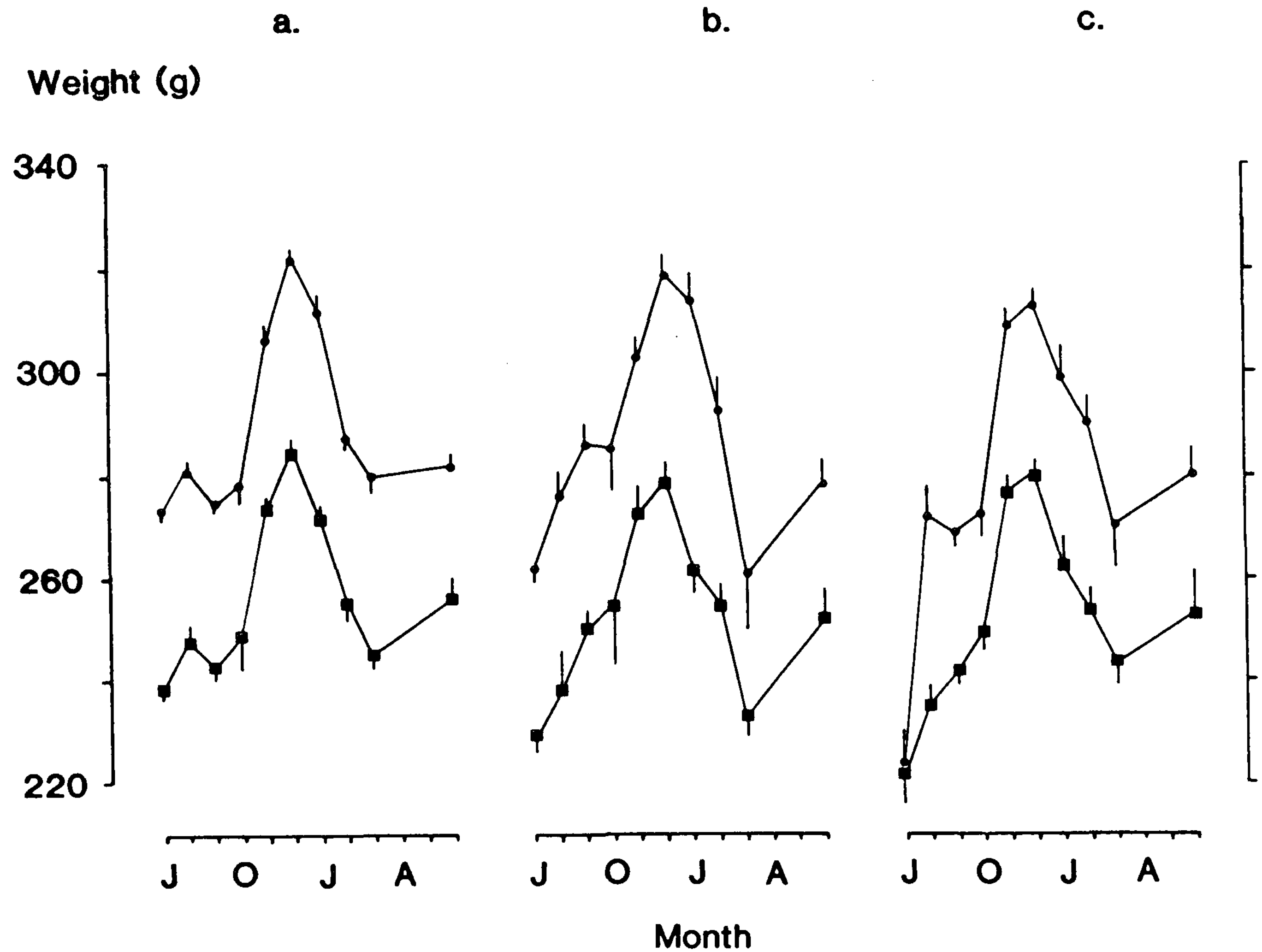
In the following analysis, the weights of Black-headed Gulls trapped at dawn are made comparable with birds caught later in the day by adding 7.2g to November weights. The mean difference between early and late catches in December and January is 19.7g, and this correction value has been added to weights of all Black-headed Gulls caught at dawn from December to February. Although the small sample size of birds caught at dawn prevented the calculation of a mean difference for February, it is reasonable to use the December/January correction factor since daylength is still short in February. No correction was necessary for birds caught at dawn from July to October. These corrections ensure that mean weights are standardised to represent birds which have replenished their food reserves after the overnight fast.

5:3.2 Monthly changes in weight

Black-headed Gulls trapped at all sites (i.e. all refuse tips, coastal sites, playing fields, and the two breeding colonies) were pooled, and mean monthly weights found for male and female adults, second-years and first-years. An analysis of covariance showed that the overall pattern of monthly weight change was not significantly different for males and females in each age-class, but males were invariably heavier than females (Fig. 5:1). In both adult males and females, the mean weight was lowest in July, remaining at a similar level until October (Fig. 5:1). Marked increases in weight occurred in November and December, representing

Figure 5:1

The mean monthly weights (g) (with 1 standard error) of a) adult, b) second-year and c) first-year Black-headed Gulls. Males shown by ● and females by ■ .



increases of 12% and 18% since July in males, and 15% and 20% in females. After the peak in December, weights declined in both males and females, reaching their lowest level in March. No results were obtained for April and May, but by June the birds' weights were slightly higher than in March, significantly so for females ($P<0.05$).

Analysis of covariance showed that second-years followed the adults' pattern of monthly weight change, although second-year females had significantly lower weights than adult females in three out of ten months. The percentage increase in weight from July to November was 16% for males, and 19% for females, and from July to December, increases of 22% occurred in both sexes. These increases were slightly larger than for adult birds. Both male and female second-years had significantly lower weights than adults in July, suggesting that the young birds did not catch up to the mean adult weight until August of the second year of life.

Both first-year males and females were significantly lighter in weight than adults (analysis of covariance, $F=10.3$, 1 and 1067 d.f., $P<0.01$ for males, and $F=8.2$, 1 and 948 d.f., $P<0.01$ for females). The monthly pattern of weight change was significantly different between adult and first-year males (analysis of covariance, $F=2.21$, 9 and 1058 d.f., $P<0.05$), and although the difference between adult and first-year females was not significant, inspection of Fig. 5:1 shows that monthly changes in weight of first-year males and females have similar characteristics. The sample of three first-year males caught in July had extremely low weights but by August had increased by 21%, compared to an increase of 6% in females. There was little difference in patterns of weight change otherwise. There was no significant increase in weight between November and December in either male or female first-years. It seems that first-year Black-headed Gulls ceased to gain weight in December although the older birds continued to gain. The November weights were 38% and 25% higher than the July weights of male and female first-years respectively. There was no appreciable difference in the weights of first-years and adults in June, indicating that first-year weights had caught up with those of adults. The following month, the immature birds' weights had significantly declined relative to those of adults.

5:3.3 Variation in mean monthly weight

Male Black-headed Gulls are always heavier than females, and the weighted mean difference is 34.4±0.9g, males weighing 12-15% more than females. So that mean weights of Black-headed Gulls in individual catches can be compared, the female birds have been made comparable to males by adding a correction factor of 34.4g to all female weights. The mean weights of Black-headed Gulls (i.e. males and corrected females) have been compared by catch for each month (Table 5:2). There is significant variation between catches in every month except September and December, indicating that a further source of variation other than age, sex, time of day and month is involved. This section considers the effects of cold weather, especially frost and snow on the weight of Black-headed Gulls.

During very cold weather, birds use more energy in maintaining body temperature. When the ground is frozen, they cannot feed as successfully as usual in fields, as earthworms descend deeper into the soil. It might be expected that after a period of cold weather, the birds' weights would be below average for the time of year. It is assumed that the birds can recover small weight losses due to severe weather within a few days, and so the effect of the weather during the seven days before the birds were caught is considered.

Table 5:2

The mean weight (g) of adult Black-headed Gulls caught each month (males and corrected females, see text), and the variance attributable to the catch.

Month	Number of catches	Weight	F	d.f.	P
Jul	9	272.8	6.68	8 & 250	<0.001
Aug	8	281.3	3.37	7 & 84	<0.01
Sep	4	276.0	2.07	3 & 69	n.s.
Oct	5	280.4	4.33	5 & 44	<0.01
Nov	10	306.8	2.17	9 & 130	<0.05
Dec	12	321.0	1.82	11 & 247	n.s.
Jan	12	309.1	4.70	11 & 238	<0.001
Feb	8	289.7	5.88	7 & 181	<0.001
Mar	3	279.9	32.74	2 & 110	<0.001

Table 5:3

The mean weight of each catch from November to March of adult Black-headed Gulls (males and corrected females) has been subtracted from the overall mean weight for the appropriate month. A weighted mean difference between catch weight and monthly weight has been found for catches occurring after 0-7 days of frozen ground during the previous week.

Days of frozen ground	0	1	2	3	4	5	6	7
Number of catches	9	6	6	7	6	2	2	5
Mean difference	+1.9	-0.4	+3.7	+2.3	-3.7	-6.9	-3.5	-0.8

From November to March, the number of days which had frozen or snow-covered ground during the seven days prior to each catch is taken as the index of weather severity. The mean weights (corrected to male standard) of adult birds in individual catches are compared with the overall mean weights of adult birds for that month, and a weighted mean difference found for each level of weather severity (Table 5:3). For all indices of weather severity, the mean weight of adult gulls in each catch deviates little from the monthly means, and the overall mean differences range from 6.9g to -3.7g, and there is no trend for birds to weigh less at higher indices. This clearly indicates that the adult Black-headed Gulls caught did not lose weight in cold weather.

5:4 Discussion

Black-headed Gulls reach their peak weight in December, adults having increased their July weights by 18-20%. Adult Herring Gulls maintain a low weight from July to September (921g) and reach their winter peak in November (1000g), an increase of 8% (Coulson et al. 1983c). Unlike Black-headed Gulls, whose weights decline the month after the peak is reached, Herring Gulls maintain a high weight until February, after which there is a progressive decline to the post-breeding low in July. Black-headed Gulls put on proportionately more weight in the autumn than Herring Gulls, but maintain this high winter weight for a shorter time. The difference between the species may be physiological, but is is possible that the larger Herring Gulls are able to exclude Black-headed Gulls partially from the best food sources (e.g. sewage outfalls, pers. obs.). However, there is no evidence that severe weather affects the weights of Black-headed Gulls. Even after extended periods of cold weather, weights are not much below average. It is possible that the heaviest birds survive, whilst thin birds die and are not included in the average weights, but in Chapter 3, it was shown that survival rates of Black-headed Gulls were not affected by severe winters, except in 1962-63. It is clear that Black-headed Gulls are well able to obtain enough food to maintain weight during cold spells.

Chapter 6 AGE AND SEX COMPOSITION OF FLOCKS OF BLACK-HEADED GULLS

6:1 Introduction

In many long-lived species of birds, maturity is delayed so that the age of first breeding varies from two years (e.g. some Grey Herons, Cramp & Simmons 1977) to five years (e.g. Herring Gulls, Coulson *et al.* 1982) or even older (e.g. Fulmars, 6-12 years, Cramp & Simmons 1977). Lack (1968) argued that young birds are often less successful at breeding than older birds (e.g. Kittiwakes, Coulson 1966), as they are less efficient in competing for mates, territory and nesting sites, and especially in finding food for their offspring. The learning of feeding skills may take a number of years to develop and perfect. Adult birds have been shown to be more efficient at obtaining food than immatures in Royal Terns (Buckley & Buckley 1974), Brown Pelicans (Orians 1969), Little Blue Herons (Recher & Recher 1969) and Herring Gulls (Verbeek 1977). There is a progressive increase in feeding efficiency of Herring Gulls from the first to the fourth year of life (Greig *et al.* 1983). Immature birds may adopt different feeding strategies to adults. Young Herring Gulls steal much of their food from conspecifics and other gull species (Verbeek 1977, Greig *et al.* 1983), probably to compensate for their low level of skill at finding their own food. Young Oystercatchers on the Exe estuary avoided the mussel-beds where most adults fed, probably due to competitive exclusion by the dominant adults (Goss-Custard & Durell 1983).

Black-headed Gulls of different ages do not distribute themselves randomly throughout their winter range. Vernon (1970) found that the percentages of first-years in flocks on grassland increased with increasing distance from the coast, and similar results were found by Van de Weghe

(1971) for Black-headed Gulls in Belgium and the Netherlands. The proportions of first-years present may vary according to habitat, even within a small area. Spencer and Welch (1956) noticed that proportionately fewer first-year Black-headed Gulls were present on remote parts of the shore than at a lake in a nearby park, and suggested that first-years were less wary of people than older birds.

In this chapter, the effects of time of year, area and type of site on the age-composition and sex-composition of Black-headed Gull flocks in northeast England are considered, and the distribution of birds of different ages and sexes throughout the study area is related to their feeding ecology.

6:2 Methods

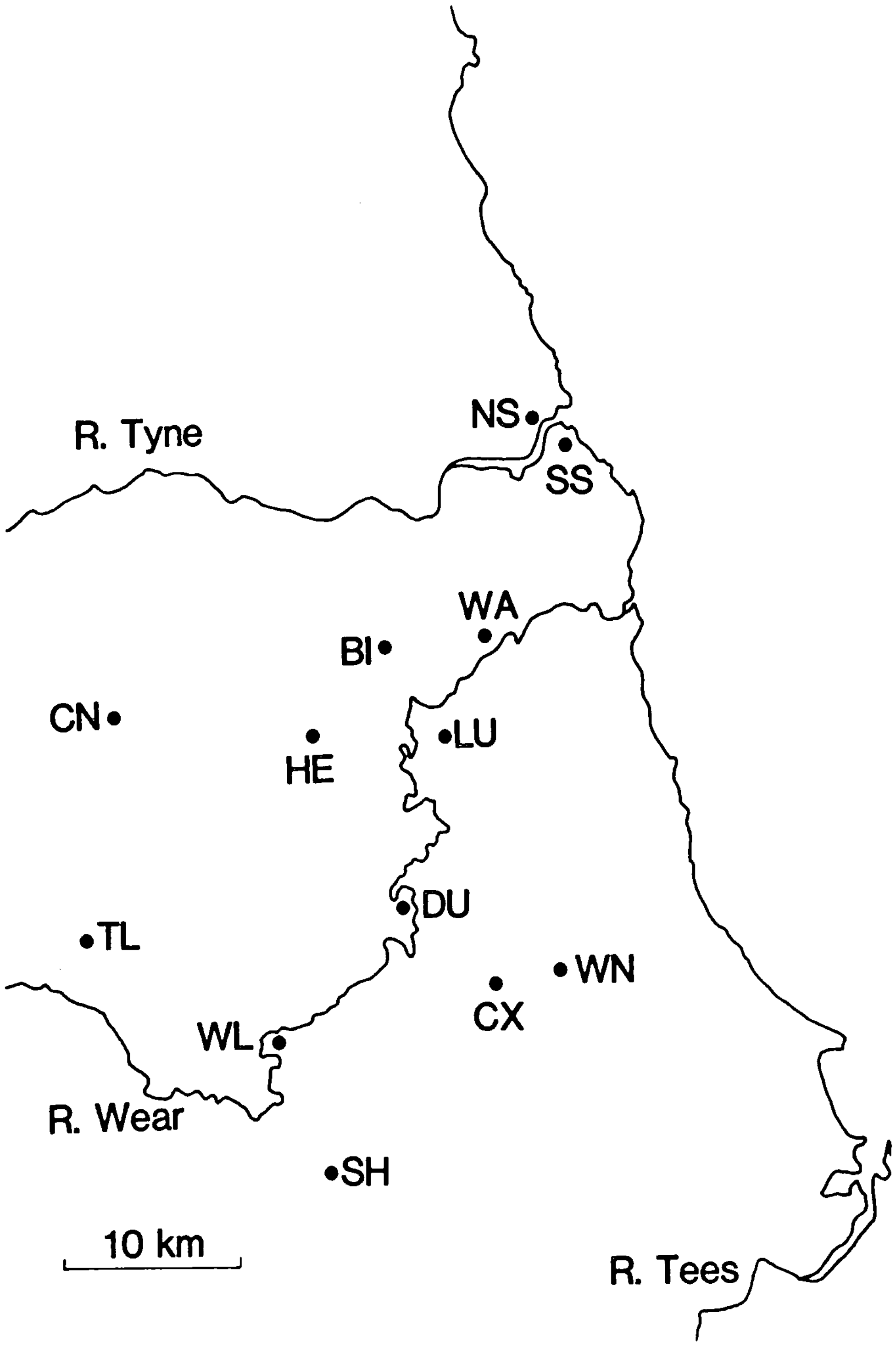
6:2.1 Study sites

Overwintering Black-headed Gulls were caught by cannon-netting between October 1978 and February 1985 at sites in County Durham and Tyne & Wear, and observations on flocks were carried out between November 1982 and February 1985 (Fig. 6:1). These sites were characterised by the types of feeding which occurred at each:

i. Black-headed Gulls were caught at five municipal refuse tips: Consett, Hett Hills, Lumley, Wingate and Coxhoe. Hett Hills closed in the summer of 1983, and nearby Lumley tip was opened to replace it. Observations were carried out at tips at Consett, Lumley, Coxhoe, Shildon, Tow Law, Willington and Birtley (Fig. 6:1). Black-headed Gulls, usually together with Herring and Great Black-backed Gulls, fed on domestic refuse at tips, where three

Figure 6:1

Sites in northeast England where Black-headed Gulls were trapped, and sites where they were regularly observed. BI=Birtley, CN=Consett, CX=Coxhoe, DU=Durham, HE=Hett Hills, LU=Lumley, NS=North Shields, SH=Shildon, SS=South Shields, TL=Tow Law, WA=Washington, WL=Willington, WN=Wingate.



main types of feeding took place (Greig et al. 1985):

a) Undisturbed primary feeding, where gulls fed on piles of freshly dumped refuse, mainly when the tip was closed between 1200h and 1230h. Feeding was competitive, with a high density of gulls present.

b) Disturbed primary feeding, where gulls fed behind the bulldozer as it flattened the piles of refuse. The gulls spent little time on the ground but flew behind the bulldozer, and either dipped or landed briefly for food items.

c) Secondary feeding, where gulls searched for food items on earth-covered refuse. This type of feeding was characterised by the low density of gulls, and its non-competitive nature.

ii. The two main coastal catching sites are at the mouth of the River Tyne (North Shields Fish Quay and South Shields beach), where the following food sources were used:

a) Fish offal and other sewage which is discharged into the bay via sewage pipes at North Shields fish quay, the gulls obtaining pieces of food by either swimming on the water, or by hovering and dipping to the surface to pick up food items while on the wing. This type of feeding is similar to the disturbed primary feeding described at tips.

b) Invertebrates in the mud exposed at low tide.

c) During the summer months, refuse left by visitors to the beach.

d) Invertebrates found on playing fields and grassland close to the shoreline.

Feeding on the three latter food sources does not require the aerial skill needed for feeding on fish offal from the sewer. Observations of marked birds have shown that the same individuals fed at both North and South Shields, and these sites will be referred to collectively as the Tyne site.

Observations have also been carried out on fields within about 5 km of the Tyne site. Additional counts of Black-headed Gulls were made in four areas having similar feeding sites to the Tyne, i.e. muddy beaches with sewage outfalls discharging into the water. These were near the mouths of the Rivers Wear, Tees and Humber, and several sites on the Northumbrian coast from Blyth to Budle Bay collectively made up the fourth area (Fig. 6:2).

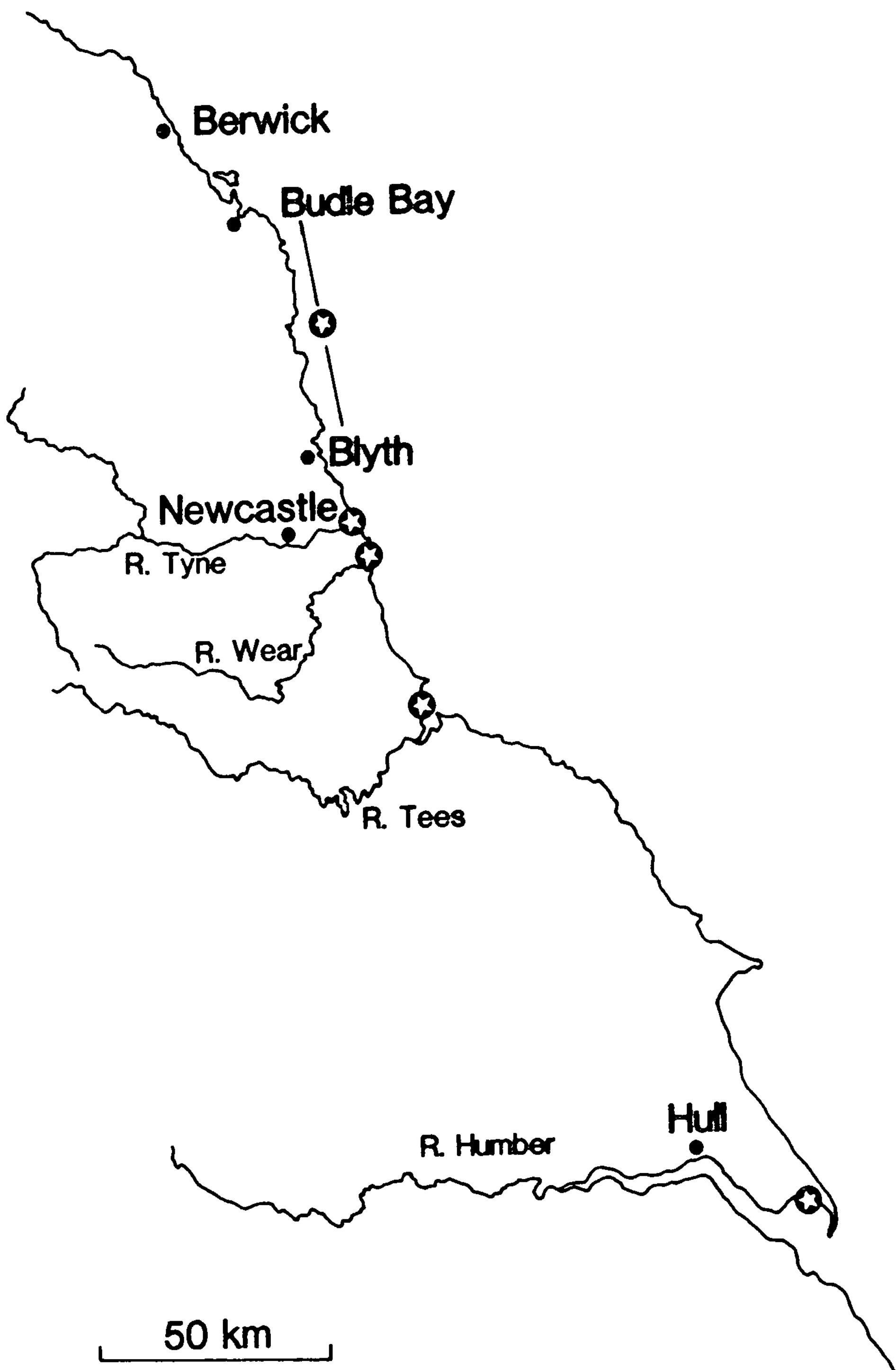
iii. Black-headed Gulls were caught on playing-fields in Durham City, where they fed on earthworms and insects (e.g. tipulid larvae), walking over the ground in dispersed flocks. Competitive interactions were seldom observed. Feeding and resting birds were seen in Durham town centre where they were fed by passers-by, and at a variety of fields in the Durham area.

6:2.2 Determination of the sex-composition and age-composition of flocks of Black-headed Gulls

The sex of Black-headed Gulls can only be determined for captured birds, as they are sexed on head and bill length (see Chapter 2). The age-composition of flocks was estimated either by the proportion of birds of each age in catches, or by direct counts of flocks. Individuals caught at each site were aged as first-year, second-year or adult on plumage and soft part characteristics (see Chapter 2), but second-year Black-headed Gulls are virtually indistinguishable from adults in the field. From November 1982 to April 1985, Black-headed Gull flocks were examined to determine the age-composition. Counts were made at most catching sites, and at many other sites throughout the study area. Data were collected for each month from July to April.

Figure 6:2

Five coastal areas in northeast England ✪ , for which the age-composition of Black-headed Gull flocks was determined.



6:2.3 Feeding rates

In July and August 1985, data were collected comparing the feeding efficiency of first-year Black-headed Gulls, and birds in adult plumage (which included those in their second year). The sites used were:

i. A playing field in Durham, where birds searched for invertebrates on the ground.

ii. A field being ploughed in Durham. Birds landed behind the plough on newly turned soil, searching for invertebrates.

iii. A sewage outlet at the mouth of the River Tyne. Birds sat on the water, and pecked at floating particles which were discharged into the water.

Black-headed Gulls were the main or only species present at each of these sites. A stop watch was set to sound every 12 seconds, and the number of food items swallowed within the next 12 seconds by a randomly chosen bird were counted. The size of food items was not considered.

6:3 Results

6:3.1 Proportions of first-year Black-headed Gulls in catches and in flocks

For the three types of study site, a comparison was made between age-composition of catches, and age-composition of observed flocks (Table 6:1). On Durham playing fields, there was a greater percentage (between 2% and 50%) of first-years in catches than in observed flocks in every month from July to February, and these differences were significant for five months. With data pooled for all months, significantly higher proportions of first-year Black-headed Gulls (about double) were present in

Table 6:1

The differences in the percentages of first-year Black-headed Gulls observed and trapped a) each month on playing fields in Durham, b) during July-November and December-March at the coast, and c) during July-November and December-February at refuse tips, tested for significance using chi-square tests, or Fisher's Exact Probability Test (*).

a) Playing fields

Month	Observed flocks: Total	Observed flocks: First years	Observed flocks: % first years	Caught: Total	Caught: First years	Caught: % first years	Chi-square (1 d.f.)	P
Jul	3424	168	5	98	7	7	0.6	n.s.
Aug	2418	523	22	136	54	40	23.0	<0.001
Sep	2035	645	32	108	41	38	1.6	n.s.
Oct	749	119	16	98	49	50	61.3	<0.001
Nov	1980	485	24	117	56	48	30.3	<0.001
Dec	2336	475	20	114	64	56	15.5	<0.001
Jan	2688	602	22	34	18	53	16.1	<0.001
Feb	1463	244	17	6	4	67	*	0.017
Mar	1527	320	21	-	-	-		
Total	18620	3581	19	711	293	41		

b) Coast

	Observed: Total	Observed: No. 1st-years	Observed: % 1st-years	Caught: Total	Caught: No. 1st-years	Caught: % 1st-years	Chi-square (1 d.f.)	P
Jul-Nov	13471	719	5	113	4	4	0.4	n.s.
Dec-Mar	11081	525	5	409	42	10	24.6	<0.001
Total	24552	1244	5	522	46	9	13.9	<0.001

c) Tips

	Observed: Total	Observed: No. 1st-years	Observed: % 1st-years	Caught: Total	Caught: No. 1st-years	Caught: % 1st-years	Chi-square (1 d.f.)	P
Jul-Nov	6780	739	11	584	144	25	95.1	<0.001
Dec-Mar	5428	1094	20	483	98	20	0.0	n.s.
Total	12208	1833	15	1067	242	23	43.1	<0.001

catches than would be expected from the proportions observed at the same sites ($P<0.001$). At the coast and at tips, data were pooled for July to November, and for December to February, since catches were not made in every month. Twice the proportion of first-years were trapped as observed in flocks at the coast during the second part of the year (December to February) although there was no difference from July to November. At tips, more than twice the proportion of first-years were caught as observed in flocks from July to November ($P<0.001$), but there was no difference from December-February. At all sites, the catchability of first-years was usually greater than that of adults, probably because the birds were baited into the catching area and first-years were more strongly attracted to the easy food source. Obviously the field observations provide a better estimate of age-composition of flocks than catches, and in the rest of the analysis, age-composition is derived from field counts, whilst of necessity sex-composition is taken from catches.

6:3.2 Monthly differences in age-composition of flocks

The age composition of feeding and resting flocks of Black-headed Gulls is given by month for the three main types of feeding area: playing fields (Durham area), refuse tips and the coast (Table 6:2). There were marked differences in the monthly changes in age-composition of flocks between three types of feeding site. At refuse tips, first-year birds made up only 5% of flocks in July, but increased significantly ($P<0.001$) to 10% in August and to 20% in September. From October to March, the percentage of first-years fluctuated significantly but apparently randomly between 11% (November) and 24% (February). A similar result was found for Black-headed Gulls on fields around Durham. The main changes in flock composition

Table 6:2

The number of Black-headed Gulls observed at refuse tips, playing fields in Durham City, and at the coast each month, and from September to February inclusive, and the number and percentage of first-years present.

Month	Refuse tips			Playing fields			Coast		
	Total	Number 1st-years	% 1st-years (s.e.)	Total	Number 1st-years	% 1st-years (s.e.)	Total	Number 1st-years	% 1st-years (s.e.)
Jul	1384	65	5 (0.6)	3424	168	5 (0.4)	2170	69	3 (0.4)
Aug	1609	156	10 (0.7)	2418	523	22 (0.8)	2469	99	4 (0.4)
Sep	716	145	20 (1.5)	2035	645	32 (1.0)	3828	120	3 (0.3)
Oct	819	116	14 (1.2)	749	119	16 (1.3)	2651	150	6 (0.5)
Nov	2252	257	11 (0.7)	1980	485	24 (1.0)	2353	87	4 (0.4)
Dec	833	143	17 (1.3)	2336	475	20 (0.8)	1802	99	5 (0.5)
Jan	2375	444	19 (0.8)	2688	602	22 (0.6)	3527	169	5 (0.4)
Feb	1575	374	24 (1.1)	1463	244	17 (1.0)	3404	210	6 (0.4)
Mar	645	133	21 (1.6)	1527	320	21 (1.1)	2348	241	10 (0.6)
Apr	-			-			307	138	45 (2.8)
Sep-Feb	8570	1479	17 (0.1)	11251	2570	23 (0.2)	17565	835	5 (0.2)

occurred between July (5% first-years), August (22%) and September (32%) ($P<0.001$). Differences between months were all significant (except between December and January), but no consistent trend was apparent from September to March. No counts were made in April either at tips or in Durham. The marked increase in proportions of first-years from July to September is probably due to recently fledged first-years arriving later than adults from Continental colonies (see Chapter 4).

The situation at the coastal Tyne site was completely different to that at tips and on fields. Flock-composition changed little from July to February (despite some significant differences between adjacent months, Table 6:2), first-years comprising between 3% and 6% of the flocks. This suggests that first-years arriving in the northeast for the winter avoid the coast. Marked increases in first-year proportions in March (10%) and particularly in April (45%) were probably due to some adults departing for the breeding colonies (see Chapter 4). No April counts were made at Durham or the tips, and there was no evidence of increased proportions of first-years in these areas in March.

The percentages of first-years present at each site in July, and at the Tyne in April, are clearly very different to those during other months so July and April together with the adjacent months of August and March were excluded. Counts for the months of September to February inclusive were pooled for further analysis.

6:3.3 Age-composition of flocks of Black-headed Gulls at different sites (September-February)

A comparison was made between the age-compositions of flocks at the three main groups of study sites (Table 6:2). The highest percentage of first-year Black-headed Gulls was found on fields (23%), with 17% first-years in flocks at refuse tips, and only 5% first-years in flocks at the coast. The differences in age-composition between each of these sites are highly significant ($P<0.001$). First-years avoided the coast, and were more common in fields in Durham than at refuse tips.

In order to test whether age-composition of flocks was related to the type of feeding site or its location, counts of Black-headed Gulls in Durham City town centre, Lumley refuse tip and the coast were each compared with counts made in fields close by (in practice, within 5 km of each site) (Table 6:3). In the Durham area, first-years made up $23\pm0.4\%$ and $24\pm1.0\%$ of flocks in fields and the town centre respectively, and in the Lumley area, they made up $27\pm1.5\%$ and $29\pm0.9\%$ of flocks in fields and the refuse tip respectively. The differences between fields and other sites were non-significant in each case. In the Tyne area, flocks on inland fields were made up of $3\pm0.3\%$ first-years, whilst at the coast itself, $5\pm0.2\%$ of the Black-headed Gulls present were first-years. This difference is significant but small, and is a consequence of the very large sample size. It is obvious that first-years are present in similar proportions at different feeding sites in the same areas. Flock-compositions in the fields in the Durham, Tyne and Lumley areas were significantly different (Table 6:3), which also suggests that the distribution of first-year and older Black-headed Gulls depends partly on location, and not entirely on the type of feeding site.

Comparing counts by month, there were no appreciable differences in the age-composition of Black-headed Gull flocks in different coastal areas from the Northumberland coast to the River Humber, compared to the Tyne site (Table 6:4). Although differences between the Tyne and the other coastal sites were significant in four out of ten comparisons, it is clear that

Table 6:3

The number of Black-headed Gulls, and the number and percentage of first-years seen in flocks from September to February in Durham town centre, at Lumley refuse tip and at the coast, compared with percentages of first-years seen in fields from September to February within 5 km of each site.

	Town. tip & coast			Fields			Chi-square (1 d.f.)	P
	Total	Number 1st-years	% 1st years	Total	Number 1st-years	% 1st years		
Durham	1917	462	24	11251	2570	23	1.39	n.s.
Lumley	2722	790	29	900	247	27	0.75	n.s.
Tyne	17565	835	5	3430	104	3	19.5	<0.001

Comparison of percentages of first-years seen in fields in three areas:

Durham and Lumley Chi-square = 9.6. 1 d.f.. $P<0.001$

Durham and Tyne Chi-square = 691. 1 d.f.. $P<0.001$

Lumley and Tyne Chi-square = 567. 1 d.f.. $P<0.001$

Table 6:4

The number and percentage of first-year Black-headed Gulls observed in flocks in different monthsat the mouth of the River Tyne and at four other northeastern coastal areas: a) mouth of the River Wear (County Durham), b) mouth of the River Tees (County Cleveland), c) mouth of the River Humber (Humberside) and d) the Northumbrian coast from Blyth to Budle Bay.

a)

Month	River Tyne Total	River Tyne No. 1st years	River Tyne % 1st years	River Wear Total	River Wear No. 1st years	River Wear % 1st years	t	P
Jul	2170	69	3	216	11	5	1.67	n.s.
Aug	2469	99	4	652	32	5	0.82	n.s.
Feb	3404	210	6	271	7	3	5.18	<0.001

b)

Month	River Tyne Total	River Tyne No. 1st years	River Tyne % 1st years	River Tees Total	River Tees No. 1st years	River Tees % 1st years	t	P
Jul	2170	69	3	1094	31	3	0.19	n.s.
Aug	2469	99	4	473	27	6	2.40	n.s.
Oct	2651	150	6	185	14	8	0.83	n.s.
Mar	2348	241	10	125	5	4	4.52	<0.001

c)

Month	River Tyne Total	River Tyne No. 1st years	River Tyne % 1st years	River Humber Total	River Humber No. 1st years	River Humber % 1st years	t	P
Sep	3828	120	3	907	9	1	11.91	<0.001

d)

Month	River Tyne Total	River Tyne No. 1st years	River Tyne % 1st years	Northumbrian coast Total	Northumbrian coast No. 1st years	Northumbrian coast % 1st years	t	P
Aug	2469	99	4	539	10	2	5.28	<0.001
Oct	2651	150	6	501	23	5	0.73	n.s.

first-year proportions were consistently low (1-10%) at coastal sites which were separated by up to 240 km. There was no evidence of consistent seasonal changes in flock composition at any one site, except at the Tyne where significant increases in first-year percentages occurred from February to April (Table 6:2).

6:3.4 The relationship between age-composition and sex-composition of flocks (September-February)

It is reasonable to expect that first-year Black-headed Gulls will be most common in feeding situations where a low level of skill is needed for food to be successfully acquired, or where competition from older, and therefore more dominant Black-headed Gulls, is at a low level. Where intra-specific competition is important, adult females should also tend to be excluded by the larger, dominant males. Where skill is more important than dominance, adult females should not be excluded by males, but the inexperienced first-years should be relatively few.

The sex-ratio of adult Black-headed Gulls caught during September to February at five sites (Lumley, Coxhoe and Consett tips, Durham fields and the Tyne coastal area) varied considerably and significantly (chi-square=35, 4 d.f., $P<0.001$, Table 6:5). Differences were not significant between Lumley, Durham and Coxhoe, but pooled together, the percentage of females at these three sites (34%) was significantly different ($P<0.001$) from both the Tyne (45%) and Consett (18%). This indicates either that certain sites were more favoured by one sex, or that competitive exclusion of one sex occurred. The sex-ratio of first-year and second-year Black-headed Gulls varied little between sites (Table 6:5), and the differences are not significant, suggesting that although adult males and females varied in their

Table 6:5

The number of adult, second-year and first-year Black-headed Gulls, and the number and percentage of females, caught at five sites in northeast England (September-February). There is a significant difference in the percentages of adult females caught at different sites (chi-square=35, 4 d.f., $P<0.001$). but no significant differences in the percentages of second-year females (chi-square=5.46, 3 d.f.) or first-year females (chi-square=1.26, 4 d.f.).

Site	Adult			Second-year			First-year		
	Total	Number of females	%	Total	Number of females	%	Total	Number of females	%
Tyne	317	144	45.4	99	33	33.3	41	20	48.8
Lumley	62	25	40.3	23	11	47.8	75	32	42.7
Durham	178	64	36.0	67	34	50.7	232	110	47.4
Coxhoe	161	46	28.6	17	7	41.2	46	20	43.5
Consett	132	24	18.2	8	2	*25.0	42	17	40.5

* Not included in chi-square test.

distribution, the factors affecting the distribution of first-years and second-years acted equally on males and females. The percentage of females in catches was always less than 50% (except for second-years caught in Durham). Proportionately more first-year than adult females were caught at each site, and the differences were significant at Durham and Consett.

There were significant differences ($P<0.001$) between the percentages of first-year Black-headed Gulls present in counts at each of the same five sites (Table 6:6). The percentages of adult females (out of all adults in catches) and first-year Black-headed Gulls have been compared and the correlation between these was not significant (Fig. 6:3). Although there is a positive correlation between adult female and first-year percentages at four of the sites, at the Tyne site, the highest percentage of adult females (45%) and the lowest percentage of first-years (5%) occurred. Intraspecific competition for food may exclude first-years from the Tyne site, but the high proportion of adult females probably indicates that skill is important in determining flock composition here.

There is a high correlation between proportions of adult females and first-years at tips and on fields ($r=0.96$, 2 d.f., $P<0.05$) (Fig. 6:3). Adult Black-headed Gulls are socially dominant over first-years, and adult males are dominant over adult females by virtue of their greater size. It seems likely that intraspecific competition caused the exclusion of subordinate individuals to a greater or lesser degree at these sites. By this hypothesis, Consett probably represents the most competitive feeding situation, with 18% adult females and 9% first-years. At Coxhoe feeding is less competitive (29% adult females, and 13% first-years), followed by Durham (36% adult females and 23% first-years). Lumley, with its high proportions of female (40%) and first-year (29%) Black-headed Gulls represents the least competitive feeding site.

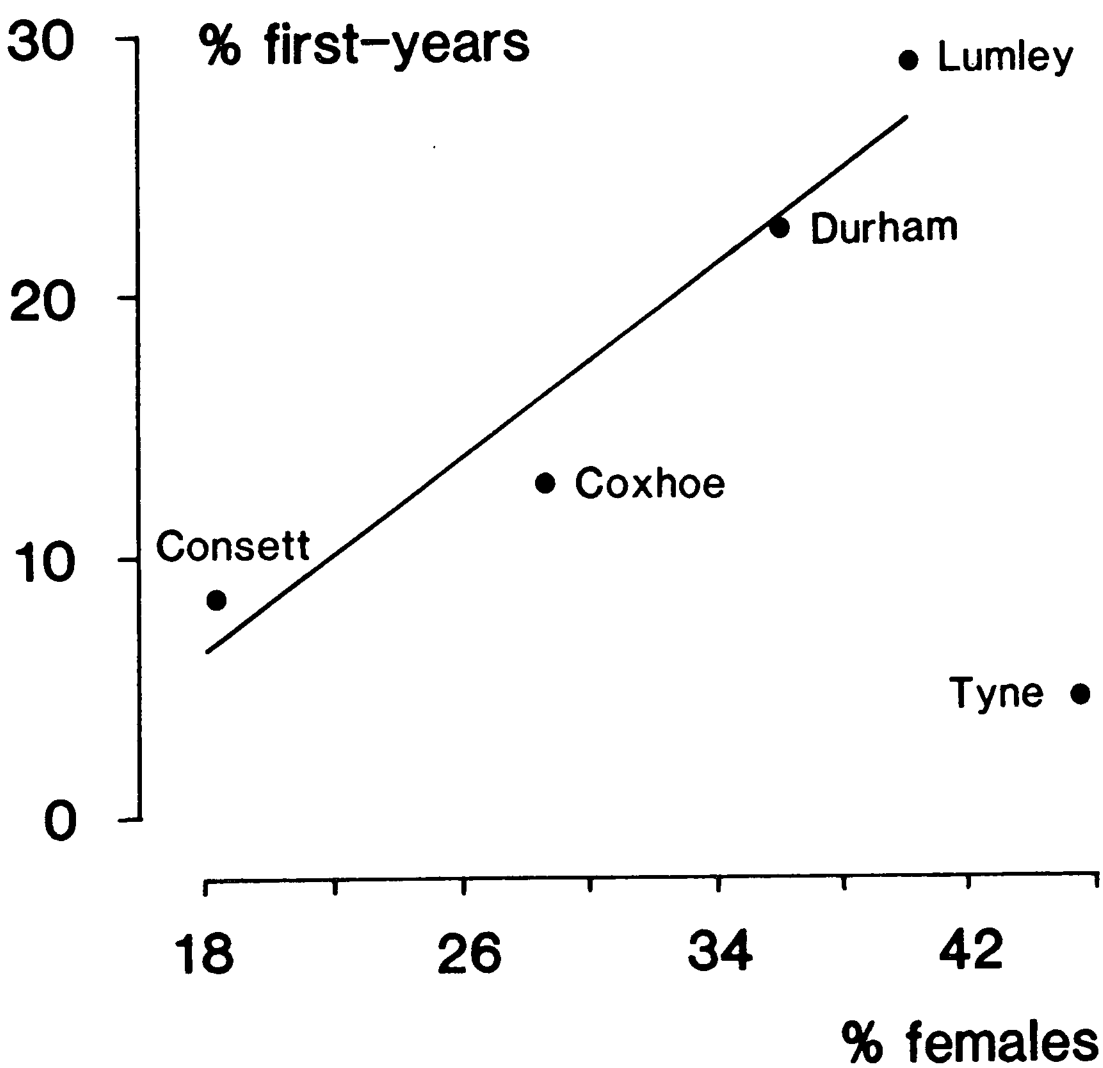
Table 6:6

The number of Black-headed Gulls observed at each of five sites (September-February), and the number and percentage which were first-years. The difference between the percentages of first-years at each site is significant (chi-square=2672, 4 d.f., P<0.001).

	Total	Number of first-years	%
Tyne	17565	835	4.8
Lumley	2722	790	29.0
Durham	11251	2570	22.8
Coxhoe	1392	178	12.8
Consett	2082	180	8.6

Figure 6:3

The relationship between the percentage of adult female Black-headed Gulls in catches and the percentage of first-years observed in flocks at four inland feeding sites in northeast England (Consett, Coxhoe, Durham and Lumley), and one coastal site (Tyne). The correlation is significant for the four inland sites: r_2=0.96, P<0.05, y=0.92x-10.12.



6:3.5 Swallowing rates of adult, second-year and first-year Black-headed Gulls

Adult Black-headed Gulls swallowed, on average, twice as many food items every 12 seconds as first-years at each of three feeding sites. The differences were significant on the ploughed field (P<0.01) and at the sewage outlet (P<0.05) (Table 6:7). Adults were consistently more successful at obtaining food than first-years in July and August when the younger birds are just a few months old. It is assumed that first-years improve their feeding skills with time. This assumption is supported by the observation that the mean feeding rate of three second-year Black-headed Gulls (identified by their first-summer plumage) at the sewage outlet was intermediate between adults and first-years, although not significantly different from either.

6:4 Discussion

Proportionately more male Black-headed Gulls were trapped at each site than females. This may be explained by males being easier to catch, by there being a greater proportion of males in the overwintering population, or by females preferentially overwintering in other areas. There is no evidence in the literature to suggest that female Black-headed Gulls suffer heavier mortality than males, although the opposite occurs in Kittiwakes, males having a higher mortality rate than females (Coulson & Wooller 1976). However, there were higher proportions of females amongst first-years than amongst adults, significantly higher at two out of five sites, which suggests that higher mortality of adult females may occur after maturity has been reached. The possibility remains that overwintering female

Table 6:7

The feeding rate (swallows/12 seconds) of adult, second-year and first-year Black-headed Gulls at three types of feeding site during July and August 1985. There was no significant difference between adults and first-years on the playing field ($t=1.72$, 71 d.f.), but adults had significantly higher feeding rates than first-years both on the ploughed field ($t=2.60$, 40 d.f., $P<0.01$) and at the sewage outfall ($t=2.40$, 35 d.f., $P<0.05$).

Site	Adult			Second-year			First-year		
	N	Swallows/ 12 seconds	s.e.	N	Swallows/ 12 seconds	s.e.	N	Swallows/ 12 seconds	s.e.
Playing field	47	0.15	0.05	-			26	0.04	0.04
Ploughed field	21	1.10	0.21	-			21	0.43	0.15
Sewage outfall	27	6.48	1.05	3	4.67	2.03	10	3.10	0.94

Black-headed Gulls avoid the northeast. Supporting evidence from sexing of birds caught in other parts of the British Isles would help decide whether this is likely.

In northeast England, Black-headed Gulls exploit several sources of food, including refuse tips, invertebrates from playing-fields and pastures, fish-offal from sewers at the coast, and bread thrown or dropped by people in the town centres. The feeding-rate of adult birds is greater than that of first-years, and this difference in feeding efficiency is common in large, long-lived birds (e.g. Herring Gulls, Greig et al. 1983). Disproportionate numbers of first-year Black-headed Gulls have been trapped at all sites, and this is particularly marked on playing fields. It suggests that first-year birds have difficulty in finding sufficient food: they are particularly attracted to easy sources of food such as bread laid out as bait for catching. On playing fields at least, this continues throughout the first year of the birds' life. There is evidence of differences related to both age and sex in the exploitation of different feeding areas by Black-headed Gulls in northeast England. It has been shown that age-composition of flocks is the same at different types of feeding site within three main areas of the study area. Observations of marked birds have shown that individual birds tend to feed at several sites close to each other (Chapter 7) and so it is likely that the characteristic flock-composition of the most important feeding site in any area will also occur at nearby feeding sites of minor importance.

In the coastal area, flocks of Black-headed Gulls typically have a very low proportion of first-years (5%), with roughly similar proportions of male and female adults. An important food source is the fish offal discharged at the river mouth, a regular and normally predictable food source. The birds mainly obtain scraps of fish by hovering, and dipping at the surface of the water, which calls for a high degree of aerial skill, and thus precludes much participation by first-years. Greig, Coulson & Monaghan (1985) found that female Herring Gulls are favoured over males in disturbed primary feeding at tips due to their lower weight and consequent lower wing-loading. Feeding on fish offal from the sewer requires similar skills, and this probably accounts for the relatively high proportion of adult females here (45%). At low tide, the Black-headed Gulls feed on invertebrates in the mud at North Shields. Some birds fly inland a few miles and feed on fields and behind the plough, but there is no evidence that they normally fly more than a few kilometres away from the mouth of the Tyne (Chapter 7). The strategy of these birds is to exploit a predictable source of food (fish offal), supplemented by other food sources close by. Proportions of first-year Black-headed Gulls similar to those found in the Tyne area were found at other coastal sites in the northeast (1-8%), and on beaches on the Belgian coast (4.6%, Van de Weghe 1971). This suggests that first-year Black-headed Gulls normally avoid all coastal areas, where they are presumably at a competitive disadvantage.

Black-headed Gulls which feed in the Durham area roost at the coast off Sunderland, at the mouth of the River Wear. There is no major fish quay at Sunderland, and few Black-headed Gulls gather there to feed at low tide. The birds leave the roost before dawn, and fly up the River Wear, flocks of birds stopping to feed in fields at varying distances up the river. Feeding in fields, characterised by high proportions of first-years and adult females, is relatively non-competitive. Females have no particular advantage over males, as food is found by walking on the ground. This may account for there being fewer adult females in the Durham flocks (36%) than at the Tyne, although the difference is not significant. First-year Black-headed Gulls are apparently compelled to feed mainly in fields, as they cannot compete successfully against adults at tips, nor have they the skill to exploit the food-sources at the coast.

The flock-composition of Black-headed Gulls at Lumley tip is similar to that found on playing fields in the Durham area, although more first-years occur at Lumley. The tip is small, and the birds present are frequently disturbed by the volume of traffic through the tip. Observations of marked gulls show that the same individuals also feed in fields in the area, and it is highly probable that the flock-composition in the Lumley area is associated with feeding in fields (the main food source), rather than by feeding at the tip (the secondary food source). Although a high proportion of first-years are present at Lumley tip, they probably do not compete successfully against the adult Black-headed Gulls during undisturbed primary feeding.

In comparison with the Durham and Lumley areas, fewer first-years (13%) and adult females (29%) use the Coxhoe tip, but the difference is significant only for first-years. Flocks of gulls are seldom seen on fields in the area, probably because of the conditions at the tip. A very large area is available for gulls to rest undisturbed when they are not feeding on the piles of refuse. Plenty of water is available at Coxhoe tip and this combination of drinking water and an undisturbed resting area means that gulls in the Coxhoe area need not leave this tip throughout the day. The composition of flocks here reflects the highly competitive nature of the feeding situation with first-years and adult females partially excluded by adult males.

At Consett tip, about 15 km away from Coxhoe, significantly lower proportions of first-year (9%) and adult female (18%) Black-headed Gulls occur compared to Lumley, Durham and Coxhoe. A possible reason for this is that there is little opportunity for undisturbed feeding at Consett, due to the activities of human scavengers at the tip. This serves to increase the competitive pressure whenever feeding opportunities do arise.

If first-year Black-headed Gulls are at a disadvantage at refuse tips and the coast, it might be expected that they would avoid these sites altogether. However, it must be advantageous for first-years to gain experience in foraging at these sites early in the autumn in readiness for the winter months when feeding on fields is difficult or impossible. The superabundance of food at certain refuse tips means that even inexperienced individuals can obtain sufficient food, but it may be necessary for them to feed for longer periods than older birds. The inefficiency of immatures at foraging has been suggested as a cause of delayed maturity in seabirds (Lack 1968). Black-headed Gulls first breed in their second, third or fourth summer (Lebreton & Isenmann 1976), compared to Herring Gulls which first-breed in the fourth or fifth summer or even later (Coulson et al. 1982). It is hard to believe that Herring Gulls, which feed at similar types of sites to Black-headed Gulls (Mudge & Ferns 1982), take three years longer to acquire the feeding skills necessary for breeding. Other factors, possibly physiological or behavioural, must also be involved in the delayed breeding of seabirds.

Chapter 7 MOVEMENTS OF BLACK-HEADED GULLS MARKED IN NORTH-EAST ENGLAND DURING THE NON-BREEDING SEASON

7:1 Introduction

Bird ringing began in Britain in 1908 (Spencer 1984) and through the recovery of ringed birds, a wealth of information regarding post-fledging dispersal and migration has been collected for numerous species. After being ringed, information concerning individual birds is usually confined to details of the date and place where the bird was found dead, although retrapping of live birds can provide additional information. Studies on the behavioural ecology of animals is limited if individuals cannot be identified in the field. To overcome this problem, techniques such as colour-ringing (e.g. Herring Gulls, Tinbergen 1965; Blackbirds, Snow 1958) and wingtagging (e.g. Wood Ducks, Jones & Leopold 1967; Mallards, Eiders & Moorhen, Anderson 1963) have been successfully used.

Despite regular ringing of Black-headed Gulls in Durham City and nearby areas between 1980 and 1982, few ringed birds were retrapped and it was suspected that most Black-headed Gulls moved out of the area after a short period and failed to return. In order to investigate this further, Black-headed Gulls trapped in County Durham and Tyne & Wear from September 1982 onwards were individually colour-marked with rings or wingtags. This permitted the study of the daily movements to feeding areas, timing of movements in and out of the study area, and destinations in subsequent breeding and non-breeding seasons of the marked birds.

7:2 Methods

7:2.1 Study area

Black-headed Gulls have been trapped and ringed in County Durham and Tyne & Wear since 1980, and colour-marked since September 1982. The two main study areas were:

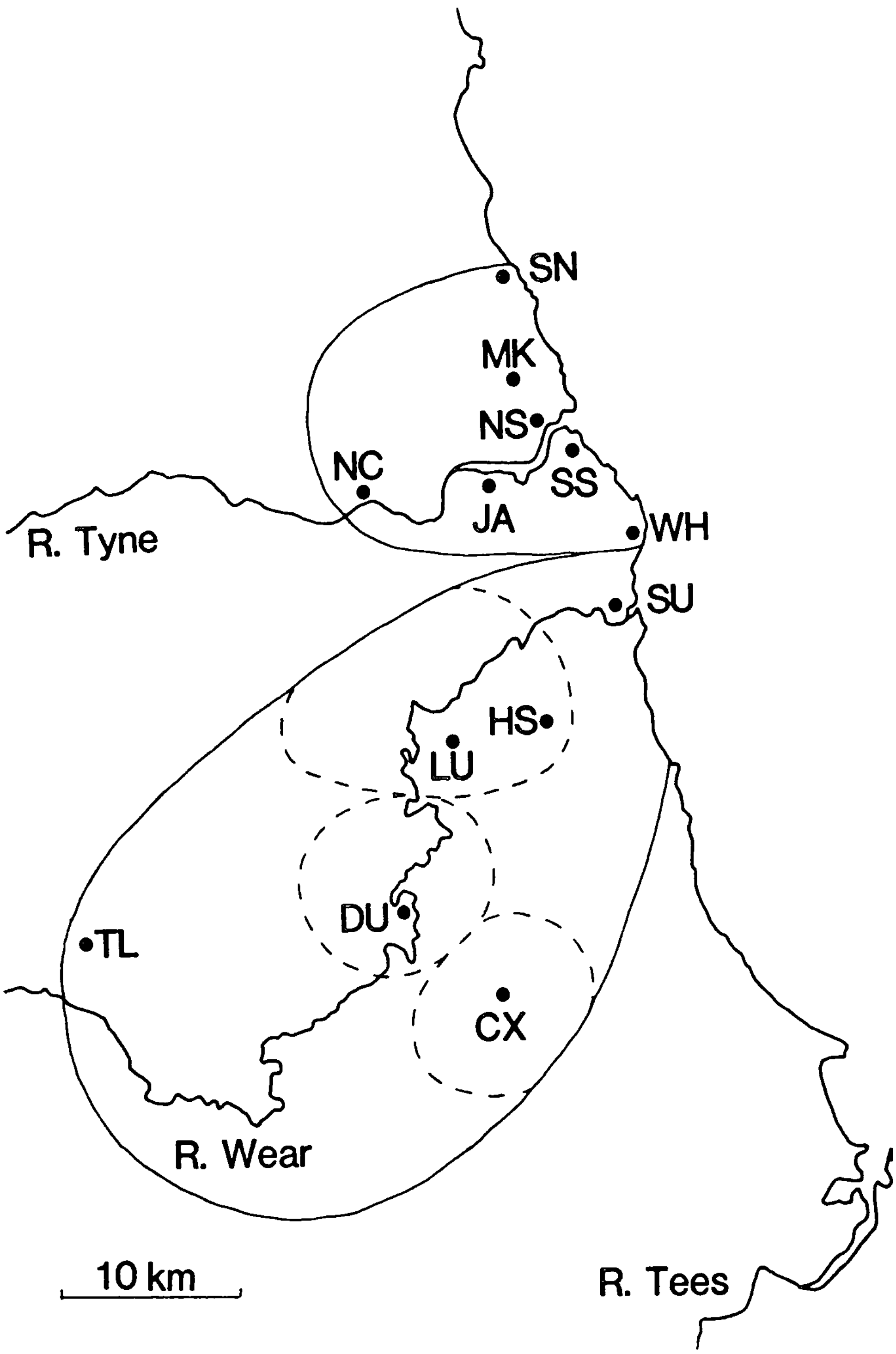
i) The Wear area, encompassing the River Wear from its mouth at Sunderland to Tow Law, 35 km away upstream, and extending several kilometres either side (Fig. 7:1). Three subareas (Lumley, Durham and Coxhoe) are treated separately in section 7:3.2, and are shown in Fig. 7:1.

ii) The Tyne area, encompassing the River Tyne from its mouth to Newcastle (12 km upstream), and extending from Seaton Sluice (8 km north of the river mouth) to Whitburn (7 km south of the river mouth).

In each of the three Wear sub-areas, there were one or more main sites where Black-headed Gulls were regularly observed, although birds were searched for and observed throughout the areas. The main sites for observing birds in the Lumley area were refuse tips and sewage works where the birds fed, and at a lake and a nearby pond near Washington where the birds regularly rested during the day and formed pre-roosting flocks in the evening. In the Coxhoe area, Black-headed Gulls were almost exclusively observed at three refuse tips. There is no refuse tip in the Durham area, but several playing fields and pastures were regular feeding and resting sites and birds were also attracted to the town centre, where they waited on buildings to be fed by passers-by. The main sites for observing birds in the Tyne area were near the mouth of the River Tyne. As the tide falls, an area of muddy sand adjacent to the North Shields Fish Quay is exposed, and Black-headed Gulls fed there in large numbers, whilst many rested on exposed

Figure 7:1

Map showing the sites referred to in the text. The Tyne and Wear study areas are outlined by solid lines, and the Lumley, Durham and Coxhoe subareas by dashed lines. CX=Coxhoe, DU=Durham, HS=Houghton-le-Spring, JA=Jarrow, LU=Lumley, MK=Monkseaton, NC=Newcastle, NS=North Shields, SN=Seaton Sluice, SS=South Shields, SU=Sunderland, TL=Tow Law, WH=Whitburn.



rocks. In the afternoon and evening, pre-roosting flocks of birds usually formed on grassy areas near to the shore in South Shields, before flying onto the sea to roost. Others flew direct to the roost.

7:2.2 Marking methods

A total of 893 Black-headed Gulls were marked with either colour-rings or wingtags. Details of the design of wingtags are given in Chapter 2. Black-headed Gulls feed largely on fields (e.g. Mudge & Ferns 1982), and colour-rings were not considered to be an ideal method of marking since the rings can be hidden by grass. This was expected to be less of a problem with birds feeding at the coast, and to test the comparative reliability of tags and colour-rings, 55 Black-headed Gulls trapped at the coastal North Shields Fish Quay during 1982-83 were wing-tagged and 87 were colour-ringed. The following season, the percentages of returning birds marked by each method were compared. For both wing-tags and colour-rings, 65.5% of marked Black-headed Gulls returned to the Tyne area. It is clear that the two marking methods are comparable at least in the Tyne area, and birds marked by each method have been pooled for analysis.

During the 1982-83 season, a few birds were noticed to have lost one tag, and so the next season the first three tags out of each series of ten were attached with two pins instead of one to reduce the risk of tag loss (Fig. 2:2). The presence or absence of tags on birds seen in the field was recorded from July 1983 to April 1985, and the percentages of birds known to have lost single- or double-pinned tags were compared. Altogether, 110 birds had each wing checked at least once during the season after being tagged, i.e. from four months (tagged in March, seen again next July) to 20 months (tagged in July, seen again in March of the following season) after being tagged. Out of 85 birds with single-pin tags, 18 (21%) lost one, whilst two out of 25 (8%) birds lost a double-pinned tag, but this difference is not significant (one-tailed Fisher's Exact Probability Test).

In several cases, the presence/absence of tags was confirmed on a subsequent occasion. In 13 cases out of 43 (30%), a single-pin tag previously noted as lost was seen to be present after all. It was also noticed that single-pin tags could rotate around the securing pin, and be folded underneath the birds' wings. This "loss" of tags cannot occur with the double-pinned type. Since single-pin tags were liable to be hidden under the birds' wings, it is reasonable to expect that there would be fewer sightings of birds with single-pin than double-pin tags. The mean number of sightings per month during the season of tagging was compared for birds marked with the two types of tag. Only those birds known to have had both tags present in the season after tagging were considered, to avoid bias due to genuine loss. There were no significant differences in the number of sightings per month of single-pin tagged birds and double-pin tagged birds in either the Tyne or the Wear areas (Table 7:1). The tendency of single-pin tags sometimes to lie under the wing apparently made little difference to the number of sightings of individual birds. This is probably because searches of flocks were often made from more than one direction, so both wings of each bird were usually observed. Single-pin and double-pin tags were equally effective markers, at least for the duration of this study.

Although 18 out of 85 individuals had apparently lost one tag, about 30% of these "lost" tags were probably concealed beneath a wing. Consequently, it was assumed that out of 85 birds tagged with single-pin tags, only 12.6 (14.8%) had really lost a tag. The probability of a bird losing one wing tag or the other is assumed to be equal, and the proportion

Table 7:1

The mean number of sightings per month of adult Black-headed Gulls marked with single-pin and double-pin tags, from the time of tagging to the end of the same non-breeding season. Two study areas are considered, and only birds known definitely to have kept both tags to the end of the season have been included.

Study area	Birds with single-pin tags		Birds with double-pin tags		t	P
	N	Sightings/month (1 s.e.)	N	Sightings/month (1 s.e.)		
Wear	17	0.63 (0.15)	16	0.64 (0.14)	0.05	n.s.
Tyne	12	1.89 (0.42)	6	1.56 (0.61)	0.45	n.s.

of birds having lost one or both single-hole tags by the season after being marked was estimated using a binomial distribution. Whilst 14.8±0.7% of marked birds lost one tag by the following season, only 0.6±0.6% lost both and this loss of 0.6% from the pool of marked birds has minimal effects on calculated rates of return.

7:3 Results

7:3.1 Daily movements of Black-headed Gulls

Observations made between September 1982 and April 1985 of flocks of Black-headed Gulls have been considered, and a general picture has been formed of the birds' daily movements in the Tyne and Wear areas.

i) Tyne

Trapping and marking of Black-headed Gulls in the Tyne area took place at the coast, either at the fish quay at North Shields or on the beach at South Shields. Sightings of marked birds mainly occurred in these two places, relatively few sightings occurring further up or down the coast, inland or upriver in Newcastle. Visits to the Tyne area were usually made to coincide with low tide, to observe the large flocks of Black-headed Gulls which fed on the exposed mud at North Shields Fish Quay (Chapter 6). The number of feeding birds depended partly on how much mud was exposed; over 1000 Black-headed Gulls were counted during some spring tides, but numbers were smaller at neap tides. At times when the mud was covered by the tide, or the area of exposed mud was limited at neap tides, Black-headed Gulls either fed on inland fields, refuse tips etc., or remained at the coast to feed on fish offal discharged into the river mouth from the fish quay. Even when the tide was low, flocks of Black-headed Gulls were often noticed flying inland from the coast at dawn, presumably to feed, and feeding flocks regularly formed on playing fields in Jarrow and North Shields (Fig. 7:1). Not all the Black-headed Gulls roosting at the coast necessarily fed there.

Some Black-headed Gulls which fed at North Shields Fish Quay in the morning moved up to 5 km inland after the tide covered the intertidal feeding area. On different occasions, four marked birds were seen feeding at North Shields Fish Quay early in the morning and subsequently on playing fields at Monkseaton (5 km distant) less than three hours later. Including these four sightings, 39 sightings of Black-headed Gulls at the coast were followed the same season by sightings inland in the Tyne area. In the afternoon and early evening, multi-species pre-roosting flocks of gulls often formed on playing fields close to the beach at South Shields. Black-headed Gulls were present all day there, feeding or resting on playing fields, the sands, car parks etc., but numbers increased later in the day. Some of the birds which fed at North Shields Fish Quay in the morning probably moved directly to South Shields when the tide rose, whilst others moved inland and then to South Shields the same day. Altogether, 21 marked Black-headed Gulls have been seen at both North Shields Fish Quay and near the shore at South Shields (1 km apart) during the same day, and one marked bird moved 6 km from an inland site (Monkseaton) to South Shields during the same day. Birds marked at North and South Shields have subsequently been seen at Newcastle (10 km upriver) and other sites at a similar distance from the mouth of the Tyne, but there is no evidence that these birds fed at the coast as well as at inland sites. It is not known whether they roosted at the coast, or whether they had changed their roosting site.

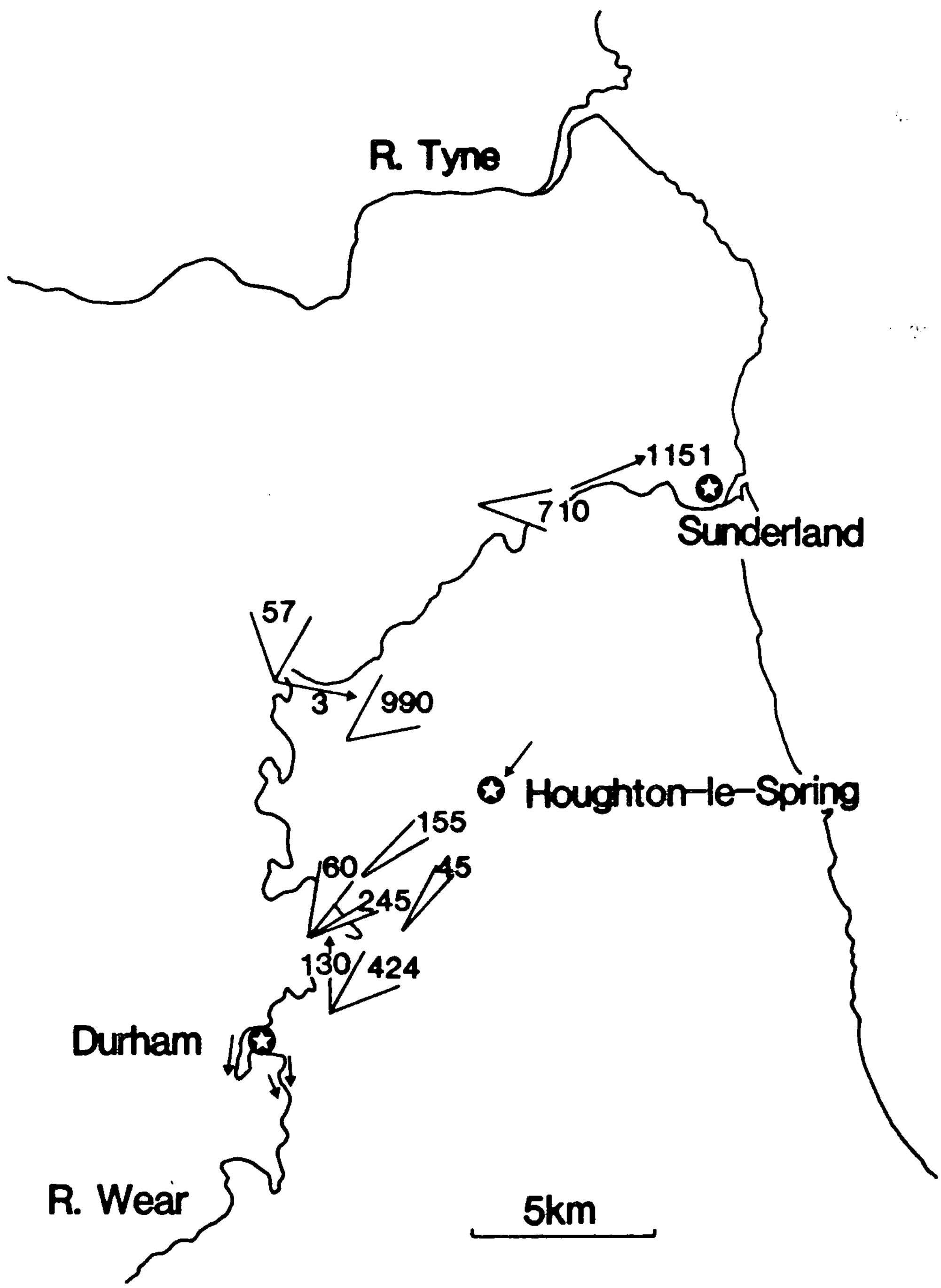
ii) Wear

The Wear study area differed markedly from the Tyne, in that no major feeding or pre-roosting sites were found near the mouth of the River Wear at Sunderland. Black-headed Gulls marked in the Wear area were observed at a variety of sites from Sunderland (near the river mouth) to Willington (32 km upriver) (Fig. 7:1). In Durham City (15 km from the river mouth), Black-headed Gulls were regularly observed arriving at feeding sites soon after dawn. Flocks of birds were clearly following the River Wear upstream, until they arrived at suitable feeding sites. At Houghton-le-Spring, some 5 km from the river, birds were observed arriving from a north-easterly direction in the morning (Fig. 7:2), suggesting that these birds had flown directly from Sunderland. The direction in which Black-headed Gulls flew to the roost at dusk was recorded at several localities in the Wear area, and the results presented in Fig. 7:2. Black-headed Gulls either followed the River Wear downstream, or departed in a direction taking them directly towards Sunderland, suggesting that Black-headed Gulls which feed in the Wear area roost at the coast, probably off Sunderland. Only 12 birds from the Wear area have been seen twice in the same day. In 11 cases, the distance moved by the bird was less than 5 km, whilst one bird was seen in two places 10 km apart during the same day. Although Black-headed Gulls moved between sites, this suggests that they forage within a small area during any one day.

The total number of Black-headed Gulls feeding within a 3 mile (4.8 km) radius of Durham City was estimated by carrying out 19 complete censuses between December 1982 and July 1984. As one small section of this study area was inaccessible, an adjacent area of a similar size was used in its place, so that an overall area of 72.4 km square was censussed. All grassland in the study area including playing fields was checked, and other

Figure 7:2

Directions and numbers of Black-headed Gulls seen flying to and from the roost. The three arrows close to Durham City, and the arrow close to Houghton-le-Spring indicate birds seen arriving early in the morning. Other arrows show the direction, and sectors show the range of directions taken by birds departing in the evening.

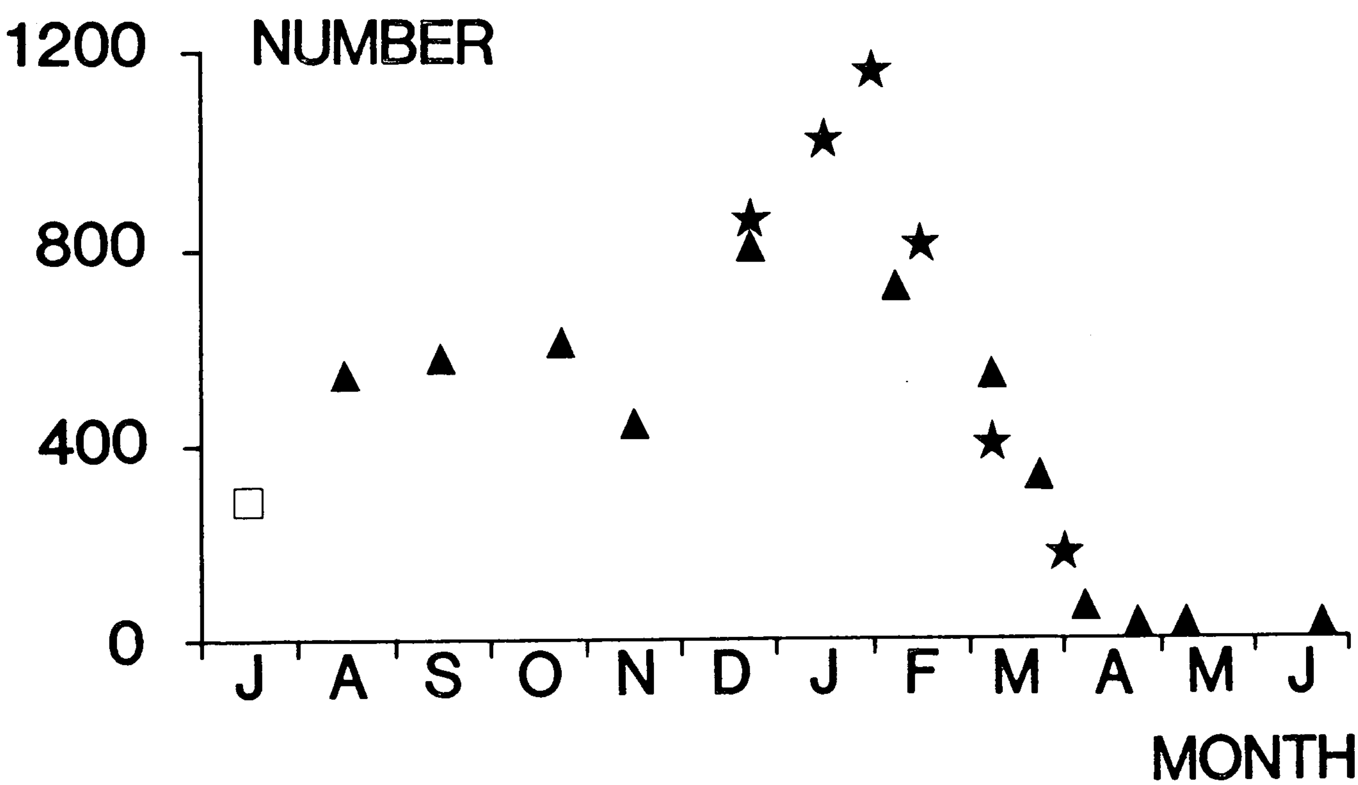


sites (e.g. sewage works) where Black-headed Gulls might be expected to feed were visited. Each complete census took between one and four days to complete, depending on daylength, visibility and the number of birds present. As far as possible, censuses were carried out in similar weather conditions, avoiding periods when fields were snow-covered or when there were very strong winds. Since the birds obviously moved about during the period of each census, it was clearly impossible to avoid missing some flocks, and counting some birds twice. It is probable that most of these errors cancelled one another and the counts obtained are believed to be reasonable estimates of the true numbers present. This assumption is supported by comparing the total number of birds counted at the same time of year in two successive seasons (1982-3 and 1983-4). For example, there is a good agreement between estimates for 20-22 December 1982 (858) and 19-21 December 1983 (803).

The total number of Black-headed Gulls counted in the study area in each census varied between none (May 1984) and 1155 (late January 1983) (Fig. 7:3). No Black-headed Gulls were present in the Durham study area in May, and there were only five present in late June. The influx of Black-headed Gulls into the Durham study area in July (286) and in August (536) corresponds with the onset of arrival of Black-headed Gulls into Britain from the Continent (Chapter 4). There was little change in numbers until a decline in November (434), and thereafter numbers increased to reach a peak in late January (1155). There was a steady decline in numbers throughout February, March and April, with only two birds seen in the study area in mid-April. There is a high correlation between date and the number of birds present in the Durham study area from the January peak and the end of April ($r=-0.96$, 7 d.f., $P<0.001$), further indicating that similar numbers were present in 1982-83 and 1983-84. The numbers of birds counted on fields

Figure 7:3

The number of Black-headed Gulls counted within a three mile (4.8 km) radius of Durham City in 19 surveys. Counts made during the 1982-83 season, ★ ; counts made during the 1983-84 season, ▲ ; count made during July 1984, □ .



and in urban habitats (e.g. sewage works and rooftops) in each census are presented in Table 7:2. The greatest numbers were present in urban habitats from November to February, but the percentage of Black-headed Gulls present on fields was always at least 68%.

7:3.2 Movements during the non-breeding season

Observations were made throughout the Tyne and Wear study areas from September 1982 to April 1985, and the date and place of all sightings of marked Black-headed Gulls were recorded. The Durham, Coxhoe and Lumley areas (Fig. 7:1), where the majority of observations in the Wear study area were made, are treated separately in this section. Many marked birds were seen several times during one non-breeding season, and so a picture of the movements of individuals was built up. In this section each sighting of an individual bird, together with the next sighting of that bird during the same season, was considered separately. A bird seen three times in Durham and a fourth time in the Coxhoe area would contribute three times to the dataset: twice as a Durham bird which was faithful to Durham, and once as a Durham bird which moved to Coxhoe. Fidelity to an area is expressed as the percentage of 'subsequent sightings' which occur in the same area. Individuals captured as first-years contributed to the first-year dataset in the non-breeding season of capture only, as they changed age-class on the following 1 July.

There were no significant differences in the percentages of adult and second-year birds which were faithful to each area, and so these groups have been pooled. The percentage of birds which were faithful to each of four areas (i.e. seen a second time) have been compared for males and females (Table 7:3). There was no difference in the percentages of adult and

Table 7:2

The number of Black-headed Gulls counted each month within a three mile radius of Durham City, and the number and percentage present on fields. Two censuses were carried out during January 1983, March 1983, March 1984 and April 1984.

Month & year of count	Total Black-headed Gulls	Number on fields	% on fields
Dec 1982	858	662	77
Jan 1983	1015	952	94
Jan 1983	1155	1025	89
Feb 1983	802	658	82
Mar 1983	396	347	88
Mar 1983	173	172	99
Aug 1983	536	530	99
Sep 1983	570	516	91
Oct 1983	598	434	73
Nov 1983	434	297	68
Dec 1983	803	758	94
Feb 1984	710	611	86
Mar 1984	535	501	94
Mar 1984	317	270	85
Apr 1984	54	53	98
Apr 1984	2	2	100
May 1984	0	-	-
Jun 1984	5	5	100
Jul 1984	286	221	77

Table 7:3

The number of sightings of Black-headed Gulls followed by a second sighting during the same non-breeding season, and the number and percentage of second sightings occurring in the same area for a) adult and second-year birds combined, and b) first-year birds: one bird may contribute several times to the dataset. Males and females are compared within each area using chi-squared tests or (*) Fisher's Exact Probability Test.

a) Adults/second-years

Area	Males: Total sightings	Males: Number in same area	Males: % (1 s.e.)	Females: Total sightings	Females: Number in same area	Females: % (1 s.e.)	Chi-square (1 d.f.)	P
Tyne	865	854	99 (0.4)	635	627	99 (0.4)	0.05	n.s.
Coxhoe	178	172	97 (1.4)	40	34	85 (5.6)	*	0.010
Durham	327	267	82 (2.1)	123	85	69 (4.2)	7.64	<0.001
Lumley	143	110	77 (3.5)	113	77	68 (4.4)	2.05	n.s.

b) First-years

Area	Males: Total sightings	Males: Number in same area	Males: % (1 s.e.)	Females: Total sightings	Females: Number in same area	Females: % (1 s.e.)	Chi-square (1 d.f.)	P
Durham	47	25	53 (7.3)	47	15	32 (6.8)	3.52	n.s.
Lumley	40	35	87 (5.3)	64	60	96 (2.4)	*	n.s.

There was no significant difference in the degree of fidelity of adult/second-year males to the Tyne and Coxhoe areas, nor to the Durham and Lumley areas. but adult/second-year males were significantly more faithful to Coxhoe than to Durham (chi-square=21.5, 1 d.f., $P<0.001$). Adult/second-year females were more faithful to Tyne than to Coxhoe (Fisher's Exact Probability= 0.00006), to Durham (chi-square=154, 1 d.f., $P<0.001$) or to Lumley (chi-square=157, 1 d.f., $P<0.001$), but there were no significant differences between Coxhoe. Durham and Lumley. First-year males (chi-square=10.3, 1 d.f., $P<0.01$) and females (chi-square=44.5, 1 d.f., $P<0.001$) were significantly more faithful to Lumley than to Durham.

second-year males (99%) and females (99%) seen a second time in the Tyne area. Significantly more adult and second-year males (97%) were seen a second time in the Coxhoe area than females (85%) (Fisher's Exact Probability Test, P=0.01), and in the Durham area the difference between males (82%) and females (69%) was also significant (P<0.01). There was a similar trend for adult and second-year males (77%) and females (68%) in the Lumley area, but the difference was not significant. There were not enough sightings in the Tyne and Coxhoe areas to compare the behaviour of male and female first-years. There was a suggestion that first-year females (32%) were less faithful to the Durham area than first-year males (53%) but the difference was not significant, nor was there a significant difference between first-year males (87%) and females (96%) at Lumley.

Adult and second-year male Black-headed Gulls were most faithful to the Tyne (99%) and Coxhoe (97%) areas (Table 7:3), and there was no significant difference between these areas. Fidelity to both Durham (82%) and Lumley (77%) was significantly less (P<0.001) than to either the Tyne or Coxhoe areas, but there was no significant difference between Durham and Lumley. Adult and second-year females were significantly more faithful (P<0.001) to the Tyne area (99%) than to Coxhoe (85%), Durham (69%) or Lumley (68%) (Table 7:3). The percentages of birds which were faithful to the Lumley and Durham areas were almost identical and there was no significant difference between these and Coxhoe, possibly due to the small sample size of Coxhoe females. There were too few first-years seen at the Tyne or Coxhoe to make a comparison possible. The greater degree of fidelity to the Lumley area in both first-year males (87%) and females (96%) was significantly higher than to Durham by first-year males (53%, P<0.01) and females (32%, P<0.001) (Table 7:3).

There were considerable and significant differences between the

Table 7:4

Differences between the percentages of second sightings occurring in the same area as the first sightings of adult/second-year and of first-year Black-headed Gulls: the sexes are considered separately in the Durham and Lumley areas. (Data from Table 7:3).

		Adult/second-year			First-year			Chi-square (1 d.f.)	P
Area	Sex	Total sightings	Number in same area	% (1 s.e.)	Total sightings	Number in same area	% (1 s.e.)		
Durham	M	327	267	82 (2.1)	47	25	53 (7.3)	17.8	<0.001
Durham	F	123	85	69 (4.2)	47	15	32 (6.8)	17.9	<0.001
Lumley	M	143	110	77 (3.5)	40	35	87 (5.3)	1.5	n.s.
Lumley	F	113	77	68 (4.4)	64	60	96 (2.4)	13.9	<0.001

fidelity of first-year and older Black-headed Gulls to the Durham and Lumley areas (Table 7:4). Both male and female first-years were significantly less faithful to Durham than older birds ($P<0.001$), with the percentage of second sightings in the Durham area about 30% higher in both sexes. First-year birds were more faithful to the Lumley area than older birds in both males (10% difference) and females (18% difference), but the difference was significant only for females ($P<0.001$).

7:3.3 Months of arrival in, and departure from the Tyne and Wear overwintering areas

The months of arrival and departure of individual adult Black-headed Gulls (i.e. months when birds were first and last seen) were determined for two successive years. Seventy-one adult Black-headed Gulls returned to the Tyne and Wear study areas in both 1983-84 and 1984-85. In 1984-85, most of the birds arrived during the same month or one month earlier or later than in 1983-84 (65%) (Table 7:5). The tendency for birds to arrive earlier in 1984-85 (49%) rather than later (30%) compared to 1983-84 was not significant. Most birds left during the same or adjacent month in 1984-85 as in 1983-84 (72%), and although in 1984-85 more birds left earlier (41%) than later (27%) compared to 1983-84, the difference was not significant.

The overall pattern of monthly arrivals and departures was investigated for the 1984-85 season, since there was a larger sample of birds than for 1983-84. Birds arrived in the study areas during every month from July to February, one bird arriving in the Tyne area in March, and the percentages of adult male and female Black-headed Gulls arriving in the Wear and Tyne areas during the periods July-September, October-December and January-March have been compared (Table 7:6). In the first three months of the

Table 7:5

Differences in the month of arrival, and differences in the month of departure of marked Black-headed Gulls in northeast England between the 1984-85 and 1983-84 non-breeding seasons. The difference is negative where the arrival (or departure) month was earlier in 1984-85 than in 1983-84, and positive where the arrival month was later in 1984-85.

Difference in months between 1984-85 and 1983-84	Arrival		Departure	
	Number of birds	%	Number of birds	%
-6	1	1.4	2	2.8
-5	1	1.4	2	2.8
-4	4	5.6	4	5.6
-3	4	5.6	4	5.6
-2	3	4.2	4	5.6
-1	22	31.0	13	18.3
+0	15	21.1	23	32.4
+1	9	12.7	15	21.1
+2	9	12.7	2	2.8
+3	3	4.2	1	1.4
+4	0	0.0	1	1.4

Table 7:6

Numbers of Black-headed Gulls arriving in and departing from the Wear and Tyne areas in three three-month periods during the 1984-85 season. The difference in time of arrival of males and females was significant both in the Wear area (chi-square=6.5, 2 d.f., $P<0.05$) and in the Tyne area (chi-square=4.9, 1 d.f., $P<0.05$), but there were no significant differences in the time of departure. There were no significant differences in time of arrival or departure between birds in the Wear and Tyne areas.

a) Wear

Months	Adult males				Adult females			
	Number arriving	% (1 s.e.)	Number departing	% (1 s.e.)	Number arriving	% (1 s.e.)	Number departing	% (1 s.e.)
Jul-Sep	32	58 (6.7)	9	16 (5.0)	7	29 (9.3)	4	17 (7.6)
Oct-Dec	14	25 (5.9)	12	22 (5.6)	8	33 (9.6)	5	21 (8.3)
Jan-Mar	9	16 (5.0)	34	62 (6.6)	9	38 (9.9)	15	62 (9.9)
Total	55		55		24		24	

b) Tyne

Months	Adult males				Adult females			
	Number arriving	% (1 s.e.)	Number departing	% (1 s.e.)	Number arriving	% (1 s.e.)	Number departing	% (1 s.e.)
Jul-Sep	40	68 (6.1)	8	14 (4.5)	24	45 (6.8)	4	8 (3.7)
Oct-Dec	10	17 (4.9)	9	15 (4.6)	14	26 (6.0)	9	17 (5.2)
Jan-Mar	9	15 (4.6)	42	71 (5.9)	15	28 (6.2)	40	75 (5.9)
Total	59		59		53		53	

non-breeding season, twice the percentage of adult males (58%) arrived in the Wear area compared to adult females (29%). Fewer male birds arrived in mid-season (25%) and only 16% of arrivals occurred from January-March. Similar percentages of adult females arrived during each three-month period and the difference in the pattern of arrivals of male and female Black-headed Gulls in the Wear area is significant ($P<0.05$). Arrival of male birds was also earlier than of females in the Tyne area, significantly more male birds arriving during July-September (68%) than adult females (45%) ($P<0.05$). There was no significant difference between arrival months in the Wear and Tyne areas of either males or females. (There were too few male and female second-years for a meaningful comparison to be made.)

Black-headed Gulls were assumed to have departed during the month when they were last seen. There was no difference in the pattern of monthly departures of male and female birds from the Wear area, with the majority (62% of each) leaving during January-March (Table 7:6). Gulls from the Tyne area also left mainly during January-March, with no significant difference in the proportions of either sex leaving in each period. Nor were there significant differences in the timing of departures from the Wear and Tyne areas in either males or females. Although females arrived significantly later than males in both Tyne and Wear areas, there were no differences in timing of departure, implying that females do not stay in the Tyne or Wear study areas for as long as males.

7:3.4 Duration of stay in the Tyne and Wear areas

The "duration of stay" of individual Black-headed Gulls over the 1983-84 and 1984-85 non-breeding seasons was defined as the number of whole months from the first sighting of a bird to the last sighting. A bird first seen during July, and last seen (that non-breeding season) during December, was considered to have been present from July to December, i.e. six months. A bird seen once was counted as present for one month. This system does not distinguish between a bird seen once (which may have been present only for a day in the study area) and a bird seen on the first and again on the last day of a particular month (obviously present for a full month). If duration of stay has thus been overestimated, the overestimate was similar in every group of birds considered, and so comparisons between groups are valid. In two instances during a single non-breeding season, a bird arrived in one study area, was subsequently seen elsewhere, then returned to the first area. Since this represented only 1% of all individuals involved in the following analysis, it is reasonable to assume that all birds were present in the particular study area for the whole period between the first and last sighting.

In both Wear and Tyne areas, adult females tended to stay for shorter periods than adult males, but differences were not significant (Table 7:7). Significantly more adult males stayed for short periods of up to 4 months in the Wear area (68%) than in the Tyne area (47%), and significantly more adult females stayed for short periods in the Wear area (84%) compared to the Tyne area (54%) ($P<0.05$).

With all ages and sexes combined, 106 birds were present in the Wear area and Tyne areas for only one month (Fig. 7:4). They may have overwintered in an area adjacent to the study area, and have been on the periphery of their ranges when seen, but as the number was not similar from month to month, it is more likely that most were moving through on the way to or from their main overwintering areas. Most of the birds which stayed one month were present during December, January and February (60%). This probably includes birds moving into new areas during the coldest months of

Table 7:7

The numbers of adult and second-year Black-headed Gulls of each sex staying in a) the Wear study area and b) the Tyne study area for different lengths of time during the non-breeding seasons following tagging: 12 birds marked in the Wear area during the the 1982-83 season. and 58 birds marked in the Tyne area during the 1982-83 season, contribute to the dataset twice, as they returned in both 1983-84 and 1984-85.

a) Wear

Length of stay (months)	Number of adult males	%	Number of adult females	%	Number of second-year males	%	Number of second-year females	%
1-4	51	(68)	31	(84)	13	(76)	11	(79)
5-9	25	(32)	6	(16)	4	(24)	3	(21)
Total	76		37		17		14	
Mean number of months	3.64		2.57		2.65		2.79	

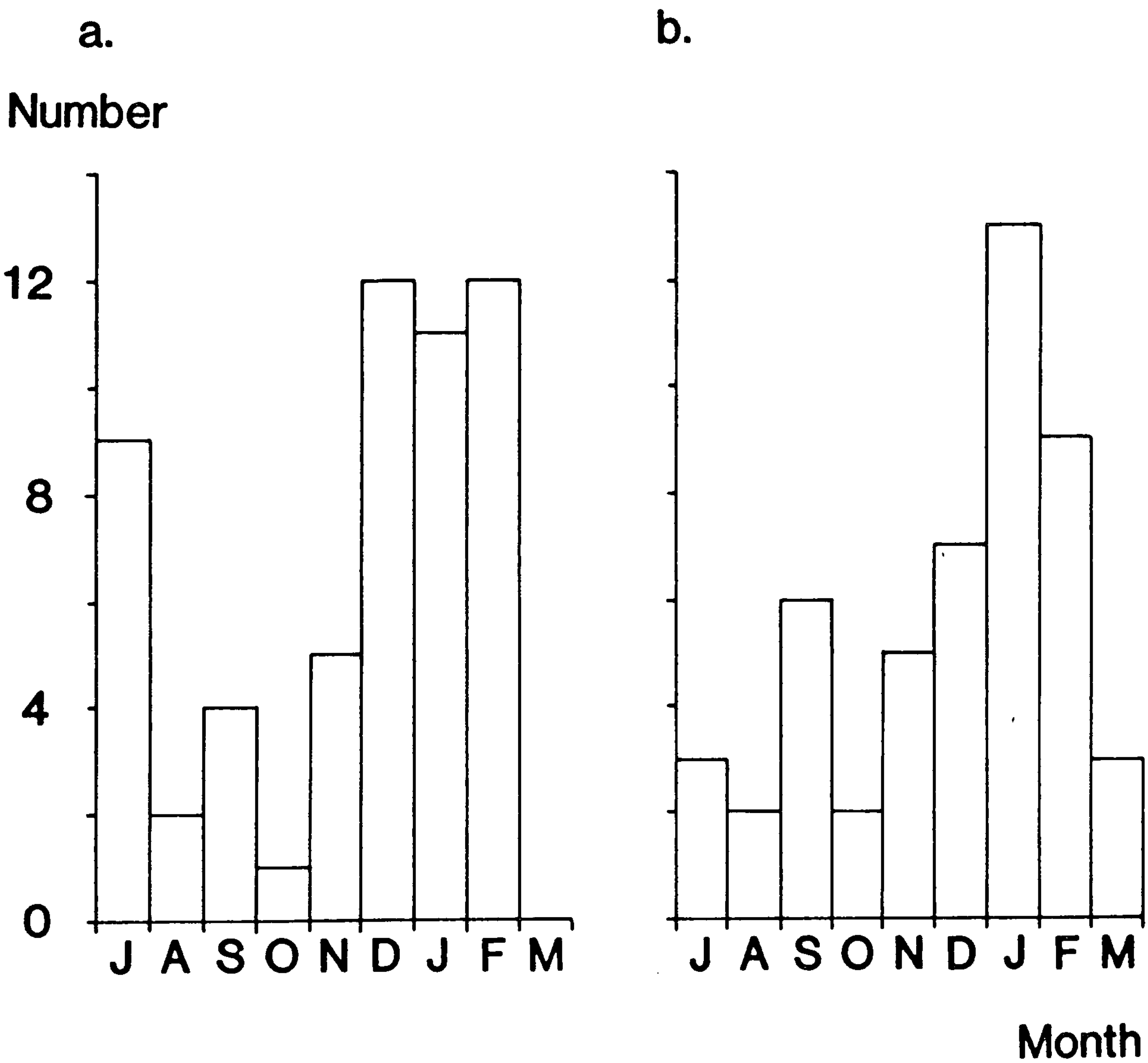
b) Tyne

Length of stay (months)	Number of adult males	%	Number of adult females	%	Number of second-year males	%	Number of second-year females	%
1-4	45	(47)	52	(54)	5	(83)	5	(83)
5-9	51	(53)	44	(46)	1	(17)	1	(17)
Total	96		96		6		6	
Mean number of months	4.69		4.09		2.67		3.00	

There were no significant differences in the lengths of stay of adult males and females. of second-year males and females nor between adult and second-year birds in either area. Both adult males (chi-square=6.24 1 d.f. $P<0.05$) and adult females (chi-square=8.76 1 d.f. $P<0.01$) stayed significantly longer in The Tyne area than in the Wear area.

Figure 7:4

The monthly numbers of Black-headed Gulls which were present in a) the Wear area and b) the Tyne area for that month alone.



the winter, but some of the birds present in February may have been moving south prior to the spring migration which takes place in late March and early April (Chapter 4). Relatively few birds pass through the study area from July to November (37%), although this is the period when Black-headed Gulls are arriving in the British Isles from the Continent.

In the Wear area, the mean number of sightings/bird in a non-breeding season (3.75) was 41.8% smaller than the mean number in the Tyne area (6.44). To eliminate the possibility of bias caused by greater observational effort having been made in the Tyne area, 41.8% of the sightings of Tyne birds were discarded at random, to make the number of sightings/bird equal in the two study areas. This had the effect of decreasing the length of time which individual birds apparently stayed in the Tyne area, and of excluding 20 birds for which all sightings were randomly discarded (Table 7:8). Comparing the corrected Tyne data with the Wear, the proportion of Black-headed Gulls which stayed for a short period (between 1 and 4 months) was still significantly different for both adult males in the Wear (68%) and Tyne areas (51%) ($P<0.05$) and adult females in the Wear area (84%) than in the Tyne area (67%) ($P<0.01$).

A comparison between the length of stay of adults and first-years must be carried out during the season of capture, because in July of the following season first-years become second-years by definition. Since birds caught early in the season had the opportunity to stay longer than those caught late, the length of stay must be compared by month of marking. The monthly sample sizes were too small to make meaningful comparisons between subsequent adult and first-year lengths of stay, and so an indication of length of stay after tagging was found by considering the proportions of birds which were not seen again in the study area during that non-breeding season. The proportion of 'disappearing' birds gives an estimate of the

Table 7:8

The number of months spent in the Tyne area (corrected value) and Wear area by a) male (chi-square=3.85, 1 d.f., $P<0.05$) and b) female (chi-square=5.21, 1 d.f., $P<0.05$) Black-headed Gulls.

a) Adult males

	Tyne		Wear	
Length of stay (months)	Number of birds	%	Number of birds	%
1-4	43	51	51	68
5-9	42	49	25	32
Total	85		76	

b) Adult females

	Tyne		Wear	
Length of stay (months)	Number of birds	%	Number of birds	%
1-4	53	61	31	84
5-9	34	39	6	16
Total	87		37	

proportion leaving soon after being tagged. The difference between first-year and older birds of each sex was found for each month, except where fewer than five birds of either age had been marked. There was no obvious seasonal trend in proportions of birds disappearing from the Wear study area (Table 7:9), although in August it was low for each age and sex group. Using the Test for a Constant Difference (Snedecor & Cochran 1980), the difference between the percentages of adult and first-year males which disappeared was significant (d=5.19, $P<0.05$, unweighted mean difference=-14.5%), but there was no significant difference between adult and first-year females (unweighted mean difference=-7.5%). No comparison could be made between adults and first-years in the Tyne area as the sample size of first-years of each sex was too small.

Using the same method, significantly more adult/second-year females disappeared from the Tyne area each month after being marked than males (d=2.60, $P<0.01$, unweighted mean difference=-17.0%) (Table 7:10). The unweighted mean difference in the Wear area was small (-1.4%) and the overall difference between adult/second-year males and females was non-significant.

7:3.5 Turnover of Black-headed Gulls during one non-breeding season (1984-85)

Turnover rates for the 1984-85 season were calculated for male and female Black-headed Gulls in the Tyne and Wear areas by expressing the number of individuals leaving each month as a percentage of the total number present that month, and a weighted mean turnover rate was calculated for each sex from July to February inclusive (Table 7:11). (Note that out of the 155 marked adult Black-headed Gulls which were seen in the two study

Table 7:9

The percentages of adult and first-year Black-headed Gulls marked in the Wear area each month which were not seen again in the area during the same non-breeding season, compared using the test for a constant difference (Snedecor & Cochran 1980). Males and females are considered separately.

a) Males

Month	Adult: Number marked	Adult: Number not seen	Adult: %	First-year: Number marked	First-year: Number not seen	First-year: %	% adult- % first-year
Aug	34	8	23.5	14	5	35.7	-12.2
Sep	11	7	63.6	11	8	72.7	- 9.1
Oct	23	12	52.2	13	9	69.2	-17.0
Nov	28	12	42.9	24	17	70.8	-27.9
Dec	49	24	49.0	34	21	61.8	-12.8
Jan	9	5	55.6	11	7	63.6	- 8.0

Mean difference = -14.5

Test for a constant difference : d=2.53 P<0.02

b) Females

Month	Adult: Number marked	Adult: Number not seen	Adult: %	First-year: Number marked	First-year: Number not seen	First-year: %	% adult- % first-year
Aug	11	1	9.1	20	8	40.0	-30.9
Sep	9	5	55.6	11	6	54.5	+ 1.1
Oct	11	8	72.7	15	12	80.0	- 7.3
Nov	11	6	54.5	17	14	82.4	-27.9
Dec	34	20	61.8	36	24	66.7	- 4.9
Jan	8	3	37.5	7	2	28.6	+ 8.9
Feb	18	15	83.3	8	6	75.0	+ 8.3

Mean difference = - 7.5

Test for a constant difference : d=1.38 n.s.

Table 7:10

The percentage of adult male and female Black-headed Gulls marked each month which were not seen again in the study area during the same non-breeding season, compared using the test for a constant difference (Snedecor & Cochran 1980). Birds marked in the Wear and Tyne areas are considered separately. Data for adult males and females marked in the Wear area were presented in Table 7:9.

a) Wear

	Male			Female			%male-%female
Month	Number marked	Number not seen	%	Number marked	Number not seen	%	
Aug	34	8	23.5	11	1	9.1	+14.4
Sep	11	7	63.6	9	5	55.6	+ 8.0
Oct	23	12	52.2	11	8	72.7	-20.5
Nov	28	12	42.9	11	6	54.5	-11.6
Dec	49	24	49.0	34	20	61.8	-12.8
Jan	9	5	55.6	8	3	37.5	+18.1
Feb	9	7	77.8	18	15	83.3	- 5.5

Mean difference = - 1.4

Test for a constant difference : d=0.82 n.s.

b) Tyne

	Male			Female			%male-%female
Month	Number marked	Number not seen	%	Number marked	Number not seen	%	
Sep	37	15	40.5	15	8	53.3	-12.8
Dec	45	19	42.2	17	11	64.7	-22.5
Jan	25	14	56.0	26	17	65.4	- 9.4
Feb	27	10	37.0	48	29	60.4	-23.4

Mean difference = -17.0

Test for a constant difference : d=2.60 P<0.01

Table 7:11

The numbers of male and female Black-headed Gulls present in a) the Wear area and b) the Tyne area each month during the 1984-85 non-breeding season, the percentages leaving out of the total present each month. and the mean monthly turnover rates.

a) Wear

Month	Males: Total present/month	Males: Number leaving/month	Males: % leaving	Females: Total present/month	Females: Number leaving/month	Females: % leaving
Jul	19	3	16	6	2	33
Aug	28	3	11	5	1	20
Sep	26	3	12	4	1	25
Oct	24	2	8	3	0	0
Nov	29	2	7	5	1	20
Dec	33	8	24	10	4	40
Jan	31	9	29	9	2	22
Feb	25	17	68	13	11	85
Mar	8	8	100	2	2	100
Jul-Feb	215	47		55	22	

Mean monthly turnover rate for July-February is 21.9% (s.e.=2.8) for males and 40.0% (s.e.=6.6) for females.

b) Tyne

Month	Males: Total present/month	Males: Number leaving/month	Males: % leaving	Females: Total present/month	Females: Number leaving/month	Females: % leaving
Jul	15	2	13	13	1	8
Aug	34	3	9	21	1	5
Sep	35	3	9	22	2	9
Oct	37	4	11	27	3	11
Nov	38	3	8	26	1	4
Dec	35	2	6	30	5	17
Jan	38	7	18	36	10	28
Feb	34	16	47	30	23	77
Mar	19	19	100	7	7	113
Jul-Feb	215	40		205	46	

Mean monthly turnover rate for July February is 15.0% (s.e.=2.2) for males and 22.4% (s.e.=2.9) for females.

areas in the 1984-85 season, 43% departed during February.) The mean monthly turnover of males from the Wear (21.9±2.8%) was significantly lower than that of females (40.0±6.6%) ($P<0.05$), indicating that females did not remain in the area for as long as males. The difference in mean monthly turnover rates from July to February for males (15.0±2.2%) and females (22.4±2.9%) in the Tyne area was also significant ($P<0.05$). There was no significant difference in mean turnover rate of males in the Wear (21.7±2.8%) and Tyne areas (15.0±2.2%) (Table 7:11), but the turnover rate of females in the Wear (40±6.6%) was twice that of females in the Tyne area (19.5±2.8%) ($P<0.05$). This indicates that female Black-headed Gulls stay in the Wear area for a shorter period than in the Tyne area (1.52 months, Table 7:7).

7:3.6 Return of birds marked in the Wear area

The numbers of marked Black-headed Gulls which returned to the Wear area in the next season (i.e. those marked in the Coxhoe, Durham and Lumley areas) have been expressed as percentages of the total numbers of birds marked in the previous season (Table 7:12), and in the case of birds marked in 1982-83, the number returning in 1984-85 is expressed as a percentage of those which returned in 1983-84. There were no significant differences in the mean number of sightings per bird between years or cohorts (Table 7:13), indicating that a similar effort went into the search for marked birds in both 1983-4 and 1984-5. There were no significant differences between percentages of returning males and females in each age-group, and so the sexes were pooled for further analysis (Table 7:12). Within each age-group, there were no significant differences in return rates of birds marked in 1982-83, and returning during 1983-84 and 1984-85. Nor were there

Table 7:12

The numbers of Black-headed Gulls marked in the Wear area as adults, second-years and first-years, and the numbers and percentages of these which were seen in the same area during the following non-breeding season.

		Adults			Second-years			First-years		
Season marked	Season returned	Total	Number returned	% (1 s.e.)	Total	Number returned	% (1 s.e.)	Total	Number returned	% (1 s.e.)
1982-83	1983-84	69	22	32 (5.6)	29	9	31 (8.6)	144	14	10 (2.5)
1982-83 *	1984-85	31	12	39 (8.7)	14	1	7 (6.9)	-	-	-
1983-84	1984-85	144	57	40 (4.1)	28	5	18 (7.2)	84	15	18 (4.2)
Total		244	91	37 (3.1)	71	15	21 (4.8)	228	29	13 (2.2)

* Figures given in the total columns are the number of birds marked in 1982-83 which returned in 1983-84. those marked as second-years and first-years having changed age class to become adults and second-years respectively.

Table 7:13

The mean numbers of sightings of Black-headed Gulls (third year or older) in the Wear area during the 1983-84 and 1984-85 seasons, not including birds which were marked during the season in question. There was no significant difference in the mean number of sightings during the 1983-84 and 1984-85 seasons of birds marked in 1982-83, nor in the mean number of sightings during the 1984-85 season of birds marked in 1982-83 and 1983-84.

	Season seen			
	1983-84		1984-85	
Season marked	N	Mean number of sightings (1 s.e.)	N	Mean number of sightings (1 s.e.)
1982-83	31	3.48 (0.70)	19	3.47 (0.71)
1983-84	-	-	62	3.71 (0.44)

significant differences between rates of return in 1984-85 of birds marked in 1982-83 and 1983-84, and consequently, birds marked and recovered in all years have been pooled to give overall return rates (Table 7:12).

Significantly more adults (37%) returned to the Wear area than either second-years (21%, $P<0.05$) or first-years (13%, $P<0.001$). Although the difference between second-years and first-years is not significant, there is a clear age-related difference in return-rate to the Wear area, where about a third of all marked adults returned, compared to about an eighth of the first-years, with second-years intermediate.

Of the 98 Black-headed Gulls marked in 1982-83 as adults and second-years, 67 (68%) were not seen during 1983-84, but four (6%) of these 67 birds did return in 1984-85. Of the 100 birds marked as first-years in 1982-83, and which were not seen in 1983-84, two (2%) returned during 1984-85. It is possible that these six birds were present in the Wear area during 1983-84, but were missed. Although they represent only a small percentage of the non-returning birds, it is clear that calculated return rates must be regarded as minimum values. Assuming that these six birds had been present during 1983-84 (when all were second-years or older), the percentage of birds marked as adults/second-years returning in 1983-84 would increase from 32% to 36%, and the percentage of birds marked as first-years returning would increase from 10% to 11%.

7:3.7 Return of birds marked in the Tyne area

The rates of return of male and female Black-headed Gulls to the Tyne area were not significantly different, and so the sexes have been combined (Table 7:14). In the 1983-84 season, 64% of Black-headed Gulls marked in 1982-83 as adults returned to the Tyne area. The following year, 72% of

Table 7:14

The numbers of Black-headed Gulls marked in the Tyne area as adults, second-years and first-years, and the numbers and percentages of these which were seen in the same area during the following non-breeding season.

		Adults			Second-years			First-years		
Season marked	Season returned	Total	Number returned	% (1 s.e.)	Total	Number returned	% (1 s.e.)	Total	Number returned	% (1 s.e.)
1982-83	1983-84	108	69	64 (4.6)	24	12	50 (10.2)	19	10	53 (11.5)
1982-83 *	1984-85	81	58	72 (5.0)	10	5	50 (15.8)	-	-	-
1983-84	1984-85	80	31	39 (5.4)	33	12	36 (8.4)	14	2	14 (9.4)

* Figures given in the total columns are the number of birds marked in 1982-83 which returned in 1983-84. those marked as second-years and first-years having changed age class to become adults and second-years respectively.

those which had been present in 1983-84 returned, and there was no significant difference between these percentages. Nor was there a difference in the percentages of second-years returning in two successive seasons. Significantly fewer adult birds marked in 1983-84 returned the season after being marked (39%) than birds marked in 1982-83 and returning in either 1983-84 or 1984-85. Although fewer second-years marked in 1983-84 returned the next year (36%) than second years marked in 1982-83 (50%), the difference was not significant, but significantly more first-year birds marked in 1982-83 (53%) returned the following season than first-years marked in 1983-84 (14%) (Fisher's Exact Probability Test P=0.027). In the 1983-84 season, 60 birds marked during the previous season were not seen in the Tyne area, but five of these 60 individuals (8%) returned in 1984-85.

Possible reasons for the observed difference in return-rates to the wintering area of the Black-headed Gulls marked in the 1982-83 and 1983-84 seasons have been considered.

a) Observational effort

There was no significant difference between the mean number of sightings of 1982-83 marked birds during 1983-84 (6.56 ± 0.63) and 1984-85 (6.31 ± 0.60), indicating that there was similar observational effort in the two seasons (Table 7:15). Additionally, the mean numbers of sightings per adult bird in 1984-85 were almost identical for the birds marked in 1982-83 (6.40 ± 0.63) and in 1983-84 (6.26 ± 1.02).

b) Catching place

Black-headed Gulls marked in 1982-83 were all caught at North Shields Fish Quay in the morning. Catches were made during September, February and March. The 1983-84 catches were made either on South Shields Beach in the afternoon (December and January) or at North Shields Fish Quay in the morning (January), the two sites being less than one kilometre apart. The

Table 7:15

The mean numbers of sightings of Black-headed Gulls (third year of life or older) in the Tyne area in the 1983-84 and 1984-85 seasons, not including birds which were marked during the season in question. There was no significant difference in the number of sightings during the 1983-84 and 1984-85 seasons of birds marked during 1982-83, nor in the number of sightings during 1984-85 of birds marked during 1982-83 and 1983-84.

	Season seen			
	1983-84		1984-85	
Season marked	N	Mean number of sightings (1 s.e.)	N	Mean number of sightings (1 s.e.)
1982-83	81	6.56 (0.63)	68	6.31 (0.60)
1983-84	-	-	43	6.26 (1.02)

possibility that birds caught at South Shields in 1983-84 were less likely to return than those caught at North Shields in 1983-84 was considered, but there were no significant differences in return-rates of birds caught at the two sites (Table 7:16).

c) Catching month

Black-headed Gulls arriving early in the season (and staying for a long period) have a greater chance of being seen than birds arriving later (and staying for only a short time). The percentages of returning 1982-83 birds caught early in the season (September 1982) and later in the season (February/March 1983) were compared (Table 7:17). The latter group probably included both early- arriving and late-arriving individuals. Significantly more September-marked adults (79%) were seen in consecutive seasons than February/March-marked adults (59%) ($P<0.01$). There was no significant difference in percentages of second-years returning, but the trend was in the same direction. (Only three first-year Black-headed Gulls were marked in September 1982, and so a comparison could not be made with those marked in February/March 1983.) These results show that the birds marked early in the 1982-83 season were more likely to return to the Tyne in consecutive seasons than birds marked later that season.

d) Season of catching

A significantly greater percentage of adults marked in February/March 1983 (59%) returned to the Tyne area in subsequent seasons than adults marked in December/January 1983-4 (37%) ($P<0.01$) (Table 7:17). The difference between second-year birds was not significant, although the trend was in the same direction, and significantly more first-years marked in February/March 1983 (62%) returned the following season than first-years marked in December/January of the 1983-84 season (14%) ($P<0.05$). Although the month of marking was clearly related to the rate of return of birds in

Table 7:16

The numbers of adult and of second-year and first-year Black-headed Gulls marked on the South Shields foreshore (December and January) and at North Shields Fish Quay (January) during the 1983-84 season, and the numbers and percentages which returned to the Tyne area in 1984-85.

Age when marked	South Shields Total marked	South Shields Number returned	South Shields % (1 s.e.)	North Shields Total marked	North Shields Number returned	North Shields % (1 s.e.)	Chi-square (1 d.f.)	P
Adult	54	20	37 (6.6)	26	10	38 (9.5)	0.01	n.s.
Second-year + first-year	28	9	32 (8.8)	19	5	26 (10.1)	0.01	n.s.

Table 7:17

The numbers of adult, second-year and first-year Black-headed Gulls marked in the Tyne area in September 1982, February/March 1983 and December 1983/January 1984, and the numbers and percentages which returned to the Tyne area in subsequent seasons.

	Month and year of marking								
	September 1982			February/March 1983			December 1983/January 1984		
Age when marked	N	Number returned	% (1 s.e.)	N	Number returned	% (1 s.e.)	N	Number returned	% (1 s.e.)
Adult	72	57	79 (4.8)	118	70	59 (4.5)	80	30	37 (5.4)
Second-year	18	10	56 (11.7)	17	8	47 (12.1)	33	12	36 (8.4)
First-year	3	1	33 (27.1)	16	10	62 (12.1)	14	2	14 (9.4)

Significantly more September 1982 adults returned in subsequent years than February/March 1983 adults (chi-square=7.08, 1 d.f., $P<0.01$), and significantly more February/March 1983 adults than December 1983/January 1984 adults (chi-square=8.23, 1 d.f., $P<0.01$). There were no significant differences in return rates of second-year birds. There were too few first-years marked in September 1982 for comparisons to be made, but significantly more February/March 1983 first-years returned than December 1983/January 1984 first-years (chi-square=5.36, 1 d.f., $P<0.05$).

subsequent years, the difference in the rate of return of 1982-83 and 1983-84 birds cannot be explained in these terms as significantly fewer December 1983/January 1984 birds returned than the February/March 1983 birds marked the previous year.

e) Arrival month

The month of arrival of Black-headed Gulls in both 1983-84 and 1984-85 was recorded and the distribution of arrival of birds trapped in September 1982, February/March 1983 and December 1983/January 1984 is presented in Fig. 7:5. Arrival into the study area begins in July, and continues throughout the non-breeding season, two birds being seen in the study area for the first time in March 1984 and one in April 1984. The pattern of arrival in the Tyne area was compared between two successive seasons (Table 7:18). Most of the birds trapped in September 1982 returned early in the season (i.e. during July, August and September) in both 1983-84 (74%) and 1984-85 (87.5%), and there was no significant difference in these proportions. It is clear that birds caught in September were typically early-arriving birds. This pattern of arrival was significantly different to that of birds marked in February/March 1983, both in 1983-84 (26% returning early) (chi-square=18.0, 1 d.f., $P<0.001$) and in 1984-85 (49% returning early) (chi-square=9.97, 1 d.f., $P<0.001$). These birds were caught late in the non-breeding season, and may have included both early and late arriving individuals. In the season after being marked, most arrivals of February/March 1983 birds occurred during mid-season (October-December, 55%), but the following season, nearly half the arrivals (49%) were early, during July-September (chi-square=6.17, 2 df, $P<0.05$) (Table 7:18). Two seasons after being trapped, the pattern of arrival of birds marked in February/March 1983 had changed, with relatively fewer birds arriving late.

Figure 7:5

The month of arrival in the Tyne area of Black-headed Gulls marked in September 1982, February/March 1983 and December 1983/January 1984, in a) the first non-breeding season after marking and b) the second non-breeding season after marking.

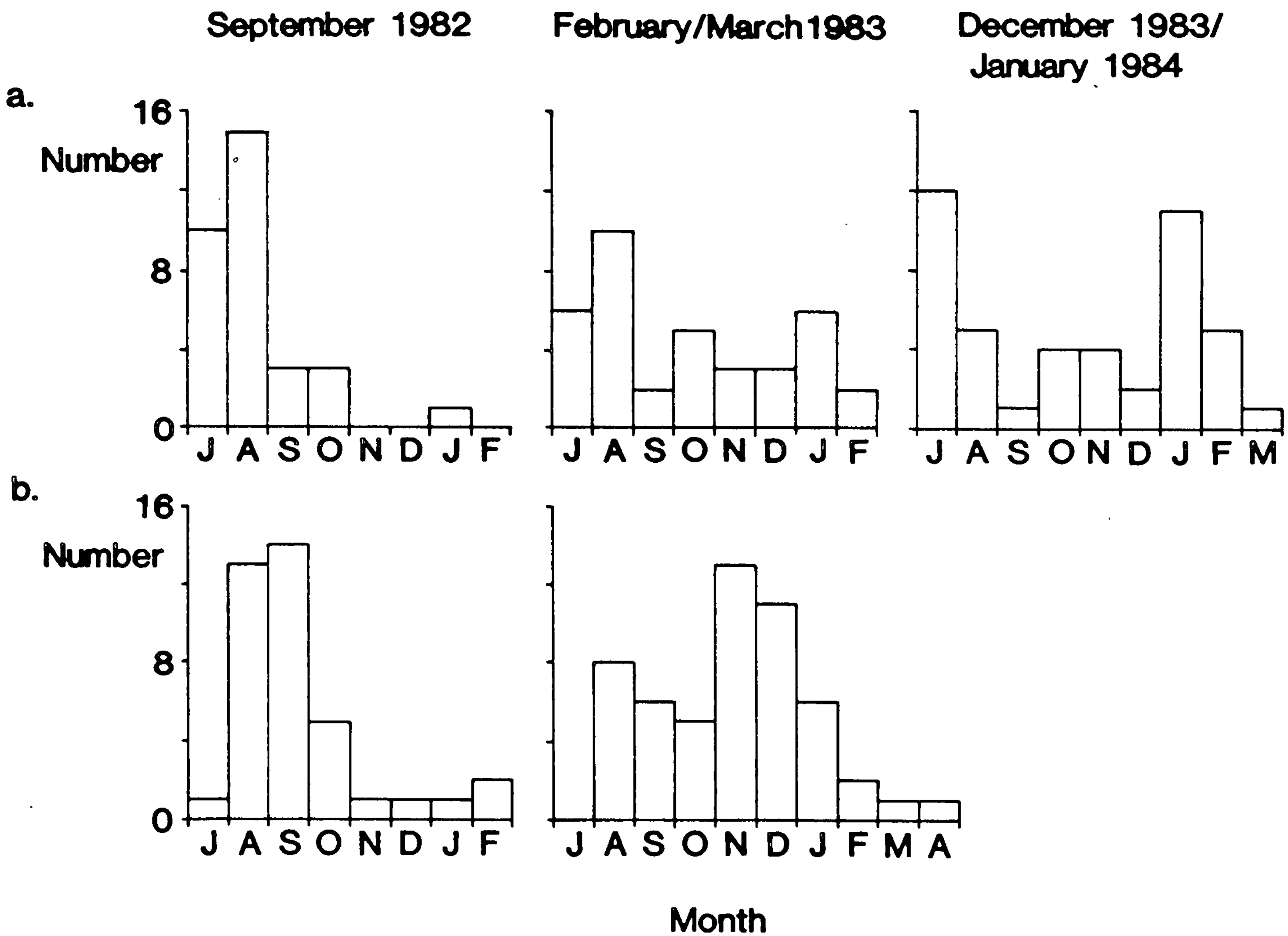


Table 7:18

The number of Black-headed Gulls marked in September 1982, February/March 1983 and December 1983/January 1984 arriving in the Tyne area during July-September, October-December and January-April a) during the 1983-84 season, and b) the 1984-85 season. Percentages are given in parentheses. Data from Figure 7:5.

a) Arrival in 1983-84

Month of arrival	September 1982	February/March 1983
Jul-Sep	28 (74%)	14 (26%)
Oct-Dec	7 (18%)	29 (55%)
Jan-Apr	3 (8%)	10 (19%)
Total	38	53

b) Arrival in 1984-85

Month of arrival	September 1982	February/March 1983	December 1983/ January 1984
Jul-Sep	28 (87%)	18 (49%)	18 (40%)
Oct-Dec	3 (9%)	11 (30%)	10 (22%)
Jan-Apr	1 (3%)	8 (22%)	17 (38%)
Total	32	37	45

All the Black-headed Gulls marked during 1982-83 which returned to the Tyne in 1983-84 were classified as early-arrivals (July-September) or as late-arrivals (October-April). The percentages of each which returned to the Tyne in 1984-85 were compared (Table 7:19) and it is clear that more early-arriving birds (86%) returned the next season than late-arriving birds (55%) (chi-square=8.65, 1 d.f., P<0.01). This explains the difference in arrival pattern of February/March 1983 birds in two successive seasons. Fewer of the typically late-arriving birds returned in 1984-85 than in 1983-84, whilst a higher proportion of the early-arrivers returned. The general pattern of arrivals in the season after tagging was compared for December 1983/January 1984 and February/March 1983 birds (Table 7:18), and there was a marked difference between the two (chi-square=17.6, 3 d.f., P<0.001). Most arrivals of February/March 1983 birds occurred during October-December (55%), but the December 1983/January 1984 birds arrived in two waves, the first in July-September (40% and the second in January-March (38%) (also see Fig. 7:5). The disproportionately low rate of return of December 1983/January 1984 birds may in some way be explained by the trend for many of these birds to arrive very late in the season.

7:3.8 Return-rates of Black-headed Gulls to the Tyne and Wear areas

The return-rates to the Wear area (birds marked in both years pooled) and to the Tyne area (birds marked in 1982-83 and 1983-84 were considered separately) were compared (Table 7:20). In each age-category, there was a significantly greater return rate of birds marked in the Tyne area in 1982-83, compared to birds marked in the Wear area, but there was no significant difference in the return rates of Black-headed Gulls marked in the Tyne area in 1983-84, compared to those marked in the Wear area. Those

Table 7:19

The numbers of Black-headed Gulls which returned to the Tyne area early (July-September) and late (October-April) during 1983-84 and the percentages of these which returned to the Tyne area in the 1984-85 season.

Month of arrival in 1983-84	Total	Number returned in 1984-85	%
Jul-Sep	42	36	86%
Oct-Apr	49	27	55%

Chi-square=8.65 1 d.f. P<0.01

Table 7:20

The percentages of adult, second-year and first-year Black-headed Gulls ringed in the Wear area (both seasons pooled), and in the Tyne area in 1982-3 and in 1983-84, which returned the next season. Data from Tables 7:11 & 7:13. Significantly more Black-headed Gulls marked in the Tyne area in 1982-83 returned the next season than birds marked in the Wear area, for adults (chi-square=20.3 1 d.f. P<0.001), second-years (chi-square=6.00 1 d.f. P<0.01) and first-years (Fisher's Exact Probability = 0.0001). There were no significant differences in the percentages of Wear birds and Tyne birds marked in 1983-84 which returned the next year.

	Area and season of ringing					
	Wear		Tyne (1982-83)		Tyne (1983-84)	
Age when marked	%	(1 s.e.)	%	(1 s.e.)	%	(1 s.e.)
Adult	37	(3.1)	64	(4.6)	39	(5.4)
Second-year	21	(4.8)	50	(10.2)	36	(8.4)
First-year	13	(2.2)	53	(11.5)	14	(9.4)

marked in the Tyne area in 1982-83 were significantly more faithful to the overwintering area in subsequent years than either birds marked in the Wear area, or birds marked in the Tyne area in 1983-84.

7:3.9 Black-headed Gulls captured in northeast England during the non-breeding season, and subsequently observed or recovered elsewhere

It has been established that at least one third of the Black-headed Gulls marked in the Tyne area, and at least two thirds of the Black-headed Gulls marked in the Wear area did not return in subsequent years. The annual average survival-rate of British Black-headed Gulls after their first-year of life, is around 84% (Chapter 3), and so one would expect a similar percentage of Black-headed Gulls to return to the study area in the year after being marked. For example, only 62% of adults marked in the Tyne area in the 1982-83 season returned the following season, and assuming that 16% of the birds died between one year and the next, 22% must have overwintered in some other area. Records of Black-headed Gulls marked or ringed in the study area and observed or recovered dead by members of the public elsewhere in the British Isles indicate the destinations of some of these non-returning birds, both in the same non-breeding season as they had been present in the study area (Fig. 7:6) and in subsequent non-breeding seasons (Fig. 7:7).

There was no evidence to suggest that first-year and older Black-headed Gulls which left the study area moved to different areas, or different distances. Similar percentages of first-years ($36\pm8.3\%$) and older birds ($28\pm12.8\%$) seen outside the study area were observed more than 25 km from the study area. In subsequent non-breeding seasons there was no difference in the distribution of birds ringed as first-years and older in the study

Figure 7:6

Black-headed Gulls present in the Tyne and Wear study areas, and subsequently seen or recovered in the British Isles during the same non-breeding season. There were also two recoveries in the Netherlands and the Frisian Islands.

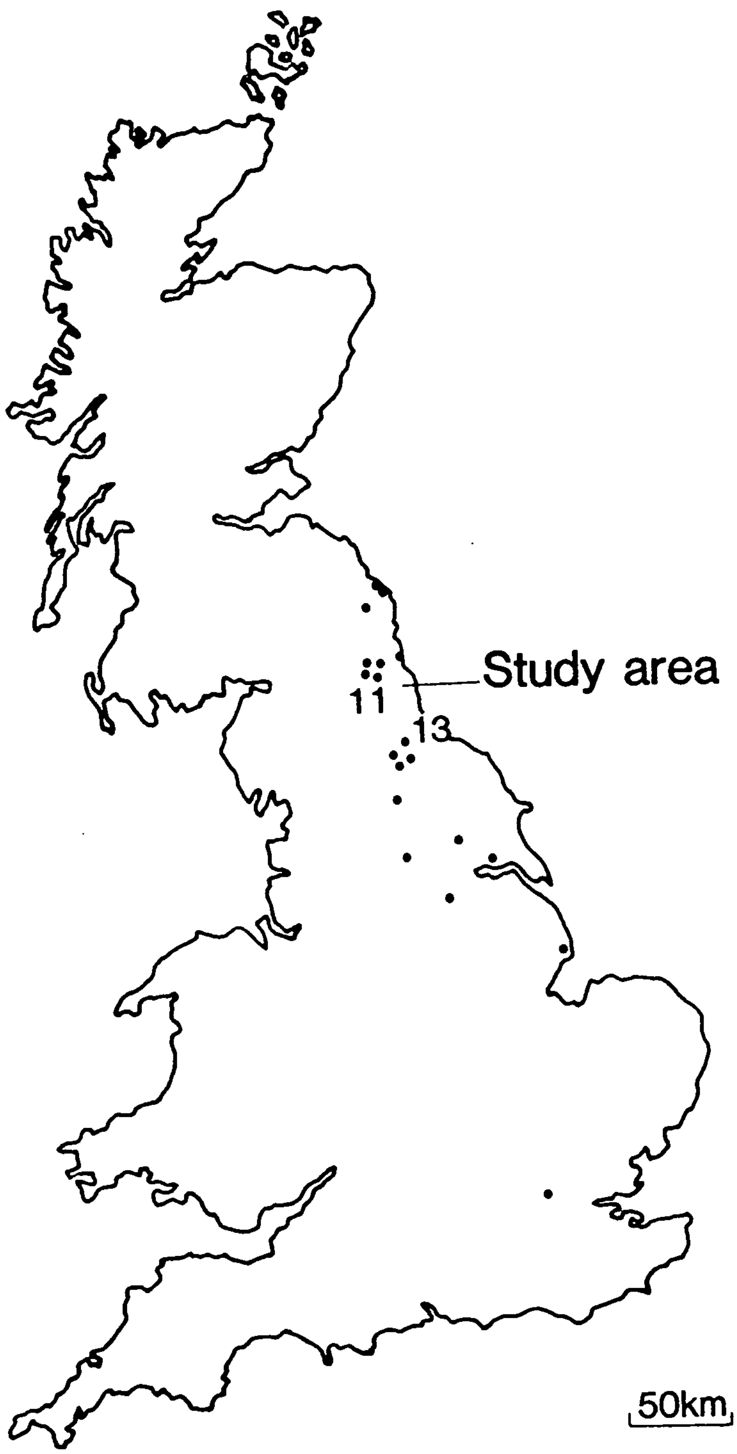


Figure 7:7

Black-headed Gulls present in the Tyne and Wear study areas, and seen or recovered in the British Isles in subsequent non-breeding seasons. There were also 36 recoveries abroad (see text).

area, and recoveries of birds of all ages have been pooled.

The only obvious difference in the distribution of males and females which left the study area during the same season was that 11 of the males (48±10.4%) were seen at Consett refuse tip (10 km northwest of Durham City) whilst none of the 15 females seen or recovered outside the study area moved to Consett. The difference is significant (P=0.001, Fisher's Exact Probability Test), and may indicate either that males tend to move inland or that males were especially attracted to this site (see Chapter 6).

During the same non-breeding season as they were seen or caught in the study area, 40 Black-headed Gulls were seen or recovered elsewhere in the British Isles, but none had moved into western regions of the British Isles (Fig. 7:6). In subsequent seasons 10 recoveries or sightings out of 65 in the British Isles were in the west of Britain (15%), and the difference between these percentages was significant (Fisher's Exact Probability Test P=0.0063). The majority of sightings in the British Isles during subsequent seasons were in eastern regions from Orkney to Kent (Fig. 7:7). Most of the 36 recoveries abroad during subsequent non-breeding seasons occurred from July to November (89%), the period of arrival of Continental Black-headed Gulls into the British Isles (Chapter 4). These recoveries abroad are probably of birds which had not yet departed for the overwintering area.

After being trapped in the study area in November, a second-year Black-headed Gull was seen in Deventer in the Netherlands later that non-breeding season. It was not seen again in the British Isles, but was recovered in Deventer again during January two seasons later. This bird had probably 'decided' that the Deventer area was favourable for overwintering and rejected the northeast study area. A similar conclusion has been drawn from sightings of a bird marked as a first-year in the study area during September 1982. The bird was not seen there again, but was seen at Cley, Norfolk during each of the three subsequent winters, indicating that northeast England had been rejected in favour of Norfolk as an overwintering area.

In four cases, marked Black-headed Gulls seen outside the study area in a subsequent season were observed in the study area soon afterwards (Fig. 7:7). One bird, marked and seen regularly in the Tyne area during 1983-84, was seen in Ripon, North Yorkshire in August 1984, then returned to the Tyne area in November 1984 where it was regularly seen until the end of February 1985. Another bird, marked during 1982-83, was present in the Tyne area from August 1983 to February 1984. The next season, it was seen in Saltfleetby, Lincolnshire on 10 August 1984, arriving in the Tyne area by 27 August 1984, and being regularly seen until early March 1985. The two birds behaved in a similar manner, being seen south of the study area in August before reaching the Tyne area and remaining there for several months. The first bird delayed about three months before reaching the Tyne, whereas the second took less than three weeks to return to the overwintering area of the previous season. The slow southward progress of another bird was observed at the end of the winter. The bird left the study area after being marked in Durham in November and was seen in West Yorkshire in January, then at Skegness, Lincolnshire in March (Fig. 7:6).

During the breeding season (May-June), most adult Black-headed Gulls from the study area (86%), but only one (7%) out of 14 recoveries of first-summer birds were recovered abroad. This difference was significant ($P<0.001$). Second-summer birds were intermediate (50%) but the difference between second-year and other age groups was not significant (Table 7:21). Most recoveries in the British Isles were in eastern or central regions (Fig. 7:8), but there was one recovery on the west coast and two birds were seen on the south coast. One of the latter was seen first on the Dorset

Table 7:21

Black-headed Gulls trapped in northeast England between July and March, and recovered or observed in Britain and abroad during May and June of the same or subsequent seasons as adults, second-years and first-years. The difference between adults and first-years is significant (chi-square=24.6, 1 d.f., P<0.001).

	Britain	Abroad
Adults	5 (14%)	30
Second-year	3 (50%)	3
First-year	14 (93%)	1

Figure 7:8

Black-headed Gulls present in the Tyne and Wear study areas outside the breeding season, and recovered or observed in the British Isles during the breeding season (May and June).

coast in May and then on the Devon coast 11 days later (Fig. 7:8). Despite exhaustive searches in County Durham and eastern Cumbria, only two marked Black-headed Gulls were seen at breeding colonies close to the study area, suggesting that adult Black-headed Gulls overwintering in the northeast were mainly of Continental origin.

7:4 Discussion

Black-headed Gulls begin to arrive in the study area in July, which agrees with the start of arrival of Black-headed Gulls from the Continent into the British Isles (Chapter 4). Individual birds were shown to have characteristic arrival and departure months in successive years, and males arrived significantly earlier than females. The mean monthly turnover rate of marked female birds in the Wear area (40%) is nearly twice that of males (22%), and the difference between males (15%) and females (22%) in the Tyne area is also significant, showing that marked females leave the study areas and are replaced by different birds more rapidly than males. First-year male Black-headed Gulls are significantly less likely to be seen again after being tagged than older males during the season of tagging, and the trend in females is in the same direction, though non-significant. This suggests either that first-years are more likely to die (first-years have a higher rate of mortality than adults until March of their first winter, Chapter 3), or are likely to move out of the study area sooner than older birds. Females are less likely to be seen again than males in the Tyne area (although not in the Wear area), and this probably indicates that they stay for a shorter length of time.

Black-headed Gulls which left the study area and were seen later the same season were seen exclusively in eastern parts of Britain (from

Northumberland to Lincolnshire, except for one bird seen in Middlesex). Since there are departures from the study area during each month of the non-breeding season, there is clearly a tendency for overwintering Black-headed Gulls to move from one area to another. The change in numbers of Black-headed Gulls within a 3 mile radius of Durham City throughout the year illustrates this point. Although numbers change little from August to November, they almost double by January, possibly due to movements of gulls from the colder uplands. The movement of marked Black-headed Gulls during the non-breeding season shows that they do not simply migrate from the breeding area to a specific wintering area, but may use more than one and possibly several wintering areas.

More departures occur in February (Tyne and Wear areas combined) than in any other month. This is more than a month earlier than the departure of Continental birds from the British Isles as a whole (Chapter 4) and suggests either that movements out of the study area occur prior to the spring migration in April, or that many marked birds were not seen between their last recorded sighting and their actual departure. The former possibility is supported by the marked decline (85%) in the number of Black-headed Gulls (marked and unmarked) counted in the Durham area between the end of January and the beginning of March. It is possible that many Continental Black-headed Gulls move south in February and March before leaving the British Isles for the breeding areas. Birds staying for a month or less in the study area were seen there mainly in December (18%), January (23%) and February (20%), which partly confirms that pre-migratory movements within the British Isles were occurring before the departure to the Continent. It is also possible that these early movements were made by the British breeding Black-headed Gulls amongst the overwintering population. Moynihan (1955) says that Black-headed Gulls at Scoulton Mere reached the area of the colony 'a matter of weeks at least' before the colony itself was occupied. The occupation of the colony began on 13 March in 1952, and so it is implied that at least some of Scoulton's breeding Black-headed Gulls had arrived in the vicinity during February. Since there is evidence of gull movements through the northeast during December and onwards, probably a gradual drift back towards the British colonies takes place, rather than a sudden departure.

Observations of Black-headed Gulls which fed in the Tyne and Wear areas indicated that these birds roosted at the coast, near the mouths of the Rivers Tyne and Wear respectively. The behaviour of individually marked Black-headed Gulls was compared between these two areas, and several differences demonstrated. There was no evidence to suggest that individuals usually fed in both Tyne and Wear areas, as birds tended to be faithful to one roost or the other during one non-breeding season. Although a few birds crossed from the Tyne to the Wear (especially to the adjacent Washington subarea) and vice versa, this occurred in relatively few instances. Whilst they remained in the Wear overwintering area, Black-headed Gulls tended to be very faithful to particular feeding areas within it, although the degree of fidelity to each of these subareas depended on the age and sex of the birds.

All age and sex classes were highly faithful to the Tyne area over a single non-breeding season, without any tendency to move into adjacent areas to feed. This suggests that the Tyne area, particularly the coast, is a very favourable area for Black-headed Gulls to spend the winter. This is supported by the rate of return to the Tyne in subsequent years of Black-headed Gulls marked in the 1982-83 season (about two thirds of the adults), although birds marked in the Tyne area in the 1983-84 season returned at about half that rate, as did birds marked in the Wear area.

Those Black-headed Gulls marked in the Tyne area in 1983-84 tended to return later in the following year than Black-headed Gulls marked in February/March 1983, and this may account for the former group's lower rate of return. Late returning birds are less likely to be seen than those which return early and thus are able to stay longer. The duration of stay of Black-headed Gulls in the Tyne area is significantly longer than in the Wear area, suggesting that the Tyne is a more preferable environment than the Wear. The reasons for the highly favourable nature of the Tyne area are discussed in Chapter 6.

Chapter 8 COMMON GULLS IN NORTHEAST ENGLAND

8:1 Introduction

British-bred Common Gulls, like British Black-headed Gulls, are not migratory, but winter in the British Isles (Radford 1960). Foreign Common Gulls which overwinter in the British Isles originate from northwest Europe, especially Scandinavia (Radford 1960).

Common and Black-headed Gulls are often seen feeding in mixed-species flocks outside the breeding season, but differences in the preferred foods and feeding areas of the two species have been noted. At the coast, Common Gulls avoid mud-flats, preferring to feed on areas of mixed mud and sand, but Black-headed Gulls are common on mudflats (Vernon 1970). Along the tidal reaches of the River Tyne, Common Gulls fed whilst resting on the water to a much greater extent than Black-headed Gulls (Fitzgerald & Coulson 1973). Common Gulls prefer to feed on well drained, upland fields, Black-headed Gulls preferring lower lying and wetter areas (Vernon 1970). In the Bristol Channel area, Common Gulls fed almost exclusively on fields (94%), whilst sewage outfalls, littoral areas and refuse tips were of little importance to them (Mudge & Ferns 1982). In the same area, 71% of Black-headed Gulls fed on fields. In areas where both species are present, there is evidence that they tend to select different fields, although the criteria adopted are not known (Jones 1985).

In this chapter, comparisons are drawn between seasonal weight changes, the preferred feeding areas and movements during the non-breeding season of Common Gulls and Black-headed Gulls in northeast England.

8:2 Methods

Common Gulls were caught along with Black-headed Gulls at the coast (Tyne area) and on fields in Durham, but in much smaller numbers. During the 1982-83 season, 37 Common Gulls were caught and marked with wing-tags, 27 were wing-tagged the next season, and 53 were marked with wingtags or colour-rings between July and September 1984. Another 11 Common Gulls were sexed and weighed, but not marked. All data on Common Gulls has been analysed in the same way as the corresponding data for Black-headed Gulls.

8:3 Results

8:3.1 Seasonal changes in weight

The small sample size of first-year Common Gulls prevents a strict comparison of their mean monthly weights with those of older birds. Inspection of Table 8:1 suggests that first-year weights are similar to those of older birds, and birds of all ages have been pooled to give overall mean monthly weights for each sex (Fig. 8:1). The seasonal pattern of weight change is not so marked as in Black-headed Gulls (Fig. 5:1), but the increase in weight from July to a winter peak and the subsequent decline are clear. In both males and females, there is little change in mean weight from July to August, then weights reach a peak in November, having increased by 15% and 12% respectively since July, increases similar to those of 12% and 15% in male and female Black-headed Gulls respectively. Common Gulls appear to reach their peak weight a month before Black-headed Gulls, which continue to gain weight during December, and Common Gull weights generally decline from November to February. The difference in weight between male

Table 8:1

The mean monthly weights of a) male and b) female first-year, second-year and adult Common Gulls caught in northeast England between September 1982 and August 1985.

a) Males

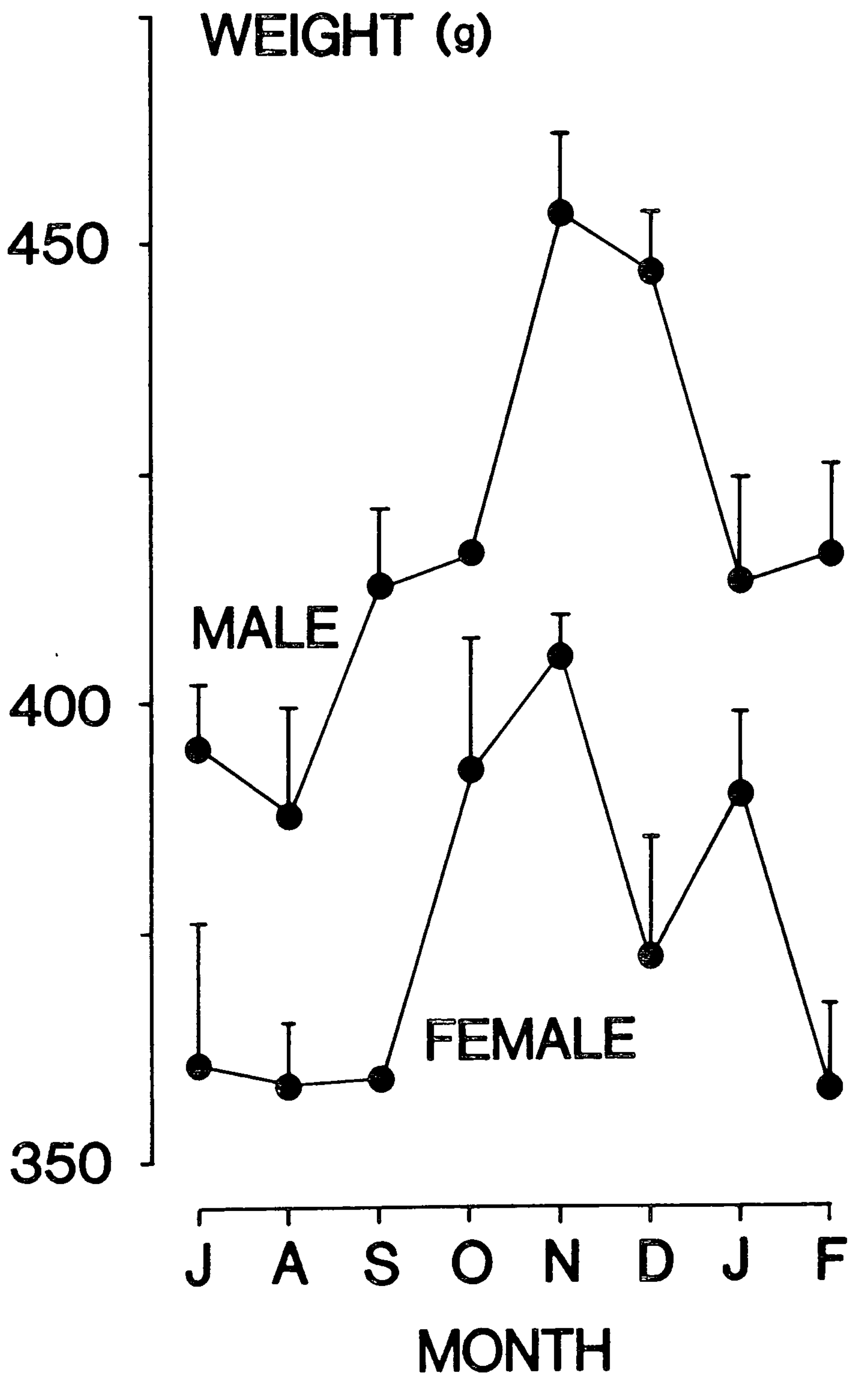
	First-year			Second-year			Adult		
Month	N	Weight	(1 s.e.)	N	Weight	(1 s.e.)	N	Weight	(1 s.e.)
Jul	0			14	394	(7.0)	1	420	
Aug	1	335		3	362	(44.2)	12	396	(11.4)
Sep	2	412	(8.5)	0			0		
Oct	1	416		0			0		
Nov	3	447	(20.3)	2	456	(1.0)	4	457	(16.4)
Dec	6	455	(11.3)	0			11	443	(8.2)
Jan	2	432	(7.5)	0			7	407	(14.4)
Feb	2	413	(11.0)	1	405		2	424	(37.0)

b) Females

	First-year			Second-year			Adult		
Month	N	Weight	(1 s.e.)	N	Weight	(1 s.e.)	N	Weight	(1 s.e.)
Jul	0			6	364	(23.1)	3	354	(9.8)
Aug	1	288		4	359	(8.5)	18	362	(7.8)
Sep				1	359		0		
Oct	1	407		1	378		0		
Nov	1	397		2	407	(8.5)	1	408	
Dec	1	393		1	321		3	382	(6.6)
Jan	1	375		0			2	398	(8.0)
Feb	3	339	(11.9)	0			5	368	(12.2)

Figure 8:1

The mean monthly weights (g) (with one standard error) of male and female Common Gulls caught in northeast England.



and female Common Gulls has been estimated by finding the weighted mean difference for the months July to February, excluding September and October owing to the small sample size (Table 8:2). The mean difference is 42.6±5.8g; thus males weigh, on average, 11-12% more than females. This difference is similar to that for Black-headed Gulls, in which males are 12-15% heavier than females.

8:3.2 Flock composition

The percentages of female Common Gulls caught at the coast and on fields in Durham have been compared (Table 8:3). Since there was no significant difference in the percentages of females amongst first-year, second-year and adult birds at each site, all age groups were pooled. There was no significant difference in the percentage of females caught in Durham (46±7.3%) and at the coast (42±5.9%). There were no significant differences in the sex ratios of Common Gulls and Black-headed Gulls caught on fields (46% and 36% respectively) or at the coast (42% and 45% respectively) (Black-headed Gull data from Table 6:5.)

The age-composition of flocks was taken from counts made in the field; second-years have been grouped with adults (Table 8:4). There were few first-years present at the coast during any month. Pooling counts for September to February, 1.9±0.3% of Common Gulls seen at the coast were in their first-year. The percentage of first-years feeding in fields in the Durham area was high in July (19%), but dropped to 6% in August, and did not increase until November (19%). A decline in the percentage of first-years occurred in February (10%) and March (8%). From September to February, 15±0.6% of birds present in flocks on fields in the Durham area were first-years. This is a significantly higher percentage of first-years than

Table 8:2

The mean monthly weights (g) ($\pm$ 1 s.e.) of male and female Common Gulls (all ages pooled), the differences in mean monthly weights of males and females, and the mean difference between the sexes. Differences were not calculated for September or October owing to the small sample sizes.

Month	Males			Females			N	Difference	s.e. of difference
	N	Weight	(1 s.e.)	N	Weight	(1 s.e.)			
Jul	15	395.3	(6.8)	9	360.6	(15.3)	24	34.7	16.7
Aug	16	386.3	(12.0)	23	358.0	(7.0)	39	28.3	13.9
Sep	2	416.0	(8.5)	1	359.0			-	
Oct	1	453.2		2	392.5	(14.5)		-	
Nov	9	453.2	(9.0)	4	405.0	(4.4)	13	48.2	10.0
Dec	17	446.9	(6.6)	5	372.0	(13.4)	22	74.9	14.9
Jan	9	412.7	(11.7)	3	390.3	(9.0)	12	22.4	14.8
Feb	5	415.8	(12.7)	8	357.0	(9.8)	13	58.8	16.0
Mean difference							123	42.6	5.8

Table 8:3

The number of adult, second-year and first-year Common Gulls, and the number and percentage of females, caught inland (Durham City) and at the coast. With all age groups pooled, the difference between the percentages of females at inland and coastal sites is non-significant (chi-square=0.03, 1 d.f.).

Age	Durham			Tyne		
	Total	Number of females	% females (1 s.e.)	Total	Number of females	% females (1 s.e.)
Adult	19	10	53 (11.5)	47	20	43 (7.2)
Second-year	9	4	44 (16.5)	18	9	50 (11.8)
First-year	18	7	39 (11.5)	6	1	17 (15.3)
Total	46	21	46 (7.3)	71	30	42 (5.9)

Table 8:4

The number of Common Gulls counted in flocks at the coast and in fields each month, and the number and percentage of first-years in the flocks. Totals for September-February are also given.

Month	Coast Total	Coast Number first-years	Coast % first-years (1 s.e.)	Fields Total	Fields Number first-years	Fields % first-years (1 s.e.)
Jul	-			180	34	18.9 (2.9)
Aug	2	0	0 (0.0)	377	23	6.1 (1.2)
Sep	32	2	6.3 (4.2)	219	14	6.4 (2.6)
Oct	66	2	3.0 (2.1)	403	30	7.4 (1.3)
Nov	8	0	0 (0.0)	974	184	18.9 (1.3)
Dec	1069	26	2.4 (0.4)	1054	192	18.2 (1.2)
Jan	1424	16	1.1 (0.3)	607	96	15.8 (1.5)
Feb	151	6	4.0 (1.6)	414	40	9.7 (1.5)
Mar	10	4	40.0 (15.5)	1234	99	8.0 (0.8)
Sep-Feb	2750	52	1.9 (0.3)	3671	556	15.1 (0.6)

at the coast (chi-square=321, 1 d.f., P<0.001), and it is clear that most first-year Common Gulls avoid the coast. There were too few counts of Common Gulls at refuse tips to determine the age-composition; during the course of this study, no more than six Common Gulls were seen at a tip at one time.

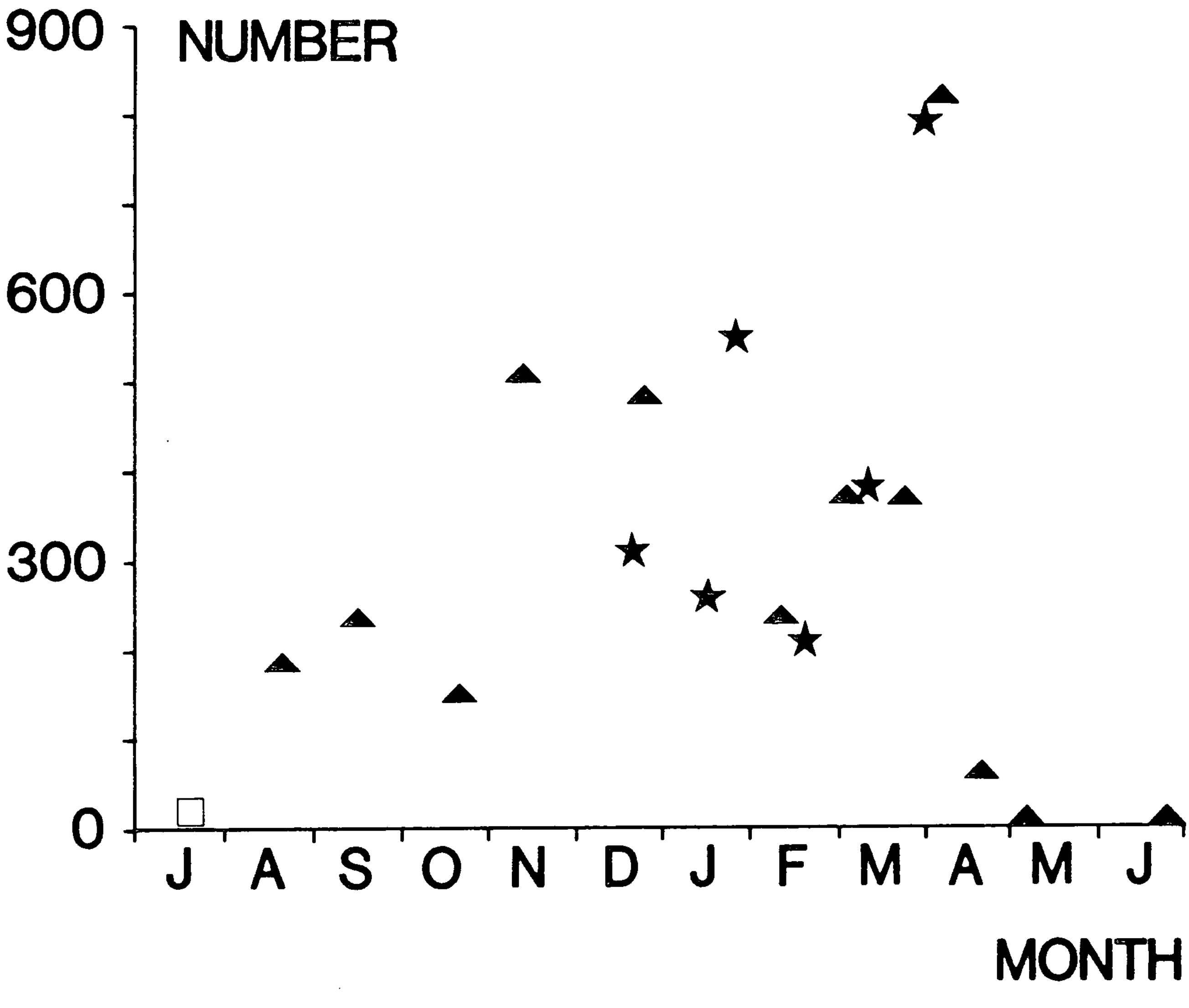
There were significantly higher percentages of first-year Black-headed (23%) than Common Gulls (15%) seen in Durham (September-February) (chi-square=98.5, 1 d.f., P<0.001), and significantly more first-year Black-headed (5%) than Common Gulls (2%) seen at the coast (September-February) (chi-square=45.0, 1 d.f., P<0.001). (Black-headed Gull data from Table 6:2).

8:3.3 Counts of Common Gulls in Durham

The number of Common Gulls within a 3 mile radius of Durham City was counted on 19 occasions between December 1982 and July 1984 at the same time as Black-headed Gulls were being counted (Fig. 8:2). (For methods see Chapter 7). Proportionately more Common Gulls (99%) than Black-headed Gulls (86%) were seen on fields (chi-square=726, 1 d.f. P<0.001), few Common Gulls being seen at sewage works or other urban habitats in the study area. There were few Common Gulls in the Durham area in July (39), but numbers increased in August (185) and remained at a similar level until late October (143). Numbers increased by a factor of 3.5 in early November (508), and varied between 200 and 550 for the rest of the winter (November to mid-March). There was an abrupt influx of Common Gulls in late March/early April, reaching totals of 794 in 1983 and 828 in 1984, an increase of about 122% on the average for the November/mid-March period. An equally abrupt decline then took place, 92% of the Common Gulls having left by mid-April. No

Figure 8:2

The number of Common Gulls counted within a three mile (4.8 km) radius of Durham City in 19 surveys. Counts made during the 1982-83 season, ★ ; counts made during the 1983-84 season, ▲ ; count made during July 1984, □ .



Common Gulls were present in May or June.

Consideration of the number of Black-headed Gulls and Common Gulls present in the study area at each count, and the percentage of Common Gulls out of all Black-headed and Common Gulls present, gives an insight into the movements of each species during the non-breeding season (Table 8:5). Both Black-headed Gulls (88%) and Common Gulls (12%) were present in July. From August to February, Common Gulls made up on, average, 29% of Black-headed and Common Gull flocks in the Durham area, with little variation about this figure, except in November (54%). From early March to early April, both numbers and percentages of Common Gulls increased, whilst numbers of Black-headed Gulls decreased. Over this period of four weeks, Black-headed Gulls were leaving the Durham area, whilst Common Gulls were arriving. In northeast England at least, Black-headed Gulls desert the Durham area before Common Gulls.

8:3.4 Return of marked Common Gulls to the Wear and Tyne study areas in the season after being marked

Adult Common Gulls were three times more likely to return to the Tyne area (40%) than to the Wear area (13%), but the difference was not significant (Table 8:6). There were too few second-year and first-year Common Gulls marked in the Tyne area to make a valid comparison with those marked in the Wear area.

Although three times the percentage of adult Black-headed Gulls (37%) than Common Gulls (13%) thanreturned to the Wear area the season after being marked, the difference was not significant (Table 8:6). There was little difference in the percentages of first-year or second-year Common and Black-headed Gulls which returned to the Wear area. Nor were there

Table 8:5

The number of Black-headed Gulls, and the number and percentage of Common Gulls counted within a three mile radius of Durham City.

Date	Number of Black-headed Gulls	Number of Common Gulls	% Common Gulls
16,17 Jul 1984	286	39	12
17,18 Aug 1983	536	185	26
15,16 Sep 1983	570	236	29
19,20 Oct 1983	598	153	20
11,13,14 Nov 1983	434	515	54
19,20,21 Dec 1983	803	454	36
20,21,22 Dec 1982	858	316	27
13,14,15,17 Jan 1983	1015	263	21
26,27,28 Jan 1983	1155	550	32
8,9,10 Feb 1984	710	238	25
14,15,16,17 Feb 1983	802	210	21
6,7 Mar 1984	535	376	41
7,8,9 Mar 1983	396	385	49
19,20 Mar 1984	317	377	54
28,29 Mar 1983	173	794	82
5,6 Apr 1984	54	828	94
18 Apr 1984	2	66	97

Table 8:6

The number of Common Gulls marked as adults, second-years and first-years a) in the Wear area, and b) in the Tyne area, and the number and percentage which returned to each area the following non-breeding season. Percentages of Black-headed Gulls from Tables 7:12 & 7:14.

a) Wear

	Common Gulls			Black-headed Gulls
	Number marked	Number returned	% returned	% returned
Adult	15	2	13	37
Second-year	6	1	17	21
First-year	18	2	11	13

b) Tyne

	Common Gulls			Black-headed Gulls	
				Marked 1982-83	Marked 1983-84
	Number marked	Number returned	% returned	% returned	% returned
Adult	20	8	40	64	39
Second-year	1	0	0	50	36
First-year	4	0	0	53	14

significant differences in the percentages of adult Common Gulls (40%) and adult Black-headed Gulls (marked in 1982-83, 64% and 1983-84, 39%) which returned to the Tyne area. Two Common Gulls marked during the 1982-83 season returned to the Wear area in the 1984-85 season, one of them having been seen in the previous season as well.

Whilst there were no significant differences in the rates of return of Common Gulls and Black-headed Gulls to the Tyne area, marked Black-headed Gulls were seen there more than twice as often per season (6.40 ± 0.41) as Common Gulls (3.00 ± 0.73) ($t=4.1$, 198 d.f., $P<0.001$). Since most searches for marked birds were carried out near the coast at North or South Shields, this suggests either that Common Gulls in the Tyne area feed inland to a greater extent than Black-headed Gulls, or that they do not stay in the area for as long. In the Wear area, there was no significant difference in the mean number of sightings per bird between Black-headed Gulls (3.70 ± 0.34) and Common Gulls (2.29 ± 0.84) ($t=1.6$, 117 d.f.).

8:3.5 Common Gulls which left the study area in the northeast of England

Thirteen Common Gulls were seen outside the Tyne and Wear study areas during the season of marking, and nine during subsequent non-breeding seasons (Fig. 8:3). Most of these birds were seen on the east coast of Britain from Aberdeen to Lincolnshire, but two were seen on the west coast during the season of marking (15%) and two during subsequent seasons (18%). There were no significant differences in the percentages of Common Gulls and Black-headed Gulls which were seen on the west coast (0% & 15% of Black-headed Gulls during the same and subsequent seasons respectively, Chapter 7). In the same season as they were marked, 11% of the 117 marked Common Gulls were seen outside the study area, whilst proportionately fewer

Figure 8:3

Common Gulls marked in the Tyne and Wear study areas, and subsequently recovered or observed elsewhere in the British Isles during the non-breeding season. The only recovery during the breeding season is shown by ◯ .

of the 893 marked Black-headed Gulls (4%) were seen outside the study area (chi-square=10.2, 1 d.f., P<0.01). This greater turnover of Common Gulls suggests that Common Gulls continued to move through the study area for longer than Black-headed Gulls, and Common Gulls probably remained in the study area for a shorter period than the Black-headed Gulls.

There have been seven recoveries in Norway, and one in Finland of Common Gulls ringed in northeast England. All but one of these recoveries occurred during the breeding season; one bird recovered during October was reported as 'not fresh', and probably died during or soon after the breeding season. The only recovery during the summer of a Common Gull ringed in the northeast in winter is of a first-year bird on the Welsh coast.

8:4 Discussion

Common Gulls become numerous in agricultural areas of the British Isles during the winter, but this study and others (Mudge & Ferns 1982, Vernon 1970) have shown that the species is uncommon in urban areas and at refuse tips compared to Black-headed Gulls.

A lower percentage of first-year Common Gulls occurred at the coast at the mouth of the River Tyne (1.9%) compared to inland fields around Durham City (15%). Whilst first-year Black-headed Gulls show a similar tendency to avoid the coast, percentages of first-year Black-headed Gulls are higher than of Common Gulls both at the coast and in the Durham area. This may be due to a genuine difference in the adult/first-year ratio, or perhaps by first-year Common Gulls moving further inland than first-year Black-headed Gulls to areas outside the study area. Van de Weghe (1971) found a similar percentage of overwintering first-year Common Gulls at the coast in the Scheldt estuary area to that found at the mouth of the River Tyne, although four times the percentage of first-year Common Gulls (63%) were present inland in his study area (Zeebrugge and Ghent) than in northeast England. The sex ratio of Common Gulls and Black-headed Gulls was similar both at the coast and in Durham.

Common Gulls and Black-headed Gulls showed a similar seasonal pattern of weight change, although Common Gulls probably reached their peak weight in November, and Black-headed Gulls in December. Adult British Herring Gulls also reach their peak weight in December (Coulson et al. 1983c), but maintain that weight for the next four months, unlike the two smaller species whose weights immediately decline after reaching the peak. Cold weather makes some earthworms move deeper into the soil (Gerard 1967), and little ploughing is done in winter, so the availability of certain invertebrate food must decline as winter arrives. The avoidance of urban areas and refuse tips by Common Gulls, where food is available throughout the winter, may be the reason for their weight not increasing from November to December like Black-headed Gulls. Black-headed Gulls more readily supplement their diets at refuse tips, sewage works, bird-tables etc.

In July, 12% of birds in Black-headed and Common Gull flocks in the Durham study area were Common Gulls, and this percentage increased to 26% in August, changing little until the end of February. This suggests that on average, Common Gulls arrived in the Durham study area about a month later than Black-headed Gulls. Relative to Black-headed Gulls, Common Gulls increased during March, then the number of Common Gulls in the Durham area doubled between mid-March and late March/early April. These were almost certainly foreign Common Gulls which congregated near to the east coast prior to the spring migration. These Common Gulls declined rapidly over the next two weeks, presumably as the birds migrated to their breeding areas. These observations agree with those of Bourne & Patterson (1962), who state that the main spring migration of Common Gulls is very abrupt, and occurs in late March/early April.

Marked Common and Black-headed Gulls returned to the study area in similar proportions, but during the non-breeding season, individual Black-headed Gulls were seen more often than Common Gulls. This suggests that Common Gulls do not remain in the study area for as long as Black-headed Gulls. Common Gulls are more likely to be seen outside the study area after being tagged than Black-headed Gulls, suggesting that the period of the autumn migration continues for longer in Common Gulls. It is also possible that Common Gulls are more inclined than Black-headed Gulls to wander between different overwintering areas throughout the non-breeding season, but further studies of large samples of marked gulls are necessary to determine which, if either of these possibilities is correct.

Chapter 9 GENERAL DISCUSSION

9:1 Population dynamics

The annual survival rate of adult Black-headed Gulls (i.e. second-year and older) in the British Isles has been estimated as 84.4%, and that of first-years as 65.7% (Chapter 3). Assuming that most Black-headed Gulls first breed when almost two years old (Patterson 1965), a fledging rate of 0.56 chicks/pair is necessary to maintain the population. Numbers of breeding British Black-headed Gulls, in England and Wales at least, have been increasing considerably for most of this century (see successive population estimates, Hollom 1940, Marchant 1952, Gribble 1962, Gribble 1976) suggesting that fledging success has been higher than 0.56 chicks/pair/year. This has not been the case at the formerly huge colony at Ravenglass, Cumbria. Fledging success was 0.44 chick/pair in 1961, 0.17 chicks/pair in 1962, and 0.32 chicks/pair in 1963 (calculated from data in Patterson 1965). The Ravenglass colony has been declining for at least 25 years, and has now disappeared (N. Anderson, pers. comm.). Despite the decline of some colonies, others have grown and new ones been founded (Gribble 1976). Since 6% of the wintering population of Continental-reared adults and 9% of second-years are present in the British Isles in summer (Chapter 4), it is possible that immigration from Continental colonies appreciably increases the British breeding population of Black-headed Gulls, although the identification of Continental-reared birds has still to be established in British colonies.

9:2 Migration

Baker (1978) defined migration as 'the act of moving from one spatial unit to another'. This broad definition includes seasonal and daily return movements, emigrations in which the animals do not return to the original area, and movements through the home range (nomadism). The most commonly accepted definition of vertebrate migration is the regular (usually annual) journey from breeding area to wintering area and back, individuals moving between the same general areas each year (Dorst 1962). This regular pattern of movement is typical of birds breeding in arctic and temperate regions. Energy requirements increase in cold weather, and at the same time, food may be more difficult to obtain in winter, so most arctic-breeding birds and many birds which breed in temperate regions leave the breeding areas at the onset of winter or earlier. For example, Swifts and Swallows feed exclusively on flying insects (Witherby et al. 1958), and since insects decline in the northern hemisphere after the summer, Swifts and Swallows migrate to winter in the southern hemisphere. Some tropical bird species also show typical seasonal migration, with the breeding range distinct from the non-breeding range (e.g. White Throated Bee-eater, Abdim's Stork (Elgood, Fry & Dowsett 1973)). A well-known example of mammalian migration is that of the Barren-ground Caribou, which annually migrates 100-700 miles (Kelsall 1968).

Baker (1978) postulates that migration thresholds exist in many animals. He suggests that an animal should not migrate until the suitability (h1) of the occupied habitat (H1) is less than the product of the suitability (h2) of the habitat to which the animal migrates (H2) and the cost (in terms of energy) of migration (M): $h1<h2.M$. This assumes that the animal is aware of conditions in both its present habitat and that to

which it will migrate, and implies that it can 'guess' the conditions in the latter from its previous experience there. Whilst there is no proof that adult birds and mammals have this ability, it clearly cannot be the case in juveniles which have not migrated before. The young animal must time its departure from the natal area according to that of adults, or have a genetically determined departure time, or simply leave when the suitability of the habitat (h1) declines below a particular level.

The protracted period of departure of some bird species in autumn could be partly explained in terms of Baker's migration equation, or, more simply, in terms of the suitability of the occupied habitat. The suitability of a habitat need not be the same for every individual of a species, implying that the 'migration threshold' varies between individuals, so that some migrate early, whilst others wait until changes in habitat suitability (h1 or h2) occur. For example, increasing proportions of Latvian-ringed Black-headed Gulls were recovered outside their country of origin from July to November, after which all had left the country (Viksne 1960), showing that the autumn departure in Latvia extends over a similar period to that of arrival in the British Isles (Chapter 4). The movements of some Black-headed Gulls out of the Baltic region in late summer and early autumn (e.g. Viksne 1960), and their arrival in the British Isles from July onwards (Chapter 4), suggest that conditions in the Baltic region deteriorate at the end of the breeding season. One possible difference between the two regions in late summer and autumn is food availability. In the British Isles, earthworms are an important part of the diet of Black-headed Gulls (Vernon 1972), and whilst drought and cold weather decrease their availability (some species descend deeper into the soil and become inactive, Gerard 1967), they are available for most of the year. Examination of the stomachs of 134 Black-headed Gulls shot on Latvian lakes between May and September showed they had mainly been feeding on insects, although oligochaetes, molluscs, spiders and fish had been taken as well (Tima 1960). The oligochaetes were taken by Black-headed Gulls from April to June, but not later in the summer. This may indicate that oligochaetes were unavailable, possibly due to the dryer summer climate in the Baltic region. Another difference between the Baltic area and the British Isles is tidal range. Unlike British waters, there is little tidal movement in the Baltic Sea, thus retricting the availability of intertidal invertebrates, which are frequently eaten by Black-headed Gulls (Mudge & Ferns 1982, Vernon 1970 & 1972).

The advantages of migration over non-migration vary according to the breeding area. Many species are migratory, resident or partial migrants (i.e. some individuals migrate from a given locality whilst others remain as residents) in different parts of their range. For example, Blackbirds are mainly sedentary in southern England, where the climate in winter is usually mild, but the proportion of migrant Blackbirds increases from south to north in the British Isles, and in Norway, where winters tend to be severe, almost all Blackbirds are migrants (Lack 1944). A similar situation exists in Black-headed Gulls. Almost all British-reared Black-headed Gulls remain in the British Isles over the winter (Radford 1962), east Baltic Black-headed Gulls all vacate the region in winter (Cramp & Simmons 1983), but Danish Black-headed Gulls are partial migrants. Depending on the area of ringing, 10-25% of Danish-ringed birds are recovered in Denmark in winter, and the rest mainly in Germany, the Netherlands, Belgium, France, Great Britain, Ireland and the Iberian peninsula (Andersen-Harild 1971). The contrast in Black-headed Gull behaviour indicates that there are important differences in the suitability of winter habitats in different regions. A major difference between the Baltic region and the British Isles is the climate. The British Isles are characterised by a mild, wet 'oceanic' climate, and the difference in temperature between summer and winter is about four times less than that in the Baltic region (Krebs 1978). Unlike British coastal waters, much of the Baltic Sea freezes in winter (Haila 1983). The severity of winter weather is probably an important reason for Black-headed Gulls leaving the area. Refuse tips (Horton et al. 1983), sewage outfalls on rivers (Fitzgerald & Coulson 1973), sewage works (Vernon 1972) and "handouts" from the public in urban areas are all important sources of food to Black-headed Gulls, especially when they cannot get invertebrate food in cold weather. The presence of a large human population is clearly of great importance to Black-headed Gulls in the winter. The human population density of England (359 people/square kilometre) is considerably greater than that of countries surrounding the Baltic Sea (14-54 people/square kilometre), which are mainly vacated by Black-headed Gulls in winter (Cramp & Simmons 1983). (Population densities calculated from data given in Bartholomew, 1985). The combination of a cold climate, low availability of invertebrate food in autumn and winter and a low human population (low availability of sewage and refuse) makes the Baltic area increasingly inhospitable after the end of the breeding season. Conditions in Denmark are mid-way between the Baltic area and the British Isles; for example, the human population density is 119 people/square kilometre. This means that although Denmark is not as favourable a wintering area as the British Isles, some of its breeding population (10-25%, Andersen-Harild 1971) can successfully overwinter there.

Numerous studies have been carried out on annual migrations of birds (e.g. Moreau 1952, Lack 1958, Thomson 1953), but less has been published concerning movements of birds once in their wintering areas. During the breeding season, birds which show parental care for their young (i.e. most species) are tied to a relatively small area surrounding the colony or territory, but afterwards neither adult nor juvenile birds are constrained to remain in a restricted area. Even in cases where the adults remain in the same area over winter, juvenile birds usually disperse in late summer or autumn (e.g. Golden Eagle, Cramp & Simmons 1980; Bittern, Cramp & Simmons 1977). Many species of birds, including migratory species, have a strong tendency to breed in the same area, or even on the identical site, year after year (e.g. Gannet, Nelson 1978; Fulmar, Macdonald 1977; Kittiwake, Coulson & Wooller 1976; Kirtland's Warbler, Berger & Radabaugh 1968; Blackbird, Snow 1958). In the same way, individual birds often return to sites which they have visited in previous winters (e.g. Black-headed Gull, Chapter 7; Common Gull, Chapter 8; Shelduck, Evans & Pienkowski 1982; Oystercatcher, Goss-Custard, Durell & Ens 1982; several wader and passerine species, Moreau 1969). A bird which spends all the non-breeding season in the same familiar area will know the location of the best food sources, the best roosting area or shelter, and should be able to exploit its resources more efficiently than a bird which is unfamiliar with the area. For example, Pied Wagtails defending winter feeding territories along a river bank fed on insects washed onto the bank (Davies & Houston 1981). The resident bird visited stretches of river bank systematically, so that the food supply had time to be renewed before the bird revisited each stretch. Davies & Houston (1981) found that territorial, resident birds fed more profitably than intruders, as the former avoided recently depleted stretches of river bank. Goss-Custard et al. (1982) had similar findings in their study of Oystercatchers wintering on the Exe Estuary. Resident birds found and swallowed significantly more mussels than transient birds.

In some cases, the suitability of wintering areas may change. If food availability declines, an animal can either switch to a different type of food or move to another area. The wide range of foods exploited by gulls wintering in the British Isles (Vernon 1972, Mudge & Ferns 1982) probably allows them to change feeding strategies when necessary. For example, the number of Black-headed, Common, Herring and Great Black-backed Gulls increases at refuse tips in severe weather (Horton et al. 1983). The Ural owl differs from most other Fennoscandian owls in being highly resident, the pairs often remaining in their territory for life (Lundberg 1979). They are able to do this by being generalist feeders, taking birds and squirrels when their preferred food (field voles and water voles) is scarce.

Species which are specialised feeders will move to wherever the preferred prey is abundant. For example, swallows and bee-eaters overwintering in Africa are itinerant, moving to areas where rains have fallen, and insects have become superabundant (Moreau 1952). The phenomenon of irruption is usually interpreted as a response to food shortage. Some bird species, dependent on an irregularly fluctuating winter food supply, and usually non-migratory, periodically emigrate in large numbers (e.g. Nutcracker, Crossbill, Great Spotted Woodpecker, Waxwing, Red Squirrel). These irruptions occur irregularly and Lack (1954) states that the ultimate factor involved is shortage of food, and that the proximate factor is both food shortage and a response to high density of the species. Svärdson (1957) suggests that irruptive species begin to migrate each year, but the migration is usually halted by the presence of abundant food before the birds have travelled far. In years when food is scarce, the migratory (or irruptive) movement should continue until a food-rich area is reached.

Another reason for changing the wintering area might be to explore new areas, thus assessing the relative suitability of several alternative sites. Baker (1978) explains autumn migration of first-year birds as an example of 'exploratory migration', with the young birds travelling through previously unfamiliar areas. He suggests that exploratory migration during the winter enables young birds to assess the suitability of several areas, as either future wintering or breeding areas. It is true that first-winter birds often travel further than older birds during the non-breeding season (e.g. Gannet, Thomson 1974; Shag, Galbraith, Russell & Furness 1981; Black-headed Gull, Flegg & Cox 1972; Song Thrush, Lack 1943). Black-headed Gulls colour-marked in northeast England in their first year are more likely to leave the study area than older birds after being ringed (Chapter 7). Black-headed Gulls marked as adults return the next non-breeding season in greater proportions than those marked as second-years, and the proportion of birds marked as first-years which return is lower still. Since differential mortality cannot account for all the difference between age groups, it is possible that proportionately more first-year and second-year birds chose an alternative wintering area in subsequent years. The length of stay in the study area is variable, some birds being seen only once, and others being seen several times over a period of up to nine months. Since fidelity to the study area was greater for second-years than first-years, and greatest of all for adults, it is possible that this trend continues throughout life, and that the birds which return regularly, staying for long periods, are the oldest adults which no longer undertake exploratory migrations during the non-breeding season. Competitive exclusion might also help explain the recorded movements of Black-headed Gulls during the non-breeding season. In Chapter 6, it was shown that both first-year and female Black-headed Gulls occurred in low proportions at three refuse tips, and in higher proportions on fields. It seems possible that competition from adult males prevented a substantial proportion of the first-years and females from feeding at the tips. Birds pushed out into less favourable feeding areas may have given up and moved on to new areas. This suggestion is supported by females staying in the study area for shorter lengths of time than males, and first-years moving out of the study area sooner than older birds (Chapter 7).

The spring migration of birds back to the breeding areas usually takes place over a shorter timespan than the autumn migration (e.g. Black-headed Gull, Prüter 1982). It is advantageous to return to the breeding area early in spring to gain the best nesting sites and to compete for mates. However, the spring migration should not take place before conditions in the breeding area are likely to ensure the birds' survival. These constraints probably result in the abrupt spring migration of some species. Immature birds which are non-breeders do not necessarily show the same behaviour in spring as adults. In some species, first-years arrive later in the breeding area than adults, and in others, first-years remain in the wintering area over the summer (Arctic Tern, Common Tern & Sandwich Tern, Langham 1971; Gannet, Thomson 1974; Manx Shearwater, Harris 1966). First-year Continental Black-headed Gulls do not depart abruptly from the British Isles in spring, but leave gradually between March and June, during which time there is a greater percentage of the wintering population of first-years present than of adults and second-years (Chapter 4). A substantial proportion of Continental first-years stay in the British Isles over the whole summer, presumably staying for their second winter as well.

9:3 Conclusion

An important outcome of this study of Black-headed Gulls has been to demonstrate that these birds are relatively immune to harsh weather and food shortage in winter. Even in very cold periods, there is no evidence that overwintering Black-headed Gulls have difficulty in obtaining sufficient food, and except in 1962-63, cold winters had no appreciable effect on the survival of the British breeding population. The omnivorous feeding habits of this species, and especially its ability to feed on refuse and sewage, must assure its success as a British breeding bird for the present time. The huge influx of Continental Black-headed Gulls in autumn shows that the British Isles can support a much higher population over the winter. It is possible that competition from Continental birds during the non-breeding season has prevented the British breeding population from expanding more than it has this century. It could be argued that a lack of suitable breeding sites will limit the population. Black-headed Gulls generally breed on moorland, in reeds and sedges surrounding tarns, on saltmarsh and on sand dunes, but there is no reason why they should not colonise urban areas, nesting on rooftops as as Herring Gulls have done for several years (Monaghan & Coulson 1977). It is not impossible that competition from foreign Black-headed Gulls for 8-9 months of the year has limited the expansion of British Black-headed Gulls so they have not yet become urban pests in the breeding season.

CHAPTER 10 SUMMARY

1. Samples of 1867 Black-headed Gulls and 128 Common Gulls were trapped during the course of the study, of which 893 and 117 respectively were individually marked with wingtags or colour-rings. Biometrics of all birds were recorded, and sex was determined using head-and-bill length (discriminant values were 81mm and 88mm for Black-headed and Common Gulls respectively).

2. Aluminium and monel rings on Black-headed Gulls lose 3.5% and 3.8% of their weight respectively each year. The eventual illegibility and loss of worn rings begins to affect survival rate estimates of ringed birds after the 10th year of life, when the estimated annual adult survival rate is 13% lower than for 2nd-10th year birds.

3. Annual survival-rates of Black-headed Gulls (2nd-10th year) varied from 89±1.2% in Scotland to 78±2.8% in Ireland. The mean survival-rate in the British Isles for 1949-80 was 84.4±0.4%.

4. First-year survival-rates varied from 67±1.7% in eastern England to 58±3.3% in Ireland. The mean survival-rate in the British Isles for 1949-80 was 65.7±0.9%.

5. The severity of winter weather had no appreciable effect on the yearly survival-rates of Black-headed Gulls, except during the exceptionally severe winter of 1962-63, when survival rates of adults and first-years were 71.4±2.4% and 45.2±3.8% respectively, i.e. mortality rates had increased by 83% and 60% respectively.

6. First-year survival-rate is lower than that of adults from fledging until the following March.

7. Black-headed Gulls from the Continent begin to arrive in the British Isles in July.

8. First-year and second-year Continental Black-headed Gulls arrive soonest in the British Isles from nearby countries, but there is no relationship between distance and time of arrival in adults.

9. Numbers of overwintering adult and second-year Continental Black-headed Gulls are greatest from November to March, and those of first-years from December to March.

10. In May and June, 5.7±0.8% of adult Continental Black-headed Gulls and 8.9±1.5% of second-years remain in the British Isles. It is not known whether they breed. In May, 36±4.2% of first-years remain and 17±3.0% remain in June.

11. The departure of first-year Continental Black-headed Gulls lasts from March to June, but that of older birds occurs abruptly in late March to early April.

12. German and Danish Black-headed Gulls leave for the breeding colonies in late March, and other Continental birds leave about a week later.

13. Overwintering Continental Black-headed Gulls are recovered in higher proportions than British birds in the south and east of the British Isles, but in lower proportions in the north and west. For example, 81% of recoveries in southeast England were of Continental birds, whilst in northwest Scotland, 9% of recoveries were of Continental birds.

14. There is no difference in weights of Black-headed Gulls caught at dawn and after mid-day from July to October, but those caught at dawn are 7.2g lighter in November, and 19.7g lighter in December and January.

15. Adult Black-headed Gulls weigh least in July (273g and 238g for males and females respectively), and reach a peak in December (322g and 285g for males and females respectively). Weights decline from January to March, but no weights were obtained for April or May. Weights of second-years were similar to those of adults.

16. First-year Black-headed Gulls were considerably lower in weight than adults in July (223g and 221g for males and females respectively). Their peak weight (313g and 280g for males and females respectively) was reached in December, although there was little difference between November and December.

17. Male Black-headed Gulls weigh, on average, 12-15% (34.4g) more than females.

18. Severe weather has no appreciable effect on the weights of Black-headed Gulls.

19. First-year Black-headed Gulls are more easily caught than older birds.

20. The percentage of first-years in inland flocks of Black-headed Gulls was low in July (5%), but from September to March, it varied between 11% and 32%. At the coast, the percentage of first-years was consistently low from July to February (3-6%), but there was a suggestion that the percentage of first-years increased in March and April.

21. There were higher percentages of first-years in inland flocks (23% in fields and 17% at tips) than at the coast (5%) (September-February pooled).

22. The low percentage of first-years at the mouth of the River Tyne was similar to that found at other coastal areas in northeast England.

23. The percentage of adult females and the percentage of first-years at different inland feeding sites were positively correlated. At the coast, there was a high percentage of adult females (45%) but few first-years (5%).

24. Adult males outnumbered adult females in all catches of Black-headed Gulls, the percentage of females varying between 18% and 45%.

25. First-years fed less efficiently than adults, obtaining fewer food-items per unit of time.

26. Black-headed Gulls caught at the coast were usually seen feeding at the coast, whilst those caught inland fed at various inland sites. There was

little interchange between the two areas.

27. Black-headed Gulls first arrived in the Durham study area in July (286), and numbers changed little from August to October. Numbers increased from November to a peak in January (1155), and declined rapidly during February and March, none remaining by May. Numbers were similar in two successive seasons.

28. Black-headed Gulls were relatively more common on fields than in urban habitats in the Durham study area, although the proportion in urban habitats increased up to 32% in midwinter.

29. Male Black-headed Gulls were more faithful to the Coxhoe (97%) and Durham (82%) areas than females (85% and 69%) during a single non-breeding season.

30. Adult Black-headed Gulls were more faithful to the Tyne and Coxhoe areas (99-85%) than to the Durham and Lumley areas (82-77%).

31. First-years Black-headed Gulls were more faithful to Lumley (87% and 96% for males and females respectively) than to Durham (53% and 32% for males and females respectively).

32. Individual birds tended to arrive in and depart from the study area at the same time in successive years: 65% returned, and 72% departed in the same or adjacent month in two successive seasons.

33. Males tended to arrive in the wintering area earlier than females, but the sexes had similar departure times.

34. Black-headed Gulls tended to stay in the Tyne area more than a month longer than in the Wear area.

34. Most birds which were present for a month or less in the study area were seen in December, January and February, suggesting that birds were moving through the study area at that time.

36. First-years stay in the study area for a shorter time after being

marked than adults.

37. The turnover rate of females is greater than that of males in both Wear ($21.9\pm2.8\%$ and $40.0\pm6.6\%$ for males and females respectively) and Tyne areas ($15.0\pm2.2\%$ and $22.4\pm2.9\%$).

38. In the season after being marked, 37% of adults, 21% of second-years and 13% of first-years returned to the Wear area.

39. The percentages of birds marked in 1983-84 which returned to the Tyne area the next season were similar to those returning to the Wear: adults 39%; second-years 36%; first-years 14%.

40. Higher percentages of birds marked in the Tyne area in the 1982-83 season returned the next season: adults 64%; second-years 50%; first-years 53%.

41. Birds which arrived early in the non-breeding season were more likely to be seen the following season (86%) than those marked late (55%).

42. Black-headed Gulls seen in the northeast are not seen in western parts of the British Isles during the same season.

43. Most first-years caught in the northeast spend their first summer in the British Isles (93%), compared to 14% of adults.

44. Common Gulls' seasonal pattern of weight change is similar to that of Black-headed Gulls, but peaks in November.

45. Male Common Gulls weigh 11-12% more than females (43 ± 5.8g).

46. First-year Common Gulls were scarce at the coast: 1.9% of Common Gulls in flocks there were first-years compared to 15% in inland fields. Common Gulls avoided refuse tips.

47. Common Gulls avoided urban habitats, sewage works and refuse tips.

48. Numbers of Common Gulls in the Durham study area increased from June (0) to November (515), then numbers remained similar until late March/early April when numbers more than doubled (800). This abrupt influx of Common

Gulls was followed by an equally abrupt decline, and no Common Gulls remained by May.

49. A greater percentage of adult Common Gulls returned to the Tyne area the season after being marked (40%) than to the Wear area (13%).

50. Individual Black-headed Gulls were seen more often each season (6.4 times/bird in the Tyne area, 3.7 times/bird in the Wear area) than Common Gulls (3.0 times/season in the Tyne area, 2.3 times/season in the Wear area).

51. More Common Gulls (11%) than Black-headed Gulls (4%) were seen in another area after being seen in the study area that season.

52. The movements and migrations of Black-headed Gulls are discussed and compared to other species. The effects of immigration from the Continent on the British breeding population are considered.

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APPENDIX 1 Scientific names of bird and mammal species mentioned in the text

Bee-eater, White-throated	Aerops albicollis (Vieillot)
Bittern	Botaurus stellaris (Linnaeus)
Blackbird	Turdus merula Linnaeus
Caribou	Rangifer tarandus groenlandicus (Linnaeus)
Crossbill	Loxia curvirostra Linnaeus
Duck, Wood	Aix sponsa (Linnaeus)
Duck, Eider	Somateria mollissima (Linnaeus)
Dunlin	Calidris alpina (Linnaeus)
Eagle, Golden	Aquila chrysaetos (Linnaeus)
Fulmar	Fulmarus glacialis (Linnaeus)
Gannet (European)	Sula bassana (Linnaeus)
Gull, Black-headed	Larus ridibundus Linnaeus
Gull, Common	Larus canus Linnaeus
Gull, Great Black-backed	Larus marinus Linnaeus
Gull, Herring	Larus argentatus Pontoppidan
Gull, Lesser Black-backed	Larus fuscus Linnaeus
Heron, Grey	Ardea cinerea Linnaeus
Heron, Little Blue	Florida caerulea (Linnaeus)
Kittiwake	Rissa tridactyla (Linnaeus)
Mallard	Anas platyrhynchos Linnaeus
Moorhen	Gallinula chloropus (Linnaeus)
Nutcracker	Nucifraga caryocatactes (Linnaeus)
Owl, Ural	Strix uralensis Pallas

Oystercatcher	_Haematopus ostralegus_ Linnaeus
Pelican, Brown	_Pelecanus occidentalis_ Linnaeus
Shag,	_Phalacrocorax aristotelis_ (Linnaeus)
Shearwater, Manx	_Puffinus puffinus_ (Brünnich)
Shelduck	_Tadorna tadorna_ (Linnaeus)
Squirrel, Red	_Sciurus vulgaris_ Linnaeus
Stork, Abdim's	_Sphenorynchus abdimii_ (Lichtenstein)
Swallow	_Hirundo rustica_ Linnaeus
Swift	_Apus apus_ (Linnaeus)
Tern, Arctic	_Sterna paradisaea_ Pontoppidan
Tern, Common	_Sterna hirundo_ Linnaeus
Tern, Royal	_Sterna maxima_ Boddaert
Tern, Sandwich	_Sterna sandivicensis_ Latham
Thrush, Song	_Turdus ericetorum_ Turton
Wagtail, Pied	_Motacilla alba yarelli_ Gould
Warbler, Kirtland's	_Dendroica kirtlandii_
Waxwing	_Bombycilla garrulus garrulus_ (Linnaeus)
Woodpecker, Great Spotted	_Dendrocopus major_ (Linnaeus)