The distribution and feeding ecology of gulls on the tidal reaches of polluted rivers in North East England

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ABSTRACT

The study was concerned with investigating the manner in which six species of gulls utilized a tidal river habitat and with studying the factors that influence their distribution in this habitat. The study areas were on the tidal reaches of the Rivers Tyne, Wear and Tees. Regular censuses were taken of the numbers of gulls of each species in the study areas and their distribution was studied in relation to a number of factors which included the amount of sewage entering the section, the amount of mud exposed along the banks at low tide, the degree of urbanization along the banks of the sections, and the width of the river. The various species were found to be affected differently by the factors studied. From the census data observations were made on the seasonal variations in the number of gulls along the rivers.

An investigation was made of the feeding behaviour and food preferences of the gulls frequenting the rivers. The study indicated that the species concerned had specialized in their food preferences and feeding methods so that the food sources present were used by one or more species. Detailed work was done on the effects of tide and time of day on the feeding patterns of Common and Black-headed Gulls and some detailed studies were made on the distribution of gulls feeding on the rivers in relation to sewage outfalls. Observations were also made on the preferred resting places of the

gulls along the rivers. The relative importance of sewage outfalls as feeding sites gives a means of predicting the effects of proposed reduction of sewage pollution of the river. Such sections are likely to affect the Black-headed, Herring and Greater Black-backed Gulls to the greatest extent and the Kittiwake least.

THE DISTRIBUTION AND FEEDING ECOLOGY OF GULLS ON THE TIDAL REACHES OF POLLUTED RIVERS IN NORTH EAST ENGLAND

by

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..... being a thesis presented in candidature for the degree of Master of Science in the University of Durham 1970

ACKNOWLEDGMENTS

The writer wishes to express his thanks to Dr. J.C. Coulson who supervised his work, and Professor D. Barker for making available the facilities in the Department of Zoology, Durham.

Thanks are also due to :-

The Port of Tyne Authority for permission and the Harbour Master and his staff for their assistance in taking the censuses of the River Tyne,

The Tyneside Joint Sewerage Board, the Sunderland Borough Engineer and the Engineer of the Teesside County Borough for the information which they so readily made available,

Dr. A.G. Hawkes for his assistance with some statistical problems,

Members of the Department for their helpful discussion,

Mrs. R.J. Ashton for typing the final draft,

Mr. E. Henderson for the photographic work.

INTRODUCTION

In the last fifty years the number of gulls in Britain has progressively increased (Meadows 1961, Parslow 1967). This has been attributed to two main factors; increases in the amount of domestic human wastes in the forms of sewage, fish offal, and garbage tips, coupled with the adaptation of the gulls' behaviour to exploit these new food sources (Sparck 1951); and increased protection for gull species (Coulson 1963, Parslow 1967). These increases in the numbers of gulls have resulted in an expansion of species habitats and probably increased competition among the species.

One area where the gulls have greatly expanded is on the polluted rivers which pass through urban areas. The River Tyne is one such river. Even as recently as thirty years ago it had salmon runs but it is now heavily polluted with almost 40 million gallons of untreated sewage being discharged daily into its tidal reaches. The River Tyne, however, is important in supplying food for many gulls, particularly in the winter months. At the present time there is a sewage system under consideration which is expected to solve the pollution problems in the river. If this scheme comes to fruition it would have a major effect on the abundance and distribution of gulls feeding along the river. In order to take advantage of this situation it is necessary to have an understanding of the ways in which the gulls use the present river habitat so that any changes can be detected and evaluated.

Crook (1953), studying the gulls of Southampton Water, looked in detail at their roosting behaviour and dispersion from the roost over what he called a "dispersal system". The study was also concerned with the feeding behaviour of estuarine birds in relation to the state of the tide and the time of day. To some extent it was concerned with inland feeding.

Cramp & Teagle (1955) investigated two stretches of the River Thames in London, looked at the status of the gulls in the areas, and recorded the monthly variations in the numbers present in each species. They studied the feeding behaviour of the gulls and made notes on their perching sites. The differences in the numbers of gulls in the two sections were discussed but no indication was given of the relative importance of the individual factors affecting the distribution.

In a study on the Severn Estuary, Vernon & Walsh (1966) made observations on the feeding behaviour of the Common Gull (Larus canus) which included both inland and river feeding. They also looked at the roosting behaviour of the species.

Forty years ago Rollin (1928, 1930, 1931) studied the gulls of the River Tyne and the Tyneside area. This study included work on the feeding and roosting behaviour. He hoped eventually to "reconstruct a detailed picture of the winter life of" the gulls of the area but such an account has not been published.

Coulson & MacDonald (1962) gave accounts of the numbers of Kittiwakes (Rissa tridactyla) in the region of the Newcastle Swing Bridge and showed that there had been an increase in their numbers in that area. They also discussed the feeding behaviour of the Kittiwakes in the river.

Besides these studies little work has been done on the gulls in the river habitat. A few investigations showed some of the habitat preferences of some species of gulls (Courtenay 1933; Barnes 1950, 1952; Erskine 1963). There have also been some inquiries into the food preferences and feeding behaviour of various species of gulls. The more important of these studies were carried out by Mendall (1939), Sparck (1951), Mills (1957), Davis (1958), Boswall (1960), Harris (1964) and Parslow (1967).

This study was carried out primarily on the River Tyne with additional observations being made on the Rivers Wear and Tees over the period from October 1969 to September 1970. These rivers are frequented throughout the year by six species of gulls, the Herring Gull (Larus argentatus), Lesser Black-backed Gull (Larus fuscus), Greater Black-backed Gull (Larus marinus), Black-headed Gull (Larus ridibundus), Common Gull and the Kittiwake. The purpose was to investigate the feeding ecology and distribution of gulls in the rivers; to determine and assess the relative importance of the factors that influence the distribution of the gulls; and to look at the seasonal

variations of the gull populations on the rivers. The results give some indication as to how pollution influences the various species and provide a base line from which the effects of future changes in the amount of pollution can be measured.

STUDY AREAS

I. General

The three study areas were on the tidal reaches of the Rivers Tyne, Wear and Tees. In these areas untreated domestic and industrial sewage is released directly into the rivers. The rivers are used as ports and are in part navigable. Much of the area around the rivers is highly industrial and there are large urban areas with a high density of population.

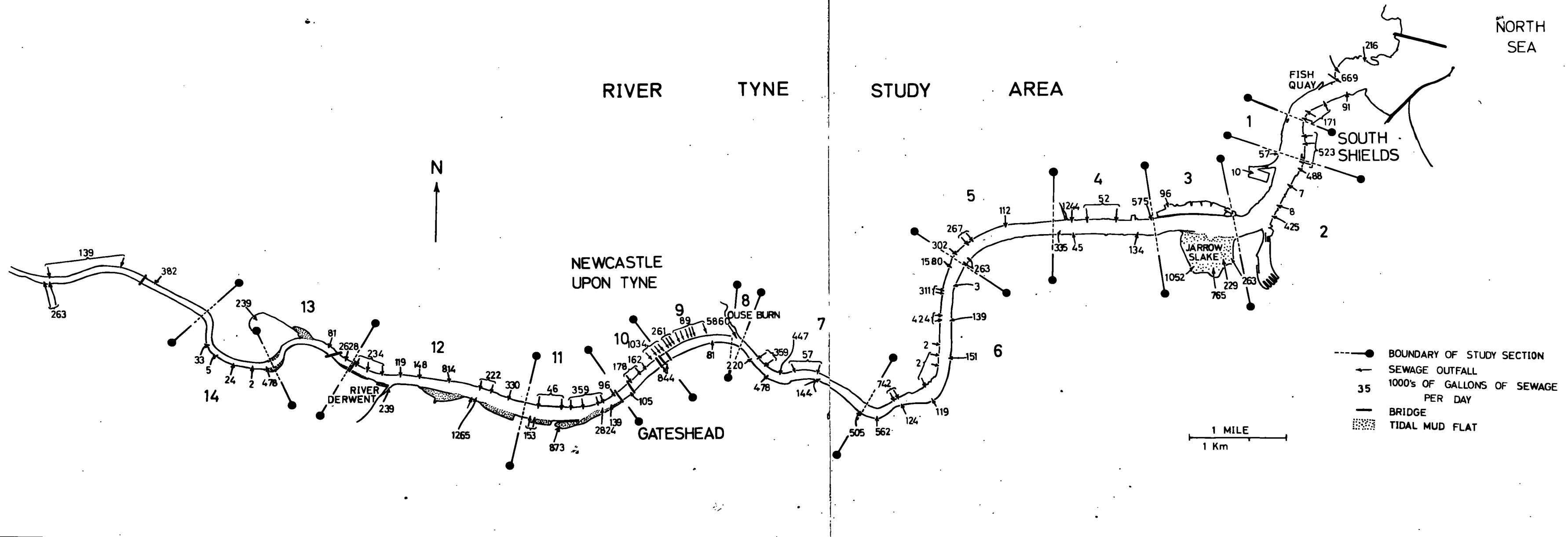
II. River Tyne

The River Tyne was the main study area. It was divided into 14 consecutive study sections which extended 24.25km (15 miles) upstream from the North Shields Ferry landing. These sections were of arbitrary length being divided by obvious landmarks such as buildings or bridges which could easily be seen. Some observations were also made in the area of the Fish Quay which is 0.8km from the North Shields Ferry landing and 0.65km from the river mouth (Figure 1). Shipbuilding and ship repair yards make up the bulk of the industry along the river. The port facilites of the River Tyne extend as far as the Newcastle Swing Bridge but the river is navigable as far as the end of section 14 for smaller ocean craft. Table 1 gives a description of each section.

TABLE: 1 DESCRIPTION OF THE RIVER TYNE STUDY AREA

SECTION	AMOUNT OF RAW SEWAGE ENTERING THE SECTION (MILLION GAL./DAY)	LENGTH OF THE SECTION (Km)	AVERAGE WIDTH OF THE SECTION (Km)	AMOUNT OF MUD EXPOSED AT LOW TIDE (Km)	NUMBER OF OUTFALLS	NOTES
1	0.521	0.69	0.36	0.00	2	Industrial banks and ship docking
2	0.995	1.62	0.35	0.00	6	
3	1.844	1.37	0.42	0.90	5	Jarrow Slake, a large tidal mudflat dotted with mooring posts
4	2.537	1.70	0.25	0.31	7	Industrial banks, ship docking and warehouses
5	1.009	1.21	0.31	0.22	7	
6	4.213	3.64	0.20	1.97	17	South bank, open and grassy, garbage tip. North bank, lined with warehouses
7	2.206	2.43	0.15	1.70	9	Open grassy banks
8	5.860	0.15	0.14	0.00	1	Warehouses on north bank, River Ouse enters here. South bank, open.
9	1.371	1.22	0.13	0.00	14	Wharfs and sheds line banks
10	1.384	1.97	0.18	0.77	7	4 bridges, many buildings on banks
11	4.482	1.67	0.20	0.80	12	A few warehouses on banks, North bank built up, South bank, open
12	3.371	3.04	0.18	3.52	13	
13	2.710	1.65	0.12	1.38	2	Banks open and grassy
14	0.543	1.70	0.07	1.69	5	

Figure 1. River Tyne Study Area


RIVER TYNE STUDY AREA
NORTH SEA
N
NEWCASTLE UPON TYNE
GATESHEAD
RIVER DERWENT
LOUSE BURN
FISH QUAY
SOUTH SHIELDS
JARROW SLAKE
1 MILE
1 Km
BOUNDARY OF STUDY SECTION
SEWAGE OUTFALL
35 1000's OF GALLONS OF SEWAGE PER DAY
BRIDGE
TIDAL MUD FLAT

III. River Wear

The River Wear study area had 8 discontinuous sections (Figure 2). These sections could easily be observed from accessible places along the bank or from bridges. The industry along the river is mostly ship repair services and shipbuilding with the port facilites extending to the end of section 3. Beyond this point the river is not navigable. See Table 2 for a description of the individual study sections.

IV. River Tees

The River Tees study area consisted of 5 discontinuous study sections (Figure 3). The main difference between the River Tees and the other rivers is that there is a large industrial effluent released into it from the numerous chemical plants that border it. The navigable portion of the river extended beyond the end of section 4. See Table 3 for a description of the individual sections.

TABLE: 2 DESCRIPTION OF THE RIVER WEAR STUDY AREA

SECTION	AMOUNT OF RAW SEWAGE ENTERING THE SECTION (MILLION GAL./DAY)	LENGTH OF THE SECTION (Km)	WIDTH OF THE SECTION (Km)	AMOUNT OF MUD EXPOSED AT LOW TIDE (Km)	NUMBER OF OUTFALLS	NOTES
1	0.000	1.127	0.269	0.322	0	Harbour mouth, some boats docked most banks clear
2	2.091	1.158	0.080	0.510	4	Some shipbuilding, banks mostly free of development
3	2.444	0.595	0.085	0.463	3	Shipbuilding yards along most of this section
4	1.313	1.175	0.107	2.305	3	Banks mostly open, large amounts of mud exposed at low tide
5	0.682	0.708	0.053	1.416	5	Banks free of development
6	0.000	0.322	0.027	0.644	0	Banks grass covered, free of urban or industrial development
7	0.000	0.579	0.023	1.158	1	
8	0.000	0.579	0.021	0.463	1	

TABLE: 3 DESCRIPTION OF THE RIVER TEES STUDY AREA

SECTION	AMOUNT OF RAW SEWAGE ENTERING THE SECTION (MILLION GALL./DAY)		LENGTH OF THE SECTION	AVERAGE WIDTH OF THE SECTION	AMOUNT OF MUD EXPOSED AT LOW TIDE	NUMBER OF OUTFALLS		NOTES
	DOMESTIC	INDUSTRIAL	(Km)	(Km)	(Km)	DOM.	IND.	
1	0.00	0.00			-	0	0	Large tidal mud and sand flat
2	9.40	0.20	4.34	0.20	2.89	6	13	North bank, mostly open fields South bank, industrial, ship docking
3	3.80	232.30	1.08	0.12	2.16	4	5	North bank, open fields South bank, railway yard and buildings, partly open
4	0.00	0.00	0.70	0.08	0.32	4	0	Buildings line most of the banks
5	0.24	0.00	0.28	0.04	0.56	2	2	Grassy banks

Figure 2. River Wear Study Area

RIVER WEAR STUDY AREA

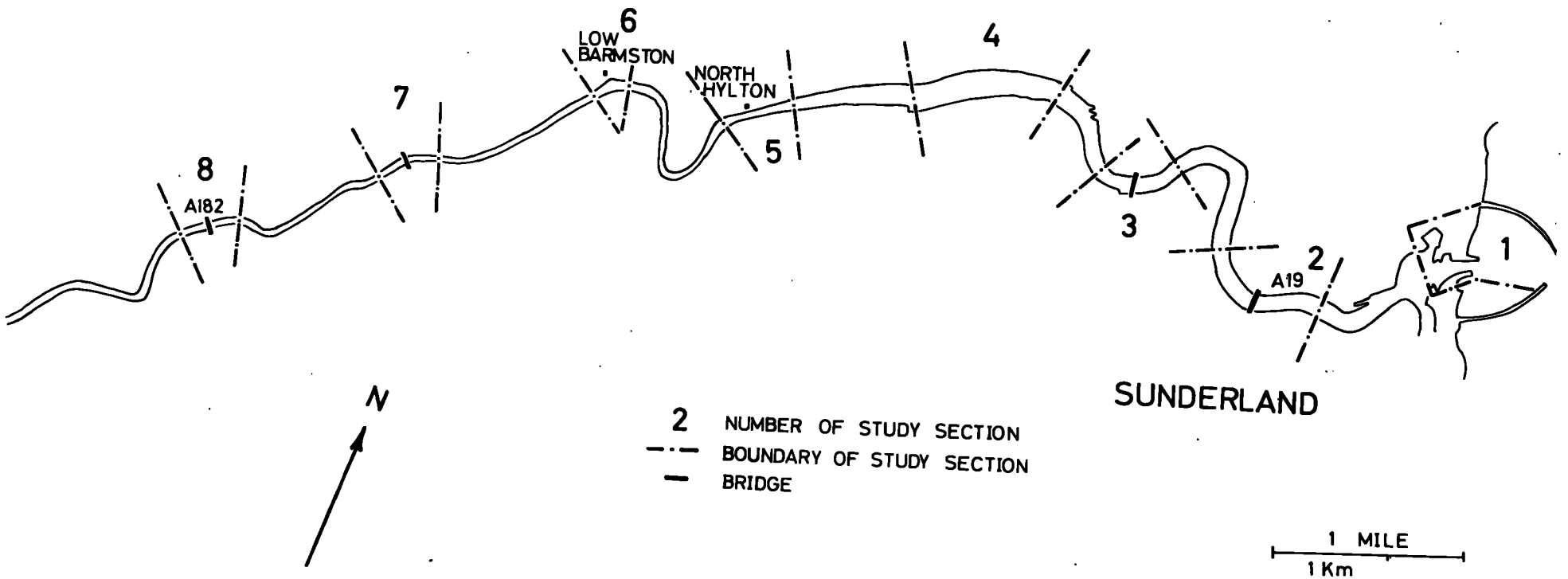
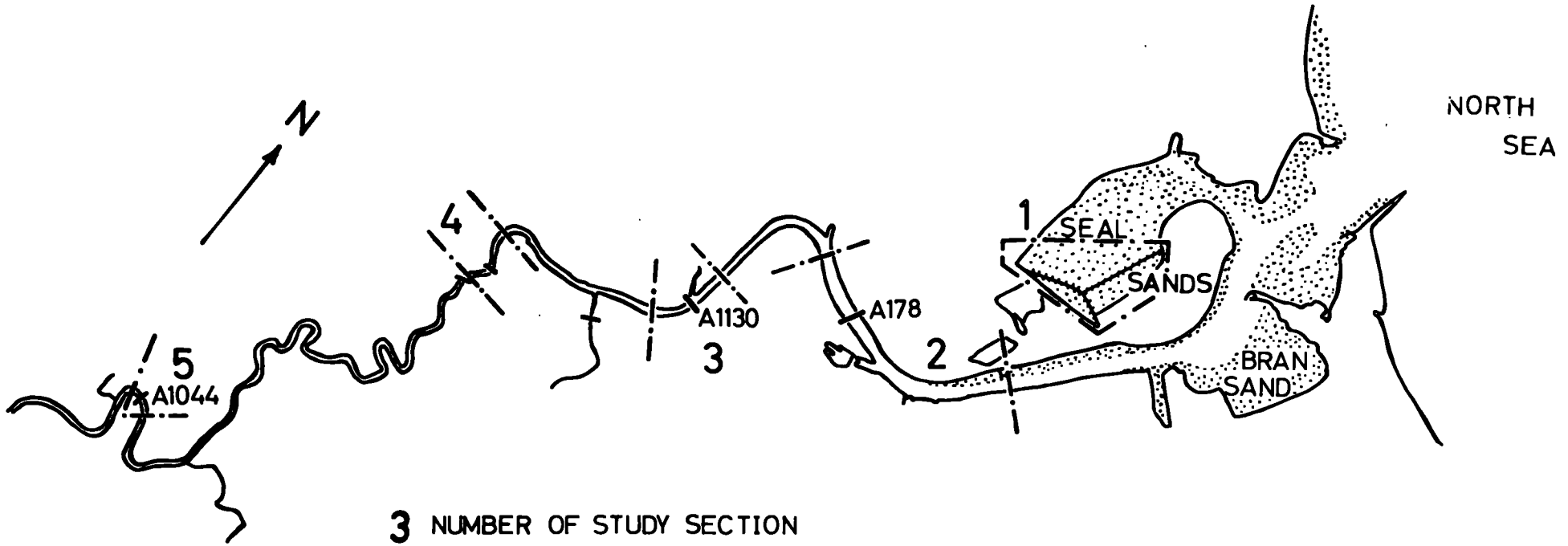


Figure 3. River Tees Study Area

RIVER TEES STUDY AREA



METHODS

I. Census Techniques

1. River Tyne

The River Tyne, being mainly inaccessible from the banks, was censused during the river inspection by the Patrol Boat of the Port of Tyne Harbour Authority. One sampling run took about one and one half hours. The observations were usually made in the morning, starting at least one hour after sunrise and finishing about noon. The numbers of each species of gull flying over the river and surrounding buildings and fields as well as those sitting on the river, wharfs, breakwaters and surrounding buildings were recorded. Observations of this type were made at intervals of two to three weeks. The Fish Quay area near the river mouth was sampled from the bank as this was outside the area patrolled by the boat. During the winter months this was done on separate days but as the days lengthened it was possible to sample this area after the regular survey of the river. On 1 April 1970 the patrol boat's schedule was changed so the Fish Quay was then sampled at about 12.30 B.S.T. Until April 1970 the patrol boat made only one trip a day, leaving the North Shields Ferry landing at 9.00 B.S.T. It went up the river to the end of section 14 and returned to the Swing Bridge at Newcastle about 11.15 B.S.T. where it lay until about 14.30 B.S.T. before returning to North Shields about 15.45 B.S.T.

After 1 April 1970 the boat made two trips daily. Between 9.00 and 12.00 B.S.T. it made a return trip from North Shields to the end of section 14, and from about 14.00 to 16.00 B.S.T. it made a return trip from North Shields to the Newcastle Swing Bridge (end of section 9). The censuses were always made on return trips to the end of section 14.

2. Rivers Wear and Tees

The Rivers Wear and Tees were censused from bridges or accessible portions of the river banks. For each section the numbers of gulls flying or resting in the study sections which included the river, the surrounding terrain and buildings were recorded for each species.

3. Analysis of census data

In evaluating the distribution of the species on the rivers and to determine the relative importance of individual factors a stepwise regression was used in the University's IBM 360 computer. The programme's code was BMD02R (Dixon 1968). Regressions were calculated for all six species on the River Tyne and for all but the Kittiwake and Lesser Black-backed Gull on the River Wear for which there were too little data. For computational purposes the stepwise regressions were calculated using the average number of gulls in each section. This was done in an effort to reduce the effects of large daily and seasonal fluctuations in the numbers of gulls.

In computing the regressions for the Black-headed, Lesser Black-backed, Herring and Greater Black-backed Gulls on the River Tyne the distance from Jarrow Slake was used instead of the distance upstream. This was done because these species roosted on Jarrow Slake and it was assumed that their distribution would be focused from that point.

For each equation the variable "length of the section" was forced into the equation first to remove the obvious variation due to the random choice of lengths of the sections. After this a sequence of multiple linear regression equations was computed in a stepwise manner. At each step one variable was added to the regression equation. The variable added was the one which made the greatest reduction in the error sum of squares. Equivalently it was the variable which had the highest partial correlation with the dependent variable partialed on the variables which had already been added; and equivalently was the variable which, if it were added, had the highest F value (Dixon 1968). From the series of regressions the one which was considered to be the "best" predictive equation was the one which had the largest Multiple R value and a significant F value.

4. Discussion of Census Techniques

In taking a census of the rivers it was possible to get accurate data by making a direct count of the gulls

of each species present in the study sections. The study on the effect of tide and time on the activity of Common and Black-headed Gulls (page46) showed that there were mass movements of Black-headed Gulls in the river around sunrise and that Common Gulls did not enter the river in any numbers until just after sunrise. By one hour after sunrise, however, their mass movements upstream ceased and the numbers of these gulls in any area remained relatively constant until about one hour before sunset. Observations also revealed that the other species were relatively constant from 1hr after sunrise to 1hr before sunset. By making the observations during this period any errors which could be introduced by the movements up and down the river were reduced. Some individual movements were observed but it was assumed that the gains balanced the losses. The short time required to take the censuses also helped to limit the effects of the gulls' movements about the rivers. It was therefore assumed that the counts taken give an accurate picture of the numbers and distribution of the gulls on any given day.

II. Feeding Behaviour

1. General Methods

The methods of feeding used by each species of gull were observed from accessible places on the river bank with the use of a 15-60X zoom telescope and 8X binoculars. These observations were made at great enough distance so as not to disturb the gulls. The information collected in this way was supplemented by observations made during the regular census trips and other work along the rivers.

Quantative information was gathered during the regular census trips on the Rivers Wear and Tees. On the River Tyne feeding information was gathered on a few occasions while going the opposite direction to that in which the census was made. The number of gulls observed using each method of feeding was recorded for each species.

2. Types of food taken

Observations were made on the types of food taken and the importance of each type was estimated for each species of gull. The types of food were classified under 6 categories; offal, live fish, floating insects and/or bits of sewage, carrion, organisms on or in the mud, and "hand outs" from humans. A "hand out" is defined as any item of food which is thrown to the gulls

by passers by. It was impossible to be more specific than this as there was no way of collecting specimens for stomach content analysis. The gulls could not be netted over the river and it was not possible to shoot them as the area around most of the study sections was highly urbanized. It was beyond the scope of this study to sample the river or mud for potential food material.

3. Feeding about sewage outfalls

To determine the extent to which gulls feed on the effluent of sewage outfalls, feeding birds were divided into two classes; those feeding at sewage outfalls and those feeding over the remainder of the river. From experience the area about an outfall was defined as extending 15 metres from the bank and 20 metres long. Only gulls which were feeding on the wing were recorded as it was difficult to determine whether birds which were standing or floating by an outfall were actively feeding. Observations were made along the length of the River Tyne study area.

Throughout the year investigations were made on Common and Black-headed Gulls whilst Kittiwakes and Lesser Black-backed Gulls were only studied when abundant along the river. Herring Gulls were studied at the same time as Kittiwakes and Lesser Black-backed Gulls. Greater Black-backed Gulls were not recorded as they were very rarely seen feeding on the wing, spending most of their time apparently resting and observing.

4. The effects of tide and time on the activity and feeding rates of Common and Black-headed Gulls

This study was carried out over the winter, from November to March inclusive, on a small study area just east of the boundary between sections 6 and 7 on the River Tyne. The study area was about 140 metres long. Observations were made from a hill on the north bank from which the study area could be easily observed with a pair of binoculars.

On the hour and half hour the numbers of Common and Black-headed Gulls flying in the study area were recorded. Between the hour and half hour several observations of the numbers of feeding dips per minute of each species were recorded. A "dip" is defined as each time a flying bird dropped to, or near, the water's surface and put its bill into the water. For each observation one bird was followed for a period of one minute and the number of dips it made was recorded. If the gull flew out of sight another gull of the same species was immediately observed for the remainder of the time period. If there was no other gull to continue observing, the trial was discontinued. Observations were made from about three quarters of an hour before sunrise until after sunset when it was too dark to make further observations.

On each day the tide cycle was different so a complete series in tide cycles was observed in relation

to time. In this way the effect of the state of the tide cancelled itself out when considering the time in relation to sunrise or sunset, and vice versa.

For each species the mean for the observations of the numbers of gulls flying during the day was set to equal 100 per cent and the appropriate results for that day were calculated to give an "index of activity" for that species for the period of observation. For a measure of the feeding rate the "index of activity" was multiplied by the number of "dips" per minute to give the "population feeding rate" for that period of observation. By using the "index of activity" instead of the numbers observed flying, the effect of large fluctuations on the number of birds present, due to changes in the weather, was removed and the data could be averaged without a minority of days observations overriding the entire set of results.

III. Resting Sites

Data were collected during the regular census trips. The heights at which the gulls were resting were recorded with the water surface being the zero point of reference. The heights were divided into five categories, 0 metres (on the water), 0 - 2 metres (on the mud and gravel banks), 2 - 8 metres, 8 - 14 metres, and greater than 14 metres. Qualitative notes were also made on species perch preference at other times.

There are inherent inaccuracies in a method like this when a moving grid is used to sample sites which are either stationary (water surface and mud) or moving with respect to it. There were also problems in being accurate when quickly estimating heights from a moving boat. To overcome these problems obvious categories such as water/surface and mud were used and the categories which required estimations of height were quite wide to reduce errors and to reduce the effect of the changing grid. It is therefore assumed that the results from this study give a good picture of the preferences of the individual species.

IV. Physical characteristics of the rivers

Lengths, widths, and areas of the study sections were obtained from Ordnance Survey maps. Information about the types of banks was also taken from Ordnance Survey maps and was supplemented by observations along the rivers. Measurements of the amount of mud along the banks were made at low tide. Figures for the amounts of sewage, both industrial and human, being released into the River Tyne were obtained from the Joint Tyneside Sewerage Board and from the appropriate Borough Councils for the Rivers Wear and Tees. The extent of urbanization along the river banks was given as a rank value from 1 to 5; 1 equalled 0 - 20% urban development; 2 equalled 21 - 40% urban development, and so on up to 5 equalling 81 - 100% urban development as measured by the percentage of the bank taken up by warehouses, factories and shipyards etc.

RESULTS AND DISCUSSION

I. Seasonal variation in the numbers of gulls along the rivers

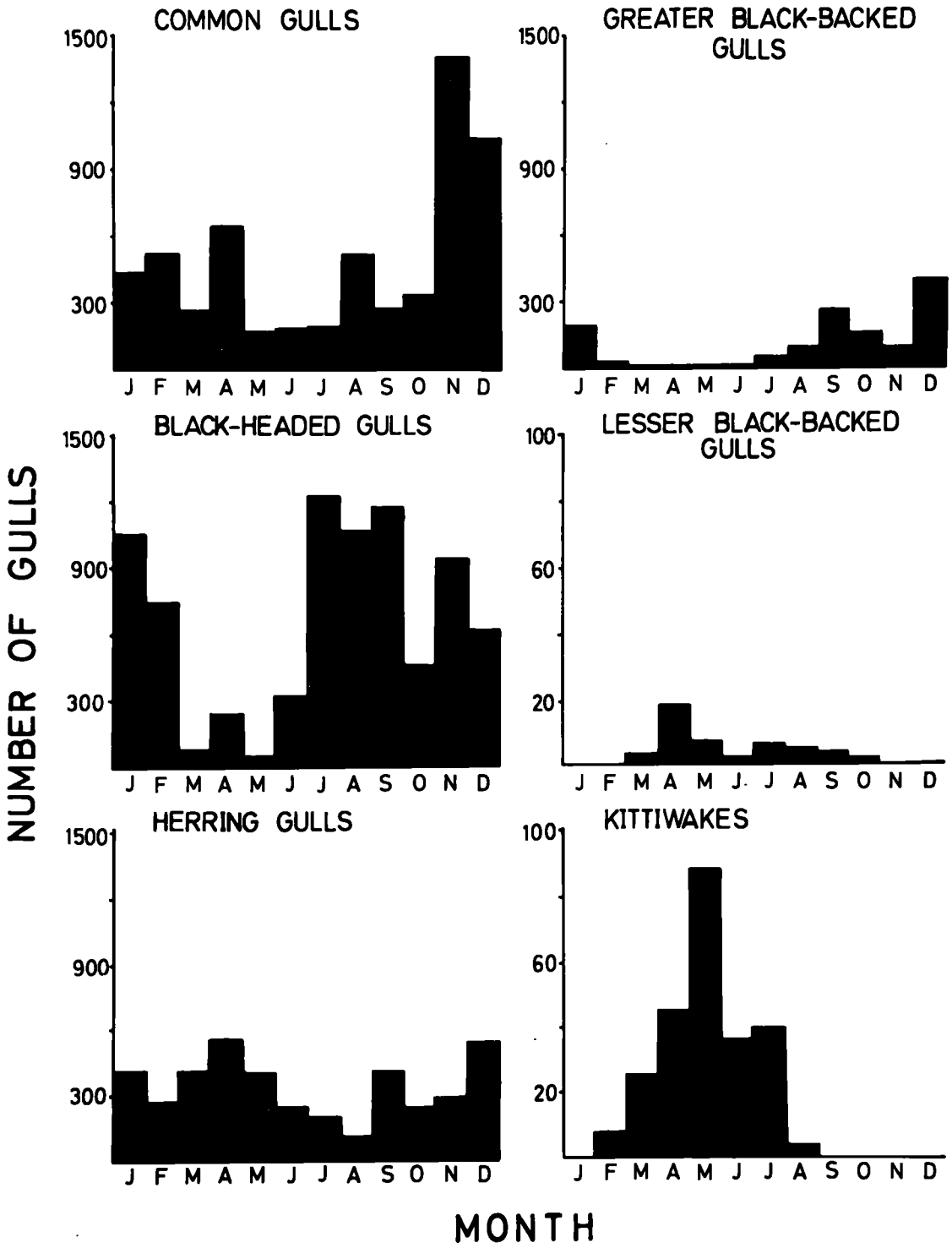
The Common, Black-headed, Herring and Greater Black-backed Gulls all had higher population levels throughout the winter than in the summer (Figure 4, Table 4). Their numbers dropped in February and March when the adult birds returned to the breeding colonies and did not increase again until after the breeding season was over. While the adults were away during the breeding season there was an influx of immature birds. The numbers of immature birds was high during the breeding season but declined in the autumn and remained low throughout the winter. During the winter a very small percentage of the Common, Black-headed and Greater Black-backed Gulls were immature but the percentage of immature Herring Gulls was much higher and approached 15%. The low numbers of Common and Black-headed Gulls along the rivers in October 1969 was probably the result of the mild autumn. When the weather was fine they tended to feed in the fields and the exceptionally fine weather during this period allowed the farmers to do their ploughing. The Common and Black-headed Gulls which regularly feed behind the plough (Roper 1946, Vernon 1970) apparently took advantage of this situation.

The Kittiwakes, which are an oceanic species, were absent from the River Tyne from October to January (Figure 4, Table 4). They returned to the river in February and their numbers increased to a maximum in early

Table 4. Population composition of the River Tyne study area. Each species is given as a percentage of the monthly totals

	1969 Oct	Nov	Dec	1970 Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Kittiwake	0.0	0.0	0.0	0.0	0.5	3.2	2.9	12.1	4.6	2.3	0.2	0.0
Black-headed Gull	38.8	34.7	23.7	50.5	47.2	9.7	15.9	5.1	4.8	71.6	59.8	56.2
Common Gull	28.7	52.1	40.1	20.9	33.3	31.2	41.7	22.9	21.9	11.5	28.6	12.3
Lesser Black-backed Gull	0.3	0.0	0.0	0.0	0.0	0.5	1.2	1.0	0.3	0.4	0.2	0.1
Herring Gull	20.2	10.2	20.7	19.5	16.9	53.7	37.3	56.9	30.3	11.4	6.1	19.0
Greater Black-backed Gull	12.0	3.0	15.4	9.1	2.1	1.8	0.9	2.0	1.3	2.8	5.0	12.4
Average Monthly Totals	1171	2695	2579	2068	1575	792	1546	708	790	1694	1788	2121

Figure 4. Seasonal Variation in the numbers of Gulls on the River Tyne Study Area. Observations were taken from October 1969 to September 1970


COMMON GULLS
GREATER BLACK-BACKED GULLS
BLACK-HEADED GULLS
LESSER BLACK-BACKED GULLS
HERRING GULLS
KITTIWAKES
1500
900
300
100
60
20
J F M A M J J A S O N D
NUMBER OF GULLS
MONTH

May. This represents a build-up in numbers prior to the breeding season. In mid-May there was a sudden decline in the numbers feeding along the river which corresponds with the mean time of egg laying at the North Shields colony. Mean egg laying time at the North Shields Kittiwake colony was 18 May 1970 (J.C. Coulson pers comm). The numbers remained low during the period of incubation and caring for the young (Coulson & Macdonald 1962). All the Kittiwakes had left the river by September. The immature Kittiwakes seen along the river in July can be attributed to the influx of non-breeding Kittiwakes at that time which can increase the numbers at the breeding colonies by as much as 30% (J.C. Coulson pers comm).

The Lesser Black-backed Gulls were absent from the rivers during the winter but made their reappearance in March. They regularly returned to the Wearmouth Bridge in Sunderland at this time (Courtenay 1934). This is during their northwards migration in the British Isles which begins in mid-February and ends in May (Barnes 1953). Their peak numbers occurred in early April when the passage migrants were going to the breeding colonies. The last breeding Lesser Black-backed Gulls reached the breeding colonies by the end of April (Witherby et al 1945). There was a decrease in the numbers of Lesser Black-backed Gulls in May and June during the breeding season and then an increase in July when they started to desert the breeding colonies which were not completely abandoned until the end of August. The last stragglers on the South migration

leave Britain by the first week in November (Witherby et al 1945). The autumn migration is spread out over a greater period than the spring one, accounting for no sharp peak in their numbers along the study areas at this time, and there was a gradual decline in their population level until they had all left the area by the end of October. No overwintering Lesser Black-backed Gulls were seen along the study areas.

There were large day to day fluctuations observed in the numbers of gulls counted along the study areas. These fluctuations appeared to be correlated with the weather conditions and were particularly noticeable throughout the winter for the Common and Black-headed Gulls. Mild spells or periods of rain reduced their numbers along the study areas. During mild weather there is an abundance of food available in the fields and rain brings the earthworms to the surface (Vernon 1970), which the gulls feed on, but periods of snow or severe frost increased the numbers of gulls along the rivers. Under these conditions the food supplies inland were reduced or removed (Vernon 1970) and the gulls were forced to feed along the rivers. The larger gulls appeared to be affected less than the smaller gulls. Along with these factors Cramp & Teagle (1955) showed that the numbers of gulls along the rivers were higher at low tide than at high tide. Unfortunately there was insufficient data to investigate this.

During the summer the numbers of gulls along the river are considerably lower than the winter population level (Table 4). It appears that many more gulls could be supported along the river during the summer than actually are at the present time. It is difficult, however, to say whether the figure of 2600+ gulls (Table 4) is the maximum number that can be maintained along the River Tyne during the winter.

II. Resting Sites

1. Kittiwakes

The most commonly used perches were in the area of the breeding colonies where they sat on the roofs and window ledges of the nearby buildings and of the ones on which their colonies were situated. In the area of the North Shields colony they were also observed to sit on street lamp standards. Kittiwakes appeared to prefer high places (Table 5) which were sheltered from the wind. Away from the colonies they were observed sitting on the water, roofs of sheds, pier railings and mooring posts. During this study no Kittiwakes were observed sitting on the banks of the rivers or along the tide line.

2. Black-headed Gulls

Black-headed Gulls were most commonly observed to rest along the banks of the rivers. They also frequented the buildings, wharfs and breakwaters along the river but were seldom seen on the roofs of high buildings (Table 5). Black-headed Gulls were frequently observed resting on the water but were not nearly as abundant here as were the Common Gulls. They were frequently seen resting on the mooring lines of ships.

3. Common Gulls

A large number of Common Gulls rested on the surface of the water with the next largest number using

TABLE: 5 DISTRIBUTION OF RESTING HEIGHTS

HEIGHT (above river water level)	KITTIWAKE*		BLACK-HEADED GULL		COMMON GULL		LESSER BLACK-BACKED GULL		HERRING GULL		GREATER BLACK-BACKED GULL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
On the water	65	9.5	133	15.3	444	51.2	2	4.6	921	47.4	8	8.9
On the mud banks (0-2 meters)	0	0.0	411	47.4	317	36.5	15	34.9	316	16.3	30	33.3
2 - 8 meters	157	22.9	181	20.9	97	11.2	25	58.2	388	20.0	36	40.0
8 - 14 meters	143	20.8	103	11.9	10	1.2	1	2.3	176	9.1	7	7.8
Over 14 meters	320	46.8	39	4.5	0	0.0	0	0.0	140	7.2	9	10.0

* The data for the Kittiwakes excludes those sitting on nests but does include those in the club areas of the colonies

the banks of the river and the tidal mud-flats (Table 5). They were frequently seen on the breakwaters and wharfs along the rivers but were seldom seen on the roof of buildings and tended to avoid sites over 10m high.

4. Lesser Black-backed Gulls

Lesser Black-backed Gulls were often seen resting on the quays and the pontoons of the bridges in the area of the Newcastle Swing Bridge. They also frequented the mooring posts along the river. Lesser Black-backed Gulls were seldom seen resting on the water (Table 5) and were not observed to use the roofs of buildings as perches except at the Fish Quay.

5. Herring Gulls

Herring Gulls were most commonly seen resting on the water but they also made frequent use of the banks, wharfs and breakwaters along the river (Table 5). The large tidal mud-flats were a particularly popular place at low tide and at high tide they sat on the posts on Jarrow Slake. High buildings were rarely used as resting places except in the vicinity of the Fish Quay and the breeding colony in section 3 on the River Wear study area where some rested on factory roofs.

6. Greater Black-backed Gulls

Greater Black-backed Gulls were seen most frequently on the mud banks and on low structures along the rivers (Table 5). In the area of the Fish Quay they were frequently seen on the roofs of high buildings but this area appeared to be the exception as in other areas high resting places were rarely used. They also gathered on the large tidal mud-flats but seldom rested on the water. Like Herring Gulls they used the posts on Jarrow Slake at high tide.

7. Inter and Intraspecific interactions

In any group of gulls a Greater Black-backed Gull was generally in the "best" place from which to observe the surrounding area, with Herring Gulls taking the next best places. For example, on the buildings in the area of the Fish Quay the Greater Black-Backed Gulls were usually on the chimneys or raised edges of the roofs. On a wharf the posts were usually occupied by the dominant larger gulls while the remainder of the wharf would be used by the smaller gulls. A smaller gull sitting on a chimney or post would move for a larger gull. In the absence of a Greater Black-backed Gull, the "best" place would be taken by Herring Gulls.

There appeared to be a random arrangement on resting sites between Common and Black-headed Gulls with neither being dominant over the other. Adults of any species were dominant over immatures of the same species

and immature Herring and Greater Black-backed Gulls were dominant over the smaller gulls.

8. Discussion of Resting Sites

It was considered at the beginning of the study that the preferred resting sites of the species could possibly have a limiting effect on their distribution along the rivers. A study of the preferred resting places soon revealed how wide a variety of places were used and indicated that this factor was of no importance in determining the distribution of the various species along the rivers. There were, however, some interesting results. The Kittiwakes, which are a marine species, rested chiefly on buildings near their breeding colonies and on the water. They very rarely rested on posts and quays etc. and were not seen along the mud showing that they had not completely adapted to the river habitat. The Herring and Greater Black-backed Gulls were often seen resting on good vantage points. From these places they could quickly take advantage of any available food. The Herring, Lesser Black-backed and Greater Black-backed Gulls were rarely seen on the roofs of buildings except in the area of the Fish Quay (Cramp & Teagle 1955). The roofs in this area were the best places to watch for food without being disturbed by people.

III. Feeding Behaviour

1. Methods of Feeding and types of food taken

i. General

The gulls feeding on the rivers were observed to have five basic types of feeding :

a) On the wing : This method involves flying over the river in search of food and upon sighting an article of food the gull drops to the water to pick it up. It can vary from a dive for a fish to a gentle "dip" for a particle on the surface of the water.

b) Clepto-parasitism : A gull will chase another gull and attempt to make it drop an item of food which is too big to be swallowed immediately. If successful it will attempt to get the food for itself. Larger gulls also force smaller ones to give up carrion which washes up along the river.

c) Mud feeding : The gull walks over the exposed mud banks left by the falling tide and feeds on the items on or in the mud. This can be either the invertebrate fauna of the mud or items left by the falling tide.

d) Tide line : The gull stands along the water's edge feeding on items which are washed up or left there by the falling tide. This method is less active than feeding on the mud.

e) Surface feeding : The gull either floats on the water or actively swims over it picking up items which float on the surface. Most of these items are very small.

ii. Kittiwakes

The bulk of the Kittiwakes feeding is done on the wing (Table 6). They patrol the river and upon sighting an item of food hover momentarily then drop for it. This can vary from a gentle dip to a sudden dive. Kittiwakes take large quantities of live fish and offal by this method (Table 7). They also feed on items such as small invertebrates or bits of sewage which are taken by dipping or when floating on the water. When surface feeding they are very active and peck at the water continually. Kittiwakes were not seen feeding along the shore or on the mud and did not pirate food from other gulls. They were not seen to take hand-outs from man as reported by Coulson & Macdonald (1962) for neighbouring areas. They were seen feeding around the Fish Quay on offal and spilled fish.

iii. Black-Headed Gulls

One of the main feeding places for the Black-headed Gulls was on the mud banks exposed by the falling tide. Here they fed actively, walking almost constantly and pecking as they moved along. Feeding on the wing over the water was another very important method of feeding (Table 6). They flew into the wind, being almost stationary at times, and upon sighting an item of food they hovered momentarily, dropped to the water's surface and dipped.

TABLE: 6 THE RELATIVE INTENSITIES OF THE DIFFERENT TYPES OF FEEDING METHODS USED BY THE INDIVIDUAL GULL SPECIES ON POLLUTED RIVERS

	KITTIWAKE	BLACK-HEADED GULL	COMMON GULL	LESSER BLACK-BACKED GULL	HERRING GULL	GREATER BLACK-BACKED GULL
On the wing	XXX	XXX	XXX	XXX	XXX	XXX
On the water	XX	X	XXX	-	XX	X
On mud banks	-	XXX	XXX	X	XX	-
Tide line	-	XX	XXX	XXX	XX	XXX
Clepto-parasitism	-	X	X	-	XX	XX

X Low frequency feeding method

XX Moderate frequency feeding method

XXX High frequency feeding method

- Method not observed

TABLE: 7 THE TYPES OF FOOD EATEN BY GULLS ON RIVERS AND THE RELATIVE IMPORTANCE OF EACH AS A FOOD SOURCE FOR THE INDIVIDUAL SPECIES

	KITTIWAKE	BLACK-HEADED GULL	COMMON GULL	LESSER BLACK-BACKED GULL	HERRING GULL	GREATER BLACK-BACKED GULL
Offal	XX	X	X	XXX	XXX	XXX
Fish	XXX	X	X	X	X	-
Floating sewage and insects	X	XXX	XXX	XX	X	X
Items on and in the mud	-	XXX	XXX	-	X	-
Hand outs	-	X	X	-	X	X
Carrion	-	-	-	XX	XX	XXX

X Item makes up a small percentage of the species' diet.

XX Item makes up a moderate percentage of the species' diet.

XXX Item makes up a high percentage of the species' diet.

- Species not observed feeding on these items. They make up an insignificant part of the species' diet.

Usually only their feet went into the water. This method was modified to feed about sewage outfalls where they were particularly successful feeders. They hovered over the effluent, dropped to the water, dipped, then flew up and resumed hovering or circled about and again hovered over the effluent.

Occasionally a Black-headed Gull was observed to dive for and capture fish. They did not plunge dive the way Kittiwakes were sometimes observed to, but rather they landed breast first in the water and plunged their heads into the water. They then flew up and swallowed the fish on the wing. Black-headed Gulls were observed on occasion to pirate food from another Black-headed or Common Gull and to attempt to steal food from a Kittiwake. They also feed along the tide line but were not observed to eat any large pieces of carrion (Table 7). Black-headed Gulls were rarely seen feeding while floating on the water but to a much less extent than Common Gulls and they readily flocked around a person offering hand-outs.

iv. Common Gulls

Their methods of feeding while on the wing were the same as those of the Black-headed Gulls (Table 6) but they were somewhat less agile about the sewage outfalls. When feeding on mud banks Common Gulls moved about considerably less than the Black-headed Gulls and often

made several pecks at the same place. They also fed along the tide line but were not observed eating carrion (Table 7). On a few occasions they were observed to pirate food from other Common Gulls, Kittiwakes or Black-headed Gulls and rarely Herring Gulls. Common Gulls were often seen feeding whilst floating on the water. This appeared to be rather passive as they pecked at items which floated by and rarely swam actively. Hand-outs were not as readily accepted by Common Gulls as by Black-headed Gulls.

v. Lesser Black-backed Gulls

The Lesser Black-backed Gulls used almost every food source available along the rivers (Table 7). The bulk of their feeding, however, was on carrion and around sewage outfalls. They were also seen around the Fish Quay where they fed on offal and spilled fish. They were often seen standing on the mud beside a sewage outfall. Lesser Black-backed Gulls were not observed stealing or attempting to steal food from other gulls (Table 6).

vi. Herring Gulls

A large number of Herring Gulls fed on offal and spilled fish from around the Fish Quay. In this area they mostly fed on the wing but were also observed to feed on the wing along other parts of the rivers (Table 6)

and were seen to dive for and catch fish. They were commonly observed standing along the tide line where they fed on carrion and small items which were washed up on the banks (Table 7) and some actively fed along the mud and rocky banks. Many Herring Gulls floated on the rivers to rest where they were seen to feed on small items which floated past them, but they were not observed to swim actively and feed on the surface. On several occasions Herring Gulls attempted to pirate food from another species, victimizing all but the Greater Black-backed Gull. Hand-outs were readily accepted.

vii. Greater Black-backed Gull

Offal and spilled fish from around the Fish Quay and carrion make up a very important part of the diet of the Greater Black-backed Gulls (Table 7). Workers along the River Tyne reported seeing them eating drowned rats and kittens. They were observed eating crabs, flat-fish and carcasses which had washed up along the banks. Greater Black-backed Gulls will accept hand-outs and occasionally feed on floating items when resting on the water, but this is very passive. They were observed attempting to pirate food from all the species of gulls on the rivers except the Lesser Black-backed Gull. Greater Black-backed Gulls were not observed feeding on the river banks exposed by the tide (Table 6).

2. Feeding distribution in relation to sewage outfalls

All the gull species on which observations were made of the numbers feeding on the wing over the river were found to be more concentrated around sewage outfalls than over

Table 8. The distribution in relation to sewage outfalls of the gulls feeding on the wing over the River Tyne

	No. of days of observation	About outfalls		Away from outfalls		% of gulls feeding at sewage outfalls
		No. observed	Density * (No./Km^2/day)	No. observed	Density * (No./Km^2/day)	
Kittiwake	7	19	145	105	5.63	15.3
Black-headed Gull						
Winter	7	336	1467	64	1.96	84.0
Summer	4	76	581	14	0.75	84.0
Common Gull						
Winter	7	23	100	414	12.69	5.3
Summer	4	53	405	155	8.33	25.5
Lesser Black-backed Gull	4	3	23	6	0.33	33.3
Herring Gull	4	323	2469	78	4.18	80.5

* The area about the sewage outfalls on the River Tyne study area was estimated to be 0.0327km (area about each outfall (15 x 20 = 300m^2) X (the number of sewage outfalls entering the river in the area studied (109)). The area of the remainder of the River Tyne study area was 4.660km^2 and for this study included sections 1 - 14 and the area along the north side of the River Tyne along the Fish Quay and Hailing Station.

the remainder of the river (Table 8). The Herring and Black-headed Gulls had a majority of their population feeding at the outfalls and these were more attracted to the outfalls than the other species (Table 8). Although Kittiwakes, Lesser Black-backed Gulls and Common Gulls were more concentrated about sewage outfalls than away from them in absolute numbers, more of them fed away from the outfalls than at outfalls.

Of the 19 Kittiwakes observed feeding at the outfalls 16 were at one outfall near the Fish Quay where wastes from the fish cleaning houses is discharged into the River Tyne. Similarly, about 70% of the Herring Gulls observed feeding on the wing at outfalls were seen at the same outfall. On the other hand, very few Common and Black-headed Gulls fed there.

In the summer when fewer Black-headed Gulls were feeding in the study area the concentration of Black-headed Gulls about outfalls was much lower than in the winter but at both times of the year, the same percentage of the population fed on the wing at sewage outfalls. Of the observed Black-headed Gulls feeding at the outfalls almost 100% were adult in the winter and an average of 48% were adult in the summer. There appeared to be no differences between mature and immature Black-headed Gulls with regard to feeding about sewage outfalls.

The number and percentage of Common Gulls feeding at outfalls were higher in the summer than

in the winter. In the winter almost all of the Common Gulls observed were mature whereas in the summer only about 44% on average were mature. There appears, however, to be no differences in preference between mature and immature Common Gulls with regard to feeding about sewage outfalls.

An investigation should be made into the feeding areas of your Common and Black-headed Gulls in winter.

3. Discussion of feeding

Generally as the size of the gull species increases the size of the food items increased and the rate of feeding activity decreased. The only exception was the Kittiwake which was successful at catching live fish and fed primarily on them. They supplemented their diet with fish offal and bits of sewage. The fish were larger than the bits of sewage and invertebrates that the Black-headed and Common Gulls fed on and their success at feeding allowed them to rest a large part of the time. The larger gulls were scavengers feeding primarily on offal and carrion whereas the Black-headed and Common Gulls fed on small items of sewage and floating invertebrates. The large gulls were inactive the majority of the time but were watching for suitable food items.

Common and Black-headed Gulls were observed feeding on fish offal in the area of the Fish Quay whereas

Kittiwakes readily fed there along with large numbers of Herring and Greater Black-backed Gulls. It is surprising that there were few Common and Black-headed Gulls feeding in the area. A possible explanation is that the Kittiwakes which are very agile fliers could avoid the pirating attempts by the Herring Gulls. The Common and Black-headed Gulls were clepto-parasitized by the Herring Gulls and being less agile than the Kittiwakes could not easily avoid this. The high concentration of Herring Gulls was then apparently responsible for the absence of Black-headed and Common Gulls in the area.

Herring Gulls scavenged along the water's edge (Gomp & Teagle 1955) and at sewer drains (Rollin 1931), the bulk of their food consisting of fish offal, refuse, carrion and to a lesser extent invertebrates (Brown 1967, Mills 1957, Sparck 1955, Harris 1965, Mendall 1939). The Greater Black-backed Gulls fed almost exclusively on carrion and offal, feeding along the tide line, on rubbish tips (Gomp & Teagle 1955), at sewer drains (Barnes 1961), and at the Fish Quay on the River Tyne. The bulk of their food was animal remains which was composed of mammals, fish, birds, and garbage (Florence 1912, 1917, 1915; Davies 1958; Harris 1965).

In contrast to the larger gulls, the Black-headed and Common Gulls which in general are basically inland feeders and insectivores (Sparck 1951, Crook 1953) feed primarily over the river and along the banks on small

items of sewage and invertebrates. They were extremely active in their feeding and were not seen feeding on carrion although there are records of this habit (Coleman 1968, Temperley 1951). It is probable that the larger gulls quickly took any items of carrion for themselves.

The information about the Lesser Black-backed Gulls along the River Tyne is quite limited as they are never very abundant in the study areas but they appeared to be intermediate between the Black-headed and the Herring Gulls in their feeding behaviour. Although it has been reported that Lesser Black-backed Gulls feed naturally along the shore (Brown 1967), they were not observed to feed on the mud banks along the rivers. Contrary to Harris (1965) who reported that Lesser Black-backed Gulls ate more live food than fish wastes and garbage, and that they did not visit the fish markets, a few Lesser Black-backed Gulls were seen at the Fish Quay where they fed on offal and they were commonly seen about sewage outfalls. Wastes are apparently a very important food source for them along the rivers.

Kittiwakes fed only slightly at sewage outfalls, this being a new food source for the species (Coulson & Macdonald 1962). Their numbers were correlated inversely with the amount of domestic sewage being discharged into the section of the river (Table 15). This negative correlation is probably because pollution reduces the number of fish in the river and fish appear to be their staple food. They were not seen feeding along the banks of the rivers. This is probably because they are a true

oceanic species and have not completely adapted to the river habitat.

4. The effects of the time of day on activity and feeding rate

This study was carried out only on Common and Black-headed Gulls as a great deal of time was required to make such a study on even one species and because the other species were either absent from the study section or present only in small numbers.

i. Black-headed Gulls

One hour before sunrise there were no Black-headed Gulls in the study area. At about 20 minutes before sunrise the numbers began to arrive until a peak in flying activity was reached just before sunrise (Figure 5A). During this period of high activity there were large flights of gulls moving upstream, but only the gulls that were flying low and feeding along the river were recorded. The high flying gulls were omitted. The numbers then began to decrease and by one hour after sunrise a level of activity was reached which then remained constant ($P < .05$) throughout the remainder of the day until a final drop in activity occurred at sunset. By one hour after sunset there were at the most only one or two Black-headed Gulls remaining in the study area.

The number of feeding dips per minute for each hunting bird (Figure 5B) remained relatively constant throughout the day with no significant changes.

The population feeding rate followed that of the level of flying activity (Figure 5C). There was a peak ($P < .01$) which lasted from approximately one half hour before to one hour after sunrise. After this peak the feeding level remained relatively constant throughout the day with no significant changes until a small peak occurred just before sunset ($P < .05$). The numbers feeding then dropped away as the gulls gradually moved downstream either singly or in small groups. By 45 minutes past sunset it was too dark to make further observations. Upon first arriving in the study section the Black-headed Gulls fed on the wing over all of the section of the river as well as just at the sewage outfalls but they soon moved to feed mostly about the outfall with only occasional outbreaks of feeding over the remainder of the river.

ii. Common Gulls

The Common Gulls began to appear in the study section just after sunrise (Figure 6A) when groups were flying upstream. Many of them settled on the water or mud to feed while others fed on the wing, and by one hour after sunrise the mass movements upstream had finally finished. From sunrise until

Figure 5. The effect of the time of day on the flying activity and feeding rates of Black-headed Gulls

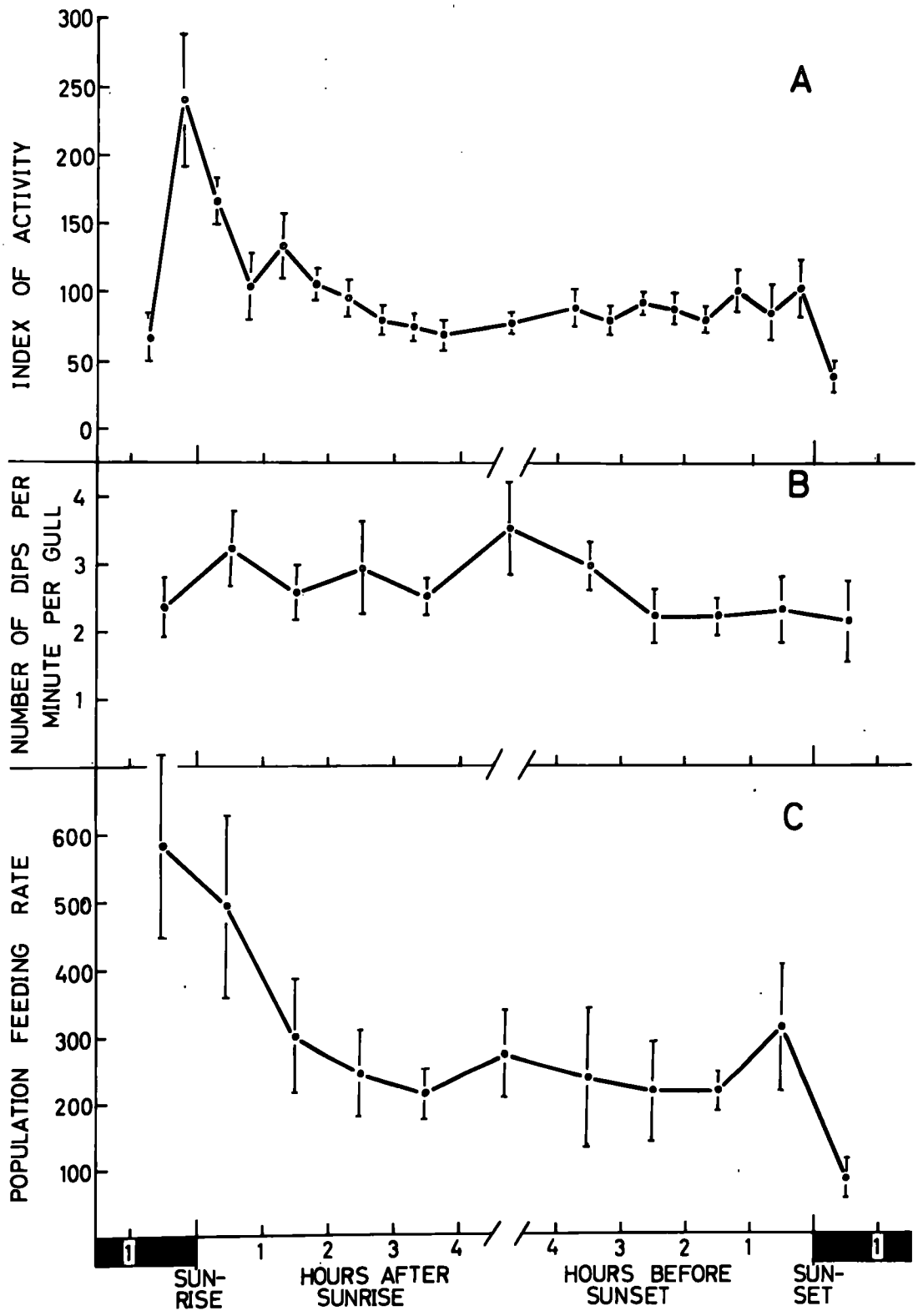
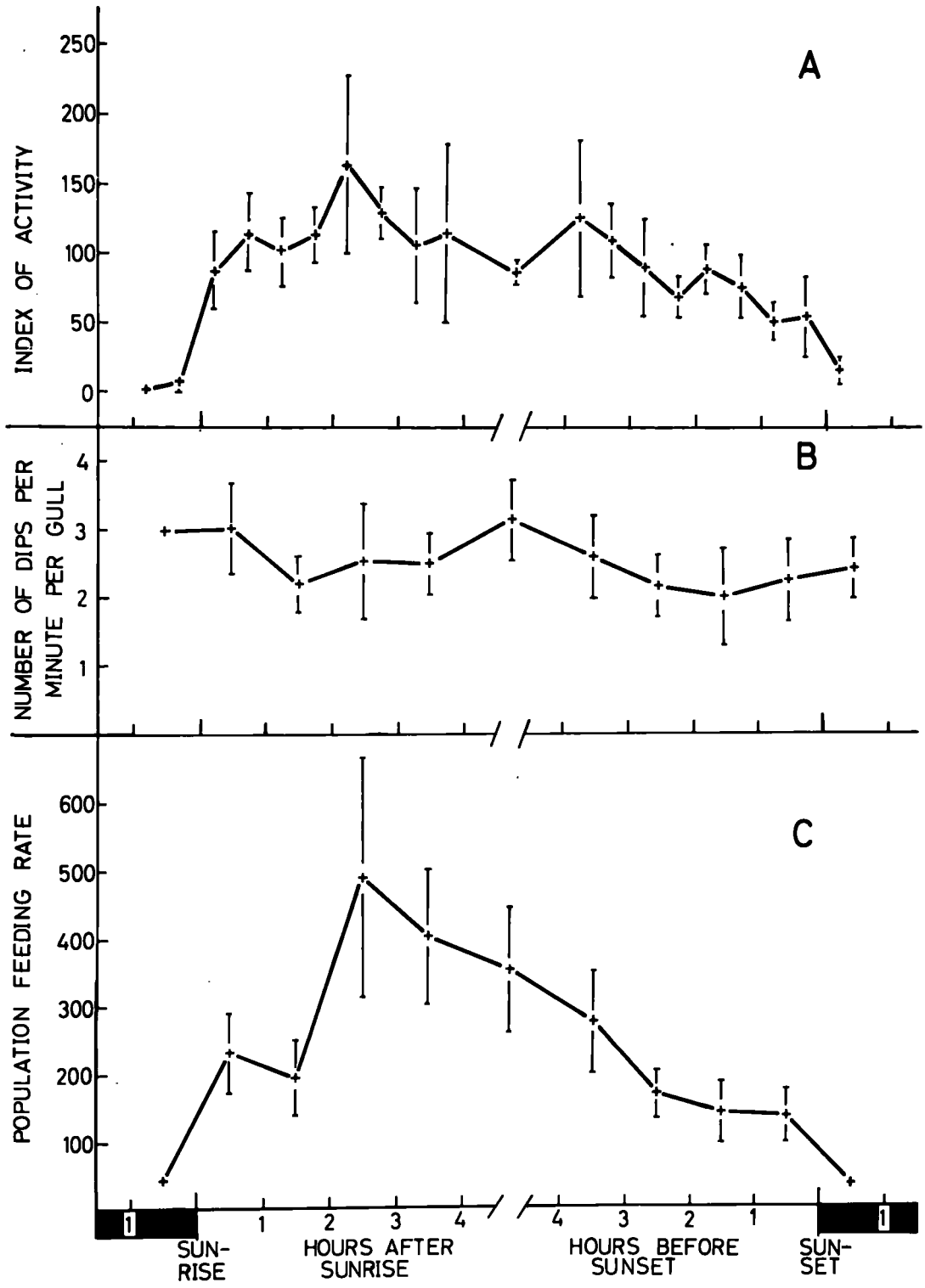

A
INDEX OF ACTIVITY
300
250
200
150
100
50
0
B
NUMBER OF DIPS PER MINUTE PER GULL
4
3
2
1
C
POPULATION FEEDING RATE
600
500
400
300
200
100
1
1
2
3
4
4
3
2
1
1
SUN-RISE
HOURS AFTER SUNRISE
HOURS BEFORE SUNSET
SUN-SET

Figure 6. The effect of the time of the day on the flying activity and feeding rates of Common Gulls


A
INDEX OF ACTIVITY
250
200
150
100
50
0
B
NUMBER OF DIPS PER MINUTE PER GULL
4
3
2
1
C
POPULATION FEEDING RATE
600
500
400
300
200
100
1
1
2
3
4
4
3
2
1
1
SUN-RISE
HOURS AFTER SUNRISE
HOURS BEFORE SUNSET
SUN-SET

about one hour before sunset there was a relatively constant level of activity with no significant fluctuations. One to one and a half hours before sunset the Common Gulls began to collect in groups on the river, feeding on items which drifted by. There was a gradual downstream movement from these groups and by a half hour after sunset there were almost no Common Gulls remaining in the study area.

The number of feeding dips per minute per gull (Figure 6B) remained constant throughout the day with no significant fluctuations but the number of dips/min/gull was lower ($P < .05$) for Common than for Black-headed Gulls.

For two hours after sunrise the population feeding rate of the Common Gulls was low (Figure 6C). It then rose suddenly reaching a peak between two and three hours after sunrise. This corresponds with the time when the Black-headed Gull's population feeding rate dropped (Figure 5C). The Common Gull's population feeding rate then continued to decrease throughout the day until a half hour after sunset when it was approaching zero.

5. The effects of the state of the tide on activity and feeding rate

The data for this study were taken from the same investigation as the one on the effects of the time of day on activity and feeding rate and similarly was carried out on Common and Black-headed Gulls.

i. Black-headed Gulls

Black-headed Gulls show no significant changes in the numbers flying (index of activity) throughout the tide cycle (Figure 7A). There were, however, significant increases ($P < .01$) in the population feeding rate when the tide was rising and when it was ebbing (Figure 7C). These peaks correspond with increases in the numbers of feeding dips per minute made by individual birds (Figure 7B) and occurred at the times when the river water level was between the upper and lower edges of the sewer outfall in the study section.

ii. Common Gulls

The state of the tide produced no significant changes in the numbers of Common Gulls feeding on the wing (Figure 8A) or in their population feeding rate (Figure 8C). The pattern for the number of dips per minute made by individual Common Gulls (Figure 8B), however, followed that of the Black-headed Gulls with peaks when the tide was rising and when it was ebbing.

6. Discussion of the effects of time of day and the state of the tide on the activity and feeding of Common and Black-headed Gulls

The flying activity and population feeding rate on the wing of the Black-headed Gull (Figure 5) was greatly affected by the time of day. The peak just before sunrise

Figure 7. The effect of the state of the tide on the flying activity and feeding rates of Black-headed Gulls

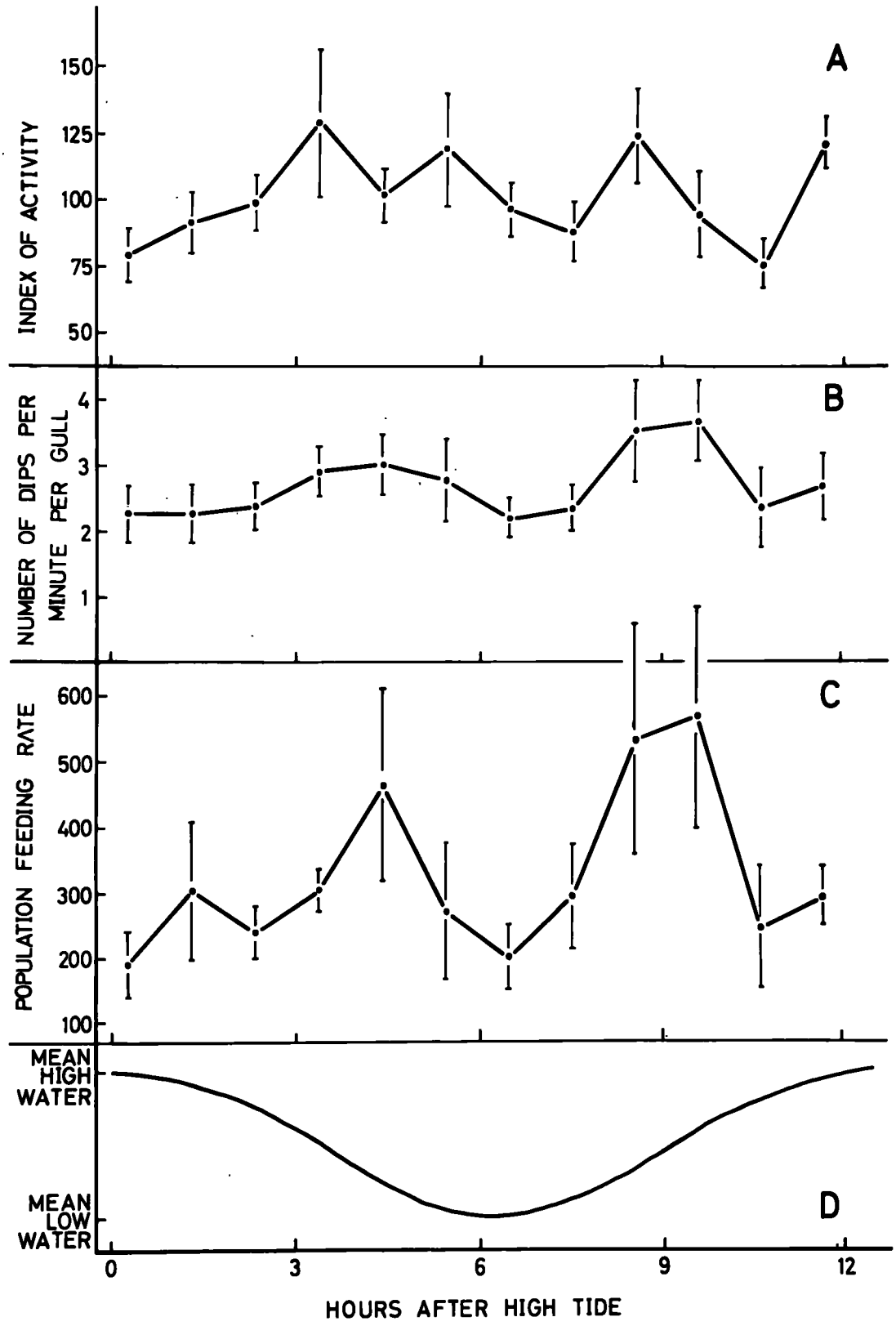
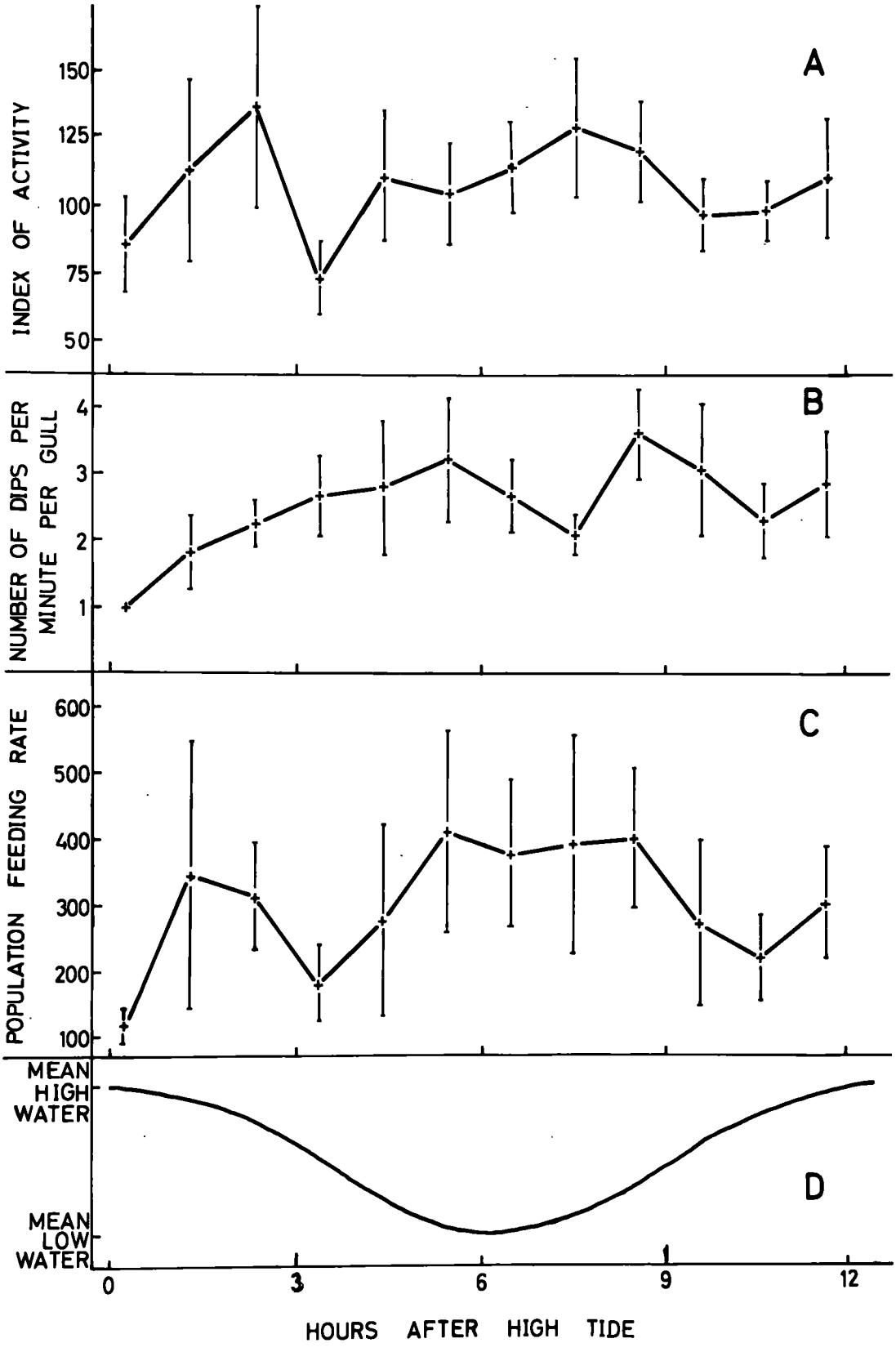

A
INDEX OF ACTIVITY
150
125
100
75
50
B
NUMBER OF DIPS PER MINUTE PER GULL
4
3
2
1
C
POPULATION FEEDING RATE
600
500
400
300
200
100
MEAN HIGH WATER
MEAN LOW WATER
D
0
3
6
9
12
HOURS AFTER HIGH TIDE

Figure 8. The effect of the state of the tide on the flying activity and feeding rates of Common Gulls


A
INDEX OF ACTIVITY
150
125
100
75
50
B
NUMBER OF DIPS PER MINUTE PER GULL
4
3
2
1
C
POPULATION FEEDING RATE
600
500
400
300
200
100
MEAN HIGH WATER
MEAN LOW WATER
D
0
3
6
9
12
HOURS AFTER HIGH TIDE

corresponds with the time that the roosts broke up (Rollin 1928). These gulls were hungry and started to feed immediately after arriving at the feeding areas along the river. The small peak in the population feeding rate just before sunset is indicative of their increased feeding rate before returning to the roost for the night.

The state of the tide had no effect on the flying activity of the Black-headed Gulls but did affect the population feeding rate of flying gulls by varying the amount of food available (Figure 7) as measured by the number of dips per minute per gull. The peaks in the feeding rate occurred both when the tide was rising and when it was ebbing, that is, when the water was at a similar height. When the tide was low the sewage poured from the outfall into the water. Under these conditions it was likely that the edible articles were forced under the water by the force of the effluent and many sank. When the tide was high the outfall was submerged and many food items never came to the surface. The peaks in feeding occurred when the outfall was only partly covered by the river water. Under these conditions many food items which otherwise sank quickly were at or near the surface for a short period of time so that the gulls could "dip" and get them. When the tide was falling, the tide and current carried many food items away quickly, but when the tide was rising the opposing action of the tide and current increased the turbulence of the water and held many of the edible items at the surface near the outfall longer than under other conditions. This situation offers a plausible explanation of the higher peak in population

feeding rate on the rising rather than falling tide.

The Common Gulls had a different daily pattern than the Black-headed Gulls in that they did not appear in the study area in any numbers until sunrise (Figure 6). They roosted off the beach at South Shields (Hickling 1960) and had farther to travel than the Black-headed Gulls, the majority of which roosted on Jarrow Slake (Rollin 1931). Upon arriving in the area, however, the Common Gulls did not show an immediate peak of feeding on the wing but many fed on the water's surface and along the banks if exposed by the tide. The peak in their feeding on the wing occurred after the Black-headed Gulls' peak feeding activity was finished. The increase in the Common Gulls' feeding rate had no apparent effect in reducing that of the Black-Headed Gulls and rather was probably a result of a reduction in the feeding rate of the Black-headed Gulls. The Common Gulls showed no increase in feeding activity on the wing before returning to the roost, but rather the majority fed when floating on the water.

The differences between the patterns of the index of activity and the population feeding rates for the Common and Black-headed Gulls could be inherent differences in the species or theycould be the result of competition. Other than the fact that the number of Common Gulls feeding on the wing was apparently reduced when the Black-headed Gulls were feeding on the wing there is another observation which supports the possibility of competition. In the summer when the number of Black-headed Gulls on the river decreases, the number of Common Gulls and the percentage of their population feeding at the outfalls increases (Table 7), that is, in the conditions

of reduced competition they utilise the outfalls. The Common Gulls appeared to be less agile than the Black-headed Gulls and possibly were less effective at feeding on the wing over the outfalls.

The state of the tide had no effect on either the index of activity or the population feeding rate of the Common Gulls (Figure 8). This is not surprising, however, as the effect of tide on the amount of food available was only a very localized effect around the sewage outfalls and the Common Gulls, unlike the Black-headed Gulls, had only a slight tendency to group about sewage outfalls (Table 8) and instead feed on the wing over the whole of the river.

Apart from its effect on the index of activity and the population feeding rate of the Common and Black-headed Gulls, tide had other effects on their feeding methods. It determined whether the banks were available for feeding, and particularly by the amount of exposed mud. The flow of the tide would also have some effect on items which might wash up along the tide line. There would probably be a greater chance of an item washing up on the banks with an ebbing tide than with a rising tide.

IV. Factors influencing the distribution of Gulls in the Study Areas

In computing the stepwise regressions to predict the number of gulls along the sections of the study areas (Tables 9 to 18), a coefficient is determined in each equation for each independent variable. This coefficient is the slope of the regression line when the independent variable is plotted against the dependent variable and shows the effect the independent variable has on the dependent variable. The lengths of the sections of the river were chosen at convenient lengths in relation to land marks, and were of no biological significance, but if the species were distributed randomly along the study area with respect to the length of the study sections, a coefficient of (average number of gulls of that species ÷ the length of the study area) would be expected.

1. Kittiwakes

The expected coefficient for the variable "length of the section" if the Kittiwakes are distributed randomly with respect to the length of the section is, the average number of Kittiwakes along the study area (39.7) ÷ length of the study area (24.25) = 1.6 for the River Tyne.

For the Kittiwakes, the best estimate of the number of Kittiwakes along any section of the River Tyne

TABLE: 9 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF KITTIWAKES ON ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=9)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	-0.7089	1.1052	0.4114	0.3315	0.1099	0.1099
2	Distance upstream (Km)	-0.2334	0.1400	2.7820	0.5584	0.3118	0.2019
3	Distance from the nearest breeding colony (Km)	-1.2605	0.5207	5.8606*	0.6777	0.4593	0.1476
4	Amount of domestic sewage discharged into the section (10^6 gall./day)	-1.2734	0.6381	3.9840	0.8177	0.6252	0.1659
	CONSTANT	12.6079					
	Standard error of the estimate of the equation		3.4003				
	F Ratio for the equation		3.754*	(f_1=4:f_2=9)			

* Significant at the .05 level of confidence

study area is given in Table 9. This equation accounts for 62.5% (r^2) of the variation in the numbers of Kittiwakes along the study sections. As the expected value of 1.6 for the coefficient of the variable "length of the section" is significantly different from the calculated value of -0.709 ± 1.105 (Table 9), the Kittiwakes were apparently not distributed randomly along the River Tyne with respect to the lengths of the study sections. The most significant factor influencing the distribution of Kittiwakes along the River Tyne was the distance from the nearest breeding colony on the river (Table 9). This factor had an inverse correlation with the numbers of Kittiwakes. Two other important factors, both of which were inversely correlated with the number of Kittiwakes, were the amount of domestic sewage discharged into the river and the distance upstream.

The majority of the Kittiwakes seen along the River Tyne were on its lower reaches and the largest breeding colony was in this area at North Shields. There appeared to be many visiting Kittiwakes around the harbour mouth, the majority of which probably came from the breeding colony at Marsden Bay (3 miles south). The Kittiwakes have only recently come up the river with only one being seen in Newcastle in 1951 (Temperley 1952), but their numbers have continued to increase since then (Coulson & Macdonald 1962). At the present time of the study there were three breeding colonies along the River Tyne whereas in 1962 Coulson & Macdonald reported only one. There appears to be an original concentration around the river mouth and a gradual diffusion upstream. Similarly

on the River Wear the Kittiwakes were present in the river mouth and in small numbers have ventured upstream as far as Sunderland, but as yet there are no breeding colonies along the river. This large concentration at the North Shields colony and the river mouth area explains the Kittiwake's inverse correlation with the variable "distance upstream".

The negative correlation between the amount of domestic sewage and the number of Kittiwakes in any section of the river shows that they avoided areas of high concentrations and did not use them extensively as a food source, a fact confirmed by direct observations. A few Kittiwakes were observed feeding at sewage outfalls by Coulson & Macdonald(1962), and during this study only a small percentage of the feeding Kittiwakes were seen at outfalls, the majority of which were at the outfall near the Fish Quay where the wastes from the fish cleaning houses are discharged, and presumably they were feeding on offal rather than sewage. Direct observations on Kittiwakes indicate that fish is the most important food for this species in the river. It is possible that sewage pollution would have an effect of reducing the fish life in the river and in this way could have a limiting effect on the numbers of Kittiwakes.

2. Black-headed Gulls

The expected coefficient for the variable "length of the section" is 27.0 for the River Tyne equation and 14.5 for the River Wear.

Black-headed Gulls were seen along all sections of the River Tyne and were common on the urbanized sections of the Rivers Wear and Tees. Although they were also present in the rural areas, their numbers in these areas were greatly reduced. Black-headed Gulls were frequently seen clustering around sewage outfalls. This practice was particularly noticeable at Ouseburn and in the vicinity of the Newcastle Swing Bridge (River Tyne, sections 8 and 9). The other most frequented places were the large areas of mudflat which were exposed by the falling tide. Large numbers of Black-headed Gulls were seen on the Seal Sand (River Tees, section 1) and along the banks of section 4 of the River Wear. Jarrow Slake (Figure 1) on the River Tyne, however, was not used extensively as a feeding ground even though c.2000 used the area as a roost. Very few Black-headed Gulls were seen in the vicinity of the Fish Quay (Figure 1) on the River Tyne.

The equations for the Rivers Tyne and Wear (Tables 10 & 11) explained 38.7% and 93.2% respectively of the variation in the distribution of Black-headed Gulls. The most important variable influencing the number of Black-headed Gulls on any section of the River Tyne was the "length of the section" and secondly the "amount of domestic sewage discharged into the section". The amount of sewage entering the section was itself insignificant but did add to the predictive accuracy of the equation. None of the other factors were significant in determining the number of Black-headed Gulls along the sections of the River Tyne

TABLE: 10 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF BLACK-HEADED GULLS ALONG ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=11)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	12.7543	6.0614	4.4276	0.5399	0.2915	0.2915
2	Amount of domestic sewage discharged into the section (10^6gall./day)	4.3445	3.3176	1.7148	0.6222	0.3871	0.0956
	CONSTANT	14.6474					
	Standard error of the estimate of the equation		19.1780				
	F Ratio for the equation		3.473	(f_1=2:f_2=11)			

TABLE: 11 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF BLACK-HEADED GULLS ALONG ANY SECTION OF THE RIVER WEAR STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=3)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	22.6500	19.2262	1.3879	0.5275	0.2783	0.2783
2	Amount of mud exposed along the banks of the section at low tide (Km)	44.6607	9.7120	21.1462*	0.7796	0.6078	0.3295
3	Amount of domestic sewage discharged into the section (10^6 gall./day)	31.7011	8.4111	14.2045*	0.8960	0.8029	0.1951
4	Number of outfalls in the section	-11.3706	4.7573	5.7129	0.9655	0.9321	0.1293
	CONSTANT	-31.3307					
	Standard error of the estimate of the equation		15.0591				
	F Ratio for the equation		10.299*	(f_1=4:f_2=3)			

* Significant at the .05 level of confidence

study area. Because the expected coefficient of the variable "length of the section" was not within the computed range of the equation (table 10), the Black-headed Gulls on the River Tyne were obviously not distributed randomly with respect to the length of the section.

The most important factors on the River Wear were the "amount of mud exposed along the banks at low tide" and the "amount of domestic sewage discharged into the section". Two other variables were the number of sewage outfalls entering the section and the length of the section. These latter two factors were important in improving the predictive powers of the equation (Table 11) but themselves were not statistically significant.

It appears that the prime factors influencing the distribution of Black-headed Gulls along the rivers are the amount of sewage and mud flats, but obviously other, undetected, factors operate in the River Tyne. Erskine (1963) reports that in North America, Black-headed Gulls prefer areas where sewage and mud flats occur together. From the observations items of waste from sewage outfalls and items found on the mud banks are the Black-headed Gulls most important foods along the rivers.

It is interesting that for the River Tyne equation (Table 10) the factor "amount of domestic sewage discharged into the section" is itself insignificant and that the variable "amount of mud exposed, along the banks at low tide" was so insignificant as to not even enter the equation. It appears that in the case of the River Tyne

there was food available along the mud banks and in the form of sewage. These were apparently not limiting factors and the Black-headed Gulls were distributed randomly along the study area. The importance of sewage and mud was evident on the River Wear where there was a larger variation in the amounts available. There has been some controversy as to whether the Black-headed Gulls prefer gravel or mud banks (Crook 1953, Cramp & Teagle 1955). Throughout this study there was no indication one way or another. They fed freely on both types of banks and were even seen feeding along rocky sections.

3. Common Gulls

The expected coefficients for the "length of the section" were 20.8 for the River Tyne and 2.6 for the River Wear. Common Gulls were seen only in small numbers at the Fish Quay during the day but their numbers increased in the evening as they began to collect in groups on the water. They also tended to be less abundant along the lower sections of the River Tyne than would be expected by a completely random distribution. Common Gulls were much less numerous along the mud flats of Jarrow Slake (Figure 1), the Seal Sand (Figure 2), and section 4 of the River Wear than the Black-headed Gulls were. They were much more abundant in sections with close proximity to urban areas than in sections in rural areas. There seemed, however, to be a preference for areas which did

not have urban development right down to the water's edge.

From the equation to predict the average number of Common Gulls on any section of the River Tyne (Table 12) none of the variables considered had a significant effect on the distribution of the species. The equation itself accounted for 72.6% of the variation in the distribution of the species. The variable "length of the section" accounted for 60.5% of the variation. Although "length of the section" had no significant effect on the Common Gulls' distribution along the River Tyne, it was obviously very important, and as the expected value of 20.8 for the coefficient of the length of the section was within the range of the computed coefficient for the variable (Table 12), it appears that the Common Gulls were randomly distributed along the River Tyne with respect to the length of the section.

The equation for the Common Gulls on the River Wear accounted for 99.9% of the variation in the distribution (Table 13). The most important factor influencing the distribution of the Common Gulls was the "length of the section". The other significant variables affecting the distribution of the Common Gulls along the River Wear were the "number of outfalls entering the section" and the width of the section. The amount of domestic sewage entering the section approached but did not exceed the 5% level of confidence.

The Common Gulls were apparently not distributed randomly along the length of the River Wear with respect to the length of the section as the expected value of 2.6

TABLE: 12 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF COMMON GULLS ALONG ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=8)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	6.1637	17.4178	0.1252	0.7777	0.6048	0.6048
2	Average width of the section (Km)	-203.7277	131.3644	2.4052	0.8080	0.6529	0.0481
3	Distance upstream (Km)	-2.9251	2.2651	1.6677	0.8213	0.6745	0.0216
4	Amount of mud exposed along the banks of the section at low tide (Km)	16.2037	13.7053	1.3978	0.8418	0.7086	0.0341
5	Number of outfalls in the section	1.3755	1.9084	0.5195	0.8523	0.7263	0.0178
	CONSTANT	78.3609					
	Standard error of the estimate of the equation		20.8350				
	F Value for the equation		4.247*	(f_1=5:f_2=8)			

* Significant at the .05 level of confidence

TABLE: 13 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF COMMON GULLS ALONG ANY SECTION OF THE RIVER WEAR STUDY AREA

STEP NO.	VARIABLE	COEEFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=1)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	8.6552	0.4520	366.2527*	0.9175	0.8418	0.8418
2	Number of outfalls in the section	-1.5066	0.0622	585.9966*	0.9330	0.8704	0.0287
3	Amount of domestic sewage discharged into the section (10^6 gall./day)	6.1780	0.4970	153.9275	0.9534	0.9091	0.0386
4	Amount of urbanization along the banks of the section	-3.2310	0.4043	63.8692	0.9847	0.9697	0.0606
5	Average width of the section (Km)	20.4613	1.3724	222.2527*	0.9991	0.9981	0.0284
6	Amount of mud exposed along the banks at low tide (Km)	0.9590	0.2603	13.5780	0.9999	0.9999	0.0017
	CONSTANT	-0.7179					
	Standard error of the estimate of the equation		0.1671				
	F Value for the equation		1296.973**	(f_1=6:f_2=1)			

* Significant at the .05 level of confidence

** Significant at the .025 level of confidence

for the coefficient of the variable "length of the section" did not correspond with the computed coefficient (Table 13).

The positive correlation between the number of Common Gulls along the sections of the River Wear and the width of the river shows that the Common Gulls preferred areas with more water. The wider study sections on the River Wear were in the Sunderland area. Here they fed to a large extent on sewage as shown by their positive correlation with the amount of domestic sewage discharged into the section. Although there was a positive correlation between the length of the section and the number of Common Gulls for the River Wear, the Common Gulls were not distributed randomly with respect to the length of the sections. It is possible that there were other factors accounting for the variation which were not accounted for in the equation. It was not surprising, even though the Common Gulls fed on sewage, that there was a negative correlation between them and the number of outfalls as they were not observed to feed about outfalls in large numbers (Table 8).

Along the River Tyne the Common Gulls were distributed randomly according to the length of the section and none of the other variables were significant in determining their distribution. It is possible that the large quantities of sewage discharged into all the sections of the river caused it and the amount of mud not to be limiting factors in the distribution of the Common Gulls on the River Tyne.

4. Lesser Black-backed Gulls

The expected coefficient for the length of the section if the Lesser Black-backed Gulls were distributed randomly with respect to the length of the section is 0.27 for the River Tyne.

The equation to predict the numbers of Lesser Black-backed Gulls along any section of the River Tyne accounted for 70.3% of the variation in the distribution of the species. The most significant factor was the "number of sewage outfalls entering the section". The factor length of the section only accounted for 0.7% of the variation in the distribution of the species along the River. Its negative coefficient (Table 14) was different from the expected value of 0.27 for a random distribution so that obviously the Lesser Black-backed Gulls were not distributed randomly along the length of the section with respect to the length of the study area. The other variables in the equation added to the accuracy of the estimate of the equation but had no significant effect on the distribution of the Lesser Black-backed Gulls.

It is not surprising that the Lesser Black-backed Gulls were attracted by sewage outfalls as they are scavengers (Barnes 1952) and fed on edible items from the outfalls. They usually occurred singly or in groups of 2 or 3, and therefore the number of outfalls would be very important in determining their distribution.

TABLE: 14 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF LESSER BLACK-BACKED GULLS ALONG ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=6)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	-0.5971	0.2167	7.5909*	0.0626	0.0039	0.0039
2	Number of outfalls entering the section	0.1486	0.0417	12.7090***	0.7695	0.5922	0.5882
3	Average width of the section (Km)	-1.4486	1.1526	1.5794	0.8154	0.6649	0.0727
4	Amount of domestic sewage discharged into the section (10^6 gall./day)	-0.0584	0.0718	0.6614	0.8267	0.6834	0.0185
5	Amount of urbanization along the banks of the section	-0.0626	0.0866	0.5225	0.8384	0.7028	0.0194
	CONSTANT	1.0277					
	Standard error of the estimate of the equation		0.3873				
	F Ratio for the equation		3.784*	(f_1=1:f_2=8)			

* Significant at the .05 level of confidence

*** Significant at the .01 level of confidence

The entire length of the River Tyne study area received large quantities of sewage which could at least in part account for the presence of Lesser Black-backed Gulls along the entire length of the area as they fed to a great extent on human wastes (Barnes 1961). On the River Wear, however, they were found on the sections of the river in Sunderland and only one was seen far upstream. The Lesser Black-backed Gulls appeared to have a preference for urban areas being less marine than the Herring or Greater Black-backed Gulls and more urban than the Common Gull (Barnes 1952).

From the equation (Table 14) the Lesser Black-backed Gulls were more abundant upstream where the river was narrower. They were not as abundant downstream as might have been expected and few were seen at the Fish Quay. It appears that they were avoiding the areas where the Herring Gulls were abundant. The Lesser Black-backed Gulls apparently cannot compete effectively with the Herring Gulls and competition with them has been given as a possible reason for the Lesser Black-backed Gulls' decline in some areas (Parslow 1967). Increased urbanization had a slight effect in reducing their numbers along the rivers. They were shy and avoided people as much as possible, but in areas such as the Newcastle Swing Bridge (between sections 9 and 10, River Tyne) where a large amount of food was available, they were abundant even though people frequented the area.

5. Herring Gulls

The expected value for the coefficients of the variable "length of the section " are 15.5 for the River Tyne and 3.3 for the River Wear if the Herring Gulls are distributed randomly with respect to the length of the section. The equation computed to predict the yearly average number of Herring Gulls along the River Tyne accounted for 79.5% of the variation in the numbers of gulls along the study sections (Table 15). The Herring Gulls were not distributed randomly along the length of the study area with respect to the length of the section as the expected value of 15.5 for the coefficient of the variable "length of the section" did not correspond with the computed value. The most significant factors affecting the distribution of Herring Gulls along the River Tyne study area were the "amount of urbanization along the banks of the section", the "number of outfalls entering the section" and the "width of the section". All of the other variables were themselves insignificant in affecting the distribution on the River Tyne.

The equation to predict the number of Herring Gulls on any section of the River Wear study area explained 99.9% of the variation in their distribution along that river (Table 16). Again the Herring Gulls were not distributed randomly along the length of the study area with respect to the length of the study section, the expected value for the coefficient of the variable "length of the section" being 3.3.

TABLE: 15 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF HERRING GULLS ALONG ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD.ERROR	F VALUE (f_1=1:f_2=7)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	1.7705	5.5548	0.1016	0.5156	0.2659	0.2659
2	Average width of the section (Km)	91.0992	40.6586	5.0202	0.6964	0.4849	0.2191
3	Amount of urbanization along the banks of the section	-4.9703	1.7135	8.4145*	0.7692	0.5916	0.1067
4	Number of outfalls entering the section	1.8361	0.7077	6.7321*	0.8842	0.7810	0.1902
5	Distance from Jarrow Slake (Km)	0.4802	0.7750	0.3838	0.8855	0.7842	0.0023
6	Amount of mud exposed along the banks of the section at low tide (Km)	-3.1300	5.0565	0.3832	0.8918	0.7954	0.0112
	CONSTANT	3.8247					
	Standard error of the estimate of the equation		6.6127				
	F Ratio for the equation		4.535*	(f_1=6:f_2=7)			

* Significant at the .05 level of confidence

TABLE: 16 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF HERRING GULLS ALONG ANY SECTION OF THE RIVER WEAR STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE ($f_1=1:f_2=1$)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	-0.8524	0.7640	1.2450	0.4696	0.2112	0.2112
2	Distance upstream (Km)	0.3060	0.0902	11.4997	0.8649	0.7480	0.5368
3	Amount of urbanization along the banks of the section	6.0310	0.2122	807.7646**	0.9289	0.8628	0.1148
4	Average width of the section (Km)	79.3509	4.9608	255.8639*	0.9942	0.9884	0.1256
5	Amount of mud exposed along the banks of the section at low tide (Km)	1.7289	0.2794	38.2832	0.9983	0.9967	0.0083
6	Number of outfalls entering the section	-0.3856	0.1190	10.4967	0.9999	0.9997	0.0030
	CONSTANT	-12.1711					
	Standard error of the estimate of the equation		0.3436				
	F Value for the equation		547.090*	($f_1=6:f_2=1$)			

* Significant at the .05 level of confidence

** Significant at the .025 level of confidence

The significant variables affecting the distribution of the Herring Gulls on the River Wear were the amount of urbanization along the banks of the section and the "width of the section". The other factors studied had no significant effect.

The Herring Gulls were more abundant in urbanized areas than in rural areas as shown by the positive correlation in their numbers with increasing urbanization along the banks. This is not surprising, however, as they are scavengers and two thirds of their food is directly related to human wastes (Harris 1965). In urban areas as shown by their negative correlation with increasing urbanization along the banks of the section, Herring Gulls have a tendency to avoid areas with development right down to the water's edge and are more abundant in areas where they will not be disturbed by people. They generally keep man at a distance (Cramp & Teagle 1955). One place on the River Tyne where the Herring Gulls did tolerate people was the Fish Quay but no doubt it was the large supply of fish offal which accounts for this.

On both the River Tyne and the River Wear the Herring Gulls were found to be more abundant in the wider stretches of the rivers. It appears that they prefer areas where there is more water and it is possible that this is so that they can avoid man more easily. This could also be true for the River Tyne as well but there is another possible explanation. The increased numbers of Herring

Gulls on the lower sections of the River Tyne could be the result of such food supplies as the tip along section 6, and the one north of section 3, the presence of the Fish Quay and its abundant food supply or the gathering effect of the roost at Jarrow Slake. In the lower reaches of the study area near the river mouth there would be a concentration of refuse from upstream. The widening of the river with the resulting decrease in current and the action of the tide would make much more food available. More food available results in more gulls along the area.

They also showed an attraction to sewage outfalls but as shown in Table 8 they concentrated about outfalls to feed and most of their food was human refuse, a ready supply coming from the outfalls.

This general pattern was found to be true on the River Tees with the Herring Gulls being most abundant along the lower reaches of the river. Large numbers of Herring Gulls roosted at the Seal Sands, an area of extensive mud flats.

6. Greater Black-backed Gulls

The expected coefficients for the "length of the section" if the Greater Black-backed Gulls are distributed randomly along the river with respect to the length of the sections are 3.8 of the River Tyne and 0.24 for the River Wear.

The Greater Black-backed Gulls were not distributed randomly along the rivers with respect to the length of the sections. On the River Wear the positive correlation of their numbers with the width of the river could be explained by the fact that the wider sections were the urbanized areas. In urban areas there was more refuse in the river and the bulk of their food came from human wastes. On the River Tyne no doubt they accumulated on the wider sections of the river for the same reasons as the Herring Gulls. They avoided areas where there was a good chance of encountering people (Cramp & Teagle 1955). The amount of sewage entering the section was of no importance in affecting their distribution but the number of sewage outfalls were. This reflected their feeding behaviour as they were usually seen singly or in very small groups about the outfalls.

Large numbers of Greater Black-backed Gulls were seen during the day on the roosts at the Seal Sands and Jarrow Slake. There tended to be large numbers around the roost throughout the day. The presence of these roosts could account for the large number of Greater Black-backed Gulls around the Rivers Tyne and Tees as an undisturbed roost and an adequate food supply are necessary for the larger gulls (Barnes 1961). There is no reason to assume an inadequate food supply along the River Wear, but the lack of a suitable roost area could explain why few Greater Black-backed Gulls were seen along that river.

TABLE: 17 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF GREATER BLACK-BACKED GULLS ALONG ANY SECTION OF THE RIVER TYNE STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=6)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	-4.3141	7.6645	0.3168	0.0131	0.0002	0.0002
2	Average width of the section (Km)	192.3785	56.9497	11.4111**	0.5220	0.2725	0.2723
3	Amount of urbanization along the banks of the section	-10.5894	2.2615	21.9263***	0.8218	0.6754	0.4029
4	Number of outfalls entering the section	2.5465	0.9494	7.1936*	0.9091	0.8265	0.1511
5	Distance from Jarrow Slake (Km)	1.4337	1.0665	1.8071	0.9183	0.8432	0.0167
6	Amount of mud exposed along the banks at low tide (Km)	-7.2246	6.9330	1.0859	0.9301	0.8651	0.0219
7	Amount of domestic sewage discharged into the section (10^6gall./day)	0.5333	1.6970	0.0988	0.9313	0.8672	0.0022
	CONSTANT	-16.8356					
	Standard error of the estimate of the equation		8.7270				
	F Ratio for the equation		5.600*	(f_1=1:f_2=6)			

* Significant at the .05 level of confidence

** Significant at the .025 level of confidence

*** Significant at the .01 level of confidence

TABLE: 18 THE EQUATION TO PREDICT THE AVERAGE NUMBER OF GREATER BLACK-BACKED GULLS ALONG ANY SECTION OF THE RIVER WEAR STUDY AREA

STEP NO.	VARIABLE	COEFFICIENT	STD. ERROR	F VALUE (f_1=1:f_2=1)	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ
1	Length of the section (Km)	0.5992	0.0797	56.5837	0.5714	0.3265	0.3265
2	Average width of the section (Km)	8.8594	0.4407	404.1028*	0.9688	0.9385	0.6121
3	Amount of domestic sewage discharged into the section (10^6gall./day)	-0.6029	0.0861	49.0674	0.9859	0.9720	0.0334
4	Amount of mud exposed along the banks of the section at low tide (Km)	-0.0982	0.0477	4.2423	0.9987	0.9974	0.0255
5	Amount of urbanization along the banks of the section	0.2596	0.0677	14.7142	0.9993	0.9986	0.0012
6	Distance upstream (Km)	-0.0264	0.0082	10.4880	0.9999	0.9999	0.0013
	CONSTANT	-0.3651					
	Standard error of the estimate of the equation		0.0295				
	F Value for the equation		1341.605**	(f_1=6:f_2=1)			

* Significant at the .05 level of confidence

** Significant at the .025 level of confidence

GENERAL DISCUSSION

All of the species studied were seen to feed in varying densities at sewage outfalls and the species showed varying degrees of dependency on this food source. At the present time large quantities of food, varying from small bits of sewage to items of carrion such as drowned kittens and rats, come from the sewer outfalls. Speculation as to what changes would follow the removal of this food source, as is projected with the new Tyneside sewerage system, can only be made in light of the present feeding habits of the species concerned, and from the information about the factors influencing the distribution of the species along the rivers. Assuming that the amount of raw domestic sewage is zero and that therefore the effective value of the sewage outfalls is zero, these values can then be substituted into the equations (Tables 9 to 18) to predict the expected number of gulls along the river if all the sewage and sewage outfalls were removed (Table 19). It is always possible, however, that the removal of sewage would only result in the gulls changing to other food sources in the river and not cause them to seek food elsewhere.

Table 19. Average number of gulls observed along sections 1 - 14 of the River Tyne Study Area

	Observed during study	Expected numbers as calculated from the distribution equations with sewage and outfalls equal to zero	Percentage Change
Kittiwakes	39.7	73.6	+ 85.4
Black-headed Gulls	655.5	505.6	- 22.9
Common Gulls	505.0	359.0	- 28.9
Lesser Black-backed Gulls	6.6	- 7.5	- 100.0
Herring Gulls	375.8	148.0	- 60.6
Greater Black-backed Gulls	93.2	- 198.0	- 100.0

From the information at hand it appears that there would be a complete disappearance of the Greater and Lesser Black-backed Gulls as species feeding on the River Tyne when the sewerage system is completed. No doubt, however, some Greater Black-backed Gulls would be seen around the roost at Jarrow Slake and some would feed around the Fish Quay on spilled fish. It also seems unlikely that all the carrion would disappear from the river. It is quite possible that all the Lesser Black-backed Gulls would leave the river to feed inland but there is the possibility that they would revert to feeding on natural food along the river.

It is evident that the Black-headed, Common and Herring Gulls would suffer a reduction in numbers with the changes in the sewerage system (Table 19). Apart from the changes along the 14 sections of the study area the Herring Gulls would suffer particularly from a reduction in effluent from the fish cleaning houses near the Fish Quay. The Common Gulls were apparently dependent on sewage as a food source and would be adversely affected by its removal. There is, however, the possibility that increased competition with the Black-headed Gulls could limit their population further than would be expected by a stoppage of untreated sewage. The figure for the number of Black-headed Gulls along the River Tyne study area after the removal of the sewage appears to mask the importance of sewage as a food for the species. From the observations on the Black-headed Gulls it is evident that sewage is a very important food item for the species. It is quite possible that the large quantities of sewage along the whole of the River Tyne study area is responsible for masking its importance.

The Kittiwakes fed only to a small extent at outfalls except in the area of the Fish Quay. A reduction in the amount of sewage would therefore not directly affect the Kittiwakes by limiting a vital food source. The reduction in the amount of sewage would, however, reduce the level of pollution in the river and allow more fish to come into the river. This would increase the amount of food available to the Kittiwakes. It appears that the Kittiwakes would be the only species to take full

advantage of this food source and that they would experience a net increase in available food and therefore increase their population level along the River Tyne (Table 19).

It could be possible to test these predictions, before the changes actually occur, by studying the feeding of these gulls on unpolluted rivers.

The distribution of each species studied was affected to different extents by several factors. All of the gull species in the rivers use the area primarily as a feeding ground and therefore their distribution reflected the abundance of potential food along the river. For example, the Lesser Black-backed, Herring and Greater Black-backed Gulls had a positive correlation with the number of sewage outfalls and the numbers of Common and Black-headed Gulls showed a positive correlation with the amounts of domestic sewage being discharged into the section. Kittiwakes avoided areas with domestic sewage as the bulk of their food came in the form of live fish which were more abundant in the less polluted areas. Other factors besides those affecting their feeding influenced the species distributions. The Greater and Lesser Black-backed Gulls which were shy of man avoided areas with urbanization along the river banks. The Kittiwakes were concentrated at the river mouths and around the breeding colonies and diffused out from these areas.

Although similar factors influenced the distribution of many of the species, and they often fed in similar ways on the same types of food, their

overall feeding behaviour and distribution were sufficiently different to allow the species to stay along the rivers together without a great amount of inter-specific competition. The species fitted into different niches, but collectively exploited the food resources of the rivers.

SUMMARY

1. A study was made of the feeding biology and the factors affecting the distribution of the Kittiwake (Rissa tridactyla), Black-headed Gulls (Larus ridibundus), Common Gull (Larus canus), Lesser Black-backed Gull (Larus fuscus), Herring Gull (Larus argentatus) and the Greater Black-backed Gull (Larus marinus) on polluted rivers. The study was carried out along sections on the tidal reaches of the Rivers Tyne, Wear and Tees between October 1969 and September 1970.

2. The study areas were divided into sections and censuses were taken to determine the distribution of the species along the study areas and the seasonal variation in numbers.

3. A number of measurements were made of different aspects of the study areas. These included the average width of the section, the length of the section, the amount of mud exposed at low tide, the degree of urbanization along the banks of the section and the distance upstream. Information was obtained from the appropriate Borough Engineers about the quantities of industrial and domestic wastes discharge into the rivers and the exact locations of the outfalls.

4. Mature Black-headed, Common, Herring and Greater Black-backed Gulls were abundant along the river at all times except the breeding season. The immatures of these species were most abundant during the breeding season. Kittiwakes were present from February to April, the peak in their numbers occurring just before egg laying time. The Lesser Black-backed Gulls were present from March to October and were most abundant during the north migration to the breeding colonies.

5. The resting site preferences of the six species were measured. These were so varied that they apparently had no effect on the distribution of the species along the rivers.

6. The feeding methods used by the different species and the types of food taken by the species were observed. Apart from the Kittiwake which fed to a great extent on fish, all the other species were dependent on human wastes for food. In general, as the size of the species increased, they became less active feeders and fed on larger items. The Common and Black-headed Gulls fed mostly on bits of sewage and invertebrates whereas the Herring and Greater Black-backed Gulls were basically scavengers feeding on offal and carrion.

7. The distribution of the Gulls feeding on the wing about the sewage outfalls and over the whole of the river was studied for all but the Greater Black-backed Gull. The Black -headed and Herring Gulls had a great affinity to sewage outfalls. The Common Gulls and Kittiwakes showed a concentration about the outfalls, but tended to feed over the whole of the river. There was very little information for Lesser Black-backed Gulls but they were attracted to sewage outfalls.

8. For both Black-headed and Common Gulls a study was made of the effects of the state of the tide and the time of day on the flying activity and population feeding rates. For Black-headed Gulls the population feeding rate was affected primarily by the time of day with large peaks in activity just before sunrise and before sunset. The state of the tide modified the population feeding rate slightly by varying the amount of food available. For Common Gulls the daily pattern of the population feeding rate was apparently only affected by the time of the day in relation to sunrise and sunset.

9. To determine the importance of the various factors influencing the distribution of the species along the rivers, a stepwise regression was calculated for each species on the River Tyne and all but the Lesser Black-backed Gulls and Kittiwakes on the River Wear.

10. Kittiwakes showed negative correlations with the "amount of domestic sewage discharged into the section", the "distance from the nearest breeding colony" and "the distance upstream".

11. The number of Black-headed Gulls varied directly with the "amount of mud exposed along the banks at low tide" and the "amount of domestic sewage discharged into the section".

12. Common Gulls were distributed randomly along the rivers with respect to the lengths of the sections. Their numbers were directly proportional to the amount of domestic sewage discharged into the section but were inversely proportional to the "number of sewage outfalls". They appeared to prefer urban areas to rural areas.

13. The number of Lesser Black-backed Gulls in any area was directly proportional to the number of sewage outfalls. They were more abundant in urban areas than rural areas, but avoided contact with people.

14. Herring Gulls were more abundant in urban areas than rural ones, but within urban sections tended to avoid contact with humans. Their numbers varied directly with the number of sewage outfalls entering the section. They were very abundant in areas where there were large quantities of offal and in the vicinity of their roosts.

15. The number of Greater Black-backed Gulls varied directly with the width of the river and the number of sewage outfalls. They were more abundant in urban areas than rural ones but tended to avoid contact with humans. They were common in areas where a large amount of offal was available and were particularly abundant at their roosts.

16. When untreated domestic sewage is no longer released into the River Tyne a reduction in the number of Black-headed, Common, Lesser Black-backed, Herring and Greater Black-backed Gulls would be expected. The number of Kittiwakes will likely increase.

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APPENDIX

Table: A1 Census data for the Black-headed Gulls along the River Tyne study area

	1969									1970								
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	18	16	-	-	-	-	48	0	2	1	0	0	0	2	20	5	8	7
2	31	150	62	40	38	6	63	12	21	0	0	0	1	18	55	162	88	26
3	32	18	16	2	5	-	39	22	16	14	0	0	2	0	225	256	16	41
4	53	111	51	49	63	26	70	11	57	2	0	0	8	15	37	141	96	95
5	32	72	35	63	53	51	48	0	9	0	0	0	5	10	108	79	111	215
6	84	58	205	192	262	95	146	8	41	0	2	0	5	47	105	147	158	201
7	14	14	57	19	75	22	20	4	11	1	0	0	18	35	53	41	30	75
8	42	26	98	80	92	44	130	5	20	0	0	0	24	105	84	50	33	65
9	14	38	98	59	100	37	107	0	37	1	0	0	59	45	41	62	172	119
10	38	16	32	17	18	6	2	4	47	0	1	2	19	11	42	67	38	19
11	22	19	30	3	14	3	34	5	39	0	3	1	45	52	20	60	51	68
12	43	31	177	34	152	51	72	3	74	4	40	4	27	27	82	216	108	158
13	31	14	218	11	169	38	179	3	63	3	13	3	30	21	91	105	78	104
14	-	18	208	27	93	37	116	-	29	8	1	1	14	14	-	99	82	-
Totals	454	590	1280	611	1044	411	1074	77	457	34	60	11	257	402	963	1490	1069	1193
% immature	-	-	-	-	-	-	-	-	-	73	72	18	13	8	3	-	-	1.5

Table; A2 Census data for the Common Gulls along the River Tyne study area

	1969									1970								
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	13	8	-	-	-	-	67	-	1	0	0	0	0	3	6	1	9	7
2	4	24	200	168	12	21	60	6	14	0	0	3	1	38	4	24	19	7
3	8	18	16	2	5	-	8	1	12	0	0	0	11	26	1	1	12	6
4	30	56	60	16	4	7	49	9	16	4	3	0	7	10	9	8	5	16
5	1	27	26	37	2	5	11	6	9	2	0	6	10	5	29	2	15	3
6	13	112	296	130	174	69	88	26	203	20	2	5	28	15	33	46	107	78
7	77	53	395	294	64	102	110	74	354	9	0	5	49	30	47	22	156	78
8	0	5	23	0	5	2	20	0	13	0	0	0	0	0	10	0	1	0
9	11	9	200	41	40	22	99	27	28	1	2	0	5	4	22	1	22	6
10	4	6	75	21	2	8	0	0	70	2	11	0	1	0	10	0	12	7
11	56	53	376	60	18	66	38	23	100	18	34	0	29	3	22	13	58	18
12	93	50	338	139	51	43	100	16	215	35	110	13	28	4	31	37	62	29
13	26	11	135	87	7	13	36	5	67	2	70	50	8	0	3	5	19	6
14	-	42	191	40	48	13	36	-	77	9	3	7	31	0	-	2	11	-
Totals	336	474	2331	1035	432	371	678	247	1179	111	235	89	208	138	227	162	512	261
% immature	-	-	-	-	-	-	-	-	-	23	69	60	51	42	22	-	-	1

960

Table: A3 Census data for the Lesser Black-backed Gulls along the River Tyne study area

	1969						1970											
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	0	0	-	-	-	-	0	-	1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0
3	0	0	0	0	0	-	0	1	1	0	0	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	2	0	1	0	0	1	0	1	0	0
7	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	1	2	1
8	0	0	0	0	0	0	0	0	2	0	1	3	0	0	0	0	0	0
9	3	0	0	0	0	0	0	2	13	1	2	0	1	0	2	1	0	1
10	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0
11	0	0	0	0	0	0	0	0	3	1	1	0	0	0	1	0	1	0
12	0	0	0	0	0	0	0	0	3	1	2	0	0	0	3	0	1	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	-	0	00	0	0	0	0	-	0	0	1	0	0	0	-	0	0	-
Totals	3	0	0	0	0	0	0	4	32	6	9	4	2	1	8	3	4	2

Table: A4 Census data for the Herring Gulls along the River Tyne study area

	1969									1970								
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	36	0	-	-	[illegible]	-	38	30	10	2	24	10	20	6	24	25	23	12
2	29	27	34	34	15	61	43	42	115	48	29	15	6	2	5	48	10	34
3	6	6	2	250	41	-	73	12	37	13	4	5	52	70	63	58	21	89
4	4	16	17	34	15	12	29	27	17	16	23	3	38	9	8	18	18	76
5	1	3	7	3	2	23	4	11	50	9	23	0	12	0	9	1	3	12
6	5	9	80	3	229	18	13	35	189	7	48	3	23	2	0	5	12	35
7	8	21	48	83	36	1	6	33	40	7	103	14	59	4	9	4	14	48
8	0	2	3	7	0	0	0	50	100	0	1	14	2	0	0	7	0	6
9	2	9	31	23	3	41	19	95	156	17	17	0	12	1	11	5	0	10
10	23	27	34	48	8	4	15	17	21	1	60	3	4	4	1	1	5	5
11	53	45	32	18	3	13	69	2	66	10	70	0	11	0	25	23	22	47
12	36	13	14	29	15	4	20	39	75	102	143	11	8	2	6	23	1	27
13	34	2	42	3	31	2	10	32	23	2	48	19	11	0	0	3	0	2
14	-	11	16	0	5	3	11	-	7	14	69	46	119	3	-	13	0	-
Totals	237	191	360	535	403	182	350	425	906	248	662	143	377	100	151	234	109	403
% immature	-	-	-	-	-	-	-	-	-	51	88	71	42	-	28	-	-	16

Table: A5 Census data for the Greater Black-backed Gulls along the River Tyne study area

	1969						1970											
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	0	0	-	-	-	-	1	0	0	0	0	0	0	0	1	0	0	0
2	6	2	3	4	4	3	1	2	0	0	0	0	0	0	0	0	1	0
3	91	11	28	345	125	0	28	2	2	0	0	0	0	0	13	63	80	215
4	3	1	1	2	1	2	2	0	1	1	0	1	0	0	1	3	1	5
5	2	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	2	2
6	1	2	29	30	48	2	1	5	0	1	0	0	0	0	1	2	5	9
7	1	3	10	5	3	2	0	0	1	0	0	0	0	0	0	0	0	1
8	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	3	1	0	2	0	3	0	0	20	0	0	0	0	0	0	0	0	0
10	4	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	14	10	5	2	0	2	5	1	0	0	0	0	0	0	0	1	0	2
12	10	11	7	2	1	0	2	3	0	2	0	0	3	0	0	3	1	13
13	6	3	23	2	0	5	2	1	0	0	0	0	0	0	0	1	0	0
14	-	5	3	0	5	2	3	-	0	0	0	26	10	0	-	5	0	-
Totals	141	39	122	398	189	22	44	14	24	4	0	27	13	0	16	79	90	262
% immature	-	-	-	-	-	-	-	-	-	50	-	100	77	-	19	-	-	1

Table: A6 Census data for the Kittiwakes along the River Tyne study area

	1969						1970											
Section	23.10	7.11	26.11	17.12	13.1	2.2	25.2	20.3	1.4	17.4	7.5	28.5	9.6	26.6	16.7	30.7	13.8	7.9
1	0	0	-	-	-	-	13	15	21	15	31	6	25	16	37	15	3	0
2	0	0	0	0	0	1	0	1	18	9	35	1	2	3	1	2	0	0
3	0	0	0	0	0	0	0	0	4	0	6	1	1	0	2	1	0	0
4	0	0	0	0	0	0	0	0	2	1	9	1	0	0	0	0	1	0
5	0	0	0	0	0	1	0	0	1	10	10	2	1	0	0	1	0	0
6	0	0	0	0	0	0	0	1	1	0	2	1	1	3	0	1	0	0
7	0	0	0	0	0	0	0	0	1	0	7	1	0	2	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	7	16	1	13	3	2	0	2	1	0	0
10	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	1	0	0	12	6	5	0	5	2	0	0
12	0	0	0	0	0	0	0	0	0	0	0	7	7	0	0	7	0	0
13	0	0	0	0	0	0	0	0	0	0	0	18	1	0	0	0	0	0
14	-	0	0	0	0	0	0	0	0	0	0	0	3	0	-	0	0	-
Totals	0	0	0	0	0	2	13	25	64	26	129	47	48	24	47	30	4	0
No. of immatures	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	7	0	0

Table: A7 Census data for the Black-headed Gulls along the River Wear

	1969							1970					
Section	21.10	28.10	4.11	11.11	25.11	22.1	4.2	10.3	7.4	8.5	16.6	14.7	11.8
1	4	9	13	1	37	5	2	12	5	0	0	3	6
2	5	34	23	58	103	12	20	69	14	0	18	16	45
3	59	76	46	55	171	61	48	61	2	0	3	1	44
4	42	240	16	20	285	11	4	320	2	37	2	11	495
5	13	88	10	10	8	1	2	4	5	15	0	3	4
6	7	10	0	16	0	0	0	-	0	0	0	0	-
7	-	34	0	3	16	0	1	0	0	0	0	0	11
8	34	27	0	15	8	0	1	22	0	0	0	0	6
Total	163	518	108	178	628	90	76	488	28	52	23	34	611

Table: A8 Census data for the Common Gulls along the River Wear

Section	21.10	28.10	4.11	11.11	25.11	22.1	4.2	10.3	7.4	8.5	16.6	14.7	11.8
1	0	27	8	1	0	13	4	91	2	0	0	1	4
2	0	12	2	13	20	12	0	53	8	0	0	0	5
3	[illegible]	0	2	2	10	13	0	24	0	0	0	0	0
4	0	0	6	98	15	0	4	12	15	0	0	1	34
5	1	2	0	1	2	0	2	1	6	0	0	1	1
6	0	0	0	1	0	00	0	-	0	0	0	0	-
7	-	111	0	2	1	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	2	2	0	0	0	0
Total	5	52	18	118	48	38	10	183	33	0	0	3	46

Table: A9 Census data for the Herring Gulls along the Rvier Wear study area

	1969								1970				
Section	21.10	28.10	4.11	11.11	25.11	22.12	4.2	10.3	7.4	8.5	16.6	14.7	11.8
1	21	8	0	19	6	2	0	10	0	125	0	0	1
2	0	10	4	27	6	9	5	15	48	15	3	3	0
3	7	17	3	19	11	6	34	22	23	18	38	25	26
4	4	3	2	12	12	0	0	4	0	17	0	3	23
5	0	0	0	0	0	0	0	0	0	2	2	0	0
6	2	0	0	0	0	0	0	-	0	0	0	0	-
7	-	4	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	34	42	9	77	35	17	39	51	71	177	43	31	50

Table: A10 Census data for the Greater Black-backed Gulls along the River Wear study area

	1969					1970						
Section	21.10	28.10	4.11	11.11	25.11	22.1	4.2	10.3	7.4	8.5	16.6	14.7	11.8
1	1	2	1	10	1	2	0	0	0	0	20	1	0
2	1	1	0	2	2	0	0	0	0	0	0	0	0
3	0	1	0	1	0	0	0	0	0	0	0	0	0
4	0	1	0	4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	5	1	17	3	2	0	0	0	0	20	1	0

Census data for the Kittiwakes along the River Wear study area

April 7,1970	2 on section:1, 4 on section:2, 1 on section:3
May 8,1970	2 on section:1, 9 on section:2, 1 on section:3
June 16,1970	200 on harbour breakwater
July 14,1970	2 on section:2
August 11,1970	35 on section:1

Census data for the Lesser Black-backed Gulls along the River Wear study area

April 7,1970	2 on section:2
August 11,1970	1 on section:4, 1 on section:8

Table: A11 Census data for the Black-headed Gulls along the River Tees study area

	1969						1970		
Section	26.10	30.10	6.11	4.12	24.1	4.4	19.5	13.6	22.7
1	5	16	45	84	100	12	30	33	191
2	118	143	97	54	denied access to Dorman Long Ltd.				
3	42	36	1	1	0	0	1	11	26
4	13	6	12	3	3	0	0	0	2
5	7	9	2	0	2	0	0	0	0
Total	185	210	157	142	105	12	1	44	219

Table: A12 Census data for the Common Gulls along the River Tees study area

	1969						1970		
Section	26.10	30.10	6.11	4.12	24.1	4.4	19.5	13.6	22.7
1	0	2	2	60	1	70	0	1	0
2	44	23	49	50	-	-	-	-	-
3	20	11	4	6	28	5	0	0	0
4	22	4	5	4	5	5	0	0	0
5	2	6	9	4	20	4	0	0	0
Total	88	46	69	124	54	84	0	1	0

Table: A13 Census data for the Herring Gulls along the River Tees study area

	1969						1970		
Section	26.10	30.10	6.11	4.12	24.1	4.4	19.5	13.6	22.7
1	12	2	6	40	0	68	4	42	4
2	27	21	22	36	-	-	-	-	-
3	2	3	0	0	1	0	1	0	1
4	0	0	0	0	0	0	0	0	2
5	0	0	0	0	0	0	0	0	0
Total	41	26	28	76	1	68	5	42	7

Table: A14 Census data for the Greater Black-backed Gulls along the River Tees study area

Section	26.10	30.10	6.11	4.12	24.1	4.4	19.5	13.6	22.7
1	95	78	59	157	1	5	0	4	0
2	5	6	12	22	-	-	-	-	-
3	3	1	2	1	1	0	0	0	0
4	0	1	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
Total	103	86	73	180	2	5	0	4	0

No Kittiwakes or Lesser Black-backed Gulls were observed along the River Tees study area.