A STUDY OF THE EFFECTS OF DETERRING GULLS FROM GLOUCESTER LANDFILL SITE FOR A TWO WEEK PERIOD IN MARCH 2004

FOR

GLOUCESTERSHIRE GULL ACTION GROUP

by

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PREAMBLE

The present study was conducted in response to the offer by Cory Environmental to deter gulls from Gloucester Landfill (Hempsted) for a period of two weeks in March 2004 made at the Gloucestershire Gull Action Group (GGAG) meeting on 18th December 2003. It was suggested that a short term scaring trial at the landfill would provide an insight into the complications/issues of long term bird control measures at the landfill.

GGAG is comprised of representatives of Gloucester County, Gloucester City and Cheltenham Borough Councils, The Environment Agency, Cory Environmental, The Severn Estuary Gull Group (SEGG) and various co-opted members as appropriate.

INTRODUCTION

Part one.

It is well known that gulls utilise landfills throughout Britain and abroad as feeding sources (Cramp & Simmons 1984). Indeed, after the Second World War a great many new landfills were opened accepting household (putrescible) waste where, prior to the War, the largest percentage of waste material dumped was inert (mostly ash) (Institute of Waste Management in litt). This post-War proliferation of landfills signalled the beginning of 'Throw-Away Society' in Britain.

Gulls were quick to take advantage of this new food source (Parslow 1967). However, it was the Clean Air Act of 1956 (which forbade the burning of rubbish at landfills and, instead, required that tip faces should be covered with inert material at the end of a day's tipping) which turned this new food source into a massive feeding opportunity for gulls – particularly the resident breeders.

Prior to the Second World War gull populations in the Severn Estuary Region had remained at relatively low levels (excluding annual fluctuations) and, possibly, had been this way for centuries. The massive, new feeding opportunity engendered by 'Throw-Away Society' and facilitated to a very high degree by the Clean Air Act resulted in rapid population expansions. Numbers in the Severn Estuary Region, for example, rose 15-fold by the mid-1970's (Mudge & Ferns 1980). The result of large population rises was that traditional breeding grounds were outgrown and gulls began to colonise towns and cities (e.g. Rock 1990). The first breeding in Gloucester, for instance, was in 1967 (Owen 1967) and in Bristol in 1972 (P. Chadwick pers comm.).

Since then urban populations have grown exponentially and most urban conurbations in the Severn Estuary Region, as of 2003, supported colonies of varying sizes from two pairs in Bradford on Avon (Rock 2003a) to 3,100 pairs in Cardiff (Rock 2004a), making Cardiff a colony of national significance.

The national survey of gulls nesting on buildings in 1994 (Raven & Coulson 1997) described six regions in Britain. The Severn Estuary (Bristol Channel) Region was estimated, at that time, to contain 1,780 urban pairs (913 and 867 pairs of Herring Gulls and Lesser Black-backed Gulls respectively).

From assessments made at 14 colonies and by extrapolation, it was estimated that the number of urban pairs in the region stood at circa 20,000 pairs in 2003 (Rock 2004) and that urban gulls outnumbered wild gulls by more than 3:1. Further, that the generally accepted annual rate of increase of 13% has been superseded and, instead, was closer to 21%.

It is suggested here that in the summer of 2003 the total number of large gulls (both wild and urban) closely associated with the Severn Estuary Region (i.e. breeding birds, their offspring of the year and offspring from the previous three years) was of the order of 150,000 individuals.

The indeterminate numbers of gulls wintering and gulls on passage (i.e. passing through the region), but which do not breed will, in late 2003, have increased this figure to rather more than 150,000 individuals. This is because, apart from large gulls breeding in other regions and abroad, it will have included the smaller, continental breeding Black-headed and Common Gulls which leave the region en masse during the spring (pers obs).

It is suggested that circa 250,000 individual gulls may have been inhabiting the Severn Estuary Region during the early spring of 2004 (the period of the present study). Certainly, numbers of small gulls were equal to or higher than those of large gulls during the first two phases of the study (see below).

Part two.

That such a large number of gulls is present in the Severn Estuary Region during the winter and early spring, it must be assumed that feeding opportunities are sufficient to support them.

Large numbers of gulls are often to be seen at landfills throughout the region at this time of year and counts of 10,000 birds at Gloucester Landfill, for example, are not uncommon (pers obs). Because of their essentially black and white plumage and sheer numbers, such congregations of gulls are highly visible and thus noticeable, especially where landfills are close to human habitation. It is often assumed (perhaps mistakenly) that gulls depend almost exclusively upon landfills.

Gulls, being opportunistic feeders (Cramp & Simmons 1984) will take almost anything of suitable size and consistency and it is clear that the compacting of waste at landfills provides them with just such easy pickings. Food supplies at landfills are potentially abundant and, perhaps more importantly, are also predictable.

Rather less noticeable, however, are the many individuals and small groups of gulls which seek out alternative feeding opportunities. These opportunities are legion and include the vast tidal mudflats of the Severn Estuary, the River Severn and other rivers in the region, sewage outfalls, green fields, farms, suburban gardens and even the scraps thrown to gulls by well wishers and, inadvertently, discarded take-aways in town. Thus it is that some gulls do not visit landfills as regularly as others (pers obs).

It is salutary to note that approximate foraging times for Black-headed Gulls on green fields/parkland are seven hours, for pasture (cattle/sheep inhabited), four hours, but only 20 minutes on landfills (Baxter & Flack).

The wide range and quantity of feeding opportunities available in the Severn Estuary Region are critical to the survival of the large numbers of gulls which originate from within the region and beyond. This is particularly the case in winter.

As an example, the Lesser Black-backed Gull, formerly a complete migrant, with only occasional birds remaining in Britain in winter, is a species whose migratory pattern has changed in the past 40 years. Nowadays, large numbers are seen in winter (e.g. Hickling in Lack 1986). Since 1986, up to 25% of adult, Bristol-ringed Lesser Black-backed Gulls appear to have dispensed with migration (Rock in prep). The reasons for this change in behaviour are to do with food and safe roosting (Hickling in Lack1986) and, possibly to some extent, with milder winters in the last two decades (Rock 2002). (The winter gull survey (organised by BTO), currently in progress, will reveal just how many Lesser Black-backed Gulls are wintering in Britain).
From discussions with other gull ringers, it appears that urban gulls are rather more prone to dispensing with migration than wild gulls. In this respect (and others), urban gulls show somewhat different behaviours from their wild-breeding cousins.

However, the most important factor in gull survival and breeding is food. Bristol gulls raise between two and three offspring per year (pers obs) in contrast to Skomer Island gulls which raise only one offspring every 10 years (Perrins 2000). This is to do, primarily, with changes in fishing practice in the Celtic Sea. Where some years ago, fishing was carried out by small, inshore boats which discharged offal as they were fishing, nowadays it is carried out by much larger vessels and the discharging of offal is irregular and, most importantly, unpredictable. Secondly, in dry summers, the quantity of invertebrates from green fields is limited by hard ground and thirdly, the landfill at Haverfordwest (previously extensively used by Skomer gulls (P. Todd pers comm.)) closed in 1985.

Urban gulls tend to find ample food whereas some populations of wild gulls do not.

Though it was landfills which provided the impetus for the establishment of urban colonies, it is not at all clear how significant landfills are within the gulls' feeding regimes today (Rock 2004b) and until fundamental research is undertaken, this lack of clarity will persist.

CONTEXT

Gloucester Landfill opened in 1965, some two years before the first colonisation of Gloucester and, at that time, was directed by Gloucester County Council. Cory Environmental took it over in 1997.

Under the Environmental Act of 1990, it is licensed under Waste Management Licensing Regulations (1994) to accept Industrial, Commercial and Domestic Wastes, Inert and Contaminated Soils. Latterly, it accepts approximately 1,500 tonnes per day, of which approximately 70% is organic waste (i.e. household, restaurant and supermarket waste), or, some 1,000 tonnes per day (G. Ricketts pers comm.).

Gloucester Landfill is the most important landfill for gulls within a radius of 100 km (Rock 2003b). It supports large numbers at all times of the year. However, counts show a distinct seasonal variation (pers obs), with the highest numbers (10,000+) observed during the winter and early spring (indeed, there was one count of 9,000 during the present study on 4/3/2004 and several counts in excess of 5,000). By contrast, during the late spring and summer, counts tend to be of the order of 2,000 to 4,000 (pers obs). This is due, in large part, to migratory movements – particularly by Black-headed Gulls – away from the area to continental breeding grounds (Cramp & Simmons 1984, Wernham et al 2002).

It is clear, therefore, that Gloucester Landfill is a major food resource for wintering gulls and an important staging point for a large number of gulls on passage during the spring and autumn. This is evidenced by the wide variety of gull species recorded (J. Sanders pers comm.).

Table 1. Gull species recorded at Gloucester Landfill Site between 1994 and 2004..

Species	**Scientific Name**
Black-headed Gull	*Larus ridibundus*
Common Gull	*L. canus*
Ring-billed Gull	*L. delawarensis*
Mediterranean Gull	*L. melanocephalus*
Herring Gull	*L. argentatus*
Caspian Gull	*L. cachinnans*
Yellow-legged Gull	*L. michahellis*
Lesser Black-backed Gull	*L. fuscus*
Great Black-backed Gull	*L. marinus*
Glaucous Gull	*L. hyperboreus*
Iceland Gull	*L. glaucoides*
Kumlien's Gull	*L. g. kumlieni*
Laughing Gull	*L. atricilla*
Franklin's Gull	*L. pipixcan*
Kittiwake	*Rissa tridactyla*

During the late spring and summer, the vast majority of gulls observed at Gloucester Landfill are Herring and Lesser Black-backed Gulls. Most of these are local breeders (i.e. within a radius of +/- 50 km) and of these, more than three quarters are likely to be urban breeders (e.g. McCarthy 2004).

The Severn Estuary Gull Group (SEGG) has been involved in monitoring gulls of all species in their study area of Gloucestershire and Hereford & Worcester since 1986. This has involved capturing full grown birds (using cannon nets) at various landfills, ringing and then releasing them. A grand total of 24,573 gulls has been ringed during this time (P. Stewart pers comm.).

The first gull catch at Gloucester Landfill was made on 3rd August 1987 and since that time, 13,765 gulls (56% of the grand total) have been ringed and 741 (5.6%) have been recovered.

Table 2. Ringing totals and recoveries for each gull species from Gloucester Landfill Site 1986-2003. Data from SEGG.

Species	Ringed	Recovered
Black-headed Gull	4430	241
Common Gull	26	0
Mediterranean Gull	1	0
Herring Gull	1303	37
Lesser Black-backed Gull	8001	463
Great Black-backed Gull	15	0
Totals	13765	741

The work carried out by SEGG has been instrumental in our understanding of gull movements not only within the study area, but also further afield in the United Kingdom and abroad.

Table 3. Recoveries by region of Black-headed and Lesser Black-backed Gulls ringed at landfills in Gloucestershire and Hereford & Worcester 1986-2003. Data from Stewart (SEGG).

Species	BHG	LBB	Species	BHG	LBB
Recovery region			**Recovery region**		
Britain & Ireland, 0-9 km	20	55	Poland	11	
Britain & Ireland, 10-99 km	72	90	Denmark	79	
Britain & Ireland, 100+ km	89	440	Germany	40	4
Denmark		2	Netherlands	79	69
Norway	16	9	Belgium	8	2
Sweden	34		France	3	17
Finland	36		Spain		8
Russia	8		Portugal		41
Estonia, Latvia & Lithuania	17		Morocco		13
Greenland		2	Western Sahara		1
Iceland		22	Mauritania		1
Faeroes		18	**TOTALS**	512	794

The recovery locations shown in Table 3 describe the movements of Black-headed and Lesser Black-backed Gulls ringed in the SEGG study area. Thus, it can be seen that Black-headed Gulls tend to move northwards and eastwards, whereas Lesser Black-backed Gulls tend to move in a more southerly direction on migration. These are the expected migratory movements for these two species (Wernham et al 2002). However, the two recoveries in Greenland are exceptional in that they are trans-Atlantic movements.

The majority of these birds were ringed using metal rings only and it is only since 1995 that individually-coded colour-rings have been fitted to birds in the SEGG study area. It is hoped, with very much higher recovery rates achievable using colour-rings (Rock 1999) that considerably more information will be gleaned in future years.

Table 3, however, does not fully describe the origins of the gulls visiting the area. Therefore, field records of individually, colour-ringed birds are also presented.

Table 4. Field records of individually, colour-ringed Lesser Black-backed Gulls in Gloucestershire and Hereford & Worcester 1986-2003 showing the number of individual birds and the number of records of those birds. Data from SEGG.

RINGING SITE	Individuals	Records
Iceland	4	4
Norway	22	41
Netherlands	7	9
Belgium	1	1
Spain	3	4
Isles of Scilly	2	25
Bristol	274	1819
Bath	16	43
Cheltenham	6	15
Gloucester	15	101
Gloucester Landfill	118	1372
Flat Holm, Glamorgan	70	333
Llyn Trawsfynydd, Wales	16	58
Widemarsh, Hereford	15	49
Skomer Island, Wales	12	27
Lundy Island, Devon	2	4
Pilsworth, Bury	12	40
Walney Island, Cumbria	114	274
Orfordness, Suffolk	22	76
Port of Felixstowe	1	9
Tarnbrook Fell, Lancs	91	205
Ribble Estuary. Lancs	65	138
Salt Ayre, Lancs	1	14
Craigleith, Scotland	1	1
Bishopbriggs, Scotland	1	2
Helensburgh, Scotland	1	4
Isle of May, Scotland	2	3
TOTALS	894	4671

Apart from those ringed at Gloucester Landfill and Gloucester, the origins of Lesser Black-backed Gulls seen in the SEGG study area range from 12 km (Cheltenham) to 1,800 km (Norway).

However, if the birds ringed at Gloucester Landfill and recovered in Greenland originated from there, then the range extends to over 4,500 km.

Thus, it can be seen that gulls utilising Gloucester Landfill (principally) and Stoke Orchard Landfill (secondly) originate from various parts of Britain and beyond, further reinforcing the notion that these two landfills play a vital role in the survival of many thousands of gulls not only from the immediate area, but also from considerable distances away.

Birds originating from outside the immediate area are recorded annually on passage, thus showing how important Gloucester Landfill and Stoke Orchard are to passage migrants.

RATIONALE FOR STRATEGIC MONITORING

It is clear that the relationship between gulls breeding in Gloucester and Gloucester Landfill is a highly significant one (Rock 2003b). Of 112 known breeders, 110 (98.2%) were shown to have visited Gloucester Landfill during the breeding season. Thus, if this percentage is applied to the Gloucester population of 1,688 pairs (Rock 2003c), some 3,315 individual breeders plus approximately 1,500 non-breeders (n= 4,800) are involved.

This figure makes no allowances for other breeding areas such as Quedgeley, Stonehouse, Cheltenham and further afield.

The impact of rendering the Gloucester Landfill unavailable to gulls in search of food will enable:

1 The identification of alternative feeding sources.
2 The discovery of whether or not there are short-term increases in numbers in Gloucester City.
3 The discovery of whether or not this action has any effect on breeding numbers in Gloucester City.
4 The discovery of any possible effects on other local colonies.
5 The discovery of whether or not this action has any lasting effect on Gloucester Landfill.

The proposal to monitor the effects of deterring gulls from Gloucester Landfill was approved at the GGAG meeting on 2nd February 2004.

METHODS

The monitoring effort was split into three phases:

1. Pre-Deterrence (23rd February 2004 – 7th March 2004)
2. Deterrence (8th March 2004 – 21st March 2004)
3. Post-Deterrence (22nd March 2004 – 16th April 2004)

Initially, the proposal to monitor the effects of deterring gulls from Gloucester Landfill was to have been a period of six weeks (i.e. two weeks for each phase). However, because the gulls were reluctant to return to their usual behaviour patterns at Gloucester Landfill after deterrence, this was extended for a further two weeks.

Deterring gulls from Gloucester Landfill was undertaken by NBC and consisted, primarily, of flying trained falcons (Peregrine x Saker hybrids), with some secondary actions

The principal observers during the study were John Sanders and Peter Rock, but a further 14 observers contributed information to the project in varying degrees.

Sites where gulls are to be found (both breeding and feeding sites) are well known and these received close attention during the monitoring effort. Some 184 visits to 26 sites in the region were made in total. These were:

Table 5. Sites visited during monitoring with numbers of visits to each. Feeding sites are highlighted in red and breeding sites in blue. Other sites are utilised by gulls for roosting, or bathing, preening and loafing.

Site	No Visits
Ashchurch	1
Barrow Gurney Reservoir	5
Bath	1
Bristol	13
Calne	16
Castlemeads	1
Cheltenham	7
Chew Valley Lake	2
Chippenham	1
Compton Bassett	2
Cotswold Water Park	1
Dix Pit (Stanton Harcourt)	2
Frampton-on-Severn	16
Frampton Lake	1
Gloucester	11
GLS	22
Grundon's	4
Hallen	9
Longney	3
Northwick	20
Stoke Orchard	19
Studley Grange	2
Swindon	1
Throckmorton	22
Walmore Common	1
Witcombe Reservoir	1
26 Sites	184 Visits

Apart from Gloucester Landfill Site, particular emphasis was placed upon Stoke Orchard (Wingmoor Farm), Grundon's (immediately adjacent), Frampton and Hallen. Further afield, Throckmorton and Calne (immediately adjacent to Compton Bassett Landfill) were regularly visited.

Visits to feeding sites lasted between 5 and 8 hours. Visits to other sites were determined by numbers of gulls present.

Counts were made at all sites at every visit, separating **large gulls** (i.e. Herring and Lesser Black-backed Gulls, etc.) and **small gulls** (i.e. Black-headed and Common Gulls, etc.) and where site visits lasted more than two hours, repeat counts were made in order to determine any changes. Other species, such as corvids, were also noted where these birds were present.

The major breeding sites of Gloucester and Bristol were visited repeatedly throughout the three phases. Other breeding sites were also visited to a lesser degree based upon population sizes.

The principal data gathering method involved locating colour-ringed birds.

The rationale behind the recording of colour-rings

Bird ringing in Britain using metal rings (now overseen by the British Trust for Ornithology (BTO)) began in 1909. Since that time some 31,086,165 birds have been ringed and 593,839 recovered producing a recovery rate of 2% (Clark et al 2003).

Recoveries, generally speaking, provide us with two pieces of information – the date and place of ringing and the date and place of recovery (most often of the dead bird). Information of this kind has enabled us to discover a wealth of knowledge about our avifauna (e.g. The Migration Atlas). However, for the longer-lived species (including gulls), more detail is necessary to understand their lives in a meaningful way.

BTO metal rings for gulls are small, grey and difficult to locate and read in the field. Even at very close range, because ring numbers (usually seven digits) are stamped around the ring, either the bird, or the observer must move before they can be read.

Plastic colour-rings, by contrast, are large (Bristol rings are 37mm tall) with engraved, much simpler codes which identify individual birds. And, of course, rings are brightly coloured, enabling observers to locate and read them at some distance using a telescope with relative ease. John Sanders has made innumerable visits to Gloucester Landfill precisely for this purpose.

Most importantly, though, and unlike other regions in Britain, the unusually high proportion of individually, colour-ringed gulls in the Severn Estuary Region (potentially, something over 7,000 from various locations within the region and rather more when colour-rings from other more distant UK and foreign schemes are taken into account), means that sites where gulls occur in any numbers (e.g. Gloucester Landfill), good numbers of colour-rings are to be expected. This, of course, is why John Sanders spends so much time at Gloucester Landfill.

John Sanders at Gloucester Landfill, February 2004.

Because, nowadays, the vast majority of colour-rings enable the identification of individual birds, each observation carries with it rather more information than simply the bird's presence at any particular site.

Firstly, many colour-ringed birds already have long life-histories (Bristol-ringed gulls, for example, commonly have life histories in excess of 50 records and some considerably more). Therefore, the past history of individual birds, particularly where these individuals have been recorded at sites visited in the present study, has a direct bearing on the interpretation of data. Thus, data from Gloucester Landfill immediately prior to the study, from the equivalent periods in 2002 and 2003 and from further observations after the study have been included in the analysis in order to present a complete picture.

Secondly, the ageing of the large gulls, despite many descriptions (e.g. Grant 1982), remains riddled with pitfalls (pers obs). It is also the case that once the large gulls reach their fourth summer ageing becomes impossible because at this stage they have acquired full adult plumage which only varies according to season and not by age. However, if birds have been ringed as nestlings, it is, of course, possible to age individuals by year of ringing. Those birds for which ringing dates are available (the vast majority) have been aged and the age structures of visitors to each important site have been analysed.

Thirdly, determining the sex of individual birds in the field is often difficult because of considerable overlap in size (where sexes were certain, of course, these were recorded). Nevertheless, a large amount of information on the sexes of individuals is available. The 1993 and 1994 Bristol cohorts were sexed by DNA analysis (Griffiths 1991). At the same time, measurements were taken of each bird (i.e. wing length, total head length and bill depth) when it was ringed. From multivariate analysis a predictive formula for sexing was arrived at for future cohorts based on measurements alone. Thus, for the purposes of the present study, the potential pool of birds of known sex is approximately 3,000 and this information has been used in the analysis.

The times of all observations at all sites of colour-rings were recorded at five-minute intervals in order to assess stay lengths at the various sites visited and any possible same-day movements.

Where colour-rings were found, estimates of numbers of birds controlled (i.e. checked for rings) were also made in order to gauge the proportion of colour-rings within the site population during visits and to examine the efficiency of observations.

Some older colour-ringing schemes have used only site identifying codes which show (usually) a single, engraved letter (e.g. Flat Holm, showing only the letter F), making it impossible to identify individual birds safely. Though several of these rings were found during the study (n=14), all but one have been discarded for the major part of the analysis. The single exception was a hybrid LBB x HG which was particularly easy to identify.

Therefore, only records of individual birds whose identity was able to be established (n=701) were used in this analysis.

RESULTS

From 186 visits to 26 sites some 351,000 gulls were counted and just over one third of these (120,000) were controlled (i.e. checked for colour-rings). Some 1,949 records of colour-ringed birds were collected from all sites during the period. Excluding birds which were not individually identifiable, the number of records collected was 1,863 of 701 individuals (mean = 2.7 records per individual), producing a strike rate of one colour-ring identified for every 64 birds controlled.

This is a very high strike rate (the mean strike rate from recent expeditions to Portugal, for instance, is one colour-ring in every 220 birds controlled (pers obs)) and reflects the high proportion of individually marked birds in the population. More will be said about strike rates below.

On 12th and 13th March 2004 several observers were stationed at eight sites (Bristol, Calne, Frampton, GLS, Hallen, New Passage, Stoke Orchard and Throckmorton) and counts totalled 37,100. However, these counts do not allow for other gull sites in the area covered by this study. By inserting mean figures from other sites visited and estimates from breeding, bathing and preening sites (but excluding roosting sites), it is estimated (somewhat roughly!) that the total number of gulls present in the study area at that time was of the order of 80,000 birds.

As expected, the highest proportion of individually-marked birds was found to be amongst Lesser Black-backed Gulls, followed by Herring Gulls and then others.

Table 6. Showing numbers of individuals of each species recorded during the present study.

SPECIES	Individuals	%
Black-headed Gull	9	1.30%
Caspian Gull	1	
Common Gull	1	
Great Black-backed Gull	1	
Herring Gull	172	24.50%
Lesser Black-backed Gull	514	73.30%
Yellow-legged Gull	1	
Mediterranean Gull	1	
Hybrid LBBxHG	1	
TOTALS	**701**	**99.10%**

Individually-marked Lesser Black-backed Gulls outnumbered Herring Gulls by 3:1. This ties in with the 2004 regional breeding figures at 3.2:1 (Rock, in prep).

Yellow-legged (*L.michahellis*) and Caspian Gulls (*L.cachinnans*) are present in Britain in small numbers for most of the autumn and winter, but it is relatively recently that colour-ringing schemes have identified their origins. These two were from France (Rhone Delta) and Poland respectively.

The Common Gull (*L.canus*) was a most unusual record from Estonia and the Mediterranean Gull (*L.melanocephalus*), from France, is also unusual because this species is rarely associated with landfills. The Great Black-backed Gull was ringed as an adult in the north of Norway, close to the Russian border.

Hybrid gulls are to be found in most urban colonies in the Severn Estuary Region (e.g. Rock 2003c). Hybridisation frequently occurs between congeners where species are expanding their ranges. The urbanisation of Herring and Lesser Black-backed Gulls (which are closely related species) could be seen as a form of range expansion.

Colour-ringed birds recorded during the study originated from 32 locations.

Table 7. Showing origins and numbers of individuals recorded during the present study. Origins shown in red = foreign**:** origins shown in blue = Bristol scheme: * = local origins.

Origin	Individuals	%
Denmark	3	
Estonia	1	
Finland	1	
France	2	
Holland	14	2.0
Iceland	3	
Norway	3	
Poland	1	
Spain	2	
Bath *	16	2.3
Bristol *	396	56.5
Cheltenham *	2	
Flat Holm *	36	5.1
Gerrards Cross (Heathrow)	8	1.2
Glasgow	7	1.0
Gloucester *	13	1.9
GLS *	76	10.9
Heathfield (Devon)	3	
Hereford *	6	
Isle of May	1	
Lancs. (Ribble)	8	1.2
Lancs. (Tarnbrook)	24	3.4
Lancs. (Walney)	17	2.4
Llyn Trawsfynydd (Gwynedd)	4	
Mallydams (Hastings)	1	
Orfordness (Suffolk)	5	
Pilsworth (Bury)	2	
Isles of Scilly	1	
Skomer Island (Pembs.)	3	
Stoke Orchard *	40	5.7
Unknown	1	
Worcester *	1	
Totals	**701**	**93.6%**

As expected, the majority of colour-ringed birds are from the Bristol scheme (which includes Bath, Cheltenham and Worcester) and, together, make up a total of 415 individuals (59.2%).

Since 1980, 4,949 birds have been individually colour-ringed in the Bristol scheme. The SEGG scheme (GLS, Gloucester, Hereford and Stoke Orchard) has marked 236 birds in this way and the Flat Holm scheme 1,200, making a total of 171 individuals (24.4%).

115 individuals (16.4%) were recorded during the study which originated away from the present study area.

Therefore, by extrapolation, it is estimated that some 13,000 of the 80,000 birds present in the study area on 12th and 13th March 2004 originated from further afield and that 67,000 were local birds.

The oldest bird recorded during the study was L/R right, B/Metal left, ringed by Glasgow University as a 2nd winter bird at Bishopbriggs in December 1978. This makes it **27** years old.

All birds colour-ringed as part of the Bristol scheme and those ringed in Gloucester and Hereford (n=434) were ringed as nestlings in urban colonies. These birds are local

breeders or will recruit into local, urban colonies once they are old enough (less than 2% of Bristol-ringed birds recruit into traditional, wild colonies (pers obs)).

The Lesser Black-backed Gulls originating from Spain were ringed at landfills as full-grown birds – probably British breeding birds and, possibly, breeding locally.

During the study, several rare gulls were found. The Polish Caspian Gull created considerable interest amongst the birding fraternity, as did two Ring-billed Gulls (*L.delawarensis*), from North America. However, the star of the show was a Kumlien's Gull (*L.glaucoides kumlieni*), from Arctic Canada, which first appeared at Gloucester Landfill then at Calne, but was later seen by many at Chew Valley Lake and Cotswold Water Park.

Kumlien's Gull at Calne, March 2004 (Mark Coller).

Kumlien's Gull is a race of Iceland Gull, but differs by showing grey, sub-terminal bars on the white primary flight feathers, clearly visible in this picture.

The 701 individuals recorded during the study visited 21 sites. Many moved between sites and some moved between several sites.

Table 8. Showing number of individuals visiting 21 sites during the study period.

Site	Individuals
Radipole (Weymouth)	1
Slimbridge	1
Worcester	1
Moliets Plage (France)	1
Barrow Gurney Reservoir	2
Cheltenham	2
Chippenham	2
Brownhills (Cannock)	2
Bath	5
Chew Valley Lake	5
Northwick	5
Dix Pit (Stanton Harcourt)	12
Frampton-on-Severn	16
Throckmorton	17
Hallen	28
Gloucester	49
Grundon's	50
Calne	103
Bristol	179
GLS	306
Stoke Orchard	322
Total	**1109**
Study	**701**

408 movements were recorded during the study period (see also Natural Movements, below).

The shortest were between Stoke Orchard and Grundon's at a few hundred metres and the furthest was to Moliets Plage, Landes, France at 903 km.

Orange 4 LN (which had visited Gloucester Landfill several times during 2002 and 2003), was first recorded for the study on 17th March at Calne. It was then recorded twice at Stoke Orchard on 22nd and 23rd April before disappearing to Moliets Plage at the south-eastern end of the Bay of Biscay, turning up there on 5th May! More surprisingly, it was back at Calne on 21st May! This is a round trip of 1,749 km. An astonishing movement!

Three birds moved from Stoke Orchard (two to Brownhills, just north of Birmingham and one to Radipole – distances of 80 and 149 km respectively.

1. The identification of alternative feeding sources.

The seven feeding sites given the greatest attention during the study were Calne (including Compton Bassett), Frampton, GLS, Hallen, Northwick (including New Passage), Stoke Orchard (including Grundon's) and Throckmorton. Dix Pit (Stanton Harcourt, near Oxford) was also visited twice.

Coverage

Coverage at the seven feeding sites was as follows:

Table 9. Number of visits to seven sites in the three phases of the study.

Site	Phase 1	Phase 2	Phase3	Totals
Hallen	2	5	1	8
Calne	3	5	8	16
Frampton (on-Severn)	4	5	7	16
Stoke Orchard	3	9	7	19
Northwick	11	7	2	20
GLS	8	4	10	22
Throckmorton	5	11	7	23
Totals	**36**	**46**	**42**	**124**

In order to assess quality of effort, counts from the feeding sites were totalled for the three phases as were the number of birds controlled. Adjustments have been made for biases from Throckmorton (observation difficulties – see below), from Northwick (small gulls not recorded) and for difficulties inherent in controlling small gulls.

Table 10. Count numbers, numbers of birds controlled and strike rates from 5 feeding sites (Calne, Frampton, Gloucester Landfill, Hallen and Stoke Orchard) in the three phases of the study.

	Phase 1	Phase 2	Phase3	Totals
Counts	50,825	60,210	55,801	166,836
Controlled	35,370	39,440	26,391	101,201
%	69.6%	65.5%	47.3%	60.1%
Strike Rates	**1:88**	**1:99**	**1:55**	**1:81**

It should be stressed that the number of birds controlled in any observation period is dependent on several factors, not least of which is the behaviour of the birds. During the Post-Deterrence Phase birds at Gloucester Landfill were extremely nervous (see below) and making satisfactory observations was frequently impossible.

The strike rate during Phase 3 reflects the absence of small gulls (only 407 were recorded where large numbers were present during the first two phases). It is estimated that all regular users of the seven sites were found and that effort and quality of effort enable meaningful comment to be made.

Before dealing with the results of objective 1, **it should be stated that there are two important caveats associated with interpreting movements away from Gloucester Landfill Site during the Deterrence Phase of the present study.**

(a) Passage Movements

Large numbers of birds (Black-headed Gulls, in particular) were on passage to breeding grounds away from the study area and, in some cases, considerable distances from the study area. Additionally, local breeders (principally Lesser Black-backed Gulls) were arriving back from southern latitudes, or winter dispersal areas.

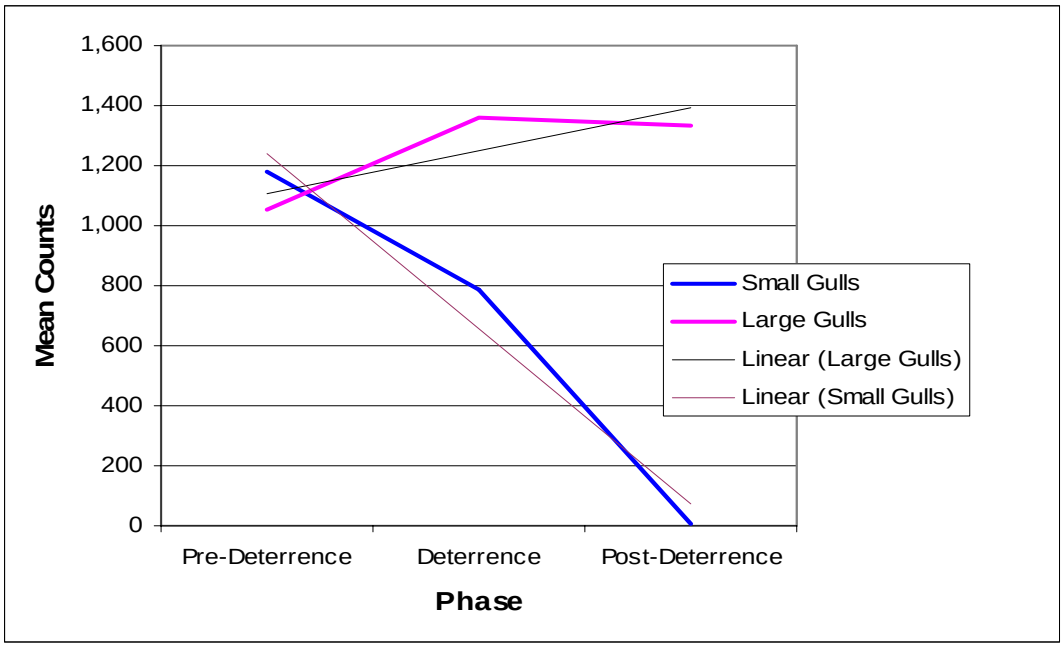
Table 11. Declines in numbers of Small Gulls and increases in numbers of Large Gulls (with means) during the three phases of the study at seven feeding sites.

Phase	Small	Mean	Large	Mean
Pre-Deterrence	42,380	1,177	37,843	1,051
Deterrence	36,215	787	62,606	1,361
Post-Deterrence	423	10	56,112	1,336

On 12th and 13th March 2004 large numbers of small gulls were observed at all sites (1,500 at Calne, 2,000 at Stoke Orchard and 5,000 at Throckmorton). Thereafter, numbers dropped dramatically (apart from one count of 2,000 at Castlemeads on 15/3/2004) to 200 at Stoke Orchard on 19/3/2004 and 15 at Throckmorton on 20/3/2004! It is clear, therefore, that during this week there was a massive movement out of the study area. This explains the apparent discrepancy between actual and mean numbers of small gulls during the Deterrence Phase.

The slight drop in numbers of large gulls during the Post-Deterrence Phase is thought to be as a consequence of passage migrants leaving slightly later than the small gulls.

Figure 1. Declines in mean numbers of Small Gulls and increases in mean numbers of Large Gulls during the three phases of the study at seven feeding sites showing relative trends.



The cross-over between large and small gulls is neatly illustrated in Figure1. There is some annual fluctuation in timings (pers obs), but it was expected that this would occur at some point during the study.

(b) Natural Movements

Gulls are opportunistic feeders, taking anything of suitable size and consistency (Cramp & Simmons 1984). Part of this opportunism is taking advantage of various feeding sources and it is clear that the vast majority of large gulls, in particular, do not rely upon single food sources. Bristol-ringed individuals, for example, have been recorded at a number of different food sources (pers obs). It was expected, therefore, that movements between feeding sites, irrespective of the deterrence in place at Gloucester Landfill Site, would occur in all three phases.

However, until the present study, it has not been possible to assess daily/weekly differences in movements to these different food sources because data collection at this study's intensity has not been attempted before.

Table 12. Showing number of observations (Records) of individual birds throughout the study (All Indivs) and at eight feeding sites within the study area.

Records	All Indivs	8 Sites
1	329	330
2	280	250
3	75	27
4	16	1
5	1	
Indivs	701	608

Of 701 individuals recorded during the study, 372 (53%) were also recorded at different sites between November 2003 and June 2004. One individual (White4 AJ) was recorded at five sites!

The eight feeding sites monitored were visited by 608 individuals (87%) during the same period. Of these, 278 individuals (46%) were also recorded at different sites. With approximately 50% of all birds recorded as moving between sites it can be seen that the gull species are highly mobile. It is suspected that this percentage would have been higher had more observations been possible at several sites prior to deterrence.

Table 13. Showing the number of individuals visiting eight feeding sites within the study area.

Site	Indivs
Northwick	7
Dix Pit	12
Frampton	15
Throckmorton	17
Hallen	26
Calne	106
Stoke Orchard	338
GLS	394
Total	**915**

There were 307 movements (915-608) between the sites listed between November 2003 and June 2004.

The movements described do not differentiate between natural and forced movements. Though 20 individuals moved between feeding sites during the two weeks of the Deterrence Phase, it is considered unwise to label their movements as natural. In order to assess natural movements, only those individuals recorded prior to deterrence are considered. Thus:

Of **332 individuals** recorded prior to deterrence, **72 (22%)** were recorded moving between sites naturally. **Therefore, when interpreting movements arising as a consequence of deterrence, allowances must be made for the birds' tendency to move naturally (i.e. without prompting).**

Results of Objective 1 – Alternative Feeding Sources

The eight feeding locations listed above are all landfills receiving between 400 and 1,500 tonnes of waste per day, with percentages of organic waste varying between almost nothing (Northwick) to 70% (GLS).

Table 14. Showing average daily tonnages, percentages of organic waste and tonnages of organic waste received at eight landfills with distances from Gloucester Landfill.

Site	Tonnes	% Organic	OrgTon	Distance
Northwick	700	1%	7	39
Hallen	400	10%	40	45
Frampton	450	10%	45	11
Dix Pit	250	70%	175	61
Calne	1,400	25%	350	49
Stoke Orchard	750	66%	495	11
Throckmorton	1,300	60%	780	36
GLS	1,500	70%	1,050	

With the varying tonnages of organic waste at these sites, it could be expected that gull numbers would reflect these differences. This did, indeed, prove to be the case.

Table 14 will be referred to in various sections below.

Table 15. Showing maximum counts at seven feeding sites in the study area.

Site	Max Counts	Phase
Northwick	110	2
Frampton	1200	1
Hallen	1800	1
Calne	6100	2
Stoke Orchard	7000	2
Throckmorton	8000	2
GLS	9000	1

These counts are collated from the first two phases of the study and are intended only to show how counts appear to reflect the relative levels of organic waste received at the seven sites in order to appreciate each site's capability in supporting feeding gulls. All three phases are dealt with in more detail below.

As shown above, a record of an individually, colour-ringed bird does not simply provide a present/absent statistic. It carries with it a great deal more information. Therefore, in order clearly to present this wealth of information, the findings for Objective 1 are split into 6 units dealing with movements observed during the study. These are:

Unit 1. Major Movements
Unit 2. Other Categories
Unit 3. Age Structure
Unit 4. Stay Lengths
Unit 5. Inter-Site Movements
Unit 6. Same Day Movements
Unit 7. All Records

Unit 1 – Major Movements

Birds recorded at Gloucester Landfill prior to deterrence were identified at seven alternative sites and appear in section 1 of Table 16. With the cessation of deterrence birds returned to Gloucester Landfill and those which had visited the seven sites during deterrence appear in section 2 of Table 16.

Table 16. Showing records of colour-ringed gulls at eight sites during the Deterrence Phase and records of birds from Gloucester Landfill (GLS) during the Post-Deterrence Phase which had previously visited the same sites.
Legend: Framp = Frampton, SO = Stoke Orchard, North = Northwick, Throck = Throckmorton. Indivs = Individuals, Recs = Records, Multi = Records of birds moving between the seven sites.

1. Moves away from GLS during Deterrence to feeding sites									
Indivs	**Calne**	**Dix Pit**	**Framp**	**Hallen**	**SO**	**North**	**Throck**	**Recs**	**Multi**
172	25	1	7	10	139	2	2	186	14
	13.4%		3.8%	5.4%	74.7%	1.1%	1.1%		8.1%
2. Returns to GLS after Deterrence from feeding sites									
Indivs	**Calne**	**Dix Pit**	**Framp**	**Hallen**	**SO**	**North**	**Throck**	**Recs**	**Multi**
127	9	1	1	1	121	0	1	134	7
	6.7%				90.3%				5.5%
3. Excluding birds ringed at Stoke Orchard 13/3/04									
Indivs	**Calne**	**Dix Pit**	**Framp**	**Hallen**	**SO**	**North**	**Throck**	**Recs**	**Multi**
101	9	0	1	1	95	0	1	107	1
	8.4%				88.8%				

The **Multi** column refers to birds which moved between the seven sites (viz. natural movements) during the Deterrence Phase and accounts for the discrepancy between the number of individuals and the number of records.

Table 17. Movements between feeding sites prior to and as a consequence of deterrence (**1. G&**), returns to Gloucester Landfill after deterrence (**2. &G**) and movements by birds ringed on 13/3/2004 (**3. Ex**). 20 individuals (6.7%) were involved in 22 movements.

Moves	**1. G&**	**2. &G**	**3. Ex**	**Totals**	**Dist**
SO + Calne	6	5		11	59
SO + Dix Pit	1	1	1	3	63
SO + Frampton	3			3	21
SO + Hallen	2			2	55
SO + Throckmorton		1		1	26
Frampton + Calne	1			1	44
Hallen + Calne	1			1	47
Indivs	**14**	**7**	**1**	**20**	
				6.7%	

Most inter-site movements were made between five other sites and Stoke Orchard. Mean distance=51 km.

131 individuals visited Stoke Orchard prior to and as a consequence of deterrence.

On 13/3/2004 (i.e. during the Deterrence Phase) 87 birds were caught at Stoke Orchard and individually colour-ringed by SEGG (thus giving them identities within the study, but introducing a slight bias in the results).

It is possible that some (or all?) of these birds had visited Gloucester Landfill prior to deterrence (26 of them were subsequently recorded at Gloucester Landfill (and may be local breeders) and 6 in Gloucester (breeding) during the Post-Deterrence Phase). **It is immediately apparent that the vast majority of birds displaced from Gloucester Landfill utilised Stoke Orchard as an alternative feeding site with smaller numbers moving to Calne, Hallen, Frampton, etc.**

Similarly, of birds returning to Gloucester Landfill after the cessation of deterrence, the vast majority had visited Stoke Orchard with even smaller numbers having visited the other sites.

However, great care should be exercised when interpreting these figures because Table 16 describes information gathered about 235 individuals. A further 97 individuals are not accounted for and will be dealt with in Table 19 and conclusions presented.

This notwithstanding, there is much to be gleaned from Table 16.

Referring back to Table 14 (tonnages of organic waste) it could have been expected that a large number of birds would move to Throckmorton (780 organic tonnes daily). However, Throckmorton operates intermittent gull deterrence which includes birds of prey (P. Stewart pers comm.). Though there were often large numbers of gulls present, observation difficulties prevented consistent data gathering. Throckmorton is also 36 km from Gloucester Landfill whereas Stoke Orchard is only 11 km distant.

Frampton is also 11 km from Gloucester Landfill and though seven displaced birds (3.8%) visited this site during the Deterrence Phase, it is clear that with only 45 tonnes of organic waste daily, Frampton could not support the large numbers of gulls displaced from Gloucester Landfill. The situation is similar at Hallen (40 tonnes) which was visited by ten displaced birds (5.4%). It is concluded, therefore, that birds displaced from Gloucester Landfill positively rejected both sites

These two percentages, whilst of passing interest, are insignificant in comparison to those noted at Stoke Orchard and, to a lesser extent, at Calne. With Throckmorton's deterrence policy, a feeding journey (round trip) of 72 km might appear to be a time consuming (and risky?) venture when feeding opportunities are not predictable.

Neither Stoke Orchard, nor Calne operate deterrence policies and daily tonnages of organic waste (495 and 350 respectively) would appear to be sufficient to support large numbers of gulls. More importantly, feeding opportunities are predictable. Therefore, it is suggested that the majority of gulls present in the study area were familiar with the monitored sites (viz. natural movements).

Other movements by the 17 visitors to Frampton and Hallen are enlightening. Five later moved to Stoke Orchard and two to Calne. A further seven (visiting Hallen) are Bristol breeders, one of which had already visited Calne and one (a Danish BHG) was a passage migrant and therefore possibly unfamiliar with the area. All but one of the visitors to these two sites were recorded in the early stages of deterrence.

Stoke Orchard with almost 500 tonnes of organic waste per day (and only 11 km from Gloucester Landfill) was therefore an obvious choice for birds familiar with the area and seeking alternative feeding opportunities. Calne, despite the fact that it is 49 km from Gloucester Landfill, was visited by 25 displaced birds.
183 individuals visited Gloucester Landfill during the Post-Deterrence Phase, 127 (69%) of which had previously been recorded at one or more of the seven landfills. Over 90% of these birds had visited Stoke Orchard and, interestingly, the percentage returning to Gloucester Landfill from Calne was halved and from other sites there

were only single birds. It is likely that as the Deterrence Phase wore on, birds gravitated to Stoke Orchard because the other sites were not viable. Further, by the time deterrence ended (22/3/2004) breeding activity in all colonies (with the progressive return of migrant birds) had become more competitive.

Movements from the seven feeding sites to breeding colonies are dealt with below, but it is apposite to deal with Gloucester breeders here.

Some 110 individuals have been recorded as breeding in Gloucester over the years (pers obs), but whether or not this number bred in 2004 is unclear. During the study and later (during the Gloucester survey), 68 birds were recorded as breeding. Of these, 39 (57%) visited Stoke Orchard prior to and during the Deterrence Phase. Altogether, 50 Gloucester breeders (74%) visited Stoke Orchard during the study. None was recorded at any of the other sites.

Table 18. Showing expected and observed numbers of Gloucester breeders based on observed percentages at three landfills.

Site	Obs %	Expected	Observed
Stoke Orchard	72.1%	49	50
Calne	13.7%	9	0
Hallen	6.6%	4	0
Frampton	4.6%	3	0

After deterrence 38 Gloucester breeders were recorded back at Gloucester Landfill.

Gloucester breeders are certainly familiar with the feeding sites in the study area, with several having been recorded at each of the seven sites in the past (pers obs). It is not known how many colour-ringed birds are breeding in colonies close to Gloucester. Quedgeley, for example, is thought to support approximately 1,000 pairs and should contain something over 30 colour-ringed birds. Frequent breeding season records from Gloucester Landfill of birds whose breeding locations are unknown would suggest that this is probably the case.

Therefore, it is possible that the percentage of Gloucester breeders PLUS other local breeders utilising Stoke Orchard during the Deterrence Phase would have been considerably higher.

However, that such a large percentage of Gloucester breeders did visit Stoke Orchard (and, it is suggested, rejected the other sites), raises questions about the birds' breeding priorities. Time spent flying is time lost on breeding territories. Further comment is made on this aspect below.

Of 68 Gloucester breeders recorded in 2004, 50 (74%) visited Stoke Orchard at some point during the study. Self-evidently, 26% did not and these are dealt with in Unit 2.

Unit 2 – Other Categories

Prior to deterrence 265 individuals were recorded at Gloucester Landfill. Of these 172 (65%) visited one of the seven feeding sites, leaving 93 individuals (35%) unaccounted for. These birds are dealt with in Table 19.

Table 19. Showing two categories from Table 16 (in red), with three additional categories (in blue) of birds affected by deterrence. Numbers of individuals recorded in each category are listed and divided into numbers of each species. Sexes (where known) have been included.

Category	Indivs	Lesser Black-backed Gull	Herring Gull	Black-headed Gull	Yellow-legged Gull	Great Black-backed Gull	Common Gull	Hybrid	Females	Males
Disappeared	31	21	6	2		1	1		5	10
No Move	34	28	5		1				16	7
GLS to Other	172	100	72	3					50	50
Other to GLS	127	99	27					1	34	27
GLS to Non-Feeding	28	13	15						4	22
GLS-Other-GLS	64	44	20						22	21

Note:

The **Disappeared** category refers to birds recorded at Gloucester Landfill prior to deterrence, but not subsequently. The **No Move** category refers to birds recorded at Gloucester Landfill prior to deterrence *and* after deterrence, but not during. The **GLS to Non-Feeding** category refers to birds recorded at Gloucester Landfill prior to deterrence and recorded again during/after, but not at one of the seven feeding sites. These categories will be dealt with together.

Of 31 birds recorded in the Disappeared category, 7 were passage migrants, 6 are Bristol breeders (but were not recorded again during the study) and 5 are probably Flat Holm breeders. These birds may simply have left the study area to return to their breeding colonies (n=18). From past history (2002 & 2003) at Gloucester Landfill, 7 appear to be local breeders and 6 remain unclassified (n=31). Interestingly, three ('local breeders') of these birds were recorded at Stoke Orchard prior to deterrence.

Orange2 BU, ringed 28/6/1991, retrapped Stoke Orchard 6/12/2003.

Of 34 birds recorded in the No Move category, 15 (22%) were recorded breeding in Gloucester and, from past history at Gloucester Landfill, 10 are probably local breeders (n=25). Two birds were passage migrants and 7 were unclassified (n=34). Only one of these birds visited one of the seven feeding sites (Northwick) prior to deterrence. However, 6 birds have visited Stoke Orchard since data collection ended. With 50 Gloucester breeders accounted for at Stoke Orchard and 15 in the No Move category (n=65), only three birds remain unaccounted for. Where did they feed?

Of 28 birds in the GLS to Non-Feeding category, 22 are Bristol breeders and 6 were unclassified (n=28). None of these birds was recorded at Stoke Orchard prior to deterrence, or subsequently.

Table 20. Showing classifications of birds recorded in three categories.

	Disappeared	No Move	Elsewhere	Totals
Gloucester		15		15
Local	7	10		17
Passage Migrants	7	2		9
Bristol	6		22	28
Flat Holm	5			5
Unclassified	6	7	6	19
Totals	31	34	28	**93**

The birds in these three categories will have found food without visiting the seven feeding sites. Clearly, it is possible that some (or all) could have visited the seven feeding sites at times when observers were not present, but this possibility is rejected because coverage at the sites was high and it should be expected that if birds were utilising these sites regularly, they would have been picked up.

In the No Move and GLS to Non-Feeding categories it will be seen that there is a distinct difference between the number of males and females. Almost all of the birds recorded in these two categories are Bristol-ringed and a sex bias should be expected. This is because males tend to return to natal colonies once they are old enough to breed (philopatry), whereas females find other colonies (e.g. Rock 2002). Thus, Bristol-ringed Gloucester breeders are predominantly female and Bristol breeders are predominantly males (χ^2 (Yates' Correction) = 14.889, P<0.01).

Unit 3 – Age Structure

An assessment of ringing effort and number of records is necessary in order to set results properly into context. As the Bristol scheme accounts for the majority of records during the study (60%), it is considered appropriate to look at Bristol ringing and records of Bristol-ringed birds during the study.

Table 21. Showing numbers of Bristol scheme birds ringed (Ring) and numbers of individuals (Recs) recorded during the study for each cohort (Ring Year).

Ring Year	LBB Recs	LBB Ring	HG Ring	HG Recs
1982	1	92	46	0
1983	0	N/A	N/A	0
1984	0	N/A	N/A	0
1985	1	76	73	0
1986	0	N/A	N/A	0
1987	3	107	59	2
1988	5	139	54	1
1989	9	129	46	2
1990	3	122	40	2
1991	8	141	56	0
1992	13	152	50	3
1993	10	174	71	7
1994	37	257	71	6
1995	18	222	54	5
1996	23	243	58	7
1997	24	166	63	14
1998	31	223	68	18
1999	23	161	49	10
2000	22	180	59	16
2001	24	207	64	24
2002	6	243	60	22
2003	2	245	76	13
Totals	**263**	**3279**	**1117**	**152**

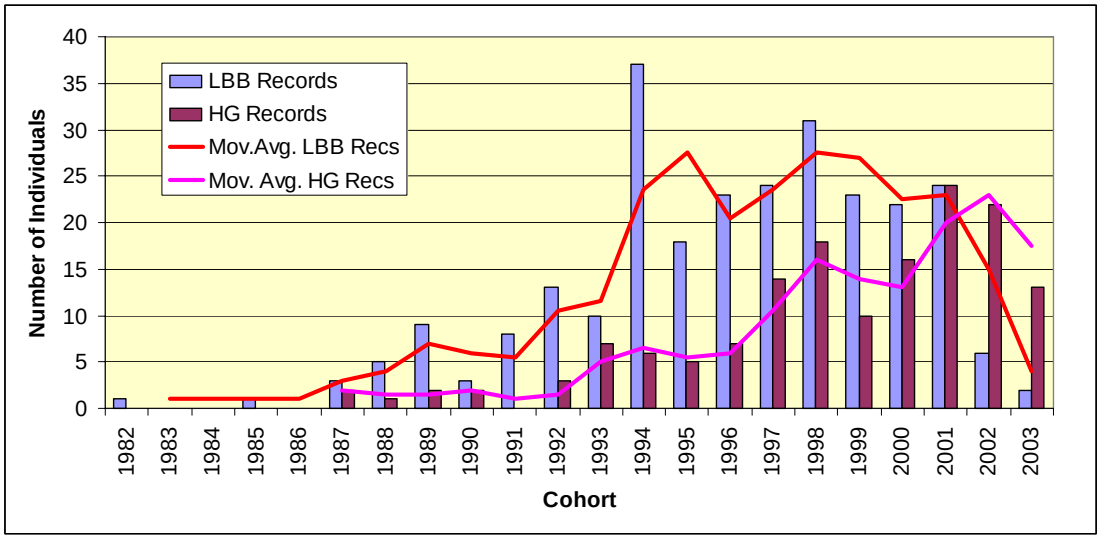
The oldest Bristol bird recorded was White1 JL (Calne) at 22 years of age.

Numbers of individuals of Herring Gulls and Lesser Black-backed Gulls recorded during the study from each cohort are shown in Figure 2.

Numbers of individuals and numbers ringed of both species from each cohort are shown in Figures 3 & 4.

Only 20 Herring Gulls from other schemes were recorded during the study.

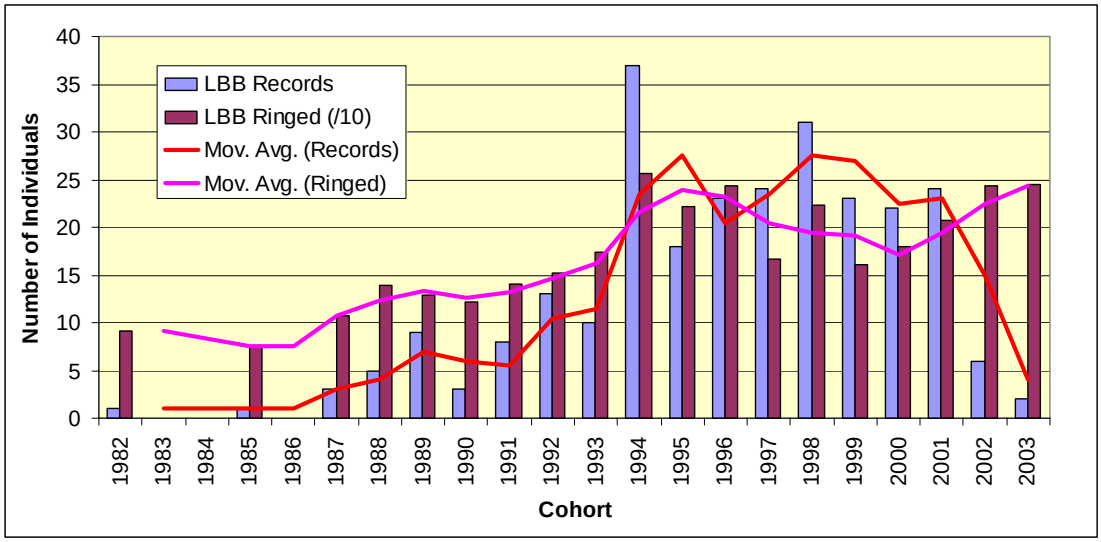
Figure 2. Numbers of records of individuals of both species from each cohort (age class).



The Bristol scheme has ringed 2.6 times more Lesser Black-backed Gulls than Herring Gulls. It was therefore to be expected that more records of Lesser Black-backed Gulls would be gathered. However, where a reasonably even spread of records could have been expected (and this is roughly the case), there are two discrepancies. The first concerns the 1994-96 cohorts. In these years the percentage difference between the two species was rather higher than in all other years with many more

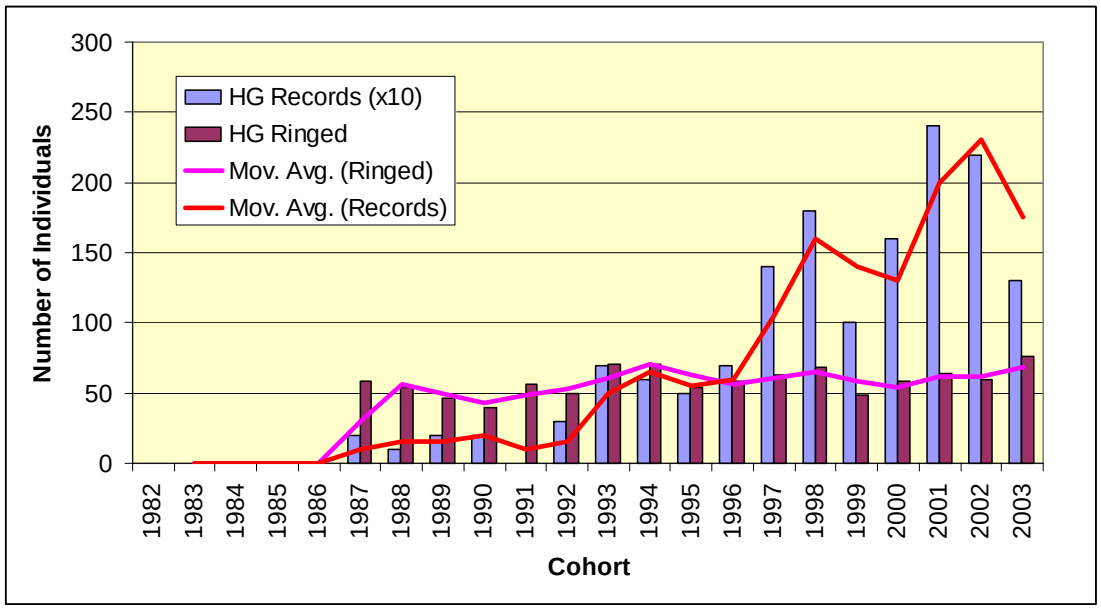
Lesser Black-backed Gulls being ringed. The second concerns the 2002-03 cohorts and will be dealt with below.

Figure 3. Showing records of Lesser Black-backed Gull individuals vs. ringing totals from each cohort (age class) ÷ 10 to bring totals together for ease of interpretation.



Numbers of records are roughly in line with expectations apart from the 1999 and 2000 cohorts. During these two years fewer birds were ringed than in the preceding and subsequent years. It is also possible that survival rates for these cohorts are lower than previous cohorts. Again, there is a discrepancy between numbers ringed and observed for the 2002-03 cohorts.

Figure 4. Showing records of Herring Gull individuals (x 10 for ease of interpretation) vs. ringing totals from each cohort (age class).

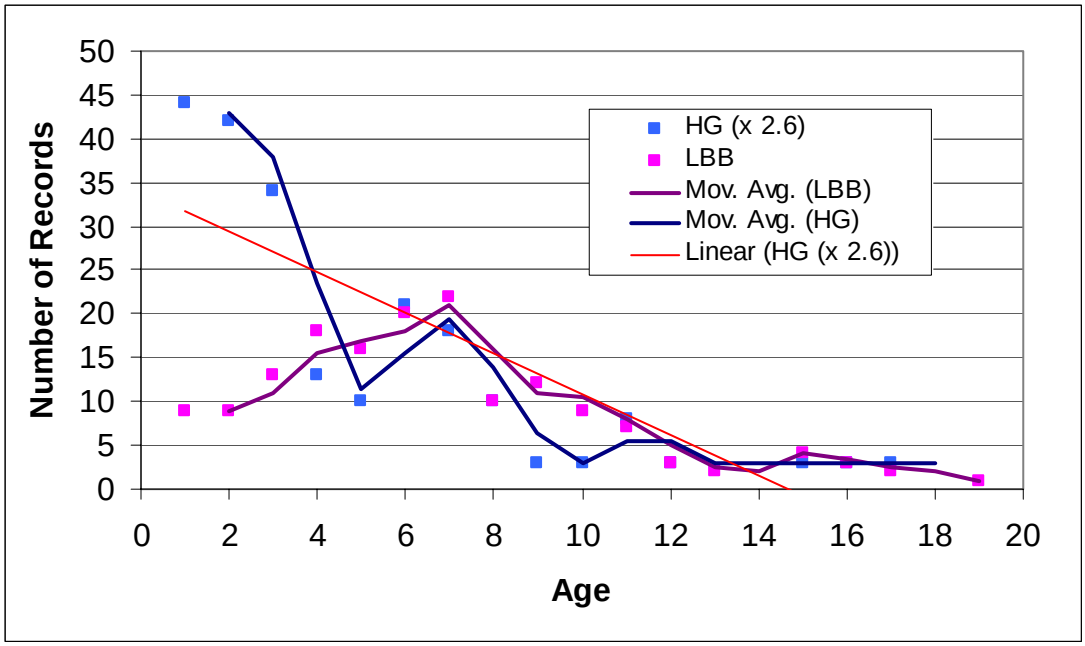


Numbers of Herring Gulls ringed have been roughly similar throughout the Bristol study (between 46 and 73 annually). With so few Herring Gulls ringed throughout, it

is to be expected that survival of older birds is proportionately limited and that the higher number of records would be amongst the younger birds. The 1999 cohort (as with Lesser Black-backed Gulls) reveals a poor ringing year.

The discrepancies referred to in Figures 2 and 3 are dealt with in Figure 5.

Figure 5. Numbers of records of Herring (HG) x 2.6 (for ease of interpretation) and Lesser Black-backed Gulls (LBB) of all ages observed during the study.



By multiplying the numbers of Herring Gull records by 2.6 (the species split during ringing) the two trend lines show fair agreement. The 1999 cohort is again a hiccup, but this is overcome by inserting a linear trend line.

It can now be seen that there is a major proportional difference in numbers of records between the two species. Bristol-ringed Herring Gulls are rather sedentary with few birds moving further than 100 km from natal areas, whereas Lesser Black-backed Gulls are (for the most part) migratory (pers obs).

The vast majority of Bristol-ringed Lesser Black-backed Gulls migrate in their first autumn to Spain, Portugal and North Africa and many of them do not return until their second summer. By their third summer, the majority are back. However, some birds do not appear until they are even older (pers obs).

Therefore, the relatively small number of young Lesser Black-backed Gulls and proportionately higher numbers of young Herring Gulls recorded during the study were to be expected. This discrepancy in numbers neatly illustrates the behavioural differences between the two species.

Within the study as a whole the number of positively aged birds was based only on ringing information from birds ringed as pulli (nestlings). Certainty when ageing unringed, immature, large gulls in the field (particularly 2nd, 3rd and 4th summer types)

is questionable (pers obs). Ages beyond 4th summer (i.e. when birds are in full adult plumage) are impossible to deduce without ringing information. Of 701 individuals recorded during the study, it has been possible to age 575 individuals positively. When assessing the results of Objective 1, it is important to look at the age structure of birds visiting alternative feeding sites. As has been shown previously, the birds' breeding considerations have influenced the outcome of the present study. Therefore, excluding non-breeding birds will allow a better appreciation of the extent of this influence.

Urban gulls breed commonly at three years of age and a small, but increasing percentage is also breeding at two years of age (pers obs). However, for the purposes of this analysis, only 4th year and older birds are considered.

Though urban gulls make up 61% (n=428) of the total observed during the study, only 42.5% (n=139) visited Stoke Orchard.

Table 22. Showing numbers of individuals of known age recorded during the study in three categories. Numbers of non-breeding birds (i.e. 3rd years and younger) within each sample are shown with percentages, leaving the number of birds of breeding age.

	Known Age	Non-Breed	%	Breed Age
All Sites	441	107	24.3%	334
Stoke Orchard Total	251	64	25.5%	187
Stoke Orchard (Deterrence)	193	54	28%	139

During the Deterrence Phase, the mean number of large gulls at Stoke Orchard was 3,244 (9 visits). The mean number of urban gulls of breeding age, therefore, was 993 (42.5% - 28%). Of these, 21.6% were Gloucester breeders (n=193). Roughly, then, it is possible that 68% of all Gloucester breeders (2,715) visited Stoke Orchard at some point during deterrence. These figures are based on assumptions and are tentatively included simply to illustrate possible levels.

Unit 4 – Stay Lengths

In order to assess stay lengths at feeding sites colour-ringed birds were recorded in five-minute intervals and repeat sightings were noted only if they were still present at the site after half an hour. A shorter period, it was felt, would add unnecessary complication to the recording process and (if Baxter & Flack's assessments on required feeding time at landfills are applied), would add little to the outcome of assessments. From impressions during the study, it was thought that few gulls stayed for periods shorter than half an hour.

For the purposes of this analysis Grundon's and Stoke Orchard were treated as the same site (Stoke Orchard) as birds move freely between the two.

131 individuals (21.5% of the 608 individuals observed at feeding sites) were recorded more than once at the same site on the same day with 166 stays in total (a small sample). Stay lengths (in hours and minutes) ranged between 0:30 and 6:20 with **a mean stay length of 2 hours and 4 minutes**.

Table 23. Number of stays at five feeding sites and number of individuals (indivs) involved.

Site	Stays	Indivs
Stoke Orchard	101	83
GLS	42	34
Calne	14	14
Throckmorton	7	7
Hallen	2	2
Total	**166**	**140**

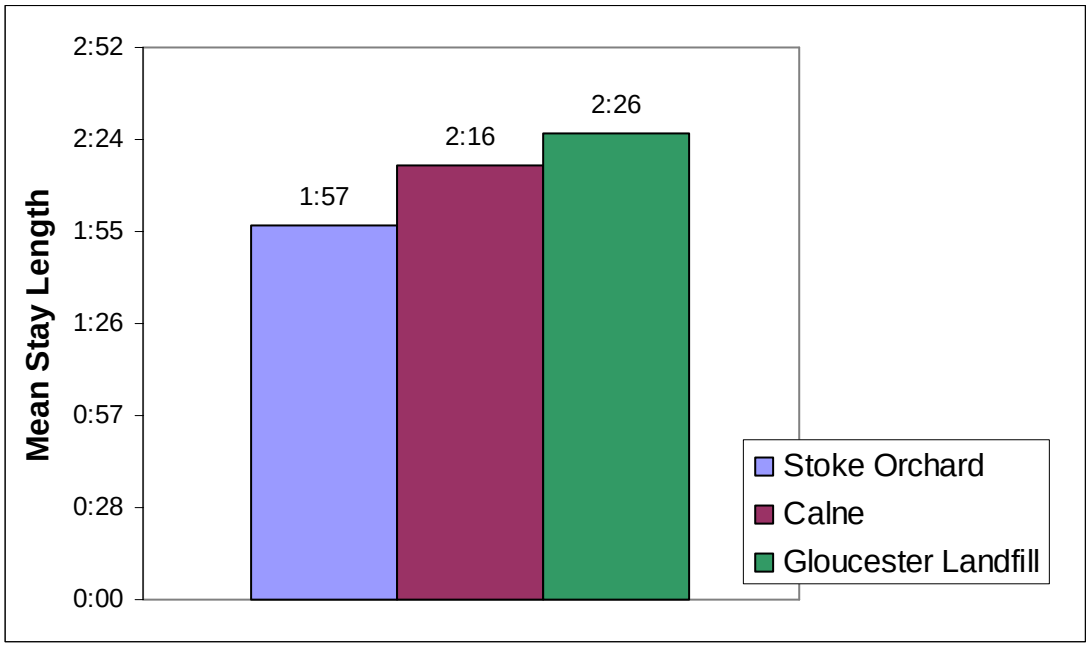
With only 14 stays at Calne and less at Throckmorton and Hallen, stays from these sites were discarded for the more detailed analysis below except where it has been necessary to look at the global figure (e.g. stay lengths of birds of different ages).

Nine individuals were recorded staying at more than one site.

(a) Major Sites

The major sites are Stoke Orchard and Gloucester Landfill with 143 stays. Calne is shown only as an illustration.

Figure 6. Mean stay lengths (in hours and minutes) of gulls recorded at three landfills.



The difference in mean stay lengths at Stoke Orchard and Gloucester Landfill is 29 minutes. The difference not especially significant (Mann-Whitney, P<0.24).

With such a large number of Gloucester breeders visiting Stoke Orchard, however, it is pertinent to remember that flying time back and forth as well as feeding time is a consideration for territory holders (flying speeds will be dealt with in Unit 6 – Same Day Movements).

It is not known how long territory holders are prepared to stay away from territories at this time of year when competition is most intense (absence tolerance). Once eggs are laid, territorial competition decreases markedly (pers obs) and it is possible that non-incubating birds could spend longer away from nest sites during the incubation phase.

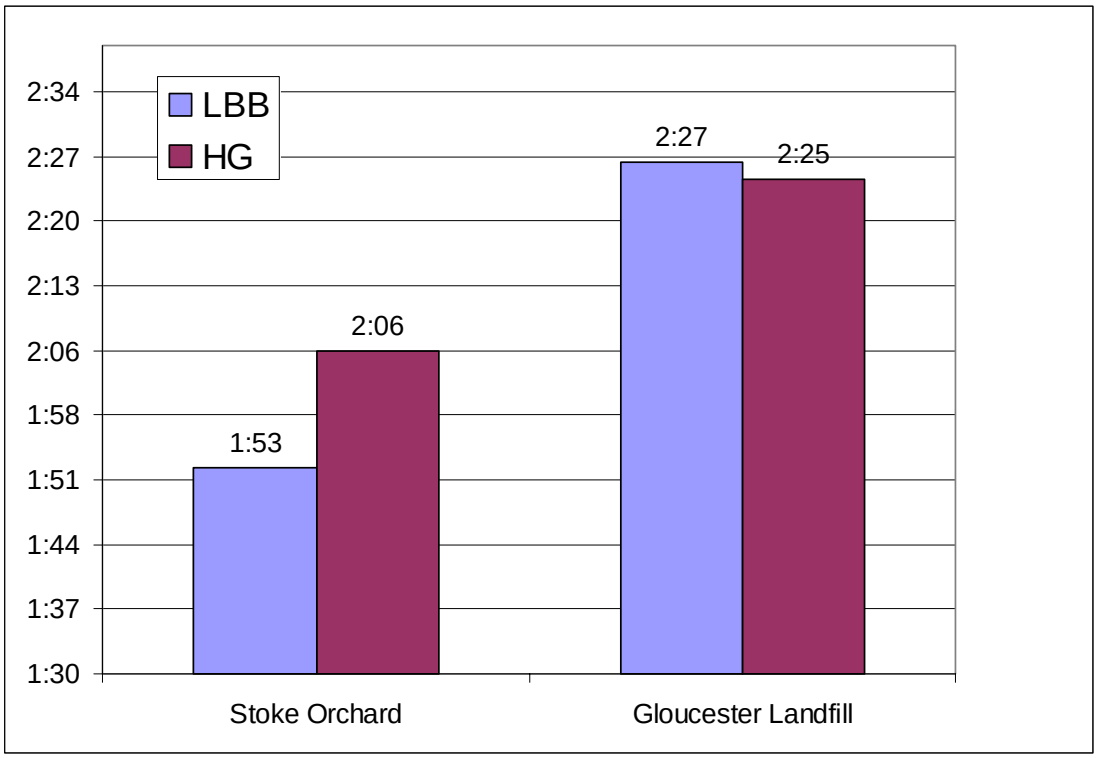
For Gloucester breeders utilising Gloucester Landfill, flying time is minimal and, perhaps, they can afford to stay longer. This possibly accounts for the mean stay length at Gloucester Landfill being longer than that at Stoke Orchard.

Nine Gloucester breeders were recorded staying at Stoke Orchard (mean stay length = 1:26) and two Gloucester breeders at Gloucester Landfill (mean stay length = 2:43). One Cheltenham breeder stayed at Stoke Orchard for 3:00 (distance = 4 km). These samples are tiny (and are only indicative), but they do illustrate the point.

(b) Species

No stays were recorded for any other gull species apart from Herring and Lesser Black-backed Gulls during the study.

Figure 7. Mean stay lengths (in hours and minutes) of Lesser Black-backed Gulls (LBB) and Herring Gulls (HG) at Stoke Orchard and Gloucester Landfill.



The differences in stay lengths between the two species are not statistically significant, but are nevertheless quite interesting. At Stoke Orchard, the mean stay length difference is 13 minutes.

The contrast between the tip faces at Stoke Orchard and Gloucester Landfill during the study was marked. At Stoke Orchard the tip face was on a steep slope and narrow, whereas, at Gloucester Landfill, it was broad and mostly level (as a result of higher daily tonnages?). This meant that in order to feed at Stoke Orchard, birds appeared to fight over food items more at Stoke Orchard than at Gloucester Landfill and time spent feeding was in short bursts rather than for sustained periods which was the case at Gloucester Landfill prior to deterrence.

The Lesser Black-backed Gull is the dominant species in all but two (Chepstow and Aberthaw) urban colonies in the Severn Estuary Region and it outnumbers the Herring Gull by more than 3:1 (pers obs).

Breeding success, of course, is entirely dependent upon adequate food supplies. It is not known if Lesser Black-backed Gulls breed more successfully than Herring Gulls in the region, but as numbers grow, it might be assumed that they do. This, in turn, leads to the assumption that they must be more efficient at foraging.

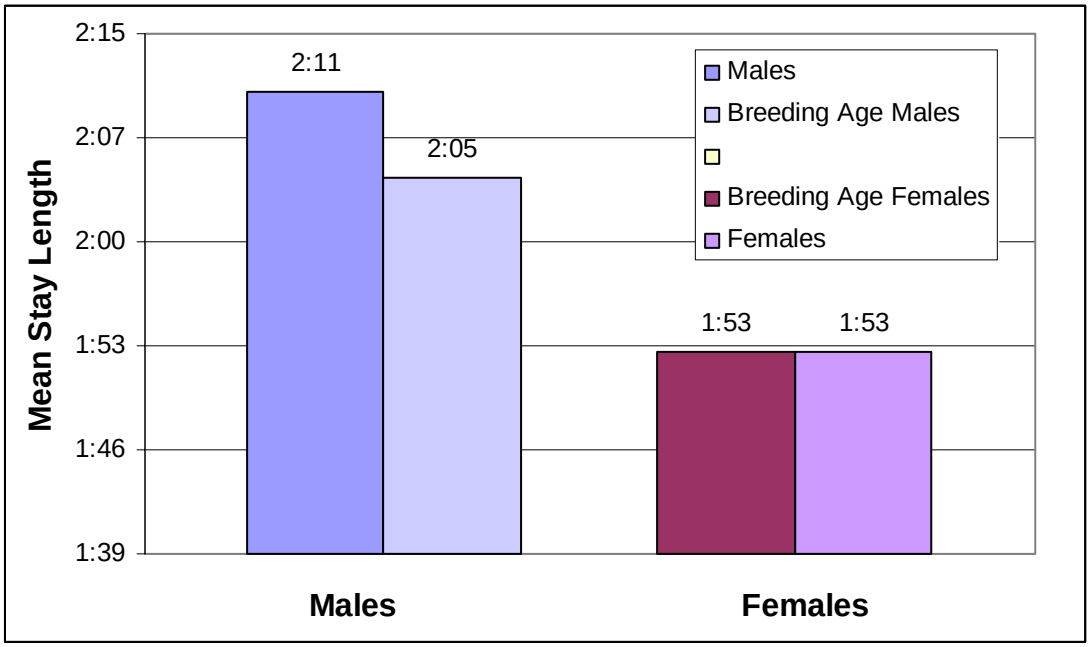
Lesser Black-backed Gulls are, on average, slightly smaller and lighter than Herring Gulls and are, thus, more agile. This may be of direct benefit in the melee at tip faces. Therefore, it is possibly the case that Lesser Black-backed Gulls require less time at the tip face in order to find sufficient food, but this is an area which needs more work.

The difference in mean stay lengths between the two species at Gloucester Landfill is negligible. It is therefore possible that both species have similar time limits for absence from territories. Generally, the large gulls will bathe and preen after feeding. Are mean absence times approximately 3-4 hours at this time of year?

(c) Sexes

The difference in mean stay length between the sexes is 18 minutes (sample size = 92 (54 males, 37 females)), taken from four landfills. However, for birds of breeding age the difference is only 12 minutes (sample size = 63 (33 males, 30 females)).

Figure 8. Mean stay lengths (in hours and minutes) of gulls of known sex recorded at four landfills.



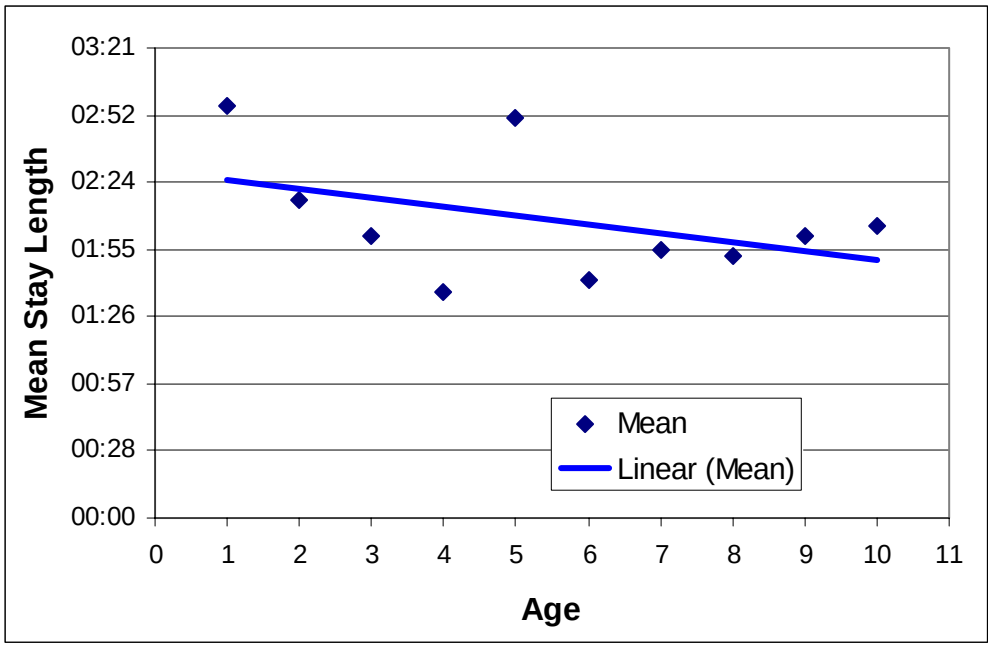
There are several possible explanations for the difference in mean stay lengths of males and females. For example, it could be that males are more aggressive than females during food competition at tip faces and lose time in prolonged fighting over food items, or that males lose time displaying in loafing areas, etc. However,

investigations of this kind would have required individuals to have been trapped and marked with picric acid (some birds from Gerrards Cross were marked in this way) and would also have been very time consuming.

(d) Ages

There was insufficient data available for birds older than 10 years. Sample size = 120.

Figure 9. Mean stay lengths (in hours and minutes) of gulls of known age at four landfills.



The general trend is for younger birds to stay longer than adults (breeders) with first year birds staying for the longest periods. Immatures (non-breeders) are less experienced (and possibly, less aggressive) at foraging than adults and it is thought that they need more foraging time. They also have no breeding pressure.

The differences between breeding age (i.e. adults) and non-breeding birds (i.e. 3rd year birds and younger) at Stoke Orchard and Gloucester Landfill are revealing. At Stoke Orchard non-breeding birds, on average, stayed 22 minutes longer than adults (2:18 vs. 1:56 – again very similar to mean stay lengths at Stoke Orchard as a whole (1:57). At Gloucester Landfill, by contrast, the stay lengths of non-breeders was almost the same as at Stoke Orchard (2:18), but adults tended to stay 23 minutes longer (2:39) – and similar to mean stay lengths at Gloucester Landfill as a whole (2:26).

Adult stay lengths appear to be in line with possible absence times as suggested above at their preferred feeding site. Non-breeders appear to spend uniform amounts of time wherever they are feeding.

Unit 5 – Inter-Site Movements

It has been shown that 72 (22%) birds moved between feeding sites prior to deterrence (natural movements). A further 20 birds moved between feeding sites during the Deterrence Phase, but because these movements might have been influenced by deterrence, their 'natural' status was questioned.

Inter-site movements during the Post-Deterrence Phase were also noted (21). Again, because of the birds' lingering nervousness at Gloucester Landfill (see Objective 5), these movements were also questioned.

More recently, however, there have been 44 movements between Gloucester Landfill and Stoke Orchard alone (J. Sanders pers comm.). With regular observation visits between these two sites, it has been possible to show that some birds are using one landfill on one day and the other on the next day (n=5).

In total, **662 movements** (both natural and influenced) **between November 2003 and June 2004** have been documented involving 361 (i.e. 51.5% of all individuals) to all sites monitored.

There were three movements involving Black-headed Gulls, two movements by one Yellow-legged Gull and one movement by a hybrid. All other movements (n=656) were made by Herring Gulls (280 by 122 individuals) and Lesser Black-backed Gulls (376 by 234 individuals).

Table 24. Showing movements into listed sites by Herring & Lesser Black-backed Gulls, number of individuals and mean distance travelled.

Site	HG	LBB	Total	Indivs	MeanDist
Bristol	88	62	150	107	45.5
Calne	22	35	57	52	51.1
Frampton	5	6	11		
Gloucester	2	16	18		
GLS	69	112	181	174	23.4
Hallen	18	2	20		
Northwick	4	0	4		
Stoke Orchard	64	123	187	154	22.6
Throckmorton	2	4	6		
Elsewhere	6	16	22		
Totals	**280**	**376**	**656**		**35.7**

The figures presented in Table 24 are self-evident. With large numbers of local breeders feeding at both Gloucester Landfill and Stoke Orchard it is to be expected that mean distances travelled will be small and proportionately higher for Bristol and Calne.

Table 25. Movements away from nine sites to Stoke Orchard and Gloucester Landfill by Herring & Lesser Black-backed Gulls, distances involved (in kilometres) and mean distance travelled.
Legend: Inds=individuals, SO=Stoke Orchard, Fra=Frampton, Cal=Calne, Hal=Hallen, Bris=Bristol, Glos=Gloucester, N/W=Northwick, Thro=Throckmorton

	Inds	**Dist**	**11**	**21**	**59**	**55**	**60**	**9**	**49**	**26**		
Site		**SO**	**GLS**	**Fra**	**Cal**	**Hal**	**Bris**	**Glos**	**N/W**	**Thro**	Totals	Mean
			264		177		1140	9		52	1642	**33.5**
HG	28		24		3		19	1		2	49	
SO	130		118		12		31	16		3	180	**22.7**
			1298		708		1860	144		78	4088	
LBB	102		92		9		12	15		1	129	**18.8**
			1012		531		720	135		26	2424	
Dist		**11**		**11**	**49**	**45**	**49**		**39**	**36**		
Site		**SO**	**GLS**	**Fra**	**Cal**	**Hal**	**Bris**	**Glos**	**N/W**	**Thro**	Totals	Mean
		440		44	490	315	2401		117		3807	**33.7**
HG	41	40		4	10	7	49		3		113	
GLS	99	121		8	25	8	77		3	3	245	**28.6**
		1331		88	1225	360	3773		117	108	7002	
LBB	58	80		4	15	1	28			3	131	**24.3**
		880		44	735	45	1372			108	3184	

It appears that Herring Gulls visiting Stoke Orchard and Gloucester Landfill originated from further afield than Lesser Black-backed Gulls. For example, the species split in Gloucester as of 2004 is 4:1 in favour of Lesser Black-backed Gulls, whereas in Bristol the split is 2.2:1 (Rock in prep) where both colonies are the same size (1,996 and 1,932 pairs respectively). It is possible, therefore, that Herring Gulls are more prepared to travel longer distances than Lesser Black-backed Gulls in search of food.

Unit 6 – Same Day Movements

Apart from several movements between Grundon's and Stoke Orchard (landfills within a few hundred metres of each other) and between Gloucester and Gloucester Landfill Site (at between 1 and 3 km apart), there were, disappointingly, only 4 same-day movements recorded during the study.

The two fastest recorded movements during the study were Throckmorton – Stoke Orchard at 5.3 kph and Gloucester Landfill – Stoke Orchard at 7.3 kph. These speeds are very slow (5.3 kph = 3.3 mph). Two same day movements were recorded on 29/7/2004 between Gloucester Landfill – Stoke Orchard at 10.2 kph (elapsed time between records = 1:05 over 11 km).

The two critical variables in all cases are departure times after recording and arrival times before recording. It is suggested that the recorded flying speeds above could, therefore, have been considerably faster. The fastest movement recorded for a Bristol-ringed Lesser Black-backed Gull during migration was estimated at 25 kph (pers obs).

Table 26. Flying time (in hours and minutes) required to complete round trips from GLS to five sites at four speeds.

Site	Distance	5.3 kph	7.3 kph	10.2 kph	25 kph
Stoke Orchard	22	4:09	3:00	2:10	0:53
Throckmorton	72	13:34	9:52	7:04	2:53
Hallen	90	16:59	12:20	8:49	3:36
Calne	98	18:29	13:43	9:37	3:55
Dix Pit	126	23:46	17:15	12:21	5:00

Feeding journeys (i.e. flying time plus feeding time) are, it is suggested, of less importance for passage migrants and non-breeders than for breeding birds. Indeed, the majority of movements between distant sites were made by young birds and birds on passage, or by more distant breeders (e.g. Bristol).

For Gloucester and other local breeders, however, absence from breeding territories is of considerable importance. It is suggested, therefore, that for these birds feeding journeys are completed in the least possible time. It is further suggested that the shorter stay lengths at Stoke Orchard (mean = 1:57) were dictated by Gloucester and other local breeders with little time to waste (9 confirmed Gloucester breeders stayed on average for 1:26).

If absence tolerances are of the order of 4 hours, then feeding journeys to Stoke Orchard at anything less than 10.2 kph would not be achievable. Even at 10.2 kph, the time required would be 2:10 for flying, 1:57 for feeding and x time for bathing and preening (and resting?) and the journey time would therefore be well over 4 hours. At 25 kph, the same feeding journey could be made in less than 3 hours. It is thus proposed that flying speeds for breeding birds will have been somewhere between 10.2 and 25 kph.

No confirmed Gloucester breeders were recorded at any other feeding site monitored during the study and, having positively rejected Frampton at 11 km, demonstrated a high degree of local knowledge about feeding possibilities. At 25 kph, a feeding journey to Throckmorton would be feasible but, again, local knowledge might have ruled out this possibility. For birds with more flexible absence tolerances, a feeding journey to Calne would also be possible, but moving further afield might not.

Bristol breeders (see Objective 4), on the other hand, regularly travelled rather further than Gloucester breeders to Calne at 42 km, to Gloucester Landfill at 49 km and to Stoke Orchard at 60 km (but no same day movements were recorded during the study). A feeding journey to Stoke Orchard (round trip of 120 km) would have to be made at speeds in excess of 25 kph if tolerable absence times are to be met.

Flying speeds in excess of 25 kph have not been recorded by any of the ringing schemes in the Severn Estuary Region. One Lesser Black-backed Gull moved 190 km from Gloucester Landfill in one day in December 2003 (J. Sanders pers comm.). With approximately 12 hours of daylight at this time of year, the speed would have been 16 kph. However, it is considered unlikely that this bird would have made a sustained flight of more than 8 hours (24 kph). It is also possible that it flew rather faster.

Eight confirmed Bristol breeders made feeding journeys to Stoke Orchard and were recorded on successive days during March 2004. This raises two possibilities: either these birds were dispensing with territory defence altogether, or they were feeding regularly at Stoke Orchard, making same day journeys.

Dispensing with territorial duties may be possible for large, aggressive males because they could (in theory) displace interlopers and six of the eight were males, one of which is known to be highly aggressive (pers obs). However, breeding density in the part of Bristol where four of the observed birds held territories is very high and territory maintenance under such conditions would be of prime importance.

If these birds were making same day feeding journeys, in order to meet tolerable absence times, flying speeds would have to be of the order of 40 kph.

Stoke Orchard was selected as the nearest, viable, alternative feeding site by a large number of gulls when Gloucester Landfill became unavailable. The time required for feeding journeys was within acceptable absence tolerances (and effectively ruled out utilising landfills further afield) and it is suggested that this is why Stoke Orchard was chosen by Gloucester breeders in particular.

However, from observations during the study and after it is clearly the case that birds are alternating between feeding sites on a regular basis. This would appear to be a sensible survival strategy.

Unit 7 – All Records

More than half of all individuals recorded during the study moved between monitored sites in the period November 2003 – June 2004. The relative importance of each site to the study was calculated by dividing the number of records by the number of visits.

Table 27. Number of individuals visiting sites within the study area, percentage of records, percentage of study individuals and each site's relative importance (R.I.) to the study.

Site	Indivs	% of Records	% of Study	R.I.
Northwick	8	0.6%	1.2%	0.5%
Throckmorton	18	1.5%	2.6%	1.2%
Frampton	16	1.3%	2.3%	1.4%
Elsewhere	43	3.6%	6.1%	3.4%
Hallen	28	2.3%	4.0%	4.4%
Gloucester	51	4.2%	7.3%	6.6%
Calne	110	9.1%	15.7%	9.8%
Bristol	197	16.3%	28.1%	21.6%
Stoke Orchard	336	27.8%	47.9%	25.1%
Gloucester Landfill	402	33.3%	57.3%	26.0%
	1209	100.0%		100.0%

Elsewhere encompasses all sites where individual birds were observed and, apart from Northwick, were placed into this category because each had less than 10 records.

The small relative importance percentages at Northwick, Frampton and Hallen reflect the non-use of these sites (47 visits) and, at Throckmorton, observation difficulties prevented significant data collection (22 visits).

As expected, the two most important sites were Gloucester Landfill and Stoke Orchard (41 visits). Half of all individuals recorded during the study were recorded at these two sites reflecting their importance as feeding sites.

Mean counts at Calne of 2,500 and a mean strike rate of 1:100 (compared to 1: 58 at Stoke Orchard), would suggest that Calne (though attracting 110 study individuals) is utilised primarily by birds breeding in colonies within a radius of approximately 25 km. These are Bath, Trowbridge, Westbury, Melksham, Devizes, Swindon, Chippenham, etc. The populations of these breeding colonies amount to some 1,000 pairs (Rock in prep). Bath is the only site where ringing has taken place (and the oldest of these birds are 3 years of age). Though Bristol-ringed birds have been recorded as breeding in most of these colonies, numbers are considerably lower than at the major colonies of Bristol and Gloucester.

CONCLUSION TO OBJECTIVE 1

Deterring gulls from Gloucester Landfill for two weeks in March 2004 resulted in large numbers of birds visiting one of the other seven landfills in the study area. These were (in order of usage):

1 Stoke Orchard
2 Calne
3 Hallen
4 Frampton
5 Throckmorton
6 Northwick
7 Dix Pit (Stanton Harcourt)

Some 332 individuals were recorded at Gloucester Landfill prior to the Deterrence Phase. Of these, 235 (70.8%) visited one or more of the seven landfills and 93 did not.

Translating percentages into numbers of gulls, the maximum count at Gloucester Landfill prior to deterrence of 9,000 (on 4/3/2004) is used as an example (it is certain that many more gulls were utilising Gloucester Landfill on a daily basis, but calculating turnover was not within the remit of the present study).

Example:

Of 9,000 gulls recorded at Gloucester Landfill on 4th March, approximately 6,400 utilised one of the seven landfills as a consequence of deterrence and 3,600 gulls found food from **other sources**.

Of those gulls which visited landfills 74.7% visited Stoke Orchard. Thus, of 6,400, some 4,800 visited Stoke Orchard (some 850 visited Calne and other landfills were visited by decreasing numbers amounting altogether to 750 gulls).

Both Stoke Orchard and Calne receive significant tonnages of organic waste (i.e. potential gull food) every day. However, Calne is 49 km from Gloucester Landfill whereas Stoke Orchard is only 11 km away.

Gulls are opportunistic feeders and will forage widely in search of food. During the study it was observed that the average distance travelled to landfills was 35.7 km. Gulls visiting to Stoke Orchard, however, travelled only 22.6 km. This suggests that the majority of gulls visiting Stoke Orchard were breeding birds from (or immatures associated with) Gloucester, or close to Gloucester. Indeed, 50 confirmed Gloucester breeders were recorded at Stoke Orchard during the study and none was recorded at any of the other landfills.

Having rejected the landfills with insignificant tonnages of organic waste, gulls were demonstrating a high degree of local knowledge. Frampton, for example, receives approximately 45 tonnes of organic waste daily (whereas Stoke Orchard receives approximately 500 tonnes) and is also only 11 km from Gloucester Landfill. This knowledge is derived from many exploratory, foraging flights. Indeed, many of the individuals recorded during the study have previously been recorded at two or more of the seven landfills.

It was found that 22% of gulls recorded at Gloucester Landfill prior to deterrence had moved between landfills naturally (i.e. without prompting). In total, 662 movements involving 361 individuals were recorded between November 2003 and June 2004.

With this high degree of local knowledge, it was not surprising to discover that gulls displaced from Gloucester Landfill (the majority of which were Gloucester and other local breeders), in selecting Stoke Orchard, were choosing to travel to the closest, viable, alternative feeding site where food supplies were predictably adequate.

With breeding season priorities (such as defending territories), the majority of gulls visiting Stoke Orchard would not have used up more time than was necessary. Stay lengths at Stoke Orchard were, on average, some 29 minutes shorter at Stoke Orchard during deterrence than those recorded at Gloucester Landfill before and after deterrence. This is because as well as feeding time, flying time for a round trip of 22 km (approximately an hour and a half) is an important consideration.

It was also found that Herring Gulls spent longer at landfills than Lesser Black-backed Gulls and that males of both species tended to stay longer than females.

Young (i.e. non-breeding) birds of both species spent about the same amount of time (between two and three hours) at whichever landfill they visited, staying longer, on average, than adults.

Once deterrence had ceased, the vast majority of birds which had visited Stoke Orchard returned to Gloucester Landfill further indicating that most were breeding in Gloucester or environs. However, it is also the case that the interchange between Gloucester Landfill and Stoke Orchard continued after deterrence with some birds visiting these two sites on alternate days. Therefore, a round trip of 22 km is not seen as a hindrance but, instead, as normal (and sensible) behaviour.

Though the gulls which did not visit any of the seven alternative landfills (more than one third of those recorded at Gloucester Landfill prior to deterrence) were not observed feeding, several of them were noted in Gloucester. These birds were clearly able to survive without having to rely on alternative landfills. It is possible that they foraged in the city and the suburbs, at green field sites, farmland, in the Severn Estuary and so on. The significance of these food sources has yet to be investigated.

2. The discovery of whether or not there are short-term increases in numbers in Gloucester City.

In a letter dated 13th July 1995 from the then director of Environmental Services, Gloucester City Council to Cory Environmental, fears were expressed that if gulls were deterred from the landfill, they might, instead, descend upon the city. This idea was explored fully and it was found that **these fears were misplaced**.

Detailed observations were made in Gloucester City on 11 occasions throughout the study (Pre-Deterrence Phase = 4, Deterrence Phase = 3, Post-Deterrence Phase = 4).

Sample observations were made from a single viewpoint (Gloscat) for consistency in the assessment of objective 2. These observations were not designed to assess numbers of gulls present throughout the city but, instead, to gauge the level of gull presence in the centre. The full survey of breeding numbers in Gloucester was undertaken in May 2004 (Rock in prep).

There are several buildings in Gloucester City upon which gulls habitually congregate at this time of year (early spring), but do not necessarily breed later in the season. These same buildings see variable numbers later on and act as congregating points for that group of non-breeding birds known as 'the Club'(Tinbergen 1953) during the breeding season. Though passage and non-breeding birds were noted on a variety of buildings in Gloucester, most of these were not consistently used. The three which were consistently used were Shire Hall, Social Security and Southgate House and they were checked several times during the study.

Table 28. Highest counts made in Gloucester during the Pre-Deterrence, Deterrence and Post-Deterrence Phases at (1) three buildings, (2) Gloucester Centre and (3) Castlemeads.

	Site	Pre-D	Det	Post-D
(1)	Shire Hall	223	80	44
	Social Security	115	161	54
	Southgate House	91	21	4
		429	**262**	**102**
(2)	Gloucester Centre	1,600	800	900
(3)	Castlemeads	2,800	3,500	?

Note: these figures should be taken only as exemplars because visits to Gloscat lasted no more than two hours and were at different times of day.

However, it is immediately apparent is that there were more gulls present in Gloucester in the Pre-Deterrence Phase than in the other two phases of the study.

As shown above, there were large numbers of small gulls in the study area during the Pre-Deterrence Phase which declined progressively and then rapidly during the remaining two phases. This was reflected in numbers present in Gloucester City. Maximum counts of small (Black-headed) gulls on rooftops were 200 during the Pre-Deterrence Phase, 180 on 9/3/2004 and 20 on 15/3/2004 during the Deterrence Phase and none during the Post-Deterrence Phase.

Thus, during the Pre-Deterrence Phase, the maximum count of large gulls was 1,400. The Shire Hall roof appeared to be dominated at most times of day by 1st summer birds (mostly Herring Gulls) during Pre-Deterrence. These birds will not have bred during the 2004 season and, during this phase, used these roofs (and to a lesser degree, the Social Security and Southgate roofs) as congregating areas (the Club). Later, many of these birds moved to the sports centre close to the Land Registry and to a large roof further away along the Bristol Road. The Club's congregating points often change in urban situations (pers obs) in response to changing circumstances (e.g. pressure from adults).

Therefore, it is concluded that numbers of adult birds in Gloucester were not different from expected levels, with several known birds already on station, or appearing as the study progressed. The small rise in numbers of large gulls in the Post-Deterrence phase reflects the influx of breeding birds noted above.

Of interest was the flooded meadow at Castlemeads (shown in Table 28). Numbers here were high during the first two phases, but as the standing water drained away decreased accordingly and during the Post-Deterrence Phase no gulls were counted (disturbance?), but some 200 were noted (from GLS) to be moving in that area on 27/3/2004, but because of obscured views proper assessments could not be made.

Rather than moving into Gloucester City during the Deterrence Phase, gulls appeared to prefer to congregate in outlying areas at a safe distance from the landfill which, in this instance, was only a few hundred metres away.

3. The discovery of whether or not deterrence had any effect on breeding numbers in Gloucester City.

Gloucester City has a large population of roof-nesting gulls which, as of 2004, stands at 1,996 pairs (Rock in prep), making it a large colony in national terms. However, Quedgeley, which is outwith the city boundary and which is estimated to support circa 1,000 pairs, makes Greater Gloucester (with a population of some 3,000 pairs) a very large colony in national terms on a par with Cardiff at 3,100 pairs (Rock 2004a) and Aberdeen at 3,500 pairs (R. Duncan, pers comm.).

The Gloucester breeding population is dominated by Lesser Black-backed Gulls by a factor of 5:1. It was suggested, with Gloucester Landfill being made unavailable as a feeding source at a time when many Lesser Black-backed Gulls were arriving back from migration to set up territories, that food competition, as a consequence, might have a negative influence on breeding within the city.

What has been shown is that the large gulls are capable of adapting to changing and sometimes difficult circumstances by finding alternative feeding sources.

Gloucester was visited on 11 occasions during the study. Apart from Gloscat, vantage points used were St Michael's Tower and the Land Registry. Other observations were made from street level in various parts of the city. The purpose of observations for objective 3 was to identify colour-ringed birds, particularly those known to have bred in previous years.

Of 37 colour-ringed individuals found in Gloucester City during the study, 33 were of breeding age (the four non-breeders were 1st summers (2) and 2nd summers (2)). There were 16 birds with records from previous years and 9 were probably breeding in previous years (n=25). The probable breeders were made up of birds ringed as adults at Stoke Orchard during the study (3) and birds seen in previous Gloucester surveys in specific areas and noted for future reference, but were not identified precisely (6).

Therefore, only 8 new recruits were found in Gloucester during the study. Three Bristol-ringed birds and one GLS-ringed bird were 4th years and may have been breeding for the first time (i.e. normal). Four of the remaining birds were ringed at GLS as adults in 2000 and 2001 and may simply have been overlooked in previous surveys and the other, Black T4DY (first recorded during the study, but reconfirmed during the 2004 Gloucester survey) was a 6th year bird. Interestingly, this bird was hatched at Tarnbrook Fell, Lancashire (a wild colony) and may have bred elsewhere before arriving at Gloucester (relocation). No birds known to have bred in Gloucester in previous years were recorded in other colonies.

It is concluded, therefore, that there is no evidence to support the notion that the deterrence of gulls at Gloucester Landfill for two weeks in March 2004 had any negative effect upon breeding numbers in Gloucester City.

As a postscript, it should be said that the Gloucester colony grew by 18.3% between 2003 and 2004 (Rock, in prep). This rise was less than that observed (25.5%) between 2002 and 2003 (Rock 2003c). Whilst it is possible that the two week deterrence might have contributed to the observed slight slowing of growth, it is considered more likely that important demographic changes observed within the colony during the survey and expected annual fluctuations would account for this.

4. The discovery of possible effects on other local colonies.

Four colonies of known size and where colour-ringed birds were known to breed were visited during the study. These were:

Table 29. Breeding sites visited showing number of individuals (Indivs) recorded in each during the study. Also shown are numbers of individuals recorded at each site prior to and after the study (All).

Site	No of Visits	Indivs	All
Bristol	13	179	186
Cheltenham	7	2	3
Chippenham	1	2	2
Bath	1	7	16
Totals	22	190	207

It has long been known that Bristol breeding birds visit Gloucester Landfill during the breeding season (pers obs). However, this has never been quantified. During the present study it has been possible to look at 207 individuals, 129 of which have been recorded at Gloucester Landfill within the last two years.

Table 30. Number of individuals with records from each site (Study) and those individuals which have been recorded at Gloucester Landfill (Know GLS) since 2002. The number of breeding birds (Breeders) from each and those which have been recorded at Gloucester Landfill in 2004.

Site	Study	Know GLS	%	Breeders	GLS 2004	%
Bristol	186	116	62.4%	174	53	30.5%
Cheltenham	3	3	100%	3	3	100%
Chippenham	2	1	50%	2	1	50%
Bath	16	9	60%	15	2	13.3%
Totals	207	129	62.3%	194	59	30.4%

Gloucester Landfill is clearly an important food resource for gulls breeding in all parts of the study area, but the further away the colonies, the less inclined breeding birds are to visit.

During the Deterrence Phase all birds made alternative feeding arrangements. Most simply switched to one or more of the other landfills, often closer to their colonies. However, some birds moved between landfills (as has been shown) and a few returned to Gloucester Landfill after deterrence.

Repeat assessments were made at Bath and Chippenham during the 2004 breeding season and numbers were found to have increased rather than decreased (Rock in prep). With regional growth rates at approximately 20% per annum (Chippenham, for example saw a rise of 22%) it is felt that deterrence at Gloucester Landfill had little or no effect on colony growth.

Despite data searches over a period of many years for early arrival dates of individuals recorded during the study, no evidence was found that deterrence at Gloucester Landfill caused any earlier return to Bristol than was normal.

Much of the difficulty in assessing early return dates is that during the winter known Bristol breeding birds (especially Herring Gulls) are to be found in the colony, often at territories occupied during the previous breeding season (pers obs). During the last ten years, though, it has been found that increasing percentages (up to 25%) of adult Lesser Black-backed Gulls are dispensing with migration and are also to be found in the colony (Rock in prep).

Bristol breeding Lesser Black-backed Gulls returning from migration have sometimes been recorded in the early spring at Gloucester Landfill before their first appearance in Bristol (pers obs). None of these birds, unfortunately, was recorded during the study.

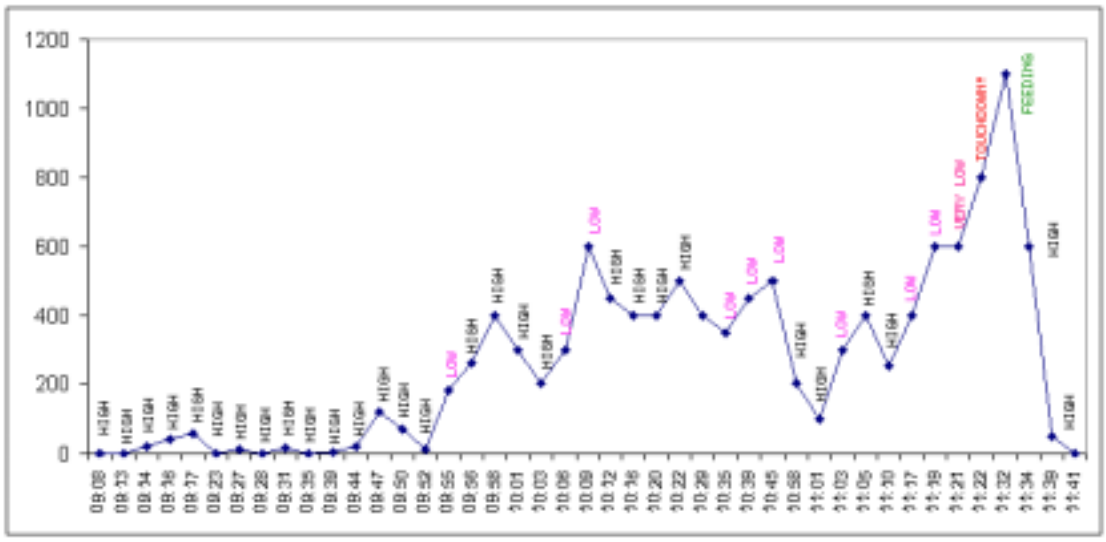
It is concluded that there were no apparent differences in other colonies as a consequence of deterrence and, thus, no discernible effects.

5. The discovery of whether or not this action has any lasting effect on Gloucester Landfill.

On Monday 22nd March 2004, both John Sanders and I were in position at Gloucester Landfill Site at 07.15 anticipating the arrival of gulls. There WERE no gulls!! Finally, 41 gulls arrived at 09:17, building to 450 at 10:26, at which time they landed to feed, but for only eight minutes...

The typical Post-Deterrence pattern of behaviour was closely monitored on 26th March. Minute by minute counts were made over a period of two and a half hours.

Figure 10. Gull numbers at Gloucester Landfill Site on 26.3.04 between 09:14 and 11:41. Altitude is shown as HIGH = above 20 metres: LOW = below 20 metres: VERY LOW = below 5 metres.



Typically, small numbers of gulls would approach the landfill later than they had prior to deterrence at great height (usually above 100 metres), circle for a short while before leaving. On 26/3/2004, the first gulls (2) appeared at 09:08. It was 47 minutes (at 09:55) before the first of several forays to an altitude below 20 metres was observed. At 09:56 there were three Buzzards (*Buteo buteo*) thermalling over the landfill which may well have reinforced the gulls' reluctance to approach. Thereafter, a further four forays at low altitude, interspersed by periods at high altitude (with fluctuations in numbers between 100 and 600) occurred before touchdown – some two hours and eight minutes after the first appearance. Note that once the gulls became serious (i.e. circling the tip face below 5 metres), touchdown followed quickly and numbers increased dramatically (almost doubling in 11 minutes).

The feeding call is a powerful attractant and gulls streamed into the landfill from all directions (a few from the south, more from the river to the west, some from Castlemeads, but the majority from Gloucester).

Note, too, that feeding time lasted only 12 minutes and that all birds had disappeared some 7 minutes later.

In order to interpret this behaviour, it is necessary to describe typical behaviour prior to the fortnight's deterrence. Thus, it was usual to find small numbers of birds at Gloucester Landfill at first light (approx. 07:00). Soon after, birds would arrive quickly (principally from the roosts on the River Severn to the south, but also from Gloucester City, rising in numbers to several thousands within an hour or two (e.g. 8,000 at 09:00 on 23/2/2004 and, significantly, 2,000 at 07:30 on 8/3/2004 (the first day of deterrence)). Feeding began when compactors started moving at about 08:00, but intensified once the first dustcarts appeared. As birds arrived at the landfill, they would frequently bathe in the small pool, or congregate on various patches of ground on the site, including the earth mounds surrounding the tip face.

Thereafter, birds were present at the landfill until some time after the last dustcarts had discharged their loads (approx. 16:00) in large numbers (J. Sanders, pers comm.). Whilst some birds clearly stay at the landfill for several hours (as determined by observations of colour-rings), the majority remain for an hour or two to feed and loaf to be replaced by others as time goes on. (Turnover was not assessed in the present study). In general, gulls were quite confiding at Gloucester Landfill, allowing reasonably close approach.

Therefore, it can be seen that the gulls' behaviour after the cessation of deterrence was **radically different** to that observed prior to deterrence. During the Post-Deterrence Phase gulls arrived at the landfill late, in small numbers initially, were very reluctant to approach, did not congregate anywhere on the site and usually moved away after feeding.

The deterrence regime involved flying falcons (specifically trained to attack gulls) with some secondary pyrotechnics. The scaring of the gulls with Peregrine x Saker crosses (large, fast falcons) was seen to be most effective. The falconer (Dave Taylor) arrived at the landfill at 07:30 and left at 18:00 when all activity at the landfill had stopped. Falcons were flown on every day of the scare.

The falconer's strategy was to release a bird as soon as gulls appeared in any numbers. The gulls' response was immediate. They took off, gained height and uttered alarm calls. This alerted all gulls at the landfill to the clear and present danger.

Dave Taylor and Diamond

Once the gulls had become aware of the presence of the falcons, numbers dropped quickly and for long periods there were few or no gulls to be seen over the landfill. Frequently, they moved to the flooded meadow at Castlemeads, presumably waiting for a safe opportunity to return.

It should be said, however, that gulls were noted at Gloucester Landfill on several dates (e.g. 1,500 at 07:10 on 9/3/2004, 2,500 at 07:00 on 12/3/2004, etc.) during the Deterrence Phase and some were able to feed (e.g. 1,000 at 08:05 on 15/3/2004), but each of these observations was made before the arrival of the falconer. Once falcons were released, the gulls moved away.

Interestingly, the falcons appeared not to affect the feeding behaviour of the corvids (i.e. Crows, Rooks and Jackdaws) present at the landfill. Typically, there were between 100-300 present during all three phases, but the corvids tended to feed away from the active tip face and would congregate along the site's boundary fence and in the safety of the trees beyond.

Initially, the Post-Deterrence Phase was typified by the highly unusual behaviour described above. It was not until 31/3/2004 that the first loafing birds (500) were recorded on site. However, these birds exhibited a high degree of nervousness and would not allow any kind of approach close enough to be able to read rings with a telescope (approx. 200 metres).

The gulls, as ever, appeared undisturbed by the presence of the compactor drivers even when they moved away from compactors on foot. It is thought that the gulls are habituated to these employees and view them as non-threatening.
It was not until 5/4/2004 – two weeks after the cessation of deterrence – that it was possible to approach loafing flocks within suitable range to make observations of colour-rings, but birds were nervous and Buzzard activity tended to spook them.

On 10/4/2004 the first gulls arrived at 09:45, but exhibited the same behaviour described above. One touchdown at 11:17 for 20 minutes and another at 12:32 for 4 minutes. Finally, at 13:00, 3,000 gulls touched down and feeding took place, without interruption until 14:30, but numbers declined to 1,500 in this time. Though 15 colour-rings were identified during the period, the gulls would not settle in one place as they habitually did prior to deterrence. It was felt that, even at this stage, a certain amount of nervousness was still affecting gull behaviour at Gloucester Landfill.
By 11th May (and possibly earlier – John Sanders had been away and there was thus no coverage at GLS), all vestiges of the nervousness associated with deterrence appeared to have been lost.

The large gulls are at the higher end of animal intelligence (J. Bell, pers comm.) and evidence of recognition and good memory have frequently been noted in Bristol during ringing operations (pers obs). Having visited nest sites on rooftops, adult gulls have often singled me out for aggressive attention on the street where other passers by remain undisturbed. This behaviour has been noted not just on the ringing day, but from day to day and from week to week whether or not I have been wearing the same clothes.

Further, at one landfill in the Severn Estuary Region which operates falconry deterrence, it is apparent that the gulls recognise the falconer's vehicle and when it appears, they disperse. However, they also appear to know when the falconer takes tea and lunch breaks (driving from the tip face to the landfill's mess room) and descend upon the tip face again at these times (pers obs).

Similar behaviour has also been noted during the autumn at controlled landfills in Portugal where the majority of large gulls are migrants on passage rather than resident (pers obs). Two very large landfills (9 km apart) close to Lisbon are controlled by one falconer who visits on alternate days. The gulls, of course, simply switch sites.

During the Deterrence Phase at Gloucester Landfill, gulls clearly took advantage of the early morning absence of the falconer on three recorded occasions. It is not known if this behaviour was consistent throughout this phase, but it is suspected.

On the first day of deterrence (8/3/2004), whilst falcons effectively excluded gulls from the landfill, it was noted that corvids attacked and brought down the younger of the two falcons used. It was, of course, rescued by the falconer with some alacrity.

However, on 15/3/2004, a serious attack on the older, more experienced falcon was launched by at least three gulls at 08:10. This kind of aggressive behaviour is common at breeding sites and birds of prey have been noted being brought down by gulls (pers obs). However, this is the first time I have noted a serious attack at a feeding site on such a formidable predator.

Under normal circumstances, the large gulls do not seek aggressive encounters unless they have an important investment (such as nestlings) to defend (pers obs). It is thought that this is because the risk of personal injury (thus jeopardising a breeding attempt at this time of year) is too high. It was, therefore, somewhat surprising to note the attack on 15/3/2004 at a feeding site. However, the position of the landfill is less than 1 km from the closest breeding territories in Gloucester and though breeding had not yet begun in earnest, gull territories had surely been established.

Attacks by gulls (with serious intent to strike) on humans in breeding colonies almost invariably come from behind and at high speed (pers obs). In this way, the gulls decrease the risk of personal injury. Attacks on birds of prey and other species are similarly executed, but always from above and at sufficient speed to ensure avoidance of retaliation. Once an injury has been inflicted, the bird of prey is disorientated and is rendered incapable of effective defence or escape. Thus, if several gulls continue to attack, the bird of prey will be brought down.

It was later discovered from conversations with various people that falcons had, in fact, been brought down by gulls on at least two separate occasions during the Deterrence Phase.

Conclusion to Objective 5 – Lasting Effects on Gloucester Landfill

The **unprecedented** behaviour exhibited by gulls seeking to feed at Gloucester Landfill after deterrence had ceased (i.e. from 22/3/2004 onwards) appears to have

been determined by the constant presence of falcons at the landfill during the previous two weeks.

It is suggested that the gulls' first approaches in small numbers, at great height and for short periods were cautionary. In order to mount an effective attack, a falcon would need to gain sufficient height. Therefore, by remaining high, the gulls would easily be able to detect the presence of any falcon and take appropriate avoidance action.
It is concluded that the **gulls were expecting to find a falcon on site and behaved accordingly**. Thorough scrutiny (which clearly took some time) was necessary before confidence was high enough to approach the tip face and even then, extreme caution was exercised.

Because the large gulls are capable of adapting intelligently to changing circumstances (viz. arriving before the falconer) **it is suggested that if deterrence is a consideration, total exclusion will not be achieved unless operatives are on site at first light and do not leave until dusk.**

The Post-Deterrence recruitment back to Gloucester Landfill by the gulls was hesitant and nervous and birds were reluctant to remain on the ground for any longer than was necessary. The first sign of any familiar behaviour (i.e. loafing on site) was noted on 31/3/2004, some 9 days after cessation, but marked nervousness persisted for at least another ten days.

It is concluded that deterrence at Gloucester Landfill by using falcons for 14 days was certainly effective and that gulls remained very cautious about returning for 19 days after the cessation of deterrence. Thereafter, normal behaviour was observed.

In terms of future deterrence, attention is drawn to the following:

1. Gloucester Landfill is an important winter and staging food resource for several thousand gulls annually whose origin is well away from the immediate area.
2. Both Herring and Lesser Black-backed Gulls are amber-listed (Gibbons et al 1996). Lesser Black-backed Gulls because Britain holds a high proportion of the world population of the race graellsii, but Herring Gulls because of long-term declines in numbers of breeding birds.
3. The significance of Gloucester Landfill within the feeding regimes of breeding birds is not entirely clear.

DISCUSSION

The conclusions of the present study are that:

1. Two thirds of gulls deterred from Gloucester Landfill found alternative feeding sources at other landfills within the study area and the majority used the nearest, viable landfill (Stoke Orchard). However, one third found food elsewhere.
2. No increases in gull numbers in Gloucester as a consequence of deterrence were observed. In fact, greater numbers were observed in the city prior to deterrence.
3. Negative effects on breeding numbers of gulls in Gloucester as a consequence of deterrence were not observed.
4. Effects on other colonies within the study area as a consequence of deterrence were not discernible.
5. Immediately after the cessation of deterrence gulls were reluctant to visit Gloucester Landfill. Thereafter nervousness decreased steadily and, 19 days later, gulls had reverted to pre-deterrence behaviour.

The majority of individuals recorded during the study were urban gulls (66%). Once large numbers of passage migrants had left the study area, this rose to 73% and after the end of the study to 78%. Therefore, landfills in the study area play an important role in the survival of local breeding birds, but their significance within the feeding regimes of urban gulls is unknown.

Time constraints, observation difficulties and man power precluded any thorough investigation of small, unpredictable, or green field/pasture feeding sources. Aside from landfills, it is well known that the large gulls utilise of a wide range of feeding sources (e.g. Cramp & Simmons 1984). Much anecdotal evidence exists about gulls feeding in town (on discarded take-aways, etc.) and in suburbs and many personal observations on how quickly gulls take advantage of such opportunities. However, little is known about the significance of these food sources.

One third of study individuals did not visit landfills during deterrence and, therefore, must have taken advantage of such food sources. Several of these individuals were noted in Gloucester during deterrence.

The feeding regimes of the large gulls (Herring and Lesser Black-backed Gulls) have been revealed by the present study to be rather more complex than was first thought. More than half of individuals recorded during the study moved between sites either naturally, or were influenced by deterrence. Many of these birds moved between more than two sites and one bird moved between five sites. We know little or nothing about the dynamics of foraging strategy within the feeding regimes of urban gulls. It is hoped that these questions will begin to be investigated in 2005.

Clearly, there is a great deal of work still to be done – "All survey work is necessarily a compromise between effort and accuracy" (P. Meininger pers comm.). It is felt, however, that our understanding (despite many questions having to remain unanswered) of what happens when a major food source is removed for a short period and of the way it happens has been considerably enhanced, but this is not the full picture!

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