USE OF FALCONS TO DISPLACE NESTING GULLS FROM AN URBAN AREA

FINAL REPORT:

Executive Summary

1. A study to determine the effect of a non-hunting falconry programme was implemented over a specified 10-week period from March 16th 2009 within a designated Campaign Zone covering Dumfries town centre.

2. Falcons were released from different rooftops over a 10-hour period each day. All falcons were flown to lures and were trained not to hunt other species. No other methods were trialed.

3. Gull populations were monitored and behaviour recorded both inside and outside the Campaign Zone.

4. New flying regimes for falcons (from building to building) were developed as part of the study.

5. Disturbance caused by flying the falcons occurred for the first five weeks of the 10-week study after which the gulls showed habituation.

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6. Lesser Black-backed Gulls were more profoundly affected than Herring Gulls although none were caught or killed by falcons at any point during the study.

7. The total number of gulls nesting at the end of the campaign had increased in comparison to predicted levels.

8. These increases occurred across both the Campaign and Control Zones suggesting immigration from other locations had occurred.

9. The destruction of a colony located at Cargenbridge, 4km away from the trial site, displaced approximately 50 pairs of gulls and could have accounted for some of the rises observed.

10. Methodological changes to allow the inclusion of other techniques and deployment of regimes earlier in the season are recommended.

11. Research to monitor whether provision of hunting falcons used as part of an integrated strategy could reduce breeding populations is recommended.

1. Introduction

The number of gulls, especially Lesser Black-backed (*Larus fuscus*) and Herring Gulls (*Larus argentatus*), nesting in towns and cities in the UK has increased steadily (Mitchell *et al.*, 2004). Away from traditional rooftop nesting sites in coastal towns, gulls now breed in significant numbers in the majority of the major built up areas in Scotland, England and Wales (Calladine *et al.*, 2006), (Burton *et al.*, 2004). These species are often cited as causing problems in terms of noise nuisance to residents, blockage of drains, ventilation and gas outlets, transfer of disease organisms or ectoparasites to dwellings, aggression towards the public near nests and fouling of buildings and pavements (Butterfield *et al.*, 1983; Baxter & Robinson, 2007). The growth in urban nesting by gulls shows no sign of slowing at the moment hence reliable, scientifically proven techniques for management of these issues are required.

Falcons and hawks have been used for many years to deter gulls from a variety of industrial and domestic landscapes (Baxter & Allan, 2006). Deployments have ranged, for example, from occasional flying of single falcons within small domestic estates, through regular flights of several (consecutively flown) hawks or falcons across industrial complexes to long-

standing daily flights at landfill sites or on airport facilities (Cain, pers comm.). Their effect has, however, rarely been documented with the scientific approach required to fully evaluate their use. Little is also known about the wider impacts of the use of falconry and how it impacts on the movements and behaviour of targeted birds. Where scientific studies have been completed, hybrids of Peregrine falcons (*Falco peregrinus*) have the potential to be used successfully against gulls (Baxter & Allan 2006). These studies have shown that falcon hybrids (*Falco* sp.) were more effective than hawk species (*Buteo* and *Parabuteo* sp.) at deterring gulls in a waste management situation but that effective control required a permanent dawn to dusk presence. They have also suggested that the driver behind the success of falcon hybrids, as opposed to hawk species, is their ability to capture target birds. The benefits of having a regime in which such a 'lethal threat' is exhibited have also been recorded in other studies (Dolbeer, 1998; Meltofte *et al.*, 1996). The opportunity to scientifically monitor gull deterrence using Peregrine Falcons and associated hybrids of Peregrine Falcons, within Dumfries town centre, was therefore presented by Dumfries and Galloway Council, the Scottish Government and Scottish Natural Heritage (SNH). This report summarises the findings from these studies.

2. Aims

1. To implement, during a pre-specified ten-week period in spring 2009, a programme of dawn to dusk falconry flights within Dumfries Town Centre.
2. To reduce numbers, aggression and breeding attempts of Lesser Black backed and Herring Gulls within the Campaign Zone.
3. To evaluate the behaviour of key gull species in response to falcons.
4. To review, in the event of successful deterrence, whether birds move to other areas.
5. To develop strategies for enhancing the use of falcons within a wider scale urban environment.
6. To present a cost-benefit analysis

3. Methods

Falconry Deployment

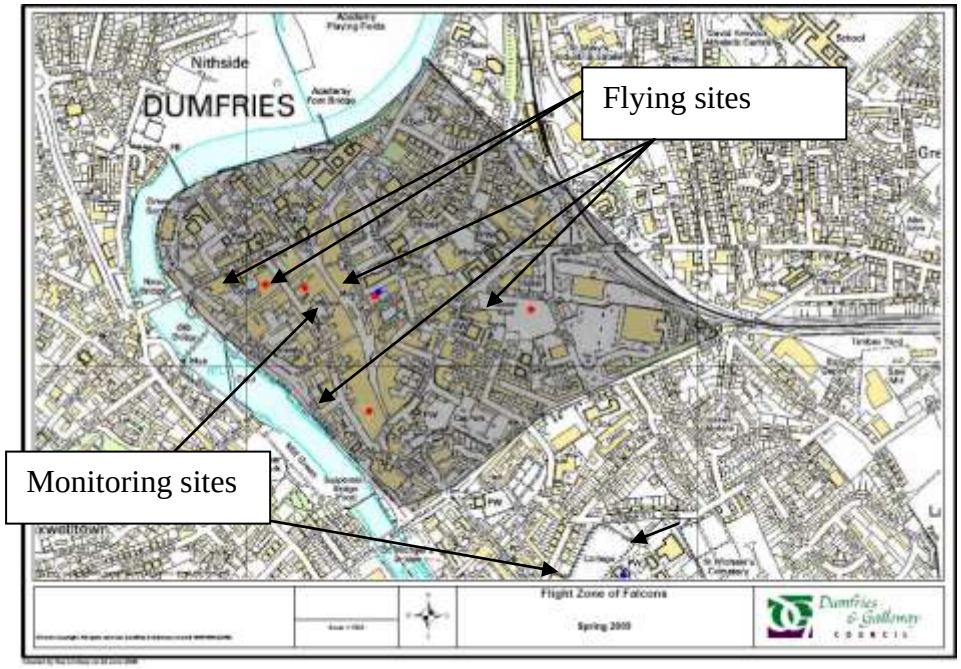
Falconry was implemented over a ten-week period from the 16th March through to the 22nd May 2009. Up to eight different falcons were flown, independently, during the course of the project. Birds ranged in size from small male Peregrine x Lanner (*F. biarmicus*) hybrids to larger female Peregrine x Lanner or Saker (*F. cherrug*) hybrids, a pure female Peregrine, a pure female Saker and, briefly, a Gyr (*F. rusticolus*) x Saker hybrid. Two staff needed to be used simultaneously for health and safety reasons. This limited the availability of personnel

to implement the dawn to dusk programme and resulted in a routine 10-hour period of effort each day instead. The smaller falcons were deployed from the outset of the study with the larger birds introduced from week four onwards.

A series of vantage point locations were evaluated prior to commencement of the study and sites selected from which falcons could be flown and / or gulls could be monitored. One central rooftop was selected for monitoring gull behaviour within the Campaign Zone with another selected for monitoring behaviour outside the Control Zone. Three different rooftops were selected for preliminary falcon flights.

Access to the third roof was withdrawn at a late date resulting in monitoring effort being switched to the central council rooftop at the outset of the study. Further permissions were obtained for flying falcons from two other rooftops in the south and west of the Campaign Zone by week two of the study. Key sites are highlighted in Figure 1.

Figure 1. Campaign Zone for Falcons: Flying Sites (Red), Monitoring Sites (Blue).



The duration and range of falconry flights were increased as the project progressed. Initial flights retained direct line of sight contact between the falconer and falcon, involved regular stooping of a falcon to a lure from the same rooftop as they were released, and resulted in birds remaining in the air for approximately 5-6 minutes. Birds were flown three to four times an hour to habituate each individual falcon to the local area. Flight length and range was extended when the falconers were confident that birds had learned where each key rooftop within the Campaign Zone was located. By week three birds were flown, for example, between roof one and two, then from roof two to three and back again. Flights from the central roof routinely involved birds being released into the Campaign Zone and out over the northern quadrant of the Campaign Zone. This resulted in flights of falcons across the whole of the Campaign Zone. The process was continued for each bird as it was introduced to the programme. By the end of week four, falcons were frequently in the air and circuiting the area for a mean of over 30 minutes each hour. In very wet weather, birds were not flown.

Gull Behavioural Monitoring

Gull behaviour was recorded within four key categories:

- Undisturbed or Resting; birds on nests, sitting, standing, preening or displaying / interacting with conspecifics on the ground.
- Disturbed: birds visibly agitated but remaining on the ground.
- Flying: birds in flight, regardless of cause.
- Feeding; birds on the ground actively foraging,

Three hundred and sixty degree (360^{o}) paired scan samples recording the number of Lesser Black-backed (*Larus fuscus*), Herring (*L. argentatus*) and Great Black-backed Gulls (*L. marinus*) exhibiting each behaviour were recorded on the hour or half hour from the monitoring sites. Gull ages were recorded as 'adult' or 'sub-adult' based on plumage characteristics. Coverage was limited to that which occurred on or directly above rooftops from which sitting or standing gulls could be observed from the vantage points.

A 360^{o} random number generator was used to select a gull (either on or clockwise from the angle presented), for individual focal observations. The selected gull was tracked and monitored for 10 minutes between each scan sample count and the time it spent exhibiting each behaviour type was recorded. Weather conditions including wind force and direction, precipitation, cloud cover and temperature were recorded each hour.

Monitoring was completed every hour on a randomly selected afternoon each week from midday to dusk and over the same regime from 7:00am to midday the following day. A total of 247 counts were completed.

Gull Censusing

The numbers of nesting pairs of Herring and Lesser Black-backed Gulls were obtained by a census count made by J. Coulson following cessation of the trial. In addition to recording nests, observations were made of the number of gulls present in predetermined areas of the town centre, the presence of breeding birds with traces of immature plumage (indicating recent breeding recruits), the number of gulls attracted to food on the riverside and in the town centre where the general public had complained about gull activity, and of evidence of interactions between gulls and the general public in the town centre. Nests were located by surveys at street level and searches from vantage points overlooking the town centre. The survey was a repeat of surveys from previous years using identical methodology to that described in Coulson & Coulson (2009). Exceptions were a change of vantage point from the former Social Security building in Irish Street to an adjacent roof, which gave a near comparable coverage. Data from this census were evaluated with reference to the specific Campaign Zone selected for the falconry trial and therefore deviates slightly from more general count data presented to Dumfries and Galloway Council in previous reports.

4. Results

Development of Falconry Flights

Falcons were flown every day throughout the Campaign Zone for the full ten-week programme of deterrence. Flying was not undertaken when wet-weather conditions risked a bird's plumage becoming wet. These periods, whilst not infrequent, were generally limited to 20-minutes and did not, therefore, cause any reductions in flying attempts. Delays that prevented more than one-hour of flying occurred on only five separate occasions with the maximum 'no flying' duration being four hours. This was an exceptional result with birds flown on every single day of the study.

Early falcon flights involved short (generally less than 10 minute) bursts flying smaller falcons (Peregrine x Lanner hybrids) to a lure from individual rooftops. From week four of the study, falcons were routinely released from one side of the Campaign Zone and retrieved from a separate location on the other side over one hour later. Some falcons would circuit the central area for this entire period; others would fly to the central clock tower and perch on the steeple until brought in by the falconer. Flights around the Campaign Zone stayed well within it although they affected birds up to its south-east, south-west and north-west facing boundaries during the first half of the study, i.e. although the falcons flew well within the Campaign Zone they affected gulls up to the boundary of the Zone. No deterrence response was observed beyond the boundary of the study area except for the river where some loafing gulls above the weir were lifted by the localised presence of the falcon. By the end of the study, falcons were present in the air or on buildings for 6-8 hours every day over a 10-hour period to dusk each day. During the whole study period, the use of lure bound birds resulted in zero target birds, i.e. gulls, being caught or killed.

Preliminary responses of gulls to the presence of falcons were extensive, but disturbance impacts were limited to approximately 300m from the position of the falcon. As time progressed, for the majority of birds, this distance declined such that many gulls at a 50m range were not taking flight. Flights across the Campaign Zone did not occur within 300m of nest sites that were occupied outside the Zone, i.e. nesting gulls outside the Campaign Zone were unaffected by the presence of the falcon. A direct comparison of the numbers of gulls and their behaviour within and outwith the Campaign Zone was completed. Observations of gulls outwith the Campaign Zone occurred at least 300 metres beyond the Zone boundary.

Numbers of Gulls

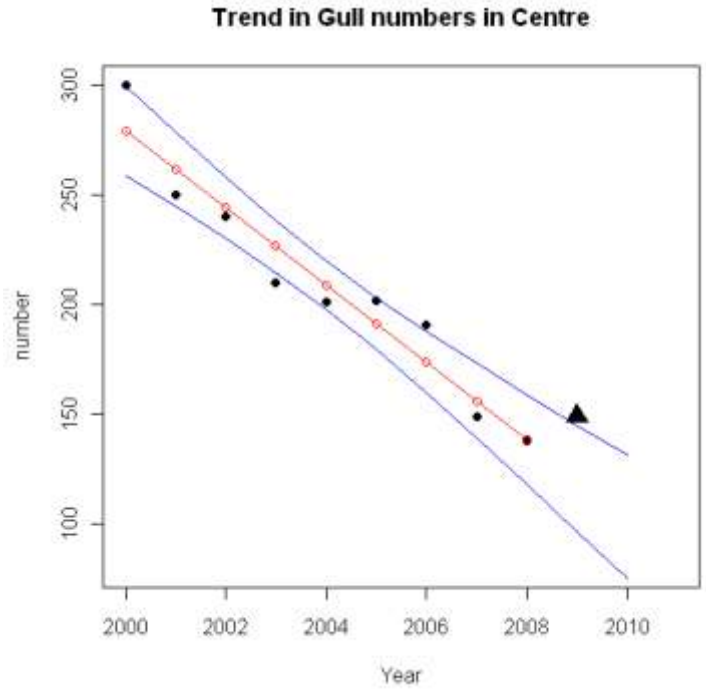
Data were gathered by Dumfries and Galloway Council between 2000 and 2009 that showed the number of breeding pairs of gulls present across an area covering both the Campaign and Control Zones. Total numbers varied between 296 and 390 pairs.

Table 1. Number of Gull Nests Recorded by Dumfries and Galloway Council Between 2000 and 2009 Within a Central Area Including That of the Campaign Zone and Outlying Area.

Year	Centre	Outlying	Total
2000	300	65	365
2001	250	113	363
2002	240	150	390
2003	210	169	379
2004	201	175	376
2005	202	150	352
2006	191	133	324
2007	149	147	296
2008	138	160	298
2009	149	204	353

Within the central area of Dumfries (an area including the whole of the Campaign Zone), a gradual decrease in the breeding population was recorded through to the year 2008. These data were limited and normally distributed so a linear regression model, which allowed confidence intervals to be estimated, was the most robust model available to predict the expected population range in 2009. A comparison with the actual population level was then determined to assess the overall impact in the central area.

Figure 2. Linear Population Prediction for Gulls within Central Area of Dumfries.



Solid points are the observed bird counts. Hollow points and the straight line are the linear modelled values. Outer lines are the 95% confidence intervals of the regression line. The 2009 actual count is represented by the black triangle (149 pairs). This falls out with the predicted values and confidence interval for this year and was higher than would be expected. Non-hunting falcons did not, therefore, result in a reduction in nesting gull population levels in the central area in 2009.

Of the 149 nests located within the central area, 138 were overflown by falcons operating within the Campaign Zone. This compared with 130 nests in 2008 thereby matching the increases recorded within the overall central area.

Table 2. Total Number of Nests Within and Outwith the Campaign Zone in 2008 and 2009. Count 1 Shows the Change in Numbers of Nests in the Campaign Zone. Count 2 Shows the Change in Nests Outwith this Zone.

Count Area	Characteristic	2008	2009	Percentage Change
1	Campaign Zone	130	138	+6.2%
2	Control Zone	168	215	+28.0%
	Total	**298**	**353**	**+18.5%**

Between 2008 and 2009 the numbers of breeding pairs of gulls increased in both areas by a mean of 18.5%; within the Campaign Zone by 6.2% and within the Control Zone by 28.0%.

The overall number of gulls sampled during the behavioural studies did not vary during regular censuses undertaken throughout the falconry period within the Campaign Zone (mean 90.5, SE 3.44, n = 247), or the Control Zone (mean 66.4, SE 2.21, n = 247). This suggests the breeding birds present at the outset of the study remained through to its completion.

***Table 3. Mean No Gulls Sampled Within each Study Area*.**

Species	Control Zone			Campaign Zone		
	Mean	Max	Min	Mean	Max	Min
LBB	46.7	114.7	18.9	61.9	87.5	34.2
HG	19.7	31.6	14.1	28.6	43.6	12.6
Total	66.4	146.3	3..0	90.5	131.1	46.8

Separate vantage point counts undertaken on the 14th April and the 15th May also revealed little change in the number of large gulls present within the Campaign Zone from 112 birds to 97 birds. Anecdotal evidence suggested that sub-adult birds may have been displaced on arrival of the falcons into the area. Any reductions that could have occurred as the Campaign began were not, however, recorded as no data were provided from the pre-study period. Evidence that sub-adult birds were dispersed is present from the proportion data gathered for sub-adult and adult birds. In 2009, for example, only three out of every hundred breeding gulls in the Campaign Zone showed signs of immature plumage (repeat examination of same individuals on subsequent days could not be excluded). In contrast, twelve gulls with signs of immature plumage were found breeding in a similarly sized sample from the Control Zone. Similarly, no day roosts of gulls within the Campaign Zone occurred in 2009. Three of these areas, used by off-duty adults and young or prospecting individuals, were present in 2008 when falconry was not in place. Members of the public and the falconry company also perceived that an initial reduction in gull numbers was achieved at the outset of the study. This was not reflected in the data gathered during the course of the programme.
(see appendix 1).

The presence of gulls within the townscape, however, varied significantly during each hour of the day (Appendix 2). This was particularly prominent during the earlier weeks of the study as birds flew south and departed the area towards dusk. This occurred within both the

Control and Campaign Zones, however, and suggests the departure was caused by roost behaviour not a displacement caused by the falconry.

Time of Laying

Time of laying was delayed by at least one week compared to any of the previous eight years (Coulson, pers comm.). This was consistent across the Campaign Zone, Control Zone and out-lying areas. It also ties in with a general trend reported across Scotland for later breeding of large gulls in 2009.

Gull Behaviour

The behaviour of gulls in response to falconry contrasted markedly between the Campaign and Control Zones. These data therefore provide a reference as to the direct impact falconry had. A total of 494 scan sample counts (247 in each Zone), were completed alongside 2432 minutes of observations of gull behaviour within the Control Zone, and 2591 within the Campaign Zone. All observations of feeding behaviour observed were recorded (69 minutes within the Campaign Zone and 42 minutes within the Control Zone).

The proportion of undisturbed (i.e. relaxed) behaviour recorded within the Control Zone was 61% for Lesser Black-backed Gulls and 79% for Herring Gulls. This declined to 51% and 74% respectively within the Campaign Zone. Observations over time, however, suggest a far greater impact occurred during the initial stages of the study after which gulls were observed gradually increasing their tolerance of falcons.

Impact of Falcons on Lesser Black-backed Gull Behaviour

Figure 3a – Comparative behaviour of Lesser Black-backed Gulls within the Campaign Zone.

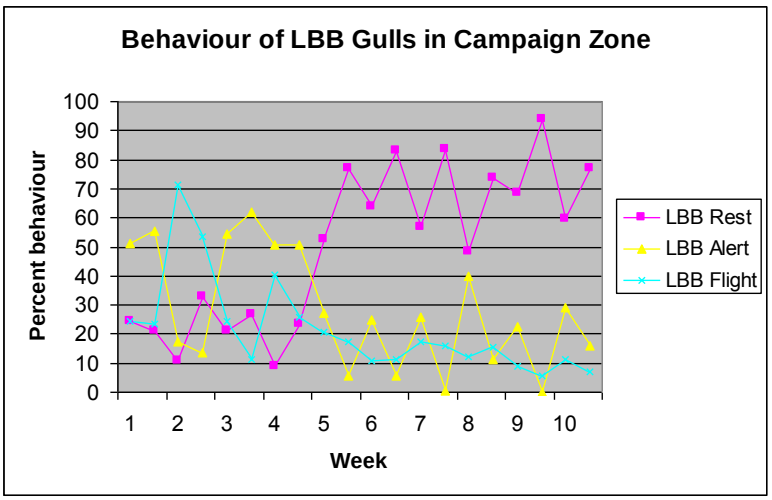
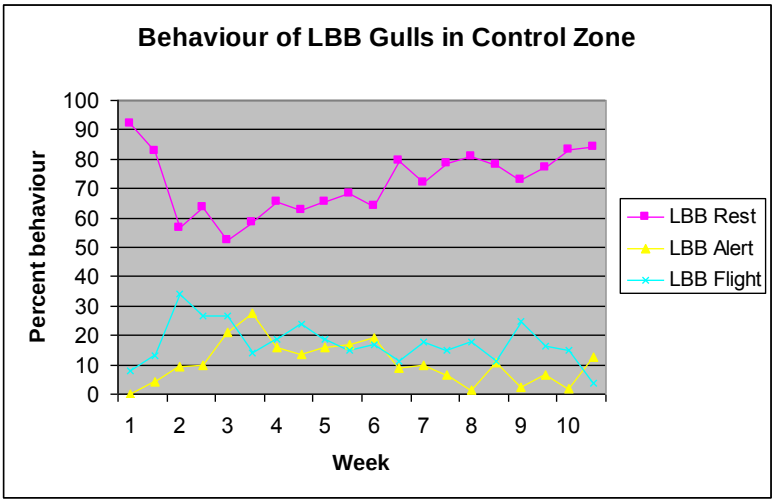


Figure 3b – Comparative behaviour of Lesser Black-backed Gulls within the Control Zone



Lesser Black-backed Gulls exhibited more disturbed behaviour (alert + flight behaviour) during the first half of the study within the Campaign Zone than they did within the Control Zone (Mann Whitney U = 6.783, P< 0.001). A change in this behaviour occurred at the half way stage of the study after which there was no significant difference between the levels of disturbed behaviour exhibited between the Campaign and Control Zones (Mann Whitney U = 1.157, P = 0.247). Significantly more disturbed behaviour was observed during the first half of the study (weeks 1-5) than the second half of the study (weeks 6 – 10) within the

Campaign Zone (Mann Whitney U = 3.044, P< 0.001). The key change in behaviour occurred during week 5 (ending Sunday 19th April). This contrasted with the behaviour in the Control Zone where there was no change in the level of disturbed behaviour across the first and second halves of the study (Mann Whitney U = 1.451, P = 0.157).

Lesser Black-backed Gull Foraging Bouts

During foraging bouts (38 minutes in the Campaign Zone and 23 minutes in the Control Zone), no aggressive behaviour was observed being carried out by Lesser Black-backed Gulls. All foraging was targeted at discarded food waste on a streetscape or from children on a playing field during college breaks. Only one 'potentially' aggressive situation arose in the town centre from the 11 events recorded by the research team.

Impact of Falcons on Herring Gull Behaviour

Figure 4a – Comparative Behaviour of Herring Gulls Within the Campaign Zone.

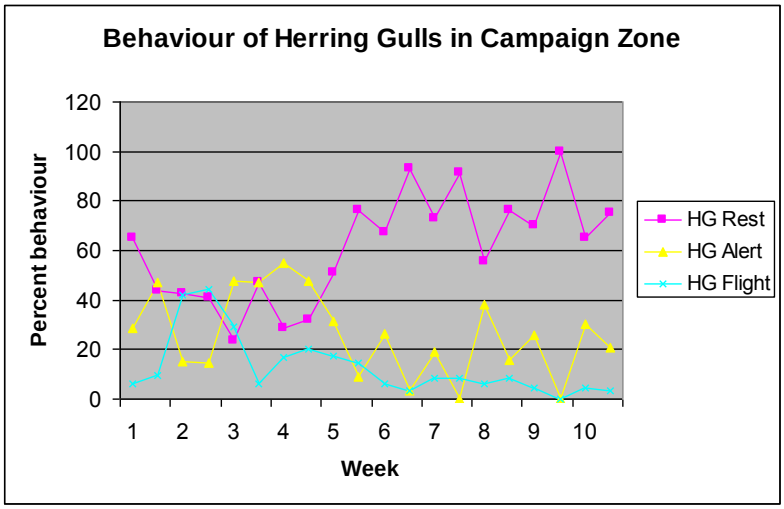
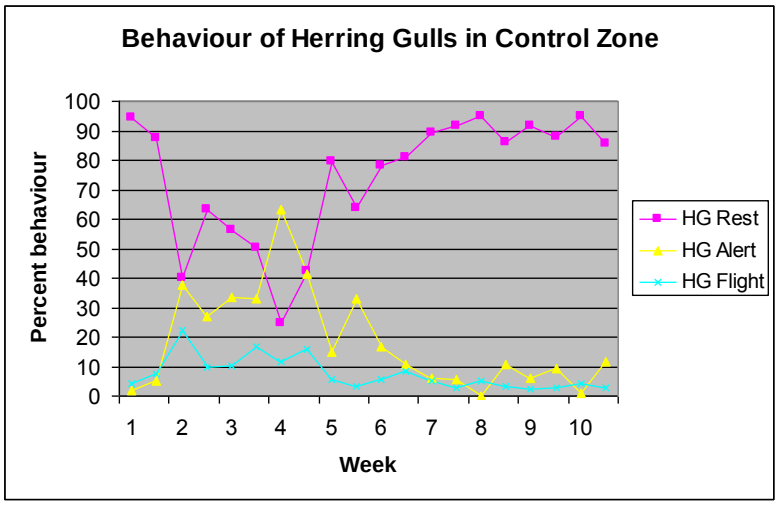


Figure 4b – Comparative Behaviour of Herring Gulls Within the Control Zone



Herring Gull behaviour within the Campaign Zone appeared to be similar to that of Lesser Black-backed Gull behaviour. A significant difference was observed in disturbed behaviour (disturbed + flying) between the first and second halves of the study within the Campaign Zone (Mann Whitney U = 2.312, $P < 0.05$). This was mirrored, however, within the Control Zone (Mann Whitney U = 2.691, $P < 0.001$) and confirmed when no difference was observed in disturbed behaviour between the Campaign and the Control Zone during the first half of the study (Mann Whitney U = 0.920, $P = 0.400$). Territorial and courtship behaviour, thought to have been responsible for apparently disturbed behaviour records did not continue outside weeks 2 to 4 with the result that disturbance within the Control Zone had ceased by the latter half of the study. Greater levels of disturbed behaviour were therefore recorded within the Campaign Zone compared to the Control Zone (Mann Whitney U = 6.728, $P < 0.001$) in the latter half of the study. This suggests that falcons were causing disturbance throughout the study but it was masked by aggressive courtship and territorial behaviour observed during the first half of the study.

Herring Gull Foraging Bouts

During foraging bouts (31 minutes in the Campaign Zone and 19 minutes in the Control Zone), no aggressive behaviour towards man was observed. All but 8 minutes of foraging (one single Herring Gull feeding on worms in the Control Zone) was targeted at discarded food waste.

The overall behavioural differences recorded between the first (weeks 1 – 5) and second (weeks 6 – 10) periods of the study within the Control and Campaign Zones are summarised in Table 4 below.

***Table 4. Summary of Gull Behaviours Observed During Study Period*.**

Species	Campaign Zone weeks 1-5			Campaign Zone weeks 6-10		
	Rest	Disturbed	Flight	Rest	Disturbed	Flight
LBB Ad	38.4%	19.9%	40.9%	58.7%	23.9%	15.2%
HG Ad	60.7%	15.5%	22.5%	78. 8%	12.7%	8.0%
	Control Zone weeks 1 - 5			Control Zone weeks 6 –10		
LBB Ad	54.4%	8.1%	35.7%	65.7%	21.5%	12.0%
HG Ad	73.3%	8.5%	12.4%	85.4%	13.1%	1.5%

Restful behaviour increased by approximately 20% between the first and second half of the study for both species of gulls within the Campaign Zone and by about 10% within the Control Zone. In all cases greater levels of flight plus disturbed behaviour and lesser levels of restful behaviour were observed in the Campaign Zone. The number of gulls present within the Campaign and Control Zones varied between study Zones and with time of day.

Gulls Taking Food

The attraction of gulls to food presented by the general public on the riverside and in the central shopping area (both within the Campaign Zone) was assessed. Food, deliberately dropped by the general public, or when such situations did not occur, by the observers, was rapidly collected by gulls that were typically standing on vantage points overlooking the streetscape. The numbers attending these food provisions declined by the end of the study.

Table 4. Mean Number of Gulls Attending Food Drops.

Date	**Number of gulls attending (N = no. of observations)**
15-16 April	9.3 (3)
14-15 May	5.3 (3)

The total number of complaints from the public rose slightly during the study period from 4 “food stealing events” in 2008 to 6 swooping or food stealing events in 2009.

5. Results Summary

Falcons were flown without any target bird fatalities occurring throughout the deployment of non-hunting birds. The amount of airborne flying of falcons increased as the study progressed although some falcons showed a preference for the central steeple rather than flying around the Campaign Zone. Lesser Black-backed Gulls responded by exhibiting high levels of disturbed behaviour (either alert or taking flight) during the first half of the Campaign but this effect declined with time. Herring Gulls began to tolerate the presence of falcons whether in the air or perched on high buildings and any initial impact of falcons was largely masked by aggressive territorial behaviour exhibited within the Control Zone. Nevertheless, disturbance of both species was consistently higher within the Campaign Zone than the Control Zone.

Records of food stealing behaviour were observed on six occasions but not by project staff. Anecdotal evidence suggests that sub-adult birds were driven out of the Campaign Zone and three day-roosts were also lost. Nevertheless, compared to 2008 and the previous sequence of censuses, the number of breeding pairs was not decreased by the use of falcons under this regime. In fact, nesting populations increased. Possible drivers of this could be the destruction of nesting habitat at Cargenbridge, increases in return rates from previously successful years or displacement of birds from other colonies. The behaviour of gulls, particularly for the majority Lesser Black-backed Gulls, clearly showed that high levels of disturbance were achieved but that the impact of this reduced over time.

6. Discussion

Falconry had a clear impact on gull behaviour within the Campaign Zone in Dumfries but by the end of the study had failed to reduce the numbers of pairs attempting to breed. It is unlikely that falcons would have been responsible for an increase in gull presence (as confirmed by behavioural observations (see figures 2, 3a & 3b)), hence other factors must have influenced the overall increases in numbers. Strong breeding success in earlier years could have resulted in increased return rates or, similarly, the displacement of between 40 and 70 breeding pairs of gulls from an industrial estate in Cargenbridge (outwith Dumfries, approximately 4 Km to the south), may have combined to increase numbers. Without mark-recapture studies it is not possible to determine how these factors will have influenced the results.

The initial programme clearly resulted in gulls perceiving a significant threat thereby suggesting the technique has merit for development. During week one, for example, the mere presence of falcons on their perches (weatherings) was sufficient to have all gulls within a 300m radius circling in the air. At this stage, actual flights were not required to create a deterrent effect. The short falcon flights implemented from individual rooftops, therefore also had a long lasting impact and consistently kept gulls on the wing and off the ground throughout the day. This response level demonstrated gulls had either previous experience of predation from hunting Falcons, or were being impacted through a neophobic response caused by the novelty value of falcon presence within the townscape. It was apparent, however, that both species of gull began to tolerate the presence of falcons as the trial period progressed and no actual threat occurred.

It is likely that the start date for the trial was implemented too late to prevent returning birds from settling into the area to breed. This factor, combined with the testing of non-hunting falcons only, is thought to have resulted in breeding gulls firstly being settled into the area in the first place, and secondly developing a tolerance of the falcons by the end of the trial. By the time gulls were forced to either begin nest building and egg laying, or depart the area (half way through the trial programme), the majority were showing signs of habituation. By this point, the longer range (between different rooftops), longer lasting flights of falcons were not sufficient to cause significant disturbance. Several gulls remained sitting and exhibited relaxed, if observant behaviour as falcons flew past at short (<20m) range. Without any lethal reinforcement by hunting falcons or the deployment of other techniques as part of an integrated strategy, the end result was not affected by the initial disturbances created.

Early disturbance at breeding colonies is often cited as key to preventing an area being attractive to gulls when they arrive back from their wintering grounds (e.g. Abbeystead gull colony (Coulson, 1991)). Lesser Black-backed and Herring Gulls were already present within the townscape of Dumfries hence a recommendation for any future management activity would be to ensure deterrence methods are in place prior to the return of gulls. If immediately presented with a potentially hazardous breeding location, gulls would have a greater opportunity to relocate to a new area. The reduction in the numbers of sub-adult birds in the area suggests these birds were disturbed and may have been influenced to breed outside the Campaign Zone in future years. Further data would be required to determine if this is the case.

The total number of breeding gulls present across the town of Dumfries increased in 2009 over and above the numbers recorded in 2008. The programme implemented therefore failed to reduce the nesting population. As there is no literature suggesting that falconry should increase the presence of birds, however, (Baxter & Allan, 2006), a more general change in numbers between years must have occurred. The cause of this is unknown. Many populations of inland gulls are known to be rising and recruitment is considered a key driver of these changes. Urban breeding gulls are thought to have higher survival rates than coastal cliff nesting gulls (Rock 2005) hence successful nesting in 2005 may have provided an increase in the number of returning adults available in 2009. In line with this, very little egg control was implemented within the Campaign Zone in 2008 thereby making the area favourable to newly prospecting birds visiting that year. Similarly, destruction of an industrial area at Cargenbridge and the removal of habitat for between 40 and 70 nesting pairs of gulls could equally well have resulted in displacement into the Campaign and Control Zones. These factors are difficult to qualify and can only be measured via individual bird recognition and use of a mark-resighting scheme.

The potential for falconry to have displaced gulls into the surrounding area is also difficult to quantify. Anecdotal evidence suggests that fewer non-breeding, prospecting gulls were present thereby suggesting return rates in 2010 could be reduced. Behavioural data from the monitoring programme also suggests that gulls were generally less disturbed within the Control Zone and that such locations may therefore have offered a better breeding area. Data from the censuses, however, show that birds actually moved into, rather than out of, the whole area. Increases observed within the Control Zone cannot therefore be attributed to decreases in the Campaign Zone.

The lack of day roosts observed in the Campaign Zone and anecdotal evidence of reduced levels of sub-adult and juvenile birds suggests the falcons may only have been tolerated by birds that had already elected to breed. If prospecting birds in 2009 did not perceive a credible breeding location due to the disturbance levels created, 2010 could be positively affected by the efforts of 2009, although it will not be possible to tease apart the relative effects of the falconry from the egg and nest removal programme.

What was also evident from the results was that Lesser Black-backed Gulls showed higher levels of response to the flights of falcons than Herring Gulls. As a less robust species, it is possible that Lesser Black-backed Gulls could be targeted more frequently by wild falcons and may have developed a greater sense of 'fear' at their presence. During studies in Devon in 2004 and Aberdeen in 2009, Peregrines were seen taking Common, Lesser Black-backed and Black-headed Gulls but not Herring Gulls (pers obs). This indicates that Herring Gulls may indeed be aware of the threat falcons could create. As the study progressed, the lack of actual threat from the falcons resulted in fewer gulls of either species exhibiting a disturbance response. Disturbance was momentarily increased in week 8 when a single, large, Gyr x Saker hybrid was briefly introduced from one of the buildings. Whilst the results of this flight are masked by the generally tolerant behaviour exhibited at that time, all gulls within view of the bird took flight. Variation of species used alongside creation of an actual threat (hunting bird), may thus assist with developing and continuing disturbance.

Neither gull species were observed exhibiting aggressive behaviour to people. Observations undertaken by falconers, monitoring staff and census staff all failed to witness such behaviour despite gulls routinely being observed in close proximity (within 5 metres) to the public when food was made available. The majority of aggressive activity is, however, normally associated with the period between late incubation and the fledging of young when the adult birds will protect the investment they have made in the development of their young. This period did not arise during these studies.

Falconry clearly impacted, therefore, on the behaviour of gulls but was insufficient to create an overall reduction in breeding numbers in 2009. The deployment of any novel scaring technique will always elicit a response from a newly targeted population (Bomford & O'Brien, 1990), but maintenance of response rates over time becomes increasingly difficult. Companies offering falconry-based services routinely suggest that target birds have an innate fear of falcons but this is clearly not the case if routine deployment of falcons that do not hunt is deployed. The opportunity to use hunting falcons was not possible, however, as the method was aimed at a highly public area and did not want to result in capture of a gull

within a busy public area. The inability to re-enforce the use of falconry with an element of lethal control, however, prevented a full assessment of standard falconry methods from being evaluated.

The methods developed by the bird control team were new methods that, to our knowledge, have not previously been used in an urban environment. Coverage of a wide area achieved by flying birds between different rooftops and members of staff represents a breakthrough in this field. Being able to present the level of coverage that was achieved by the end of the programme from the outset of any future studies may therefore help to increase the value of such activity across many sites. It would also benefit the control strategies if gulls were to have the perceived threat from the falcons reinforced whenever indications of habituation or tolerance were observed. This could be through direct lethal control, through deployment of hunting / novel falcons or via other techniques and strategies. It may be possible, for example, to use dead gulls as lures for the falcons so that birds in the area are able to witness the falcon's apparently 'catching and dispatching' conspecifics. Further discussion is required to determine the most appropriate forward strategy but evidence from many other studies confirms that a lethal element or perception of a lethal element of control can create a significant improvement in non-lethal methods (Baxter & Allan, 2008).

Further study to streamline the implementation and timing of the falconry programme, trial the inclusion of a lethal element of control and allow the adoption of complementary strategies to facilitate sustained reductions over a wider area is therefore recommended.

7. Cost / Benefit Development

Whilst the impact of non-hunting falconry during this study was unable to give rise to breeding population declines, opportunities to utilise the methodologies developed in this study may benefit urban gull control strategies in future. The following summary provides an outline cost analysis of the various regimes available for deterrence of gulls. Costs will vary depending on the environment, circumstances, timing, techniques and contractors used, hence these figures should be viewed as an approximate baseline guide only.

Netting

To achieve full exclusion of gulls from rooftops, bird deterrent netting systems, correctly installed, will prevent birds from nesting on rooftops. Assuming relatively simple flat roof exclusion can be implemented, the following assessment is pertinent to the Campaign Zone in Dumfries.

Net installation costs @ £6.37 - £10 / square metre (mean £8.19 psm).
Approximate estimate of of the area covered by roof space = 200,000 sq m roof space available = £1.64 million for coverage.
Minimal annual maintenance cost estimated at conservative 7.5% = £122,850.

Result = full prevention of breeding gull activity within Campaign Zone.

Integrated Deterrence Systems

Cost estimate based on these studies of c.£3 - £5k per week for a dawn to dusk method that includes falconry. Additional measures such as pyrotechnics, hand held distress call units, laser bird scaring units etc should be included. Cost assuming 16 week requirement to deter gulls = c.£64k.

Current Dumfries coverage of 800,000 sq m of Campaign Zone could be enhanced by flying falcons / deploying methods on fewer days then backing the system up with other methods to maintain impact of falcons. System would require deployment of hunting birds and / or use of other strategies to maintain early successes. No large area studies completed within an urban environment that can confirm the levels of success that could be achieved. System would only be in use for the period for which it was deployed, i.e. full coverage year round would increase costs to c.£208k per year. Frequency, hence cost, could be reduced if birds departed the area completely.

Automated Systems

Depending on system to be implemented, cost range of £90 - £5k per roof.
Assuming 200 roofs could have deterrence installed at a cost of £2.5k each, total cost = £500,000.

Systems would then be fully installed but reliant on gulls being suitably disturbed. No studies have been completed on the large-scale deployment of automated systems across adjacent areas. Single roof automated systems often rely on making one particular location less attractive than another hence birds have the choice to move to a non-deterred site. This may not be the case if all sites were covered. Systems are likely to need to be rotated between roofs on a regular basis.

Egg Removal / Replacement

Egg removal vs. artificial egg replacement (mean of £21 in situ per egg (based on estimates from 2008 Bristol programme where 1400 eggs were replaced)). Egg removal programmes require regular access to sites to remove first, second and possibly third clutches of eggs / nests between late April and late June. Cost based on Bristol programme of accessing, and then removing and replacing (or oiling) eggs would entail approximately £9k of expenditure in Dumfries.

No gulls would be deterred from an area but the critical aggression period occurring during late incubation / early fledging should be eliminated and future benefits may accrue. Studies are currently underway to assess viability of these programmes in the south west of England. Such methods could be combined with other measures as part of an integrated strategy.

Fertility Control

Fertility treatment options currently need to ensure the target species eats a sufficient drug dose throughout the breeding cycle. There are no methods currently licensed for use in the UK and definitive ways of administration are difficult to confirm without risk of affecting non-target species. The method is therefore not yet suitable for consideration.

The following recommendations for development of an integrated falconry programme are presented:

8. Recommendations for Enhancing the use of Falcons to Displace Gulls from an Urban Nesting Area.

- The use of non-hunting falcons was unsuccessful so initiating an integrated deterrence programme utilising falcons trained to reinforce the impact of control is suggested.

- Have flexibility to amend any programme whenever behaviour of gulls suggests they have built up a level of tolerance to any one technique. Use of complementary measures could include and should not be limited to; distress calls, kites, pyrotechnics, lasers etc.

- Ensure any programme is in place and established prior to gulls returning to breed and settling into territories.

- Consider sequential deterrence across different locales to offer greater coverage with less risk of habituation. i.e. implement sufficient deterrence to create high level disturbance for 2-3 days in each area, each week. Ideally target deterrence at disrupting arrival / settling, courtship, nest building, egg laying, and egg incubation. Keeping incubating birds off the nest for long enough to render eggs unsuccessful, for example, may be all that is required.

- Target control over limited periods to cover key risks. E.g. fly birds intensively within streetscape environments at lunchtimes / school leaving hour.

- Where possible, mark individual gulls to determine actual displacement consequences.

- Continue programme through the breeding season towards late June to ensure consequences of programme are not just a delayed breeding season.

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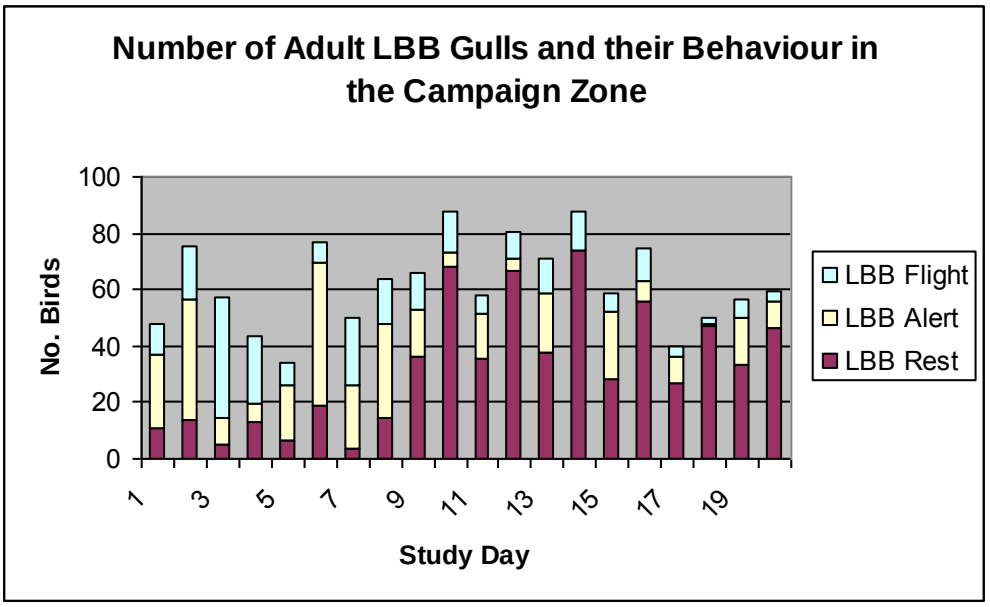
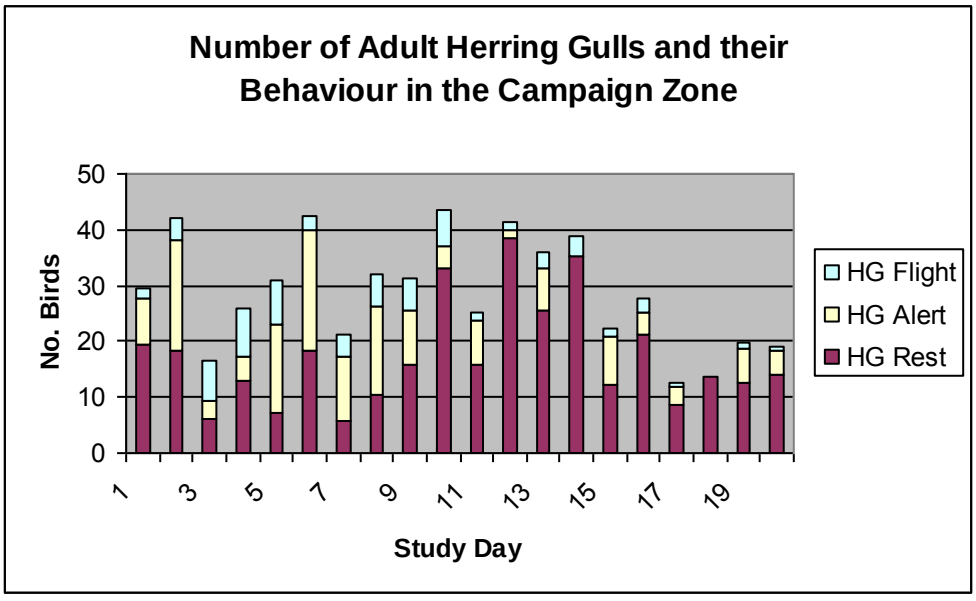
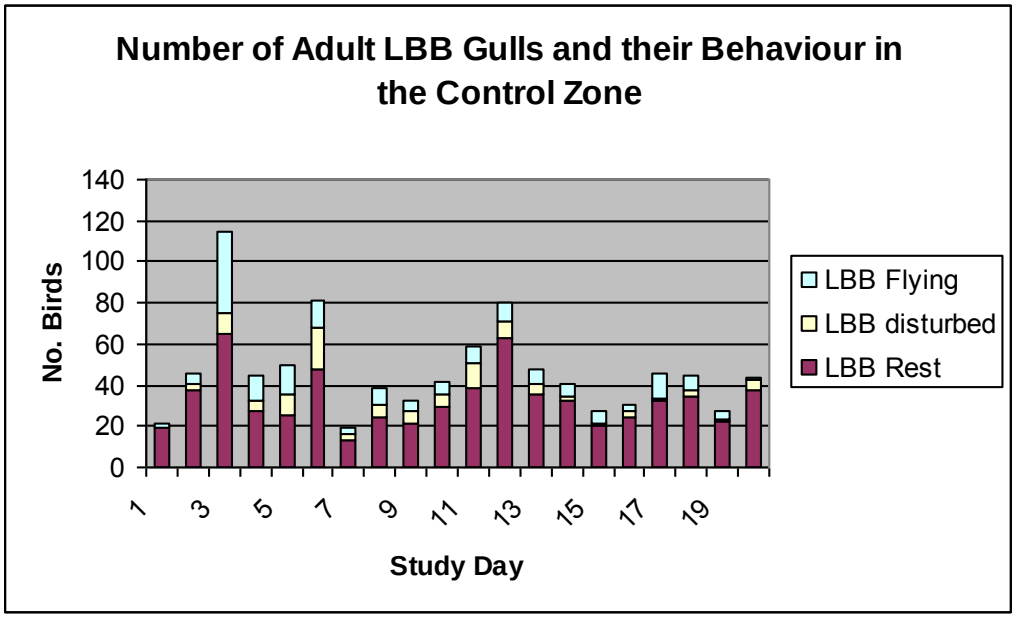
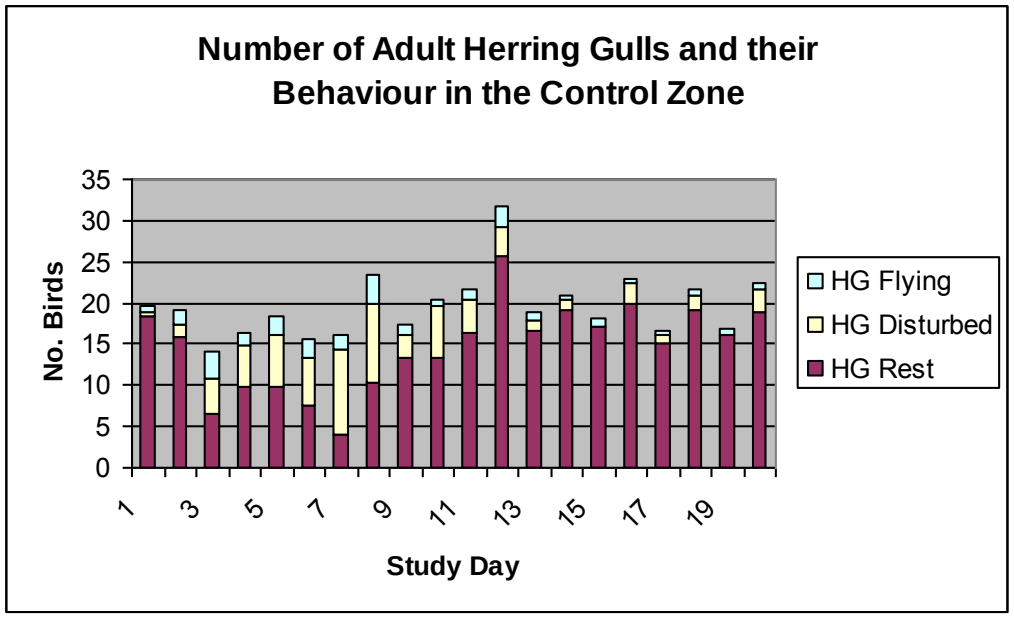
11. Appendix 1

Daily Mean Numbers and Behaviour Classifications of Each Gull Species Within Each Sample of the Campaign and Control Zones.



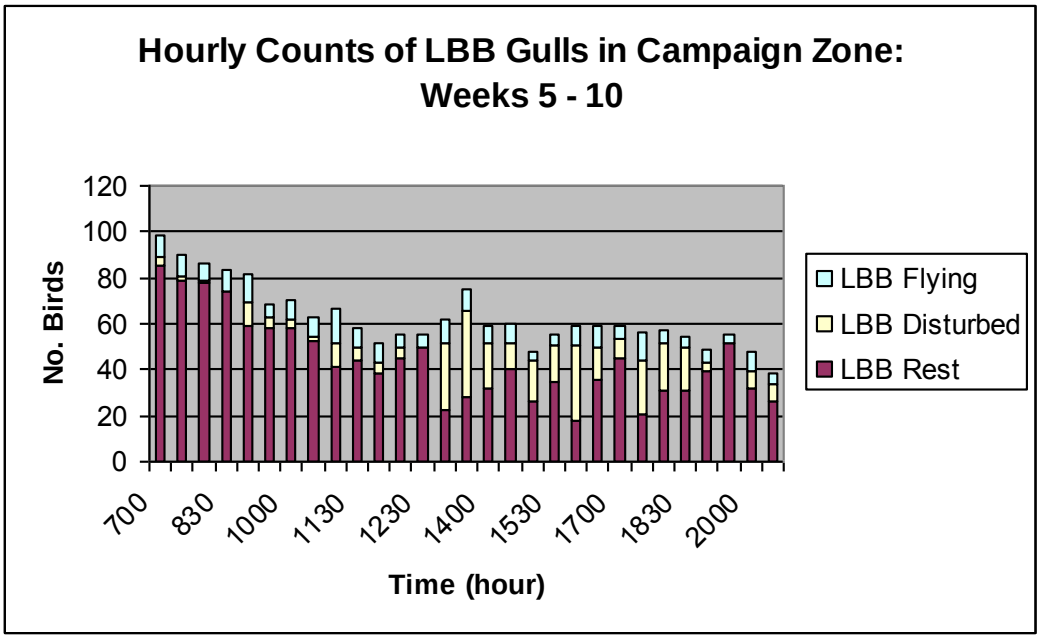


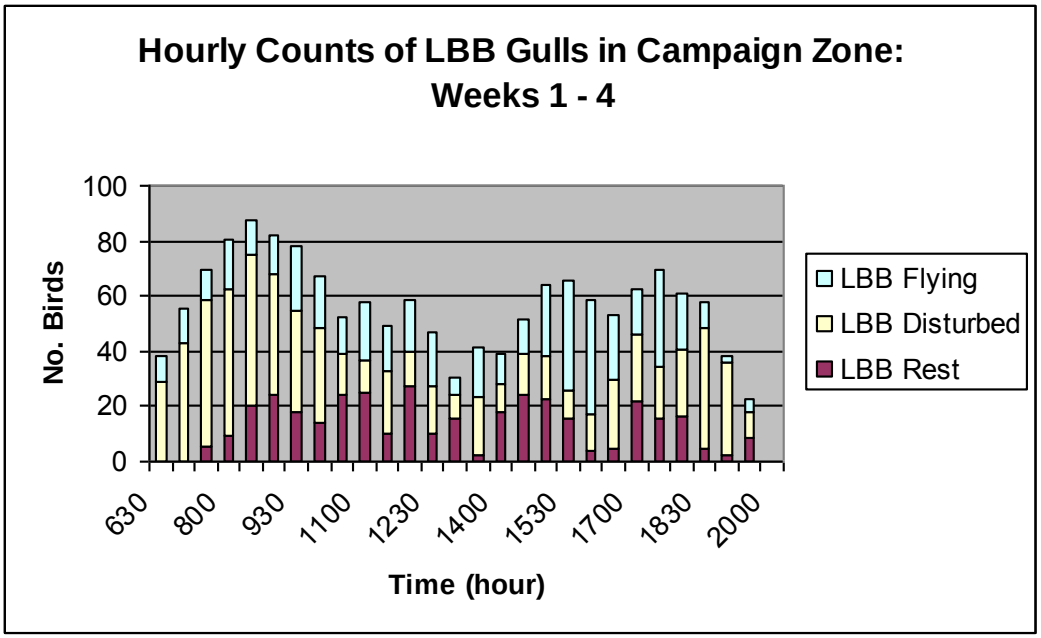

Number of Adult LBB Gulls and their Behaviour in the Control Zone
No. Birds
140
120
100
80
60
40
20
0
1
3
5
7
9
11
13
15
17
19
Study Day
LBB Flying
LBB disturbed
LBB Rest

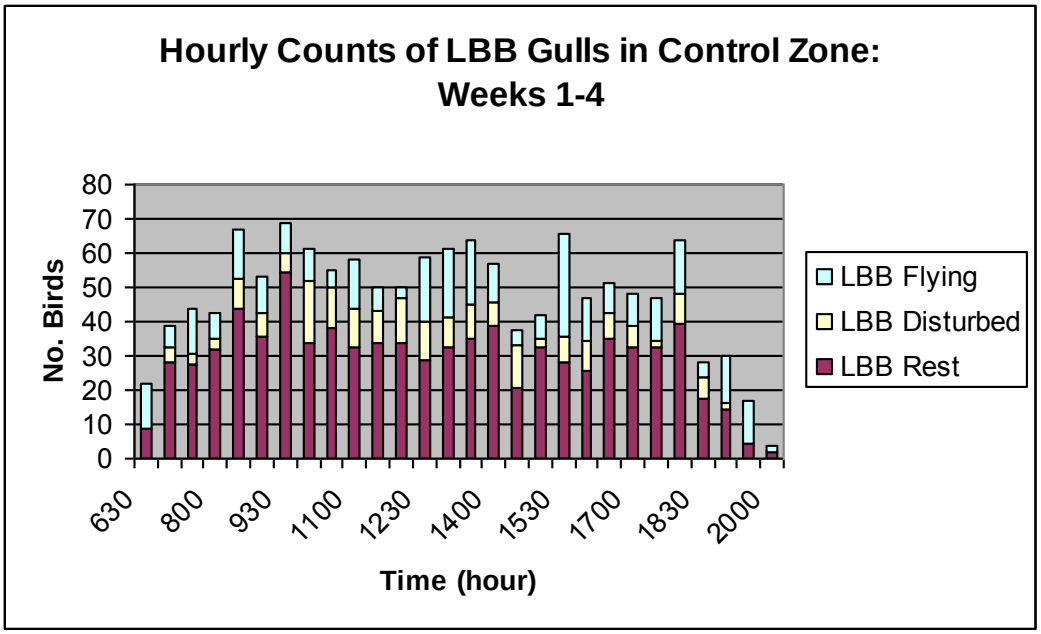

Number of Adult Herring Gulls and their Behaviour in the Control Zone
No. Birds
35
30
25
20
15
10
5
0
1
3
5
7
9
11
13
15
17
19
Study Day
HG Flying
HG Disturbed
HG Rest

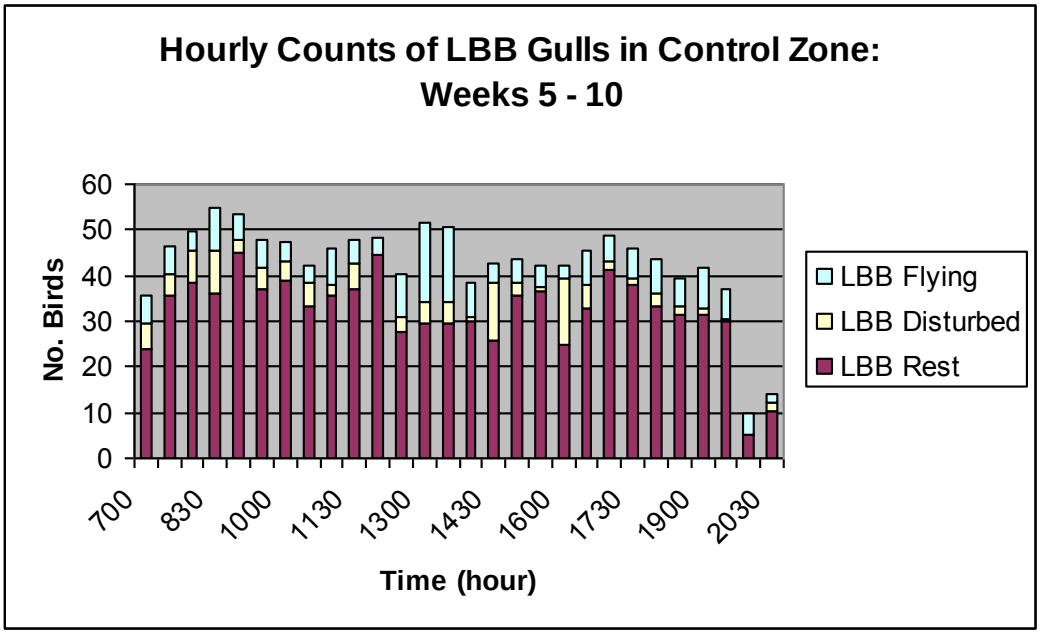
12. Appendix 2

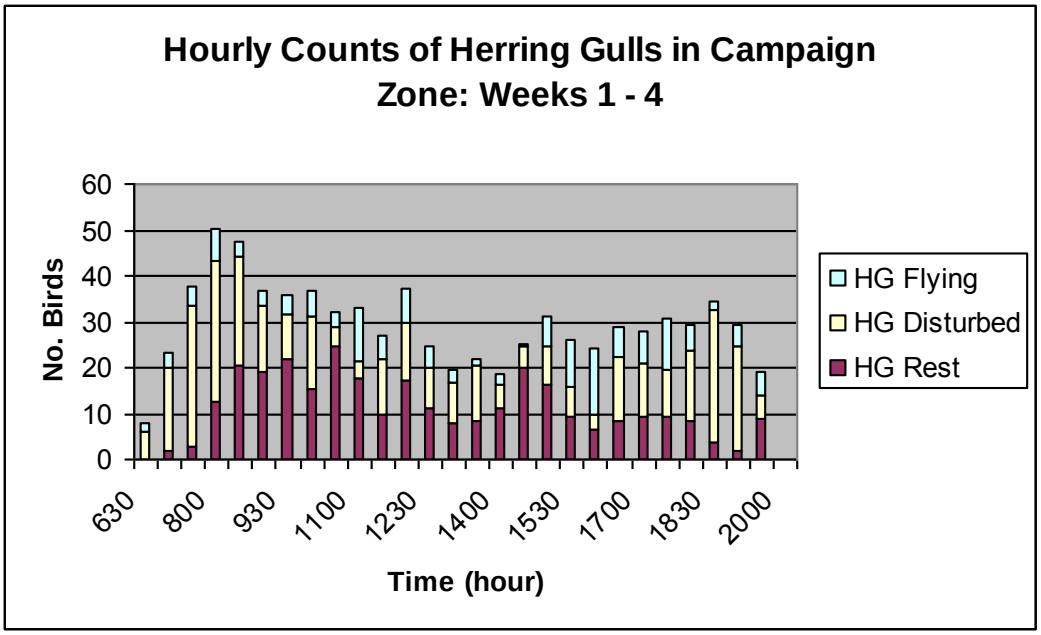
Daily Counts of Each Gull Species Within Each Sample of the Campaign and Control Zones.

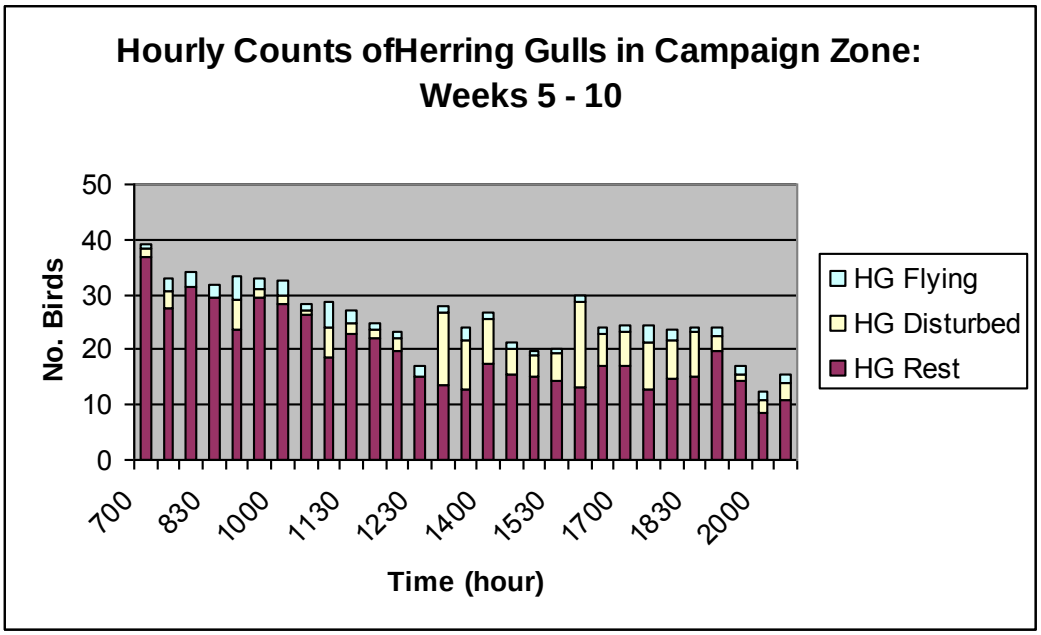


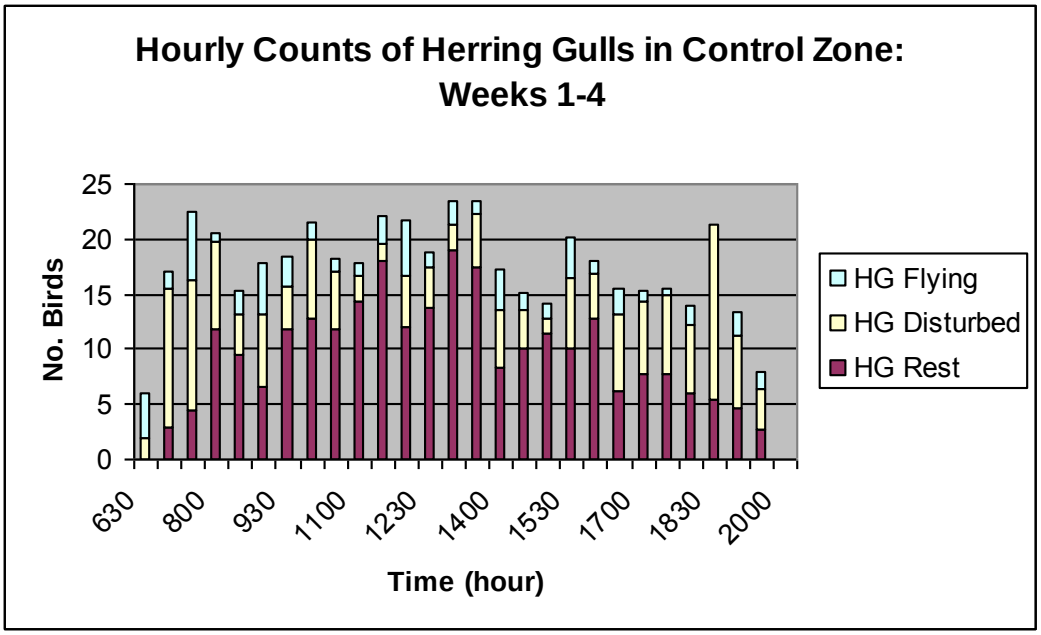


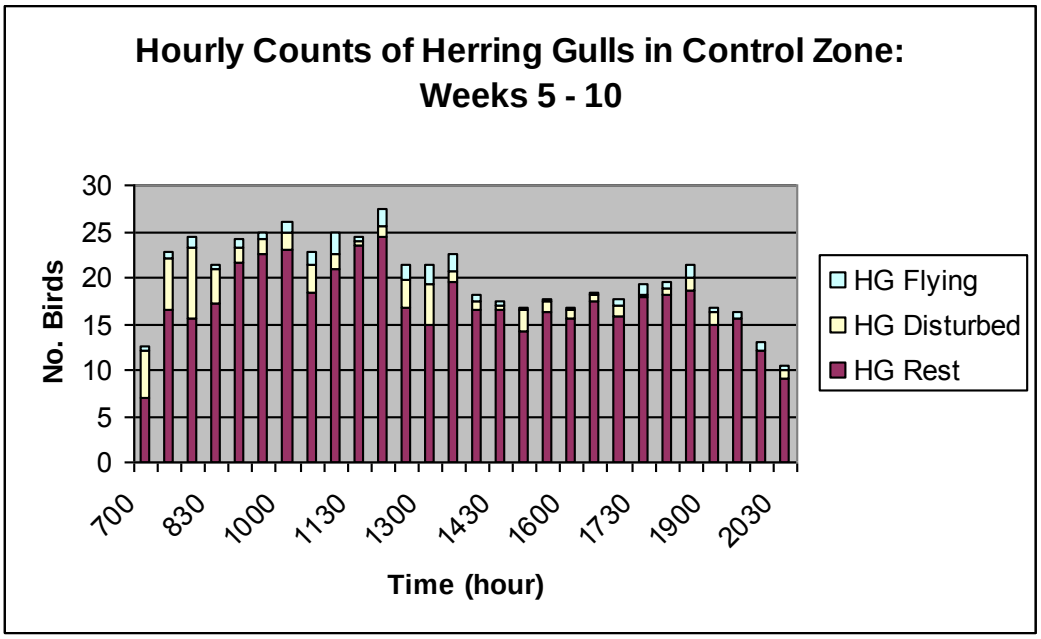

Hourly Counts of LBB Gulls in Control Zone:
Weeks 1-4
No. Birds
80
70
60
50
40
30
20
10
0
630
800
930
1100
1230
1400
1530
1700
1830
2000
Time (hour)
LBB Flying
LBB Disturbed
LBB Rest


Hourly Counts of LBB Gulls in Control Zone:
Weeks 5 - 10
No. Birds
60
50
40
30
20
10
0
700
830
1000
1130
1300
1430
1600
1730
1900
2030
Time (hour)
LBB Flying
LBB Disturbed
LBB Rest


Hourly Counts of Herring Gulls in Campaign Zone: Weeks 1 - 4
No. Birds
60
50
40
30
20
10
0
630
800
930
1100
1230
1400
1530
1700
1830
2000
Time (hour)
HG Flying
HG Disturbed
HG Rest


Hourly Counts ofHerring Gulls in Campaign Zone: Weeks 5 - 10
No. Birds
50
40
30
20
10
0
700
830
1000
1130
1230
1400
1530
1700
1830
2000
Time (hour)
HG Flying
HG Disturbed
HG Rest





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