Annual review of scientific monitoring 2008

Damian Bubb

SCOTTISH NATURAL HERITAGE

BUCCLEUCH ESTATES

Game & Wildlife CONSERVATION TRUST

RSPB

NATURAL ENGLAND

Review of scientific monitoring 2008

This report has been prepared for the STAG meeting (12/12/08).

Summary

1. Four males and two female hen harriers were present at Langholm in the spring. Two pairs nested successfully with four young fledging from the first nest and five from the second. The low number of breeding females present continues the trend of recent years however breeding success was higher than in recent years with the highest number of young fledged at Langholm since 2001.

2. Diversionary food was provided in the spring in three male hen harrier territories. No harriers were observed taking any diversionary food in the spring but substantial amounts of the diversionary food were taken, primarily rooks with carrion crows and short-eared owls taking lesser amounts.

3. Diversionary food was provided close to the two harrier nests once young had hatched. Only harriers were observed taking food from the nest feeding posts and a total of 66 rats and 1076 day old chicks were removed from the posts.

4. Watches of the harrier nests were conducted to record prey delivery and identification. A total of 106 prey items were observed being bought to the nests. Passerines were the majority of identified prey items (54%) with diversionary food forming 29%. No grouse were recorded being delivered to the nest.

5. Monitoring of peregrine, merlin, raven and buzzard nests across the project area was conducted by a combination of raptor study group workers and LMDP staff. Within the project area and 1 km of the boundary there was: 2 successful peregrine pairs, 1 successful merlin pair, 5 successful pairs of raven, 10 successful buzzard nests.

6. Red grouse spring abundance was slightly up on 2007 and continued the trend of a gradual increase in numbers since 2003. July abundance of red grouse counted within standard blocks did not show an increase on 2007 but was broadly similar in number to the last two years. Although observer/dog biases may have influenced July counts in 2008 reducing the number of grouse counted. Breeding success was above average for recent years with an average young to hen ratio of 3.1.

7. Only a very limited numbers of caecal droppings were collected from Langholm making assessments of the parasite burden within the grouse population at Langholm difficult. Parasite burdens of red grouse were estimated during autumn from 15 fresh caecal dropping which were analysed for strongyle eggs. Mean eggs g^{-1} 0f 1125 suggest that the worm burden of the limited samples collected were low..

8. 25 species of bird were recorded during breeding bird transects. Abundance of waders, meadow pipit and skylark were similar to recent years. Curlew, lapwing and golden plover abundance is much reduced compared to that recorded during the JRS.

9. Small mammal trapping in 2008 recorded 3.4 small mammals per 100 trap nights. Most mammals trapped were field voles, with 3.1 voles per 100 trap nights. 2008 appears to have been a peak vole year (Langholm has a 4 year vole cycle) with numbers of voles the second highest since 1992.

10. Fox abundance was estimated from scats collected at monthly intervals (April, May, June) along approximately 50km of transects across the moor. There was a progressive decline in number of scats collected between months in 2008 with numbers collected similar to recent years.

11. Mustelid (stoat and weasel) abundance indices were estimated from footprint tracking tunnels deployed in spring and autumn for two weeks. Tunnels gave a positive score of 20% and 22% in March and September respectively. Spring abundance of mustelids was high in 2008 in comparison with recent years but in contrast to monitoring in unkeepered years there was no substantial increase in numbers of mustelids over the summer.

12. Weekly records of effort and predators controlled have been entered onto cards by the keepers and collated on a monthly basis by the senior scientist. Predator control totals for the period March – October 2008: 194 foxes, 325 carrion crow, 49 rook, 31 stoat, 145 weasel.

13. 400 permanent vegetation quadrats have been established across the project area. These were surveyed in 2008 and will be resurveyed in subsequent years to allow changes in vegetation, principally heather, to be monitored.

Contents

1. Breeding success of raptors and ravens

Hen harriers

Male birds were recorded on the moor from mid March onwards, and three males had established territories by early April with a further male present by late April. All four males were located in the traditional core breeding area used by harriers in previous years. One of the four males had previously been wingtagged and was identified as having fledged from Langholm Moor in 1998. Extensive checks were made of all previously used nesting habitats but displaying males were restricted to the area surrounding Tarras Valley. Female harriers were initially observed on the moor in late March but possibly due to a period of cold weather did not remain. Two female harriers were subsequently observed and nested with two of the established males (Figure 1). The first pair laid 6 eggs all of which hatched, 4 chicks fledged (3 males, 1 female), the two youngest chicks died during a period of poor weather probably as a result of a combination of hyperthermia and starvation. The second pair laid 5 eggs, all of which hatched and fledged. All 4 fledged birds from the first nest and 3 of the chicks from the second nest were ringed with conventional metal leg rings. Wing tagging was not possible due to being prohibited by the current legislation.

The low number of pairs breeding in 2008 is similar to the numbers which have been present in recent years (Figure 1), however the number of young fledged and the number of young fledged per female was the highest since 2001.

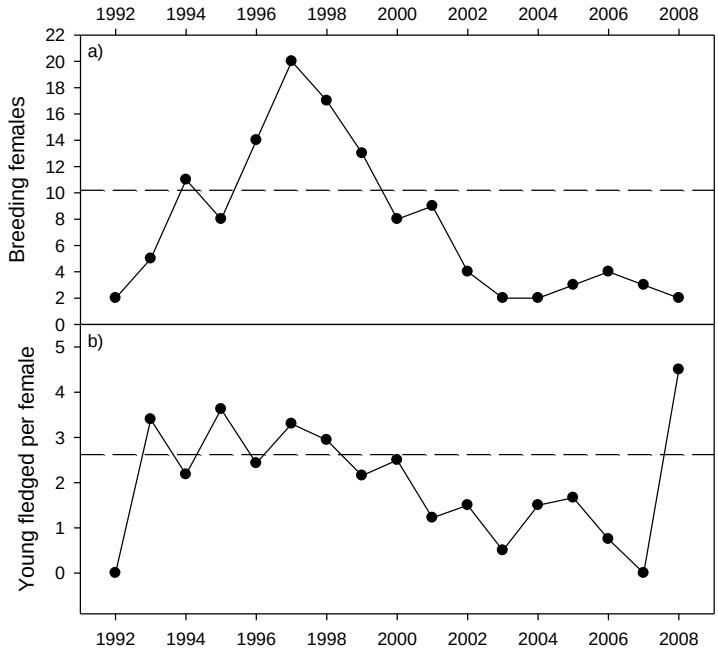


Figure 1. Numbers of a) breeding female hen harriers and b) mean number of young fledged per female at Langholm Moor 1992-2008. Dashed lines indicate success criteria for the LMDP (10.2 breeding females and 2.62 young fledged per female).

Peregrine

All traditional sites both within the LMDP boundary and in the immediate surrounding area were checked for occupancy. A single site on the project area was occupied, 4 eggs were laid and 2 young fledged. A second site about 500m from project boundary was also occupied, 3 eggs were laid and 2 young fledged. Chicks at both nests were ringed with conventional metal rings and with rings incorporating passive integrated transponder (PIT) tags.

Raven

All traditional nest sites within the project area were checked. A total of four pairs of ravens nested on the project area, and a further pair <500m from the project boundary. All nests were successful with between 1 and 5 chicks fledging. No raven chicks were ringed in 2008.

Merlin

A single merlin nest was located within the project area. The nest was located in a tree in an old crow nest adjacent to Little Tarras Water. 5 eggs were laid, all of which hatched and fledged. The 5 juveniles were all ringed.

Buzzard

Ten active buzzard nests were located across the project area all of which appeared to successfully fledge young. Nests were mainly located relatively late in the season therefore nests which failed early were unlikely to have been recorded.

Goshawk

No Goshawk nested within the project area. A single nest is known from the 5km buffer area around the project boundaries. This pair bred successfully and fledged 3 young. The nest was located within Tinnisburn Forest to the south of the project boundary.

Short-eared owl

Frequent repeated sightings were made of short-eared owls in two areas (NY4588 & NY4586), suggesting a minimum of two breeding pairs on the project area.

2. Diversionary feeding

Diversionary feeding of harriers at Langholm in 2008 followed the method described by Redpath et al. 2001. During the spring food was provided daily in each territory in which males were observed displaying and prospecting for nest sites. In each territory identified two feeding platforms (T bars) were erected and freshly thawed diversionary food (one white rat and four day old cockerel chicks on each feeding platform) was put out daily and any remaining food from the previous day was removed. After placing the food on the platform the feeding posts were watched for 30 minutes and any species taking food or being within 100m of the feeding posts was recorded. Due to limited time available by field staff the 30 minute observations of the feeding posts was only conducted until the 25 April, from the 5 May cameras supplied by RSPB (intended primarily for the nests) were used to

provide information on the species taking food from feeding platforms. Feeding was conducted in each male territory until the start of incubation or unpaired males left their territories.

Both successfully hatching clutches were provided with further supplementary food from hatching until 60 days after hatching. During incubation feeding posts were gradually moved closer to the nest so that on hatching feeding posts were positioned about 10m from the nest. A combination of day old cockerel chicks and white rats was provided daily with the quantities determined by the age and number of chicks (Redpath & Thirgood 1997). When nest cameras were not required they were used to provide information on species taking food from feeding platforms.

Spring feeding

Three males established territories during the spring and were provided with diversionary food. A fourth male was present during late April/ early May in the vicinity of Combsfellend but did not show strong attachment to a particular area so no feeding platforms were provided for this male. Feeding was started in the Muckle Knowe , Charlies Moss and Terrona Hill territories on the 30th March, 2nd April and 10th April respectively (Figure 2b). The cock harriers at Muckle Knowe and Terrona Hill each attracted a female and successfully nested. Spring feeding ceased in these territories on the 14th May at Muckle Knowe and 3rd June at Terrona Hill as incubation had commenced. Food was provided in the Charlies Moss territory until the 28th May when the unpaired male was only occasionally seen, there was also a break in feeding in the Charlies Moss territory from the 21st to the 25th May as the male appeared to have left the area during this time.

A total of 304 white rats and 1216 day old chicks were provided in the spring on the feeding platforms, of these 65 (21.4%) rats and 456 (37.5%) day old chicks were removed. The proportion of food which was removed varied considerably over the period in which the feeding posts were being provisioned in the spring (Fig. 2c,d). In early April a high proportion of cockerel chicks were being removed from the posts, this appeared primarily due to carrion crows. Carrion crows were observed taking food from the posts on the 4 April and 7 April and were frequently observed on the moor during this time. The numbers of carrion crows present on the moor subsequently declined as keepering became established and were not recorded taking diversionary food after 27/4/08. From 10th April until early May the amount of diversionary food removed declined to a relatively low level but from early May onwards most food provided on the feeding posts was being removed (Fig. 2c,d). This was mostly attributable to rooks (73% of observations) with short-eared owls taking a smaller proportion (27% of observations) of the food (Fig. 2a). No harriers were observed taking any food from the posts in spring.

Motion sensitive cameras were operational for a total of 58.3 days during spring feeding. During this time 210 visits to the feeding posts by potential scavengers were recorded. The images recorded by the camera did not always allow the observer to determine if food had been taken on each recorded visit. Rooks were observed to visit the feeding posts 151 times, with food available on 75% of their visits. Short eared owls were recorded visiting the feeding posts 57 times, with food available on 57.9% of visits. No harriers were recorded taking food from the posts or perching on the posts whilst the cameras were operating. A merlin was recorded briefly once on the feeding post but did not take any food.

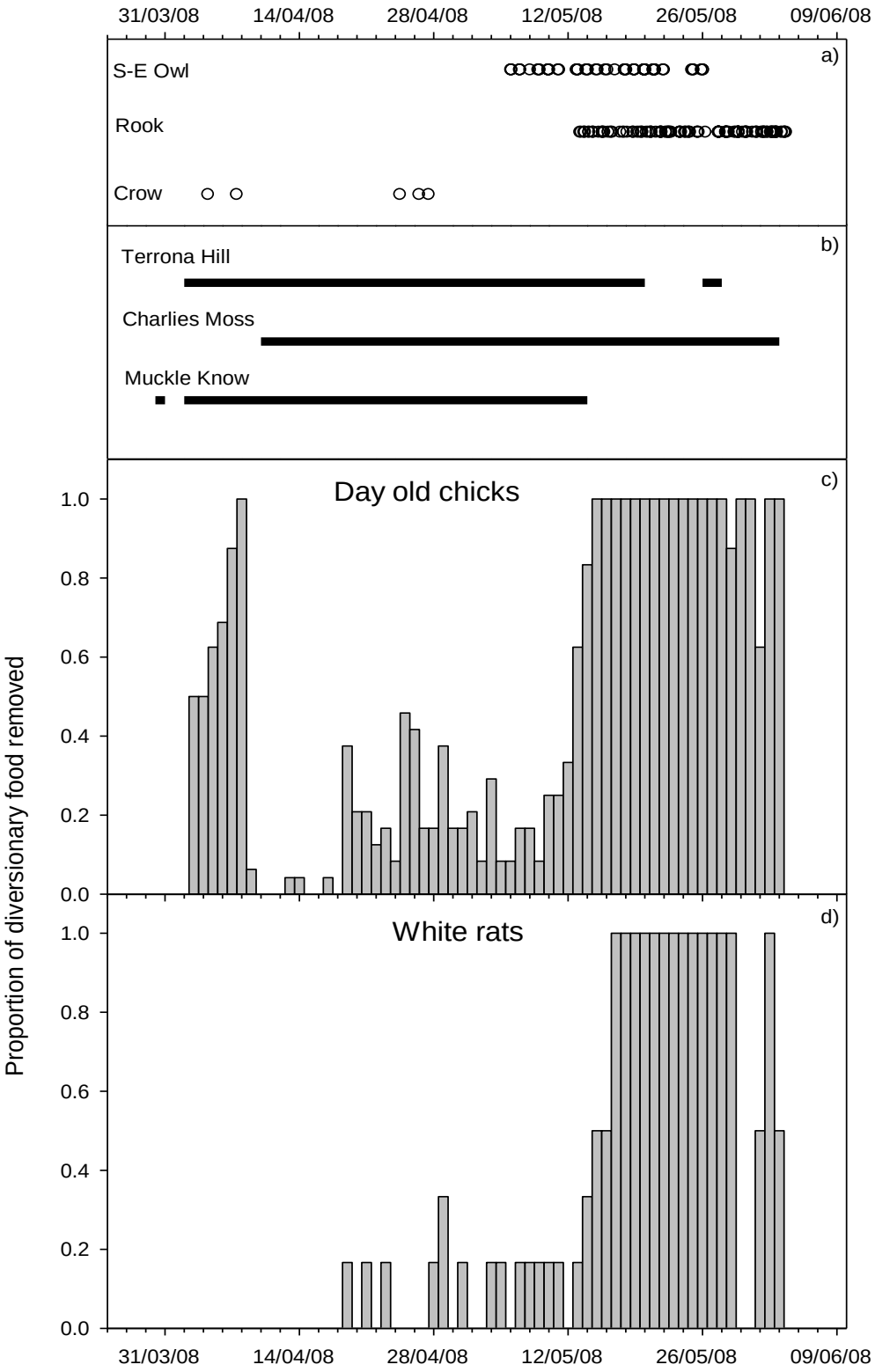


Figure 2 a) Records of rook, short-eared owl and crow at the feeding posts b) period during which diversionary feeding was taking place in the spring at each of the three male territories c) proportion of day old cockerel chicks and b) proportion of white rats removed each day from feeding posts.

Summer Feeding

During summer feeding when the harriers had chicks a total of 66 rats and 1076 cockeral chicks were removed from feeding posts. This is over 60% of the day old cockerel chicks and 18% of the rats which were provided as diversionary food (Table 1.).

Table 1. Proportion of diversionary food provided and removed from the feeding posts at the two harrier nests.

	Food provided		Food taken (%)	
	White rats	**Day old chicks**	**White rats**	**Day old chicks**
Muckle Nest	180	765	19 (10.6%)	464 (61.0%)
Terrona Nest	188	886	47 (25.0%)	612 (69.1%)

It appeared that over the summer feeding period only harriers took the diversionary food. Motion sensitive cameras trained on the feeding platforms operated for a total of 25.5 days at the nests. Only harriers were recorded taking food from the posts with a total of 118 visits by harriers recorded by cameras. All records were of female/juvenile harriers taking food from the posts. Potential scavengers (crow, rook, raven, buzzard) which were observed in the vicinity of the nest were aggressively mobbed by the hen harriers and were not recorded by cameras or observed during hidewatches or opportunistically taking any food.

Harriers did not immediately take food from the feeding posts once eggs had hatched and food was being provided (Figure 3). To encourage the harriers to take the diversionary food when diversionary food was being provided but not taken by harriers a day old chick was torn open and placed on the edge of the nest to try and condition the harriers into associating the day old cockerel chicks on the post with food. This was repeated daily until harriers started taking food from the posts. The female at the Muckle Knowe nest on finding a chick adjacent to the nest immediately started eating the cockerel chick and feeding it to the harrier chicks. The first item of food was taken by the harrier at Muckle nest 4 days after feeding had commenced. A similar method was followed at the Terrona nest, initially the female at Terrona would remove the chick that was left in the nest, after several days she started eating the chick. To further encourage the Terrona female to take the diversionary food, food was also placed on a rock adjacent to the nest which was used by the female as a perch. The female immediately took food from the rock. One of the feeding posts was then moved to adjacent to the rock, this appeared successful and the female started taking food from the posts, but this did not occur until 19 days after feeding had commenced.

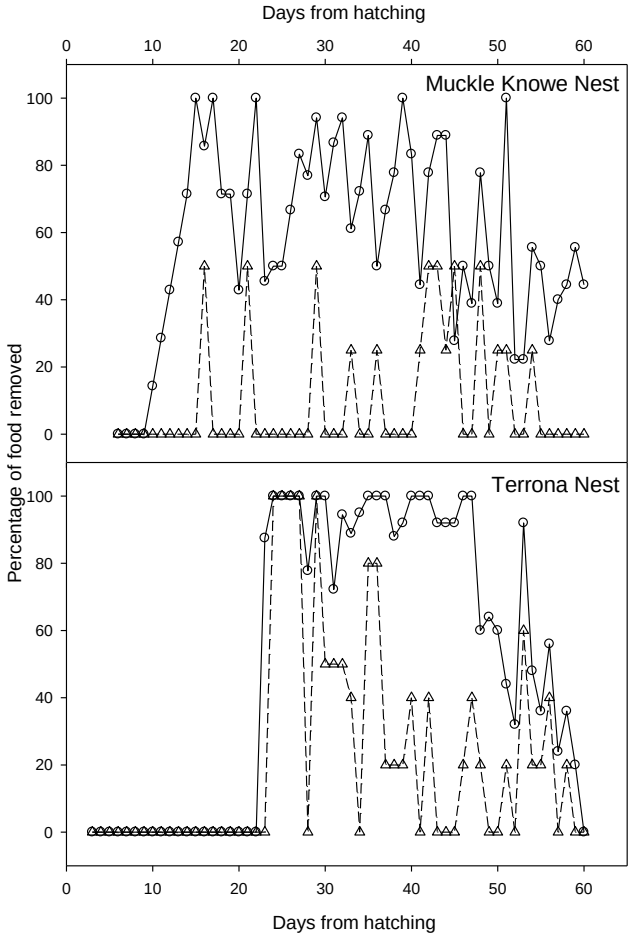


Figure 3. Daily percentage of diversionary food taken from the nest feeding posts. Triangles and dashed line refer to white rats, Circles and solid line refer to day old cockerel chicks.

3. Harrier prey identity and delivery rates

To examine harrier diet whilst rearing their chicks, hides were erected 5-7m from the nests (after being gradually moved closer to the nest over several days). A total of 80.7 hrs observation split between the two nests was conducted stratified both across daylight hours and time from hatching.

A total of 106 items were observed being bought to the harrier nests (Table 2). The majority of food items delivered to the nest were passerines (54%) with diversionary food accounting for a further 30% of the food. No grouse were observed being bought to the nest although three items could not be identified.

Table 2. Numbers and identity of prey observed bought to harrier nests whilst conducting hide watches.

	Nest		Total (%)
	Muckle Nest	Terrona Nest	
Day old chick (diversionary food)	17	14	31 (29.3%)
Passerine	25	32	57 (53.8%)
Meadow pipit	14	23	37 (34.9%)
Unidentified	11	9	20 (18.9%)
Small mammal	2	2	4 (3.8%)
Lizard	11	0	11 (10.4%)
Unidentified food	3	0	3 (2.8%)
Total food items	58	48	106

Nest cameras

Motion sensitive cameras were trained on the harrier nests primarily to record any predation events. They successfully operated from midway through incubation until the young fledged. The cameras did not appear to disturb the harriers except in one instance. At the second nest after the camera had been operating at the nest for several weeks the camera was repositioned to obtain a better picture, after this the female harrier would not resettle at the nest. After watching for approximately 1 hr the camera and hide were removed and the female resettled at the nest shortly after.

In addition to recording predation events a higher definition camera was used with one recorder to explore the possibility of the cameras replacing hidewatches. The quality of pictures obtained in 2008 does not suggest that the hide watches can currently be replaced by the cameras. The cameras usually would allow diversionary vs. natural food to be distinguished but would only permit occasional identification of natural food. Additionally as the harrier chicks became larger and more mobile the view of the camera when food was delivered was often obscured reducing the chance that a clear view of the prey would be obtained.

4. Red grouse

Grouse were counted twice using pointer dogs. The first count was conducted in late March/early April to determine pre-breeding densities and again in the second half of July/early August to assess breeding success and post breeding densities. Two methods were used to count the grouse at Langholm; block counts and distance sampling transects.

Block Counts

Grouse have been counted in the same ten 50 ha plots each spring and July since 1992. Each block is counted along parallel transects that attempt to ensure that the ranging area of the dog does not overlap but does not miss areas either. In effect this means that each block is usually counted by three parallel transects, with a total of 3km walked with a pointer ranging either side of the observer.

Spring grouse numbers continued to show a gradual increase in numbers since a low in 2003 (Figure 4). In 2008 a total of 73 grouse were counted (in eight blocks the two Lodgegill blocks were not counted) representing a density of 9.1 birds per 0.5 km^2. A total of 87 birds (young and old) were counted in July with a mean density of 8.7 birds per 0.5 km^2. The breeding success in 2008 appeared reasonable, the mean number of young per hen during the July block counts was 2.9, which is the second highest number of young per hen in the last 9 years (Figure 5), and number of young per hen rises to 3.1 if all broods in blocks counts and distance sampling are included. 25% of hens recorded during July counts were recorded without any young (Figure 6)

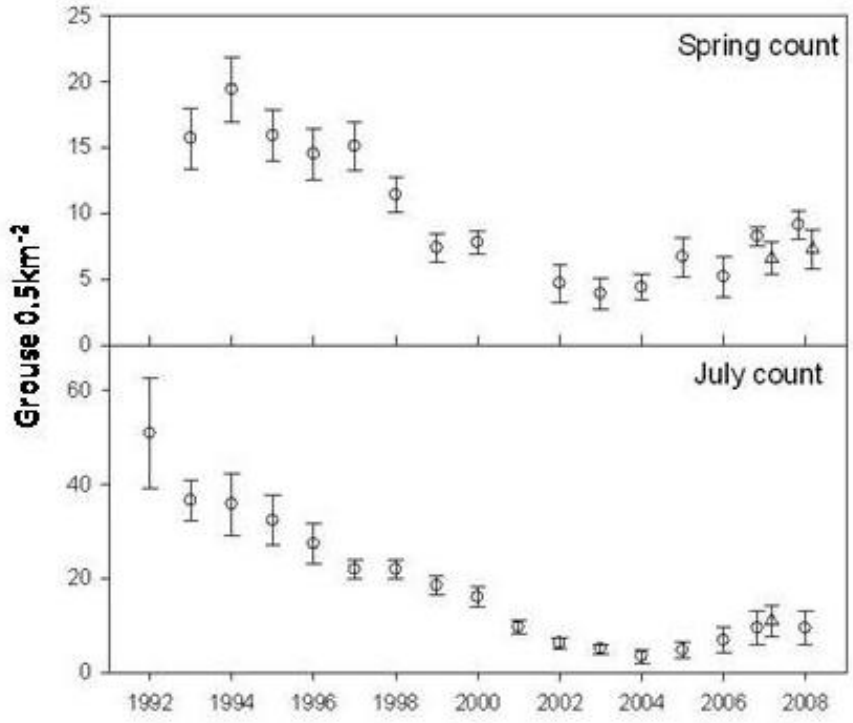


Figure 4. Average numbers of grouse per block as counted within 10 traditional blocks at Langholm. Error bars represent 1 standard error. In spring counts in 2007 and 2008 and July counts in 2007 the two Lodgegill blocks were not counted. Circles in these years refer to average counts for the blocks counted, triangles if it is assumed that the uncounted blocks contained no grouse.

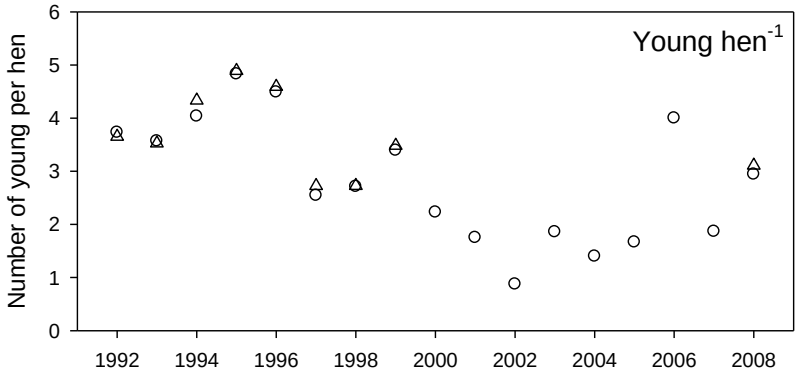


Figure 5. Number of young per hen counted during July counts at Langholm. Circles refer to grouse counted within the 10 traditional block areas. In some years additional areas were counted triangles refer to all grouse counted within those years.

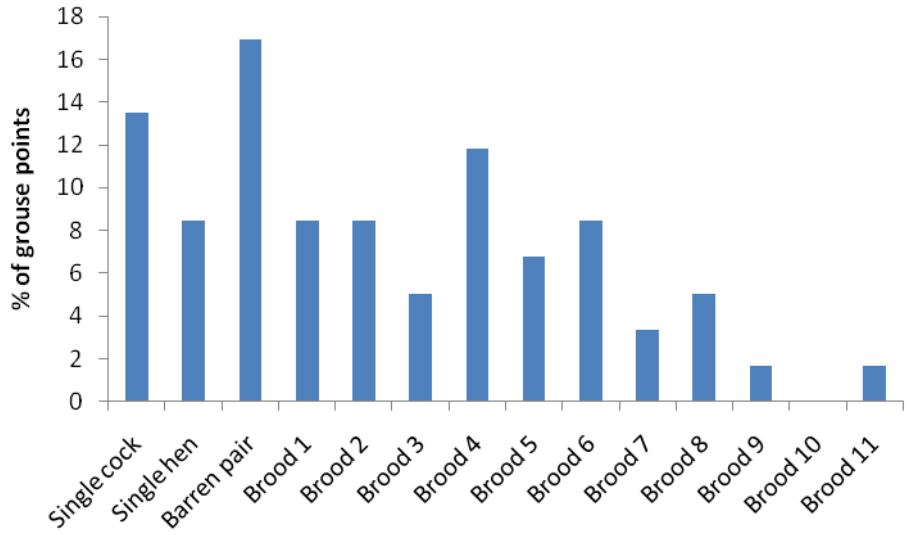


Figure 6. Size distribution of grouse broods recorded during July counts.

Distance sampling transects

In 2008 in addition to the counts of blocks, an additional 35.1 km of line transects were established. The distance sampling transects run across the heather ground at Langholm and are spaced at approximately 500m intervals. Each transect was walked with a trained pointer and all grouse flushed were recorded. The distance from the observer to each point was recorded (measured at right angles from the transect line). This enables the effective search area of the dog to be calculated. The area searched can vary considerably between different pointers, using distance sampling accounts for this variation. In the distance sampling analysis both counts of birds made in the blocks and on the line transects are included as distance to point was measured both during block counts and distance sampling transects.

Spring 165 birds Transect length = 59.1km
(35.1km line transects + 8 blocks (each 3 km))
Strip width = 66.2m (95% Confidence Interval: 55.1,79.5)

Area searched = (0.0662 x 2) x 59.1 = 7.82 (6.51, 9.40)

Spring density = 165/7.82 = **21.1** (17.55, 25.35) **grouse km^{-1}**

July 258 birds Transect length 65.1km

Strip width = 43.4m (35.5, 52.9)

Area searched = (0.0434 x 2) x 65.1 = 5.65 (4.62, 6.89)

July density = 258/5.65 = **45.7** (37.5, 55.8) **grouse km^{-1}**

Radiotracking

40 radiotags have been purchased and we are in the process of tagging birds. To date 9 birds have been caught and tagged. Catching birds is proving time consuming with the 9 birds being caught over 5 evenings lamping with a team of two people. Catching and tagging and relocation of tagged birds will continue throughout the winter.

Parasite burdens

Only a very limited numbers of caecal droppings were collected from Langholm making assessments of the parasite burden within the grouse population at Langholm difficult. In addition all samples were collected from the Whita Hill / Terrona Hill area, and medicated grid had been put out and would have been available to grouse within these areas throughout the summer. A total of 15 caecal pats were collected in autumn and analysed for strongyle eggs. Eggs g^{-1} ranged from 0 to 5850 with mean of 1125 this is low when compared with other grouse moors but additional samples are required (will be collected when catching birds for radiotagging) from a wider area before conclusions can be made regarding the parasite burden of grouse at Langholm. A single old cock red grouse carcass (road kill) was collected during November and worms counted, estimated number 260, this can be considered a low parasite burden.

5. Black grouse

Two black grouse leks were found. A single male bird was repeatedly seen at Lodgegill (NY 420913) in addition a maximum of four lekking males were recorded at on the edge of the moor adjacent to Newcastleton golf course (NY 470881). Further sightings of black grouse were made in the area surrounding the second lek, this includes several sightings of a grey hen with a single well grown young.

6. Breeding Bird Surveys

The abundance of all birds but predominantly passerines and waders has been estimated annually since 1992. The methodology is based on the BTO breeding bird survey, 1 km squares are surveyed by the observer walking two parallel 1km transects 500m apart and recording all birds seen or heard.

From 1992 to 2002 a single count usually in June was made each year. Since 2003 two counts have been made with the first count usually between mid-April and mid-May and repeated around late-May to mid June. Most counts have been conducted between 5:00 and 9:00. From 1992 to 2007 the same 15 1km squares have been surveyed, three in each of the five moorland beats. An additional 5 plots have been added in 2008.

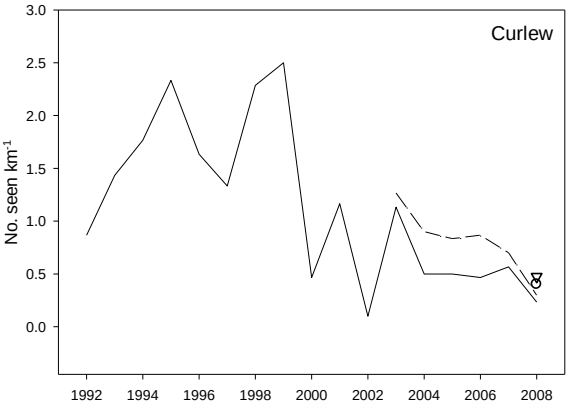
A total of 25 bird species were recorded during 2008 (table 3). The changes in abundance of the dominant passerines (meadow pipits and skylarks) and waders along with red grouse and carrion crows as recorded during BBS surveys since the JRS are shown in figure 7.

Table 3. Species recorded during breeding bird surveys at Langholm in 2008.

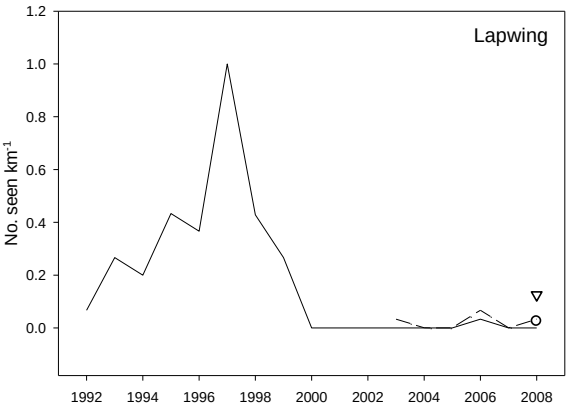
	Number of encounters km^{-1}	
Species	**Early count (April-May)**	**Late count (June)**
Meadow pipit	12.9	12.2
Skylark	2.8	2.95
Curlew	0.4	0.48
Lapwing	0.03	0.13
Golden plover	0.05	0.08
Snipe	0.05	0.2
Red grouse	0.48	0.15
Black grouse	0.08	0
Hen harrier	0.03	0.03
Buzzard	0.05	0.18
Carrion crow	0.25	0.08
Raven	0.05	0
Wren	2.05	1.28
Chaffinch	0.18	0.1
Wheatear	0.08	0.08
Lesser black-backed gull	0.08	0.03
Stonechat	0.03	0.55
Dipper	0.03	0
Blackbird	0.03	0
Winchat	0	0.03
Willow warbler	0	0.48
Reedbunting	0	0.03
Grey heron	0	0.03
Sand martin	0	0.03
Wood pigeon	0	0.03

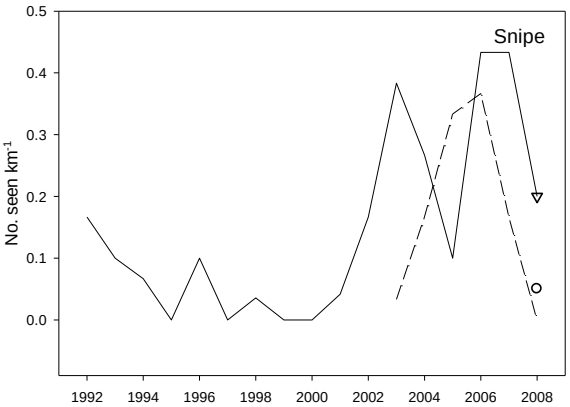

Meadow pipit
No. seen km-1
30
25
20
15
10
5
1992
1994
1996
1998
2000
2002
2004
2006
2008


Skylark
No. seen km-1
14
12
10
8
6
4
2
0
1992
1994
1996
1998
2000
2002
2004
2006
2008


Curlew
No. seen km-1
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1992
1994
1996
1998
2000
2002
2004
2006
2008


Golden plover
No. seen km-1
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1992
1994
1996
1998
2000
2002
2004
2006
2008


Lapwing
No. seen km-1
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1992
1994
1996
1998
2000
2002
2004
2006
2008


Snipe
No. seen km-1
0.5
0.4
0.3
0.2
0.1
0.0
1992
1994
1996
1998
2000
2002
2004
2006
2008

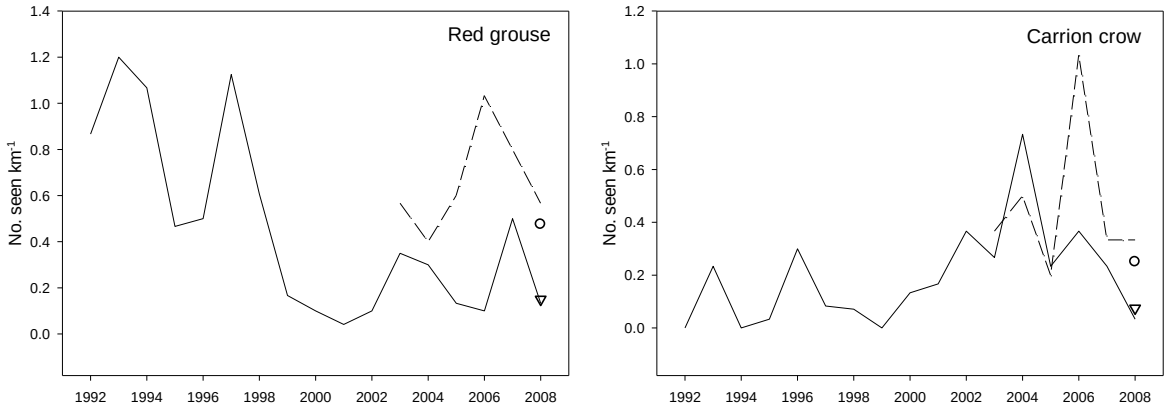


Figure 7. Changes in abundance of selected species recorded at Langholm during BBS surveys 1992 to 2008. Solid line refers to late/June counts and dashed line to early (mid April-mid May) counts (15 km squares counted in all years). The abundance recorded in 2008 in 20 km squares is shown by open circle (early count) open triangle (late count).

Abundance of curlew, lapwing and golden plover in 2008 was similar to recent years although the abundance of these species has declined to a lower level since the end of JRS and keepering at Langholm ceased. Meadow pipit abundance was similar to the previous couple of years but has declined from a recent peak in numbers in 2004.

Carrion crow numbers have been relatively high in recent years (2002 onwards). In 2008 the early count recorded numbers broadly in line with those recorded in the last 5 years but numbers of crows had apparently declined to a lower level by the time the June counts were conducted.

7. Small mammal surveys

The relative abundance of small mammals was estimated through snap trapping in March. Snap trapping on set transects has operated at Langholm since 1992. During the JRS study 10 transect lines were established and seven of these transects have continued to be surveyed annually since then. The position of three transects shifted accidentally and new positions were surveyed from 2003 to 2007. In 2008 13 transects were surveyed, the 10 original positions and the three misplaced transect lines. Fifty traps were set at each transect over two nights to give 100 trap nights per site.

Small mammal trapping in 2008 of the 13 transects gave an estimate of 3.4 small mammals per 100 trap nights. Species trapped were field voles (37), field mice (2), common shrew (1), pygmy shrew (1). If only voles are considered there were 3.07 per 100 trap nights. Langholm seems to have a 4 year vole cycle (Figure 8) and 2008 appears to have been a peak year in the cycle.

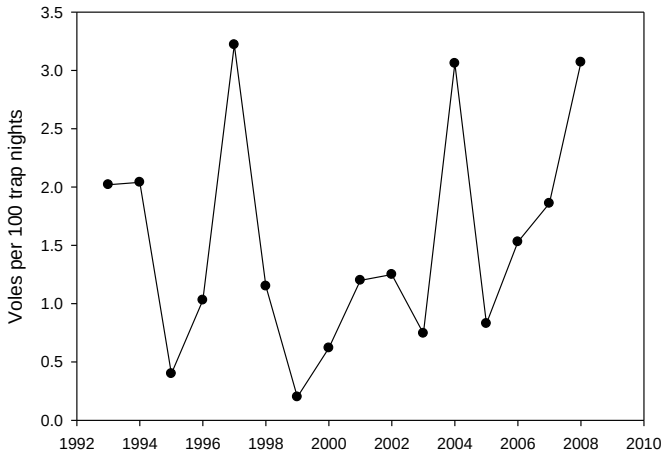


Figure 8. Number of field voles trapped at Langholm in spring (per 100 trap nights)

8. Mammal predator abundance

Foxes

An index of fox abundance has been derived through the use of scat transects. Scat transects run along linear features such as walls and fences to ensure the route is accurately repeatable. An observer walks the transect recording scats 2m of either side of the transect, scats within 10m are considered the same encounter. A clear-up round is performed in March then each transect is walked at monthly intervals in April, May and June (ideally in the last week of the month). Each transect is approximately 10km in length. Three transects were established in 2002 and have been surveyed annually since then, an additional two transects were established in 2008 to provide greater coverage of the project area.

Table 4. The number of fox scats recorded on each transect during 2008.

Transect	Number of scats		
	April (30/4-2/5)	**May (27/5 – 1/6)**	**June 23/6 – 27/6)**
1 – Terrona/Combs	28	6	3
2 – Whita/Middlemoss	15	13	5
3 – Arkelton/Lodgegill	49	19	5
4 – Tinnis Hill	18	4	3
5 – Watch Hill	32	13	9

The number of scats recorded declined between months on all transects in 2008 (Table 4.), this declining trend between months is similar to that recorded in previous years (Figure 8).

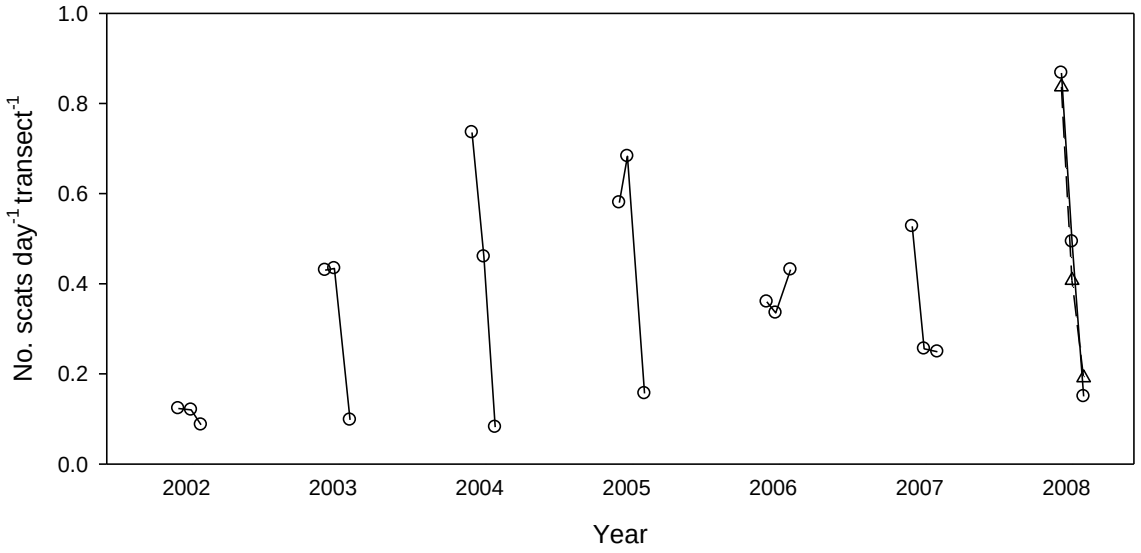


Figure 9. Mean number of scats per day per transect recorded at Langholm 2002-2008. The three points in each year refer to the mean from April, May and June. In 2008 circles refer to the 3 transects which have been covered since 2002, triangles refer to the average of all five transects (3 traditional ones and 2 new transects established in 2008)

Fox lamping surveys

During early summer (18/5 – 22/5) and autumn (10/9 – 7/10) five fox lamping surveys undertaken either by two science monitoring staff or by a scientist with a keeper. These supplement the records of fox lamping which the keepers provide. On each occasion the same route was driven (25.7 miles). During early summer a total of six foxes (1,2,0,2,1 on each night) were seen and in autumn 5 foxes (2,1,0,1,1 each night). This equates to 0.34 foxes hr^{-1} in early summer and 0.29 foxes hr^{-1} in autumn.

Mustelid

An index of small mustelid abundance has been obtained using footprint tracking tunnels set in locations likely to be used by stoats and weasels (King & Edgar 1977). A network of fifty tracking tunnels was established in 2002. These tunnels have been set annually for 14 days in late April / early May and again in September. To reflect the larger project area the 50 original tunnels have been augmented by a further 25 tunnels placed in new locations to expand the geographic coverage. In 2008 tunnels in spring were set on the 26^{th} – 28^{th} March and autumn tunnels 22^{nd} – 23^{rd} September. During spring 71/75 successfully operated and in the autumn 68/75. In spring 20% of tunnels showed signs of mustelids (stoats and weasels) whilst in autumn footprints were recorded in 22% of tunnels. Spring abundance in 2008 was high in comparison with recent years (Figure 10) but in contrast to monitoring in unkeepered years there was no substantial increase in the proportion of tunnels containing footprints between spring and autumn (Figure 10).

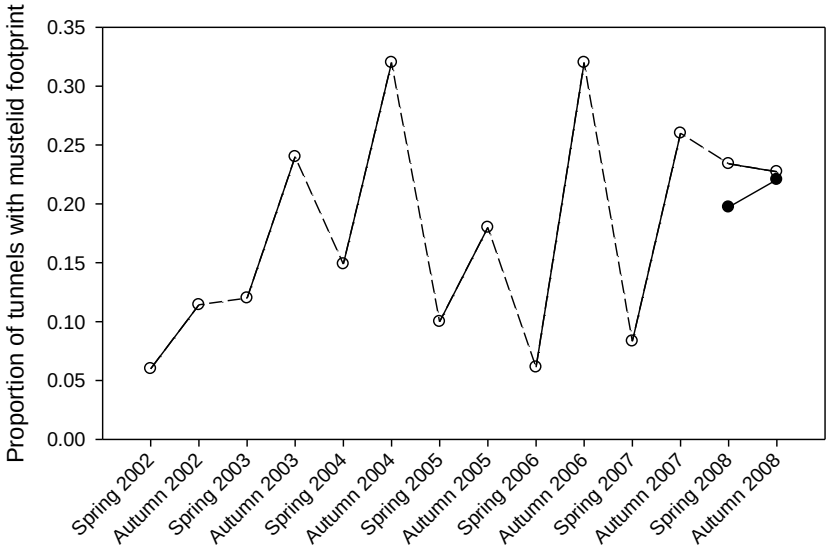


Figure 10. Index of mustelids at Langholm 2002 – 2008. Open circles refer to network of 50 tunnels which have operated from 2002 – 2008, Filled circles refer to 50 original tunnels plus 25 additional tunnels operated in 2008.

9. Predator control records

Weekly records of effort and kills are entered onto cards by the keepers. These are passed onto the senior scientist on a weekly basis for collation and entry onto a database. Reported here are the records of predator control carried out by the keepers from April to October.

Effort

Up to the end of October snares had been set for a total of 25459 days, tunnel traps 30975 days, crow cages had operated for 903 days and Larsen traps for 1981 days. Keepers had been lamping for foxes 313 times with a total of 727 hrs spent lamping.

Kill totals

The total number of predators culled is detailed in table 6.

Table 5. Recorded number of predators controlled by keepers at Langholm March-October 2008.

Species	Total killed	Method used
Fox	194	151 shot (103 lamped) 41 snared 5 dogs
Carrion crow	325	218 larsen 56 shot 51 cage
Rook	49	31 shot 18 cage
Stoat	31	27 trap 4 shot
Weasel	145	141 trap 3 shot 1 ran over

The number of foxes observed per hour whilst lamping varied from 0.47 foxes hr^{-1} in October to 0.32 foxes hr^{-1} in August (Figure 10) but does not appear to show any general trends April to October.

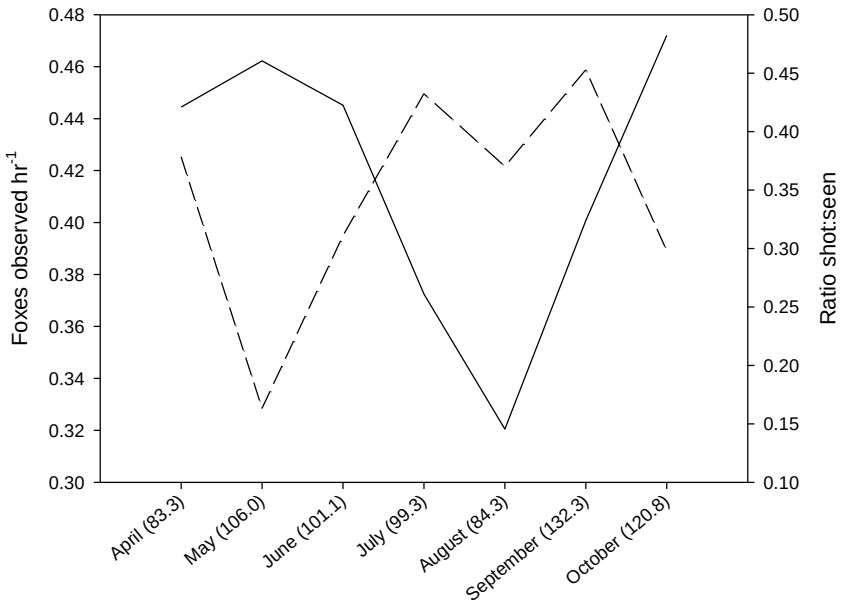


Figure 10. Foxes seen per hr(solid line) and ratio of foxes shot:seen (dashed line) by keepers lamping at Langholm, April to October. Numbers in parenthesis after month refer to monthly hours spent lamping by keepers.

The numbers of foxes killed against time (April to October) showed a broadly linear relationship (Figure 11a), in contrast the number of crows killed was highest in May and June (Figure 11b).

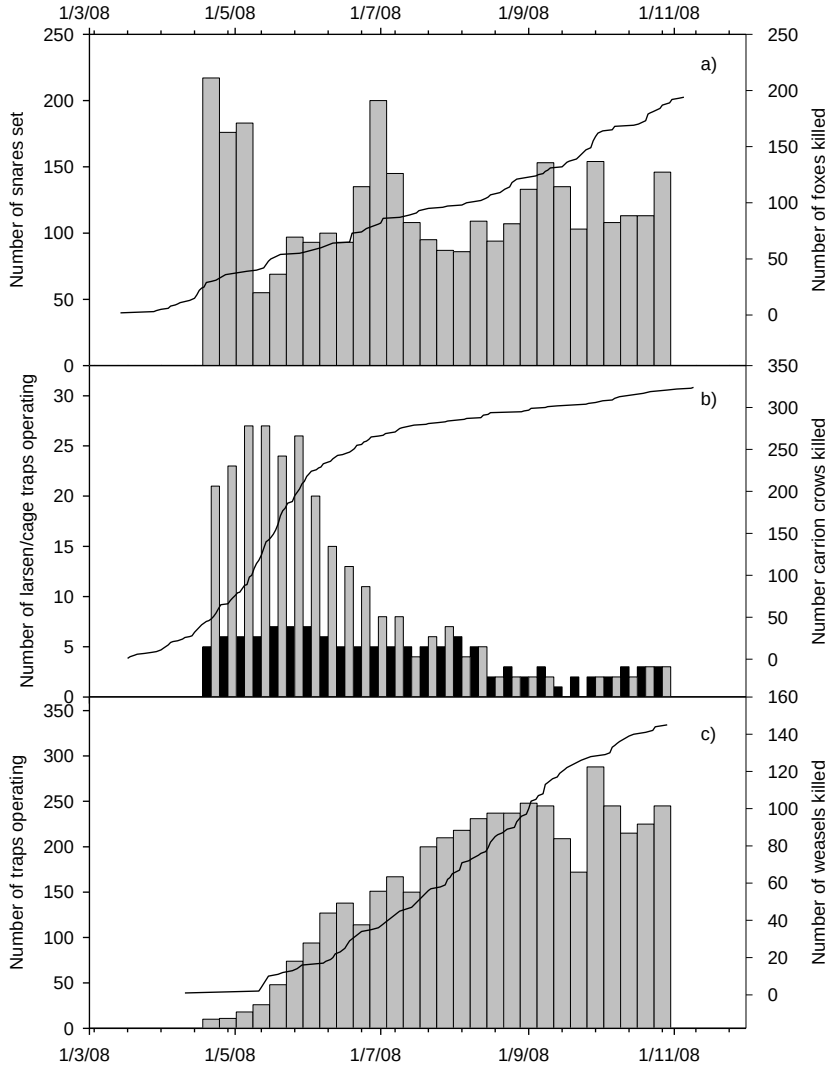


Figure 11. Weekly level of predator control effort a) snares b) crow cages (black bars) and Larsen traps (grey bars) and c) Fenn traps. Cumulative number of a) foxes b) carrion crows and c) weasels killed.

10. Vegetation Surveys

Twenty 1km long transects have been established across the project area. The transects have been stratified geographically and by habitat type (blanket bog, wet heath and dry heath) and positioned to run from areas with better heather cover through to more degraded areas. Transects have been marked at 50m intervals with wooden posts. Wooden markers denote the south corner (offset by 5m to avoid potential biases due to livestock) of a 5m x 5m quadrat in which the vegetation has been surveyed. Within the quadrat the % and height of heather has been estimated visually and the three most abundant plant species (not included heather) recorded. In additional to the visual estimates diagonally across each quadrat passing from the north to south corner a line transect has been established. At 10cm intervals along the line transect the presence or absence and height of heather to the nearest 5cm has been recorded. Photos of each quadrat looking along the line transect from

south to north have been taken. Vegetation plots were marked out and surveyed during September 2008, with the intention to resurveyed every 3 years during August/September.

Information from the 2008 surveys is currently being inputted into spreadsheets.