ENGLISH NATURE

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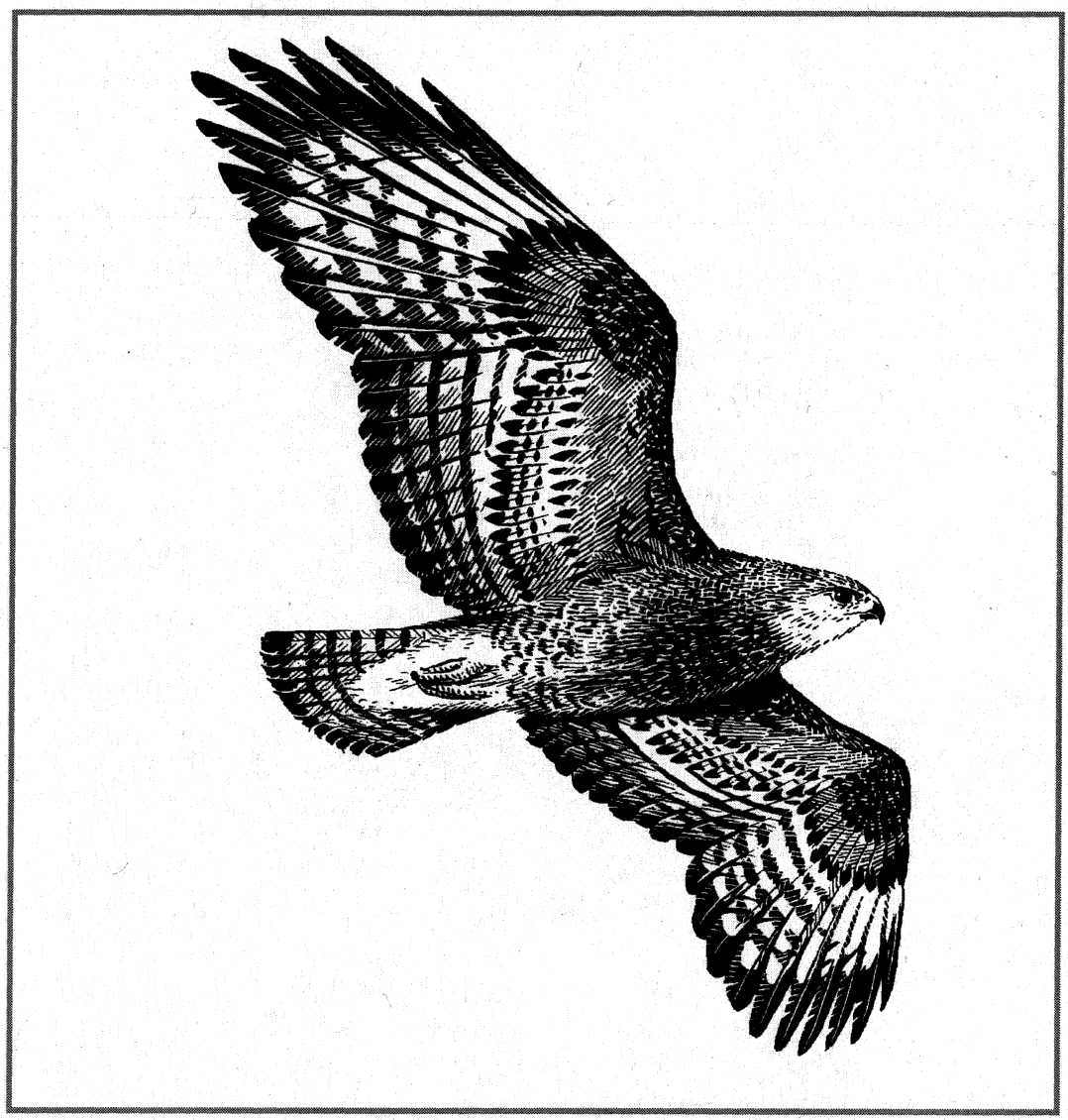
A study in northern England

No. 401 - English Nature Research Reports



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English Nature Research Reports

No. 401

Do raptors disturb driven grouse shoots?: A study in northern England

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ISSN 0967-876X

Contents

1. Summary

1. English Nature in partnership with Yorkshire Water, RSPB and the Harewood Estate have recently begun a project to re-introduce the red kite in West Yorkshire. During the consultation process, grouse moor interests expressed concern about the potentially disturbing effects of red kites and other raptors on driven grouse shooting.

2. To assess levels of raptor disturbance to driven grouse shooting, a pilot study was carried out in 1999, involving systematic observations of 63 grouse drives in North Yorkshire and Durham. To gain a greater insight into the level of disturbance caused by raptors the study was repeated in 2000, and systematic observations were carried out on a further 107 drives.

3. During 1999, raptors were observed on 14% of drives, but were only considered to have caused disturbance to grouse on 2% of drives. During 2000, there was a small increase in the number of raptors observed and drives disturbed. Raptors were observed on 18% of drives and were considered to have caused disturbance to grouse on 7% of drives.

4. The survey work showed that, overall, raptors caused little disturbance to driven grouse shooting. When disturbance was observed, it was, in most cases, relatively minor. During both years the proportion of drives cancelled due to bad weather (3% in 1999 and 10% in 2000) was greater than the proportion of drives disturbed by raptors.

5. When casual observations from gamekeepers were combined with data collected systematically, the proportion of drives where disturbance was recorded increased, but was still relatively low. When this combined data was compared between years, the proportion of drives where raptors were observed declined between 1999 and 2000 (25% and 20% respectively), as did the proportion of drives that were disturbed (17% and 9% respectively).

6. Gamekeepers who cooperated with the project agreed that disturbance of driven grouse by raptors appeared to be relatively minor during both seasons.

7. In years when grouse densities are higher, incidents of disturbance involving raptors may increase as high grouse densities may attract more raptors. However, although grouse numbers were higher during 2000 than in 1999, this did not result in a major increase in raptor numbers or disturbance incidents.

2. Introduction

Moorland managed for red grouse generally consists of a mosaic of different aged patches of heather and other habitat patches such as rough grassland and wet flushes. Such diversity is known to be beneficial to red grouse (Miller 1980) and may also benefit other bird species (see Robson 1998, Sutherland & Hill 1995, Mowforth & Sydes 1989 and Watson 1977 for example).

Red grouse shooting provides a major source of income to rural economies in many areas of upland Britain. Hudson (1992) estimated that approximately 450,000 grouse are shot each year in Britain, which, using a value of £70 per brace (on driven days), would result in a gross income of £35 million. Although this is likely to be an over-estimate, as not all grouse are shot during organised drives, upland economies also benefit from the money spent by shooters visiting the area during the season (Hudson 1992). A report by Strathclyde University (mentioned in Hudson 1992) estimated that the total expenditure on grouse shooting in Scotland alone was £21 million.

One of the major issues currently concerning grouse moor owners and managers in northern England is the perceived impact of raptors on driven grouse shooting. Whilst the major concern is the effect of direct predation on adult and juvenile red grouse, particularly by hen harrier and peregrine, many owners and managers are also concerned that raptors may disturb grouse and reduce the numbers that are driven over the guns on shoot days.

Such concerns were voiced during the consultation process for a red kite re-introduction project in Yorkshire, which began in summer 1999. During discussions between English Nature staff, moor owners and gamekeepers it became clear that, although scientific studies had been carried out to determine the impact of raptor predation on grouse numbers, there was little information on the impact of raptor disturbance. There was general agreement that it would be useful to try to assess the effects of disturbance by raptors on driven grouse shooting and a pilot study was carried out in 1999 (Robson & Carter 1999).

The pilot study found only very low levels of disturbance of grouse shoots by raptors. However, red grouse numbers were low in 1999 and it was suggested that in years when grouse densities were higher, incidents of disturbance could increase as a result of higher densities of raptors. Since there were early indications that grouse numbers had improved following the poor year in 1999, the work was repeated during 2000 to determine whether the higher grouse densities would attract increased numbers of raptors.

This report details the results of the work carried out in 2000 and, for completeness, also includes the results from the pilot study in 1999.

2.1 Aims

The aims of this study were two-fold:

1. To build on the 1999 pilot study in quantifying the effects of raptor disturbance on driven grouse shoots.

2. To investigate whether higher grouse densities would result in increased numbers of raptors and increased levels of disturbance.

3. Methods

The methodology employed during the 1999 pilot study was followed during work in 2000, including the use of the standard survey form (Appendix 1) to record information on numbers of birds of prey seen and any disturbance caused during grouse drives. The survey form also allowed for the recording of other types of disturbance, including dogs, vehicles and walkers, in order to help put the effects of disturbance by raptors into context.

In 1999 the study was carried out on nine moorland blocks owned by seven different estates. In 2000, a further two estates allowed access and drives were surveyed on a total of eleven different moorland blocks. Within each block there was often a rotation of drives throughout the season so that different areas were covered during visits on different days.

Each shoot day consisted of a number of drives (generally 4 or 5) and each drive involved a line of beaters walking across a moor directing flushed grouse to a line of grouse butts concealing the 'guns'. The locations from which observations were made were determined by the gamekeepers who generally allowed free access, providing that safety was not compromised and drives were not disturbed. In practice, survey locations were mainly influenced by site topography and one of two approaches were followed:

1. Wherever possible, a good vantage point from where the whole drive could be observed was selected. Such ideal locations were limited, but, in most cases, it was possible to observe the majority of the drive from a single location. The best vantage points were usually remote from the drive (e.g. on an adjacent hill top), but observations were occasionally made from a grouse butt along the gun line or at a point to one side of the drive.

2. Where no suitable vantage points were available, surveys were carried out while walking with the beaters. This was less satisfactory than observing from a fixed point because concentration was required when walking over uneven terrain and this reduced the time available for scanning for raptors. In addition, depending on the topography of the drive, only a limited area could be viewed at any one time.

Initially, moorland owners had suggested that survey forms could be used by keepers to record information about raptors during grouse drives. However, in order to collate information on raptor numbers and disturbance in a consistent way, a project officer was employed to carry out the bulk of the study. This approach reduced the potential for bias arising from variations in individual ability and motivation when many different observers are involved (Bibby *et al* 1992). Keepers were also occupied with organising and taking part in drives and were therefore unable to devote all their time to looking for and recording disturbance incidents. However, the project officer consulted all head-keepers following each shoot to determine whether anyone who was present (guns, beaters and keepers) had observed any disturbance factors and these were recorded separately.

4. Results

A total of 107 drives were surveyed in 2000, adding to the 63 drives surveyed in 1999. The results collected using the standard survey forms are summarised in tables 1 and 2 for 1999 and 2000 respectively. Data from all drives attended in 1999 were analysed, but 6 drives from 2000 surveys were not included in the analysis due to poor visibility caused by fog.

Table 1 Summary of 1999 survey results

Much of the information collected, such as date and drive location, has been omitted at the request of moorland owners. To give some indication of the distribution of surveys, the code for the SSSI within which the shoots took place is given followed by a Y or D in brackets indicating North Yorkshire or Durham respectively. One shoot took place on moorland not designated as a SSSI and therefore only the county code is given. The name of each SSSI and their corresponding codes are given below the table. Drives are listed in the order in which the work was carried out.

Drive	Location	Bird/animal sighted	Public/dogs sighted	Description of impact
1	e.n.(Y)	none	none	na
2	e.n.(Y)	none	none	na
3	e.n.(Y)	none	none	na
4	l.s.-s.m.(Y)	none	none	na
5	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
6	l.s.-s.m.(Y)	none	none	na
7	l.s.-s.m.(Y)	none	none	na
8	l.s.-s.m.(Y)	none	none	na
9	u.t. (D)	kestrel & merlin	none	no impact observed or reported
10	u.t. (D)	none	none	na
11	u.t. (D)	none	none	na
12	u.t. (D)	none	none	na
13	l.s.-s.m.(Y)	buzzard	none	no impact observed or reported
14	l.s.-s.m.(Y)	none	none	na
15	l.s.-s.m.(Y)	none	none	na
16	l.s.-s.m.(Y)	none	none	na
17	l.s.-s.m.(Y)	none	none	na
18	l.s.-s.m.(Y)	none	none	na
19	l.s.-s.m.(Y)	none	none	na
20	l.s.-s.m.(Y)	none	none	na
21	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
22	l.s.-s.m.(Y)	none	none	na

Drive	Location	Bird/animal sighted	Public/dogs sighted	Description of impact
23	b.m.(D)	kestrel	none	no impact observed or reported
24	b.m.(D)	none	none	na
25	b.m.(D)	none	none	na
26	e.n.(Y)	none	none	na
27	e.n.(Y)	none	none	na
28	e.n.(Y)	none	none	na
29	e.n.(Y)	fox	none	no impact observed or reported
30	l.s.-s.m.(Y)	none	none	na
31	l.s.-s.m.(Y)	none	none	na
32	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
33	l.s.-s.m.(Y)	none	none	na
34	u.t. (D)	none	none	na
35	u.t. (D)	none	none	na
36	u.t. (D)	none	none	na
37	u.t. (D)	peregrine	none	no impact observed or reported
38	u.t. (D)	none	none	na
39	u.t. (D)	none	none	na
40	u.t. (D)	none	none	na
41	u.t. (D)	none	none	na
42	(Y)	short-eared owl & fox	none	no impact observed or reported
43	(Y)	buzzard	none	no impact observed or reported
44	(Y)	none	none	na
45	(Y)	kestrel & hen harrier	none	harrier chased 2 driven grouse away from guns, no other impact observed or reported
46	(Y)	buzzard	none	no impact observed or reported
47	(Y)	none	none	na
48	e.n.(Y)	none	none	na
49	e.n.(Y)	none	2 walkers	drive delayed by 15 minutes
50	e.n.(Y)	none	none	na
51	e.n.(Y)	none	none	na
52	e.n.(Y)	short-eared owl	none	no impact observed or reported
53	e.n.(Y)	none	none	na
54	e.n.(Y)	none	none	na
55	e.n.(Y)	none	none	na
56	e.n.(Y)	sparrowhawk & peregrine	none	no impact observed or reported
57	l.s.-s.m.(Y)	peregrine	none	no impact observed or reported
58	l.s.-s.m.(Y)	none	none	na
59	l.s.-s.m.(Y)	none	none	na
60	u.t. (D)	none	none	na
61	u.t. (D)	none	none	na
62	u.t. (D)	kestrel	none	no impact observed or reported
63	u.t. (D)	none	none	na

e.n.= East Nidderdale Moors, l.s.-s.m.= Lovely Seat-Stainton Moor, b.m.= Bowes Moor and u.t= Upper Teesdale

Table 2 Summary of 2000 survey results

Note that drives in bold text, where visibility was poor, were not included in the analysis.

Drive	Location	Bird/animal sighted	Public/dogs sighted	Description of impact
1	l.s.-s.m.(Y)	none	none	na
2	l.s.-s.m.(Y)	none	none	na
3	e.n.(Y)	peregrine	none	peregrine pursued 3 driven grouse over guns, no other impact observed or reported
4	e.n.(Y)	none	none	na
5	e.n.(Y)	none	none	na
6	e.n.(Y)	kestrel	none	no impact observed or reported
7	u.t. (D)	3 kestrels, 1 hen harrier	none	low numbers of grouse in drive initially blamed on hen harrier (see discussion)
8	u.t. (D)	none	none	na
9	u.t. (D)	none	none	na
10	u.t. (D)	none	none	na
11	u.t. (D)	none	none	na
12	e.n.(Y)	none	none	na
13	e.n.(Y)	none	none	na
14	e.n.(Y)	none	none	na
15	e.n.(Y)	none	none	na
16	e.n.(Y)	none	none	na
17	e.n.(Y)	kestrel and hen harrier	none	no impact observed or reported (see note 1 below)
18	e.n.(Y)	kestrel	none	no impact observed or reported
19	e.n.(Y)	stoat	none	no impact observed or reported
20	e.n.(Y)	none	none	na
21	l.s.-s.m.(Y)	2 kestrels	none	no impact observed or reported
22	l.s.-s.m.(Y)	none	none	na
23	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
24	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
25	e.n.(Y)	2 kestrels and a sparrowhawk	none	no impact observed or reported
26	e.n.(Y)	2 kestrels	none	no impact observed or reported
27	e.n.(Y)	3 kestrels and a sparrowhawk	none	no impact observed or reported
28	e.n.(Y)	kestrel	none	no impact observed or reported
29	e.n.(Y)	none	none	na
30	e.n.(Y)	none	none	na
31	e.n.(Y)	none	none	na
32	e.n.(Y)	kestrel	none	no impact observed or reported
33	u.t. (D)	3 kestrels	none	none
34	u.t. (D)	none	none	na
35	u.t. (D)	none	none	na

Drive	Location	Bird/animal sighted	Public/dogs sighted	Description of impact
36	u.t. (D)	none	none	na
37	e.n.(Y)	kestrel	none	no impact observed or reported
38	e.n.(Y)	none	none	na
39	e.n.(Y)	none	none	na
40	e.n.(Y)	peregrine	none	no impact observed or reported
41	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
42	l.s.-s.m.(Y)	none	none	na
43	l.s.-s.m.(Y)	3 kestrels	none	no impact observed or reported
44	l.s.-s.m.(Y)	none	2 walkers	no impact as they waited for drive to finish before continuing
45	l.s.-s.m.(Y)	none	2 pot-holers	no impact - appeared from hole near guns just before drive started
46	l.s.-s.m.(Y)	none	none	na
47	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
48	l.s.-s.m.(Y)	none	none	na
49	l.s.-s.m.(Y)	2 buzzards	none	no impact observed or reported
50	l.s.-s.m.(Y)	fox	none	no impact observed or reported
51	**l.s.-s.m.(Y)**	**none**	**none**	**poor visibility**
52	l.s.-s.m.(Y)	none	none	na
53	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
54	l.s.-s.m.(Y)	none	none	na
55	b.m.(D)	none	none	na
56	b.m.(D)	none	none	na
57	b.m.(D)	none	none	Na
58	b.m.(D)	hen harrier	none	none observed as many groups of grouse went over guns before and after harrier appeared. Keeper suspected that it may have driven 2 groups of grouse out of drive during the early part of it
59	b.m.(D)	2 kestrels	none	None
60	**l.s.-s.m.(Y)**	**none**	**none**	**poor visibility**
61	**l.s.-s.m.(Y)**	**none**	**none**	**poor visibility**
62	l.s.-s.m.(Y)	merlin	none	no impact observed or reported
63	l.s.-s.m.(Y)	none	none	no impact observed or reported
64	l.s.-s.m.(Y)	none	none	Na
65	l.s.-s.m.(Y)	buzzard	none	no impact observed or reported
66	l.s.-s.m.(Y)	none	none	Na
67	l.s.-s.m.(Y)	kestrel	none	no impact observed or reported
68	l.s.-s.m.(Y)	none	none	Na
69	l.s.-s.m.(Y)	none	none	Na
70	l.s.-s.m.(Y)	none	none	Na
71	(Y)	kestrel	none	no impact observed or reported
72	(Y)	kestrel and 2 short-eared owls	none	no impact observed or reported

Drive	Location	Bird/animal sighted	Public/dogs sighted	Description of impact
73	(Y)	none	none	na
74	(Y)	2 short-eared owls	none	no impact observed or reported
75	(Y)	none	none	na
76	**b.m.(D)**	**none**	**none**	**poor visibility**
77	b.m.(D)	kestrel	none	no impact observed or reported
78	b.m.(D)	none	none	na
79	b.m.(D)	none	none	na
80	b.m.(D)	none	none	na
81	b.m.(D)	buzzard	none	grouse spooked making them difficult to drive
82	b.m.(D)	peregrine, buzzard and kestrel	none	grouse spooked making them difficult to drive
83	b.m.(D)	none	none	na
84	b.m.(D)	none	none	na
85	b.m.(D)	none	none	na
86	l.s.-s.m.(Y)	none	none	na
87	l.s.-s.m.(Y)	none	none	na
88	l.s.-s.m.(Y)	none	none	na
89	l.s.-s.m.(Y)	none	none	na
90	l.s.-s.m.(Y)	none	none	na
91	**b.m.(D)**	**none**	**none**	**poor visibility**
92	**l.s.-s.m.(Y)**	**none**	**none**	**poor visibility**
93	l.s.-s.m.(Y)	none	none	na
94	l.s.-s.m.(Y)	none	none	na
95	l.s.-s.m.(Y)	2 buzzards	none	no impact observed or reported
96	l.s.-s.m.(Y)	none	none	na
97	l.s.-s.m.(Y)	none	none	na
98	b.m.(D)	peregrine and hen harrier	none	grouse spooked and difficult to drive, harrier observed chasing driven grouse
99	b.m.(D)	2 ravens and kestrel	none	no impact observed or reported
100	b.m.(D)	none	none	na
101	b.m.(D)	2 ravens, 3 kestrels and hen harrier	none	grouse spooked and difficult to drive over guns
102	b.m.(D)	none	none	na
103	u.t. (D)	2 buzzards	none	no impact observed or reported
104	u.t. (D)	none	none	na
105	u.t. (D)	none	none	na
106	u.t. (D)	none	none	na
107	u.t. (D)	none	none	na

1. The keeper did not observe any disturbance by the hen harrier which briefly flew through the drive. He thought that at this early stage in the season (mid-August) the hen harrier would have little impact on the drive as a whole because grouse were still in small family groups.

Tables 3 and 4 summarise the observations collected opportunistically by keepers and beaters during 1999 and 2000 respectively. To maintain confidentiality, observations reported by keepers were tabulated separately and no indication of drive location is given. Each drive is labelled with a letter for reference purposes only and does not correspond to the order in which the work was carried out.

Table 3 Summary of observations reported by keepers/beaters in 1999

Drive	Bird/animal sighted	Description of impact
a	2 stoats	No impact observed or recorded
b	merlin	No impact observed or recorded
c	hen harrier and 2 ravens	Numbers of grouse seen leaving drive and flying to adjacent estate on strong wind prior to initiation of drive. Very low grouse numbers in this and reverse drive. Some of the remaining grouse sat tight.
d	hen harrier	Grouse had taken cover from hen harrier in rushes adjacent to moor.
e	peregrine	No impact observed or recorded
f	peregrine	May have caused a slight reduction in the number of grouse being driven over guns for a few minutes.
g	kestrel	No impact observed or recorded
h	3 ravens	Grouse aggregated into large packs, which were described by keeper as being difficult to handle. Reverse drive was also affected in the same way.
i	buzzard	Shifted grouse from one drive to another (one drive had higher numbers of grouse than expected by keepers while the reverse had lower numbers than expected.
j	hen harrier	Lower numbers of grouse in area than expected by keepers– hen harrier shifted grouse out of area in this and reverse drive.

Table 4 Summary of observations reported by keepers/beaters in 2000

Drive	Bird/animal sighted	Description of impact
a	kestrel & merlin	None observed or reported
b	hen harrier	Keeper reported two groups of approximately 20 grouse which appeared to have been flushed and driven out of drive area. Further grouse did go over guns before and after this incident.
c	2 hen harriers	Reported by one of the beaters. Grouse numbers were a little less than expected but keeper could not say whether this was due to the hen harriers as he did not see them.

Table 5 Summary of disturbance incidents in 1999 and 2000

The figures in standard text are those derived by using data collected systematically. Figures in brackets include data collected opportunistically by keepers and beaters. The figures do not include eight drives in 1999 and 20 drives in 2000 where only kestrels and/or merlins were observed as these species are not blamed by grouse moor managers for disturbing drives. All of the other species recorded (hen harrier, peregrine, buzzard, sparrowhawk, short-eared owl and raven) were, for the purposes of this study, considered capable of causing disturbance to drives.

Year	Number of drives where raptors/ravens were observed	Percentage of drives where raptors/ravens were observed	Number of drives disturbed by birds	Percentage of drives disturbed by birds
1999	9 (16)	14 (25)	1 (11)	2 (17)
2000	18 (20)	18 (20)	7 (9)	7 (9)

Figure 1 Proportion of drives on each survey area in 1999

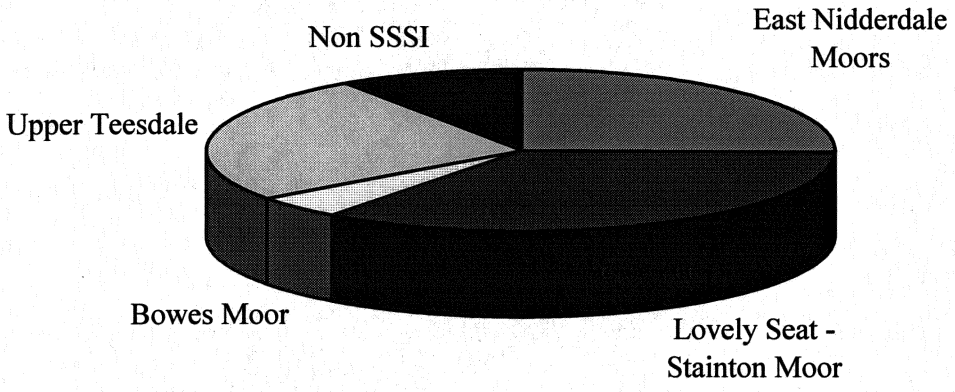

Figure 2 Proportion of drives on each survey area in 2000

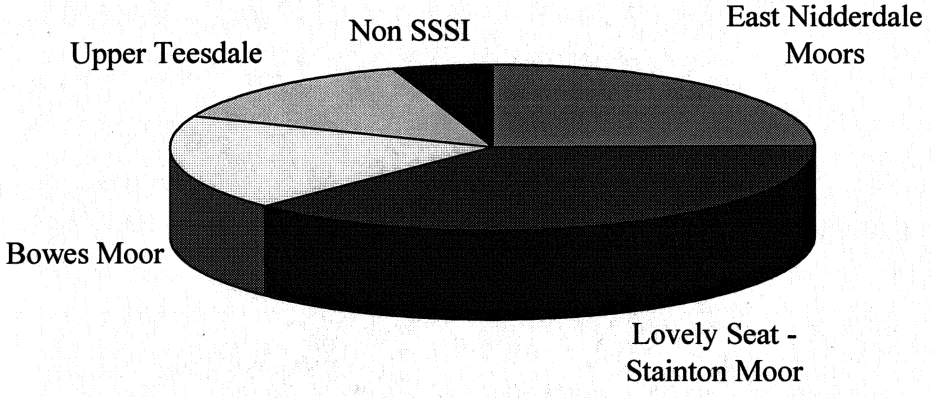

Figure 3 Proportion of drives with potentially disturbing activity in 1999

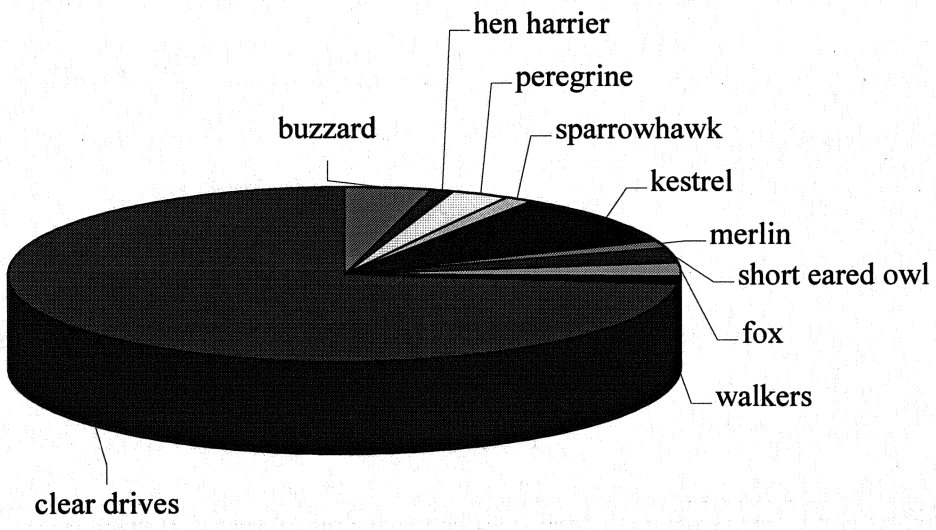

Figure 4 Proportion of drives with potentially disturbing activity in 2000

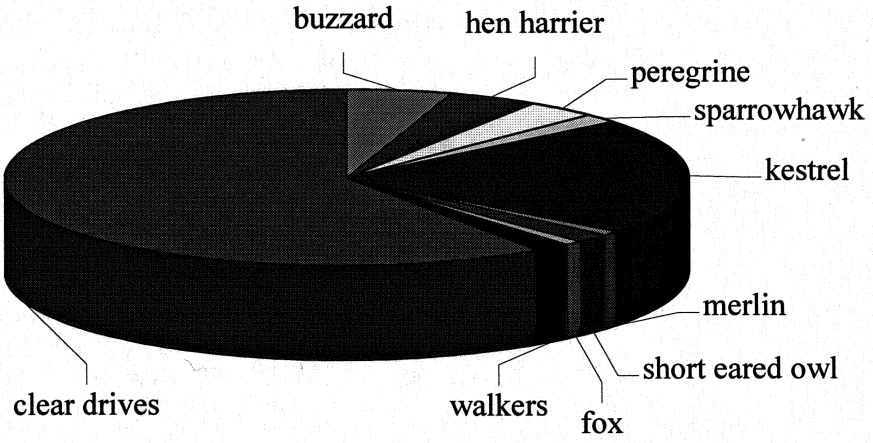

Table 6 Between years comparison of grouse bags and shoot days.

Number of shoot days on each estate		Number of brace shot on each estate	
1999	**2000**	**1999**	**2000**
6	15	600	1100
3	7	298	714.5
3	4	120	180
7	16	313.5	1500
8	11	265	450
10	13	331.5	530
9	12	508.5	605
2	1.5	106.5	70.5
10	11	600	700
Total: 58	**Total: 90.5**	**Total: 3143**	**Total: 5850**

5. Discussion

Raptors have the potential to disturb driven grouse shooting by flying over the moor either before or during a drive. The presence of a hen harrier can cause grouse to aggregate into larger packs, which may then fly in all directions and become difficult to drive. Grouse can also be cleared from one area onto adjacent areas by a passing harrier (Hudson 1992) and buzzards and ravens sometimes have a similar effect (L. Waddell pers. comm.). A different response may result from the presence of a peregrine. In this situation grouse may sit tight as they are vulnerable to being taken on the wing by this species. Once grouse have been 'spooked' by a potential predator they tend to be more alert and take flight more readily if there is any further disturbance (L. Waddell pers. comm.).

Recording the number of raptors encountered and their location with respect to the grouse drives during this study was straightforward. However, assessing the level of disturbance caused by raptors required subjective interpretation of grouse behaviour and only when grouse were flushed by a raptor and flew directly away from the guns or the beaters was it clear that disturbance had taken place. It was much more difficult to detect incidents where a passing raptor caused grouse to sit tight and refuse to fly. Interpretation was made even more difficult because patterns of grouse behaviour vary, not only with the type of predator involved, but also in relation to the type of drive, weather conditions and even the state of alertness of the grouse. During this study there was regular consultation with gamekeepers in order to utilise their experience of driven grouse shooting and make the interpretation of disturbance incidents as accurate as possible.

Excluding kestrels and merlins, species not considered to cause disturbance, raptors were recorded on 14% of drives in 1999 and disturbance to grouse was recorded during only a single drive (2%) (drive 45, Table 1). This incident involved a female hen harrier flying across the line of the drive and pursuing two grouse. The incident was considered to be relatively minor as a number of grouse packs were driven over the guns both before and after the harrier passed through. The only other disturbance of any kind occurred when two walkers delayed the start of a drive by 15 minutes (drive 49, Table 1).

In 2000, raptors (again excluding kestrels and merlin) were recorded on 18% of drives and disturbance to grouse was recorded during 7% of drives. The majority of the disturbance incidents were of a relatively minor nature and, in at least one case, it was impossible to be certain that any disturbance at all had taken place. This incident (drive 7, Table 2) involved a hen harrier that was seen both before and during the drive and was initially blamed for the low numbers of grouse flushed. However, by the end of the day, after five drives had been completed, it was apparent that there were very few grouse across the whole area and the estate decided not to shoot over that area again during the remainder of the season. This type of incident illustrates the difficulties involved in trying to quantify disturbance and demonstrates the ease with which raptors could be blamed unfairly for interfering with drives.

There were four drives in 2000 (81, 82, 98 and 101, Table 2) where the level of disturbance caused by raptors was considered to be significant, with grouse being described by keepers as 'spooked' and therefore difficult to drive over the guns. Groups of grouse were observed flying in all directions during these drives, often away from the guns. This problem was exacerbated in some cases by adverse winds that tended to drift groups of grouse away from the drive rather than over the guns. The majority of these disturbance incidents occurred during a single day on the same estate and the head-keeper considered that the day had been

'badly affected' by raptors. Despite the relatively high number of disturbance incidents, the grouse bag for the day was reasonable (6% below the mean daily bag) when compared to bags for the four other shoot days observed on the same estate. Other incidents in 2000 included a peregrine pursuing three grouse over the guns and a hen harrier flying within a drive and flushing two groups of grouse. Both incidents were considered to be minor and many groups of grouse were observed flying over the guns both before and after the raptors were observed.

In 1999, when additional information from keepers was collated (Table 3), the proportion of drives where raptors were observed increased to 25% and the proportion of disturbed drives rose to 17%, although all additional incidents were considered by keepers to be minor. In all, disturbance incidents in 1999 involved one peregrine, four hen harriers, one buzzard and five ravens, affecting a total of 11 drives. Interestingly, keepers from a single estate recorded 82% of all the observations of raptors. This could be because there were a higher number of raptors in this area but could also result from bias due to differences in reporting rates between observers, emphasising the value of the data collected systematically by the project officer.

In 2000, the inclusion of observations reported by keepers (Table 4) increased the proportion of drives where raptors were observed to 20% and the proportion of disturbed drives to 9%. This is only a small increase compared to the systematic observations and the additional incidents were considered to be relatively minor by keepers. In all, disturbance incidents in 2000 involved three peregrines, seven hen harriers, two buzzards and two ravens, affecting a total of nine drives.

It was thought that the low incidence of raptor disturbance in 1999 might, in part, have resulted from the low numbers of grouse present in the areas surveyed. An area with low grouse numbers may support lower numbers of raptors, particularly hen harriers and peregrines for which adult grouse can form a significant part of the diet. It was therefore decided to repeat the work in a year when grouse numbers were higher. In general, the 2000 season was much better for grouse than 1999 in the opinions of most estates visited and this was reflected in the increased number of shoots carried out and higher grouse bags (Table 6). The results of this study show that there was not a major increase in the number of raptors seen or disturbance incidents in 2000. When the two years are compared, the percentage of drives where raptors were observed increased only slightly (from 14% to 18%). There was a small increase in the percentage of drives where disturbance incidents were recorded based on systematically collected data, from 2% to 7%, but, when additional information from keepers is included, there was a reduction in the number of incidents between 1999 and 2000, from 17% to 9% of drives.

Despite substantially higher grouse bags on most estates in 2000, this was still not thought to be a particularly good year for grouse. Many estates reported that in a good year, bags could be at least twice as high as in 2000. It is therefore possible that a more marked increase in grouse numbers could lead to increasing raptor numbers and a greater risk of disturbance to drives.

During both years, disruption due to poor weather had a far greater negative impact on grouse drives than disturbance caused by raptors. Two drives (3%) were cancelled due to poor weather in 1999 and disruption was even greater in 2000 when thick fog led to the cancellation of 12 of the drives (10%) that were due to be surveyed.

6. Acknowledgements

English Nature would like to thank those people who agreed to allow access onto the grouse moors on which this project was carried out; Lord Barnard (Raby Estate), Lord Bolton (Bolton Estate), S.N. & G.S. Bostock (Dallowgill), Mr. A.C. Elliot (Bowes Moor), R.C.H. Harrison-Topham (Caldbergh Moor), Richard Johnson (Staggs Fell Estate), Ministry of Defence, Lord Swinton (Swinton Estate) and the Trustees of Downshire 1992 Settlement (Jervaulx Estate).

We are also grateful to the land agents who assisted with access provision; Ian Cox (Dacre, Son & Hartley), Robert Frewen and John Hills (John Hills), Nigel Graham, Mike Stanton (Clark Scott-Harden) and Martin Watson (MOD), and keepers who provided assistance on shoot days; Richard Britton, Des Coates, John Lambert, Doug Morrison, David Pearson, Thomas Spencley, Bruce Watson and Paul Wilby. The Chief Range Warden, Tim Helps provided the invaluable assistance usually carried out by the keepers while surveying on MOD land.

We are particularly grateful to L.G. Waddell for arranging access on to Raby Estate moorland, providing considerable assistance on shoot days and for sharing his expertise on driven grouse shooting.

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Appendix 1 Survey sheet used by project officer

Assessing the impact of raptor disturbance on driven grouse shooting

Estate: _____ Shooting date_____ Bag record (as expected(E), lower(L) or higher(H)_____

Drive location	Time	Weather/wind	Bird/animal - sighted	Public/dogs sighted	Description of any impact

NB. Please provide as much detail as possible – e.g. estimate of wind speed: type of bird plus height and time spent over moor: detail of public/dog activity: impact on grouse activity e.g. "little effect noticed" or "most birds flew at least 1km off the drive area and did not return" or "birds sat tight and did not drive well.

Additional information e.g. low flying aircraft observed during drives or predators observed between drives.

Appendix 2 Scientific names of species in the order mentioned

Common Name	Scientific name
Red grouse	*Lagopus lagopus*
Red kite	*Milvus milvus*
Heather or Ling	*Calluna vulgaris*
Hen harrier	*Circus cyaneus*
Peregrine	*Falco peregrinus*
Kestrel	*Falco tinnunculus*
Merlin	*Falco columbarius*
Buzzard	*Buteo buteo*
Fox	*Vulpes vulpes*
Short-eared owl	*Asio flammeus*
Sparrowhawk	*Accipiter nisus*
Stoat	*Mustela erminea*
Raven	*Corvus corax*