Chapter 1

Further Ornithological Survey for the Logiealmond Wind Farm Proposal

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1 FURTHER ORNITHOLOGICAL SURVEY RESULTS

1.1 Introduction

1 This report presents Further Environmental Information (FEI) to the Environmental Statement (ES) produced for the proposed Logiealmond wind farm. This mainly comprises the results of a structured programme of vantage point watches and ground nesting raptor surveys that have been carried out in accordance with SNH guidance (SNH 2005). In addition, this data is assessed and conclusions drawn on the likely impacts of the Logiealmond wind farm on the target species in the area. This additional work has been carried out in order to satisfy concerns regarding data collection and interpretation held by SNH.

2 No further data or assessment of the general breeding bird community (e.g. waders) is presented in this report as the information provided in the ES is sufficiently detailed and robust.

3 Section 2 of this report sets out the methodology adopted for the survey programme and section 3 presents the results. These results are then evaluated in section 4 and a comparison is made with the findings presented in the ES in order to determine whether there are any changes to the assessment that are required.

1.2 Methodology

1.2.1 Vantage Point Watches

4 Vantage-point watches, based upon the method statement prepared by Mike Madders for SNH, and appended to SNH (2005), were undertaken throughout the survey period (March to August 2008). Vantage-point watches focus on identifying flight-paths of target species such as raptors, swans and geese, and allow any regularly used flight lines to be identified. This allows turbine locations to be altered, where necessary, to reduce collision risk to birds. The data generated can also be used, where appropriate, to estimate the theoretical risk of collision with turbines by incorporation into a suitable model.

5 According to the Madders methodology, vantage-points should be chosen parsimoniously to achieve maximum site visibility from the minimum number of locations such that all parts of the survey area are within 2km of a vantage-point. This is to reduce potential bias in the results from disturbance of birds caused by the presence of surveyors. During the initial survey programme (2004 to 2006) Heritage Environmental Limited used a large number of vantage points (15 in total) at different times. This non-standard methodology was employed due to changes in the size of the survey area, evolution of wind farm design and the complex topography of the area. SNH expressed concerns regarding the reliability of the data presented and lodged an objection on the grounds that no robust assessment could be carried out without further data provision. In order to satisfy SNH concerns regarding the potential for bias in the data, the minimum number of vantage points required to have visibility over all the proposed turbine positions was determined for the layout presented within the ES. Four vantage points were decided upon following a desk exercise and site visit which determined the minimum number of VPs required. Two of these VPs are outside the planning application boundary and two are within; however the planning application

boundary does not represent the survey area (an area encompassing all of the turbines and a 200m buffer zone to account for surveyor error) due to it being dictated by previous design iterations (NB: all vantage points are outside the survey area). The vantage point locations and their approximate distance from the closest proposed turbine locations are shown in Figure 1.1 and described in Table 1.1.

Table 1.1 Vantage Point Locations at Logiealmond

Vantage Point	Grid Reference	Distance from nearest wind turbine (m)	Turbines Visible from VP
A (Rose Craig)	NN 954 362	900	1, 2, 3, 9, 10, 12*
B (East of Creag Ghorm)	NN935 345	400	1*, 2, 3, 4*, 6*, 7, 8
C (Middle Hill)	NN 948 335	780	5*, 6, 8, 11*,13
D (East of Ruhumman)	NN 971 339	800	9, 10, 13, 14*

* Wind turbines visible from only one VP

6 The cumulative survey area visible from these vantage points is shown in Figure 1.1. Figures 1.2 to 1.5 show the individual viewsheds for each vantage point.

7 SNH guidance on survey methods for the assessment of bird communities at proposed onshore wind farms (SNH 2005) states that survey effort should be matched to conservation sensitivity. Further survey requirements should be identified once knowledge as to what is required for the purpose of the assessment has been established. Different sites will have different requirements according to their scale and conservation sensitivity. For the purposes of survey at Logiealmond, surveys were structured to exceed the minimum recommended 36 hours of effort per vantage-point per season due to the presence of a number of target species.

8 Table 1.2 shows the amount of time spent watching from each vantage point.

Table 1.2 Vantage Point Watch Information

Vantage Point	Date	Time (Start – Finish)	No. of Hours
A	15/03/08	11.30 – 14.30	3
A	16/03/08	15.30 – 18.30	3
A	29/03/08	07.00 – 10.00	3
A	05/04/08	06.00 – 09.00	3
A	26/04/08	12.00 – 15.00	3
A	27/04/08	17.00 – 20.00	3
A	11/05/08	12.00 – 15.00	3
A	17/05/08	06.30 – 09.30	3
A	24/05/08	18.00 – 21.00	3
A	08/06/08	06.30 – 09.30	3
A	14/06/08	12.30 – 15.30	3
A	29/06/08	18.30 – 21.30	3
A	12/07/08	17.30 – 20.30	3
A	16/07/08	12.00 – 15.00	3
A	27/07/08	17.30 – 20.30	3
A	09/08/08	17.00 – 20.00	3
A	17/08/08	12.00 – 15.00	3
A	23/08/08	06.30 – 09.30	3
TOTAL A			**54**
B	16/03/08	11.45 – 14.45	3
B	22/03/08	07.30 – 10.30	3
B	30/03/08	16.00 – 19.00	3

Vantage Point	Date	Time (Start – Finish)	No. of Hours
B	05/04/08	11.30 – 14.30	3
B	19/04/08	06.00 – 09.00	3
B	20/04/08	17.00 – 20.00	3
B	10/05/08	11.30 – 14.30	3
B	18/05/08	18.30 – 21.30	3
B	25/05/08	06.30 – 09.30	3
B	08/06/08	12.00 – 15.00	3
B	14/06/08	18.00 – 21.00	3
B	28/06/08	06.30 – 09.30	3
B	12/07/08	12.45 – 15.45	3
B	16/07/08	06.45 – 09.45	3
B	27/07/08	18.00 – 21.00	3
B	09/08/08	12.00 – 15.00	3
B	16/08/08	06.30 – 09.30	3
B	23/08/08	17.00 – 20.00	3
TOTAL B			**54**
C	22/03/08	11.30 – 14.30	3
C	23/03/08	07.30 – 10.30	3
C	29/03/08	16.00 – 19.00	3
C	06/04/08	12.00 – 15.00	3
C	20/04/08	06.00 – 09.00	3
C	26/04/08	17.00 – 20.00	3
C	10/05/08	06.00 – 09.00	3
C	17/05/08	12.00 – 15.00	3
C	24/05/08	06.30 – 09.30	3
C	09/06/08	12.15 – 15.15	3
C	15/06/08	06.30 – 09.30	3
C	28/06/08	18.30 – 21.30	3
C	13/07/08	12.00 – 15.00	3
C	18/07/08	17.30 – 20.30	3
C	20/07/08	06.30 – 09.30	3
C	10/08/08	12.00 – 15.00	3
C	17/08/08	06.30 – 09.30	3
C	24/08/08	17.30 – 20.30	3
TOTAL C			**54**
D	15/03/08	15.30 – 18.30	3
D	23/03/08	12.00 – 15.00	3
D	30/03/08	07.15 – 10.15	3
D	06/04/08	06.00 – 09.00	3
D	19/04/08	17.00 – 20.00	3
D	27/04/08	12.00 – 15.00	3
D	11/05/08	07.00 – 10.00	3
D	18/05/08	12.00 – 15.00	3
D	25/05/08	18.30 – 20.30	3
D	09/06/08	18.00 – 21.00	3
D	15/06/08	12.00 – 15.00	3
D	29/06/08	06.30 – 09.30	3
D	13/07/08	07.00 – 10.00	3
D	18/07/08	13.00 – 16.00	3
D	20/07/08	18.00 – 21.00	3
D	10/08/08	06.30 – 09.30	3
D	16/08/08	17.30 – 20.30	3
D	24/08/08	12.30 – 15.30	3
TOTAL D			**54**

9 The 54 hours spent at each vantage point is greater than the time spent during a single breeding season at any of the original vantage points used by Heritage Environmental Limited. The total amount of time spent watching (i.e. 216 hours) is however comparable with previous years, given the smaller number of vantage points used in 2008.

10 All vantage point watches were undertaken by Alan Ross, a well-known freelance surveyor with a good reputation within both the consultancy community and SNH.

1.2.2 Timing of Survey

11 The vantage point surveys in 2008 were focused on the months March through August due to the lack of migratory and winter activity noted during the 3 years of previous survey at the site (please refer to the ES for details). Despite short-comings in the methodology employed between 2004 and 2006 it is beyond doubt that if significant migratory or winter activity of any target species did occur on or near the site, this would have been detected (285 hours of winter vantage point watches were undertaken between 2004 and 2006). It was therefore concluded that there was no need to carry out further migratory and winter surveys.

1.2.3 Ground-Nesting Raptor Survey

12 A walk-over survey focused on identifying the breeding locations of ground-nesting raptors and owls was undertaken at Logiealmond following a combination of various methods set out in Gilbert et al. 1998. Four visits were undertaken during the breeding season (18/04/08, 24/05/08, 28/06/08, 15/07/08) in order to identify, and latterly confirm, nesting locations; in addition, later visits were also used to estimate breeding success where possible. The surveyor walked to within 250m of all parts of the site during each survey visit and recorded all activity of ground-nesting raptors and owls seen or heard.

1.2.4 Collision Risk Analysis

13 Quantifying the risk of collision for proposed wind farms is difficult as it is widely acknowledged that each individual site will pose a differential level of threat dependent on a large number of factors such as topography, bird abundance, species make-up and wind turbine specification. In order to standardise the assessments carried out in Scotland (and to some extent in the rest of the UK) Scottish Natural Heritage (SNH) advocate the use of a collision risk model developed by Band et al. (2007). Where appropriate this model has been used for the species recorded at Logiealmond in 2008. No data collected between 2004 and 2006 has been included in the collision risk analysis due to methodological issues caused by the data collection (as previously outlined in response to the ES by SNH). All flight lines recorded at collision risk height have been included in the analysis irrespective of there proximity to the proposed wind turbine locations in order to provide a precautionary result; following recommendations in SNH guidance (2005) collision risk has been calculated per vantage point and summed.

1.3 Results

1.3.1 Red Kite

14 A pair of red kite was known to nest approximately 3km south of the wind farm area in 2005 and 2006; in 2008 the pair of red kite using this area of plantation woodland for nesting was again present. The level of flight activity noted in 2008 was lower than that for the same period in previous years. In total 5 flights were noted during the vantage point watches in 2008, as opposed to 16 in 2004, 28 in 2005 and 31 in 2006.

15 However, an appraisal of the data from earlier years reveals that there is significant temporal clustering of activity. During 2004 all red kite activity was recorded on just 8 days with most vantage point watches providing no records of flights for this species; in 2005 and 2006 all activity of red kite was recorded on 8 and 11 days respectively. Given the obvious temporal clustering in the data it is possible that the same individual was being recorded several times on one day. In 2008 the 5 flights recorded were noted over 4 separate dates (out of a possible 36) suggesting that the encounter rate per individual is unlikely to have been significantly higher in previous years. When this information is considered in conjunction with the fact that the vantage points used in 2008 result in a much smaller area being watched over (due to a smaller number of more focused VPs being employed) it is unlikely that the level of red kite flight activity is significantly different from previous years.

16 See Figure 1.6 for details of the flights recorded.

1.3.2 Hen Harrier

17 Two potential breeding pairs of hen harrier were noted during the first visit of the ground nesting raptor survey; in subsequent visits it was determined that neither pair had settled in the area. This result is similar to previous years when breeding attempts noted early in the season have remained unconfirmed on subsequent visits. Both breeding attempts were within the planning application boundary but were significant distances (in excess of 1km) away from noted attempts in previous years (also distributed without a pattern) suggesting that they do not represent core areas to which individual harriers return regularly.

18 Nine hen harrier flights were noted in 2008 which is comparable to the levels recorded in 2005 (15 flights) but significantly less than the 50 in 2004 and 57 in 2006. As with red kite the differences between years are more pronounced when considering total numbers of flights rather than their distribution over time. All flights in 2008 were recorded on 6 days compared with 15 days in 2004, 5 days in 2005 and 12 days in 2006. Again it is probable that some of the difference in flight activity is due to the more confined survey area overlooked in 2008.

19 See Figure 1.7 for details of the flights recorded and Figure 1.11 for breeding attempt locations.

1.3.3 Merlin

20 A pair of merlin was noted as breeding on the site in 2008; this location was in the same area as that used consistently in all previous years of survey. Five merlin flights were noted in 2008 compared with 8 in 2004, 18 in 2005 and 45 in 2006 (in which year there were two territories in the general area). As with hen harrier and red kite, the greater number of flights recorded in previous years are often clustered on a few days; in the case of merlin all flights in 2004 were noted on 7 days, in 2005 on 6 days, in 2006 on 9 days and in 2008 on 5 days.

21 It is therefore likely that the level of merlin activity is also roughly equivalent with previous years.

22 See Figure 1.8 for details of the flights recorded and Figure 1.11 for breeding attempt locations.

1.3.4 Peregrine

23 Four peregrine flights were recorded from the vantage points in 2008 which is comparable with the numbers from previous years (range = 1 – 12). The flights occurred in 3 different months of survey activity suggesting that the use of the area is minimal. No signs of breeding were noted in Little Glen Shee to the east of the site around the historical nest location noted during the desk-study for the ES.

24 See Figure 1.9 for details of the flights recorded.

1.3.5 Short-eared Owl

25 Three short-eared owl breeding locations were discovered in 2008, two being within the planning application boundary and one some distance to the north-east (distances to nearest proposed turbines were approximately 200m, 800m & 2000m). In 2004 eight breeding attempts were noted, with none recorded in either 2005 or 2006. These records are consistent with the nomadic lifestyle of this species which shifts its breeding location between years to follow the availability of prey. Six flights were recorded in 2008 which is significantly fewer than the 96 noted in 2004, and is consistent with the reduced number of breeding birds and the differences in methodology.

26 The two breeding attempts closest to the wind farm produced three fledged young each, with a further short-eared owl with three juveniles noted to the west of proposed wind turbine 8 on 15/07/08.

27 See Figure 1.10 for details of the flights recorded and Figure 1.11 for breeding attempt locations.

1.3.6 Black Grouse

28 Black grouse were noted lekking to the west of the main access track to the Logiealmond site during the first visit of the ground nesting raptor survey, approximately 1km from the closest proposed wind turbine (see Figure 1.11). The lek was diffuse and held few males (a maximum of three) and was in a location not noted in any previous years.

1.3.7 Other Species

29 A pair of long-eared owl was noted ground-nesting close to the access track approximately 1km north of the wind farm area (see Figure 1.11). Golden eagle and osprey, which were noted in previous years, were not observed in 2008.

1.4 Evaluation of Resources

1.4.1 Evaluation Criteria

30 When considering bird populations, importance is taken as meaning that a site supports at least 1% of the population under consideration i.e. regional, national or international[1]. With the exception of a few species, however, estimates of regional population size are generally unavailable. In most cases, therefore, professional judgement, based on experience, consultation with knowledgeable local consultees and extrapolation from national population estimates and breeding range, is used to determine whether species present are likely to occur in regionally important numbers. It should be noted that the definition of what constitutes a 'region' also varies for those species where numbers are known. However, for the purposes of this assessment, and consistent with SNH guidelines, the 'region' in which Logiealmond is located is regarded as Natural Heritage Zone 15 (Loch Lomond, the Trossachs and Breadalbane). Although the site is close to the boundary with NHZ 16 (Eastern Lowlands) the contrast in the types of habitats present is marked and therefore bird populations in the Eastern Lowlands will not, for the most part, be considered. In a number of cases the recording of species information does not follow the same boundary outlines as the NHZs; in these cases the region evaluated will be that which corresponds to geographical units used for relevant data collection e.g. Scottish Raptor Study Group (SRSG) data (Etheridge et al. 2005, 2006). For many species information collected by regional groups is based on administrative boundaries rather than physical geography or areas of similar habitat like the NHZs).

31 For the purpose of this assessment, the value of the site with regards to the percentage of the population (regional, national or international) under consideration that it supports, and the conservation status of the species in question, are used (along with other factors) to assess the nature conservation importance of the site. The terminology and evaluation methods used are consistent with those described in the ES. The evaluation criteria to establish the nature conservation importance of the site for each species is detailed in Table 1.3 and the magnitude of the impact in relation to the resource is described in Table 1.4.

[1] There is no fundamental biological reason to take 1% of a population as the threshold level for establishing the international importance of a site. However, this percentage is widely considered to be of value in giving an appropriate level of protection to populations, and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention. Thereafter, the 1% level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud, Mudge & Pienkowski, 1990).

Table 1.3 Definitions Relating to Nature Conservation Importance of Site

VERY HIGH	Regular presence of species that form the cited interest of SPAs and SSSIs.
HIGH	Regular presence of: other non-cited species which contribute to the integrity of an SPA or SSSI; Ecologically sensitive species such as rare birds (<300 breeding pairs in the UK) and the less common birds of prey (golden eagle, honey buzzard, osprey, marsh harrier and hen harrier for example); Species present in nationally important numbers (>1% UK population); Species listed on Annex 1 of the EU Birds Directive and/or Schedule 1 of the Wildlife and Countryside Act 1981.
MEDIUM	Regular presence of: Species in regionally important numbers (>1% regional population). Species listed as priority species in UK Biodiversity Action Plan subject to special conservation measures that occur at high densities/numbers.
LOW	Species covered above which are present very infrequently or in very low numbers. Regular presence of high densities/numbers of any other species of conservation interest not covered above, e.g. species listed on the red or amber lists of Birds of Conservation Concern (Gregory et al 2002).
NEGLIGIBLE	Species of conservation interest, e.g. red or amber listed species which are present very infrequently or in very low numbers. Species that remain common and widespread e.g. magpie, woodpigeon.

Table 1.4 Definitions of Terms Relating to the Magnitude of Effects

VERY HIGH	Total loss or very major alteration to key elements / features of the baseline conditions such that the post development character / composition / attributes will be fundamentally changed and may be lost from the site altogether.
HIGH	Major loss or major alteration to key elements / features of the baseline (pre-development) conditions such that post development character / composition / attributes will be fundamentally changed.
MEDIUM	Loss or alteration to one or more key elements / features of the baseline conditions such that post development character / composition / attributes of baseline will be partially changed.
LOW	Minor shift away from baseline conditions. Change arising from the loss / alteration will be discernible but underlying character / composition / attributes of baseline conditions will be similar to pre-development circumstances / patterns.
NEGLIGIBLE	Very slight change from baseline conditions. Change barely distinguishable, approximating to the "no change" situation.

1.4.2 Evaluation

1.4.2.1 Red Kite

32 Red kite are listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife & Countryside Act 1981 (as amended) making them a species of high nature conservation importance. The population in Scotland is re-introduced following extinction in the late nineteenth century. The Scottish population was estimated to be 64 breeding pairs in 2004, which between them produced 115 fledged young (Etheridge et al. 2006). This number had increased to 76 pairs in 2005 (RSPB press release 2006) and by 2008 had jumped to 122 pairs (RSPB press release September 2008). Logiealmond is within the Tayside region (SRSG area definitions) but is close to the border with Central region. The red kites in this area have become established following a programme of releases near Doune in west Perthshire between 1996 and 2001, and supplemented as a result of 4 birds released in Dumfries & Galloway moving into the area. The populations in both Tayside and Central Region have been increasing. There was a combined total of 22 breeding pairs in 2004 and 25 in 2005. These produced 28 fledged young in 2005 (RSPB press release 2006). By 2008 the central region alone supported 45 pairs of red kite demonstrating a large increase in the population in this area (RSPB press release September 2008).

33 Each pair of red kites breeding in Scotland accounts for 0.8% of the national population (in 2008) making the proposed Logiealmond wind farm site of high importance for this species.

34 The level of flight activity over the course of the winter across the site during the 2004 to 2006 period was low with only 6 flights (including incidental observations) recorded. It is likely that during the harsher winter weather this pair of red kite moves to lower lying areas or joins a communal roost elsewhere (to the south, east or west of the known nest site). The Logiealmond site can therefore be considered to be of some use during the

breeding season although its usage is unlikely to be uniform (i.e. activity over the site is unlikely to occur every day).

35 It is concluded that the site is of high importance for red kite during the breeding season.

1.4.2.2 Hen Harrier

36 Hen harrier is listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife & Countryside Act 1981 (as amended) making them a species of high nature conservation importance. Hen harrier numbers increased by 32% in Scotland between 1998 and 2004 (Etheridge et al 2006) to a total of 417 breeding pairs (219 of which fledged young); Perthshire supported 25 of these pairs (18 of which fledged young). The proposed Logiealmond wind farm has the potential to support hen harrier with a maximum of 3 pairs (2004 data) attempting to breed within 1km of the wind farm area; however it is thought that over the 4 years of survey only a single pair has maintained a presence past early spring. Being very precautionary, if it is assumed that up to 3 home ranges can be accommodated, within the planning application boundary and the 2km surrounding it, approximately 0.7% of the national total or 12% of the Perthshire population are within the general area of the proposed wind farm.

37 The level of flight activity over the course of the winter across the site is very low with a total of 8 flights (including incidental observations) recorded in all winter months (September through March) between January 2004 and March 2006 (a total of 285 hours of observation). These flights were all undertaken by either sub-adult or adult male birds. The site has been used relatively regularly in the early part of the breeding season in all years of survey by this species and is therefore concluded that it is of high importance at this time of year.

38 The site is therefore of high importance for hen harrier during the breeding season.

1.4.2.3 Merlin

39 Merlin are listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife & Countryside Act 1981 (as amended) making them a species of high nature conservation importance. The Scottish population of merlin is at least 776 breeding pairs (derived from Rebecca & Bainbridge 1998), although numbers are thought to have increased over the past few years. The SRSG recorded 28 occupied territories in Perthshire in 2004 (Etheridge et al 2006), although the level of coverage is unknown and is unlikely to be complete.

40 One breeding pair was noted in the same area within the turbine envelope every year between 2004 and 2008 (in 2006 a further pair of breeding merlin were noted). This species is mainly present in the breeding season, with only one flight recorded between 2004 and 2006 in winter.

41 The site is therefore of high importance for merlin during the breeding season.

1.4.2.4 Peregrine

42 Peregrine are listed on Annex I of the Birds Directive and Schedule 1 of the Wildlife & Countryside Act 1981 (as amended) making them a species of high nature conservation importance. The numbers of peregrine increased following recovery from the effects of organo-chlorine pesticides and the Scottish population in 1991 was determined as 611 breeding pairs (Crick & Ratcliffe 1995). However, when this national survey was repeated in 2002 the results showed declines in north and west Scotland, and in Perthshire (http://www.bto.org/survey/complete/peregrine_results.htm), and the Scottish population was estimated at 542 breeding pairs with a further 50 territories occupied by single birds (Park et al. 2005). In 2004 the SRSG survey identified 24 breeding pairs in the area of land west of the A9/M90 within the Tayside & Fife region.

43 At Logiealmond the historic nest site location (approximately 1km from the proposed wind farm site) provided by RSPB did not have a breeding pair in residence, although in both 2004 and 2005 peregrine activity in this area was detected (in 2005 the activity noted was by an immature female). Flights of peregrine across the site were noted in all years in both the breeding season and over-winter, although activity was sporadic.

44 The site is therefore of low importance for peregrine.

1.4.2.5 Short-eared Owl

45 Short-eared owl is listed on Annex I of the Birds Directive making them a species of high nature conservation importance. It is difficult to assess the population size of short-eared owl due to their nomadic lifestyle, resulting in large ranges in population estimates. The 'best guess' extent of the Scottish population is that it varies between 640 and 2,700 breeding pairs (Park et al 2005). Survey data collected during the national hen harrier survey provided an estimate of between 423 and 658 pairs of short-eared owl in 2004. It is acknowledged that this is likely to be an under-estimate, however, due to the survey methods not being optimal for this species (i.e. focused on hen harrier and not short-eared owl: Etheridge et al 2006). Regional numbers of short-eared owl do not appear to be available in the literature.

46 In 2004 (a year noted for its high vole populations in some areas) the numbers of short-eared owls at the Logiealmond site was large with 2 confirmed nest locations and up to 6 further possible nestings. In contrast no nesting attempts were confirmed or suspected in 2005 and 2006 with a corresponding reduction in the amount of activity seen from the vantage points. In 2008 three breeding sites were recorded in the general area; two of these nest sites were some distance from the proposed wind farm (800m and 2km away respectively).

47 The importance of the site to short-eared owl is difficult to assess, as it is less the location than the temporal availability of prey that is of importance, although the habitat at Logiealmond is suitable given adequate prey density. In 2004 and 2008 the site could be considered to be of high importance to this species, however in 2005 and 2006 the sites importance falls to low or negligible. For the purposes of this assessment the site of the proposed wind farm site will be considered to be of high importance to short-eared owl.

1.4.2.6 Black Grouse

48 Black grouse receives little formal protection, except for a closed season defined in the Game Act, although there is a largely successful voluntary shooting ban in place (NB: the continental sub-species only is listed on Annex I of the Birds Directive). Black grouse are on the red list of Birds of Conservation Concern (Gregory et al. 2002) due to large and widespread declines; for this reason it is a priority species on the UK BAP. The Scottish population of 3,344 lekking males recorded in 2005 was down 29% from the figure recorded in 1995/96 (GCT 2005). Although there appears to be no regional estimate for Perthshire a block of 700km2 just to the north of the proposed Logiealmond site supported 270 lekking males in 2002 (Pearce-Higgins et al. 2007).

49 It is considered that most grey hens nest within 1.5km of the lek site on which they mated (Black Grouse UK; www.blackgrouse.info). This suggests that at most the site could support a small number of nesting hens given the numbers of males noted in the general area throughout the survey period (2004 – 2008). The number is unlikely to be of national significance, although it could be regionally important.

50 The site is therefore of medium importance for black grouse throughout the year.

1.5 Potential Impacts

51 The key issues relating to birds and wind farms can be categorised as follows:

- The effects of direct habitat loss due to land take by wind turbine bases, tracks and ancillary structures.
- The effects of indirect habitat loss, i.e. the displacement of birds due to the proximity of the wind turbines. Such displacement may occur as a consequence of disturbance associated with construction work, or due to the presence of the wind farm close to nest or feeding sites or on habitual flight routes.
- The effects of collision with rotating turbine blades, overhead wires, guy lines and fencing (i.e. killing or injury of birds), which is of particular relevance for sites located in areas known to support raptors or large concentrations of waterfowl.

52 The predicted level of impact of each of these effects is discussed with relevance to each species below.

1.5.1 Red Kite

53 Red kite use the Logiealmond wind farm site during the breeding season for foraging and socialising, but breed approximately 3km away from the nearest proposed wind turbine position. Therefore the impacts of direct habitat loss and displacement will impact upon this species in a different way than if it had been breeding within the confines of the wind farm area.

54 The land occupied by the construction and operation of the Logiealmond wind farm (including all wind turbines, bases, tracks and associated ancillary

structures) will be approximately 17ha, which is around 2% of the area within the planning application boundary. As much of the access track is already in existence (from the River Braan to the wind farm area) the area of habitat lost will be less than this figure. This loss of habitat is highly unlikely to impact significantly on red kite as it would appear from the data collected that the wind farm area does not make up a core area of territory (given the sporadic use of the area) suggesting that this species can access resources elsewhere. In addition the small amount of habitat lost, in comparison to the range of a red kite pair, and the diffuse distribution of wind farm infrastructure suggests the impact will be minor.

55 Red kites are known to forage within operational wind farms within the UK. At the closely monitored Braes of Doune wind farm near Stirling, following its completion in 2007, there has been no detectable change in range use following significant levels of monitoring (both visual and through radio-tracking individual kites) . This strongly suggests that this species is not at particular risk of disturbance due to the presence of wind turbines. It is therefore concluded that the pair of red kite using the general area around the Logiealmond wind farm is likely to continue to use the area following construction. Therefore no impacts due to displacement are predicted.

56 Recently published/publicised information from Germany suggests that red kite may be particularly susceptible to collision with turbines in parts of its range (Durr, 2006). This is considered to be due, at least in part, to management of the area around the turbines resulting in the creation of prey 'hotspots' early in the breeding season that attract foraging birds (*pers. comm*. Durr 2007); a similar situation to that reported for other species at the Altamont Pass wind farm in the USA. Fallow areas develop a sward structure that supports high numbers of rodents, while the surrounding fields have young cereal crops which support very little prey. The number of collisions reported from Germany is relatively high at 81 individuals (as of February 2007), while in the UK the number of collision victims recorded is just 3 including a single female at the Braes of Doune wind farm . The difference in the figures will be mainly due to the 15 to 20 times larger population of red kite in Germany, however differences in habitat type and land management in wind farms between the two countries as well as the migratory behaviour of continental birds are also likely to be factors.

57 The Collision Risk Analysis (CRA) undertaken for red kite (following the Band model method) in the ES is considered (both by Vattenfall and SNH) to be flawed due to the non-standard methods of data collection making analysis unreliable. Therefore the 2008 data has been used to supply an estimate of collision risk. As all flights at collision risk height were noted from vantage point B the analysis was carried out on the basis of an individual view shed (as recommended in Band et al. 2007); in addition to ensure a precautionary approach all flights were included in the analysis irrespective of the distance between them and the proposed wind turbines. When using an avoidance rate of 98% (Whitfield & Madders 2006a) 0.05 collisions are predicted per year equating to a loss of 1.25 individuals over the course of the operational life of the wind farm (see Appendix 1B for collision risk analysis workings). This level of collision, especially in light of the current rates of population growth, is highly unlikely to result in a detectable population effect either at the national, regional or local levels.

58 It is therefore concluded that red kite will not be significantly impacted upon by the construction of the proposed Logiealmond wind farm.

1.5.2 Hen Harrier

59 As with red kite the direct loss of habitat is unlikely to result in a significant impact due to the relatively small area involved and the extent of available habitat in the general surrounds. The impacts of displacement are also likely to be minimal given the levels of effect detailed in the literature. In a review of the available information Whitfield & Madders (2006b) conclude that the displacement of foraging harriers is unlikely to exceed 100m from an operational wind turbine. If an exclusion zone of 100m around each turbine is calculated for Logiealmond then the indirect loss of habitat is approximately 44ha – this area is still very small in comparison to the extent of similar available habitat in the general surrounds.

60 Nesting attempts are considered unlikely to occur within 300m of an operational wind turbine (Whitfield & Madders 2006b). However given the lack of a consistent nesting area for hen harrier at Logiealmond (i.e. they do not attempt to breed consistently in one place) and their general failure to reproduce within the site, the construction of a wind farm will not impinge on a territory that is used regularly each year and at worst will result in prospecting pairs nesting outside the wind farm area (as they have attempted to do frequently during the survey period). Therefore, despite the indirect loss of habitat, it is unlikely that hen harrier will be prevented from undertaking nesting attempts in the general area following wind farm construction.

61 In a recent review of the impacts of wind farms on hen harriers, Whitfield & Madders (2006b) reported that in ten studies examining collision risk of hen harriers at operating wind farms only three reported harrier deaths, and of those only one recorded more than one fatality (Altamont Pass where three deaths were recorded over 7,500 turbine-years of searches). Whitfield and Madders concluded that this species does not appear to be particularly susceptible to collision with turbines and that collision mortality is unlikely to be of serious concern.

62 During 2008 none of the flights of hen harrier recorded at Logiealmond were at a height that would place them within a zone where they are at risk of collision. This data suggests that hen harrier is only at a very small risk of collision due to the proposed Logiealmond wind.

63 It is therefore concluded that hen harrier will not be significantly impacted upon by the construction of the proposed Logiealmond wind farm.

1.5.3 Merlin

64 The direct loss of habitat is considered to be too small to result in a significant impact on merlin; however, as a pair nest regularly within the wind farm area there is the potential for them to be impacted upon by the effects of disturbance/displacement. Merlin are known to regularly fly through and forage within wind farms in the UK (Phillips 1994, Hawker 1997, Williams & Young 1997 – all quoted from Pentland Road Wind Farm – Report to Inform an Appropriate Assessment by Percival 2001) and a breeding pair has been noted nesting approximately 600m from Dun Law wind farm (Land Use

Consultants 2005) suggesting that they are relatively tolerant of wind turbines. It is therefore suggested that merlin will be able to continue to forage within the wind farm area without suffering any negative effects following construction.

65 In a review of disturbance distances of merlin, Ruddock & Whitfield (2007) suggest that merlin are able to habituate to disturbance at nest sites and are likely to be protected by respecting a stand-off of between 300 and 500m. At Logiealmond the known nest location is 344m from the nearest proposed turbine suggesting that it could continue to be occupied in the presence of wind turbines, especially as wind turbines are a predictable stimulus that could be habituated to. It is therefore unlikely that merlin will be significantly disturbed or displaced by the proposed Logiealmond wind farm.

66 The flights of merlin recorded in 2008 at collision risk were noted from three vantage points. If the results from each viewshed are calculated separately and summed (the most precautionary method) it is predicted that 0.01 collisions will occur for each year of operation if the avoidance rate used is 98% - this equates to 0.25 fatalities over 25 years of operational life. This rate of loss is so small as to be insignificant at the level of the regional or local population.

1.5.4 Peregrine

67 Due to the very low level of usage of the area by peregrine it is considered highly unlikely that direct or indirect habitat loss will have any detectable impact upon the local population of this species.

68 As individuals do cross the site occasionally, it is possible that this species will be put at risk of collision. Using the 2008 data the Band model predicts 0.024 collisions per breeding season or 0.6 birds over the course of the wind farms operational life. This rate of loss is so small as to be insignificant at the level of the regional or local population. If it is assumed that peregrine have similar levels of activity over winter the levels of predicted loss would still be negligible at the level of the regional or local population.

1.5.5 Short-eared Owl

69 It is difficult to assess the potential for short-eared owl to be displaced or disturbed by a wind farm given their habit of moving areas between years in search of sites with greater prey abundance. It is apparent from the nesting distribution in 2004 and 2008 that eight of the 10 nesting attempts were outside of the wind farm area and at least 500m from a proposed turbine position. This suggests strongly that even given a high density of prey there is adequate habitat in the areas surrounding the proposed wind farm to support large numbers of short-eared owl. The two breeding attempts within the wind farm area (one in 2004 and one in 2008) would also have to move only a short distance to be able to nest within similar habitats and maintain a 500m stand-off to any wind turbines. As most of the breeding attempts in previous years have been outside the wind farm area it can be concluded that it is unlikely that short-eared owl will be disturbed or displaced from the majority of breeding habitat in the area. The foraging area may be reduced (i.e. individuals avoid flying close to wind turbines) but given the large distances between turbines (in excess of 300m) and the avoidance of grass

dominated stream courses (areas that are likely to support the greatest numbers of voles) the impact is likely to be low.

70 During 2008 none of the flights of short-eared owl recorded at Logiealmond were at a height that would place them within a zone where they are at risk of collision. This data suggests that short-eared owl is only at a very small risk of collision due to the proposed Logiealmond wind.

1.5.6 Black Grouse

71 Grey hens are usually considered to nest within 1.5km of the lek on which they mated. The closest lek site to a proposed wind turbine is within 1km of the proposed wind farm, suggesting that there is some, albeit limited, risk that nesting distribution could be altered by the presence of wind turbines. Given the habitats present within the area, however, it is likely that nesting occurs on the moorland edge habitats to the north of the site rather than within the wind farm area given the habitat preferences of this species. It is considered unlikely that the effects of disturbance or displacement will impact significantly upon black grouse.

72 Black grouse tend to spend the vast majority of their time on foot and do not usually make long or sustained flights unless flushed. This is especially true in open habitats such as at Logiealmond where there is no potential to roost in trees; in addition, any dispersal/commuting flights or escape flights are usually at low levels and follow the contours of the surrounding land. This suggests that they are also at very low risk of colliding with wind turbine blades.

1.5.7 Cumulative Impacts

73 It is possible that a series of wind farms could lead to an increased risk of collision as an individual bird ranges across the area occupied by a number of them. Alternatively (since collision and displacement are antagonistic), it may be that a number of birds could be displaced from potentially large areas as a result of multiple wind farms (assuming birds are displaced by the wind farm).

74 There are two wind farms, Griffin (consented) and Calliacher (awaiting appeal decision) within 15km of the proposed Logiealmond wind farm. The approximate distances of these wind farms from Logiealmond (nearest wind turbine to nearest wind turbine) and the number of turbines are as follows:

- Griffin, 6.2km north of Logiealmond, 68 turbines
- Calliacher, 8.7km north west, 14 turbines

75 The Griffin wind farm is located mainly within a forestry plantation and as such has few target species that correspond to those at Logiealmond. Black grouse occur on or close to both sites and will be part of the same local population. However, as there are no significant impacts on black grouse predicted for the Logiealmond scheme and low levels of potential impacts predicted at Griffin it is considered highly unlikely that there will be any significant cumulative impacts.

76 Calliacher wind farm is located on open moorland and supports a range of bird species, many of which are the same as at Logiealmond. Of particular

interest in the context of cumulative impact assessment is hen harrier. Two to four pairs of hen harrier nest in and around the proposed Calliacher wind farm and although it is considered unlikely that these birds will be displaced they are at risk of collision with wind turbines. The theoretical collision risk to hen harriers posed by the 14 turbines at Calliacher equates to 0.05 birds per year or 1 collision victim every twenty years. Given the very low to negligible collision risk assumed for Logiealmond (based on no recorded flights at collision risk height in 2008) the predicted cumulative losses in the area due to collision with wind turbines remain very low; these predicted losses are highly unlikely to result in a significant increase in the background mortality rate.

1.6 Conclusions

77 This report presents further data to aid in the assessments of the potential ornithological impacts of a wind farm at Logiealmond, near Dunkeld. Although it is apparent that, for an upland area in Perthshire, there is a wide range of 'target' bird species present the levels of activity over the proposed area of the wind farm is low. This low level of activity suggests that although the wind farm area is used sporadically it does not form the core foraging areas of any of the species noted. Only merlin have consistently nested close to the proposed development; however given the distance between this traditional nest location and the nearest wind turbine, the anecdotal evidence of regular commuting and foraging within operational wind farms and their tendency to hunt low to the ground, it is concluded that they will not suffer a significant impact due to the operation of a wind farm at Logiealmond.

1.7 References

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APPENDIX 1A

Details of target species flights

Species	Date	Vantage Point	Flight Duration within Collision Risk window (secs)	Flight Duration outside Collision Risk Window (secs)
Red Kite	10/05/08	B	270	30
Red Kite	10/05/08	B	255	30
Red Kite	25/05/08	D	0	285
Red Kite	29/06/08	A	0	270
Red Kite	24/08/08	D	0	300
Hen Harrier	20/04/08	B	0	270
Hen Harrier	20/04/08	B	0	225
Hen Harrier	20/04/08	C	0	270
Hen Harrier	26/04/08	A	0	285
Hen Harrier	26/04/08	A	0	150
Hen Harrier	26/04/08	A	0	210
Hen Harrier	10/05/08	B	0	300
Hen Harrier	18/05/08	B	0	270
Hen Harrier	14/06/08	A	0	435
Hen Harrier	18/07/08	C	0	165
Merlin	30/03/08	B	60	30
Merlin	26/04/08	A	0	180
Merlin	14/06/08	B	0	60
Merlin	18/07/08	D	15	105
Merlin	10/08/08	C	180	0
Peregrine	10/05/08	C	60	240
Peregrine	29/06/08	A	105	75
Peregrine	12/07/08	A	150	0
Peregrine	13/07/08	D	90	45
Short-eared owl	27/04/08	A	0	300
Short-eared owl	24/05/08	A	0	270
Short-eared owl	25/05/08	B	0	300
Short-eared owl	28/06/08	B	0	*
Short-eared owl	12/07/08	A	0	270
Short-eared owl	09/08/08	A	0	285

* Juvenile seen hunting along Milton Burn (outside of wind farm area) for approximately 40 minutes – all flight activity below 20m.

APPENDIX 1B

Collision Risk Calculations for Merlin – Viewpoint B Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	376.5
survey time (mins)	3240
bird obs time@10-100m (mins)	1

proportion of time between 10-100m (t)

0.000308642 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

8.19766E-07

Flight risk area (ha) inc 25m buffer for blades: 376.5

3 proportion of time at 20-130m

F*flight risk area

0.000308642

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.000224467 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

0.549494949 (days present*hrs active per day)* prop time in turbines

n (mins)

32.96969697

n(secs) (used in calc later)

1978.181818

6 flight risk volume V_w (m^2)

301200000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

132880

No of turbines	7
Rotor depth (m)	3.5
Bird Length (m)	0.275
radius	40
radius^2	1600
pi	3.142857143
piR^2	5028.571429

8 occupancy of rotor swept area b (bird seconds)

0.872711819 (n*(Vr/Vw)

9 flight speed (m/s) 12.6

Time to fly through and clear rotors time

0.299603175 (rotor depth + bird length)*flight speed(m/s)

10 Number of transits through rotors per year

2.91289243 (b/time)

Collision rate

0.200989578 Number of transits * probability of bird strike from stage 2

0.002009896 (% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance 0.010049479

Collision Risk Calculations for Merlin – Viewpoint B Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.275	m	0.025	0.575	9.87	25.52	1.00	0.00125	25.31	1.00	0.00125	
Wingspan	0.555	m	0.075	0.575	3.29	8.58	0.42	0.00311	8.37	0.40	0.00304	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	6.09	0.29	0.00368	5.83	0.28	0.00353	
			0.175	0.860	1.41	5.20	0.25	0.00441	4.89	0.24	0.00414	
Bird speed	12.6	m/sec	0.225	0.994	1.10	4.62	0.22	0.00503	4.26	0.21	0.00464	
Rotor Diam	80	m	0.275	0.947	0.90	3.66	0.18	0.00487	3.31	0.16	0.00440	
Rotation Period	4.92	sec	0.325	0.899	0.76	2.99	0.14	0.00469	2.65	0.13	0.00417	
			0.375	0.851	0.66	2.49	0.12	0.00452	2.18	0.11	0.00395	
			0.425	0.804	0.58	2.11	0.10	0.00434	1.81	0.09	0.00373	
			0.475	0.756	0.52	1.81	0.09	0.00415	1.53	0.07	0.00351	
Bird aspect ratio: β	0.50		0.525	0.708	0.47	1.57	0.08	0.00400	1.31	0.06	0.00334	
			0.575	0.660	0.43	1.39	0.07	0.00387	1.15	0.06	0.00320	
			0.625	0.613	0.39	1.24	0.06	0.00374	1.01	0.05	0.00306	
			0.675	0.565	0.37	1.10	0.05	0.00361	0.90	0.04	0.00293	
			0.725	0.517	0.34	0.99	0.05	0.00347	0.80	0.04	0.00280	
			0.775	0.470	0.32	0.89	0.04	0.00333	0.71	0.03	0.00268	
			0.825	0.422	0.30	0.80	0.04	0.00318	0.64	0.03	0.00256	
			0.875	0.374	0.28	0.71	0.03	0.00303	0.58	0.03	0.00244	
			0.925	0.327	0.27	0.64	0.03	0.00287	0.52	0.03	0.00233	
			0.975	0.279	0.25	0.57	0.03	0.00271	0.47	0.02	0.00223	
				Overall p(collision) =			**Upwind**	**7.4%**		**Downwind**	**6.4%**	
								Average	**6.9%**			

Collision Risk Calculations for Merlin – Viewpoint C Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	500
survey time (Mins)	3240
bird obs time@10-100m (Mins)	3

proportion of time between 10-100m (t)

0.000925926 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

1.85185E-06

Flight risk area (ha) inc 25m buffer for blades: 500

3 proportion of time at 20-130m

F*flight risk area

0.000925926

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.000673401 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

1.648484848 (days present*hrs active per day)* prop time in turbines

n (mins)

98.90909091

n(secs) (used in calc later)

5,934.545455

6 flight risk volume V_w (m^2)

40,000,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

94,914.28571

	No of turbines	5
	Rotor depth (m)	3.5
	Bird Length (m)	0.275
	radius	40
	$radius^2$	1600
	pi	3.142857143
	piR^2	5028.571429

8 occupancy of rotor swept area b (bird seconds)

1.408182857	(n*(Vr/Vw)

9	flight speed (m/s)	12.6

Time to fly through and clear rotors time

0.299603175	(rotor depth + bird length)*flight speed(m/s)

10 Number of transits through rotors per year

4.70016	(b/time)

Collision rate

0.32431104	Number of transits * probability of bird strike from stage 2
0.00324311	(% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance	0.016215552

Collision Risk Calculations for Merlin – Viewpoint C Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.275	m	0.025	0.575	9.87	25.52	1.00	0.00125	25.31	1.00	0.00125	
Wingspan	0.555	m	0.075	0.575	3.29	8.58	0.42	0.00311	8.37	0.40	0.00304	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	6.09	0.29	0.00368	5.83	0.28	0.00353	
			0.175	0.860	1.41	5.20	0.25	0.00441	4.89	0.24	0.00414	
Bird speed	12.6	m/sec	0.225	0.994	1.10	4.62	0.22	0.00503	4.26	0.21	0.00464	
Rotor Diam	80	m	0.275	0.947	0.90	3.66	0.18	0.00487	3.31	0.16	0.00440	
Rotation Period	4.92	sec	0.325	0.899	0.76	2.99	0.14	0.00469	2.65	0.13	0.00417	
			0.375	0.851	0.66	2.49	0.12	0.00452	2.18	0.11	0.00395	
			0.425	0.804	0.58	2.11	0.10	0.00434	1.81	0.09	0.00373	
			0.475	0.756	0.52	1.81	0.09	0.00415	1.53	0.07	0.00351	
Bird aspect ratio: β	0.50		0.525	0.708	0.47	1.57	0.08	0.00400	1.31	0.06	0.00334	
			0.575	0.660	0.43	1.39	0.07	0.00387	1.15	0.06	0.00320	
			0.625	0.613	0.39	1.24	0.06	0.00374	1.01	0.05	0.00306	
			0.675	0.565	0.37	1.10	0.05	0.00361	0.90	0.04	0.00293	
			0.725	0.517	0.34	0.99	0.05	0.00347	0.80	0.04	0.00280	
			0.775	0.470	0.32	0.89	0.04	0.00333	0.71	0.03	0.00268	
			0.825	0.422	0.30	0.80	0.04	0.00318	0.64	0.03	0.00256	
			0.875	0.374	0.28	0.71	0.03	0.00303	0.58	0.03	0.00244	
			0.925	0.327	0.27	0.64	0.03	0.00287	0.52	0.03	0.00233	
			0.975	0.279	0.25	0.57	0.03	0.00271	0.47	0.02	0.00223	
				Overall p(collision) =			**Upwind**	**7.4%**		**Downwind**	**6.4%**	
								Average	**6.9%**			

Collision Risk Calculations for Merlin – Viewpoint D Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	301
survey time (Mins)	3240
bird obs time@10-100m (Mins)	0.25

proportion of time between 10-100m (t)

7.71605E-05 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

2.56347E-07

Flight risk area (ha) inc 25m buffer for blades: 301

3 proportion of time at 20-130m

F*flight risk area

7.71605E-05

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

5.61167E-05 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

0.137373737 (days present*hrs active per day)* prop time in turbines

n (mins)

8.242424242

n(secs) (used in calc later)

494.5454545

6 flight risk volume V_w (m^2)

240,800,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

75,931.42857

	No of turbines	4
	Rotor depth (m)	3.5
	Bird Length (m)	0.275
	radius	40
	$radius^2$	1600
	pi	3.142857143
	piR^2	5028.571429

8 **occupancy of rotor swept area b (bird seconds)**

0.155944945	(n*(Vr/Vw)

9 flight speed (m/s) 12.6

Time to fly through and clear rotors time

0.299603175	(rotor depth + bird length)*flight speed(m/s)

10 **Number of transits through rotors per year**

0.520504983	(b/time)

Collision rate

0.035914844	Number of transits * probability of bird strike from stage 2
0.000359148	(% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance 0.001795742

Collision Risk Calculations for Merlin – Viewpoint D Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.275	m	0.025	0.575	9.87	25.52	1.00	0.00125	25.31	1.00	0.00125	
Wingspan	0.555	m	0.075	0.575	3.29	8.58	0.42	0.00311	8.37	0.40	0.00304	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	6.09	0.29	0.00368	5.83	0.28	0.00353	
			0.175	0.860	1.41	5.20	0.25	0.00441	4.89	0.24	0.00414	
Bird speed	12.6	m/sec	0.225	0.994	1.10	4.62	0.22	0.00503	4.26	0.21	0.00464	
Rotor Diam	80	m	0.275	0.947	0.90	3.66	0.18	0.00487	3.31	0.16	0.00440	
Rotation Period	4.92	sec	0.325	0.899	0.76	2.99	0.14	0.00469	2.65	0.13	0.00417	
			0.375	0.851	0.66	2.49	0.12	0.00452	2.18	0.11	0.00395	
			0.425	0.804	0.58	2.11	0.10	0.00434	1.81	0.09	0.00373	
			0.475	0.756	0.52	1.81	0.09	0.00415	1.53	0.07	0.00351	
Bird aspect ratio: β	0.50		0.525	0.708	0.47	1.57	0.08	0.00400	1.31	0.06	0.00334	
			0.575	0.660	0.43	1.39	0.07	0.00387	1.15	0.06	0.00320	
			0.625	0.613	0.39	1.24	0.06	0.00374	1.01	0.05	0.00306	
			0.675	0.565	0.37	1.10	0.05	0.00361	0.90	0.04	0.00293	
			0.725	0.517	0.34	0.99	0.05	0.00347	0.80	0.04	0.00280	
			0.775	0.470	0.32	0.89	0.04	0.00333	0.71	0.03	0.00268	
			0.825	0.422	0.30	0.80	0.04	0.00318	0.64	0.03	0.00256	
			0.875	0.374	0.28	0.71	0.03	0.00303	0.58	0.03	0.00244	
			0.925	0.327	0.27	0.64	0.03	0.00287	0.52	0.03	0.00233	
			0.975	0.279	0.25	0.57	0.03	0.00271	0.47	0.02	0.00223	
				Overall p(collision) =			**Upwind**	**7.4%**		**Downwind**	**6.4%**	
								Average	**6.9%**			

Collision Risk Calculations for Peregrine – Viewpoint A Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	350
survey time (Mins)	3240
bird obs time@10-100m (Mins)	4.25

proportion of time between 10-100m (t)

0.001311728 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

3.7478E-06

Flight risk area (ha) inc 25m buffer for blades: 350

3 proportion of time at 20-130m

F*flight risk area

0.001311728

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.000953984 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

2.335353535 (days present*hrs active per day)* prop time in turbines

n (mins)

140.1212121

n(secs) (used in calc later)

8,407.272727

6 flight risk volume V_w (m^2)

280,000,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

118,272

No of turbines	7
Rotor depth (m)	3.5
Bird Length (m)	0.42
radius	40
radius^2	1600
pi	3.142857143
piR^2	5028.571429

8 occupancy of rotor swept area b (bird seconds)

3.551232 (n*(Vr/Vw)

9 flight speed (m/s) 13.5

Time to fly through and clear rotors time

0.29037037 (rotor depth + bird length)*flight speed(m/s)

10 Number of transits through rotors per year

2.91289243 (b/time)

Collision rate

0.843870563 Number of transits * probability of bird strike from stage 2

0.008438706 (% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance 0.016877411

Collision Risk Calculations for Peregrine – Viewpoint A Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.42	m	0.025	0.575	9.87	30.16	1.00	0.00125	29.95	1.00	0.00125	
Wingspan	1.025	m	0.075	0.575	3.29	10.12	0.49	0.00367	9.91	0.48	0.00360	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	7.02	0.34	0.00425	6.76	0.33	0.00409	
			0.175	0.860	1.41	5.86	0.28	0.00497	5.55	0.27	0.00470	
Bird speed	12.6	m/sec	0.225	0.994	1.10	5.14	0.25	0.00560	4.77	0.23	0.00520	
Rotor Diam	80	m	0.275	0.947	0.90	4.08	0.20	0.00543	3.73	0.18	0.00496	
Rotation Period	4.92	sec	0.325	0.899	0.76	3.34	0.16	0.00526	3.01	0.15	0.00473	
			0.375	0.851	0.66	2.80	0.14	0.00508	2.49	0.12	0.00451	
			0.425	0.804	0.58	2.38	0.12	0.00490	2.09	0.10	0.00429	
			0.475	0.756	0.52	2.05	0.10	0.00472	1.77	0.09	0.00407	
Bird aspect ratio: β	0.41		0.525	0.708	0.47	1.78	0.09	0.00453	1.52	0.07	0.00386	
			0.575	0.660	0.43	1.56	0.08	0.00433	1.31	0.06	0.00366	
			0.625	0.613	0.39	1.38	0.07	0.00418	1.16	0.06	0.00350	
			0.675	0.565	0.37	1.25	0.06	0.00408	1.04	0.05	0.00340	
			0.725	0.517	0.34	1.13	0.05	0.00398	0.94	0.05	0.00331	
			0.775	0.470	0.32	1.03	0.05	0.00387	0.86	0.04	0.00322	
			0.825	0.422	0.30	0.94	0.05	0.00376	0.79	0.04	0.00314	
			0.875	0.374	0.28	0.86	0.04	0.00364	0.72	0.03	0.00306	
			0.925	0.327	0.27	0.79	0.04	0.00352	0.67	0.03	0.00298	
			0.975	0.279	0.25	0.72	0.03	0.00339	0.62	0.03	0.00291	
Average	**7.9%**			**Overall p(collision) =**			**Upwind**	**8.4%**		**Downwind**	**7.4%**	

Collision Risk Calculations for Peregrine – Viewpoint C Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	500
survey time (Mins)	3240
bird obs time@10-100m (Mins)	1

proportion of time between 10-100m (t)

0.000308642 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

6.17284E-06

Flight risk area (ha) inc 25m buffer for blades: 500

3 proportion of time at 20-130m

F*flight risk area

0.000308642

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.000224467 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

0.549494949 (days present*hrs active per day)* prop time in turbines

n (mins)

32.96969697

n(secs) (used in calc later)

1,978.181818

6 flight risk volume V_w (m^2)

400,000,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

98,560

	No of turbines	5
	Rotor depth (m)	3.5
	Bird Length (m)	0.42
	radius	40
	$radius^2$	1600
	pi	3.142857143
	piR^2	5028.571429

8 occupancy of rotor swept area b (bird seconds)

0.487424	(n*(Vr/Vw)

9	flight speed (m/s)	13.5

Time to fly through and clear rotors time

0.29037037	(rotor depth + bird length)*flight speed(m/s)

10 Number of transits through rotors per year

1.678628571	(b/time)

Collision rate

0.115825371	Number of transits * probability of bird strike from stage 2
0.001158254	(% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance	0.002316507

Collision Risk Calculations for Peregrine – Viewpoint C Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.42	m	0.025	0.575	9.87	30.16	1.00	0.00125	29.95	1.00	0.00125	
Wingspan	1.025	m	0.075	0.575	3.29	10.12	0.49	0.00367	9.91	0.48	0.00360	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	7.02	0.34	0.00425	6.76	0.33	0.00409	
			0.175	0.860	1.41	5.86	0.28	0.00497	5.55	0.27	0.00470	
Bird speed	12.6	m/sec	0.225	0.994	1.10	5.14	0.25	0.00560	4.77	0.23	0.00520	
Rotor Diam	80	m	0.275	0.947	0.90	4.08	0.20	0.00543	3.73	0.18	0.00496	
Rotation Period	4.92	sec	0.325	0.899	0.76	3.34	0.16	0.00526	3.01	0.15	0.00473	
			0.375	0.851	0.66	2.80	0.14	0.00508	2.49	0.12	0.00451	
			0.425	0.804	0.58	2.38	0.12	0.00490	2.09	0.10	0.00429	
			0.475	0.756	0.52	2.05	0.10	0.00472	1.77	0.09	0.00407	
Bird aspect ratio: β	0.41		0.525	0.708	0.47	1.78	0.09	0.00453	1.52	0.07	0.00386	
			0.575	0.660	0.43	1.56	0.08	0.00433	1.31	0.06	0.00366	
			0.625	0.613	0.39	1.38	0.07	0.00418	1.16	0.06	0.00350	
			0.675	0.565	0.37	1.25	0.06	0.00408	1.04	0.05	0.00340	
			0.725	0.517	0.34	1.13	0.05	0.00398	0.94	0.05	0.00331	
			0.775	0.470	0.32	1.03	0.05	0.00387	0.86	0.04	0.00322	
			0.825	0.422	0.30	0.94	0.05	0.00376	0.79	0.04	0.00314	
			0.875	0.374	0.28	0.86	0.04	0.00364	0.72	0.03	0.00306	
			0.925	0.327	0.27	0.79	0.04	0.00352	0.67	0.03	0.00298	
			0.975	0.279	0.25	0.72	0.03	0.00339	0.62	0.03	0.00291	
Average	**7.9%**			**Overall p(collision) =**			**Upwind**	**8.4%**		**Downwind**	**7.4%**	

Collision Risk Calculations for Peregrine – Viewpoint D Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	301
survey time (Mins)	3240
bird obs time@10-100m (Mins)	1.5

proportion of time between 10-100m (t)

0.000462963 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

1.53808E-06

Flight risk area (ha) inc 25m buffer for blades: 301

3 proportion of time at 20-130m

F*flight risk area

0.000462963

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.0003367 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

0.824242424 (days present*hrs active per day)* prop time in turbines

n (mins)

49.45454545

n(secs) (used in calc later)

2,967.272727

6 flight risk volume V_w (m^2)

240,800,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

78,846

	No of turbines	4
	Rotor depth (m)	3.5
	Bird Length (m)	0.42
	radius	40
	$radius^2$	1600
	pi	3.142857143
	piR^2	5028.571429

8 **occupancy of rotor swept area b (bird seconds)**

0.971609302 (n*(Vr/Vw)

9 flight speed (m/s) 13.5

Time to fly through and clear rotors time

0.29037037 (rotor depth + bird length)*flight speed(m/s)

10 **Number of transits through rotors per year**

3.346103465 (b/time)

Collision rate

0.230881139 Number of transits * probability of bird strike from stage 2

0.002308811 (% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance 0.004617623

Collision Risk Calculations for Peregrine – Viewpoint D Stage 2

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue W Band 29/04/2009

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution from radius	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	r	length	p(collision)	from radius r	
Bird Length	0.42	m	0.025	0.575	9.87	30.16	1.00	0.00125	29.95	1.00	0.00125	
Wingspan	1.025	m	0.075	0.575	3.29	10.12	0.49	0.00367	9.91	0.48	0.00360	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.97	7.02	0.34	0.00425	6.76	0.33	0.00409	
			0.175	0.860	1.41	5.86	0.28	0.00497	5.55	0.27	0.00470	
Bird speed	12.6	m/sec	0.225	0.994	1.10	5.14	0.25	0.00560	4.77	0.23	0.00520	
Rotor Diam	80	m	0.275	0.947	0.90	4.08	0.20	0.00543	3.73	0.18	0.00496	
Rotation Period	4.92	sec	0.325	0.899	0.76	3.34	0.16	0.00526	3.01	0.15	0.00473	
			0.375	0.851	0.66	2.80	0.14	0.00508	2.49	0.12	0.00451	
			0.425	0.804	0.58	2.38	0.12	0.00490	2.09	0.10	0.00429	
			0.475	0.756	0.52	2.05	0.10	0.00472	1.77	0.09	0.00407	
Bird aspect ratio: β	0.41		0.525	0.708	0.47	1.78	0.09	0.00453	1.52	0.07	0.00386	
			0.575	0.660	0.43	1.56	0.08	0.00433	1.31	0.06	0.00366	
			0.625	0.613	0.39	1.38	0.07	0.00418	1.16	0.06	0.00350	
			0.675	0.565	0.37	1.25	0.06	0.00408	1.04	0.05	0.00340	
			0.725	0.517	0.34	1.13	0.05	0.00398	0.94	0.05	0.00331	
			0.775	0.470	0.32	1.03	0.05	0.00387	0.86	0.04	0.00322	
			0.825	0.422	0.30	0.94	0.05	0.00376	0.79	0.04	0.00314	
			0.875	0.374	0.28	0.86	0.04	0.00364	0.72	0.03	0.00306	
			0.925	0.327	0.27	0.79	0.04	0.00352	0.67	0.03	0.00298	
			0.975	0.279	0.25	0.72	0.03	0.00339	0.62	0.03	0.00291	
Average	**7.9%**			**Overall p(collision) =**			**Upwind**	**8.4%**		**Downwind**	**7.4%**	

Collision Risk Calculations for Red Kite – Stage 1

NB	Populate bordered boxes	Calculation Results from Inputs

1 Area visible from vps combined

cum (ha) **(A)**	376.5
survey time (Mins)	3240
bird obs time@10-100m (Mins)	9.25

proportion of time between 10-100m (t)

0.002854938 (obs time/survey time)

2 flight activity per ha (F)

F = t/A *cum*

7.58284E-06

Flight risk area (ha) inc 25m buffer for blades: 376.5

3 proportion of time at 20-130m

F*flight risk area

0.002854938

4 hub height (m)	67
blade diameter (m)	80
rotor top	107
rotor bottom	27

proportion of time in turbine area

0.002076319 ((top of rotor-bottom of rotor)/(130-20))*F

5 days likely present	153
hours active	16

bird occupancy period in wind farm n (hrs)

5.082828283 (days present*hrs active per day)* prop time in turbines

n (mins)

304.969697

n(secs) (used in calc later)

18,298.18182

6 flight risk volume V_w (m^2)

301,200,000 (wind farm area*rotor diameter)

7 combined volume swept by rotors V_r (m^3)

14,5376

	No of turbines	7
	Rotor depth (m)	3.5
	Bird Length (m)	0.63
	radius	40
	$radius^2$	1600
	pi	3.142857143
	piR^2	5028.571429

8 occupancy of rotor swept area b (bird seconds)

8.831728021 (n*(Vr/Vw)

9 flight speed (m/s) 13.5

Time to fly through and clear rotors time

0.408910891 (rotor depth + bird length)*flight speed(m/s)

10 Number of transits through rotors per year

21.59817264 (b/time)

Collision rate

2.354200818 Number of transits * probability of bird strike from stage 2

0.023542008 (% probability value at stage 2 as a proportion e.g. 10% would be 0.1)

Collision risk at 95% avoidance 0.047084016

Collision Risk Calculations for Red Kite – Stage 2

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**									
No. Blades	3						Upwind:				Downwind:	
MaxChord	3.52	m	r/R	c/C	α	collide		contribution	collide		contribution	
Pitch (degrees)	3		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r	
Bird Length	0.63	m	0.025	0.575	6.26	24.36	1.00	0.00125	24.14	1.00	0.00125	
Wingspan	1.85	m	0.075	0.575	2.09	8.19	0.62	0.00468	7.98	0.61	0.00456	
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.25	5.54	0.42	0.00527	5.28	0.40	0.00503	
			0.175	0.860	0.89	4.52	0.34	0.00603	4.20	0.32	0.00561	
Bird speed	8	m/sec	0.225	0.994	0.70	3.90	0.30	0.00669	3.54	0.27	0.00607	
Rotor Diam	80	m	0.275	0.947	0.57	3.12	0.24	0.00655	2.77	0.21	0.00581	
Rotation Period	4.92	sec	0.325	0.899	0.48	2.58	0.20	0.00639	2.25	0.17	0.00557	
			0.375	0.851	0.42	2.18	0.17	0.00623	1.87	0.14	0.00533	
			0.425	0.804	0.37	1.87	0.14	0.00606	1.57	0.12	0.00510	
			0.475	0.756	0.33	1.65	0.13	0.00596	1.37	0.10	0.00495	
Bird aspect ratio: β	0.34		0.525	0.708	0.30	1.50	0.11	0.00601	1.24	0.09	0.00497	
			0.575	0.660	0.27	1.38	0.11	0.00607	1.14	0.09	0.00500	
			0.625	0.613	0.25	1.28	0.10	0.00611	1.06	0.08	0.00503	
			0.675	0.565	0.23	1.19	0.09	0.00615	0.99	0.08	0.00508	
			0.725	0.517	0.22	1.12	0.09	0.00618	0.93	0.07	0.00513	
			0.775	0.470	0.20	1.05	0.08	0.00620	0.88	0.07	0.00518	
			0.825	0.422	0.19	0.99	0.08	0.00622	0.83	0.06	0.00524	
			0.875	0.374	0.18	0.93	0.07	0.00623	0.80	0.06	0.00531	
			0.925	0.327	0.17	0.88	0.07	0.00624	0.76	0.06	0.00539	
			0.975	0.279	0.16	0.84	0.06	0.00623	0.74	0.06	0.00547	
				Overall p(collision) =			**Upwind**	**11.7%**		**Downwind**	**10.1%**	
								Average	**10.9%**			