Appendix 8.1 Ornithology Technical Appendix

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DOUGLAS WEST EXTENSION WIND FARM

ORNITHOLOGY

Appendix 8.1

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FIGURES

1 INTRODUCTION

MacArthur Green was commissioned by Douglas West Extension Ltd to complete ornithological surveys at the proposed Douglas West Extension Wind Farm site, near Douglas in South Lanarkshire (hereafter referred to as the 'Proposed Development' and the 'site'). The surveys were conducted between March and August 2018 to inform an assessment of the potential ornithological effects of the Proposed Development on the species assemblage present.

This technical report summarises the methods employed and the results of the field surveys and is supported by the following Annexes:

Annex A: Ornithological Legal Protection;
Annex B: Ornithological Survey Methodology;
Annex C: Ornithological Survey Effort and General Information;
Annex D: Ornithological Survey Results;
Annex E: Review of the Effects of Artificial Light on Birds in Relation to Deployment of Obstruction Lighting on Wind Turbines; and
Annex F: Supplementary Desk Study Information.

A range of surveys were employed to accurately record baseline conditions within the site and appropriate survey buffers (detailed in Annex B). In this Technical Appendix, associated Annexes (A – F) and Chapter 8 (Ornithology) of the Environmental Impact Assessment (EIA) Report, terms referred to are as follows:

- the site refers to the area within the red line boundary (**Figure 8.3**);
- 'survey area' is defined as the area covered by each survey type at the time of survey (refer to Annex B for details of various survey buffers); and
- 'study area' is defined as the area of consideration of effects on each species at the time of assessment (**Figure 8.3**).

2 LEGAL PROTECTION

With limited exceptions, all wild birds and their eggs are protected by law. Specific levels of protection are determined by a species' inclusion on certain lists. Annex A to this report details the various levels of legal protection afforded to UK bird species.

3 FIELD SURVEY METHODS

The following surveys were undertaken at the site between March and August 2018:

- Scarce breeding bird surveys (one breeding season), within a minimum 2 km survey buffer; and
- Black grouse surveys (one breeding season), within a minimum 1.5 km survey buffer.

In addition, the following surveys were undertaken during the same period directly to the south of the site, for the proposed Hagshaw Hill Wind Farm Repowering project:

- Flight activity surveys (one breeding season), from one vantage point around 2.5 km south of the site (**Figure 8.4**), following SNH (2017[1]) guidance;
- Breeding bird surveys (one breeding season), within a 500 m survey buffer of Repowered Hagshaw Hill Wind Farm site (see results in **Figure 8.6**) following SNH (2017) guidance;

These survey results have been considered here, and summarised within Chapter 8: Ornithology to provide further contextual information to inform the impact assessment, but are not reproduced in detail here.

Survey methods followed the recommended SNH (2017) guidelines and methods are described in detail within Annex B. Where possible, each survey was carried out beyond the site within a buffer distance specific to that method (e.g. 2 km buffer for the scarce breeding bird surveys) and these are detailed within Annex B.

The relative importance of the data collected was determined by the specific level of protection assigned to those species recorded, coupled with their perceived susceptibility to potential impacts resulting from the Proposed Development. The resulting 'target species' and 'secondary species' lists are a standard assessment tool for wind farm ornithological studies (see Annex B).

4 FIELD SURVEY RESULTS

All surveys were undertaken during suitable weather conditions (as described within Annex B – Survey Methodologies). Surveys for raptor species on Schedule 1 of the Wildlife & Countryside Act 1981 were carried out by appropriately licensed surveyors. All survey data were reviewed, inputted, and analysed by MacArthur Green.

Survey effort and results of the field surveys are detailed within Annexes C & D and survey results are also illustrated within **Figure 8.5** to **Figure 8.8**. The following sections summarise the results from each survey undertaken.

4.1 Scarce Breeding Birds

Scarce breeding bird surveys were conducted during the 2018 (March to August) breeding season.

Peregrine was recorded in flight on two occasions during surveys for the Repowered Hagshaw Hill project (**Figure 8.5**), one of which comprising a possible pair, but no breeding attempts were located within the survey area. A single osprey flight was recorded to the south of the site during a flight activity survey for the Hagshaw Hill Wind Farm Repowering project.

Buzzard, kestrel, sparrowhawk and tawny owl (secondary raptor species) were also recorded across the survey area and are likely to have bred within the wider area.

Full details of the scarce breeding bird surveys are provided within Annexes C and D, and survey methodology is provided within Annex B.

4.2 Black Grouse

Surveys to identify areas of black grouse activity, locate lek locations and establish lek size were conducted in the 2018 breeding season during April and May. No black grouse leks or black grouse themselves were recorded

[1] Scottish Natural Heritage (2017) Recommended Bird Survey Methods to inform impact assessment of Onshore Windfarms.

during targeted surveys (nor during any other surveys during the 2018 breeding season). Full details of the black grouse surveys are provided within Annex C and survey methodology is provided within Annex B.

ANNEX A ORNITHOLOGICAL LEGAL PROTECTION

In Scotland, all wild birds are protected under the Wildlife and Countryside Act 1981 (the 'Act'), as amended by the Nature Conservation (Scotland) Act 2004. This protection also extends to their eggs and nests, with it being an offence to intentionally or recklessly[1]:

- Kill, injure or take any wild bird[2];
- Take, damage, destroy or otherwise interfere with the nest of any wild bird while it is being built or is in use[3];
- At any other time take, damage, destroy or otherwise interfere with any nest habitually used by any wild bird included in Schedule A1 (Protected Nests and Nest Sites for Birds: white-tailed eagle and golden eagle)[4];
- Obstruct or prevent any wild bird from using its nest[5]; or
- Take or destroy an egg of any wild bird[6].

It is also an offence to have in possession or control any live or dead wild bird or any part thereof; or any egg or part of an egg of any wild bird[7].

Further special protection under this legislation is afforded to those species listed in Schedule 1 of the Act. For these species, it is an offence to:

- Intentionally or recklessly disturb any wild bird listed in Schedule 1 while it is nest building, or is in, on or near a nest containing eggs or young, or disturb the dependent young of such a bird[8];
- Intentionally or recklessly disturb any wild birds included in Schedule 1 which leks, while it is doing so[9] (capercaillie is the only bird this offence applies to in Scotland);
- Intentionally or recklessly harass any wild bird included in Schedule 1A[10]. Section 1, subsection 5B states, '*Subject to the provisions of this Part, any person who intentionally or recklessly harasses any wild bird included in Schedule 1A shall be guilty of an offence*'. At this time, Schedule 1A includes golden eagle, hen harrier, red kite and white-tailed eagle. This updated legislation was introduced on 16 March 2013; or
- Intentionally or recklessly take, damage, destroy or otherwise interfere with any nest and/or nest site habitually used by any bird on Schedule A1 at any time. At this time, Schedule 1A includes golden eagle and white-tailed eagle[11].

It is also an offence to knowingly cause or permit to be done an act which is made unlawful by any of the above provisions.

Further protection is described under the EU Birds Directive which requires member states to maintain wild bird species in favourable conservation status[12] and promote the conservation of bird species listed within Annex 1 of the Birds Directive through the protection of their habitat. This is achieved via the designation of Special Protection Areas (SPAs).

Red List bird species are those deemed to be globally threatened and to be suffering population declines within the UK. Although not legally enforceable, the conservation of Red List bird species represents a material consideration, in planning terms.

[1] Exceptions to these offences exist under various circumstances (e.g. controlling pest species; taking birds during specific season; and killing sick or injured birds etc.).
[2] Wildlife and Countryside Act 1981, Section 1(1)(a)
[3] Wildlife and Countryside Act 1981, Section 1(1)(b)
[4] Wildlife and Countryside Act 1981, Section 1(1)(ba)
[5] Wildlife and Countryside Act 1981, Section 1(1)(bb)
[6] Wildlife and Countryside Act 1981, Section 1(1)(c)
[7] Wildlife and Countryside Act 1981, Section 1(2)
[8] Wildlife and Countryside Act 1981, Section 1(5)
[9] Wildlife and Countryside Act 1981, Section 1(5A)
[10] Wildlife and Countryside Act 1981, Section 1(5B)
[11] This reflects the changes introduced by the Wildlife and Countryside Act 1981 (as amended by: Variation of Schedules A1 and 1A (Scotland) Order 2013
[12] While the term 'favourable conservation status' is not used in the Birds Directive, EU court cases over recent years have progressively interpreted the concept as meaningful in a Birds Directive context (SNH, 2006).

ANNEX B ORNITHOLOGICAL SURVEY METHODOLOGY

In addition to the desk-based study undertaken for the proposed Douglas West Extension Wind Farm (hereafter referred to as 'the Proposed Development'), ornithological surveys were undertaken in 2018. The methodologies used across all surveys are summarised in the sections below; more detailed descriptions are provided in the Scottish Natural Heritage (SNH) guidance (2017[i]) on which these surveys are based.

Study Area

Scarce breeding bird and black grouse surveys were undertaken during the 2018 breeding season. Survey areas were buffered from the proposed turbine layout (**Figure 8.3**) provided by the client.

B.1 Scarce Breeding Bird Survey

The aim of the scarce breeding bird surveys was to determine the distribution of occupied nests/territories for target raptor, owl and diver species within 2 km of the site and record breeding success. Secondary species such as buzzard, sparrowhawk and kestrel were also noted but location of their nests was not the key focus of the surveys. Survey areas are detailed in **Figure 8.3**.

Surveys were undertaken by experienced and licensed[1] field ornithologists. Extreme care was taken to avoid unnecessary disturbance to breeding birds.

Guidance from SNH (SNH, 2017[i] P11-14), 'Bird Monitoring Methods' (Gilbert *et al.* 1998[ii]) and 'Raptors: a field guide to survey and monitoring' (Hardey *et al.* 2013[iii]) were all consulted to inform survey methodology and are referenced where appropriate in the species methodologies below.

Barn Owl

- The surveys followed methodology outlined in Gilbert *et al.* (1998[ii]), as mentioned in SNH Guidance (SNH, 2017[i] P12-13);
- Surveys were undertaken within 1 km of the site; and
- Surveyors checked for signs of occupation (moulted feathers, pellets) in all suitable buildings within this 1 km buffer.

Goshawk

Methodology outlined in Hardey *et al.* (2013[iii]) was used as guidance for the surveying of areas for potential goshawk breeding. Extreme care was taken not to disturb potential nests especially around the time of year when females were likely to be laying or incubating.

- Areas of suitable woodland were observed for the presence of nests. Searches for goshawk nests were focused on mature forestry blocks, although their presence was not ruled out of other wooded areas;
- Searches carried out between March and April focussed on observing territorial and nest building behaviours;
- Where nests were known to be present, scans were carried out between mid-March and May to confirm breeding. Scans were kept brief – carried out for between 5-10 minutes and from a distance; and
- When breeding was confirmed, searches for further nests were deferred until such a time as the young had hatched. Searches were then undertaken between late May and late June for evidence of provisioning young and then between late July and early August to watch for fledgling activity, this included listening for the begging calls of newly fledged young.

Hen Harrier

Methodology outlined in Hardey *et al*. (2013[iii]) was used as guidance for the surveying of areas for potential hen harrier breeding. Extreme care was taken not to disturb potential nests especially around the time of year when females were likely to be laying or in cold/wet weather when females were likely to be incubating or brooding. Areas of suitable habitat[2] were visited during four time periods across the breeding season to:

- Check for territory occupancy (between March and mid-April) – this consisted of watching over suitable habitat from a good vantage point for displaying males (and females) and checking all areas of suitable habitat to within 250 m (watching out for signs of kills);
- Locate incubating females (between mid-April and late May) by listening for female begging calls and watching for food passes between the male and female – surveyors watched for at least four hours as Hardey *et al.* (2013[iii]) notes that when the female is incubating it can be up to six hours between feeding visits from the male, but on average it is less than every four hours. Surveys were undertaken between 06:00 to 12:00 or 16:00 to 20:00;
- Check for young or breeding evidence (between late May and late June) again by listening for female begging calls and watching for food passes between male and female when the female is brooding and watching for the male and female provisioning the nest with food once brooding has ended– surveyors watched for at least two hours as Hardey *et al.* (2013[iii]) notes that an adult bird will visit the nest every 1-2 hours. Surveyors also watched for display behaviour which could indicate a failed breeding attempt; and
- Check for fledged young (between late June and late August).

Merlin

Methodology outlined in Hardey *et al.* (2013[iii]) was used as guidance for the surveying of areas for potential merlin breeding.

- Areas of suitable nesting habitat (including forest edge where trees are >5 m high) were closely observed between 20th March and 30th April;
- Boulders, fence lines, isolated posts, stone dykes, grouse butts, hummocks, stream banks, crags, trees and recently burnt areas of heather were checked for signs of occupation (e.g. plucked prey, moulted feathers, pellets and faeces);
- If merlin were observed, or signs found, areas were visited at least twice to verify occupation of the site; and
- Potential nest areas were watched for 4-6 hours if necessary.

[1] All surveyors hold SNH Schedule 1 Licences.

[2] Unsuitable habitat areas include: land above 600m; improved pasture and arable land; extensive areas of degraded land with no heather cover and low vegetation; the vicinity of cliffs, rocky outcrops, boulder fields and scree; areas within 100m of hill farms and occupied dwellings.

Peregrine

- Potential nest sites were visited and checked for evidence of occupation between March and April;
- Sites checked included crags and steep banks identified from OS maps and searches of the study area;
- Surveyors checked for signs of occupation (e.g. faecal splash, fresh plucked prey);
- If occupied sites were found they were re-visited to verify incubation; and
- Searches were made for eyries. Where this was not possible sites were watched from a suitable vantage point for 3-4 hours or until a nest was located.

Short-Eared Owl

- At least two visits between early April and the end of May were carried out;
- Suitable habitat was visited and checked for evidence of hunting males, territorial activity and other signs of presence; and
- If breeding was confirmed, a further visit was be made in June to watch birds, locate nest-sites and confirm breeding behaviour wherever possible.

B.2 Black Grouse Survey

The survey methodology used is detailed in SNH Guidance (SNH, 2007[iv]; SNH, 2017[i] P12) and a summary is provided below. Survey areas are detailed in **Figure 8.3**. Surveys were conducted in April and May in 2018.

- Breeding black grouse were surveyed within 1.5 km of the site by counting total numbers of males and females at leks, most lekking activity taking place at or soon after dawn in spring.
- Known lek sites and other areas of suitable habitat which can host leks were identified and visited during April within 2 hours of dawn on calm dry days with good visibility;
- Visits involved listening and scanning for lekking black grouse from strategic locations (avoiding disturbance of leks) and during walks between these locations ensuring that all potential habitat was covered;
- The maximum count of males in the 2 hours around dawn gives the standard count estimate but the maximum number of females seen was also presented; and
- Leks that were at least 200 m apart within the same year were treated as separate leks.

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[i] Scottish Natural Heritage (2017) Recommended bird survey methods to inform impact assessment of onshore windfarms.
[ii] Gilbert, G., Gibbons, D. W. and Evans, J. (1998) Bird Monitoring Methods. RSPB, Sandy.
[iii] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (November 2013) Raptors: a field guide for surveys and monitoring (3rd edition). The Stationery Office, Edinburgh.
[iv] Scottish Natural Heritage (2007) Black grouse survey methodology.

ANNEX C ORNITHOLOGICAL SURVEY EFFORT & GENERAL INFORMATION

Table C-1 shows the system used for recording weather conditions on all the surveys detailed in sections C.1 and C.2 below.

Table C-1 Key to meteorological conditions recorded during all surveys

Wind speed		Rain		Cloud cover		Cloud height	
Calm	0	None	0	In eighths		<150 m	0
Light air	1	Drizzle/Mist	1	*e.g.*	3/8	150-500 m	1
Light breeze	2	Light showers	2			>500 m	2
Gentle breeze	3	Heavy showers	3				
Moderate breeze	4	Heavy rain	4				
Fresh breeze	5						
Strong breeze	6	**Snow**		**Frost**		**Visibility**	
Moderate gale	7	None	0	None	0	Poor (<1 km)	0
Fresh gale	8	On site	1	Ground	1	Moderate (1-2 km)	1
Strong gale	9	High ground	2	All day	2	Good (>2 km)	2
Whole gale	10						
Storm	11						
Hurricane	12						

C.1 Scarce Breeding Bird Surveys

Scarce breeding bird surveys were undertaken during the 2018 breeding season. Table C-2 details survey dates and weather data recorded. Refer to Annex B for survey methodology and Annex D for survey results.

Table C-2 Meteorological conditions during 2018 scarce breeding bird surveys (sorted chronologically)

Date	Survey visit	Observer	Survey start time	Survey finish time	Survey hour	Wind speed	Wind direction	Rain	Cloud cover	Cloud height	Visibility	Frost	Snow
26/03/2018	1	MW	0900	1500	1	4	WSW	0	3	2	2	1	1
26/03/2018	1	MW	0900	1500	2	4	WSW	0	3	2	2	1	1
26/03/2018	1	MW	0900	1500	3	5	WSW	0	3	2	2	1	1
26/03/2018	1	MW	0900	1500	4	5	WSW	0	4	2	2	0	1
26/03/2018	1	MW	0900	1500	5	5	WSW	0	5	2	2	0	1
26/03/2018	1	MW	0900	1500	6	5	WSW	0	6	2	2	0	1
27/03/2018	1	MW	1300	1400	1	3	SSW	1	8	0	0	0	0
18/04/2018	2	SP	0630	0830	1	3	SW	1	8	2	2	0	0
18/04/2018	2	SP	0630	0830	2	3	SW	0	8	2	2	0	0
18/04/2018	2	SP	1030	1445	3	3	SW	0	7	2	2	0	0
18/04/2018	2	SP	1030	1445	4	3	SW	0	6	2	2	0	0
18/04/2018	2	SP	1030	1445	5	3	SW	0	8	2	2	0	0
18/04/2018	2	SP	1030	1445	6	3	SW	0	8	2	2	0	0
24/04/2018	2	SP	0700	1215	1	4	SW	0	7	2	2	0	0
24/04/2018	2	SP	0700	1215	2	4	SW	2	8	2	2	0	0
24/04/2018	2	SP	0700	1215	3	3	SW	2	8	2	2	0	0
24/04/2018	2	SP	0700	1215	4	3	SW	0	7	2	2	0	0
24/04/2018	2	SP	0700	1215	5	4	SW	0	6	2	2	0	0
24/04/2018	2	SP	0700	1215	6	4	SW	0	7	2	2	0	0
28/05/2018	3	SP	0905	1205	1	1	ENE	0	3	2	2	0	0
28/05/2018	3	SP	0905	1205	2	2	NE	0	3	2	2	0	0
28/05/2018	3	SP	0905	1205	3	2	NE	0	5	2	2	0	0

Date	Survey visit	Observer	Survey start time	Survey finish time	Survey hour	Wind speed	Wind direction	Rain	Cloud cover	Cloud height	Visibility	Frost	Snow
28/05/2018	3	SP	1230	1530	4	2	NE	0	5	2	2	0	0
28/05/2018	3	SP	1230	1530	5	3	NE	0	5	2	2	0	0
28/05/2018	3	SP	1230	1530	6	3	NE	0	4	2	2	0	0
29/05/2018	3	SP	0645	1245	1	0	0	0	0	0	1	0	0
29/05/2018	3	SP	0645	1245	2	1	ENE	0	0	0	1	0	0
29/05/2018	3	SP	0645	1245	3	2	ENE	0	3	2	2	0	0
29/05/2018	3	SP	0645	1245	4	2	ENE	0	4	2	2	0	0
29/05/2018	3	SP	0645	1245	5	2	ENE	0	4	2	2	0	0
29/05/2018	3	SP	0645	1245	6	3	ENE	0	5	2	2	0	0
18/06/2018	4	SP	1100	1500	1	4	WSW	0	8	2	2	0	0
18/06/2018	4	SP	1100	1500	2	4	WSW	0	5	2	2	0	0
18/06/2018	4	SP	1100	1500	3	4	WSW	0	3	2	2	0	0
18/06/2018	4	SP	1100	1500	4	4	WSW	0	3	2	2	0	0
21/06/2018	4	SP	1215	1615	1	4	NW	0	4	2	2	0	0
21/06/2018	4	SP	1215	1615	2	4	NW	0	3	2	2	0	0
21/06/2018	4	SP	1215	1615	3	4	NW	0	4	2	2	0	0
21/06/2018	4	SP	1215	1615	4	5	NW	0	4	2	2	0	0
27/06/2018	4	MW	0700	1000	1	2	SSW	0	1	2	2	0	0
27/06/2018	4	MW	0700	1000	2	2	SSW	0	1	2	2	0	0
27/06/2018	4	MW	0700	1000	3	2	SSW	0	1	2	2	0	0
27/06/2018	4	MW	1030	1330	4	2	SSW	0	1	2	2	0	0
27/06/2018	4	MW	1030	1330	5	2	SSW	0	1	2	2	0	0
27/06/2018	4	MW	1030	1330	6	2	SSW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	1	1	SW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	2	1	SW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	3	1	SW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	4	2	SW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	5	2	SW	0	1	2	2	0	0
28/06/2018	4	MW	0700	1000	6	2	SW	0	1	2	2	0	0
29/06/2018	4	MW	0500	0800	1	4	SE	0	0	2	2	0	0
29/06/2018	4	MW	0500	0800	2	4	SE	0	0	2	2	0	0
29/06/2018	4	MW	0500	0800	3	4	SE	0	1	2	2	0	0
29/06/2018	4	MW	0830	1130	4	3	SE	0	1	2	2	0	0
29/06/2018	4	MW	0830	1130	5	3	SE	0	1	2	2	0	0
29/06/2018	4	MW	0830	1130	6	2	SE	0	1	2	2	0	0
04/07/2018	5	MW	0630	0930	1	3	NW	0	1	2	2	0	0
04/07/2018	5	MW	0630	0930	2	4	NW	0	1	2	2	0	0
04/07/2018	5	MW	0630	0930	3	5	NW	0	3	2	2	0	0
04/07/2018	5	MW	1000	1300	1	5	S	0	4	2	2	0	0
04/07/2018	5	MW	1000	1300	2	5	S	0	4	2	2	0	0
04/07/2018	5	MW	1000	1300	3	5	SSW	0	3	2	2	0	0
05/07/2018	5	MW	0630	0930	1	4	WNW	0	4	2	2	0	0
05/07/2018	5	MW	0630	0930	2	5	WNW	0	4	2	2	0	0
05/07/2018	5	MW	0630	0930	3	5	WNW	0	5	2	2	0	0

Date	Survey visit	Observer	Survey start time	Survey finish time	Survey hour	Wind speed	Wind direction	Rain	Cloud cover	Cloud height	Visibility	Frost	Snow
05/07/2018	5	MW	1000	1300	1	6	WNW	0	5	2	2	0	0
05/07/2018	5	MW	1000	1300	2	5	WNW	0	6	2	2	0	0
05/07/2018	5	MW	1000	1300	3	5	WNW	0	6	2	2	0	0
24/07/2018	5	MW	0700	1000	1	3	W	0	5	2	2	0	0
24/07/2018	5	MW	0700	1000	2	4	W	0	5	2	2	0	0
24/07/2018	5	MW	0700	1000	3	5	W	0	6	2	2	0	0
24/07/2018	5	MW	1030	1330	1	5	W	0	7	2	2	0	0
24/07/2018	5	MW	1030	1330	2	5	W	0	6	2	2	0	0
24/07/2018	5	MW	1030	1330	3	5	W	0	6	2	2	0	0
25/07/2018	5	MW	0700	1000	1	6	S	0	3	2	2	0	0
25/07/2018	5	MW	0700	1000	2	6	S	0	3	2	2	0	0
25/07/2018	5	MW	0700	1000	3	6	S	0	4	2	2	0	0
25/07/2018	5	MW	1030	1330	1	6	S	0	4	2	2	0	0
25/07/2018	5	MW	1030	1330	2	6	S	0	3	2	2	0	0
25/07/2018	5	MW	1030	1330	3	6	S	0	4	2	2	0	0
17/08/2018	6	MW	0730	1330	1	6	SW	0	7	2	2	0	0
17/08/2018	6	MW	0730	1330	2	6	SW	0	8	2	2	0	0
17/08/2018	6	MW	0730	1330	3	6	SW	0	8	2	2	0	0
17/08/2018	6	MW	0730	1330	4	6	SW	0	8	2	2	0	0
17/08/2018	6	MW	0730	1330	5	6	SW	0	8	2	2	0	0
17/08/2018	6	MW	0730	1330	6	7	SW	0	8	2	2	0	0
17/08/2018	6	MW	0630	1300	1	2	SE	0	1	2	2	0	0
31/08/2018	6	MW	0630	1300	2	2	SE	0	1	2	2	0	0
31/08/2018	6	MW	0630	1300	3	3	SE	0	1	2	2	0	0
31/08/2018	6	MW	0630	1300	4	4	SE	0	1	2	2	0	0
31/08/2018	6	MW	0630	1300	5	4	SE	0	2	2	2	0	0
31/08/2018	6	MW	0630	1300	6	5	SE	0	3	2	2	0	0

C.2 Black Grouse Surveys

Black grouse surveys were undertaken during the 2018 breeding season. Table C-3 details survey dates and weather data recorded. Refer to Annex B for survey methodology and Annex D for survey results.

Table C-3 Meteorological conditions during 2018 black grouse surveys (sorted chronologically)

Date	Survey visit	Observer	Survey start time	Survey finish time	Survey hour	Wind speed	Wind direction	Rain	Cloud cover	Cloud height	Visibility	Frost	Snow
18/04/2018	1	SP	0450	0620	1	4	SW	0	4	2	1	0	0
18/04/2018	1	SP	0450	0620	2	4	SW	2	5	2	2	0	0
21/04/2018	1	SP	0455	0630	1	4	E	0	8	0	1	0	0
21/04/2018	1	SP	0455	0630	2	4	ENE	0	7	1	1	0	0
24/04/2018	1	SP	0445	0620	1	4	SW	0	7	2	2	0	0
24/04/2018	1	SP	0445	0620	2	4	SW	0	6	2	2	0	0
24/05/2018	2	SP	0350	0635	1	2	ENE	0	8	0	1	0	0
24/05/2018	2	SP	0350	0635	2	2	ENE	0	7	1	1	0	0
29/05/2018	2	SP	0355	0630	1	0	0	0	0	2	1	0	0
29/05/2018	2	SP	0355	0630	2	0	0	0	0	2	1	0	0

ANNEX D ORNITHOLOGICAL SURVEY RESULTS

D.1 Scarce Breeding Bird Records

Table D-1 details all records of raptors and owls recording during surveys, however only Annex 1[1] or Schedule 1[2] species are considered to be scarce breeding birds (i.e. target species). Refer to Annex B for survey methodology, Annex C for weather data.

Table D-1 Raptor records: 2018

Date	Species	Protection status	Number recorded	Notes
26/03/2018	Buzzard	BoCC[3] Green	1	
26/03/2018	Kestrel	BoCC Amber	1	Not mapped
21/04/2018	Buzzard	BoCC Green	2	Potentially two flying over at the same time
21/04/2018	Peregrine falcon	Annex 1, Schedule 1, BoCC Green	1	Flying over
07/05/2018	Kestrel	BoCC Amber	1	Hunting
07/05/2018	Peregrine	Annex 1, Schedule 1, BoCC Green	2	Unsexed
23/05/2018	Buzzard	BoCC Green	1	Flying over
23/05/2018	Kestrel	BoCC Amber	1	Flying over
23/05/2018	Sparrowhawk	BoCC Green	1	
23/05/2018	Sparrowhawk	BoCC Green	1	Flying over
28/05/2018	Buzzard	BoCC Green	3	At Cumberhead Forest (north east part)
28/05/2018	Buzzard	BoCC Green	1	At Long Plantation
28/05/2018	Buzzard	BoCC Green	1	At Cumberhead Forest (north east part)
29/05/2018	Buzzard	BoCC Green	1	At High Broomerfield
18/06/2018	Tawny owl	BoCC Amber	1	At Cumberhead Forest (South) in location NS 78333 32401
28/06/2018	Buzzard	BoCC Green	1	
29/06/2018	Buzzard	BoCC Green	1	
29/06/2018	Kestrel	BoCC Amber	1	
09/07/2018	Kestrel	BoCC Amber	1	
24/07/2018	Buzzard	BoCC Green	1	
24/07/2018	Kestrel	BoCC Amber	1	
24/07/2018	Sparrowhawk	BoCC Green	1	
25/07/2018	Buzzard	BoCC Green	1	
16/08/2018	Buzzard	BoCC Green	2	
16/08/2018	Kestrel	BoCC Amber	1	

D.2 Black Grouse Records

Table D-2 details all black grouse records with lek numbers indicated where appropriate. Refer to Annex B for survey methodology and Annex C for weather data.

Table D-2 Black grouse activity records: 2018

Date	Observer	Survey visit	Lek no.	No. males	No. Females
18/04/2018	SP	1	No black grouse/signs of black grouse recorded		
21/04/2018	SP	1	No black grouse/signs of black grouse recorded		
24/04/2018	SP	1	No black grouse/signs of black grouse recorded		
24/05/2018	SP	2	No black grouse/signs of black grouse recorded		
29/05/2018	SP	2	No black grouse/signs of black grouse recorded		

[1] Annex 1 of the EU Bird Directive
[2] Schedule 1 of the Wildlife and Countryside Act 1981, as amended by the Nature Conservation Act (Scotland) 2004
[3] BoCC – Birds of Conservation Concern (Eaton *et al.* 2015)

D.3 Bird Species Index

A total of 64 bird species or signs were recorded at, or adjacent, to the site during the ornithological surveys (including those for Hagshaw Hill Wind Farm Repowering). Table D-3 comprises a list of all these species along with their conservation status.

Table D-3 All bird species recorded (March to August 2018)

Species	Conservation status	Species	Conservation status
Blackbird	BoCC Green	Meadow pipit	BoCC Amber
Black-headed gull	BoCC Amber	Mistle thrush	BoCC Red
Blue tit	BoCC Green	Moorhen	BoCC Green
Bullfinch	BoCC Amber	Mute swan	BoCC Amber
Buzzard	BoCC Green	Nuthatch	BoCC Green
Carrion crow	BoCC Green	Oystercatcher	BoCC Amber
Chaffinch	BoCC Green	Peregrine	Annex 1, Schedule 1, BoCC Green
Chiffchaff	BoCC Green	Pied wagtail	BoCC Green
Coal tit	BoCC Green	Raven	BoCC Green
Common crossbill	Schedule 1, BoCC Green	Red grouse	BoCC Amber
Common gull	BoCC Amber	Redwing	Schedule 1, BoCC Red
Common sandpiper	BoCC Amber	Reed bunting	BoCC Amber
Cuckoo	BoCC Red	Ringed plover	BoCC Red
Curlew	BoCC Red	Robin	BoCC Green
Dunnock	BoCC Amber	Rook	BoCC Green
Fieldfare	Schedule 1, BoCC Red	Sand martin	BoCC Green
Goldcrest	BoCC Green	Sedge warbler	BoCC Green
Goldfinch	BoCC Green	Siskin	BoCC Green
Grasshopper warbler	BoCC Red	Skylark	BoCC Red
Great tit	BoCC Green	Snipe	BoCC Amber
Grey wagtail	BoCC Red	Song thrush	BoCC Red
House martin	BoCC Amber	Sparrowhawk	BoCC Green
Jackdaw	BoCC Green	Starling	BoCC Red
Jay	BoCC Green	Swallow	BoCC Green
Kestrel	BoCC Amber	Swift	BoCC Amber
Lapwing	BoCC Red	Tawny owl	BoCC Amber
Lesser black-backed gull	BoCC Amber	Tufted duck	BoCC Green
Lesser redpoll	BoCC Red	Wheatear	BoCC Green
Linnet	BoCC Red	Whinchat	BoCC Red
Little grebe	BoCC Green	Willow warbler	BoCC Amber
Magpie	BoCC Green	Woodpigeon	BoCC Green
Mallard	BoCC Amber	Wren	BoCC Green

ANNEX E REVIEW OF THE EFFECTS OF ARTIFICIAL LIGHT ON BIRDS IN RELATION TO DEPLOYMENT OF OBSTRUCTION LIGHTING ON WIND TURBINES

E.1 Introduction

With the increase in height of wind turbines, it is now a requirement for obstruction lighting to be added to tall turbines to make the structures more visible to pilots of aircraft. This review summarises the impacts of artificial light on birds and considers whether any of the known impacts might arise in birds as a consequence of deployment of obstruction lighting on wind turbines. This review was undertaken by Professor Bob Furness in September 2017.

E.2 Methods

A literature search was carried out, using tools such as Web of Knowledge and Google scholar, to identify relevant published work. Identified publications were obtained and read, in order to prepare this review paper.

E.3 Results Obtained from Literature Search

There is a large literature identifying a wide range of impacts of artificial lights on birds. The identified impacts all relate to effects occurring at night. These include:

- Disruption of photoperiod physiology of birds due to artificial light;
- Extension of daytime activity (earlier start at dawn, later end at dusk);
- Phototaxis of seabirds (birds attracted to light sources and grounded on land);
- Phototaxis of nocturnal migrants (birds attracted to light sources and grounded or killed);
- Ability of some birds to use nocturnal feeding assisted by artificial light;
- Increased predation risk for nocturnal birds resulting from artificial lighting;
- Birds better able to avoid collision when structures are illuminated; and
- Displacement of birds due to avoidance of lights.

These impacts are considered in turn below.

Disruption of photoperiod physiology of birds due to artificial light

In theory, low levels of artificial light have the potential to affect the physiological photoperiod experienced by birds, and thereby to affect the timing of their onset of activity in the morning and end of activity in the evening, as well as potentially affecting the seasonal triggers for activities such as deposition or shedding of fat stores, moult, breeding and migration (Titulaer *et al.* 2012, Gaston *et al.* 2013, 2015, De Jong *et al*. 2017, Da Silva *et al.* 2017). However, there are no published studies or observations reporting clear examples of any seasonal activities of birds being affected by exposure to artificial light. There are a few anecdotal examples of urban birds starting to nest in winter, and this could possibly be interpreted as birds coming into breeding condition early because their photoperiod had been affected by artificial light. However, such early breeding is generally seen only in a few bird species that are often able to breed successfully in winter if weather conditions permit. That suggests that such cases represent opportunistic breeding in urban environments rather than disruption of natural photoperiod responses. De Jong *et al.* (2017) experimented with birds in captivity, exposing them to different colours of light at night. Birds advanced their onset of activity in the morning when exposed to light at night, and advanced timing more in response to red and white light than to green light. Birds advanced timing more in response to higher intensity of artificial light. However, there have not been similar experiments with free-living wild birds, so it is uncertain if such effects occur in wild birds. Since such effects have not been reported, it seems more likely that there is very little, if any, effect of artificial light on photoperiod responses of wild birds.

Extension of daytime activity

Da Silva *et al.* (2017) used an experimental approach with wild birds, exposing the area around an automated feeding station in a forest to artificial light at night. They found a small response in some bird species, with blue tit and great tit starting to forage earlier during experimentally lighted mornings. However, no response was shown by willow/marsh tit, nuthatch, jay or blackbird, and the response of great tits was weak. The authors concluded that '*our results suggest that artificial light during winter has only small effects on timing of foraging*'. Da Silva *et al*. (2017) used an experimental approach to test whether birds start singing earlier in the morning when their forest habitat was illuminated with artificial light. They found no effect of artificial light (testing a variety of different light colours) on the timing of the dawn chorus. These results suggest that artificial light has very little, if any, impact on the available daylength for day-active birds, possibly because the natural variation in light levels is so large that artificial light makes very little difference to the natural diurnal cycle of light levels.

Phototaxis of seabirds

Most burrow-nesting shearwaters and petrels are nocturnally active. Adults rear a single chick, and 'desert' the fully-grown chick to leave it to fledge independently. Chicks fledge at night, usually just after dark, and show strong positive phototaxis; they are attracted to light. This allows them to navigate from the dark burrows at the colony to the sea, as light intensity is naturally higher over the sea than onshore. This phototaxic response is therefore important to allow fledglings to find the sea when they first leave their burrow (especially important for those petrel species that breed at colonies some distance inland from the sea). This phototaxis behavioural response is also seen, for example, in hatchling sea turtles and has the same function. Puffins also show this same response as petrels. There are numerous examples of shearwater, petrel, and puffin chicks being attracted to artificial lights at fledging, and being grounded (Wilhelm *et al.* 2013, Rodriguez *et al*. 2014, Gineste *et al*. 2017). This is well known, for example, at colonies in the Hawaii, Balearic Islands, Canary Islands and Azores where fledglings will collide with street lights and car headlights (Fontaine *et al.* 2011, Troy *et al*. 2011, 2013, Rodriguez *et al.* 2012a, b, c, 2015a, b). It also occurs in Scotland, for example at the islands of Rum and St Kilda (Miles *et al*. 2010) where Manx shearwaters, European storm-petrels, Leach's storm-petrels and Atlantic puffin fledglings are grounded at street lights and illuminated windows. In virtually all of these examples, only fledglings are attracted and grounded, during the short period in late summer when chicks are departing from nesting burrows. Adults appear to be unaffected by artificial lights. Although for most colonies the numbers of fledglings distracted by artificial lights is trivial, the impact on survival of fledglings can be significant in a few cases where large colonies are close to extensive artificial lighting. In Reunion Island, 13,200 tropical shearwater fledglings were found grounded due to artificial lights, with numbers increasing from 1996 to 2015 (Gineste *et al.* 2017). At Phillip Island, Australia, 8,871 short-tailed shearwater fledglings were found grounded by lights along the roadsides, with at least 40% of these dead or dying (Rodriguez *et al.* 2014). Turning off the street lights mitigated this mortality (Rodriguez *et al.* 2014). In Kauai, Hawaii, more than 30,000 grounded fledglings of the federally threatened Newell's shearwater have been collected under lights, an impact that may be contributing to the decline of this population (Troy *et al.* 2011).

Lights on wind farm turbines in Scotland are unlikely to affect fledging puffins, shearwaters or petrels from Scottish colonies, as most of those colonies are on offshore islands immediately overlooking the sea. Fledglings are likely to disperse over the sea without seeing lights on wind turbines. Exceptions to this might be puffins from Isle of May fledging past offshore wind farms in the Forth and Tay area, Manx shearwaters and European storm petrels fledging from Sanda Islands, Kintyre, past terrestrial wind farms on the Kintyre peninsula, puffins fledging from the Shiants Islands passing terrestrial wind farms in the Western Isles, Manx shearwaters fledging from the small isles (especially Rum) and the Treshnish Isles passing terrestrial wind farms on Skye or Mull.

However, the lights involved on wind turbines would be likely to represent a trivial amount of lighting relative to the street lights and house lights of local towns, villages, lighthouses, ships and fishing vessels. These fledglings are also thought to tend to fly low rather than at high altitudes, and so would not be likely to be particularly close to lights at the tops of turbines. Phototaxis of fledging seabirds in Scotland is, therefore, very unlikely to be a problem in relation to obstruction lighting on wind turbines.

Phototaxis of nocturnal migrants

It has been recognised for a very long time that nocturnal migrant birds are attracted to artificial light while migrating (Harvie Brown *et al.* 1881, Horring 1926, Mehlum 1977, Jones and Francis 2003). This topic has recently received considerable attention specifically in relation to lighting at communication towers (Longcore *et al*. 2008, Gehring *et al*. 2009), wind farms (Kerlinger *et al*. 2010, Hüppop and Hilgerloh 2012), oil and gas production platforms (Day *et al.* 2015, Ronconi *et al.* 2015), cruise ships (Bocetti 2011), and in general in relation to bird ecology (Zhao *et al.* 2014, Watson *et al.* 2016).

The strongest and most dramatic examples of phototaxis in nocturnal migration birds are the 'falls' of migrants that can occur at lighthouses and lightships, especially during foggy weather in autumn. These were studied in detail in the 1880s to 1920s. For example, Harvie Brown and Alfred Newton established a committee of the British Association for the Advancement of Science in the 1870s and sent questionnaires to lighthouse keepers throughout the British Isles to obtain data on nocturnal bird migration and the numbers of birds killed by collision with lights. As long ago as 1881, they reported that '*the brightest, whitest, fixed lights attract the most birds*', that most collisions occurred during autumn migration rather than during spring migration, and that most collisions occurred when the weather was foggy and windy (as also concluded over 100 years later by Mehlum 1977). These same factors were identified as affecting collision rates in a study by Zhao *et al.* (2014). The British association annual reports show the large numbers of birds that can be killed; for example, 600 thrushes killed by collision with Skerryvore lighthouse in October 1877. A high proportion of the birds killed were juveniles, which probably at least in part explains why numbers killed tended to be much higher in autumn than in spring. Similar surveys were conducted around the same period in many different European countries. For example, the 41st annual report on birds at Danish lighthouses, for the year 1923, was published in 1926 (Horring 1926). That report mentions that at least 4,600 birds, mostly thrushes and starlings, were killed by collision at Danish lighthouses and lightships in 1923. Study of birds at lighthouses fell out of favour around the 1930s, and there is very little literature on this topic after that period, although it was recognised that large numbers of migrating birds were still being killed by collision at lighthouses (e.g. Mehlum 1977, Jones and Francis 2003). Jones and Francis (2003) reported that from 1960-1989 there were kills of up to 2,000 birds in a single night in autumn at Long Point lighthouse (Ontario, Canada). However, this light was fitted with a new beam in 1989, which was narrower and less powerful, and this resulted in a huge decrease in numbers of migrant birds killed. From 1990 to 2002 the mean numbers known to be killed were reduced to only about 30 birds per year. The authors point out that this highlights the '*effectiveness of simple changes in light signatures in reducing avian light attraction and mortality during migration*'.

Ronconi *et al*. (2015) and Day *et al.* (2015) both report that poor weather (e.g. fog, rain, low cloud cover) exacerbate nocturnal attraction of bird migrants to lights at oil and gas production platforms, with on occasions thousands of birds being killed in a night, especially where gas is being flared. Kerlinger *et al.* (2010) report that bright artificial lighting may have caused '*multi-bird fatality events*' at wind farms in North America, but that obstruction lighting at turbines as recommended by the Federal Aviation Administration (FAA) (flashing red lights) had no influence on bird collisions compared with turbines at the same wind farm, where there was no obstruction lighting (see also this same conclusion in Manville 2009). Gehring *et al.* (2009) reported that communication towers equipped with non-flashing/steady-burning lights in addition to red or white flashing obstruction lights were responsible for much higher numbers of bird collisions; towers with fixed lights and flashing lights were responsible for 13 bird fatalities per season, whereas towers with only flashing obstruction lights were responsible for 3.7 bird fatalities per season. They concluded that having only flashing obstruction lights reduced bird collisions significantly, a conclusion supported by Patterson (2012). Longcore *et al.* (2008) reported that steady-burning lights increased the numbers of birds colliding with communication towers.

Watson *et al*. (2016) report that more nocturnal flight calls can be detected over artificially lit areas than over dark areas. They conclude that artificial lighting changes behaviour of nocturnal migrant birds, either by changing their flight paths to pass over lit areas, by flying at lower altitudes over lit areas, by increasing their call rates over lit areas, or by remaining longer over lit areas. Hüppop and Hilgerloh (2012) suggest that nocturnal migrants are more vocal when conditions are adverse, so that vocalisations do not indicate bird numbers but rather the stress levels of the birds. Bocetti (2011) identified that cruise ships, which often have bright external lighting during the night, also represent a collision hazard for nocturnal migrant birds, although it seems likely that the numbers of birds killed at cruise ships are rather small compared to numbers killed at lighthouses.

The evidence indicates that lights on wind turbines are likely to increase numbers of nocturnal migrant birds that collide. However, that increase is mainly seen if lights are steady-burning, whereas there is very little increase in collisions when lights are flashing. Obstruction lighting on wind turbines appears to be several orders of magnitude less effective than the light from lighthouses and lightships in attracting nocturnal migrant birds. Survival rates of small birds are low, and it is recognised that many birds die during migration, especially juvenile birds during autumn migration (Newton 2008). Birds that are attracted by artificial light are likely to be birds that are already at high risk of mortality because they are facing adverse weather conditions and are lost or exhausted (Newton 2008). Furthermore, Welcker *et al.* (2017) reported that, despite the apparent attraction of nocturnal migrating birds to lights, nocturnal migrants represented only 8.6% of all fatalities at a sample of German wind farms. They concluded that '*nocturnal migrants do not have a higher risk of collision with wind energy facilities than do diurnally active species, but rather appear to circumvent collision more effectively*'.

Phototaxis of other birds

Attraction of fledgling shearwaters, petrels and puffins, and attraction of nocturnal migrating birds to lights is well established and has been studied in detail. In contrast, there is no clear evidence from research studies or observations to suggest that other kinds of birds show attraction to lights. There seems to be little or no phototaxis shown by adult shearwaters, petrels or puffins around the British Isles, despite the strong response seen in fledglings. There is some evidence of adult petrels being attracted to bright artificial lights at night at colonies in the sub-Antarctic (e.g. Furness, pers. obvs.), but that may simply be a disorientation and grounding of birds that fly into strong beams of light such that they are unable to see where they are going. There is little evidence to suggest that those birds are attracted towards artificial light. There is little or no evidence to suggest that birds that are not undertaking migration are attracted to artificial light. While nocturnal migrants are found as collision casualties at lighthouses during the migration seasons, resident birds in summer or winter, wintering birds in winter or breeding birds in summer are not found as collision casualties in summer or winter. Seabirds breeding close to lighthouses are not found as collision casualties at lighthouses. The evidence strongly indicates that resident, breeding and wintering birds do not show phototaxis. Therefore, there is no risk due to phototaxis for resident birds, breeding or wintering birds in the vicinity of wind farms as a direct consequence of deployment of obstruction lighting on wind turbines.

Ability of some birds to use nocturnal feeding assisted by artificial light

Birds that are visual feeders and feed only during the day may benefit from artificial light that allows them to feed visually at night. This has been reported, for example, in intertidal waders. Santos *et al.* (2010) found that visual feeding shorebirds fed at night in areas of the Tagus Estuary (Portugal) where artificial light allowed them to see prey. Tactile-feeding waders did not show any change in distribution attributable to the distribution of artificial light. Similarly, Da Silva *et al.* (2017) found that blue tits and great tits started foraging earlier in the morning when artificial light was available. The availability of artificial light did not alter feeding times of willow/marsh tits, nuthatches, jays or blackbirds, and the effect on great tits was weak and only evident during nights when weather was poor. There are anecdotal observations of birds such as robins feeding under street lights during winter darkness in urban environments.

In the context of obstruction lighting on wind turbines, it is highly unlikely that the amount of light provided would allow birds to feed at times when natural light levels were low, so this effect is very unlikely to be seen at wind farms.

Increased predation risk for nocturnal birds resulting from artificial lighting

Canario *et al*. (2012) observed short-eared owls and long-eared owls catching migrating songbirds that had been attracted to artificial lights. Oro *et al*. (2005) found significantly lower survival rates of breeding adult European storm-petrels at a colony in Benidorm Island (Spain) that was illuminated by artificial lighting shining across the sea from Benidorm city compared to a control colony on the dark side of Benidorm Island. The low survival of the population exposed to artificial light was due to yellow-legged gull predation on the storm petrels which was facilitated by the artificial light allowing gulls to see, and catch, storm petrels attending the colony at night.

Amounts of light produced by obstruction lighting at the top of wind turbines will be far less than produced by the lights in the studies reported above. It is, therefore, extremely unlikely that the lighting on wind turbines would affect predation risk for nocturnal birds in the vicinity of wind farms.

Birds better able to avoid collision when structures are illuminated

Blackwell *et al.* (2012) showed that artificial lights on aircraft reduced the risk of bird strike because lights made the aircraft more detectable to birds so allowed earlier avoidance behaviour. A study of bat collisions at wind farms in Texas found that bat fatalities were more frequent at turbines without aviation lights compared with turbines with synchronised red flashing aviation lights. The lower mortality at turbines with lights applied for only one species of bat, the other species showing no difference in mortality between turbines with or without aviation lights. However, the study suggests that at least one of the bat species avoided turbines more successfully when the turbine was equipped with obstruction lighting.

Displacement of birds due to avoidance of lights

Day *et al*. (2017) reported that migrating eiders showed higher avoidance at night of an oil-production facility in Alaska when it was illuminated with a hazing light system. However, this seems to be a rare example of birds being displaced by artificial lights, and there seem to be more examples of birds using artificial lights to their benefit, such as the use by shorebirds of artificial lights to allow them to feed visually at night.

Cumulative assessment

Loss *et al.* (2015) assessed the scale of anthropogenic mortality of birds in the United States and concluded that cause-specific annual mortality was billions due to predation by domestic cats, hundreds of millions due to collisions with buildings (mainly windows) and vehicles, tens of millions due to collisions with power lines, millions due to collisions with communication towers and electrocution at power lines, and hundreds of thousands due to collisions with wind turbines. These relative impacts are likely to be in a similar ranking in Scotland, and indeed throughout most of Europe.

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ANNEX F SUPPLEMENTARY DESK STUDY INFORMATION

Table F-1 Collision estimates of target species at other wind farm projects within 2 km of Douglas West Extension Wind Farm

Wind farm site and target species	Breeding/Non-breeding season/Annual[1]	Number of collisions per year	Number of years per collision
Hagshaw Hill Extension (2003 & 2004)			
Black grouse	One flight line outside of rotor height (below 10m) was recorded within 100m of proposed turbines.		
Hen harrier	Out of 88hrs of observation time, hen harrier spent 0.004% of time at rotor height. Four out of a total of five flights were recorded within 500m of proposed turbines.		
Peregrine	Out of 88hrs of observation time, peregrine spent 0.05% of time at rotor height. Two flights were recorded within 500m of proposed turbines, one flight was recorded within 250m.		
Nutberry (2004 to 2006): 95% avoidance rate			
Curlew	Breeding (2005)	0.1779	5.6
Golden plover	Breeding (2005)	0.0579 None recorded in 2006	17.3 None recorded in 2006
	Non-breeding (2005)	0.1039	9.6
Hen harrier	Breeding (2004 & 2005)	0.0148 (2004) – 0.0187 (2005), None recorded in 2006	67.6 (2004) – 53.6 (2005) None recorded in 2006
	Non-breeding (2004/05)	0.0039	257.5
Merlin	Breeding (2004 & 2005)	0.0016 (2004) – 0.0037 (2005) None recorded in 2006	637.2 (2004) – 271.4 (2005) None recorded in 2006
	Non-breeding (2004/05)	0.0036	274.4
Galawhistle (2007 to 2009):			
Curlew	Breeding (2008 & 2009)	0.127	7.9
	Non-breeding (2007/08 & 2008/09)	0.164	6.1
Greylag goose	Non-breeding (2007/08 & 2008/09)	0.82	1.2
Golden plover	Breeding (2008 & 2009)	0.021	47.6
	Non-breeding (2007/08 & 2008/09)	0.027	37.0
Hen Harrier	Breeding (2008 & 2009)	0.016	62.5
	Non-breeding (2007/08 & 2008/09)	0.006	166.7
Lapwing	Breeding (2008 & 2009)	0.017	58.8
Peregrine	Breeding (2008 & 2009)	0.029	34.5
	Non-breeding (2007/08 & 2008/09)	0.032	31.3
Pink-footed goose	Non-breeding (2007/08 & 2008/09)	1.70	0.6
Red kite	Breeding (2008 & 2009)	0.015	66
	Non-breeding (2007/08 & 2008/09)	0.001	885
Snipe	Breeding (2008 & 2009)	0.011	87
	Non-breeding (2007/08 & 2008/09)	0.003	393
DWCW[2] (2009 to 2010):			
Curlew	Breeding (2010)	0.0641	15.6
Greylag goose	Breeding (2010)	0.0007	1386.6
Lapwing	Breeding (2010)	0.0029	348.3
Merlin	Breeding (2010)	0.0043	232.5
Osprey	Breeding (2010)	0.0229	43.7
Peregrine	Non-breeding (2010/2011)	0.004	227.1
Snipe	Non-breeding (2010/2011)	0.0008	1280.0
Dalquhandy (2011 to 2012):[3]			
Curlew	Breeding (2011 & 2012)	0.0034863	286.8
Golden plover	Annual[4] (2011 & 2012)	0.0222494	44.9
Greylag goose	Non-breeding (2011 & 2012)	0.05	18.6

[1] Annual CRM results are presented if breeding and non-breeding data is not analysed separately.
[2] CRM data taken from Ornithology Technical Appendix 8.1 Annex E for the Douglas West Wind Farm ES
[3] Greylag goose and pink-footed goose CRM is calculated at 99% avoidance
[4] Annual = October to May

Wind farm site and target species	Breeding/Non-breeding season/Annual[1]	Number of collisions per year	Number of years per collision
Lapwing	Annual[5] (2011 & 2012)	0.00000105	948231.2
Pink-footed goose	Non-breeding (2011 & 2012)	0.90	1.11
Snipe	Annual[6] (2011 & 2012)	0.0158	62.9
Cumberhead (2013 to 2004):[5]			
Curlew	Annual[7] (2013 & 2014)	0.013	77.9
Golden plover	Breeding (2013 & 2014)	0.016	64.0
	Non-breeding (2013)	0.612	1.6
Goshawk	Annual[9] (2013 & 2014)	0.007	147.5
Greylag goose	Non-breeding (2013 & 2014)	0.013	78.6
Herring gull	Annual[9] (2013 & 2014)	0.059	17.0
Peregrine	Annual[9] (2013 & 2014)	0.018	56.0
Pink-footed goose	Non-breeding (2013 & 2014)	0.025	40.5
Whooper swan	Non-breeding (2013 & 2014)	0.016	61.7
Douglas West (2014 to 2015):			
Common sandpiper	Breeding (2015)	0.0007	1460.55
Curlew	Breeding (2015)	0.0543	18.42
	Non-breeding (2014/2015)	0.0558	17.92
Greylag goose	Breeding (2015)	0.0297	33.69
	Non-breeding (2014/2015)	0.1686	5.93
Hen harrier	Breeding (2015)	0.0118	84.50
	Non-breeding (2014/2015)	0.1136	8.80
Lapwing	Breeding (2015)	0.0206	48.55
	Non-breeding (2014/2015)	0.0076	131.13
Merlin	Non-breeding (2014/2015)	0.0014	694.97
Oystercatcher	Breeding (2015)	0.0023	431.36
	Non-breeding (2014/2015)	0.0015	653.47
Pink-footed goose	Breeding (2015)	0.0362	27.62
	Non-breeding (2014/2015)	0.2179	4.59
Snipe	Breeding (2015)	0.0890	11.24
	Non-breeding (2014/2015)	0.0092	108.5
Whooper swan	Non-breeding (2014/2015)	0.0129	77.47

[5] Annual = July, October to November, February to August and November
[6] Annual = November, March to June and September
[7] Annual = May to August