Issue	Date	Revision Details
1234168 B	10/02/2021	Released

Appendix 7.1

Ornithology Technical Appendix

Contents

List of Abbreviations

Abbreviation	Description
AYR-LBAP	Ayrshire Local Biodiversity Action Plan
BBS	Breeding Bird Survey
BirdsDir-A1	BirdsDir: Birds Directive Annex 1
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CRM	Collision Risk Model
DGLBAP	Dumfries and Galloway Biodiversity Action Plan 2009
EIAR	Environmental Impact Assessment Report
GIS	Geographic Information System

Abbreviation	Description
GL	Glasgow Life
RSG	Raptor Study Group
RSPB	Royal Society for the Protection of Birds
SBL	Scottish Biodiversity List
SNH	Scottish Natural Heritage: now NatureScot
SWSEIC	South-West Scotland Environmental Information Centre
UKBAP	UK Biodiversity Action Plan
VP	Vantage Point
WCA-Sch-1	Wildlife and Countryside Act – Schedule 1

7.1. INTRODUCTION

A7.1.1. This Technical Appendix presents the following information in support of Chapter 7: Ornithology of the Environmental Impact Assessment Report (EIAR) for Daer Wind Farm (the Proposed Development):

- Existing non-confidential ornithological records within a 5 km radius of the Original Site Boundary, held by the Raptor Study Group (RSG), Royal Society for the Protection of Birds (RSPB), Glasgow Life (GL), and the South-West Scotland Environmental Information Centre (SWSEIC);
- The methods employed by Natural Power to provide baseline information on target bird species present within the proposed development area. Timings, surveyors and duration of survey work are provided for each survey type. Details of weather conditions during survey can be provided on request;
- Details of target and non-target species flights recorded during Vantage Point (VP) surveys undertaken between March 2018 and August 2020;
- Details of target raptor flights recorded during breeding raptor surveys in 2018 to 2020; and
- Calculations of the theoretical collision risk to target species (where a sufficient number of flights was recorded) using the Band Model[1] as advocated by NatureScot (formerly Scottish Natural Heritage (SNH))[2].

7.2. LATIN NAMES

A7.2.1. Latin names of all species referred to in Chapter 7: Ornithology and within this Technical Appendix are given in Table 7.1 below.

Table 7.1: Latin names of species referred to in this chapter

Scientific Name	Common Name
Branta canadensis	Canada Goose
Branta leucopsis	Barnacle Goose
Anser anser	Greylag Goose
Anser brachyrhynchus	Pink-footed Goose
Cygnus olor	Mute Swan
Cygnus cygnus	Whooper Swan
Tadorna tadorna	Shelduck
Anas querquedula	Garganey
Anas penelope	Wigeon
Anas platyrhynchos	Mallard
Anas acuta	Pintail
Anas crecca	Teal
Aythya marila	Scaup
Bucephala clangula	Goldeneye
Mergus merganser	Goosander
Mergus serrator	Red-breasted Merganser
Tetrao tetrix	Black Grouse
Lagopus lagopus	Red Grouse
Alectoris rufa	Red-legged Partridge

[1] SNH. (2007). Band, W., Madders, M. & Whitfield, D.P. Developing field and analytical methods to assess avian collision risk at wind farms. In de Lucas, M., Janss, G. & Ferrer, M. (eds.) Birds and Wind Power. Quercus, Madrid.

[2] SNH. (2010). Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. SNH Avoidance Rate Information and Guidance Note. Scottish Natural Heritage. http://www.snh.gov.uk/docs/B721137.pdf

Gavia arctica	Black-throated Diver
Podiceps cristatus	Great Crested Grebe
Ardea cinerea	Grey Heron
Phalacrocorax carbo	Cormorant
Pandion haliaetus	Osprey
Aquila chrysaetos	Golden Eagle
Accipiter nisus	Sparrowhawk
Accipiter gentilis	Goshawk
Circus aeruginosus	Marsh Harrier
Circus cyaneus	Hen Harrier
Milvus milvus	Red Kite
Haliaeetus albicilla	White-tailed Eagle
Buteo buteo	Buzzard
Haematopus ostralegus	Oystercatcher
Vanellus vanellus	Lapwing
Pluvialis apricaria	Golden Plover
Charadrius hiaticula	Ringed Plover
Charadrius dubius	Little Ringed Plover
Charadrius morinellus	Dotterel
Numenius phaeopus	Whimbrel
Numenius arquata	Curlew
Calidris alba	Sanderling
Calidris alpina	Dunlin
Scolopax rusticola	Woodcock
Gallinago gallinago	Snipe
Actitis hypoleucos	Common Sandpiper
Tringa ochropus	Green Sandpiper
Tringa totanus	Redshank
Tringa nebularia	Greenshank
Chroicocephalus ridibundus	Black-headed Gull
Larus canus	Common Gull
Larus marinus	Great Black-backed Gull
Larus argentatus	Herring Gull
Larus fuscus	Lesser Black-backed Gull
Sterna hirundo	Common Tern
Columba oenas	Stock Dove
Columba palumbus	Woodpigeon
Cuculus canorus	Cuckoo
Tyto alba	Barn Owl
Strix aluco	Tawny Owl

Asio flammeus	Short-eared Owl
Caprimulgus europaeus	Nightjar
Apus apus	Swift
Alcedo atthis	Kingfisher
Upupa epops	Hoopoe
Falco tinnunculus	Kestrel
Falco columbarius	Merlin
Falco peregrinus	Peregrine
Corvus monedula	Jackdaw
Corvus corone	Carrion Crow
Corvus corax	Raven
Periparus ater	Coal Tit
Poecile montanus	Willow Tit
Alauda arvensis	Skylark
Riparia riparia	Sand Martin
Hirundo rustica	Swallow
Delichon urbicum	House Martin
Phylloscopus trochilus	Willow Warbler
Phylloscopus sibilatrix	Wood Warbler
Acrocephalus schoenobaenus	Sedge Warbler
Locustella naevia	Grasshopper Warbler
Troglodytes troglodytes	Wren
Sturnus vulgaris	Starling
Turdus torquatus	Ring Ouzel
Turdus merula	Blackbird
Turdus pilaris	Fieldfare
Turdus iliacus	Redwing
Turdus philomelos	Song Thrush
Turdus viscivorus	Mistle Thrush
Muscicapa striata	Spotted Flycatcher
Erithacus rubecula	Robin
Ficedula hypoleuca	Pied Flycatcher
Phoenicurus phoenicurus	Redstart
Saxicola rubetra	Whinchat
Saxicola rubicola	Stonechat
Oenanthe oenanthe	Wheatear
Cinclus cinclus	Dipper
Passer domesticus	House Sparrow
Passer montanus	Tree Sparrow
Prunella modularis	Dunnock

Motacilla flava	Yellow Wagtail
Motacilla cinerea	Grey Wagtail
Motacilla alba	Pied Wagtail
Anthus pratensis	Meadow Pipit
Anthus trivialis	Tree Pipit
Fringilla coelebs	Chaffinch
Fringilla montifringilla	Brambling
Coccothraustes coccothraustes	Hawfinch

Pyrrhula pyrrhula	Bullfinch
Linaria flavirostris	Twite
Linaria cannabina	Linnet
Acanthis cabaret	Lesser Redpoll
Loxia curvirostra	Common Crossbill
Spinus spinus	Siskin
Emberiza schoeniclus	Reed Bunting
Plectrophenax nivalis	Snow Bunting

7.3. DESK STUDY RESULTS

A7.3.1. The RSG, RSPB, SWSEIC and GL provided data of bird species recorded within a 10 km radius of the Original Site Boundary. Table 7.2 lists all protected bird species and/or birds of conservation concern (BoCC Red or Amber listed) for which there were records from between 2009 and 2019 in the data provided by the above sources, along with their conservation designations.

Table 7.2: Desk Study Data from RSG, GL, RSPB and SWSEIC

Common Name	Breeding Pairs - RSG	Number of records - GL	Number of Records - RSPB	Number of Records - SWSEIC	Last recorded	Legally Protected Species	BoCC List	Biodiversity Lists
Barnacle Goose				1	2014	BirdsDir-A1	Amber	DGLBAP, SBL
Greylag Goose		1		3	2019		Amber	
Pink-footed Goose				41	2017		Amber	
Mute Swan				14	2017		Amber	
Whooper Swan				5	2017	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
Shelduck				1	2015		Amber	
Garganey				2	2012	WCA-Sch-1	Amber	SBL
Wigeon				2	2017		Amber	
Mallard				163	2017		Amber	
Pintail				1	2017		Amber	
Teal				35	2017		Amber	
Scaup				1	2017	WCA-Sch1	Red	DGLBAP, SBL
Goldeneye				2	2017		Amber	
Black Grouse			39	26	2017		Red	AYR-LBAP, DGLBAP, SBL
Red Grouse			2	37	2017		Amber	
Black-throated Diver		2			2017	BirdsDir-A1, WCA-Sch1	Amber	SBL
Osprey		4		8	2018	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
Golden Eagle				1	2010	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
Goshawk	1			7	2015	WCA-Sch1		
Hen Harrier		1		17	2017	BirdsDir-A1, WCA-Sch1	Red	AYR-LBAP, DGLBAP, SBL
Red Kite	1			41	2017	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL

White-tailed Eagle	4			2014	BirdsDir-A1, WCA-Sch1	Red	SBL
Oystercatcher	4	32	69	2019		Amber	
Lapwing	10	17	62	2019		Red	DGLBAP, SBL
Golden Plover	4	6	20	2017	BirdsDir-A1		DGLBAP, SBL
Ringed Plover	7		1	2019		Red	
Little Ringed Plover	1			2018	WCA-Sch1		
Dotterel			4	2010	BirdsDir-A1, WCA-Sch1	Red	DGLBAP, SBL
Curlew	7	21	79	2019		Red	DGLBAP, SBL
Dunlin	1			2018		Amber	SBL
Woodcock			5	2017		Red	DGLBAP, SBL
Snipe		10	40	2018		Amber	
Common Sandpiper	2		54	2019		Amber	
Green Sandpiper			2	2010	WCA-Sch1	Amber	SBL
Redshank	2	4	11	2019		Amber	
Black-headed Gull	1	2	57	2019		Amber	DGLBAP, SBL
Common Gull	1		11	2019		Amber	
Great Black-backed Gull	1			2019		Amber	
Herring Gull			17	2015		Red	DGLBAP, SBL
Lesser Black-backed Gull	1	1	13	2019		Amber	
Common Tern			1	2017	BirdsDir-A1	Amber	DGLBAP, SBL
Stock Dove			13	2017		Amber	
Cuckoo			14	2017		Red	SBL
Barn Owl			44	2017	WCA-Sch1		DGLBAP, SBL
Tawny Owl			15	2016		Amber	
Short-eared Owl		1	22	2009	BirdsDir-A1	Amber	DGLBAP, SBL
Nightjar		52	9	2015	BirdsDir-A1	Amber	AYR-LBAP, DGLBAP, SBL
Swift		10	47	2018		Amber	DGLBAP, SBL
Kingfisher			5	2017	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
Hoopoe			1	2007	WCA-Sch1		
Kestrel		1	34	2017		Amber	DGLBAP, SBL
Merlin	1		17	2019	BirdsDir-A1, WCA-Sch1	Red	DGLBAP, SBL
Peregrine	3	1	37	2016	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
Raven		2		2009			
Willow Tit			5	2017		Red	DGLBAP, SBL
Skylark	1		306	2017		Red	AYR-LBAP, DGLBAP, SBL
House Martin			124	2017		Amber	
Willow Warbler	1		90	2019		Amber	

Wood Warbler		7	2006		Red	DGLBAP, SBL
Grasshopper Warbler		29	2017		Red	SBL
Starling		164	2017		Red	DGLBAP
Ring Ouzel		11	2016		Red	DGLBAP, SBL
Fieldfare		50	2017	WCA-Sch1	Red	
Redwing		70	2017	WCA-Sch1	Red	SBL
Song Thrush		136	2017		Red	AYR-LBAP, DGLBAP, SBL
Mistle Thrush		59	2017		Red	
Spotted Flycatcher		58	2017		Red	AYR-LBAP, DGLBAP, SBL
Pied Flycatcher		7	2017		Red	
Redstart		15	2016		Amber	
Whinchat		45	2017		Red	
Dipper		78	2017		Amber	
House Sparrow		255	2017		Red	DGLBAP, SBL
Tree Sparrow		27	2017		Red	AYR-LBAP, DGLBAP, SBL
Dunnock		204	2017		Amber	
Grey Wagtail		44	2017		Red	
Meadow Pipit	1	88	2019		Amber	
Tree Pipit		52	2017		Red	SBL,
Brambling		45	2017	WCA-Sch1		SBL
Hawfinch		1	2013		Red	SBL
Bullfinch		42	2017		Amber	AYR-LBAP, DGLBAP, SBL
Linnet		9	2017		Red	AYR-LBAP, DGLBAP, SBL
Lesser Redpoll		43	2017		Red	SBL, UKBAP
Common Crossbill		41	2016	WCA-Sch1		
Siskin		217	2017			DGLBAP, SBL
Reed Bunting	2	44	2017		Amber	AYR-LBAP, DGLBAP, SBL
Snow Bunting		3	2013	WCA-Sch1		SBL

Source: RSG, GL, RSPB, SWSEIC.

BirdsDir: Birds Directive Annex 1. WCA: Wildlife and Countryside Act – Schedule 1. AYR-LBAP: Ayrshire Local Biodiversity Action Plan. DGLBAP: Dumfries and Galloway Biodiversity Action Plan 2009. SBL: Scottish Biodiversity List. UKBAP: UK Biodiversity Action Plan.

7.4. SURVEY METHODS

A7.4.1. Baseline ornithological surveys commenced in March 2018 and were completed in August 2020 to quantify the use of the Main Wind Farm Area by breeding and non-breeding birds, and to allow an estimate of the theoretical risk of bird collision with the turbine rotors. Access to the site was withdrawn during some months in 2018 due to lambing; breeding season surveys were repeated in 2019, in order to ensure full coverage of the site within the correct time periods. Additional surveys were completed in the Kinnelhead Development Area in 2020, in order to cover the updated wind turbine layout.

A7.4.2. Baseline ornithological surveys comprised:

- Vantage Point (VP) flight activity surveys;
- Breeding raptor surveys;
- Breeding bird surveys (BBS);
- Black grouse surveys;
- Barn owl surveys; and
- Nightjar surveys

A7.4.3. All ornithology surveys were undertaken by experienced ornithological surveyors:

- Adam Anderson (AA);
- Angus Murray (AM);
- Alein Shreeve (AS);
- Chris Rodger (CCR);
- Dan Carrington (DC);
- Fiona Morton (FM);
- Graeme Garner (GG);
- Helen Allinson (HA);
- John Sweeney (JS).
- Kirsten Hazelwood (KH);
- Pete Carroll (PC);
- Pawel Plonczkier (PP);
- Steven Parker (SP);

A7.4.4. The survey methods are described in detail below.

Vantage Point Surveys

A7.4.5. VP surveys were undertaken using the standard method published in NatureScot guidelines[3]. This method focuses on identifying flight-paths and flight heights of target species, such as waterfowl and raptors, and allows any regular patterns of flight lines to be identified, allowing turbine locations to be designed to minimise collision risk to birds. The data generated can also be used to estimate the theoretical collision risk of a particular species.

A7.4.6. NatureScot guidance states that VP locations are chosen in order to achieve maximum visibility with the minimum number of points; all of the survey area should be covered such that no point is greater than 2 km from a VP (see Figure 7.2). Eight VP locations were used throughout the surveys for the Main Wind Farm Area, seven were used for the breeding and non-breeding seasons of the Daer Land Portion in 2018 and 2019. An eighth VP location was added to survey the Kinnelhead Development Area (VPK1) in 2020.

A7.4.7. The weather conditions during each survey were recorded every hour, full details of survey dates, times and weather conditions during VP surveys will be provided upon request. As recommended in NatureScot guidance[3], a minimum of 36 hours per VP were carried out in conditions of good or better visibility (≥1 km).

A7.4.8. Surveys were carried out at various times of day, ensuring that a representative sample of times between dawn and dusk were surveyed. All VP surveys were 3 hours in duration, with a minimum resting period of 30 minutes between surveys, in line with the most recent NatureScot guidance[3].

A7.4.9. A summary of VP survey effort for each VP is shown in Table 7.3. Observers included AA, AM, AS, CCR, DC, FM GG, HA, JJS, JS, KH, PC, PP and SP.

A7.4.10. Focal sampling was carried out for target species. The area in view was scanned until a target species was observed, at which point it was followed until it had ceased flying or had flown out of sight. The flight lines of target bird species observed were recorded onto 1:10,000 scale maps. Following NatureScot guidance[3] the time and duration of the flight were recorded, and the altitude of the target bird(s) was recorded at the start of the observation and at 15 second intervals thereafter into one of five height bands, (1) <20 m, (2) 20-100 m, (3) 100-150 m, (4) 150-200 m, and >200 m.

A7.4.11. A map showing the flight lines for each target species was compiled in a Geographic Information System (QGIS), with each flight line linked to its associated flight duration and height information held in an Excel spreadsheet.

A7.4.12. The information collected on key target species flying over the proposed development area and the adjacent airspace was used to estimate the number of individuals per species predicted to collide with the turbine rotors. The collision risk modelling methods are described in the main ornithology chapter in Section 7.3.

A7.4.13. All secondary species were recorded using five-minute summaries. Each VP survey was sub-divided into five-minute periods. At the end of each five-minute period, the number and activity of all secondary species observed was recorded. If a target species was being tracked during a five-minute period, then the activity summary for that period was abandoned and a new one started once observations of the target species had ended. Thus observation of target species took priority over the recording of secondary species. The number of birds recorded in a five-minute period was the minimum number of individuals that could account for the activity observed.

[3] SNH. 2017. Recommended bird survey methods to inform impact assessment of onshore wind farms. SNH, Battleby.

Table 7.3: VP survey hours 2018-2020 breeding and non-breeding seasons

					Total Survey Hours							
Year	VPs	Season	Month	Observers	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VPK1
2018	1-7	Breeding	March	AA/AM/CCR/PC/SP	6	6	6	6	6			
2018	1-7	Breeding	April	AA/PC			6	6			6	
2018	1-7	Breeding	May	AA/AS/JS/SP	12	12	8	11.5	14	17.5	12	
2018	1-7	Breeding	June	AM/JS	6	6	6	6	6	6	6	
2018	1-7	Breeding	July	AM/JS	6	6	6	6	6	6	6	
2018	1-7	Breeding	August	AM	6	6	6	6	6	6.5	6	
Sum of 2018 Breeding Season					**36**	**36**	**38**	**41.5**	**38**	**36**	**36**	
2018	1-7	Non-breeding	September	AA/AM/JS	12	12	12	12	12	12	12	
2018	1-7	Non-breeding	October	AA/AM/JS	12	12	12	12	12	12	12	
2018	1-7	Non-breeding	November	AA/AM/JS/KH/PP	12	6	12	12	12	12	12	
2018	1-7	Non-breeding	December	AM/JS	6	12	6	6	6	6	6	
2019	1-7	Non-breeding	January	AA/AM/JS	6	6	6	6	6	6	6	
2019	1-7	Non-breeding	February	AA/AM/JS	6	6	6	6	6	6	6	
Sum of 2018-2019 Non-breeding Season					**54**	**54**	**54**	**54**	**54**	**54**	**54**	
2019	1-7	Breeding	March	AM/JS	6	6	6	6	6	6	6	
2019	1-7	Breeding	April	AA/AM/JS	9	9	9	9	9	9	9	
2019	1-7	Breeding	May	AA/AM/GG/JS/KH	9	9	9	9	9	9	9	
2019	1-7	Breeding	June	AA/AM/DC/JS	9	9	9	9	9	9	9	
2019	1-7	Breeding	July	AA/AM/FM/JS	15	9	12.03	3	9	9	9	
2019	1-7	Breeding	August	AM/JS	6	6	6	6	6	6	6	
Sum of 2019 Breeding Season					**54**	**48**	**51.03**	**42**	**48**	**48**	**48**	
2020	Kinnelhead	Breeding	March	AA								6
2020	Kinnelhead	Breeding	April	AA								9
2020	Kinnelhead	Breeding	May	AA								9
2020	Kinnelhead	Breeding	June	AA								3*
2020	Kinnelhead	Breeding	July	HA/KH								12*
2020	Kinnelhead	Breeding	August	HA								6
Sum of 2020 (Kinnelhead) Breeding Season												**45**

**June surveys completed in early July due to bad weather*

Breeding Raptor Surveys

A7.4.14. Breeding raptor surveys were undertaken within the Original Site Boundary between April and July 2018, and April and June 2019. A combination of ad-hoc VP surveys, and walkover surveys over suitable breeding habitat was undertaken. Ad-hoc VP surveys were carried out with the aim of identifying courtship displays and territorial

behaviour and walkover surveys were to check for signs of breeding raptors and, where relevant, to locate nest sites. Although searches focussed on areas identified during the VP surveys (both ad-hoc VPs and flight activity survey VPs) as potentially occupied by breeding raptors, all areas identified as providing suitable nesting habitat were surveyed, regardless of whether VP surveys indicated raptor occupancy. Methods are described in Hardey *et al*., 2013[4].

A7.4.15. Guidance recommends that all suitable habitat within a 2 km buffer of infrastructure should be surveyed, but due to access restrictions outwith the ownership boundary, this was not possible for the whole buffer. Therefore, during the course of walkover surveys when the surveyor was near the ownership boundary, they scanned the visible habitat outwith the site for signs of breeding, such as display behaviour.

A7.4.16. All raptor and owl species encountered were recorded. This included all observations of secondary raptor species such as buzzard, kestrel and sparrowhawk.

A7.4.17. A summary of survey effort for each raptor survey is shown in Table 7.4, full details of weather conditions during raptor surveys will be provided upon request.

Table 7.4: Breeding raptor survey hours 2018 and 2019 (Daer Land Portion) and 2020 (Kinnelhead Development Area)

Year	Observer	Month	No. Survey Hours
2018	AA	April	2.0
2018	SP/AM	May	17.5
2018	AM	June	12.5
2018	AM	July	16.5
	Total Survey Hours 2018		**48.5**
2019	AA	April	20.5
2019	AM/AA	May	16.1
2019	AM/AA	June	12.3
	Total Survey Hours 2019		**48.8**
2020	AA	April	4.0
2020	AA	May	6.0
2020	AA	June	2
2020	HA	July	3
	Total Survey Hours 2020		**15.0**

Breeding Bird Surveys

A7.4.18. Breeding bird surveys were undertaken in the breeding seasons of 2018 and 2019 in the Daer Land Portion, and in the Kinnelhead Development Area in 2020, covering all areas of open habitat within the Main Wind Farm Area. The site was surveyed using the standard methodology for assessing upland wader populations, as described by Brown and Shepherd (1993)[5]. This generic upland bird methodology. as advocated by NatureScot, is used to survey breeding upland wading birds to assess the presence and map the distribution of breeding birds in proposed development area. Four survey visits were carried out on open ground within the Daer Land Portion between April and July 2018 and 2019, and in the Kinnelhead Development Area between April and July 2020. Table 7.5 lists the survey details, full details of weather conditions during BBS surveys will be provided upon request.

A7.4.19. A single surveyor walked a pre-determined route ensuring that all parts of the survey area were approached to within 100 m. A handheld GPS unit was used to ensure that the survey route was maintained. The location and behaviour of all birds encountered during the survey visits were recorded in the field on 1:25,000 scale maps. Standard British Trust for Ornithology (BTO) behaviour and species codes were used on field forms.

A7.4.20. Following completion of the survey season, territory analysis was carried out for all waterfowl, wader, grouse and gull species. Territories were identified using a cluster analysis method, as outlined in Bibby *et al*.[6]. This method used the following principles:

- For resident bird species and summer migrants alike, a minimum of two registrations from two separate visits were required to generate a 'cluster'. This cluster was considered to represent a territory;
- Where a nest with eggs or young chicks was recorded, this record on its own constituted a cluster and hence a breeding territory;
- Species were considered to be breeding if any of the following behaviour was observed during a single visit:
  - Song, courtship or territorial display;
  - Territorial dispute;
  - Nest building and nest-hole excavation;
  - Agitated behaviour by adult bird(s) indicating the presence of a nearby nest or young (e.g. repetitive alarm calling, distraction display);
  - Adult(s) carrying food; and
  - Juveniles with parents in attendance;
- Where there were too few records to generate a cluster, with no evidence of any breeding behaviour, the individuals were not included in estimates for number of territories.

A7.4.21. The field data for each visit was combined to produce overarching species maps, showing locations of registrations and behaviour indicative of breeding for each individual species of high and moderate conservation concern. These locations and behaviour were then assessed to produce an estimate of the overall breeding population for each species recorded in the survey area.

A7.4.22. All surveys were carried out by experienced surveyors in suitable weather conditions.

Table 7.5: Breeding Bird Survey Effort 2018, 2019 (Daer Land Portion) and 2020 (Kinnelhead Development Area)

Year	Visit No.	Observer	Date Range	No. Survey Hours
2018	1	AA	25/04/2018 - 17/05/2018	18.5
2018	2	AM	03/06/2018 - 06/06/2018	22.45
2018	3	AM	27/06/2018 - 01/07/2018	23.8
2018	4	AM	13/07/2018 - 16/07/2018	23.7
2019	1	AM/PP/JS	11/04/2019 - 13/04/2019	27
2019	2	AM/AA	13/05/2019 - 15/05/2019	24.3
2019	3	AS/AA/AM	14/06/2019 - 17/06/2019	27.2
2019	4	GG/AS/AM/JS	03/07/2019 - 05/07/2019	35
2020 (Kinnelhead)	1	AA	27/04/2020	6

[4] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. 2013. Raptors: a field guide to survey and monitoring. 3rd Edition. The Stationery Office, Edinburgh.

[5] Brown, A.F. & Shepherd, K.B. (1993). A Method for Censusing Upland Breeding Waders. *Bird Study* **40**, 189-195.

[6] Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S., 2000. *Bird census techniques*. Elsevier.

2020 (Kinnelhead)	2	AA	14/05/2020	6
2020 (Kinnelhead)	3	AA	02/06/2020	4.5
2020 (Kinnelhead)	4	HA	10/07/2020 - 15/07/2020	14.25

Black Grouse Surveys

A7.4.23. Black grouse surveys were undertaken within all suitable habitat within the Daer Land Portion between April and May 2018 and 2019 and within a 1.5 km buffer of the Kinnelhead Development Area (access permitting) between April and May 2020. In the areas beyond that accessible to surveyors, time was spent at the edge of the ownership boundary looking and listening for birds lekking on the surrounding ground.

A7.4.24. Species-specific surveys for black grouse were carried out following the method specified in the National Black Grouse Survey Instructions[7]. No black grouse were recorded in the Kinnelhead Development Area during 2020 surveys, therefore results from 2020 are not considered in the results section of this technical appendix.

A7.4.25. Details of each survey visit are presented in Table 7.6. Weather conditions on each survey visit can be provided upon request.

Table 7.6: Black Grouse survey effort 2018 and 2019 (Daer Land Portion) and 2020 (Kinnelhead Development Area)

Date	Observer	Start Time	End Time
27/04/2018	AA	05:00	06:30
03/05/2018	AA	05:15	07:30
15/05/2018	AA	04:40	07:20
08/04/2019	JS	05:25	08:30
16/04/2019	AM	05:15	08:20
23/04/2019	AA	05:30	08:00
25/04/2019	AM	05:00	08:15
12/05/2019	JS	04:10	07:00
14/05/2019	AM	04:20	08:20
16/05/2019	JS	04:15	06:45
16/05/2019	AM	04:50	08:00
24/04/2020	AA	05:10	07:30
06/05/2020	AA	04:50	07:10

Barn Owl Surveys

A7.4.26. Barn owl surveys were carried out in May and July 2018 in potentially suitable nesting habitat within the Original Site Boundary (access permitting). Barn owls or their signs, such as pellets and splashing were recorded. Where signs indicating barn owl presence were located, but the birds themselves were not seen (e.g. where a potential nesting site is not accessible), then watches would be undertaken at dusk in order to establish occupancy and likelihood of breeding, in line with methods in Hardey *et al*. (2013)[4] and Gilbert *et al*. (1998)[8].

A7.4.27. No barn owl were recorded during barn owl surveys, barn owl are therefore not considered in the results section of this technical appendix.

A7.4.28. Table 7.7 lists the survey details, full details of weather conditions during barn owl surveys will be provided upon request.

Table 7.7: Barn owl survey effort 2018

Date	Observer	Start Time	End Time
25/05/2018	AM	10:30	13:15
29/07/2018	AM	17:00	23:15

7.5. SURVEY RESULTS

A7.5.1. A summary of the ornithology results is presented in Chapter 7: Ornithology of the EIAR. Further details of these results are provided below, full non-confidential survey results data can be provided on request.

Vantage Point Surveys

A7.5.2. A summary of all baseline flights of target species recorded during the breeding season surveys during 2018 and 2019 are presented in Table 7.8, and in Table 7.9 for the Kinnelhead Development Area breeding season. Flights recorded during the non-breeding season in 2018-2019 are presented in Table 7.10. Incidental observations of target species recorded during VP surveys 2018 to 2020 breeding and non-breeding seasons are summarised in Table 7.11. Secondary species observed are summarised in Table 7.12.

[7] Etheridge, B. & Baines, D. 1995. Instructions for the Black Grouse Survey 1995/6. Unpublished document, RSPB/GCT/JNCC/SNH, Edinburgh.

[8] Gilbert, G., Gibbons, D.W. & Evans, J. 1998. Bird Monitoring Methods A Manual of Techniques for Key UK Species. RSPB, Sandy

Table 7.8: VP flight activity survey results breeding season 2018 to 2019 – Daer Land Portion (VPs 1-7)

Year	Species	No. Flights	No. Individuals	Legally Protected Species	BoCC List	Biodiversity Lists
2018	Greylag Goose	13	31		Amber	
2018	Goosander	3	13			
2018	Black Grouse	4	5		Red	AYR-LBAP, DGLBAP, SBL
2018	Osprey	2	2	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
2018	Goshawk	3	3	WCA-Sch1		
2018	Marsh Harrier	5	5	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
2018	Hen Harrier	10	10	BirdsDir-A1, WCA-Sch1	Red	AYR-LBAP, DGLBAP, SBL
2018	Red Kite	34	36	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
2018	Oystercatcher	30	162		Amber	
2018	Lapwing	10	16		Red	DGLBAP, SBL, UKBAP
2018	Golden Plover	1	11	BirdsDir-A1		DGLBAP, SBL
2018	Ringed Plover	2	3		Red	
2018	Curlew	91	217		Red	DGLBAP, SBL, UKBAP
2018	Snipe	2	2		Amber	
2018	Redshank	3	3		Amber	
2018	Merlin	5	5	BirdsDir-A1, WCA-Sch1	Red	DGLBAP, SBL
2018	Peregrine	4	5	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
2019	Greylag Goose	17	61		Amber	
2019	Teal	1	2		Amber	
2019	Goosander	3	4			
2019	Black Grouse	2	2		Red	AYR-LBAP, DGLBAP, SBL
2019	Osprey	3	3	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
2019	Goshawk	3	3	WCA-Sch1		
2019	Hen Harrier	9	9	BirdsDir-A1, WCA-Sch1	Red	AYR-LBAP, DGLBAP, SBL
2019	Red Kite	10	11	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
2019	Oystercatcher	26	113		Amber	
2019	Lapwing	23	51		Red	DGLBAP, SBL, UKBAP
2019	Ringed Plover	2	2		Red	
2019	Curlew	158	365		Red	DGLBAP, SBL, UKBAP
2019	Snipe	12	13		Amber	
2019	Merlin	2	2	BirdsDir-A1, WCA-Sch1	Red	DGLBAP, SBL
2019	Peregrine	7	7	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL

BirdsDir: Birds Directive Annex 1. WCA: Wildlife and Countryside Act – Schedule 1. AYR-LBAP: Ayrshire Local Biodiversity Action Plan. DGLBAP: Dumfries and Galloway Biodiversity Action Plan 2009. SBL: Scottish Biodiversity List. UKBAP: UK Biodiversity Action Plan. Records without flight details are included in this table but excluded from CRM analyses, therefore total numbers may differ.

Table 7.9: VP flight activity survey results breeding season 2020 – Kinnelhead Development Area (VPK1)

Species	No. Flights	No. Individuals	Legally Protected Species	BoCC List	Biodiversity Lists
Greylag Goose	1	11		Amber	
Osprey	2	2	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
Red Kite	19	20	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL
Oystercatcher	6	11		Amber	
Lapwing	1	1		Red	DGLBAP, SBL, UKBAP
Golden Plover	1	4	BirdsDir-A1		DGLBAP, SBL
Curlew	39	58		Red	DGLBAP, SBL, UKBAP
Snipe	10	13		Amber	

BirdsDir: Birds Directive Annex 1. WCA: Wildlife and Countryside Act – Schedule 1. AYR-LBAP: Ayrshire Local Biodiversity Action Plan. DGLBAP: Dumfries and Galloway Biodiversity Action Plan 2009. SBL: Scottish Biodiversity List. UKBAP: UK Biodiversity Action Plan. Records without flight details are included in this table but excluded from CRM analyses, therefore total numbers may differ.

Table 7.10: VP flight activity survey results non-breeding season 2018 to 2019 – Daer Land Portion (VPs 1-7)

Species	No. Flights	No. Individuals	Legally Protected Species	BoCC List	Biodiversity Lists
Greylag Goose	3	27		Amber	
Pink-footed Goose	64	3964		Amber	
Goosander	4	6			
Black Grouse	2	2		Red	SBL, AYR-LBAP, DGLBAP
Osprey	1	1	BirdsDir-A1, WCA-Sch1	Amber	DGLBAP, SBL
Goshawk	1	1	WCA-Sch1		
Hen Harrier	7	7	BirdsDir-A1, WCA-Sch1	Red	AYR-LBAP, DGLBAP, SBL
Red Kite	16	16			
Golden Plover	1	19	BirdsDir-A1		SBL, DGLBAP
Merlin	6	6	BirdsDir-A1, WCA-Sch1	Red	SBL, DGLBAP
Peregrine	12	12	BirdsDir-A1, WCA-Sch1		DGLBAP, SBL

BirdsDir: Birds Directive Annex 1. WCA: Wildlife and Countryside Act – Schedule 1. AYR-LBAP: Ayrshire Local Biodiversity Action Plan. DGLBAP: Dumfries and Galloway Biodiversity Action Plan 2009. SBL: Scottish Biodiversity List. UKBAP: UK Biodiversity Action Plan. Records without flight details are included in this table but excluded from CRM analyses, therefore total numbers may differ.

Table 7.11: Incidental records of target species recorded during VP surveys 2018 - 2020

Year	Season	Species	No. Flights	No. Individuals	Legally Protected Species	BoCC List	Biodiversity Lists
2018	Breeding	Greylag Goose	3	26		Amber	
2018	Breeding	Black Grouse	2	3		Red	SBL, AYR-LBAP, DGLBAP
2018	Breeding	Osprey	2	2	BirdsDir-A1, WCA-Sch1	Amber	SBL, DGLBAP
2018	Breeding	Goshawk	3	3	WCA-Sch1		
2018	Breeding	Marsh Harrier	2	2	BirdsDir-A1, WCA-Sch1		SBL, DGLBAP
2018	Breeding	Red Kite	3	3	BirdsDir-A1, WCA-Sch1		SBL, DGLBAP
2018	Breeding	Oystercatcher	10	70		Amber	
2018	Breeding	Lapwing	1	1		Red	SBL, DGLBAP

2018	Breeding	Golden Plover	1	4	BirdsDir-A1		SBL, DGLBAP
2018	Breeding	Curlew	15	84		Red	SBL, DGLBAP
2018	Breeding	Snipe	12	13		Amber	
2018	Breeding	Merlin	1	1	BirdsDir-A1, WCA-Sch1	Red	SBL, DGLBAP
2018	Breeding	Peregrine	1	1	BirdsDir-A1, WCA-Sch1		SBL, DGLBAP
2018/2019	Non-breeding	Greylag Goose	4	13		Amber	
2018/2019	Non-breeding	Pink-footed Goose	12	394		Amber	
2018/2019	Non-breeding	Whooper Swan	1	2	BirdsDir-A1, WCA-Sch1	Amber	SBL, DGLBAP
2018/2019	Non-breeding	Teal	4	33		Amber	
2018/2019	Non-breeding	Goldeneye	2	2		Amber	
2018/2019	Non-breeding	Goosander	2	2			
2018/2019	Non-breeding	Black Grouse	3	10		Red	SBL, AYR-LBAP, DGLBAP
2018/2019	Non-breeding	Goshawk	1	1	WCA-Sch1		
2018/2019	Non-breeding	Golden Plover	1	1	BirdsDir-A1		SBL, DGLBAP
2018/2019	Non-breeding	Curlew	1	35		Red	SBL, DGLBAP
2018/2019	Non-breeding	Woodcock	1	1		Red	SBL, DGLBAP
2018/2019	Non-breeding	Snipe	1	1		Amber	
2018/2019	Non-breeding	Merlin	1	1	BirdsDir-A1, WCA-Sch1	Red	SBL, DGLBAP
2019	Breeding	Greylag Goose	3	41		Amber	
2019	Breeding	Teal	1	2		Amber	
2019	Breeding	Goosander	2	3			
2019	Breeding	Red-breasted Merganser	1	16			
2019	Breeding	Black Grouse	4	9		Red	SBL, AYR-LBAP, DGLBAP
2019	Breeding	Great Crested Grebe	3	3			
2019	Breeding	Goshawk	1	1	WCA-Sch1		
2019	Breeding	Marsh Harrier	1	1	BirdsDir-A1, WCA-Sch1		SBL, DGLBAP
2019	Breeding	Red Kite	1	1	BirdsDir-A1, WCA-Sch1		SBL, DGLBAP
2019	Breeding	Oystercatcher	9	19		Amber	
2019	Breeding	Lapwing	4	5		Red	SBL, DGLBAP
2019	Breeding	Golden Plover	1	2	BirdsDir-A1		SBL, DGLBAP
2019	Breeding	Curlew	17	53		Red	SBL, DGLBAP
2019	Breeding	Snipe	2	2		Amber	
2019	Breeding	Great Black-backed Gull	1	1		Amber	
2020 (Kinnelhead)	Breeding	Curlew	1	1		Red	SBL, DGLBAP

BirdsDir: Birds Directive Annex 1. WCA: Wildlife and Countryside Act – Schedule 1. AYR-LBAP: Ayrshire Local Biodiversity Action Plan. DGLBAP: Dumfries and Galloway Biodiversity Action Plan 2009. SBL: Scottish Biodiversity List. UKBAP: UK Biodiversity Action Plan

Table 7.12: Records of secondary species recorded during VP surveys 2018 - 2020

Species		Frequency of records		
		< 10 times	10-100 times	> 100 times
Canada goose		1		
Mallard			39	
Red grouse		5		
Grey heron			17	
Cormorant			34	
Sparrowhawk		7		
Buzzard				677
Black-headed gull			18	
Common gull				186
Great black-backed gull			43	
Herring gull	1 mixed flock of Herring gull and lesser black-backed gull		23	
Lesser black-backed gull	1 mixed flock of Herring gull and lesser black-backed gull		60	
Cuckoo		4		
Kestrel				164
Raven				405
Common crossbill		4		

Breeding Raptor Surveys

A7.5.3. One unoccupied nest was found during raptor surveys. There were 17 target flights recorded during raptor surveys, and a red kite pair were seen in June 2018, though no nests were located. Records from raptor surveys in 2018 and 2019 are shown in confidential Figure 7.6, Target species recorded in 2018 and 2019 are shown in Table 7.13, no target species were recorded in 2020 in the Kinnelhead Development Area, therefore no 2020 data are presented in Table 7.13. Secondary species recorded during raptor surveys in 2018, 2019 and in 2020 in the Kinnelhead Development Area are shown in Table 7.14.

Table 7.13: Target species recorded during raptor surveys 2018 - 2020

Date	Flight or point?	Species	Sex/ age	No. Individuals	Sign	Notes
18/04/2018	Point	Barn Owl			Pellet	Single (old) pellet in tin shed at Kirkhope.
18/04/2018	Point	Barn Owl			Splash	Low levels of splash, possibly from barn owl.
02/05/2018	Flight	Red Kite		1		Circling over hillside before flying off south.
02/05/2018	Flight	Red Kite		1		Circling over Rodger Cleuch.
02/05/2018	Flight	Peregrine		1		Commuting south towards Earncraig Hill.
02/05/2018	Flight	Peregrine		1		Commuting south up Rowantree Grain.
02/05/2018	Point	Unknown			Nest	Nest in lone Scots pine tree. No sign of current active use. Red kite and buzzard both observed in vicinity during earlier surveys.
02/05/2018	Point	Unknown			Pluck	Plucked remains of small passerine (possibly meadow pipit), on top of grass tussock.
03/05/2018	Point	Unidentified Owl			Pellet	Owl pellet observed at base of large Sitka spruce tree along edge of forest ride.
12/06/2018	Flight	Hen Harrier	Ringtail	1		Seen briefly quartering near summit of Over Law, lost to view when it moved to east side of hill.

12/06/2018	Flight	Red Kite		1		Feeding over open ground. Moved off south together with bird seen at 12:42.
12/06/2018	Flight	Red Kite		1		Feeding over open ground. Moved off south together with bird seen at 12:34.
12/06/2018	Flight	Red Kite		1		Feeding over open ground
28/07/2018	Flight	Merlin	Female, Juvenile	1		Perched on road-side fence post, before flying off to west north-west.
31/07/2018	Flight	Merlin	Male	1		Bird perched on post on summit of hill; loafing and preening. Then flew north north-east.
31/07/2018	Flight	Merlin	Male	1		Same as bird seen at 14:32. On fencepost, loafing and preening. Still present at end of survey.
02/04/2019	Flight	Peregrine	Male	1		Circling very high (height band 5) before dropping down and then very fast hunting flight (height band 1) at Sweetshaw Burn.
05/04/2019	Flight	Peregrine			Foraging	At Daerhead.
14/05/2019	Flight	Red Kite		1		Fairly direct transit flight with occasional quartering. All at height band 1. Untagged.
22/05/2019	Flight	Goshawk	Male	1		Alarming from forest, before rising and flying east towards suitable nesting habitat.
22/05/2019	Flight	Red Kite	Pair	2		
25/06/2019	Flight	Red Kite		1		
25/06/2019	Flight	Red Kite		1		

No target species recorded during raptor surveys in 2020 in the Kinnelhead Development Area

Table 7.14: Secondary species recorded during raptor surveys 2018 - 2020

Date	Species	Sex/age	No. Individuals	Notes
18/04/2018	Kestrel	Female	1	Perched by nest in tree (possibly old crow nest) by Crookburn, before flying off.
25/05/2018	Kestrel	Female	1	With prey, flew into stand of pines (NS 98507 09080).
25/05/2018	Kestrel		1	Hunting, hovering.
25/05/2018	Buzzard		1	Sitting on nest in isolated Scots pine.
25/05/2018	Buzzard		1	Hunting, hovering.
25/05/2018	Buzzard		1	Hunting, hovering. Raven soaring with it, being chased.
25/05/2018	Raven		1	Soaring with buzzard, chasing it.
25/05/2018	Buzzard		1	Soaring, hunting.
12/06/2018	Buzzard			Nest in Scots pine. Appeared unoccupied - no bird sitting.
12/06/2018	Carrion Crow			Old crow nest in tree.
12/06/2018	Buzzard		1	Displaying, then landed on ground.
12/06/2018	Buzzard		1	
12/06/2018	Buzzard		1	On dead tree in restocked area.
12/06/2018	Buzzard		1	
12/06/2018	Buzzard		1	Hunting, soaring.
17/06/2018	Buzzard		1	Vocal, circling, soaring then moved into forestry.
17/06/2018	Kestrel	Pair	2	Vocal, flying in and out of pines constantly. Calls included whining calls. Flights included bringing prey into pines.
17/06/2018	Buzzard		1	
28/07/2018	Buzzard		1	
30/07/2018	Buzzard		1	
30/07/2018	Buzzard		1	

30/07/2018	Buzzard		1	Hunting, hovering.
30/07/2018	Buzzard		1	Hunting, hovering.
30/07/2018	Buzzard		1	Hunting, hovering.
30/07/2018	Buzzard		1	Hunting, hovering.
30/07/2018	Kestrel		1	
30/07/2018	Raven		1	
30/07/2018	Buzzard	1 x Juvenile	2	At Brown Knees Hill on east side of road, soaring/hovering.
30/07/2018	Buzzard		1	Hunting/hovering west of road by ruined croft at Smithwood.
31/07/2018	Buzzard			Nest in Scots Pine, appeared to be unoccupied/unused this year.
31/07/2018	Buzzard		1	
02/04/2019	Buzzard		3	
22/05/2019	Buzzard		1	Alarming.
18/06/2019	Buzzard		1	
18/06/2019	Buzzard		1	Soaring, circling at Brown Kalles Hill c. NS967108
18/06/2019	Buzzard		1	Flew south down west side of Daer Water between Wintercleugh and Watermeeting Forest.
18/06/2019	Kestrel	Female	1	Hovering.
18/06/2019	Common gull	Juvenile	5	At least 5 fledged common gulls at common gull colony on dam wall.
25/06/2019	Raven		8	
24/04/2020	Raven	chicks		Active nest with chicks.
04/05/2020	Buzzard		1	
28/07/2020	Buzzard			Present throughout.

Breeding Bird Surveys

A7.5.4. Birds detected during breeding bird surveys that did not undergo territory analysis are listed in Table 7.15.

Table 7.15: Species recorded during breeding bird surveys that did not undergo territory analysis 2019 – 2020

Species	Recorded 2018	Recorded 2019	Recorded 2020 Kinnelhead Area
Canada Goose		Yes	
Red-legged Partridge		Yes	
Great Crested Grebe		Yes	
Grey Heron	Yes	Yes	
Sparrowhawk	Yes		
Hen Harrier	Yes		
Red Kite	Yes	Yes	Yes
Buzzard	Yes	Yes	Yes
Little Ringed Plover		Yes	
Greenshank	Yes		
Black-headed gull	Yes	Yes	
Great Black-backed Gull		Yes	Yes
Herring Gull	Yes		Yes
Lesser Black-backed Gull		Yes	
Woodpigeon	Yes	Yes	
Kestrel	Yes		
Jackdaw	Yes		
Carrion Crow	Yes	Yes	Yes
Raven	Yes	Yes	Yes
Coal Tit		Yes	
Skylark	Yes	Yes	Yes
Sand Martin	Yes	Yes	
Swallow	Yes	yes	
House Martin	Yes	Yes	
Willow Warbler	Yes		

Sedge Warbler		Yes		Grey Wagtail	Yes	Yes	
Wren	Yes	Yes	Yes	Pied Wagtail	Yes	Yes	Yes
Starling	Yes	Yes		Meadow Pipit	Yes	Yes	Yes
Blackbird		Yes		Chaffinch	Yes	Yes	Yes
Mistle Thrush	Yes	Yes	Yes	Twite		Yes	
Robin			Yes	Linnet	Yes		
Whinchat	Yes			Lesser Redpoll	Yes		
Stonechat		Yes		Common Crossbill	Yes		
Wheatear	Yes	Yes	Yes	Siskin	Yes		
Dipper	Yes	Yes	Yes	Reed Bunting	Yes	Yes	Yes
Dunnock		Yes					
Yellow Wagtail	Yes						

Black Grouse Surveys

A7.5.5. Black grouse recorded on site in 2018 and 2019 are shown in Figure 7.4, all records are listed in Table 7.16. Incidental records or black grouse from 2018 and 2019 are shown in Table 7.17. There were no black grouse recorded in the Kinnelhead Development Area in 2020

Table 7.16: Black grouse survey results 2018 and 2019

Date	Sex/age	No. Individuals	Easting	Northing	Sign	Notes
27/04/2018	Male	2	296100	605400	Lekking	Briefly lekking, before flying east over Crookburn and beyond at 6:07.
03/05/2018		1	299129	608458	Lekking	Flew off at 6:54.
03/05/2018		1	299285	607310	Lekking	Possibly same bird as seen at 6:37. Remained but didn't display after 7:12.
15/05/2018		4	298300	607500	Lekking	Four birds lekking until 6:46. Two flew off and the remaining two birds separated and lekked intermittently until survey end.
15/05/2018		2	299000	608600	Individuals	Two birds from group seen at 5:30 flew N and landed, but not seen again.
08/04/2019	Male	3			Lekking	200-300 m south of Crookburn Farm. Briefly joined by one female which flew off to the south.
08/04/2019	Female	1			Individuals	Briefly joined three male black grouse seen at 07:40, before flying off to the south.
16/04/2019	Male	2	298227	607349	Lekking	On area of short grass (surrounding area/adjacent ground, recently burnt). Displaying vigorously, fighting each other, still at 06:50 when surveyor left them to check elsewhere for any further birds.
23/04/2019		1	296051	605862	Lekking	Simultaneously with black grouse also seen at 06:12.
23/04/2019		1	296026	604637	Loafing	Simultaneously with black grouse also seen at 06:12.
12/05/2019	Male	1			Individuals	Flew towards location where two males were lekking.
12/05/2019	Male	2			Lekking	
14/05/2019	Male/ Adult	1	296760	605420	Lekking	Displaying strongly/vigorously until 06:54 when it flew north-west and landed by a second male black grouse at c.NS962057. Neither bird was still displaying, both loafing, feeding. Observed until 07:00.
14/05/2019					Individuals	Seen at 05:55 when it flew to join other black grouse seen at 06:42.
14/05/2019	Male	1			Individuals	Flew in (height band 1) whilst watching other black grouse seen 05:55. Did not display after landing but was joined at 06:54 by first bird (seen at 5:55).
16/05/2019	Male	1	296700	605400	Lekking	Displaying in same vicinity as lek recorded on 14/05 from 04:20 to 08:20, but slightly further uphill amongst rushes.

Table 7.17: Incidental black grouse records 2018 and 2019

Date	Sex/age	No. Individuals	Easting	Northing	Sign	Notes
27/04/2018	Females	2			Individuals	Anecdotal record from shepherd.
29/09/2018	Males	4	298200	607300	Individuals	Present in vicinity of VP2.
16/04/2019	Male	2	298227	607349	Lekking	Same birds as seen at 06:09. Still displaying 08:35-08:50 when seen on way to VP2. Not noted after 08:50.
25/04/2019	Male	2			Feeding	Photographed by farmer.

7.6. COLLISION RISK MODELLING

Parameters

A7.6.1. Collision risk modelling (CRM) was carried out for vantage point data collected at the Proposed Development between March 2018 and August 2019 inclusive from VPs 1-7 and between March and August 2020 inclusive from VPK1. Data collected during flight activity vantage point surveys were used to predict the number of individuals per species expected to collide with the turbine rotors per season. For each species, the risk of collision for an individual given that it passes through the rotor swept volume is calculated by estimating the likelihood of collision based on the characteristics of the birds and of the turbines. Where turbine specifications were not available, representative values were used. Bird parameters and wind farm specifications used in the model are provided in Table 7.18 and Table 7.19.

Table 7.18: Wind turbine specifications used in CRM

Number of turbines	17
Number of blades	3
Maximum chord length (metres)	3.1
Pitch (degrees)	6
Rotor diameter (metres)	155
Rotation period (seconds)	4.2
Number of turbines	17

Table 7.19: Bird specifications used in CRM

Species	Bird length (metres)	Wingspan (metres)	Bird speed (metres/ second)	Estimated nocturnal activity*	Calculated individual collision risk
Greylag goose	0.9	1.8	17.1	0.25	0.067
Pink-footed goose	0.75	1.7	17.1	0.25	0.061
Marsh Harrier	0.55	1.16	11.2	0	0.071
Hen harrier	0.52	1.2	9.1	0	0.083
Red kite	0.66	1.95	12	0	0.075
Oystercatcher	0.45	0.82	13	0	0.057
Lapwing	0.3	0.85	12.8	0.25	0.05
Golden plover	0.29	0.76	17.9	0.25	0.039
Curlew	0.55	0.9	16.3	0	0.052
Snipe	0.26	0.46	17.1	0.25	0.038
Peregrine	0.48	1.1	12.1	0	0.062

*as a proportion of diurnal activity

Species Collision Risk

A7.6.2. Species with sufficient data to run CRM during the breeding season are shown in Table 7.20 (VPs 1-7) and Table 7.21 (VPK1). Table 7.22 shows species with sufficient data to run CRM during the non-breeding season.

Table 7.20: Number of flights and individuals observed passing through the turbine area at collision risk height during the breeding season 2018 and 2019

Species	No. flights	Flights at risk height	Individuals at risk height	CRM carried out
Greylag Goose	30	7	16	Yes
Teal	1	0	0	No
Goosander	6	1	1	No
Black Grouse	6	2	3	No
Osprey	5	2	2	No
Goshawk	6	2	2	No
Marsh Harrier	5	4	4	Yes
Hen Harrier	19	3	3	Yes
Red Kite	43	21	22	Yes
Oystercatcher	56	4	12	Yes
Lapwing	33	3	6	Yes
Golden Plover	1	1	11	Yes
Ringed Plover	4	0	0	No

Species	No. flights	Flights at risk height	Individuals at risk height	CRM carried out
Curlew	248	37	69	Yes
Snipe	13	8	9	Yes
Redshank	3	0	0	No
Merlin	7	2	2	No
Peregrine	11	6	7	Yes

Table 7.21: Number of flights and individuals observed passing through the turbine area at collision risk height during the breeding season in 2020, Kinnelhead Development Area

Species	No. flights	Flights at risk height	Individuals at risk height	CRM carried out
Greylag Goose	1	1	11	Yes
Osprey	2	2	2	No
Red Kite	19	4	5	Yes
Oystercatcher	6	0	0	No
Lapwing	1	0	0	No
Golden Plover	1	0	0	No
Curlew	39	7	10	Yes
Snipe	8	0	0	No

Table 7.22: Number of flights and individuals observed passing through the turbine area at collision risk height during the non-breeding season 2018 to 2020

Species	No. flights	Flights at risk height	Individuals at risk height	CRM carried out
Greylag Goose	3	0	0	No
Pink-footed Goose	64	32	1981	Yes
Goosander	4	2	3	No
Black Grouse	2	0	0	No
Unidentified Diver	1	0	0	No
Osprey	1	1	1	No
Goshawk	1	1	1	No
Hen Harrier	7	0	0	No
Red Kite	16	5	5	Yes
Golden Plover	1	1	19	Yes
Merlin	6	1	1	No
Peregrine	12	7	7	Yes

A7.6.3. Details of calculations used to produce estimates for collision risk models for each goose species eligible for CRM are shown in Table 7.23. Details of calculations used to produce estimates for collision risk models for each raptor and wader species eligible for CRM during the breeding season are shown in Table 7.24 (2018 and 2019, VPs 1-7) and Table 7.25 (2020, Kinnelhead Development Area). Details of calculations used to produce estimates for collision risk models for each raptor and wader species eligible for CRM during the non-breeding season are shown in Table 7.26.

Table 7.23: Collision Risk Model for goose species

Parameter	Formula	Greylag goose Summer - 2018/2019	Greylag goose Summer – 2020 (Kinnelhead area)	Pink-footed goose Winter - 2018/2019
Total number of birds flying through wind farm polygon	a	16	11	1981
Mean survey effort (min)	b	5147	2880	3240
Daylight during survey period, based on civil twilight (min)	c	167849	168043	101842
Estimate of nocturnal activity as a proportion of daytime activity	d	0.25	0.25	0.25
Time of potential activity during survey period (min)	e = c * (1+d)	209812	210054	127303
Rate of birds recorded during survey period (birds/min)	f = a/b	0.0031	0.0038	0.6114
Estimate of number of birds during season	g = e * f	652.17	802.29	77835.28
Risk window length (m)	h	3512	5409	3948
Turbine blade length (m)	i	77.5	77.5	77.5
Number of turbines	j	17	17	17
Risk window (m^2)	k = h * i * 2	544360	838395	611940

Parameter	Formula	Greylag goose	Greylag goose	Pink-footed goose
Rotor-swept area (m^2)	l = pi * i^2 * j	320776	320776	320776
Proportion of risk area that is rotor-swept	m = l/k	0.589	0.383	0.524
Estimate of number of birds flying through rotor-swept area during season	n = g * m	384.3	307	40800.9
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet)	o	0.067	0.067	0.061
Predicted mortality with no avoidance - turbines operational 85% of the time (collisions/season)	p = n * o * 0.85	21.91	17.5	2117.33

Values have been rounded up for presentation purposes. Following the calculations using the rounded values may yield slightly different results

Table 7.24: Collision Risk Model for raptor and wader species in the 2018 and 2019 breeding seasons

Parameter	Formula	Marsh Harrier	Hen Harrier	Red Kite	Oystercatcher	Lapwing	Golden plover	Curlew	Snipe	Peregrine
Occupancy of risk volume (sec)	a	262	42	1171	138	223	409	1410	200	260
Survey effort (ha-min)	b	3941453	3941453	3941453	3941453	3941453	3941453	3941453	3941453	3941453
Observed occupancy rate for site (sec/ha-min)	c = a / b	0.0001	0.00001	0.0003	0.00003	0.0001	0.0001	0.00036	0.0001	0.00007
Daylight minutes	d	167849	167849	167849	167849	167849	167849	167849	167849	167849
Potentially active period (min)	e = d*1	167849	167849	167849	167849			167849		167849
Potentially active period (min)	e = d*1.25					209812	209812		209812	
Area of the wind farm polygon (ha)	f	411.26	411.26	411.26	411.26	411.26	411.26	411.26	411.26	411.26
Total occupancy of risk volume during period of interest (sec)	g = c * e * f	4597	732	20502	2409	4874	8961	24701	4385	4546
Rotor diameter (m)	h	155	155	155	155	155	155	155	155	155
Risk volume (m^3)	i = f * h * 10,000	637457089	637457089	637457089	637457089	637457089	637457089	637457089	637457089	637457089
Number of turbines	j	17	17	17	17	17	17	17	17	17
Rotor blade width (m)	k	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Length of bird of interest (m)	l	0.55	0.52	0.66	0.45	0.3	0.29	0.55	0.26	0.48
Rotor-swept volume (m^3)	m = j * pi * (h/2)^2 * (k + l)	1170833	1161210	1206119	1138756	1090639	1087431	1170833	1077808	1148379
Bird occupancy of rotor-swept volume (sec)	n = g * m / i	8.4	1.3	38.8	4.3	8.3	15.3	45.4	7.4	8.2
Bird flight speed (m/sec)	o	11.2	9.1	12	13	12.8	17.9	16.3	17.1	12.1
Time taken for bird to transit rotor (sec)	p = (k + l) / o	0.33	0.4	0.31	0.27	0.27	0.19	0.22	0.2	0.3
Number of rotor transits	q = n / p	26	3	124	16	31	81	203	38	28
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet)	r	0.071	0.083	0.075	0.057	0.038	0.039	0.052	0.038	0.062
Predicted mortality with no avoidance - turbines operational 85% of the time (collisions/season)	y = q * r * 0.85	1.56	0.24	7.93	0.76	1.23	0.24	9.04	1.23	1.47

Values have been rounded up for presentation purposes. Following the calculations using the rounded values may yield slightly different results

Table 7.25: Collision Risk Model for raptor and wader species in the 2020 breeding season at Kinnelhead Development Area

Parameter	Formula	Curlew	Red Kite
Occupancy of risk volume (sec)	a	129	303
Survey effort (ha-min)	b	272068	272068

Parameter	Formula	Curlew	Red Kite
Observed occupancy rate for site (sec/ha-min)	c = a / b	0.00047	0.00111
Daylight minutes	d	168043	168043
Potentially active period (min)	e = d*1	168043	168043
Area of the wind farm polygon (ha)	f	411.26	411.26
Total occupancy of risk volume during period of interest (sec)	g = c * e * f	32654	76926
Rotor diameter (m)	h	155	155
Risk volume (m^3)	i = f * h * 10,000	637457089	637457089
Number of turbines	j	17	17
Rotor blade width (m)	k	3.1	3.1
Length of bird of interest (m)	l	0.55	0.66
Rotor-swept volume (m^3)	m = j * pi * (h/2)^2 * (k + l)	1170833	1206119
Bird occupancy of rotor-swept volume (sec)	n = g * m / i	60	145.5
Bird flight speed (m/sec)	o	16.3	12
Time taken for bird to transit rotor (sec)	p = (k + l) / o	0.22	0.31
Number of rotor transits	q = n / p	306	456
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet)	r	0.052	0.075
Predicted mortality with no avoidance - turbines operational 85% of the time (collisions/season)	y = q * r * 0.85	11.94	29.75

Values have been rounded up for presentation purposes. Following the calculations using the rounded values may yield slightly different results

Table 7.26: Collision Risk Model for raptor and wader species in the non-breeding seasons 2018 - 2020

Parameter	Formula	Golden plover	Red Kite	Peregrine
Occupancy of risk volume (sec)	a	37	337	96
Survey effort (ha-min)	b	2476309	2476309	2476309
Observed occupancy rate for site (sec/ha-min)	c = a / b	0.00001	0.00014	0.00004
Daylight minutes	d	101842	101842	101842
Potentially active period (min)	e = d*1		101842	101842
Potentially active period (min)	e = d*1.25	127303		
Area of the wind farm polygon (ha)	f	411.26	411.26	411.26
Total occupancy of risk volume during period of interest (sec)	g = c * e * f	782	5700	1618
Rotor diameter (m)	h	155	155	155
Risk volume (m^3)	i = f * h * 10,000	637457089	637457089	6.37E+08
Number of turbines	j	17	17	17
Rotor blade width (m)	k	3.1	3.1	3.1
Length of bird of interest (m)	l	0.29	0.66	0.48
Rotor-swept volume (m^3)	m = j * pi * (h/2)^2 * (k + l)	1087431	1206119	1148379
Bird occupancy of rotor-swept volume (sec)	n = g * m / i	1.3	10.8	2.9
Bird flight speed (m/sec)	o	17.9	12	12.1
Time taken for bird to transit rotor (sec)	p = (k + l) / o	0.19	0.31	0.3

Parameter	Formula	Golden plover	Red Kite	Peregrine
Number of rotor transits	q = n / p	7	34	10
Probability of collision for a bird flying through rotors (estimated using SNH spreadsheet)	r	0.05	0.075	0.062
Predicted mortality with no avoidance - turbines operational 85% of the time (collisions/season)	y = q * r * 0.85	1.33	2.2	0.52

Values have been rounded up for presentation purposes. Following the calculations using the rounded values may yield slightly different results