

**CRAIGINMODDIE: UPDATED YEAR 1 ORNITHOLOGY REPORT
GEL19117**

ENERGIE KONTOR

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1 Introduction

Gavia Environmental Ltd (GEL) was commissioned by Energie Kontor (the Client) to undertake ornithology monitoring at the proposed Craiginmoddie Windfarm, which is located at Grid Reference NX 312 985, approximately 5.5 km north east of Barr, in South Ayrshire (hereafter referred to as the Proposed Development or Site).

This report presents the findings of the ornithology monitoring in order to provide a baseline dataset for the survey period from October 2018 – December 2019.

GEL were commissioned to complete further breeding bird surveys by the Client in June and July 2020 to account for an extension of the Proposed Development at Doughty Hill, located to the south-east of the original site boundary. The extension area is located at Grid Reference NX 323 983. The results from the additional 2020 breeding bird surveys are included in Appendix 1.

1.1 Surveys undertaken in 2018-2019 Survey Season

The following surveys were undertaken in the period from October 2018 - December 2019, with detailed methods for each presented in Section 3 below:

- Flight activity survey;
- Breeding raptor survey;
- Black grouse survey; and
- Moorland breeding bird survey.

1.2 Legislation

1.2.1 Birds

Under the Wildlife and Countryside Act (1981), a wild bird is defined as any bird of a species which is resident in or is a visitor to the European Territory of any member state in a wild state. Game birds however are not included in this definition (except for limited parts of the Act). They are covered by the Game Acts, which fully protect them during the close season.

All birds, their nests and eggs are protected by law and it is thus an offence, with certain exceptions, to:

- Intentionally kill, injure or take any wild bird;
- Intentionally take, damage or destroy the nest of any wild bird while it is in use or being built.
- Intentionally take or destroy the egg of any wild bird;
- Have in one's possession or control any wild bird, dead or alive, or any part of a wild bird, which has been taken in contravention of the Act or the Protection of Birds Act 1954;
- Have in one's possession or control any egg or part of an egg which has been taken in contravention of the Act or the Protection of Birds Act 1954;
- Use traps or similar items to kill, injure or take wild birds;
- Have in one's possession or control any bird of a species occurring on Schedule 4 of the Act unless registered, and in most cases ringed, in accordance with the Secretary of State's regulations (see Schedules); or
- Intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building, or at a nest containing eggs or young, or disturb the dependent young of such a bird.

2 Methodology

2.1 Desk Study

A desk study was undertaken prior to the commencement of fieldwork to provide up to date ecological information regarding any statutory nature conservation sites within 5 km of the Site, any European or UK protected species within 5 km of the Site, and the broad habitat types that occur on site and within a 500m buffer. Information was sought from the following sources:

- A search of publicly available information, available for commercial use, on protected species records in the 5 km grid square the Site is situated in, dated within the last 10 years;
- NatureScot SiteLink; and
- Multi-Agency Geographical Information for the Countryside (MAGIC).

2.2 Field Survey Methodology

2.2.1 Flight Activity Survey

Surveys followed NatureScot guidelines for conducting ornithological surveys for onshore wind farms (NatureScot, 2017). The data collected allowed the flight activity and number of birds involved to be estimated over a given timeframe as well as showing spatial and temporal flight activity patterns.

Surveys were conducted from 5 vantage point (VP) locations which were chosen to provide a wide and unrestricted view of the proposed development area and 500 m buffer. Initially, potential VPs were identified by conducting a viewshed analysis using ArcGIS software and a ground truthing reconnaissance survey further determined the suitability of these VP locations. The final locations are detailed as follows:

- VP A (NX 33283 99541) – Western slope of Black Hill of Garleffin, north of White Scaurins looking west over the north-eastern part of the Site;
- VP B (NX 31361 97269) – Top of Daljenburgh Hill looking east-northeast across the south eastern part of the Site;
- VP C (NS 31447 00527) – 1 km west of The Pilot, looking south-east over the northern part of the Site;
- VP D (NX 29748 97257) – North slope of Milton, looking north-east over the south-west of the Site; and
- VP E (NX 29933 98953) – 700 m east-northeast of Delamford Hill, overlooking the west and central part of the Site.

Each flight activity survey was carried out over a three-hour watch. On days where successive watches were undertaken, a break of at least 30 minutes between each watch was taken to avoid surveyor fatigue, as per NatureScot guidance. Surveys covered both sunrise and sunset as well as diurnal watches. Each VP was surveyed for a minimum of 6 hours each month during conditions of at least moderate visibility. Total hours for each visibility classification are listed in Table 1.

During each survey, any target species detected were observed until they landed or had flown out of sight. The paths of all observed flights were drawn directly onto 1:25,000 OS maps while the following flight data was recorded:

- Flight start time;
- Species (where identification was uncertain, observations were identified to species group level at a minimum);

- Flock size;
- Flight duration;
- Bird(s) occupancy at one of three height bands (Band 1 = <20 m, Band 2 = 20-200 m, Band 3 = >200 m) for every 15 second flight time interval; and,
- Behaviour (including territorial or nesting behaviour).

In addition to flights by target species, the presence and behaviour of any other notable species which may be potentially vulnerable to the effects of wind turbines (secondary species) was also recorded.

The list of target species included the following: all Schedule 1 raptor species, all owl species, all divers, all waders, all geese, swans and ducks (excluding mallard), all grebes, all auks, cormorant, herring gull, kittiwake, and great black backed gull. Secondary species included all other gull species, all other raptor species, and raven (NatureScot, 2017).

Weather and visibility conditions were recorded during each survey on an hourly basis using the following criteria;

Visibility: 0 = Poor (<1 km); 1 = Moderate (1-2 km); 2 = Good (>2 km)

Wind direction: according to 16-point compass

Wind strength: according to Beaufort Scale

Cloud cover: in eighths of sky (oktas)

Cloud height: 0 = <150 m; 1 = 150-500 m; 2 = >500 m

Rain: 0 = None; 1 = Drizzle/Mist; 2 = Light showers; 3 = Heavy showers; 4 = Heavy rain

Frost: 0 = None; 1 = Ground frost; 2 = All day frost

Snow: 0 = None; 1 = On site; 2 = On high ground

Table 1. VP Hours Log

VP Name	A	B	C	D	E
Non-breeding season (September – Mid-March)					
Hours per VP	36	36	36	36	36
Hours of Good Visibility (>2 km)	25	17	32	26	30.5
Hours of Moderate Visibility (1-2 km)	6.5	10.5	4	9	3.5
Hours of Low Visibility (<1 km)	4.5	8.5	0	1	2
Breeding season (Mid-March – August)					
Hours per VP	36	36	36	36	36
Hours of Good Visibility (>2 km)	32	32	27	34	32
Hours of Moderate Visibility (1-2 km)	2	3	9	2	3
Hours of Low Visibility (<1 km)	2	1	0	0	1

2.2.2 Breeding Raptor Survey

These surveys followed NatureScot guidance for ornithological surveys for onshore windfarms (NatureScot, 2017) and were conducted using a methodology adapted from the species-specific survey methods detailed in Hardey *et al.* (2013). These surveys covered the proposed windfarm development area and a buffer of 2 km to account for wider ranging raptor species (where land access permitted). Surveys involved four visits between April and July (the typical raptor breeding season) in a range of weather conditions and times of day (Table 2).

The surveys involved walkovers interspersed by short VP watches from positions overlooking broad areas of suitable raptor foraging and breeding habitat. Searches focused on habitats such as heathland and similar open habitats, craggy rock faces and cliffs (where present), steep sided burns, trees along the forest edge and older stands of trees within afforested areas. Searches were also informed by the results of the flight activity VP surveys detailed above.

Flights and observations, including behavioural notes were recorded onto 1:25,000 OS maps.

Table 2. Breeding Raptor Survey Conditions

Date	Start Time	End Time	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
29/04/2019	09:30	16:00	2	Southwest	0	2/8	2	Good	0	0
16/05/2019	07:35	15:00	3	Southwest	0	4/8	2	Good	0	0
24/06/2019	07:40	14:30	0	N/A	3	7/8	2	Good	0	0
22/07/2019	07:15	14:45	4	South	3	8/8	2	Good	0	0

2.2.3 Black grouse survey

Following the guidance of Etheridge and Baines (1995), aerial imagery was consulted to identify mosaics of moorland, heath, and margins of coniferous plantation and rough grazing (all suitable black grouse lekking habitats) prior to visiting the Site. During the March and April VP surveys, ground truthing was undertaken to further identify any potential lek sites within a 1.5 km buffer of the potential development area. In accordance with Gilbert *et al.* (1998), each suitable lek site was observed, walking within 500 m of each area, watching and listening for any displaying males during an early morning and late evening watch with surveys undertaken in early May 2019 (Table 3).

Table 3. Black Grouse Survey Conditions

Date	Start Time	End Time	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
14/05/2019	04:05	05:50	2	South	0	1/8	2	1-2	0	0

2.2.4 Breeding Bird Survey

The breeding bird survey undertaken generally followed the methodology set out by the British Trust for Ornithology (BTO) and simultaneously adapted the Constant Search Method (Brown & Shepherd, 1993), modified to four visits in accordance with Calladine *et al.* (2009). Survey area included all areas of open ground, within the potential development area plus a surrounding buffer of 500 m. Surveyors approached all areas of open moorland to within 100 m and the behaviour of all birds seen or heard was recorded on 1:10,000 OS maps using standard British Trust for Ornithology (BTO) Common Bird census (CBC) coding and notation (Marchant, 1983).

The following behaviours were used to assess residency and breeding:

- Song (the numbers of singing males were taken to be indicative of the number of breeding pairs);
- Adults carrying nest material or food;
- Adults alarm calling repeatedly, which would indicate nearby dependent young;
- Nests or young found;

- Aggressive behaviour between males or between females, indicating territorial disputes;
- Distraction displays;
- Juvenile birds; and
- Repeated contacts with birds of the same species even if breeding was not apparent.

All breeding bird survey records were entered into ArcView Geographical Information System (GIS) software. These were analysed following the methods of Calladine *et al.* (2009) to identify the minimum number of probable or confirmed breeding territories for each species encountered. Territories were assumed given certain bird behaviours such as singing, calling, aggressive encounters and displaying.

A total of four visits were undertaken between April and July (inclusive) and surveys were undertaken in suitable weather conditions as summarised in Table 4.

Table 4. Brown and Shepherd Breeding Bird Survey (BBS) Conditions

Date	Start	End	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
29/04/2019	09:30	16:00	3	Southeast	0	5/8	1	2	0	0
16/05/2019	07:35	15:00	3	Southwest	0	6/8	2	2	0	0
24/06/2019	07:40	14:30	1	N/A	0	8/8	2	2	0	0
22/07/2019	07:15	14:45	4	South	0	8/8	2	2	0	0

2.3 Limitations

The proposed maximum tip height of the turbines changed during the course of the year one surveys. This change in turbine design lead to an increase in the height bands observed during the VP surveys. Collision risk height (height band 2) increased from 20-180 m to 20-200 m. Therefore, any data collected before the change (23/11/2018) will have different height bandings and may potentially influence the outcome of the final collision risk model. The difference in collision risk height between the first and second turbine designs is low, <12% difference, and so may not significantly influence the outcome of the models. To assess this, two models can be performed, one using a collision envelope from the first turbine design and another using the second turbine designs with a larger collision envelope. These two models can be compared and any overlap in error or confidence intervals between the two can be used to assess whether any difference is significant.

During the course of surveys over the breeding season, no vantage point surveys were conducted after 7pm. During June in Galloway, sunset can be as late as 10pm, as a result three hours of daylight time has not been surveyed during the 2019 breeding season.

3 Results

3.1 Desk Study Results

3.1.1 Statutory Nature Conservation Sites

The desk study highlighted three statutory designated sites within 5 km of the Site, however, none are designated for ornithology interest:

- Blair Farm Site of Special Scientific Interest (SSSI), designated for its geology, is located approximately 2.1 km north, of the Site boundary. NatureScot site code: 224.
- Auchalton SSSI, designated for its lowland grassland, is located approximately 3.5 km north of the Site boundary. NatureScot code: 96.
- Knockgardner SSSI, designated for its Wenlock geology, is located approximately 4.4 km North-East of the Site boundary. NatureScot code: 879.

3.1.2 Bird Species

One hundred and seven bird species were recorded within a 5 km buffer of the Site. Limiting the results to species afforded enhanced levels of protection under the Wildlife and Countryside Act (1981) as amended, and the Birds Directive (1979), the following species were recorded:

- Schedule 1.1 and Annex 1: Peregrine *Falco peregrinus*, merlin *Falco columbaria* and corncrake *Crex crex*;
- Schedule 1.1: Goshawk *Accipiter gentilis*, barn owl *Tyto alba*, common crossbill *Loxia curvirostra* and fieldfare *Turdus pilaris*;
- Schedule 1.2: Greylag goose *Anser anser*; and
- Annex 1: Golden plover *Pluvialis apricaria*, dunlin *Calidris alpina* and short-eared owl *Asio flammeus*.

None of the species recorded in the desk study were recorded within the Site boundary.

Black grouse *Tetrao tetrix* were identified during the desk study, within 5 km of the Site however, no indication of potential lek sites was given.

3.2 Field Study Results

3.2.1 Flight Activity Survey

A total of eight target species were recorded, of which three (hen harrier, peregrine and merlin) are Schedule 1.1 and Annex 1 species. The majority of sightings were associated with transitional movements within or across the Site, with observations also made of species commuting across the Site and around the development area buffer zone. Tables 5-12 provide the following details of each species observed:

- Date;
- VP - the vantage point from which the observation was made;
- Duration - the duration of the observed flight (in seconds);
- Time - the time at the start of the observed flight (GMT or BST as appropriate);
- No. Birds - number of individual birds identified in the flight;
- Hight bands - the heights at which the flight was recorded at; and

- Collision risk- given the height of the turbines and blade length, any flight recorded within height bands 2 is at risk of collision (band 1 is below risk of collision and band 3 is above risk of collision).

Secondary species observed during flight activity surveys include sparrowhawk, buzzard, black-headed gull, common gull, and raven. Raven, buzzard and common gull were the species most frequently found within the potential development area during each visit.

3.2.2 Target Species

3.2.2.1 Merlin (*Falco columbarius*, Figure 4a)

Five observations of merlin, hunting across the Site, were recorded during the winter non-breeding season with both male and female individuals seen. A female was observed once in November 2018, and a male was observed twice in February 2019. The individual was observed approximately 2 hours apart and there is therefore potential that this is the same bird. Two observations were also made of a male, commuting across the Site, in September 2019. Observations were recorded both on Site and within the 500 m buffer to the north and east of the Site with all observations being recorded at collision risk height. No merlin flights were observed between March 2019 – August 2019 (inclusive) and no evidence of breeding on site was recorded.

However, absence of sightings during the summer months does not mean the species isn't present within the Site, though it is likely that merlin will move to upland areas at higher altitude during the summer months (RSPB, 2019).

Table 5. Merlin Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
15/11/2018	A	10:59	167	1	1-2	Yes
04/02/2019	B	11:03	30	1	2-3	Yes
04/02/2019	C	13:01	124	1	2-3	Yes
23/09/2019	B	12:29	121	1	1-2	Yes
24/09/2019	A	14:25	60	1	2	Yes

3.2.2.2 Woodcock (*Scolopax rusticola*, Figure 4b)

Woodcock were observed three times during the winter survey season. Twice during November 2018, an individual was observed as the surveyor walked back out from the VP location. It is highly likely this is the same individual given the timing of the observations. All observations were along the edge of the Site boundary and 500m buffer. None of the observations were recorded at collision risk height.

Table 6. Woodcock Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
15/11/2018	B	16:00	15	1	1	No
15/11/2018	B	16:00	10	1	1	No
23/01/2019	E	10:30	30	1	1	No

3.2.2.3 Hen Harrier (*Circus cyaneus*, Figure 4c)

An individual female hen harrier was observed during the winter survey season. All other observations were recorded during the breeding survey season. The observations recorded in April and August 2019 were both of an individual hunting male. All observations were recorded on the Site boundary and 500m buffer and all individuals recorded were all, or in part at collision

risk height. Several ringtails (female or juvenile) were observed during the winter months, with an individual male being observed in the spring, however no winter roosts were identified. No display flights or interactions between individuals were observed and no hen harrier flights were observed between May 2019 – July 2019 (inclusive).

Hen harrier are known to hold territory during winter which may be indicated by the observations during the non-breeding season, however, the majority of the Site is coniferous plantation, and the open areas of moorland within the Site development area are sub-optimal, due to grazing pressure, to support nesting hen harrier. The observation of a male in April 2019 would suggest breeding was attempted but was likely unsuccessful as no evidence of breeding was recorded over the remainder of the breeding season.

Table 7. Hen Harrier Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
21/02/2019	E	11:01	210	1	1-3	Yes
21/03/2019	C	13:07	15	1	1	No
29/04/2019	E	11:30*	50	1	1-2	Yes
26/08/2019	A	13:37	210	1	1-3	Yes

3.2.2.4 Grey Heron (Ardea cinerea, Figure 4d)

An individual grey heron was observed during the June survey commuting across the west of the Site and within the 500 m buffer at collision risk height.

Table 8. Grey Heron Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
11/06/2019	E	06:36	50	1	2	Yes

3.2.2.5 Peregrine (Falco peregrinus, Figure 4e)

Two observations of peregrine were recorded in June 2019 and July 2019. The flight recorded in June was of an individual emerging from the plantation, at speed and flying east along the Auchengairn Burn, and off site across the 500m buffer. The August observation was of an individual flying south west, from off site, across the buffer and lost to view in the plantation to the north of the Site. All observations were recorded at potential collision height. Whilst no nest site was identified within the Site, based on the dates of the flight lines recorded, it is likely there is a nest site within the wider area.

Table 9. Peregrine Falcon Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
10/06/2019	B	15:11	17	1	2	Yes
26/08/2019	A	12:39	5	1	1-2	Yes

3.2.2.6 Pink-Footed Goose (Anser brachyrhynchus, Figure 4f)

Six observations of pink-footed goose were recorded during the March 2019 survey. All observations were commuting across the Site, both within the Site boundary and inside the 500m buffer. Four of these observations were of birds at collision risk height.

Table 10. Pink-Footed Goose Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
21/03/2019	E	07:06	83	20	3	No
21/03/2019	C	07:07	60	15	2	Yes
21/03/2019	E	07:28	73	50	2-3	Yes
21/03/2019	B	08:20	30	>10*	2	Yes
21/03/2019	E	08:23	65	35	3	No
21/03/2019	B	10:55	20	>3*	2	Yes

Flights marked '*' could not accurately determine the number of geese present due to low cloud and poor visibility.

3.2.2.7 Snipe (*Gallinago gallinago*, Figure 4g)

Two observations of snipe were recorded during the March 2019 survey. An individual was recorded along the edge of the Site boundary and 500 m buffer to the north of the Site, the other was recorded along the edge of the 500m buffer south of the Site. The individual observed to the south of the Site was observed at potential collision risk height.

Table 11. Snipe Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
21/03/2019	C	08:20	15	1	1	No
21/03/2019	D	08:24	60	1	1-2	Yes

3.2.2.8 Curlew (*Numenius arquata*, Figure 4h)

Four records of curlew were made during the breeding survey season. Three records were made during March 2019; all observations were of individuals in flight song and recorded within the 500 m buffer south-east of the Site. An individual curlew was recorded during the June 2019 survey within the same area. Only the observations recorded during the March survey were at potential collision risk height.

Table 12. Curlew Flight Activity

Date	VP	Time	Duration (seconds)	No. Birds	Height Bands	Strike Risk
21/03/2019	D	08:55	120	1	2	Yes
21/03/2019	D	09:40	180	1	2-3	Yes
21/03/2019	D	10:31	60	1	2	Yes
11/06/2019	D	05:52	45	1	1	No

3.2.3 Secondary species

A number of secondary species were recorded during the activity surveys totalling 419 observations. These largely consisted of common raptors (buzzard *Buteo buteo*, sparrowhawk *Accipiter nisus* and Kestrel, *Falco tinnunculus*), and raven *Corvus corax* commuting across the Site development area and 500m buffer.

Buzzard and raven activity were most commonly recorded with 207 buzzard observations and 188 raven observations being made across the Site. 50.1% of buzzard flights and 64.9% of raven flights were recorded all, or in part, at potential collision risk height.

Observations of Kestrel and sparrowhawk were less frequent with 7 observations of kestrel and 9 observations of sparrowhawk recorded. 50% of all kestrel flights and 11% of sparrowhawk flights were recorded all, or in part, at potential collision risk height.

An individual lesser black-backed gull *Larus fuscus* was recorded during the May 2019 survey commuting south across the Site recorded in part at collision height.

3.2.4 Breeding Raptor Survey Results

Buzzard were most frequently observed during the breeding raptor survey, including three pairs recorded during May 2019. Buzzard home ranges can be relatively small in areas with abundant prey and therefore there is potential that all three observations are of separate pairs. A potential nest location was also observed to the north of the Site. However, this area has since been felled as of November 2019.

An individual sparrowhawk was recorded alarming, north of Craiginmoddie within the plantation, indicating the likely location of a nest site within this area.

No other target raptor species were observed during the dedicated breeding raptor surveys.

3.2.5 Black Grouse Survey Results

No lek sites, bird observations, or field signs of black grouse were found during the dedicated black grouse surveys. Small areas of potential lek habitat were recorded to the east of Doughty Hill, however the east aspect does not provide sufficient cover for female black grouse. As such it is unlikely that this area would be used as a lek site.

3.2.6 Breeding Bird Survey Results

Thirty-four species were recorded as part of the generic breeding bird surveys. Figure 6a-6c present all species observed.

Table 13 below presents a summary of the species recorded with confirmed territories.

The following species were also recorded during the breeding bird survey, but with no confirmed evidence of breeding: bullfinch *Pyrrhula pyrrhula*, carrion crow *Corvus corone*, common crossbill *Loxia curvirostra*, garden warbler *Sylvia borin*, great tit *Parus major*, grey heron, grey wagtail *Motacilla cinerea*, jack snipe *Lymnocyptes minimus*, jay *Garrulus glandarius*, lesser redpoll *Acanthis cabaret*, mistle thrush *Turdus viscivorus*, raven *Corvus corax*, reed bunting *Emberiza schoeniclus*, snipe, song thrush *Turdus philomelos*, swallow *Hirundo rustica*, wheatear *Oenanthe oenanthe*, and woodpigeon *Columba palumbus*.

Table 13. Breeding Bird Survey Territories

Species	Abundance and Distribution
Blackbird <i>Turdus merula</i>	Two blackbird territories were identified in the north of the Site towards Barony Moss, one territory within the Site boundary and one within the 500m buffer. A further third territory was identified within the Site boundary to the west of Craiginmoddie.
Chaffinch <i>Fringilla coelebs</i>	Chaffinch were observed throughout the Site with seven separate territories identified. These territories were situated throughout the Site within the Site boundary along the southern, western, and northern forestry edge.
Coal tit <i>Periparus ater</i>	A single coal tit territory was identified within the north of the Site.
Cuckoo <i>Cuculus canorus</i>	A single cuckoo territory was identified within the 500m buffer to the south-west of the Site.
Curlew <i>Numenius arquata</i>	A single curlew territory was recorded within the 500m buffer in the Doughty Hill area to the northeast of the Site.
Goldcrest <i>Regulus regulus</i>	One goldcrest territory was identified within the north to north-western part of the Site within the Site boundary.

Species	Abundance and Distribution
Goldfinch <i>Carduelis carduelis</i>	A single goldfinch territory was recorded west of the Site within the 500m buffer, east-northeast of Delamford Hill.
Meadow pipit <i>Anthus pratensis</i>	Twenty-three meadow pipit territories were identified within the 500m site buffer to the north, west and south of the Site. Two further territories were identified across the open ground north of Doughty Hill.
Robin <i>Erithacus rubecula</i>	A single robin territory was identified on the Site boundary to the west.
Stonechat <i>Saxicola rubicola</i>	Three stonechat territories were identified within the 500m buffer, two located to the north and a third located west of the Site near the Peat Rig.
Siskin <i>Spinus spinus</i>	A single siskin territory was recorded within the Site boundary to the west.
Skylark <i>Alauda arvensis</i>	Seven skylark territories were identified within the 500m site buffer to the north, west and south of the Site. Two further territories were identified across the open ground north of Doughty Hill.
Wren <i>Troglodytes troglodytes</i>	Two wren territories were identified, both within the Site boundary. One territory located to the north of the Site and the second in the south of the Site, just south of Doughty.
Willow warbler <i>Phylloscopus trochilus</i>	Nine willow warbler territories were identified within the Site boundary and within the 500m buffer. Three of these territories were located in the south, three in the north, and three in the west.
Whinchat <i>Saxicola rubetra</i>	Two whinchat territories were located within the 500m buffer west of Green Larg, and within the 500m buffer near the top of Dobbinstone Burn.

4 Summary and Recommendations

39 observations of 8 target species, as defined by Nature Scot (2017), were recorded during the year one ornithological survey period. Table 14 below presents a summary of the species recorded.

Table 14. Target Species Summary and Recommendations

Species	Conservation Designations	Presence in breeding (summer) season	Presence in non-breeding (winter) season
Hen harrier	Schedule 1.1, 1A and Annex 1	Yes	Yes
Merlin	Schedule 1.1 and Annex 1	No	Yes
Peregrine	Schedule 1.1 and Annex 1	Yes	No
Curlew	Near-threatened (BirdLife, 2019), Red listed on Birds of Conservation Concern	Yes	No
Snipe	Amber listed on Birds of Conservation Concern	Yes	No
Woodcock	Red listed on Birds of Conservation Concern	No	Yes
Pink-footed goose	Amber listed on Birds of Conservation Concern	No	Yes*

* Pink-footed geese were observed during the end of March 2019, although this is counted as the summer season, it is likely this is a late migratory flight as this species is a winter visitor to the UK and breeds in Iceland, Greenland and Spitsbergen.

Territories for breeding birds were recorded, including those for curlew which are red listed on the UK Birds of Conservation Concern List. However, no territories were confirmed within the Site development area and the closest territory recorded was approximately 400m from the Site boundary (distances for curlew disturbance are estimated between 150m – 500m, depending on topography). It is recommended that turbine locations should avoid the very edge of the Site development area thus minimising disturbance to breeding birds within the Site buffer.

No black grouse were recorded during the 2019 surveys, nor was any evidence of the species being present (droppings or lek sites) within the Site boundary or buffer area.

It was noted that previous ornithological surveys have been undertaken across the area where the proposed development area is situated in, between October 2011 and April 2013 to inform the proposed Hadyard Hill Extension Windfarm (SSE, 2015). As these observations are now 6-8 years old, they cannot be used to accurately supplement the baseline data presented in this report.

The species recorded during the year one survey provide a baseline for species which are regularly present within the Site and surrounding buffer and those which utilise the Site (for breeding, hunting etc.).

References

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- SSE (2015). Hadyard Hill Extension Wind Farm Environmental Statement, Volume 2: Main report. Available online at : <https://sse.com/media/310834/Volume-2_Main-Report.pdf>. Last accessed 4th November 2019.

Appendices

4.1 Appendix 1 - Breeding Bird Surveys (2020 Update)

Introduction

This appendix presents the findings of the breeding bird surveys undertaken in June and July 2020 for the extension area of the proposed Craiginmoddie Windfarm.

Methodology

Field Survey Methodology

The breeding bird surveys undertaken generally followed the methodology set out by the British Trust for Ornithology (BTO) and simultaneously adapted the Constant Search Method (Brown & Shepherd, 1993), modified to four visits in accordance with Calladine et al. (2009). The survey area included all areas of open ground, within the potential development area plus a surrounding buffer of 500m. Surveyors approached all areas of open moorland to within 100 m and the behaviour of all birds seen or heard was recorded on 1:10,000 OS maps using standard British Trust for Ornithology (BTO) Common Bird census (CBC) coding and notation (Marchant, 1983).

All breeding bird survey records were entered into ArcView Geographical Information System (GIS) software. These were analysed following the methods of Calladine et al. (2009) to identify the minimum number of probable or confirmed breeding territories for each species encountered. Territories were assumed given certain bird behaviours such as; singing, calling, aggressive encounters and displaying.

A total of four visits were undertaken between June and July 2020 in suitable weather conditions as summarised in Table 15 below.

Table 15. Extension Area Breeding Bird Survey Conditions

Date	Start	End	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
18/06/2020	08:00	10:15	1	NW	0	2/8	1	2	0	0
01/07/2020	09:30	11:30	0	N	2	8/8	1	2	0	0
22/07/2020	09:00	11:30	3	SW	3	8/8	2	1	0	0
29/07/2020	08:45	11:00	4	W	0	6/8	2	2	0	0

Results

Field Study Results

22 bird species were recorded during the four breeding bird surveys. Figures 8a-8c present all species observed, registrations mapped in red are species with confirmed territories.

Table 16 below presents a summary of breeding territories recorded during the four surveys. Estimates have been provided for skylark (*Alauda arvensis*) and meadow pipit (*Anthus pratensis*) based on peak number of breeding territories recorded per visit.

Table 16. Territories Recorded During Breeding Bird Surveys

Species	Abundance and Distribution	Conservation Status
Buzzard <i>Buteo buteo</i>	Two adults with young recorded in plantation above extension area.	-
Chaffinch <i>Fringilla coelebs</i>	A single Chaffinch territory was recorded to the south of the 500m buffer. Another territory was recorded out-with the Site boundary to the north west.	-
Cuckoo <i>Cuculus canorus</i>	A single cuckoo territory was recorded out-with the 500m buffer, to the north-east.	Red Listed on the UK Birds of Conservation Concern List and a Scottish Biodiversity List Species.
Great tit <i>Parus major</i>	One territory along plantation on Site.	-
Grey wagtail <i>Motacilla cinerea</i>	One grey wagtail territory recorded beside the road, at the boundary between the Site and the 500m buffer.	Red Listed on the UK Birds of Conservation Concern List.
Meadow pipit <i>Anthus pratensis</i>	Up to 28 meadow pipit territories across the Doughty Hill area and buffer.	Near Threatened on the IUCN Red List of Threaten Species and Amber Listed on the UK Birds of Conservation Concern List.
Skylark <i>Alauda arvensis</i>	Up to 21 skylark territories across the Doughty Hill area and buffer.	Red Listed on the UK Birds of Conservation Concern List and a Scottish Biodiversity List Species.
Snipe <i>Gallinago gallinago</i>	Four Snipe territories were recorded within the Site.	Amber Listed on the UK Birds of Conservation Concern List.
Song thrush <i>Turdus philomelos</i>	A single Song thrush territory was recorded on the north-eastern boundary line of the 500m buffer.	Red Listed on the UK Birds of Conservation Concern List and a Scottish Biodiversity List Species.
Stonechat <i>Saxicola rubicola</i>	12 territories recorded across the Site and buffer.	-
Willow warbler <i>Phylloscopus trochilus</i>	A single Willow warbler territory was recorded within the 500m buffer to the south.	Amber Listed on the UK Birds of Conservation Concern List.
Wren <i>Troglodytes troglodytes</i>	A single Wren territory was recorded within the 500m buffer to the south. Two Wren territories were recorded out-with the boundary lines to the north and south.	Amber Listed on the UK Birds of Conservation Concern List.

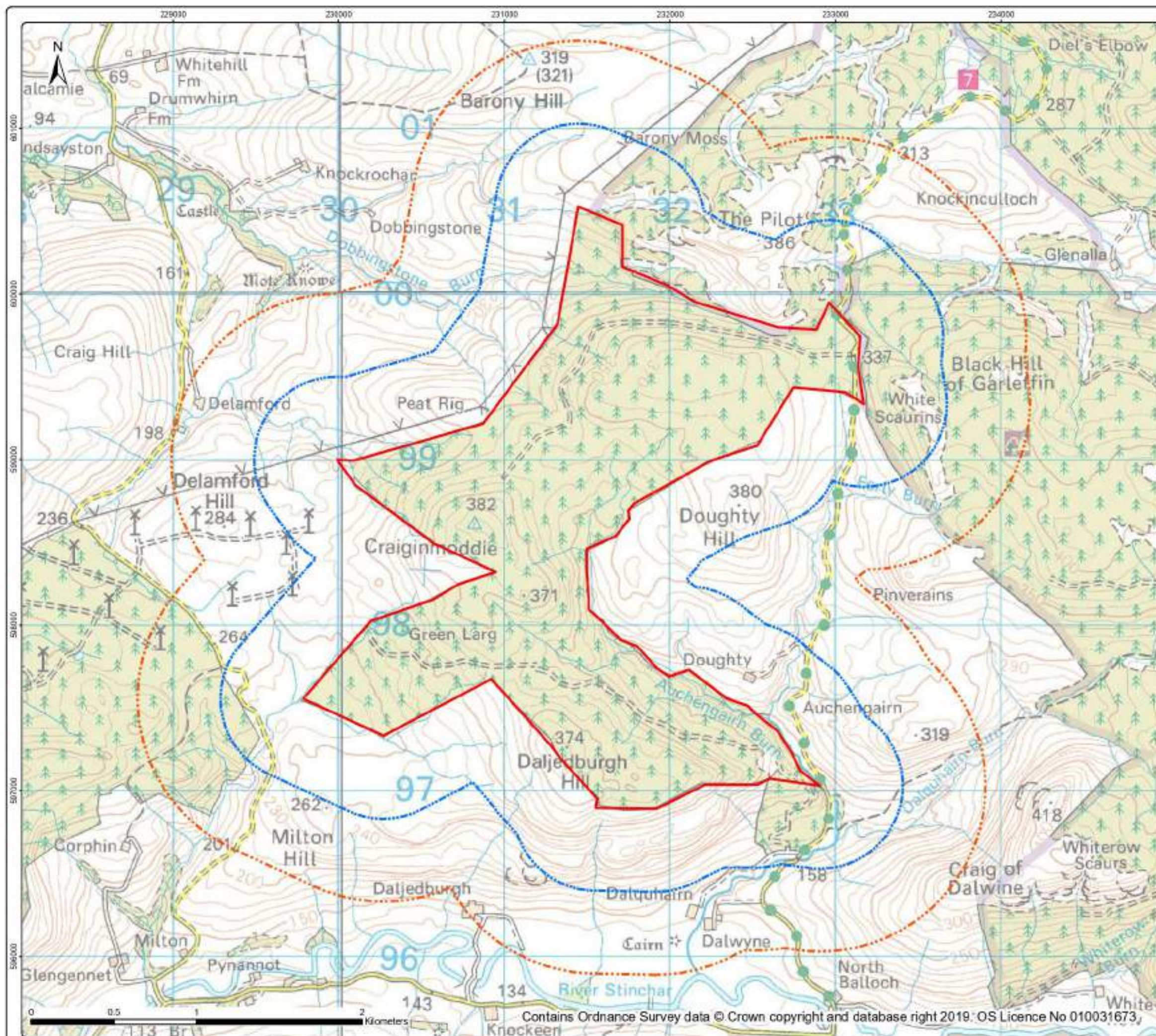
Summary

Across the four breeding bird surveys, twenty-two bird species were recorded. 12 species were recorded as breeding across the extension area and surrounding buffer. Four of these are Red Listed birds of Conservation Concern; song thrush, grey wagtail, cuckoo, and skylark.

References

- Brown A. F. and Shepherd K. B. (1993). A method for censusing upland breeding waders, Bird Study 40, pp. 189 – 195.
- Calladine, J., Garner, G., Wernham, C. and Thiel, A. (2009). The influence of survey frequency on population estimates of moorland breeding birds, Bird Study, 56:3, 381-388.
- Marchant J. (1983). Common Bird Census Instructions, British Trust for Ornithology.

4.2 Appendix 2 - Figures



Key

- Hadyard site boundary
- Hadyard site 500m buffer
- Hadyard site 1km buffer

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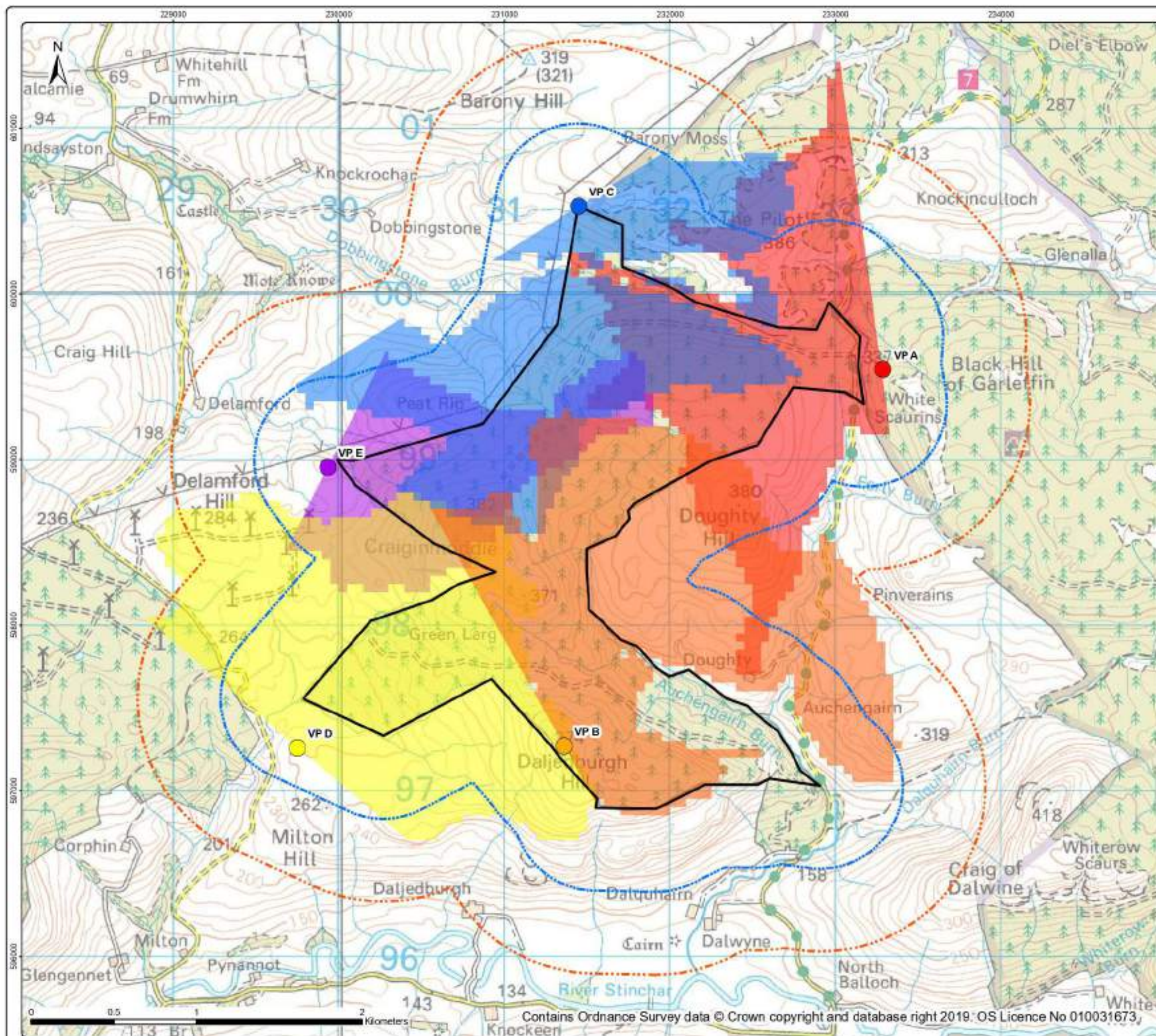
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Figure 1: Site Location

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Key

- Hadyard site boundary
- Hadyard site 500m buffer
- Hadyard site 1km buffer

Vantage Point Locations

- VP A (NX 33284 99542)
- VP B (NX 31361 97269)
- VP C (NX 31447 00526)
- VP D (NX 29748 97257)
- VP E (NX 29933 98952)
- VP A viewshed
- VP B viewshed
- VP C viewshed
- VP D viewshed
- VP E viewshed

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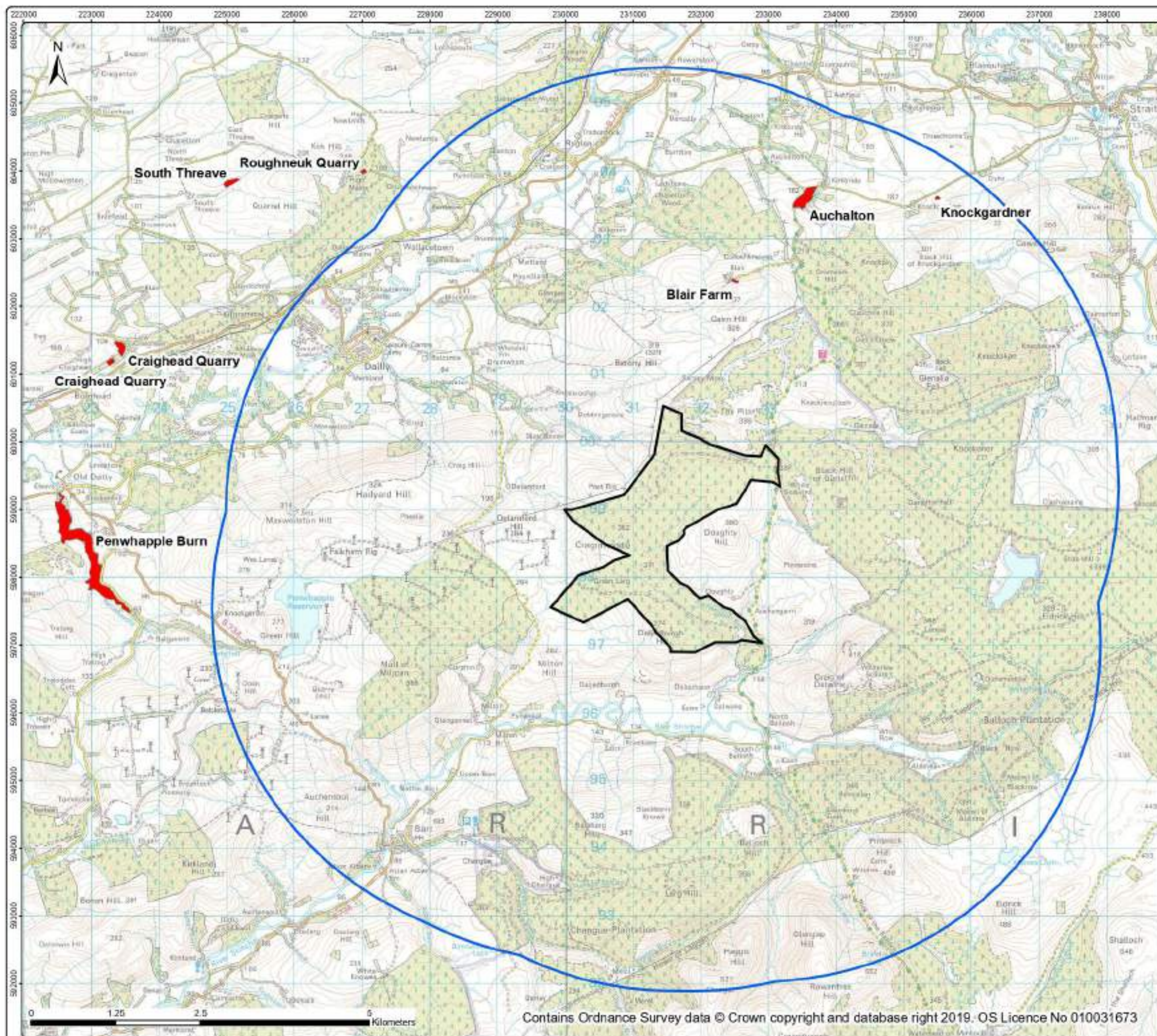
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Figure 2: Vantage Point Survey Locations

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Key

- Hadyard site boundary
- Hadyard site 5km buffer
- Site of Special Scientific Interest

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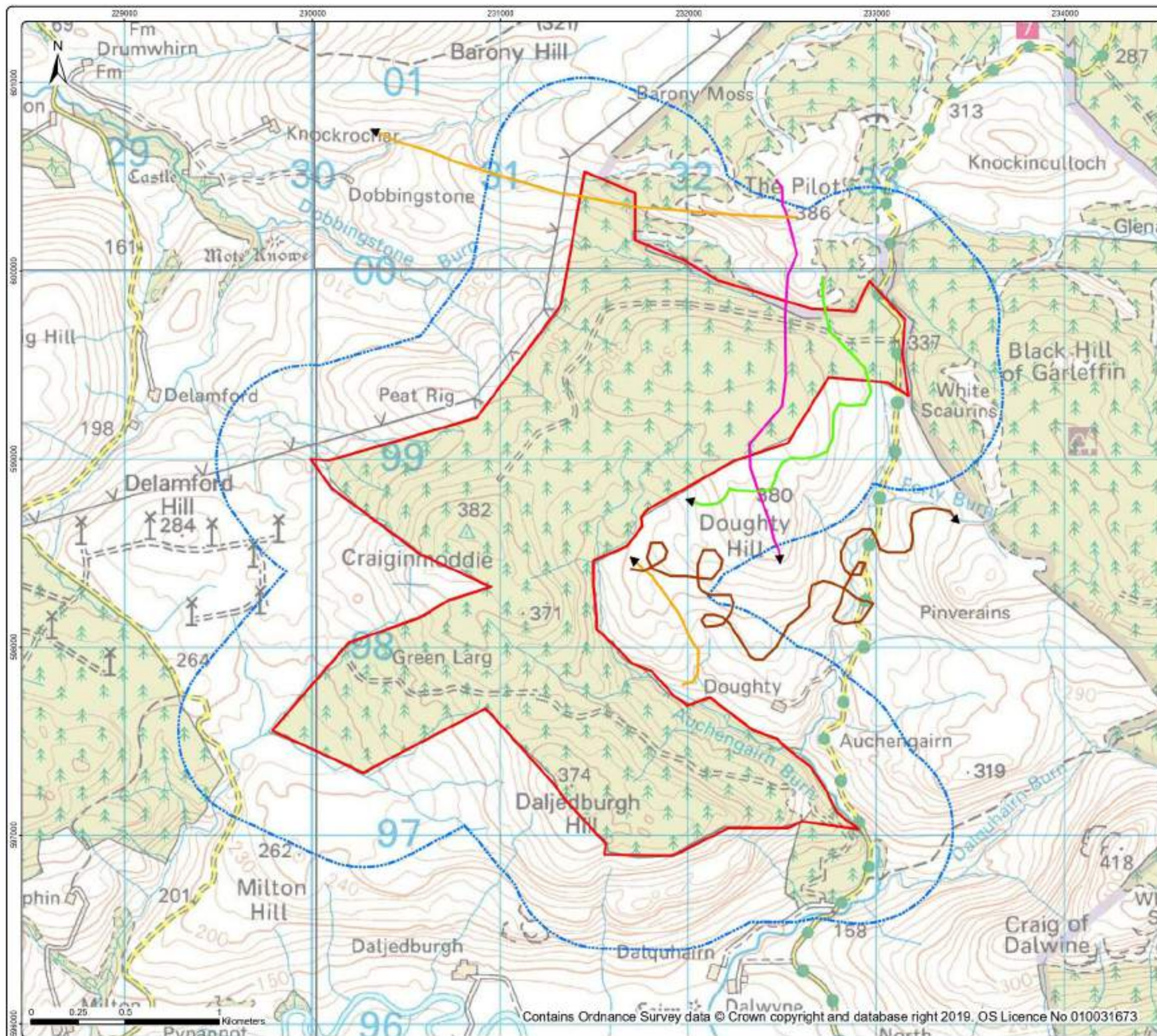
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Figure 3: Designated Site Locations

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer

Merlin Species Flightlines

- 15/11/2018
- 04/02/2019
- 23/09/2019
- 24/09/2019

Project:
Hadyard: Year One Ornithological Review

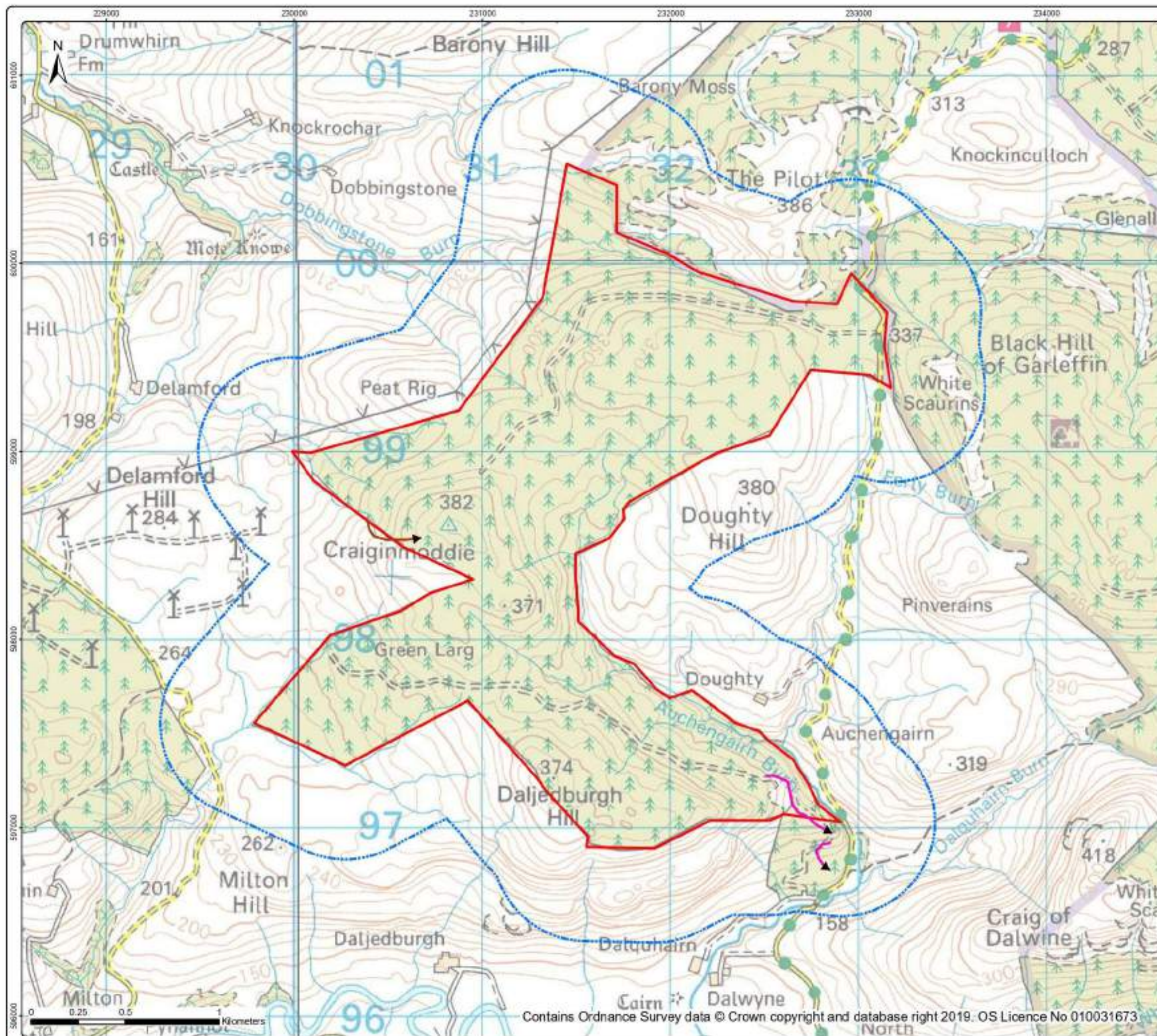
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**Figure 4a
Merlin Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer
- Woodcock Species Flightlines**
- 15/11/2018
- 23/01/2019

Project:
Hadyard: Year One Ornithological Review

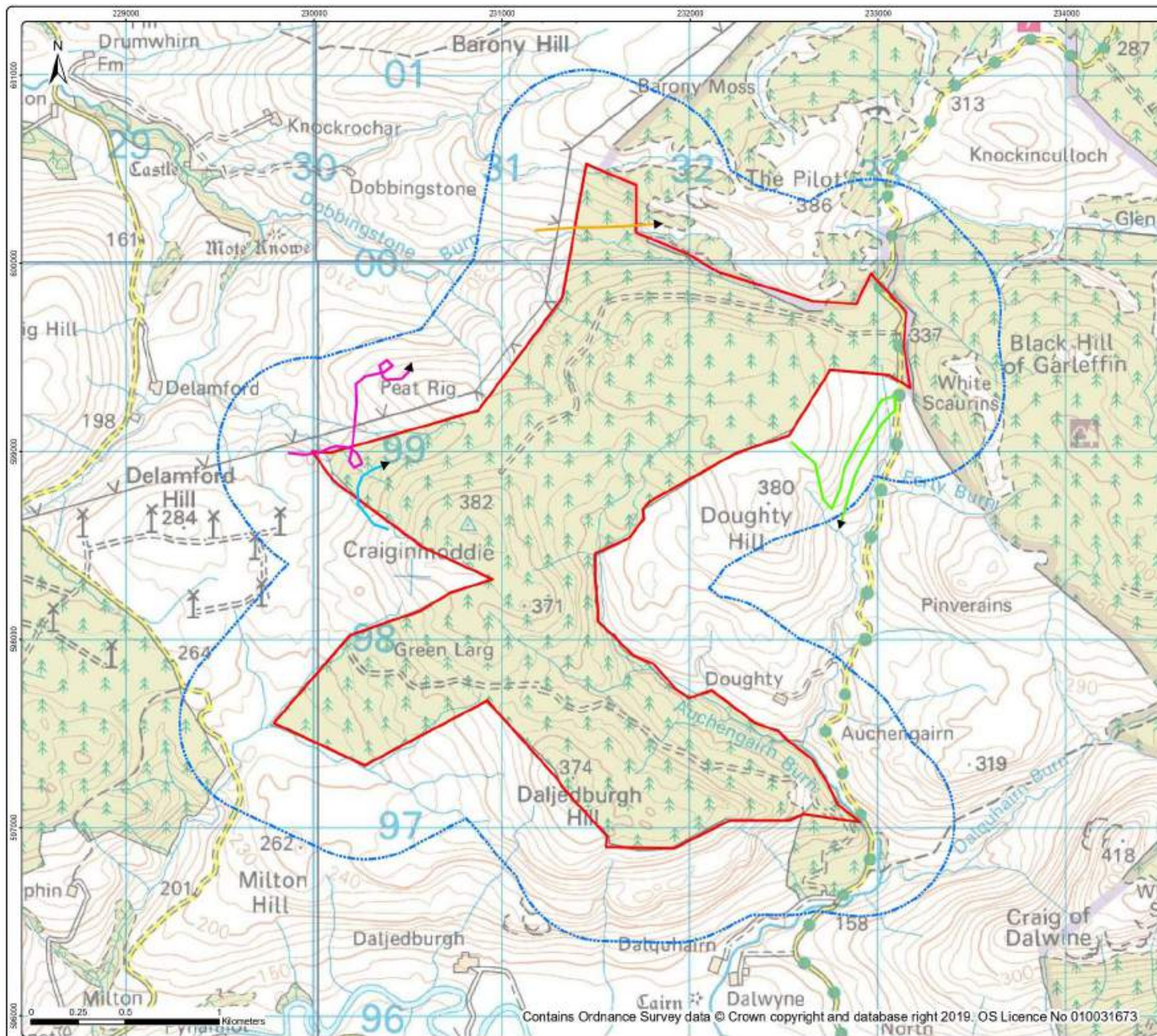
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**Figure 4b
Woodcock Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer
- Hen Harrier Species Flightlines**
- 04/02/2019
- 21/03/2019
- 29/04/2019
- 26/08/2019

Project:
Hadyard: Year One Ornithological Review

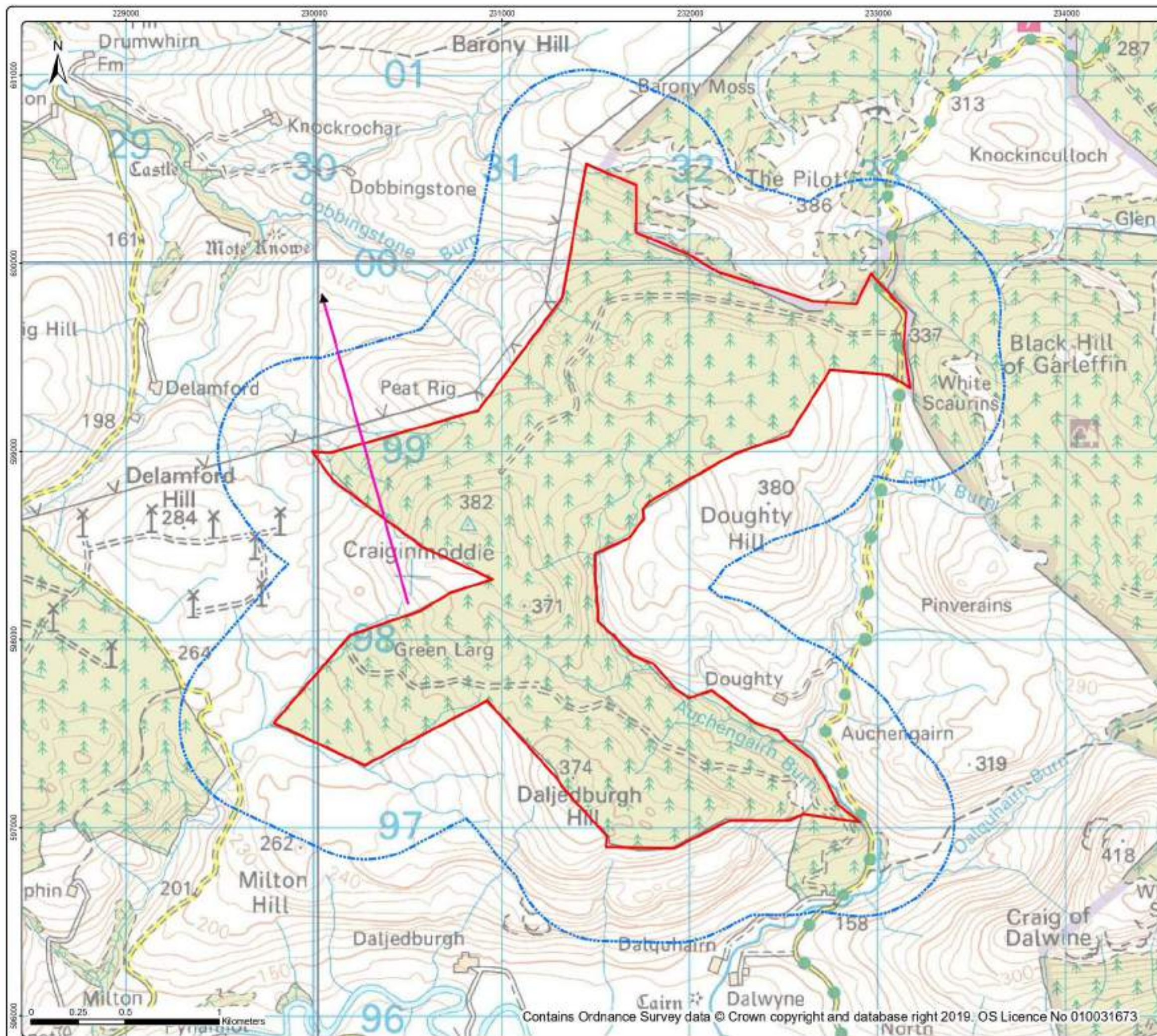
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**Figure 4c
Hen Harrier Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer
- Grey Heron Species Flightlines**
- 11/06/2019

Project:
Hadyard: Year One Ornithological Review

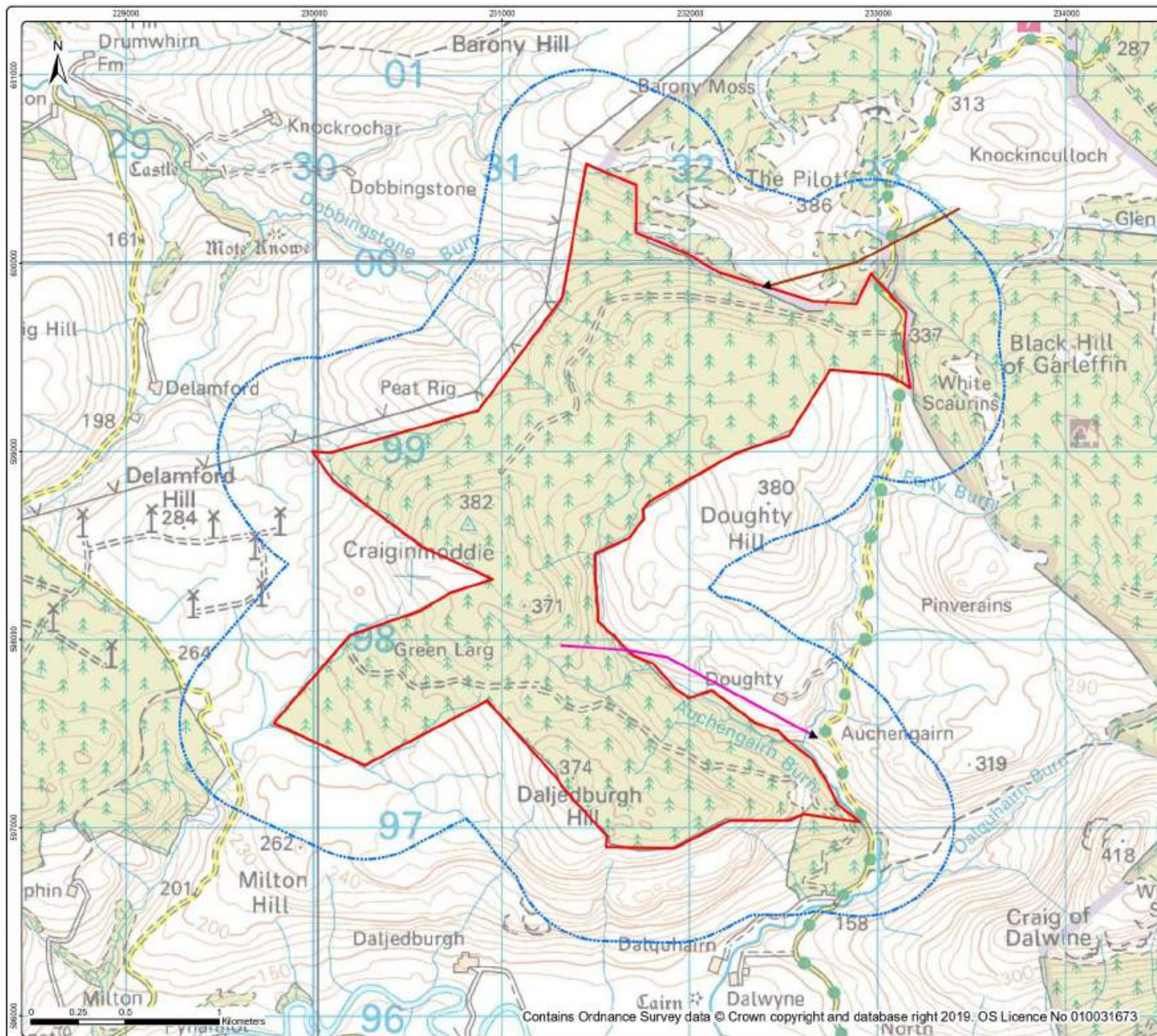
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**Figure 4d
Grey Heron Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer
- Peregrine Species Flightlines**
- 10/06/2019
- 26/08/2019

Project:
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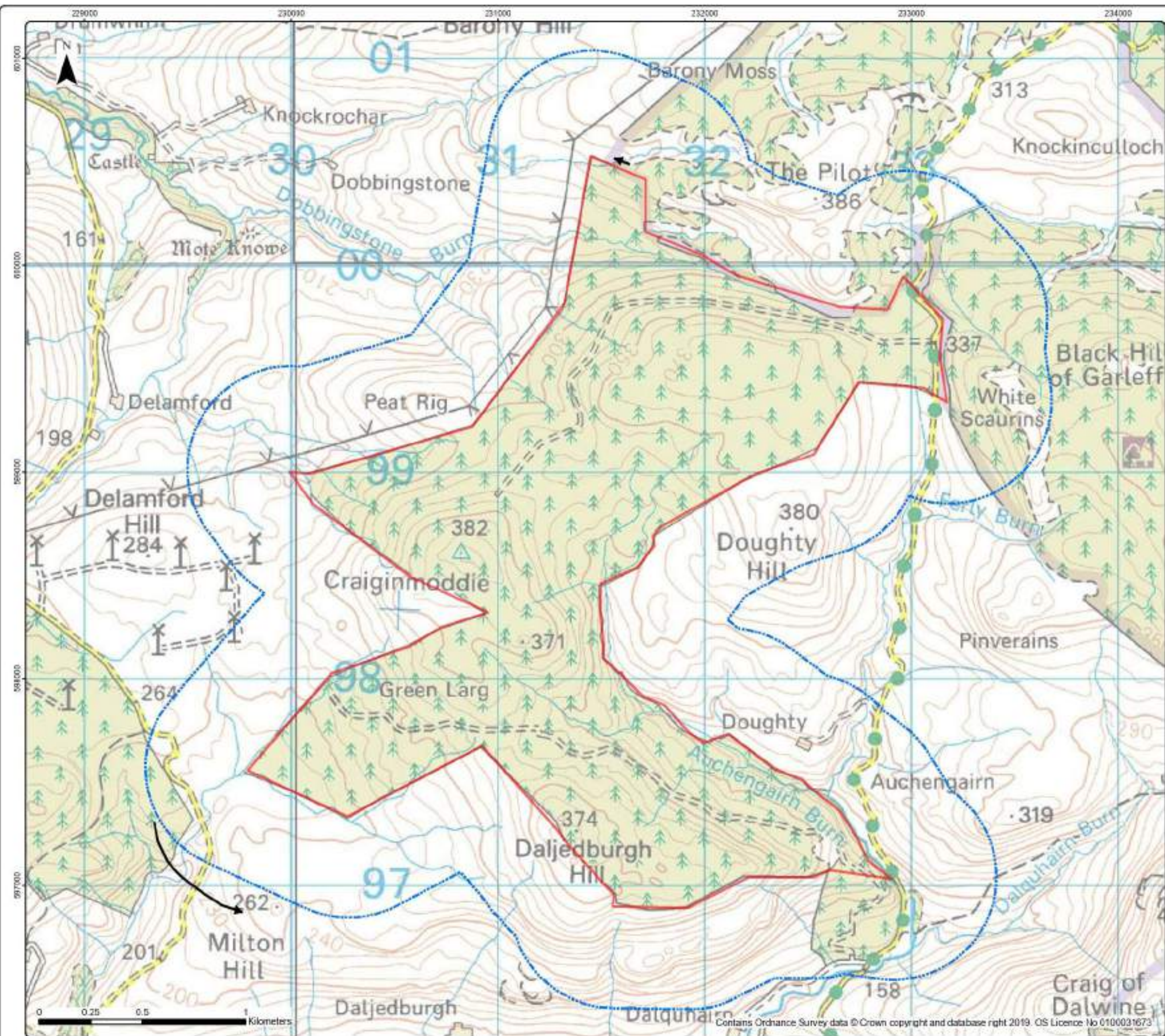
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Peregrine Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard site boundary
- Hadyard site 500m buffer

Snipe Species Flightlines

→ 21/03/2019

Project:
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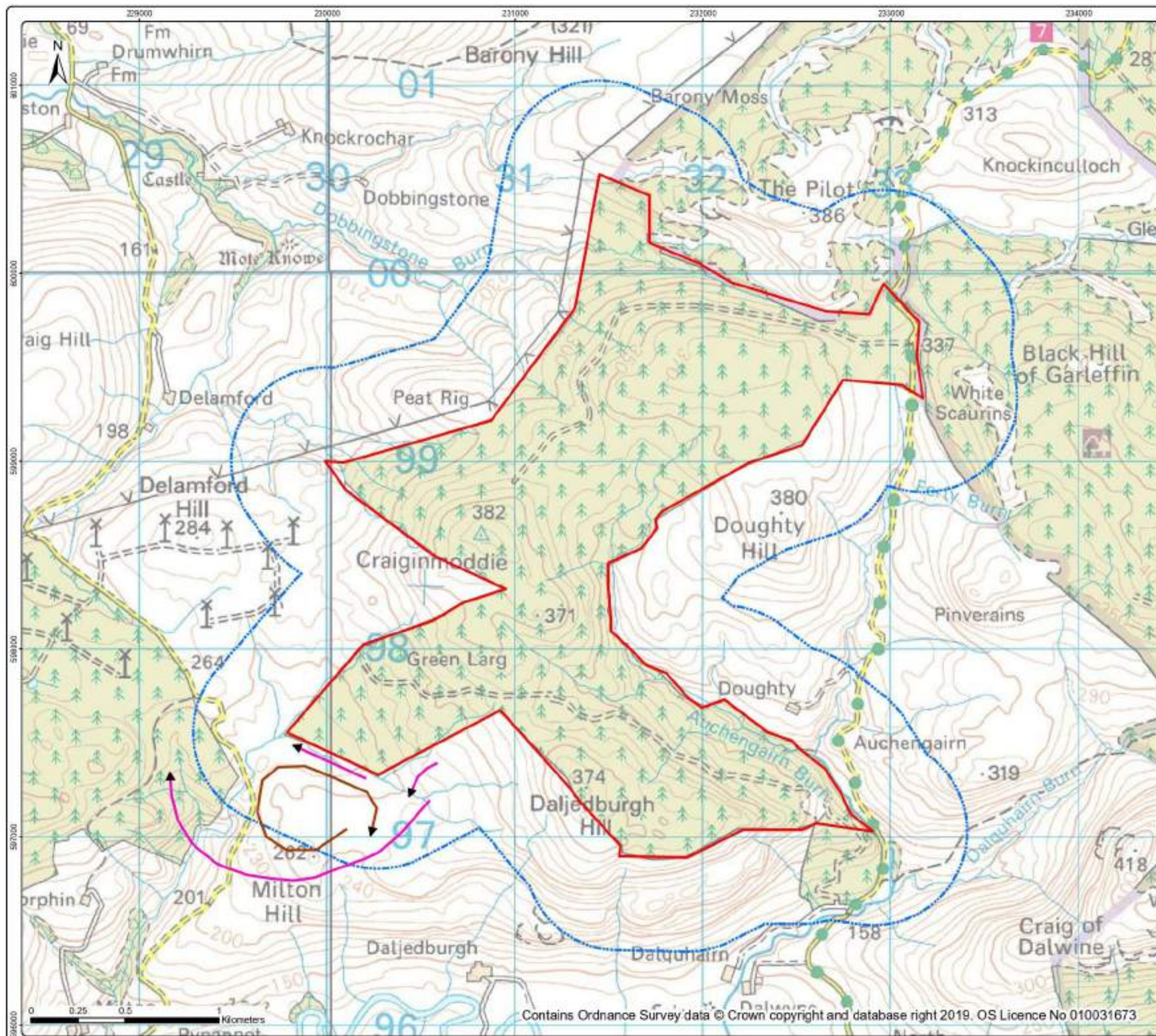
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Title: **Figure 4g
Snipe Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary 500m Buffer
- Curlew Species Flightlines**
- 21/03/2019
- 11/06/2019

Project:
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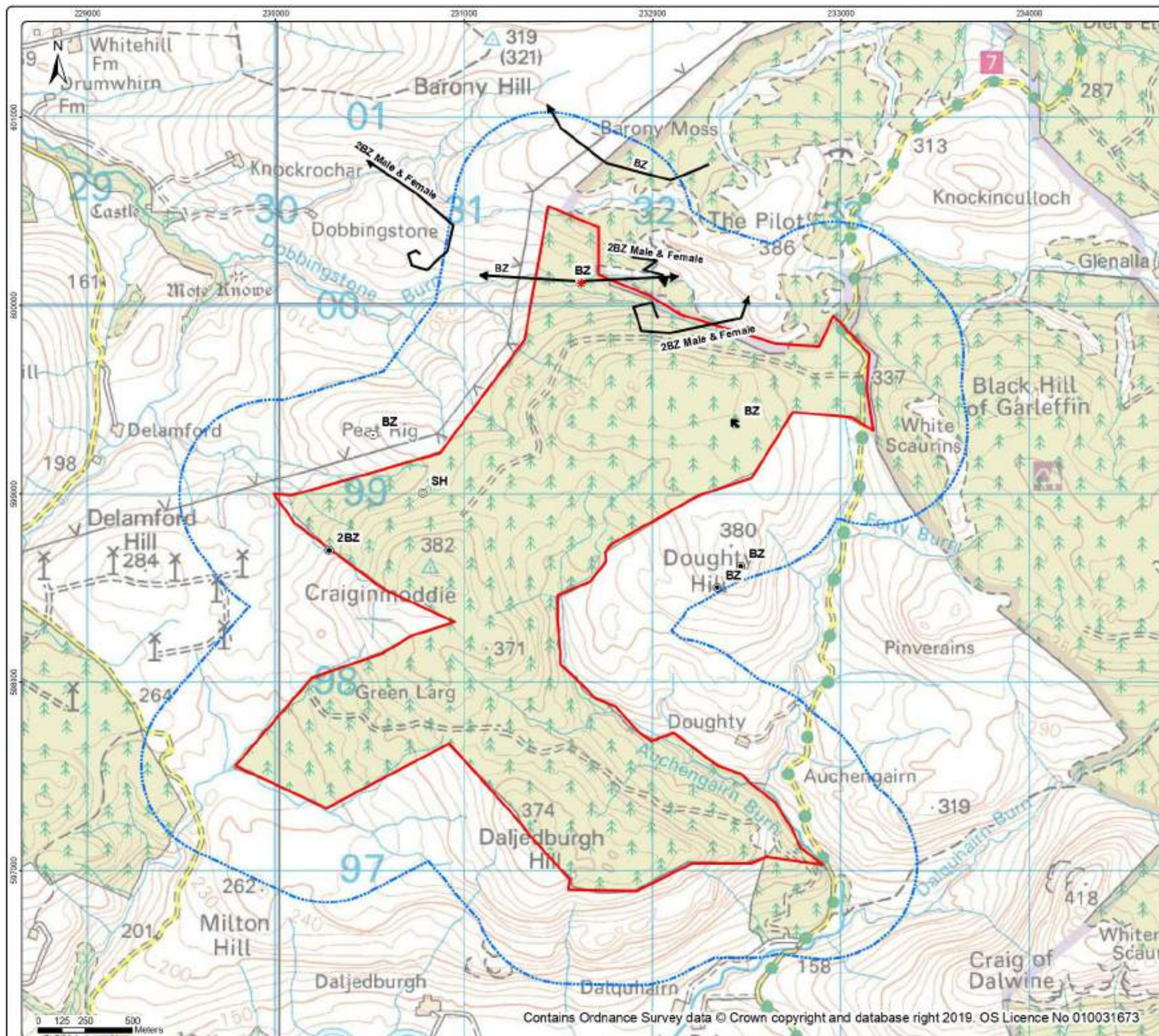
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**Figure 4h
Curlew Species Flightlines
Flight Activity Survey Results**

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Key

- Hadyard Site Boundary
- Hadyard Site Boundary with 500m Buffer

Raptors

Behaviour

- Alarming
- Calling
- ★ Potential Nest
- Sighting
- ↗ In Flight

BTO Code	Species
BZ	Common buzzard
SH	Sparrowhawk

Project:
Hadyard

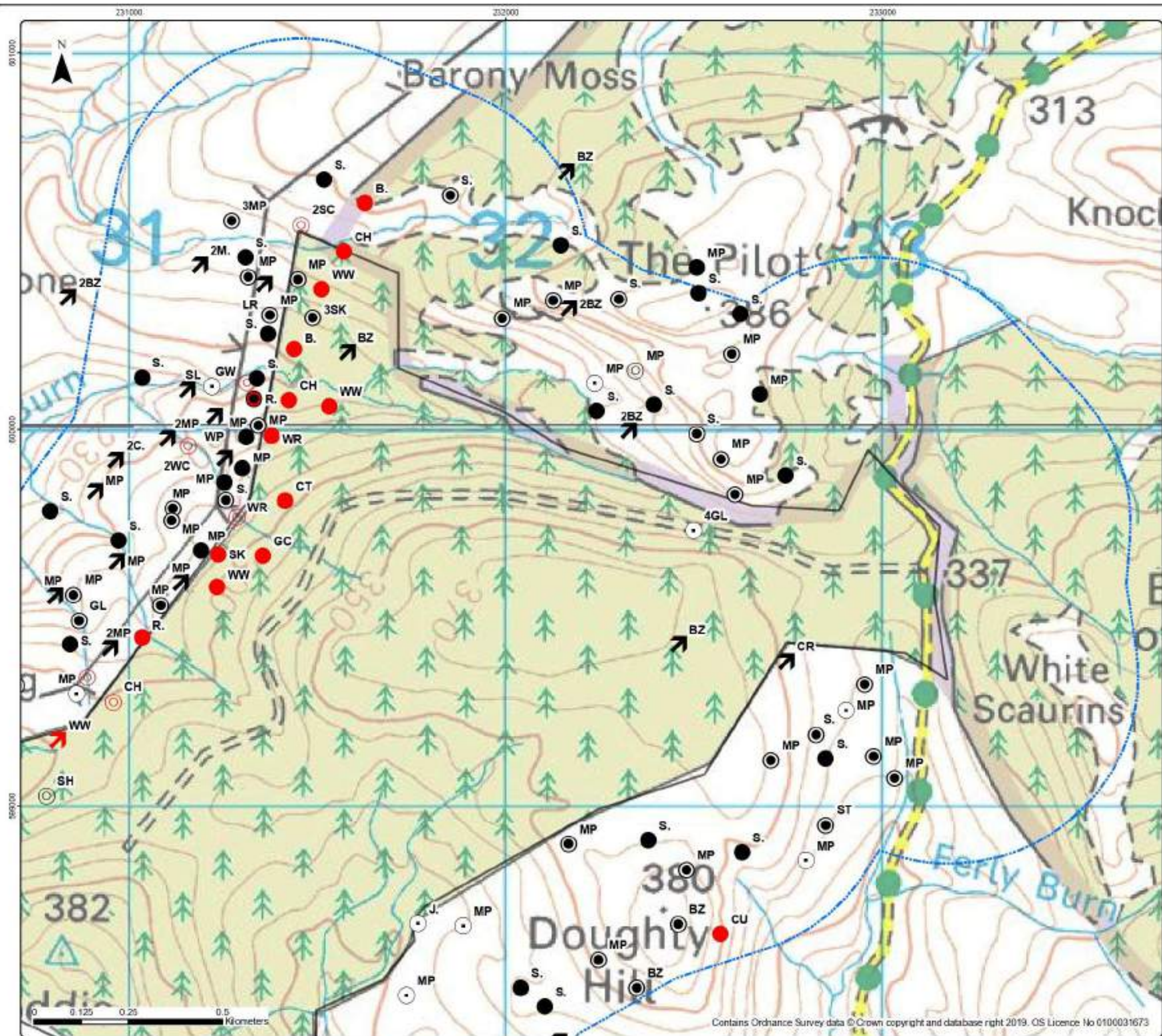
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Title:
**Figure 5
Breeding Raptor Survey Results**

Status: Final	Revision: 1	Page Size: A3
Drawn by: RM	Reviewed by: WS	Date: 11/09/2019



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Key

- Hadyard site boundary
- Hadyard site 500m buffer

Breeding Bird Survey

- Alarming,
- Alarming (territory mapped)
- Calling,
- Calling (territory mapped)
- ↗ In flight
- ↗ In flight (territory mapped)
- In song
- In song (territory mapped)
- Sighting
- Sighting (territory mapped)

B.T.O Code	Species
B	Blackbird
BF	Bullfinch
BZ	Buzzard
C	Common Crow
CH	Chaffinch
CK	Cuckoo
CR	Common Crossbill
CT	Coal Tit
CU	Curlew
GC	Goldcrest
GL	Grey Wagtail
GO	Goldfinch
GT	Great Tit
GW	Garden Warbler
H	Grey Heron
J	Jay
JS	Jack Snipe
LR	Lesser Redpoll
M	Mistle Thrush
MP	Meadow Pipit
R	Robin
RB	Red Bunting
RH	Raven
S	Siskin
SC	Stonechat
SH	Sparrowhawk
SK	Skua
SL	Swallow
SN	Snipe
ST	Song Thrush
W	Wheatear
WC	Whinchat
WP	Woodpigeon
WR	Wren
WW	Willow Warbler



Project:
**GEL19117 Hadyard:
Year One Ornithological Review**

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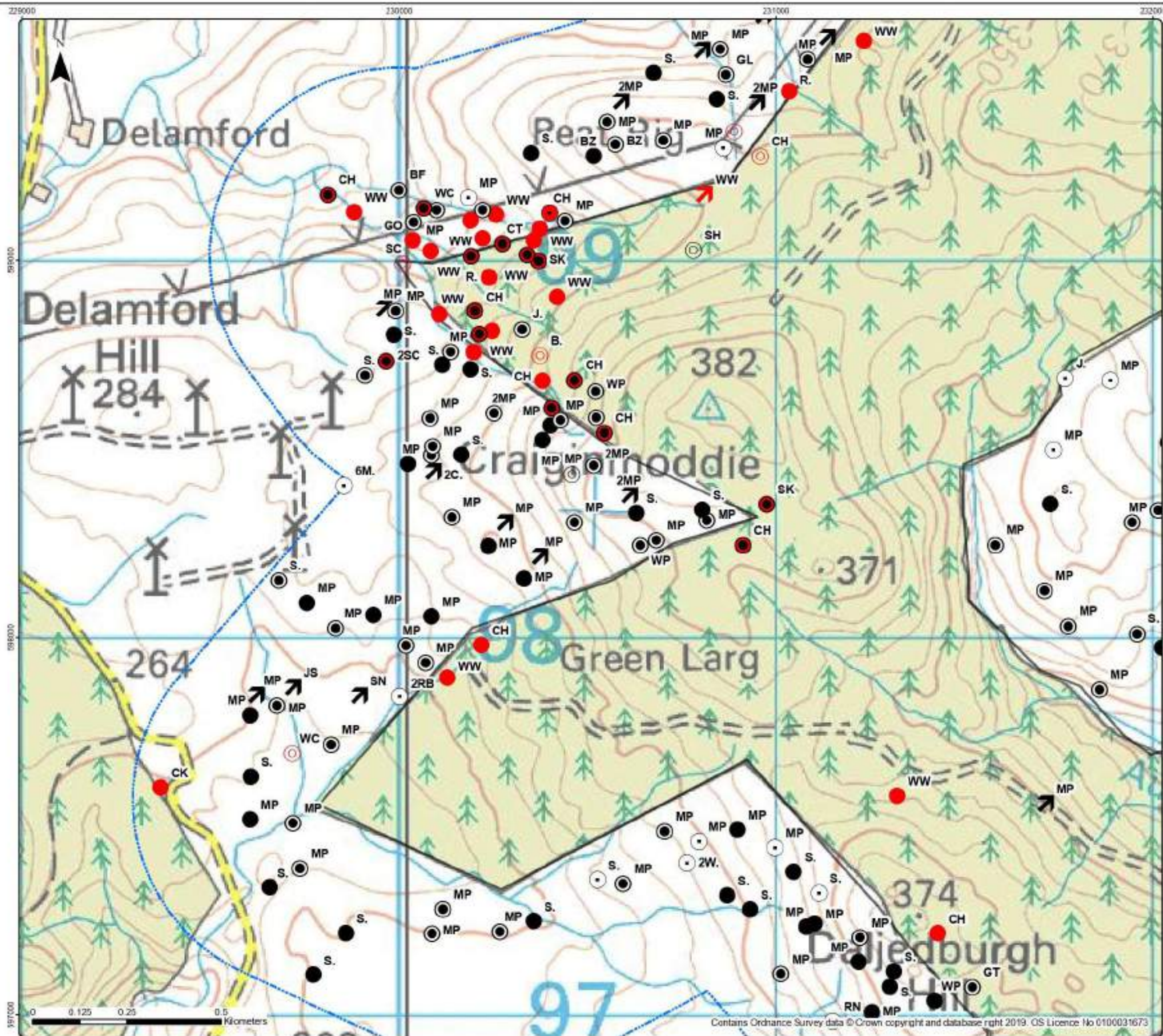
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Title:
**Figure 6a
Breeding Bird Survey Results**

Status:	Revision:	Page Size:
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Key

- Hadyard site boundary
- Hadyard site 500m buffer

Breeding Bird Survey

- Alarming,
- Alarming (territory mapped)
- Calling,
- Calling (territory mapped)
- ↗ In flight
- ↗ In flight (territory mapped)
- In song
- In song (territory mapped)
- Sighting
- Sighting (territory mapped)

B.T.O Code	Species
B	Blackbird
BF	Bullfinch
BZ	Buzzard
C	Common Crow
CH	Chaffinch
CK	Cuckoo
CR	Common Crossbill
CT	Coal Tit
CU	Curlew
GC	Goldcrest
GL	Grey Wagtail
GO	Goldfinch
GT	Great Tit
GW	Garden Warbler
H	Grey Heron
J	Jay
JS	Jack Snipe
LR	Lesser Redpoll
M	Mistle Thrush
MP	Meadow Pipit
R	Robin
RB	Red Bunting
RN	Raven
S	Skylark
SC	Stonechat
SH	Sparrowhawk
SK	Siskin
SL	Swallow
SN	Snipe
ST	Song Thrush
W	Wheatear
WC	Whinchat
WP	Woodpigeon
WR	Wren
WW	Willow Warbler



Project:
**GEL19117 Hadyard:
Year One Ornithological Review**

Client:

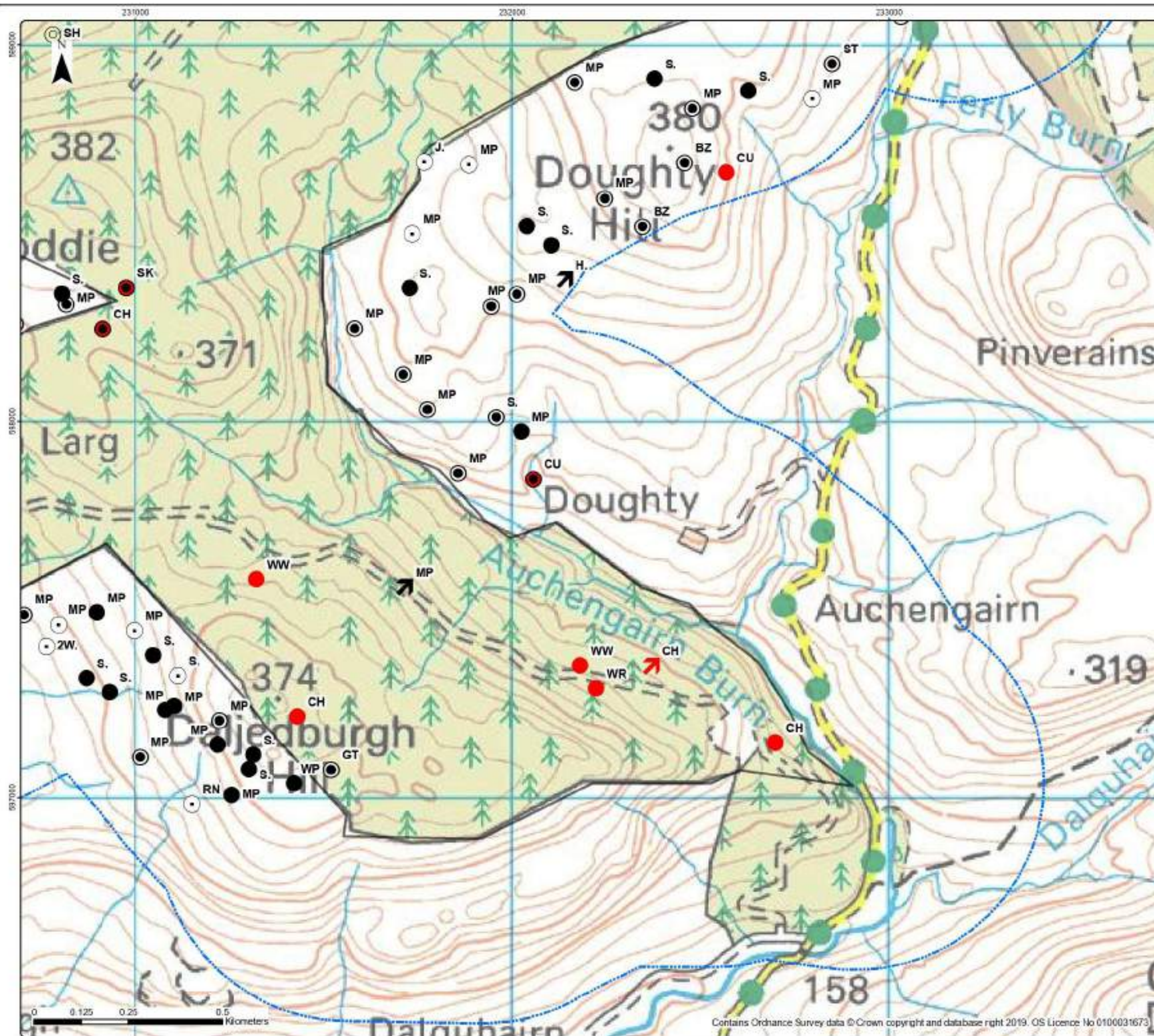
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Title:
**Figure 6b
Breeding Bird Survey Results**

Status:	Revision:	Page Size:
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Key

- Hadyard site boundary
- Hadyard site 500m buffer

Breeding Bird Survey

- Alarming,
- ◉ Alarming (territory mapped)
- Calling,
- ◐ Calling (territory mapped)
- ➔ In flight
- ➔ In flight (territory mapped)
- In song
- In song (territory mapped)
- Sighting
- Sighting (territory mapped)

B.T.O Code	Species
B	Blackbird
BF	Bullfinch
BZ	Buzzard
C	Carbon Crow
CH	Chaffinch
CK	Cuckoo
CR	Common Crossbill
CT	Coal Tit
CU	Curlew
GC	Goldcrest
GL	Grey Wagtail
GO	Goldfinch
GT	Great Tit
GW	Garden Warbler
H	Grey Heron
J	Jay
JS	Jack Snipe
LR	Lesser Redpoll
M	Mistle Thrush
MP	Meadow Pipit
R	Robin
RB	Red Bunting
RN	Raven
S	Skylark
SC	Stonechat
SH	Sparrowhawk
SK	Stalkin
SL	Swallow
SN	Snipe
ST	Song Thrush
W	Wheatear
WC	Whinchat
WP	Woodpigeon
WR	Wren
WW	Willow Warbler



Project:
GEL19117 Hadyard:
Year One Ornithological Review

Client:

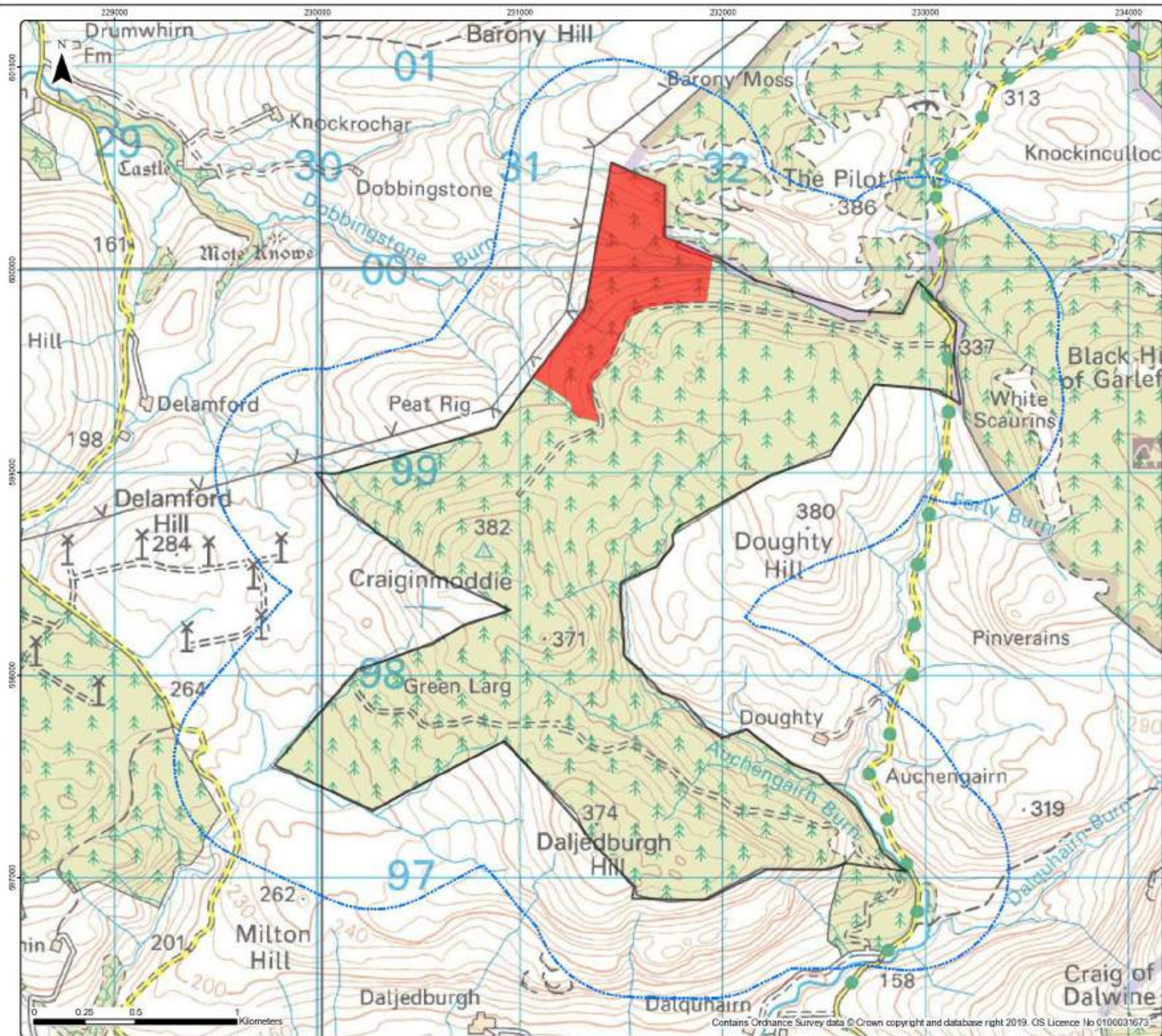
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Title:
Figure 6c
Breeding Bird Survey Results

Status:	Revision:	Page Size:
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Key

- Hadyard site boundary
- Hadyard site 500m buffer
- Hadyard active forestry area

Project:
**GEL19117 Hadyard:
Year One Ornithological Review**

Client:

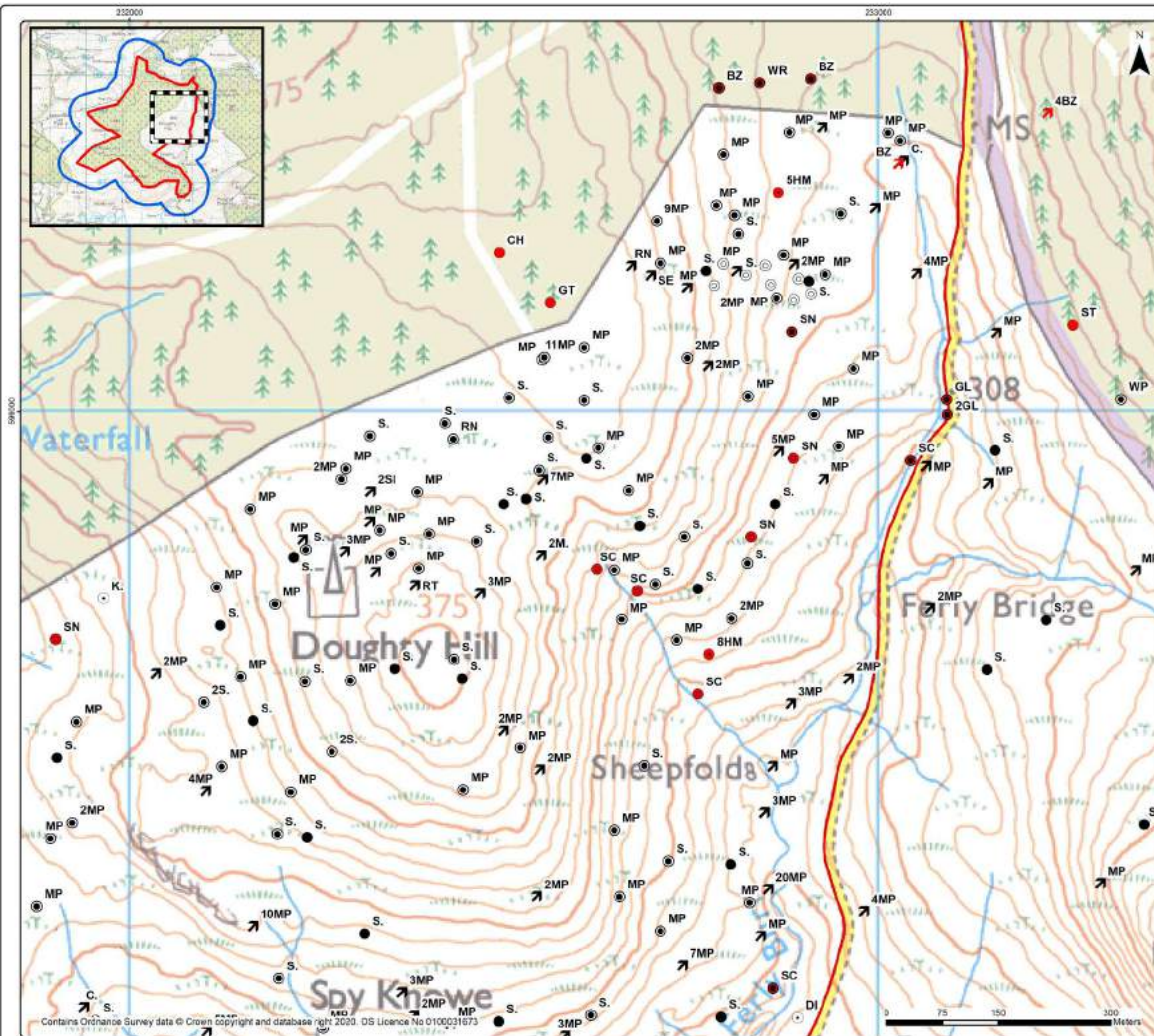
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**Figure 7
Active Forestry Area 2019**

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Key

- Hadyard Hill Site Boundary
- Site Boundary 500m buffer

Breeding Bird Survey 2020

- Alarming
- Alarming - Territory mapped
- Calling
- Calling - Territory mapped
- ↗ In flight
- ↗ In flight - Territory mapped
- In song
- In song - Territory mapped
- Sighting
- Sighting - Territory mapped

BYO Code Species

BZ	Buzzard
C.	Carion Crow
CH	Chaffinch
CK	Cuckoo
DI	Dipper
GT	Great Tit
GL	Grey Wagtail
HM	House Martin
K.	Kestrel
MP	Meadow Pipit
ML	Merlin
M.	Mistle Thrush
RN	Raven
RT	Redstart
SE	Short-eared Owl
S.	Skylark
SN	Srike
ST	Song Thrush
SC	Stonechat
SI	Swift
WW	Willow Warbler
WP	Woodpigeon
WR	Wren

Project:
GEL19117 Hadyard
Craiginmoddie Windfarm Development

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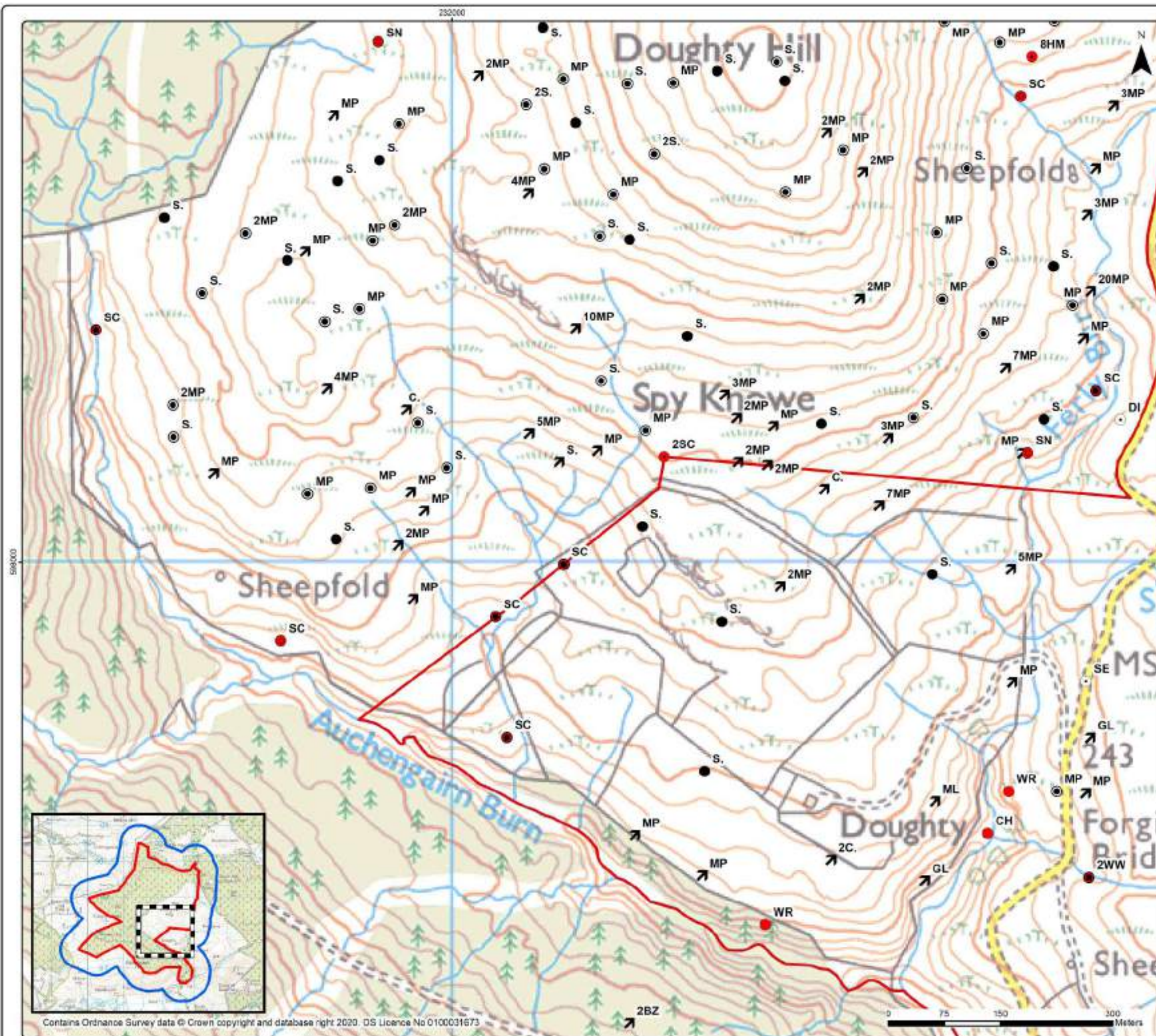
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Figure 8.5a
BBS Territory Mapping 2020

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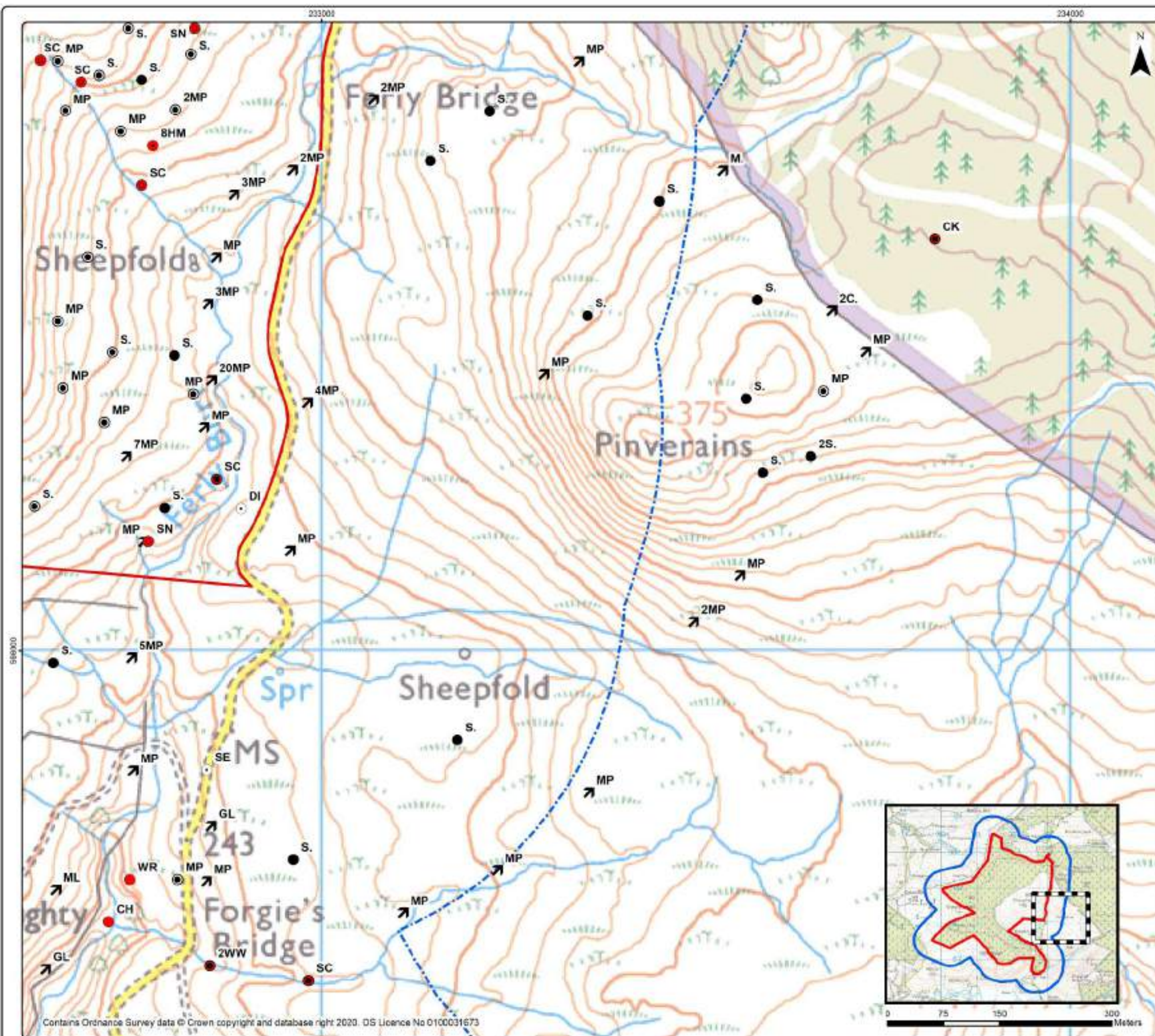
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Figure 8.5b
BBS Territory Mapping 2020

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**CRAIGINMODDIE: COLLISION RISK MODELLING
GEL19117**

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30/11/2020



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GEL19117

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1 Introduction

1.1 Scope and Purpose of this Technical Appendix

This technical appendix supports the Craiginmoddie Windfarm ('proposed development') Ornithology Chapter providing the methodology, calculations and sources of information applied to assess the potential for birds to collide with the wind turbine blades.

The theoretical risk of birds colliding with the turbine blades was evaluated using standard methods for proposed wind farms recommended by Nature Scot (SNH, where referenced) outlined in:

- SNH, 2000. Guidance notes series. Windfarms and birds: Calculating a theoretical collision risk assuming no avoiding action; and
- SNH, 2010. Use of avoidance rates in the SNH wind farm collision risk model.

The Collision Risk Modelling (CRM) method applied follows the Band Model (Band *et al.* 2007). This method is based on the analysis of observational data collected from timed bird flight activity surveys at fixed vantage points overlooking the proposed wind farm development site. It provides an estimate of the number of birds that would collide with a proposed wind farm.

Because birds may take action to avoid a wind farm, or to avoid collision with individual wind turbines, an avoidance rate is applied to the output from the CRM. Details of the methods, assumptions, parameters and avoidance rates used in this case are provided in this report.

In summary the following steps were followed in this assessment:

Digitise all flight lines and record relevant characteristics;

Define a turbine risk envelope (TRE) and identify all flights for each species which are at any point within the rotor height and which intersect the boundary of the turbine envelope;

Apportion survey effort into periods to capture differing flight intensities;

Calculate the number of transits through the turbine envelope for each period and extrapolate to determine the total predicted transits over period of interest; and,

Run the collision model with relevant turbine and ornithological parameters and avoidance rates.

1.2 Abbreviated Terms

Table 1.2.1. List of Abbreviations:

Term	Abbreviations	Definition
Collision Risk Model	CRM	Collision Risk Model derived from Band <i>et al.</i> (2007)
Turbine Risk Envelope	TRE	Flights within 500m turbine buffer and observed at risk height from turbine blades.
Digital Terrain Model	DTM	Elevation grid data for viewshed analysis to inform vantage point observer locations
Theoretical Risk Window	TRW	Calculated in Directional CRM modelling as perpendicular width within windfarm of prevailing directional flights.

1.3 Species Included within Collision Risk Model

Species to be considered within the CRM were identified based on their observed presence within the turbine risk envelope (TRE) during vantage point surveying covering the extent of the site.

The TRE includes flight lines within a theoretical 500m buffer surrounding all turbine locations and flying within the turbine blade maximum and minimum heights.

Table 1.3.1 outlines the species observed, as well as the bird biometric information applied within the CRM to indicate their flight risk relative to the proposed development.

Table 1.3.1. Biometrics of Target Species Considered within the CRM due to Observed Presence within TRE.

Common Name	Scientific Name	BTO Code	Bird Length (m)	Reported Bird Speed (m/s)	Avoidance Rate (%)
Grey heron	Ardea cinerea	H.	0.94	10.0	98%
Hen harrier	Circus cyaneus	HH	0.48	9.1	99%
Merlin	Falco columbarius	ML	0.28	9.44	98%
Peregrine falcon	Falco peregrinus	PE	0.42	20.7	98%
Pink-footed goose	Anser brachyrhynchus	PG	0.75	15.0	99.8%

Table 1.3.2 Sources for Bird Biometrics

Biometric	Species	Source
Bird Length	Grey Heron, Hen Harrier, Merlin, Peregrine Falcon, Pink Footed Goose	Snow, D. W. & Perrins, C. M. (1998) The Birds of the Western Palearctic Concise Edition. Madge, S. & Beaman, M. (2010) The Handbook of Bird Identification for Europe and the Western Palearctic (digital edition). Martínez-Vilalta, Albert; Motis, Anna (1992). "Family Ardeidae (herons)". In del Hoyo, Josep; Elliott, Andrew; Sargatal, Jordi (eds.). Handbook of the Birds of the World. Volume 1: Ostriches to Ducks.
Reported Bird Speed	Hen Harrier, Merlin, Peregrine Falcon, Pink Footed Goose Grey Heron	Snow, D. W. & Perrins, C. M. (1998) The Birds of the Western Palearctic Concise Edition. Alerstam T., Rosén M., Bäckman J., Ericson P.G.P., Hellgren O. (2007). PLoS Biol, 5, 1656-1662.
Avoidance Rate	Grey Heron, Hen Harrier, Merlin, Peregrine Falcon, Pink Footed Goose	NatureScot (2018) Use of Avoidance Rates in the NatureScot Wind Farm Collision Risk Model

1.4 Turbine and Wind Farm Specification

The proposed development would deploy 14 Siemens Gamesa SG 60.155 wind turbines distributed throughout the site. Table 1.4.1 outlines the wind farm and turbine specifications which contribute to the CRM.

Table 1.4.1 Windfarm and Turbine Specifications.

Attribute	Specification	Assumptions
Total Turbine Area (ha)	588.44	Compiled theoretical 500m buffer surrounding all the turbines, measured in hectares.
Number of Wind Turbines	14	Provided by Developer, based on most recent design iteration.
Turbine Operation Time	100%	Would be less in practice due to periods of reduced wind speed and maintenance.
Rotation Period (seconds)	6	Higher estimate to establish a cautious approach to development.
Number of Blades	3	Provided by Developer – number of blades on each turbine X number of turbines.
Blade Length (m)	76	Provided by Developer, based on most recent turbine selection.
Rotor Diameter (m)	150	Provided by Developer, based on most recent turbine selection.
Hub Height (m)	122.5	Provided by Developer, based on most recent turbine selection.
Max Blade Height (m)	200	Provided by Developer, based on most recent turbine selection.
Min blade Height (m)	45	Provided by Developer, based on most recent turbine selection.
Max Chord	4.5	Provided by Developer, based on most recent turbine selection.
Pitch (degrees)	6	Provided by Developer, based on most recent turbine selection.

2 Methodology

2.1 Selection of flight lines for CRM within the TRE

Vantage point surveys recorded bird flights of target species at the following height bands representing below, within and above theoretical turbine blade height, respectively:

- Band 1: 0m – 20m (lower than blade height);
- Band 2: 20 – 180m (within blade height); and,

- Band 3: >180m (above turbine blade height).

A result of design iteration, turbine blade height was increased to 200m increased the within TRE to 20m to 200m. To account for this change, and establish a cautious approach to CRM, flights within both Band 2 and Band 3 have been included within the TRE.

Following GIS-based assessment, final locations of vantage points were ground-truthed on site to account for visibility impacts caused by forestry and unaccounted for terrain present on the site.

A theoretical 500m turbine buffer was defined. All flights recorded at Band 2 and Band 3 within this buffer were selected for assessment within the CRM.

2.2 CRM Model and Data Processing

To determine Vantage Point locations for observations to be made, viewshed analysis was iteratively applied to a 10m DTM raster within the QGIS. The following parameters were applied in this analysis:

- Height of Observer: 1.8metres
- Height of Object: 200metres
- Viewing Radius: 2,000metres
- Field of View 180°
- Target Area Coverage: all turbine locations + 500m site buffer.

The time periods in which vantage point surveys were subdivided according to the initial setup of surveys in the following manner:

- Autumn migration – dusk and dawn watches from mid-September to November
- Winter – diurnal watches from October to March
- Spring migration – dusk and dawn watches from March to mid-May
- Summer – diurnal watches from April to September

Following the desk-based, GIS determination of five suitable vantage point locations, these locations were subsequently refined through a ground-truthing survey to determine suitability.

All target species flights lines were digitised within QGIS software in ESRI Shapefile Format. Each flight line digitised contained the following information within the corresponding attributes table:

- Unique ID
- Species
- Observer
- Date
- Time of Survey
- Vantage Point
- Time of Day Flight was Observed
- Number of Birds Observed (i.e. a flock of 15 pink-footed geese would be one flight line)
- Length of Time (total seconds)
- Band Height at 15 second intervals
- Notes
- Sex
- Age of Bird

- Length of Flight (m)

Flight lines where birds were observed to fly within Bands 2 and 3 were selected. The clip function was then applied to crop the selected flight lines within the 500m turbine buffer. New lengths of flight lines were calculated once cropped within the buffer.

To calculate time within the buffer zone at risk height, the ratio between original flight length and clipped flight length was derived. This ratio was expressed as a percentage and applied to the total flight time recorded at both Bands 2 and 3.

2.3 Flight Activity

Observed flight activity is modelled in the CRM as either direction flight activity or non-directional flight activity. Whether a species' flights were considered direction or non-directional was assessed based on known behaviour of the species and through viewing the flight lines of that species QGIS following digitisation.

Directional activity modelling is representative of flights by species which predominantly pass through the site in a defined direction such as geese commuting. Non-directional flight is where flight lines by a species are exhibiting no clear direction whilst hunting or displaying.

Grey Heron, Hen Harrier, Merlin, Peregrine Falcon were considered to display non-directional behaviour through TRE. Pink Footed Goose were observed to fly through the TRE directionally.

2.4 Bird Activity Hours

Across the five vantage points, a total of 445 hours survey per vantage point was undertaken (Table 2.4.1). To represent flights through the TRE annually, a ratio was derived between the total time a species was active annually and the amount of time surveyed at each vantage point. The season activity time of each species considered is outlined in Table 2.4.2.

Due to the relatively low volume of flights observed within the TRE and limited trend in seasonality, collision risk was modelled to give a general, annual figure based on all flight lines on a per species basis (see Figure 2.2.1 for flight records included within the TRE).

Table 2.4.1. Total Number of Vantage Point Survey Hours

Vantage Point	Hours recorded between October 2019 – December 2020
A	88
B	90
C	84
D	90
E	93

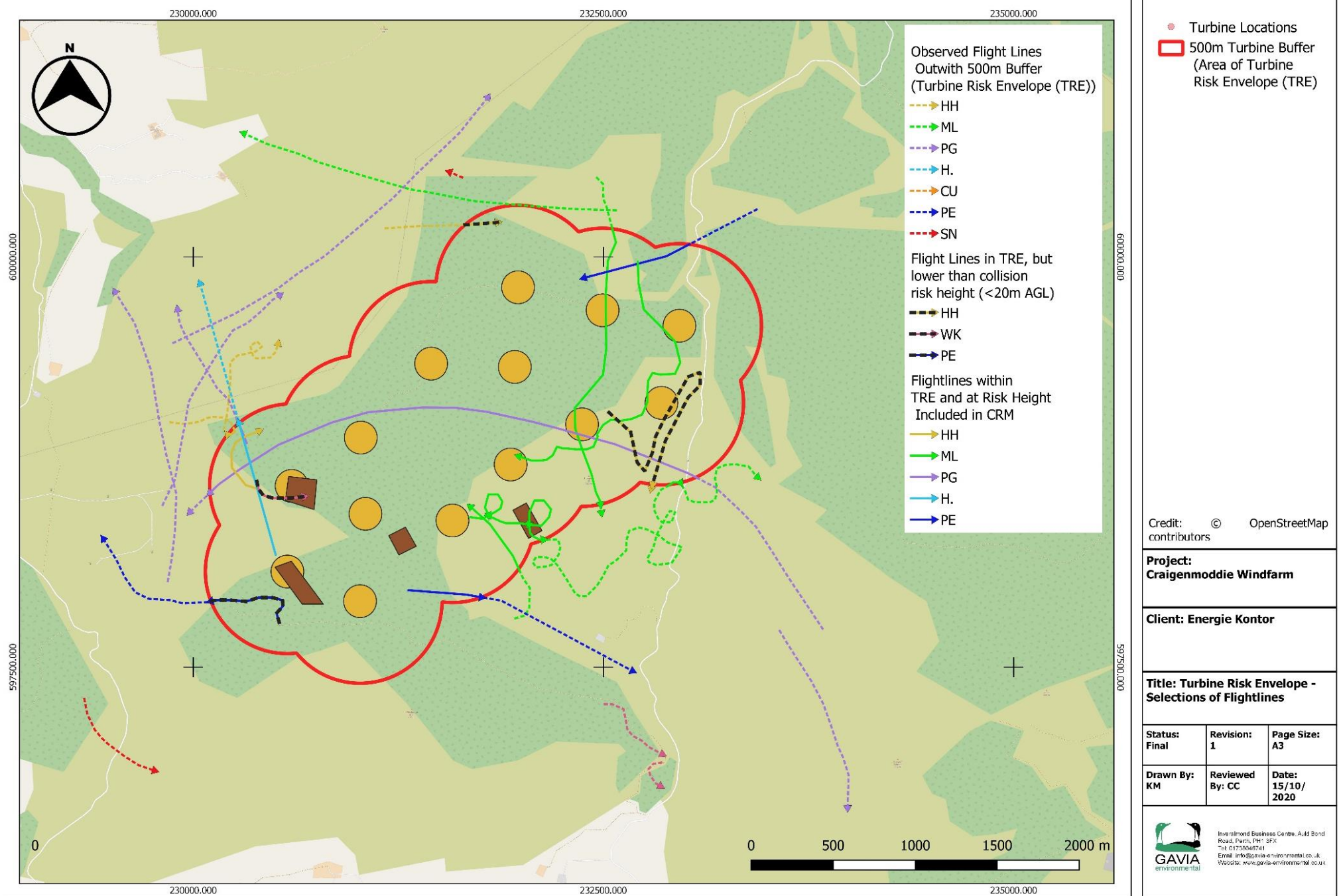


Figure 2.2.1. Flight lines included within the Collision Risk Model

Table 2.4.2. CRM Selected Species Active Hours (During Seasons, where applicable)

Species	Seasons				Annually (hours)
	April to August (hours)	September to March (hours)	March to May (hours)	September to November (hours)	
Grey heron	Annual				4380
Hen harrier	Annual				4380
Merlin	Annual				4380
Peregrine falcon	Annual				4380
Pink-footed goose	N/A	N/A	2208	N/A	2208

Annual hours calculated for all species in Table 2.4.1, with the exception of pink-footed goose, are considered to be active on the site year-round. 4380 hours is therefore the number of dusk, dawn and day light hours.

For Pink-footed goose, 2208 hours was included as both daylight and nocturnal hours required for March to May when Spring passage is undertaken by the species.

2.5 Directional Flights through Passage Calculation

To represent the passage of pink-footed geese during the March to May 2019 period, directional flight CRM modelling was applied through the following methods:

- A Cross-Sectional TRE was defined through determining the maximum width of the windfarm perpendicular to the direction of pink footed goose flight lines through the site (inclusive of the 500m turbine buffer);
- This width was then multiplied by the maximum height of turbine blades to give a theoretical risk volume (TRW).

To calculate the number of birds flying through the Cross-Sectional TRE, the following calculations were applied:

- The number of geese flights observed within the 500m turbine buffer flying at Height Bands 2 and 3 (the defined at risk heights) was counted.
- Annual geese flight totals were extrapolated by applying the ratio between total VP time and the annual geese activity time (outlined in Table 2.4.1).

Because the TRW represents the total volume between turbine height and flight passage within the 500m buffer area, collision risk would be overrepresented. This is due to the blades, which present the flight risk, only filling a proportion of the total TRW volume calculated at any given time.

To calculate a representative flight risk volume relative to the volume of blades within the theoretical risk window (TRW), the following was undertaken creating the representative flight risk ratio:

- Rotor radius (πR^2) multiplied by the number of rotors on all nearby turbines, divided by the TRW volume.

The annual number of birds passing through the rotor space within the TRW was then calculated by multiplying the extrapolated annual number of birds passing through the rotors multiplied by the representative flight risk ratio calculated in 2.5.4.

2.6 Non-Directional Flight Passage Calculation

Non-directional flight CRM calculations were applied to the following target species: grey heron, hen harrier, merlin and peregrine falcon.

Using survey data gathered from vantage point surveys, total seconds within the TRE were calculated on a per species basis representative of an entire year. This included flights which were within the 500m turbine buffer covering the whole site and time recorded at Band 2 and Band 3.

Any overlaps where sightings may have been recorded was filtered out of the dataset prior to calculations through the following methods:

- Communication on site;
- Avoiding simultaneous vantage points surveys at particular times to minimise viewing area overlap; and,
- Review of field work during digitising process.

To calculate the risk volume created by the turbine blades relative to each species, the following calculations were undertaken:

- The bird and blade transit length calculated through adding bird length and maximum depth of blade.
- Calculate the total volume of all blades by multiplying the number of turbines by the total rotor radius (πR^2)
- Multiply the bird and blade transit length by the total volume of all blades.

In order to determine the total number of at flight risk seconds recorded within the TRZ, the ratio between the total volume of all blades and the TRZ should be calculated and applied to the total seconds observed for each bird species.

2.7 Collision Probability and Assumed Avoidance Rates

Using the Nature Scot Excel Spreadsheet, turbine specifications and bird biometric data is applied to the Band *et al.* (2007) model to give collision risk output value for a single bird flight through the TRZ (full these are provided in section 3.5).

To establish a cautious approach to development, where there are multiple appropriate values to represent particular bird biometrics, the values which would increase collision risk most are applied.

To determine the number of collisions per annum per species, the output of the Band *et al.* (2007) model is applied to the estimated volume of flights through the TRE.

As a final step, assumed avoidance rates are applied to the number of collisions per annum. These values account for a birds behaviour in flight whereby they take avoidance action and not collide with the blades.

Avoidance rate values are accessed from literature and Nature Scot guidance, tending to range between 95% - 95.5%. Where no avoidance rate value has been established through research, 98% is applied.

3 Results

3.1 Species Data

Table 3.1.1. Species Flight Data Applied to CRM Resulting from Vantage Point Surveys

Species	Total Number of Flights in TRE Observed	Total Time in TRE Observed (seconds)*	Total Time in TRE Annual (seconds)*
Grey heron	1	29.12	607.46
Hen harrier	2	32.00	667.43
Merlin	4	199.81	4167.40
Peregrine falcon	2	18.02	375.76
Pink-footed goose	21	125.00	1314.27

**Extrapolated to represent a full year of activity through the application of the ratio calculated between the observation time (Table 2.4.1) and the annual activity time of each species (Table 2.4.2.)*

3.2 Species Flight Times Per Observed Turbine Risk Envelope

Table 3.2.1. Species Flight Data Applied to CRM Resulting from Vantage Point Surveys

Species	Total Observed Area within the TRE (ha)	Annual Flight Hours per Hectare in TRE*
Grey heron	588.44	0.000287
Hen harrier	588.44	0.000315
Merlin	588.44	0.001967
Peregrine falcon	588.44	0.000177
Pink-footed goose	588.44	0.000620

**Annual Flight Times within the TRE divided by the observable area of the TRE.*

3.3 Calculation of Directional Collision Risk

Table 3.2.1. Species Flight Data Applied to CRM Resulting from Vantage Point Surveys (only for pink-footed goose)

Metric Reference Number (RN)	Metric	Value	Calculation
Calculation of Turbine Risk Envelope Volume			
RN1	Windfarm Width Perpendicular to PG flights (m)	2,935	TRE m³ (RN3) calculated by multiplying RN1 by RN2.
RN2	Max Height (m)	200	
RN3	Directional Turbine Risk Envelope Volume (m³)	587,000	
Number of Directional Flights Through Site			
RN4	Geese In envelope at Risk Height (heard but not counted, so average of all activity)	65	Number of Geese Per Survey Hour (RN5) divided by Number of Observed Geese (RN4) to give per Survey Hour Rate (RN6)
RN5	Number of Survey Hours	178	
RN6	Number of Geese per Survey Hour	0.365	
RN7	Number of Goose Active Hours per Annum	2208	Apply Rate (RN6) to Annual Geese Activity (RN7) to extrapolate Goose Flights through Entire Site per Annum
RN8	Goose Flights Through Site per Annum (n)	806.29	
Total Flight Risk Area Calculated for Entire Site			
RN9	Number of Turbine Blades within Swept Area	15	Sweep Area per Turbine Blade Numbers (RN10) multiplied by Number of Turbines (RN9).
RN10	Area of Turbine Rotors (Swept Area) (m²)	18,869	
RN11	Total Turbine Rotor Swept Area Presenting Collision Risk (m²)	283,035	
Number of Birds Passing Through Direction Turbine Risk Envelope			
RN13	Total Rotor Site Area (RN11) as a Proportion of Risk Window Volume (RN3)	0.48	RN14 divided by RN8
RN14	Number of Bird Transits Passing Through Rotors within Area of Recorded Directional Flights per Annum	388.77	
RN15	% Collision Risk of Single Bird Passing Through Rotors	5.71%	Band <i>et al.</i> (2007) Model Output Value in Table 3.5.5
RN16	Average Collision Risk per Annum	22.19	Number of Bird Transits Through Rotor Area per Annum (RN14) multiplied by % of birds colliding with rotors (RN15).
RN17	Species Avoidance Rate	99.8%	Nature.Scot Guidance (2018)
RN18	Average Collision Risk incl. Avoidance per Annum	0.04	% of birds which take avoidance action to miss blades (RN17) multiplied by total Average Collisions per Annum (RN16)
RN19	Average Collision Risk incl. Avoidance Over 25 Years	1.10	Annual Collisions (RN18) multiplied by 25 years to give nominal value.

3.4 Calculation of Non-Directional Collision Risk

Table 3.4.1. Species Flight Data Applied to CRM Resulting from Vantage Point Surveys (for grey heron, hen harrier, merlin and peregrine falcon)

Metric Reference Number (RN)	Metric	Values (cells merged where values are ubiquitous across all four species)				Calculation
		H.	HH	ML	PE	
Combined Volume Sweep of All Turbines						
RN1	No. of Turbines	14				Total Rotor Sweep Area multiplied by Bird Length divided by Depth of Blade: (RN1 x RN2) x (RN4 + RN3)
RN2	Rotor Sweep Area (m²)	18,869				
RN3	Depth of Blade (m)	4.5				
RN4	Bird Length (m)	0.94	0.48	0.28	0.42	
RN5	Combined Volume Sweep (m³)	1,437,063.04	1,315,546.68	1,262,713.48	1,299,696.72	
Total Non-Directional Flight Time (seconds) within Collision Risk Volume created by Rotors Sweep per Annum						
RN6	Total Flight Turbine Risk Envelope Volume of Site (m³)	921,082,000				Area of 500m Turbine Buffer multiplied by min (45m) to max height (155m) of turbine blades (Table 1.4.1)
RN7	Total annual seconds within TRE	358.33	393.71	2458.30	221.66	Table 3.1.1
RN8	Occupancy of Rotor Sweep Volume (seconds)	0.56	0.57	3.40	0.32	Occupancy of Flight Risk Volume (RN7) divided by Total CRE Volume of Site (RN6) multiplied by Combined Rotor Volume (RN5).
Time Taken for Bird to Pass Through Rotors (seconds)						
RN9	Assumed Flight Speed	10.00	9.10	9.44	20.70	Stated In Table 1.2.1
RN10	Time Taken for Birds to Clear Rotors (seconds)	0.54	0.55	0.51	0.24	Rotor Depth (RN3) + Bird Length (RN4) divided by Flight Speed (RN9)
Number of Bird Transits Through Rotors						
RN11	Annual Turbine Operation Time (%)	100%				An upper estimate to establish cautious approach to development.

Reference Number	Metric	Values (cells merged where values are ubiquitous across all four species)				Calculation
		H.	HH	ML	PE	
RN12	Number of Transits Through Rotors	1.04	1.04	6.72	1.33	Total Occupancy of the Rotor Sweep Volume (RN8) divided by Time Taken for Bird to Clear Rotors (RN10), multiplied by the Annual Turbine Operation time expressed as a percentage (RN11)
Average Collision Risk per Annum (No Avoidance Rates Applied)						
RN13	Collision Risk Values	7.7%	5.6%	4.3%	4.2%	Derived from Band <i>et al.</i> (2007) Model (Tables 3.5.1 – 3.5.4)
RN14	Collisions Per Annum	0.08	0.058	0.292	0.056	Collision Risk Values (RN13) multiplied by Number of Transits Through Rotors (RN12) to give Collisions Per Annum (RN14)
Average Collision Risk per Annum <u>with</u> Avoidance Rates Applied						
RN15	Avoidance Rate (%)	98%	99%	98%	98%	Referenced in Table 1.3.1
RN16	Average Collision Risk Per Annum <u>with</u> Avoidance Rates Applied	0.0016	0.0006	0.0058	0.0011	Avoidance Rate (%) (RN15) applied to Collisions Per Annum (RN14)
RN17	Total Collisions in 25 Years	0.040	0.014	0.146	0.028	Multiply Annual Rate by 25 (years) to give RN17.

3.5 Calculation Band *et al.* (2007) Collision Risk Model Outputs

3.5.1 Calculation Band *et al.* (2007) Collision Risk Model Output for Grey Heron

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

H.

K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius								
NoBlades	3									
MaxChord	3.5 m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.94 m	0.025	0.575	5.09	19.77	0.99	0.00124	19.35	0.97	0.00121
Wingspan	1.84 m	0.075	0.575	1.70	6.73	0.34	0.00252	6.31	0.32	0.00237
F: Flapping (0) or gliding (+1)	0	0.125	0.702	1.02	4.62	0.23	0.00289	4.10	0.21	0.00257
		0.175	0.860	0.73	3.83	0.19	0.00335	3.20	0.16	0.00280
Bird speed	10.00 m/sec	0.225	0.994	0.57	3.36	0.17	0.00378	2.64	0.13	0.00297
RotorDiam	150 m	0.275	0.947	0.46	2.81	0.14	0.00387	2.12	0.11	0.00291
RotationPeriod	6.00 sec	0.325	0.899	0.39	2.49	0.12	0.00405	1.84	0.09	0.00299
		0.375	0.851	0.34	2.26	0.11	0.00423	1.63	0.08	0.00306
		0.425	0.804	0.30	2.07	0.10	0.00440	1.48	0.07	0.00315
		0.475	0.756	0.27	1.92	0.10	0.00456	1.37	0.07	0.00325
Bird aspect ratio: β	0.51	0.525	0.708	0.24	1.80	0.09	0.00472	1.28	0.06	0.00336
		0.575	0.660	0.22	1.69	0.08	0.00486	1.21	0.06	0.00347
		0.625	0.613	0.20	1.60	0.08	0.00500	1.15	0.06	0.00359
		0.675	0.565	0.19	1.52	0.08	0.00512	1.10	0.06	0.00373
		0.725	0.517	0.18	1.45	0.07	0.00524	1.07	0.05	0.00387
		0.775	0.470	0.16	1.38	0.07	0.00535	1.04	0.05	0.00402
		0.825	0.422	0.15	1.32	0.07	0.00545	1.01	0.05	0.00418
		0.875	0.374	0.15	1.27	0.06	0.00554	0.99	0.05	0.00434
		0.925	0.327	0.14	1.22	0.06	0.00562	0.98	0.05	0.00452
		0.975	0.279	0.13	1.17	0.06	0.00570	0.96	0.05	0.00470
Overall p(collision) =					Upwind		8.7%	Downwind		6.7%
Average								7.7%		

3.5.2 Calculation Band *et al.* (2007) Collision Risk Model Output for Hen Harrier

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA												
Only enter input parameters in blue										W Band	09/11/2020	
HH												
K: [1D or 3D] (0 or 1)			1	Calculation of alpha and p(collision) as a function of radius								
NoBlades			3				Upwind:			Downwind:		
MaxChord			3.5 m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)			6	radius	chord	alpha	length	p(collision)	from radius	length	p(collision)	from radius r
BirdLength			0.48 m	0.025	0.575	4.63	14.58	0.80	0.00100	14.16	0.78	0.00097
Wingspan			1.1 m	0.075	0.575	1.54	5.00	0.27	0.00206	4.58	0.25	0.00189
F: Flapping (0) or gliding (+1)			0	0.125	0.702	0.93	3.54	0.19	0.00243	3.03	0.17	0.00208
				0.175	0.860	0.66	3.03	0.17	0.00291	2.40	0.13	0.00230
Bird speed			9.10 m/sec	0.225	0.994	0.51	2.71	0.15	0.00335	1.99	0.11	0.00245
RotorDiam			150.00 m	0.275	0.947	0.42	2.21	0.12	0.00335	1.52	0.08	0.00230
RotationPeriod			6.00 sec	0.325	0.899	0.36	1.92	0.11	0.00344	1.27	0.07	0.00226
				0.375	0.851	0.31	1.71	0.09	0.00352	1.08	0.06	0.00223
				0.425	0.804	0.27	1.54	0.08	0.00359	0.95	0.05	0.00222
				0.475	0.756	0.24	1.40	0.08	0.00365	0.85	0.05	0.00221
Bird aspect ratio: β			0.44	0.525	0.708	0.22	1.28	0.07	0.00370	0.76	0.04	0.00221
				0.575	0.660	0.20	1.18	0.07	0.00374	0.70	0.04	0.00222
				0.625	0.613	0.19	1.10	0.06	0.00378	0.65	0.04	0.00224
				0.675	0.565	0.17	1.02	0.06	0.00380	0.61	0.03	0.00227
				0.725	0.517	0.16	0.96	0.05	0.00381	0.58	0.03	0.00230
				0.775	0.470	0.15	0.90	0.05	0.00382	0.55	0.03	0.00235
				0.825	0.422	0.14	0.84	0.05	0.00381	0.53	0.03	0.00241
				0.875	0.374	0.13	0.79	0.04	0.00380	0.52	0.03	0.00248
				0.925	0.327	0.13	0.74	0.04	0.00377	0.50	0.03	0.00256
				0.975	0.279	0.12	0.70	0.04	0.00374	0.49	0.03	0.00264
				Overall p(collision) =			Upwind	6.7%		Downwind	4.5%	
								Average	5.6%			

3.5.3 Calculation Band *et al.* (2007) Collision Risk Model Output for Merlin

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Only enter input parameters in blue										W Band	09/11/2020
ML											
K: [1D or [3D] (0 or 1)	1	Calculation of alpha and p(collision) as a function of radius									
NoBlades	3				Upwind:			Downwind:			
MaxChord	3.5 m	r/R	c/C	α	collide		contribution	collide		contribution	
Pitch (degrees)	6	radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r	
BirdLength	0.28 m	0.025	0.575	4.81	12.53	0.66	0.00083	12.10	0.64	0.00080	
Wingspan	0.56 m	0.075	0.575	1.60	4.32	0.23	0.00171	3.89	0.21	0.00155	
F: Flapping (0) or gliding (+1)	0	0.125	0.702	0.96	3.14	0.17	0.00208	2.63	0.14	0.00174	
		0.175	0.860	0.69	2.76	0.15	0.00255	2.13	0.11	0.00197	
Bird speed	9.44 m/sec	0.225	0.994	0.53	2.51	0.13	0.00299	1.78	0.09	0.00213	
RotorDiam	150.00 m	0.275	0.947	0.44	2.07	0.11	0.00301	1.37	0.07	0.00200	
RotationPeriod	6.00 sec	0.325	0.899	0.37	1.77	0.09	0.00304	1.11	0.06	0.00191	
		0.375	0.851	0.32	1.54	0.08	0.00306	0.92	0.05	0.00182	
		0.425	0.804	0.28	1.37	0.07	0.00307	0.78	0.04	0.00175	
		0.475	0.756	0.25	1.22	0.06	0.00308	0.67	0.04	0.00168	
Bird aspect ratio: β	0.50	0.525	0.708	0.23	1.10	0.06	0.00307	0.59	0.03	0.00163	
		0.575	0.660	0.21	1.00	0.05	0.00305	0.52	0.03	0.00158	
		0.625	0.613	0.19	0.91	0.05	0.00303	0.47	0.02	0.00154	
		0.675	0.565	0.18	0.84	0.04	0.00299	0.42	0.02	0.00151	
		0.725	0.517	0.17	0.77	0.04	0.00295	0.39	0.02	0.00149	
		0.775	0.470	0.16	0.71	0.04	0.00290	0.36	0.02	0.00148	
		0.825	0.422	0.15	0.65	0.03	0.00283	0.34	0.02	0.00148	
		0.875	0.374	0.14	0.60	0.03	0.00276	0.32	0.02	0.00149	
		0.925	0.327	0.13	0.55	0.03	0.00268	0.31	0.02	0.00151	
		0.975	0.279	0.12	0.50	0.03	0.00259	0.30	0.02	0.00154	
Overall p(collision) =				Upwind		5.4%		Downwind		3.3%	
						Average		4.3%			

3.5.4 Calculation Band *et al.* (2007) Collision Risk Model Output for Peregrine Falcon

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

PE

W Band 09/11/2020

K: [1D or 3D] (0 or 1)	1.00	Calculation of alpha and p(collision) as a function of radius									
NoBlades	3.00										
MaxChord	3.50	m	r/R	c/C	α	Upwind:			Downwind:		
Pitch (degrees)	6.00		radius	chord	alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
BirdLength	0.42	m	0.025	0.575	10.54	32.06	0.77	0.00097	31.64	0.76	0.00096
Wingspan	1.02	m	0.075	0.575	3.51	10.83	0.26	0.00196	10.41	0.25	0.00189
F: Flapping (0) or gliding (+1)	0.00		0.125	0.702	2.11	7.56	0.18	0.00228	7.04	0.17	0.00213
			0.175	0.860	1.51	6.36	0.15	0.00269	5.73	0.14	0.00242
Bird speed	20.70	m/sec	0.225	0.994	1.17	5.61	0.14	0.00305	4.89	0.12	0.00266
RotorDiam	150.00	m	0.275	0.947	0.96	4.48	0.11	0.00298	3.79	0.09	0.00252
RotationPeriod	6.00	sec	0.325	0.899	0.81	3.69	0.09	0.00290	3.04	0.07	0.00238
			0.375	0.851	0.70	3.11	0.08	0.00282	2.49	0.06	0.00225
			0.425	0.804	0.62	2.66	0.06	0.00273	2.07	0.05	0.00213
			0.475	0.756	0.55	2.30	0.06	0.00264	1.75	0.04	0.00201
Bird aspect ratio: β	0.41		0.525	0.708	0.50	2.01	0.05	0.00255	1.49	0.04	0.00189
			0.575	0.660	0.46	1.76	0.04	0.00245	1.28	0.03	0.00178
			0.625	0.613	0.42	1.55	0.04	0.00235	1.11	0.03	0.00167
			0.675	0.565	0.39	1.39	0.03	0.00227	0.98	0.02	0.00160
			0.725	0.517	0.36	1.26	0.03	0.00221	0.89	0.02	0.00155
			0.775	0.470	0.34	1.15	0.03	0.00215	0.80	0.02	0.00151
			0.825	0.422	0.32	1.04	0.03	0.00208	0.73	0.02	0.00146
			0.875	0.374	0.30	0.95	0.02	0.00201	0.68	0.02	0.00143
			0.925	0.327	0.28	0.86	0.02	0.00193	0.62	0.02	0.00140
			0.975	0.279	0.27	0.78	0.02	0.00185	0.58	0.01	0.00137
			Overall p(collision) =				Upwind	4.7%	Downwind	3.7%	
							Average	4.19%			

3.5.5 Calculation Band *et al.* (2007) Collision Risk Model Output for Pink Footed Goose

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Only enter input parameters in blue									W Band		09/11/2020
PG											
K: [1D or [3D] (0 or 1)	Calculation of alpha and p(collision) as a function of radius										
NoBlades	Upwind:						Downwind:				
MaxChord	3.5	m	r/R	c/C	α	collide	contribution	collide	contribution		
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.75	m	0.025	0.575	7.64	28.49	0.95	0.00119	28.07	0.94	0.00117
Wingspan	1.7	m	0.075	0.575	2.55	9.64	0.32	0.00241	9.22	0.31	0.00230
F: Flapping (0) or gliding (+1)	0.00		0.125	0.702	1.53	6.58	0.22	0.00274	6.07	0.20	0.00253
			0.175	0.860	1.09	5.44	0.18	0.00317	4.81	0.16	0.00280
Bird speed	15.00	m/sec	0.225	0.994	0.85	4.74	0.16	0.00356	4.02	0.13	0.00301
RotorDiam	150.00	m	0.275	0.947	0.69	3.82	0.13	0.00350	3.12	0.10	0.00286
RotationPeriod	6.00	sec	0.325	0.899	0.59	3.17	0.11	0.00343	2.51	0.08	0.00272
			0.375	0.851	0.51	2.69	0.09	0.00336	2.06	0.07	0.00258
			0.425	0.804	0.45	2.31	0.08	0.00328	1.73	0.06	0.00245
			0.475	0.756	0.40	2.08	0.07	0.00330	1.53	0.05	0.00242
Bird aspect ratio: β	0.44		0.525	0.708	0.36	1.91	0.06	0.00334	1.39	0.05	0.00243
			0.575	0.660	0.33	1.76	0.06	0.00336	1.27	0.04	0.00244
			0.625	0.613	0.31	1.63	0.05	0.00339	1.18	0.04	0.00245
			0.675	0.565	0.28	1.51	0.05	0.00340	1.10	0.04	0.00247
			0.725	0.517	0.26	1.41	0.05	0.00342	1.04	0.03	0.00250
			0.775	0.470	0.25	1.32	0.04	0.00342	0.98	0.03	0.00253
			0.825	0.422	0.23	1.24	0.04	0.00342	0.94	0.03	0.00257
			0.875	0.374	0.22	1.17	0.04	0.00342	0.90	0.03	0.00262
			0.925	0.327	0.21	1.10	0.04	0.00340	0.87	0.03	0.00267
			0.975	0.279	0.20	1.04	0.03	0.00339	0.84	0.03	0.00272
			Overall p(collision) =			Upwind		6.4%		Downwind	
								Average		5.7%	

Ornithological Survey Effort and Conditions at the Proposed Craiginmoddie Windfarm

Table 1 outlines the system used for recording weather conditions on all the vantage point (VP) surveys as detailed below.

Table 1. Key to Meteorological Conditions Recorded During all Surveys

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

Table 2 outlines the full name of each surveyor from the Craiginmoddie VP surveys.

Table 2. Surveyor Full Names

Initials	Full Name
JA	John Allsop
AT	Andrew Taylor
DM	Donald Morrison
RM	Roisin McLaren
JC	Jenny Chambers
VF	Vince Fertcaz
ER	Emma Robson
EA	Emma Archer
WS	William Smith
MM	Mark Mulqueeney
KM	Kerr MacKinnon
SMR	Suzie S Robinson
CL	Christopher Liang
ED	Edward Dillon

VP surveys were undertaken during the 2019 breeding season and 2018 – 2019 non-breeding seasons to record the presence and activity of target and secondary species. A summary of the surveys undertaken across each VP location are supplied in Table 3. Weather conditions and a timeline of VP surveys are shown in Table 4.

Table 3. Summary of VP Surveys Undertaken at Craiginmoddie

Date	Season	VP	Observer	Survey Start Time	Survey Finish Time	No. Hours Surveyed
16/10/2018	NBR 2018/2019	A	JA	11:30	14:30	3
16/10/2018	NBR 2018/2019	A	JA	15:00	18:00	2
16/10/2018	NBR 2018/2019	B	AT	10:30	13:30	3
16/10/2018	NBR 2018/2019	B	AT	14:00	17:00	0
17/10/2018	NBR 2018/2019	C	JA	09:30	16:00	6
17/10/2018	NBR 2018/2019	D	JC	09:00	15:30	6
17/10/2018	NBR 2018/2019	E	DM	09:40	16:10	6
15/11/2018	NBR 2018/2019	A	JA	09:55	16:15	6
15/11/2018	NBR 2018/2019	B	AT	09:30	16:00	6
22/11/2018	NBR 2018/2019	C	JA + RM	09:45	16:00	6
22/11/2018	NBR 2018/2019	D	AT	09:30	16:00	6
22/11/2018	NBR 2018/2019	E	JC	09:30	16:00	6
12/12/2018	NBR 2018/2019	A	DM	09:10	15:40	4
12/12/2018	NBR 2018/2019	B	AT	09:15	15:15	3
12/12/2018	NBR 2018/2019	C	JC	09:30	16:00	6
12/12/2018	NBR 2018/2019	D	VF	09:15	15:15	6
12/12/2018	NBR 2018/2019	E	MM	09:05	15:35	6
18/01/2019	NBR 2018/2019	B	DM	09:45	16:00	6
18/01/2019	NBR 2018/2019	C	JA	10:08	16:15	6
23/01/2019	NBR 2018/2019	A	JA	10:10	16:25	6
23/01/2019	NBR 2018/2019	D	DM	10:15	16:45	5
23/01/2019	NBR 2018/2019	E	JC	10:00	16:30	6
04/02/2019	NBR 2018/2019	B	AT	10:00	16:30	6

Date	Season	VP	Observer	Survey Start Time	Survey Finish Time	No. Hours Surveyed
04/02/2019	NBR 2018/2019	C	JA	10:15	16:30	6
04/02/2019	NBR 2018/2019	E	DM	10:30	16:30	6
06/02/2019	NBR 2018/2019	A	JA	10:35	16:35	6
06/02/2019	NBR 2018/2019	D	DM	10:00	17:00	6
21/03/2019	BR 2019	A	JC	08:30	15:00	5
21/03/2019	BR 2019	B	EA	06:45	13:15	6
21/03/2019	BR 2019	C	DM	07:00	13:30	6
21/03/2019	BR 2019	D	RM	08:00	14:30	6
21/03/2019	BR 2019	E	AT	07:00	13:30	5
29/04/2019	BR 2019	A	WS	09:30	16:00	6
29/04/2019	BR 2019	B	JC	09:30	16:00	6
29/04/2019	BR 2019	C	MM	09:30	16:00	6
29/04/2019	BR 2019	D	KM	09:30	16:00	6
29/04/2019	BR 2019	E	AT	09:30	16:00	6
13/05/2019	BR 2019	C	ER	09:45	16:15	6
13/05/2019	BR 2019	E	SMR	09:35	16:05	6
14/05/2019	BR 2019	A	SMR	06:00	12:30	6
14/05/2019	BR 2019	D	ER	06:25	12:55	6
23/05/2019	BR 2019	B	SMR	07:30	14:00	6
10/06/2019	BR 2019	A	SMR	12:00	18:30	6
10/06/2019	BR 2019	B	ER	12:30	19:00	6
11/06/2019	BR 2019	D	SMR	05:00	11:30	6
11/06/2019	BR 2019	E	ER	05:10	11:40	6
18/06/2019	BR 2019	C	SMR	09:30	16:00	6
01/07/2019	BR 2019	D	SMR	10:45	17:15	6
01/07/2019	BR 2019	E	ER	11:05	17:35	6
02/07/2019	BR 2019	A	SMR	05:10	11:40	6

Date	Season	VP	Observer	Survey Start Time	Survey Finish Time	No. Hours Surveyed
02/07/2019	BR 2019	B	ER	04:50	11:20	6
29/07/2019	BR 2019	C	SMR	11:00	17:30	6
05/08/2019	BR 2019	D	SMR	08:00	14:30	6
05/08/2019	BR 2019	E	ER	08:20	14:50	6
22/08/2019	BR 2019	C	SMR	08:45	15:15	6
26/08/2019	BR 2019	A	ER	07:35	14:05	6
26/08/2019	BR 2019	B	SMR	08:10	14:40	6
23/09/2019	NBR 2019/2020	D	ED	14:00	17:00	3
23/09/2019	NBR 2019/2020	E	ED	10:50	13:50	3
23/09/2019	NBR 2019/2020	C	WS	14:00	17:00	3
23/09/2019	NBR 2019/2020	B	WS	10:00	13:00	3
24/09/2019	NBR 2019/2020	C	ED	10:20	13:20	3
24/09/2019	NBR 2019/2020	A	ED	14:05	17:05	3
24/09/2019	NBR 2019/2020	D	WS	14:00	17:00	3
24/09/2019	NBR 2019/2020	E	WS	09:45	12:45	3
25/09/2019	NBR 2019/2020	A	WS	09:00	12:00	2
25/09/2019	NBR 2019/2020	B	ED	09:10	12:10	0
22/10/2019	NBR 2019/2020	B	ED	10:30	13:30	3
22/10/2019	NBR 2019/2020	E	DM	10:30	13:30	3
22/10/2019	NBR 2019/2020	C	ED	14:15	17:15	3
22/10/2019	NBR 2019/2020	D	DM	14:20	17:20	3
23/10/2019	NBR 2019/2020	A	DM	09:00	12:00	3
23/10/2019	NBR 2019/2020	E	ED	09:15	12:15	3
23/10/2019	NBR 2019/2020	C	DM	12:45	15:45	3
23/10/2019	NBR 2019/2020	D	ED	13:00	16:00	3
24/10/2019	NBR 2019/2020	A	ED	09:10	12:10	3
24/10/2019	NBR 2019/2020	B	DM	09:30	12:30	3

Date	Season	VP	Observer	Survey Start Time	Survey Finish Time	No. Hours Surveyed
26/11/2019	NBR 2019/2020	E	CL	09:00	12:00	3
26/11/2019	NBR 2019/2020	B	ED	09:00	12:00	3
26/11/2019	NBR 2019/2020	D	CL	13:00	16:00	3
26/11/2019	NBR 2019/2020	C	ED	13:00	16:00	3
27/11/2019	NBR 2019/2020	A	CL	09:00	12:00	3
27/11/2019	NBR 2019/2020	E	ED	09:00	12:00	3
27/11/2019	NBR 2019/2020	C	CL	13:00	16:00	0
27/11/2019	NBR 2019/2020	D	ED	13:15	16:15	2
28/11/2019	NBR 2019/2020	A	ED	09:30	12:30	3
28/11/2019	NBR 2019/2020	B	CL	09:15	12:15	3
18/12/2019	NBR 2019/2020	D	ED	08:15	15:00	6
18/12/2019	NBR 2019/2020	A	CL	08:45	15:15	6
19/12/2019	NBR 2019/2020	E	CL	09:00	15:30	6
19/12/2019	NBR 2019/2020	B	ED	09:00	15:30	6

Table 4. Meteorological Conditions During VP surveys at Craiginmoddie (Sorted Chronologically)

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
16/10/2018	A	JA	11:30	14:30	1	5	SW	0	5	2	2	0	0
16/10/2018	A	JA	11:30	14:30	2	6	SW	1	8	1	1	0	0
16/10/2018	A	JA	11:30	14:30	3	5	SW	2	8	1	2	0	0
16/10/2018	A	JA	15:00	18:00	1	6	SW	2	8	2	1	0	0
16/10/2018	A	JA	15:00	18:00	2	5	SW	1	8	0	0	0	0
16/10/2018	A	JA	15:00	18:00	3	5	SW	0	6	1	2	0	0
16/10/2018	B	AT	10:30	13:30	1	5	SE	0	7	1	2	0	0
16/10/2018	B	AT	10:30	13:30	2	5	SE	0	7	1	2	0	0
16/10/2018	B	AT	10:30	13:30	3	4	S	1	8	0	1	0	0
16/10/2018	B	AT	14:00	17:00	1	4	SE	2	8	0	0	0	0
16/10/2018	B	AT	14:00	17:00	2	3	S	1	8	0	0	0	0
16/10/2018	B	AT	14:00	17:00	3	3	S	1	8	0	0	0	0
17/10/2018	C	JA	09:30	16:00	1	2	W	1	8	2	1	0	0
17/10/2018	C	JA	09:30	16:00	2	2	W	0	8	2	2	0	0
17/10/2018	C	JA	09:30	16:00	3	3	W	0	7	2	2	0	0
17/10/2018	C	JA	09:30	16:00	4	3	NW	0	5	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
17/10/2018	C	JA	09:30	16:00	5	3	NW	0	4	2	2	0	0
17/10/2018	C	JA	09:30	16:00	6	3	NW	0	4	2	2	0	0
17/10/2018	D	JC	09:00	15:30	1	2	SW	1	8	1	1	0	0
17/10/2018	D	JC	09:00	15:30	2	2	SW	0	8	2	2	0	0
17/10/2018	D	JC	09:00	15:30	3	1	SW	0	6	2	2	0	0
17/10/2018	D	JC	09:00	15:30	4	2	SW	2	7	2	2	0	0
17/10/2018	D	JC	09:00	15:30	5	2	SW	0	7	2	2	0	0
17/10/2018	D	JC	09:00	15:30	6	3	SW	0	6	2	2	0	0
17/10/2018	E	DM	09:40	16:10	1	5	W	1	6	1	1	0	0
17/10/2018	E	DM	09:40	16:10	2	3	W	1	6	1	2	0	0
17/10/2018	E	DM	09:40	16:10	3	2	W	0	4	2	2	0	0
17/10/2018	E	DM	09:40	16:10	4	2	W	0	3	2	2	0	0
17/10/2018	E	DM	09:40	16:10	5	2	W	0	3	2	2	0	0
17/10/2018	E	DM	09:40	16:10	6	2	W	0	3	2	2	0	0
15/11/2018	A	JA	09:55	16:15	1	4	SSE	0	6	2	2	0	0
15/11/2018	A	JA	09:55	16:15	2	5	SSE	0	5	2	2	0	0
15/11/2018	A	JA	09:55	16:15	3	5	S	0	4	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
15/11/2018	A	JA	09:55	16:15	4	5	SSE	0	8	2	2	0	0
15/11/2018	A	JA	09:55	16:15	5	4	SSE	0	8	2	2	0	0
15/11/2018	A	JA	09:55	16:15	6	4	SSE	0	8	2	2	0	0
15/11/2018	B	AT	09:30	16:00	1	6	E	0	7	0	1	0	0
15/11/2018	B	AT	09:30	16:00	2	6	SE	0	5	0	1	0	0
15/11/2018	B	AT	09:30	16:00	3	6	SEE	0	2	1	2	0	0
15/11/2018	B	AT	09:30	16:00	4	5	SEE	0	8	1	2	0	0
15/11/2018	B	AT	09:30	16:00	5	5	SE	0	8	1	1	0	0
15/11/2018	B	AT	09:30	16:00	6	5	SEE	0	8	1	1	0	0
22/11/2018	C	JA + RM	09:45	16:00	1	1	E	0	0	N/A	2	1	0
22/11/2018	C	JA + RM	09:45	16:00	2	1	E	0	0	N/A	2	0	0
22/11/2018	C	JA + RM	09:45	16:00	3	1	E	0	0	N/A	2	0	0
22/11/2018	C	JA + RM	09:45	16:00	4	1	E	0	0	2	2	0	0
22/11/2018	C	JA + RM	09:45	16:00	5	1	E	0	6	2	2	0	0
22/11/2018	C	JA + RM	09:45	16:00	6	0	N/A	0	8	2	2	0	0
22/11/2018	D	AT	09:30	16:00	1	3	E	0	0	2	2	1	0
22/11/2018	D	AT	09:30	16:00	2	3	E	0	0	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
22/11/2018	D	AT	09:30	16:00	3	4	E	0	0	2	2	0	0
22/11/2018	D	AT	09:30	16:00	4	3	NE	0	1	2	2	0	0
22/11/2018	D	AT	09:30	16:00	5	3	ENE	0	6	1	2	0	0
22/11/2018	D	AT	09:30	16:00	6	3	ENE	0	8	1	2	0	0
22/11/2018	E	JC	09:30	16:00	1	2	E	0	0	N/A	2	1	0
22/11/2018	E	JC	09:30	16:00	2	1	E	0	0	N/A	2	0	0
22/11/2018	E	JC	09:30	16:00	3	1	E	0	0	N/A	2	0	0
22/11/2018	E	JC	09:30	16:00	4	1	E	0	4	2	2	0	0
22/11/2018	E	JC	09:30	16:00	5	0	ENE	0	6	2	2	0	0
22/11/2018	E	JC	09:30	16:00	6	3	ENE	0	8	2	2	0	0
12/12/2018	A	DM	09:10	15:40	1	2	SE	1	8	0	0	0	0
12/12/2018	A	DM	09:10	15:40	2	4	SE	0	8	0	1	0	0
12/12/2018	A	DM	09:10	15:40	3	6	SE	0	8	0	1	0	0
12/12/2018	A	DM	09:10	15:40	4	5	SE	0	8	1	2	0	0
12/12/2018	A	DM	09:10	15:40	5	6	SE	0	8	1	2	0	0
12/12/2018	A	DM	09:10	15:40	6	6	SE	0	8	1	2	0	0
12/12/2018	B	AT	09:15	15:15	1	2	SE	1	8	0	0	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
12/12/2018	B	AT	09:15	15:15	2	2	SE	1	8	0	1	0	0
12/12/2018	B	AT	09:15	15:15	3	3	SE	0	8	0	1	0	0
12/12/2018	B	AT	09:15	15:15	4	2	SE	0	8	0	1	0	0
12/12/2018	B	AT	09:15	15:15	5	3	ESE	0	8	0	0	0	0
12/12/2018	B	AT	09:15	15:15	6	2	ESE	0	8	0	0	0	0
12/12/2018	C	JC	09:30	16:00	1	3	SE	1	8	2	2	0	0
12/12/2018	C	JC	09:30	16:00	2	4	SE	2	8	2	2	0	0
12/12/2018	C	JC	09:30	16:00	3	3	SE	0	8	1	1	0	0
12/12/2018	C	JC	09:30	16:00	4	4	SE	0	8	1	1	0	0
12/12/2018	C	JC	09:30	16:00	5	4	E	0	8	2	1	0	0
12/12/2018	C	JC	09:30	16:00	6	4	E	0	8	2	2	0	0
12/12/2018	D	VF	09:15	15:15	1	3	SE	2	8	1	1	0	0
12/12/2018	D	VF	09:15	15:15	2	3	SE	0	8	1	1	0	0
12/12/2018	D	VF	09:15	15:15	3	3	SE	0	8	1	1	0	0
12/12/2018	D	VF	09:15	15:15	4	4	SE	0	8	1	1	0	0
12/12/2018	D	VF	09:15	15:15	5	4	SE	0	8	1	1	0	0
12/12/2018	D	VF	09:15	15:15	6	4	SE	0	8	1	1	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
12/12/2018	E	MM	09:05	15:35	1	5	WSW	3	8	1	2	0	0
12/12/2018	E	MM	09:05	15:35	2	5	WSW	3	8	1	2	0	0
12/12/2018	E	MM	09:05	15:35	3	5	WSW	1	8	1	2	0	0
12/12/2018	E	MM	09:05	15:35	4	5	SW	1	8	1	2	0	0
12/12/2018	E	MM	09:05	15:35	5	5	SW	0	8	1	2	0	0
12/12/2018	E	MM	09:05	15:35	6	5	SW	0	8	1	2	0	0
18/01/2019	B	DM	09:45	16:00	1	3	SE	0	6	1	2	1	0
18/01/2019	B	DM	09:45	16:00	2	4	SE	2	7	1	2	1	0
18/01/2019	B	DM	09:45	16:00	3	5	SE	0	7	1	2	1	0
18/01/2019	B	DM	09:45	16:00	4	5	SE	0	5	0	2	1	0
18/01/2019	B	DM	09:45	16:00	5	4	SE	0	5	0	2	0	0
18/01/2019	B	DM	09:45	16:00	6	5	SE	0	7	0	2	0	0
18/01/2019	C	JA	10:08	16:15	1	4	SE	0	8	2	2	1	0
18/01/2019	C	JA	10:08	16:15	2	4	SE	0	8	2	2	0	0
18/01/2019	C	JA	10:08	16:15	3	4	SE	1	8	2	2	0	0
18/01/2019	C	JA	10:08	16:15	4	4	ESE	0	8	2	2	0	0
18/01/2019	C	JA	10:08	16:15	5	5	ESE	0	8	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
18/01/2019	C	JA	10:08	16:15	6	4	SE	0	8	2	2	0	0
23/01/2019	A	JA	10:10	16:25	1	0	N/A	0	1	2	2	2	2
23/01/2019	A	JA	10:10	16:25	2	0	N/A	0	1	2	2	2	2
23/01/2019	A	JA	10:10	16:25	3	0	N/A	0	5	2	2	2	2
23/01/2019	A	JA	10:10	16:25	4	0	N/A	0	6	2	2	2	2
23/01/2019	A	JA	10:10	16:25	5	0	N/A	0	8	2	1	2	2
23/01/2019	A	JA	10:10	16:25	6	0	N/A	0	8	1	0	2	2
23/01/2019	D	DM	10:15	16:45	1	0	W	0	2	1	2	2	1
23/01/2019	D	DM	10:15	16:45	2	0	W	0	4	0	2	2	1
23/01/2019	D	DM	10:15	16:45	3	0	W	0	6	0	1	2	1
23/01/2019	D	DM	10:15	16:45	4	0	W	1	8	0	0	2	1
23/01/2019	D	DM	10:15	16:45	5	1	W	1	8	0	1	2	1
23/01/2019	D	DM	10:15	16:45	6	0	W	0	8	0	2	2	1
23/01/2019	E	JC	10:00	16:30	1	2	SW	0	2	2	2	0	1
23/01/2019	E	JC	10:00	16:30	2	2	SW	0	6	2	2	0	1
23/01/2019	E	JC	10:00	16:30	3	2	SW	0	8	2	1	0	1
23/01/2019	E	JC	10:00	16:30	4	3	SW	3	8	2	1	0	1

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
23/01/2019	E	JC	10:00	16:30	5	3	SW	1	8	2	1	0	1
23/01/2019	E	JC	10:00	16:30	6	3	SW	1	8	2	1	0	1
04/02/2019	B	AT	10:00	16:30	1	3	WNW	0	5	1	1	0	1
04/02/2019	B	AT	10:00	16:30	2	2	WNW	0	6	1	1	0	1
04/02/2019	B	AT	10:00	16:30	3	2	WNW	0	7	1	2	0	1
04/02/2019	B	AT	10:00	16:30	4	2	WNW	0	6	1	2	0	1
04/02/2019	B	AT	10:00	16:30	5	2	WNW	0	5	1	2	0	1
04/02/2019	B	AT	10:00	16:30	6	2	WNW	0	2	1	2	0	1
04/02/2019	C	JA	10:15	16:30	1	3	NW	1	6	2	2	0	1
04/02/2019	C	JA	10:15	16:30	2	4	NW	0	5	2	2	0	1
04/02/2019	C	JA	10:15	16:30	3	4	NW	0	5	2	2	0	1
04/02/2019	C	JA	10:15	16:30	4	3	NW	0	4	2	2	0	1
04/02/2019	C	JA	10:15	16:30	5	3	NW	0	6	2	2	0	1
04/02/2019	C	JA	10:15	16:30	6	3	NW	0	6	2	2	0	1
04/02/2019	E	DM	10:30	16:30	1	6	SW	0	4	1	2	1	1
04/02/2019	E	DM	10:30	16:30	2	5	W	0	5	1	2	1	1
04/02/2019	E	DM	10:30	16:30	3	4	W	0	5	1	2	1	1

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
04/02/2019	E	DM	10:30	16:30	4	4	W	0	6	1	2	1	1
04/02/2019	E	DM	10:30	16:30	5	5	W	0	8	1	2	1	1
04/02/2019	E	DM	10:30	16:30	6	3	W	0	5	1	2	1	1
06/02/2019	A	JA	10:35	16:35	1	4	S	0	8	2	2	0	1
06/02/2019	A	JA	10:35	16:35	2	3	S	1	8	2	1	0	1
06/02/2019	A	JA	10:35	16:35	3	4	S	0	6	2	2	0	1
06/02/2019	A	JA	10:35	16:35	4	4	SSW	0	5	2	2	0	1
06/02/2019	A	JA	10:35	16:35	5	4	SSW	0	5	2	2	0	1
06/02/2019	A	JA	10:35	16:35	6	5	SSW	0	3	2	2	0	1
06/02/2019	D	DM	10:00	17:00	1	5	S	0	8	0	2	0	0
06/02/2019	D	DM	10:00	17:00	2	5	S	1	7	0	2	0	0
06/02/2019	D	DM	10:00	17:00	3	6	S	0	6	1	2	0	0
06/02/2019	D	DM	10:00	17:00	4	6	SSW	0	5	1	2	0	0
06/02/2019	D	DM	10:00	17:00	5	6	SSW	0	6	1	2	0	0
06/02/2019	D	DM	10:00	17:00	6	6	SSW	0	5	1	2	0	0
21/03/2019	A	JC	08:30	15:00	1	2	SW	1	8	1	0	0	0
21/03/2019	A	JC	08:30	15:00	2	3	SW	1	8	1	1	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
21/03/2019	A	JC	08:30	15:00	3	3	SW	1	8	1	1	0	0
21/03/2019	A	JC	08:30	15:00	4	3	SW	0	8	2	2	0	0
21/03/2019	A	JC	08:30	15:00	5	3	SW	0	8	2	2	0	0
21/03/2019	A	JC	08:30	15:00	6	3	SW	0	8	2	2	0	0
21/03/2019	B	EA	06:45	13:15	1	0	N/A	0	8	2	2	0	0
21/03/2019	B	EA	06:45	13:15	2	0	N/A	0	8	2	2	0	0
21/03/2019	B	EA	06:45	13:15	3	0	N/A	1	8	2	1	0	0
21/03/2019	B	EA	06:45	13:15	4	1	NE	2	8	2	1	0	0
21/03/2019	B	EA	06:45	13:15	5	1	NE	0	8	2	1	0	0
21/03/2019	B	EA	06:45	13:15	6	0	NNE	1	8	2	2	0	0
21/03/2019	C	DM	07:00	13:30	1	5	SW	0	7	1	2	0	0
21/03/2019	C	DM	07:00	13:30	2	6	SW	1	8	0	2	0	0
21/03/2019	C	DM	07:00	13:30	3	6	SW	2	8	0	1	0	0
21/03/2019	C	DM	07:00	13:30	4	5	SW	1	8	0	1	0	0
21/03/2019	C	DM	07:00	13:30	5	4	SW	2	8	0	1	0	0
21/03/2019	C	DM	07:00	13:30	6	3	SW	0	7	1	2	0	0
21/03/2019	D	RM	08:00	14:30	1	4	W	1	8	1	1	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
21/03/2019	D	RM	08:00	14:30	2	2	W	1	7	1	1	0	0
21/03/2019	D	RM	08:00	14:30	3	1	W	2	8	1	1	0	0
21/03/2019	D	RM	08:00	14:30	4	2	W	2	8	1	1	0	0
21/03/2019	D	RM	08:00	14:30	5	1	W	0	7	2	2	0	0
21/03/2019	D	RM	08:00	14:30	6	1	W	0	7	2	2	0	0
21/03/2019	E	AT	07:00	13:30	1	5	SW	0	8	1	2	0	0
21/03/2019	E	AT	07:00	13:30	2	5	SW	1	8	0	1	0	0
21/03/2019	E	AT	07:00	13:30	3	4	SW	1	8	0	1	0	0
21/03/2019	E	AT	07:00	13:30	4	5	SW	3	8	0	1	0	0
21/03/2019	E	AT	07:00	13:30	5	5	SW	3	8	0	0	0	0
21/03/2019	E	AT	07:00	13:30	6	4	SW	0	8	1	2	0	0
29/04/2019	A	WS	09:30	16:00	1	2	S	0	4	2	2	0	0
29/04/2019	A	WS	09:30	16:00	2	2	SSW	0	5	2	2	0	0
29/04/2019	A	WS	09:30	16:00	3	2	SSW	0	5	2	2	0	0
29/04/2019	A	WS	09:30	16:00	4	3	S	0	6	2	2	0	0
29/04/2019	A	WS	09:30	16:00	5	3	S	0	7	2	2	0	0
29/04/2019	A	WS	09:30	16:00	6	2	S	0	6	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
29/04/2019	B	JC	09:30	16:00	1	1	SW	0	2	2	2	0	0
29/04/2019	B	JC	09:30	16:00	2	0	N/A	0	1	2	2	0	0
29/04/2019	B	JC	09:30	16:00	3	2	SW	0	4	2	2	0	0
29/04/2019	B	JC	09:30	16:00	4	1	SW	0	3	2	2	0	0
29/04/2019	B	JC	09:30	16:00	5	2	SW	0	4	2	2	0	0
29/04/2019	B	JC	09:30	16:00	6	2	S	0	6	2	2	0	0
29/04/2019	C	MM	09:30	16:00	1	2	SE	0	2	2	2	0	0
29/04/2019	C	MM	09:30	16:00	2	3	SE	0	2	2	2	0	0
29/04/2019	C	MM	09:30	16:00	3	3	SE	0	2	2	2	0	0
29/04/2019	C	MM	09:30	16:00	4	3	SE	0	2	2	2	0	0
29/04/2019	C	MM	09:30	16:00	5	4	SE	0	2	2	2	0	0
29/04/2019	C	MM	09:30	16:00	6	3	SE	0	2	2	2	0	0
29/04/2019	D	KM	09:30	16:00	1	3	NE	0	3	2	2	0	0
29/04/2019	D	KM	09:30	16:00	2	3	NE	0	3	2	2	0	0
29/04/2019	D	KM	09:30	16:00	3	3	NE	0	3	2	2	0	0
29/04/2019	D	KM	09:30	16:00	4	2	NE	0	3	2	2	0	0
29/04/2019	D	KM	09:30	16:00	5	1	NE	0	4	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
29/04/2019	D	KM	09:30	16:00	6	2	NE	0	6	2	2	0	0
29/04/2019	E	AT	09:30	16:00	1	2	SE	0	3	1	2	0	0
29/04/2019	E	AT	09:30	16:00	2	3	SE	0	5	1	2	0	0
29/04/2019	E	AT	09:30	16:00	3	3	SE	0	5	1	2	0	0
29/04/2019	E	AT	09:30	16:00	4	3	E	0	4	1	2	0	0
29/04/2019	E	AT	09:30	16:00	5	4	SE	0	4	1	2	0	0
29/04/2019	E	AT	09:30	16:00	6	5	SE	0	3	1	2	0	0
13/05/2019	C	ER	09:45	16:15	1	4	SE	0	2	2	2	0	0
13/05/2019	C	ER	09:45	16:15	2	5	SE	0	4	2	2	0	0
13/05/2019	C	ER	09:45	16:15	3	5	SE	0	4	2	2	0	0
13/05/2019	C	ER	09:45	16:15	4	4	SE	0	4	2	2	0	0
13/05/2019	C	ER	09:45	16:15	5	4	SE	0	4	2	2	0	0
13/05/2019	C	ER	09:45	16:15	6	4	SE	0	4	2	2	0	0
13/05/2019	E	SMR	09:35	16:05	1	3	SSW	0	1	2	2	0	0
13/05/2019	E	SMR	09:35	16:05	2	3	SSW	0	4	2	2	0	0
13/05/2019	E	SMR	09:35	16:05	3	3	SSW	0	6	2	2	0	0
13/05/2019	E	SMR	09:35	16:05	4	4	SW	0	7	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
13/05/2019	E	SMR	09:35	16:05	5	4	SW	0	5	2	2	0	0
13/05/2019	E	SMR	09:35	16:05	6	3	SW	0	2	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	1	0	N/A	0	2	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	2	1	SW	0	1	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	3	1	SW	0	1	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	4	1	SW	0	1	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	5	3	SW	0	1	2	2	0	0
14/05/2019	A	SMR	06:00	12:30	6	4	SW	0	1	2	2	0	0
14/05/2019	D	ER	06:25	12:55	1	1	S	0	2	2	2	0	0
14/05/2019	D	ER	06:25	12:55	2	1	S	0	2	2	2	0	0
14/05/2019	D	ER	06:25	12:55	3	3	S	0	4	2	2	0	0
14/05/2019	D	ER	06:25	12:55	4	4	S	0	4	2	2	0	0
14/05/2019	D	ER	06:25	12:55	5	3	S	0	4	2	2	0	0
14/05/2019	D	ER	06:25	12:55	6	3	S	0	4	2	2	0	0
23/05/2019	B	SMR	07:30	14:00	1	0	N/A	0	6	2	2	0	0
23/05/2019	B	SMR	07:30	14:00	2	1	SW	0	5	2	2	0	0
23/05/2019	B	SMR	07:30	14:00	3	2	SW	0	3	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
23/05/2019	B	SMR	07:30	14:00	4	2	W	0	2	2	2	0	0
23/05/2019	B	SMR	07:30	14:00	5	2	SW	0	1	2	2	0	0
23/05/2019	B	SMR	07:30	14:00	6	2	SW	0	1	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	1	4	SW	0	5	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	2	3	SW	0	4	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	3	2	SW	0	3	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	4	4	NE	0	1	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	5	4	NE	0	2	2	2	0	0
10/06/2019	A	SMR	12:00	18:30	6	4	NE	0	5	2	2	0	0
10/06/2019	B	ER	12:30	19:00	1	1	SW	0	5	2	2	0	0
10/06/2019	B	ER	12:30	19:00	2	3	SW	0	5	2	2	0	0
10/06/2019	B	ER	12:30	19:00	3	3	SW	0	3	2	2	0	0
10/06/2019	B	ER	12:30	19:00	4	3	NE	0	2	2	2	0	0
10/06/2019	B	ER	12:30	19:00	5	3	NE	0	4	2	2	0	0
10/06/2019	B	ER	12:30	19:00	6	3	NE	0	4	2	2	0	0
11/06/2019	D	SMR	05:00	11:30	1	0	N/A	0	2	2	2	0	0
11/06/2019	D	SMR	05:00	11:30	2	1	NE	0	3	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
11/06/2019	D	SMR	05:00	11:30	3	3	NE	0	4	2	2	0	0
11/06/2019	D	SMR	05:00	11:30	4	4	NW	0	6	2	2	0	0
11/06/2019	D	SMR	05:00	11:30	5	4	NW	0	7	2	2	0	0
11/06/2019	D	SMR	05:00	11:30	6	5	NW	0	7	2	2	0	0
11/06/2019	E	ER	05:10	11:40	1	2	NE	0	2	2	2	0	0
11/06/2019	E	ER	05:10	11:40	2	3	NE	0	4	2	2	0	0
11/06/2019	E	ER	05:10	11:40	3	4	NE	0	5	2	2	0	0
11/06/2019	E	ER	05:10	11:40	4	5	NE	0	7	2	2	0	0
11/06/2019	E	ER	05:10	11:40	5	5	NE	0	7	2	2	0	0
11/06/2019	E	ER	05:10	11:40	6	5	NE	0	7	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	1	2	SW	0	8	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	2	2	SW	0	8	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	3	3	SW	0	7	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	4	2	SW	0	6	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	5	2	SW	0	6	2	2	0	0
18/06/2019	C	SMR	09:30	16:00	6	2	SW	0	7	2	2	0	0
01/07/2019	D	SMR	10:45	17:15	1	4	NW	1	8	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
01/07/2019	D	SMR	10:45	17:15	2	4	NW	0	8	2	2	0	0
01/07/2019	D	SMR	10:45	17:15	3	4	NW	0	6	2	2	0	0
01/07/2019	D	SMR	10:45	17:15	4	4	NW	0	8	2	2	0	0
01/07/2019	D	SMR	10:45	17:15	5	3	NW	0	7	2	2	0	0
01/07/2019	D	SMR	10:45	17:15	6	3	NW	0	7	2	2	0	0
01/07/2019	E	ER	11:05	17:35	1	4	NW	0	8	2	2	0	0
01/07/2019	E	ER	11:05	17:35	2	3	NW	0	7	2	2	0	0
01/07/2019	E	ER	11:05	17:35	3	2	NW	0	7	2	2	0	0
01/07/2019	E	ER	11:05	17:35	4	2	NW	0	5	2	2	0	0
01/07/2019	E	ER	11:05	17:35	5	3	NW	0	5	2	2	0	0
01/07/2019	E	ER	11:05	17:35	6	3	NW	0	4	2	2	0	0
02/07/2019	A	SMR	05:10	11:40	1	1	NW	1	8	1	1	0	0
02/07/2019	A	SMR	05:10	11:40	2	1	NW	0	8	2	2	0	0
02/07/2019	A	SMR	05:10	11:40	3	1	NW	0	6	2	2	0	0
02/07/2019	A	SMR	05:10	11:40	4	2	NW	0	7	2	2	0	0
02/07/2019	A	SMR	05:10	11:40	5	3	NW	0	6	2	2	0	0
02/07/2019	A	SMR	05:10	11:40	6	3	NW	0	6	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
02/07/2019	B	ER	04:50	11:20	1	1	NW	0	8	1	1	0	0
02/07/2019	B	ER	04:50	11:20	2	2	NW	0	8	2	2	0	0
02/07/2019	B	ER	04:50	11:20	3	3	NW	0	5	2	2	0	0
02/07/2019	B	ER	04:50	11:20	4	3	NW	0	4	2	2	0	0
02/07/2019	B	ER	04:50	11:20	5	3	NW	0	5	2	2	0	0
02/07/2019	B	ER	04:50	11:20	6	3	NW	0	5	2	2	0	0
29/07/2019	C	SMR	11:00	17:30	1	3	SW	2	8	1	1	0	0
29/07/2019	C	SMR	11:00	17:30	2	3	SW	2	8	1	1	0	0
29/07/2019	C	SMR	11:00	17:30	3	2	SW	2	8	1	1	0	0
29/07/2019	C	SMR	11:00	17:30	4	3	SW	1	8	1	1	0	0
29/07/2019	C	SMR	11:00	17:30	5	3	SW	1	8	2	2	0	0
29/07/2019	C	SMR	11:00	17:30	6	2	SW	3	8	1	1	0	0
05/08/2019	D	SMR	08:00	14:30	1	4	SW	0	5	2	2	0	0
05/08/2019	D	SMR	08:00	14:30	2	4	SW	0	5	2	2	0	0
05/08/2019	D	SMR	08:00	14:30	3	3	SW	0	4	2	2	0	0
05/08/2019	D	SMR	08:00	14:30	4	3	SW	0	3	2	2	0	0
05/08/2019	D	SMR	08:00	14:30	5	4	SW	0	5	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
05/08/2019	D	SMR	08:00	14:30	6	5	SW	0	5	2	2	0	0
05/08/2019	E	ER	08:20	14:50	1	4	SW	0	4	2	2	0	0
05/08/2019	E	ER	08:20	14:50	2	3	SW	0	4	2	2	0	0
05/08/2019	E	ER	08:20	14:50	3	3	SW	0	3	2	2	0	0
05/08/2019	E	ER	08:20	14:50	4	3	SW	0	3	2	2	0	0
05/08/2019	E	ER	08:20	14:50	5	4	SW	0	4	2	2	0	0
05/08/2019	E	ER	08:20	14:50	6	4	SW	0	4	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	1	3	S	1	6	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	2	4	S	0	7	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	3	3	SSE	3	7	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	4	2	SE	2	8	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	5	2	SE	4	8	2	2	0	0
22/08/2019	C	SMR	08:45	15:15	6	2	SE	4	8	1	1	0	0
26/08/2019	A	ER	07:35	14:05	1	2	SW	0	6	2	2	0	0
26/08/2019	A	ER	07:35	14:05	2	2	SW	0	6	2	2	0	0
26/08/2019	A	ER	07:35	14:05	3	2	SW	0	6	2	2	0	0
26/08/2019	A	ER	07:35	14:05	4	3	SW	0	4	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
26/08/2019	A	ER	07:35	14:05	5	3	SW	0	4	2	2	0	0
26/08/2019	A	ER	07:35	14:05	6	3	SW	0	6	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	1	1	S	0	5	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	2	1	S	0	4	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	3	1	SW	0	4	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	4	2	SW	0	4	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	5	3	SW	0	6	2	2	0	0
26/08/2019	B	SMR	08:10	14:40	6	4	SW	0	6	2	2	0	0
23/09/2019	D	ED	14:00	17:00	1	3	SE	0	4	2	2	0	0
23/09/2019	D	ED	14:00	17:00	2	3	SE	0	5	2	2	0	0
23/09/2019	D	ED	14:00	17:00	3	3	SE	1	3	1	2	0	0
23/09/2019	E	ED	10:50	13:50	1	3	SE	0	6	2	2	0	0
23/09/2019	E	ED	10:50	13:50	2	4	SE	1	5	2	2	0	0
23/09/2019	E	ED	10:50	13:50	3	3	SE	0	4	2	2	0	0
24/09/2029	C	ED	10:20	13:20	1	2	ESE	0	6	1	2	0	0
24/09/2029	C	ED	10:20	13:20	2	2	ESE	1	6	1	2	0	0
24/09/2029	C	ED	10:20	13:20	3	3	ESE	0	7	1	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
23/09/2019	C	WS	14:00	17:00	1	3	SE	0	7	2	2	0	0
23/09/2019	C	WS	14:00	17:00	2	4	SE	0	8	2	2	0	0
23/09/2019	C	WS	14:00	17:00	3	3	SE	0	8	2	2	0	0
24/09/2019	A	ED	14:05	17:05	1	1	ESE	0	8	2	2	0	0
24/09/2019	A	ED	14:05	17:05	2	0	*	0	8	2	2	0	0
24/09/2019	A	ED	14:05	17:05	3	0	*	1	8	2	2	0	0
24/09/2019	D	WS	14:00	17:00	1	1	SE	0	8	1	2	0	0
24/09/2019	D	WS	14:00	17:00	2	2	SE	0	8	1	2	0	0
24/09/2019	D	WS	14:00	17:00	3	2	SE	1	8	1	2	0	0
24/09/2019	E	WS	09:45	12:45	1	2	SSE	1	7	1	2	0	0
24/09/2019	E	WS	09:45	12:45	2	3	SE	0	7	1	2	0	0
24/09/2019	E	WS	09:45	12:45	3	1	ESE	0	7	1	2	0	0
25/09/2019	A	WS	09:00	12:00	1	1	ESE	1	8	0	0	0	0
25/09/2019	A	WS	09:00	12:00	2	2	SE	2	8	0	1	0	0
25/09/2019	A	WS	09:00	12:00	3	2	SE	1	8	0	1	0	0
25/09/2019	B	ED	09:10	12:10	1	0	N/A	1	8	0	0	0	0
25/09/2019	B	ED	09:10	12:10	2	1	N/A	1	8	0	0	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
25/09/2019	B	ED	09:10	12:10	3	2	N/A	1	8	0	0	0	0
23/09/2019	B	WS	10:00	13:00	1	1	SE	0	6	2	2	0	0
23/09/2019	B	WS	10:00	13:00	2	2	ESE	0	5	2	2	0	0
23/09/2019	B	WS	10:00	13:00	3	1	SSE	0	4	2	2	0	0
22/10/2019	B	ED	10:30	13:30	1	1	ESE	0	8	2	2	0	0
22/10/2019	B	ED	10:30	13:30	2	2	ESE	0	8	2	2	0	0
22/10/2019	B	ED	10:30	13:30	3	2	ESE	0	8	2	2	0	0
22/10/2019	E	DM	10:30	13:30	1	1	SSW	0	7	2	2	0	0
22/10/2019	E	DM	10:30	13:30	2	2	SSW	0	8	2	2	0	0
22/10/2019	E	DM	10:30	13:30	3	2	SSW	0	8	2	2	0	0
22/10/2019	C	ED	14:15	17:15	1	4	SW	0	7	2	2	0	0
22/10/2019	C	ED	14:15	17:15	2	4	SW	0	6	2	2	0	0
22/10/2019	C	ED	14:15	17:15	3	2	SW	0	6	2	2	0	0
22/10/2019	D	DM	14:20	17:20	1	4	SW	0	8	2	2	0	0
22/10/2019	D	DM	14:20	17:20	2	4	SW	0	7	2	2	0	0
22/10/2019	D	DM	14:20	17:20	3	3	SW	0	6	2	2	0	0
23/10/2019	A	DM	09:00	12:00	1	6	S	0	7	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
23/10/2019	A	DM	09:00	12:00	2	6	S	0	7	2	2	0	0
23/10/2019	A	DM	09:00	12:00	3	5	S	0	7	2	2	0	0
23/10/2019	E	ED	09:15	12:15	1	5	S	0	7	2	2	0	0
23/10/2019	E	ED	09:15	12:15	2	4	S	1	7	2	2	0	0
23/10/2019	E	ED	09:15	12:15	3	4	S	2	6	2	2	0	0
23/10/2019	C	DM	12:45	15:45	1	5	S	0	6	0	0	0	0
23/10/2019	C	DM	12:45	15:45	2	6	S	1	6	0	0	0	0
23/10/2019	C	DM	12:45	15:45	3	7	S	2	7	0	0	0	0
23/10/2019	D	ED	13:00	16:00	1	5	S	0	6	2	2	0	0
23/10/2019	D	ED	13:00	16:00	2	5	S	0	6	2	2	0	0
23/10/2019	D	ED	13:00	16:00	3	4	S	1	8	2	2	0	0
24/10/2019	A	ED	09:10	12:10	1	5	S	0	4	2	2	0	0
24/10/2019	A	ED	09:10	12:10	2	5	S	0	6	2	2	0	0
24/10/2019	A	ED	09:10	12:10	3	5	S	1	8	2	2	0	0
24/10/2019	B	DM	09:30	12:30	1	2	NW	1	7	1	2	0	0
24/10/2019	B	DM	09:30	12:30	2	1	NW	0	8	2	2	0	0
24/10/2019	B	DM	09:30	12:30	3	1	NW	0	7	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
26/11/2019	E	CL	09:00	12:00	1	4	NW	0	8	2	2	0	0
26/11/2019	E	CL	09:00	12:00	2	5	NW	0	8	2	2	0	0
26/11/2019	E	CL	09:00	12:00	3	4	NW	2	8	2	2	0	0
26/11/2019	B	ED	09:00	12:00	1	1	NE	0	8	2	2	0	0
26/11/2019	B	ED	09:00	12:00	2	2	NE	2	8	2	2	0	0
26/11/2019	B	ED	09:00	12:00	3	4	N	3	8	2	2	0	0
26/11/2019	D	CL	13:00	16:00	1	5	E	2	8	1	2	0	0
26/11/2019	D	CL	13:00	16:00	2	6	E	3	8	1	2	0	0
26/11/2019	D	CL	13:00	16:00	3	7	E	0	6	1	2	0	0
26/11/2019	C	ED	13:00	16:00	1	4	SE	2	8	2	2	0	0
26/11/2019	C	ED	13:00	16:00	2	6	SE	3	8	2	2	0	0
26/11/2019	C	ED	13:00	16:00	3	5	SE	1	7	2	2	0	0
27/11/2019	A	CL	09:00	12:00	1	0	N/A	0	1	2	2	0	0
27/11/2019	A	CL	09:00	12:00	2	0	N/A	0	1	2	2	0	0
27/11/2019	A	CL	09:00	12:00	3	0	N/A	0	1	2	2	0	0
27/11/2019	E	ED	09:00	12:00	1	1	NE	0	1	2	2	0	0
27/11/2019	E	ED	09:00	12:00	2	0	N/A	0	0	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
27/11/2019	E	ED	09:00	12:00	3	0	N/A	0	0	2	2	0	0
27/11/2019	C	CL	13:00	16:00	1	0	N/A	0	8	0	0	0	0
27/11/2019	C	CL	13:00	16:00	2	0	N/A	0	8	0	0	0	0
27/11/2019	C	CL	13:00	16:00	3	0	N/A	0	8	0	0	0	0
27/11/2019	D	ED	13:15	16:15	1	2	S	1	8	1	0	0	0
27/11/2019	D	ED	13:15	16:15	2	1	S	1	8	0	1	0	0
27/11/2019	D	ED	13:15	16:15	3	0	N/A	1	8	0	1	0	0
28/11/2019	A	ED	09:30	12:30	1	0	N/A	0	2	2	2	0	0
28/11/2019	A	ED	09:30	12:30	2	1	S	0	2	2	2	0	0
28/11/2019	A	ED	09:30	12:30	3	0	N/A	0	2	2	2	0	0
28/11/2019	B	CL	09:15	12:15	1	3	NE	0	7	2	2	0	0
28/11/2019	B	CL	09:15	12:15	2	3	NE	0	5	2	2	0	0
28/11/2019	B	CL	09:15	12:15	3	4	NE	0	2	2	2	0	0
18/12/2019	D	ED	08:15	15:00	1	4	SE	0	8	2	2	0	0
18/12/2019	D	ED	08:15	15:00	2	4	SE	0	8	2	2	0	0
18/12/2019	D	ED	08:15	15:00	3	4	SE	0	8	2	2	0	0
18/12/2019	D	ED	08:15	15:00	4	4	SE	1	8	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
18/12/2019	D	ED	08:15	15:00	5	8	SE	4	8	2	2	0	0
18/12/2019	D	ED	08:15	15:00	6	8	SE	4	8	2	2	0	0
18/12/2019	A	CL	08:45	15:15	1	4	SE	0	6	1	2	1	0
18/12/2019	A	CL	08:45	15:15	2	4	SE	0	2	2	2	1	0
18/12/2019	A	CL	08:45	15:15	3	4	SE	0	5	2	2	1	0
18/12/2019	A	CL	08:45	15:15	4	4	SE	1	8	1	2	1	0
18/12/2019	A	CL	08:45	15:15	5	8	SE	1	8	1	2	1	0
18/12/2019	A	CL	08:45	15:15	6	8	SE	2	8	2	1	0	0
19/12/2019	E	CL	09:00	15:30	1	4	E	0	8	2	2	0	0
19/12/2019	E	CL	09:00	15:30	2	6	E	1	8	2	2	0	0
19/12/2019	E	CL	09:00	15:30	3	4	E	2	7	2	2	0	0
19/12/2019	E	CL	09:00	15:30	4	4	E	3	6	2	2	0	0
19/12/2019	E	CL	09:00	15:30	5	5	E	4	6	2	2	0	0
19/12/2019	E	CL	09:00	15:30	6	5	E	5	6	2	2	0	0
19/12/2019	B	ED	09:00	15:30	1	2	E	1	7	2	2	0	0
19/12/2019	B	ED	09:00	15:30	2	3	E	0	8	2	2	0	0
19/12/2019	B	ED	09:00	15:30	3	4	E	0	8	2	2	0	0

Date	VP	Observer	Survey Start Time	Survey End Time	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Frost	Snow
19/12/2019	B	ED	09:00	15:30	4	1	E	0	8	2	2	0	0
19/12/2019	B	ED	09:00	15:30	5	1	E	0	8	2	2	0	0
19/12/2019	B	ED	09:00	15:30	6	1	ESE	0	8	2	2	0	0