wood.

AI#2 Appendix D1
SNH Clarifications Document

Technical note:
Stornoway Wind Farm Additional Information (AI) – Response to SNH request for Clarifications

1. Overview

The purpose of this document is to respond to a number of clarifications requested by SNH following submission of the Additional Information (AI) for the proposed Stornoway Wind Farm.

2. Lewis Peatlands Special Protection Area (SPA): Divers

2.1 Introduction

2.1.1 SNH identified that the assessment for red and black-throated divers did not separate impacts on the SPA populations from impacts on the populations in the wider environment.

2.2 Response

2.2.1 Following review of the AI submission, Wood can confirm the following:

Red-throated diver

- Collision risk modelling for the SPA population for both 2018 and 2019 breeding seasons was undertaken within AI Appendix 8F, Section 4.1. The approach was similar to that undertaken for the already Consented Stornoway Wind Farm in that the flight data from all diver nests monitored were assumed to be associated with the SPA population, even if the location was outside of the SPA boundary, and as such takes a clearly precautionary approach.
- Population modelling for the SPA population for both the 2018 and 2019 breeding season was undertaken within AI Appendix 8F, Section 4.2. It applies the predicted precautionary collision risk results produced in Section 4.1 and applies them to a population model that only considers the SPA population as the starting population.
- The precautionary results from the collision risk modelling on the SPA population was assessed in AI Appendix 8D, Table 3.2 where it was identified that the annual loss of 0.287% of the SPA breeding population would not result in a detectable effect on the SPA population, at which point the impact from collision was scoped out of any further EcIA assessment.
- A summary of the assessment for the SPA population of red-throated diver is presented in AI Chapter 8, Section 8.13.

- An HRA was undertaken for the SPA population of red-throated diver for both the 2018 and 2019 breeding season and was presented within AI Appendix 8G, Section 3.7.

Black-throated diver

- The level of flight activity recorded during focal watch surveys at specific black-throated diver breeding locations was not considered sufficient to provide an accurate result. Therefore, an assessment of collision risk for the SPA population was undertaken using the flight data collected from VP locations for both 2018 and 2019 breeding seasons, and this was undertaken within AI Appendix 8E.
- The flight line data for black-throated diver collected across the Proposed Development Site was all assumed to be associated with the SPA population, even though the locations of some black-throated diver nests that contributed to it were outside of the SPA boundary, and as such takes a clearly precautionary approach. The precautionary results from the collision risk modelling on the SPA population was assessed in AI Appendix 8D, Table 3.2 where it was identified that the annual loss of 0.246% of the SPA breeding population would not result in a detectable effect on the SPA population, at which point the impact from collision was scoped out of any further Ecology Impact Assessment (EcIA).
- A summary of the assessment for the SPA population of black-throated diver is presented in AI Chapter 8, Section 8.10.
- A Habitats Regulations Assessment (HRA) was undertaken for the SPA black-throated diver population for both the 2018 and 2019 breeding season and was presented within AI Appendix 8H, Section 3.2.

3. Hen harrier PVA parameters

3.1 Introduction

3.1.1 SNH required clarification regarding the average fledging rate for female hen harrier, stating that the identified rate of 0.47 was incorrect, and that the rate was actually lower at 0.39, thus leading to an over-estimation of the population trajectory in the modelled output.

3.2 Response

3.2.1 Following review of the AI submission, Wood can confirm the following:

3.2.2 A copy of the table from AI Appendix 8F from which the average fledging rate for female hen harrier is provided below (**Table 3.1**). Over the course of five years, a total of 17 breeding attempts (total pairs known to lay eggs) produced 16 fledged young (total of minimum number of young fledged). That produces an average fledging rate of 0.94 birds. Assuming that there is a 50/50 split between male and females, this produces an average fledging rate for females of 0.47.

3.2.3 It is assumed that SNH derived their average fledging rate for female hen harrier of 0.39 from the sum of Annual Productivity (both sexes) divided by 5 years. However, given that there was no data for 2017, the sum of Annual Productivity should be divided by four years, producing an average fledging rate of 0.48.

3.2.4 Therefore, it is considered that the female fledging rate of 0.47 used in the population modelling for hen harrier does not lead to an overestimation of the population trajectory in the modelled output.

Table 3.1 Cumulative Assessment: Western Isles hen harrier

	Pairs known to lay eggs	Minimum number of young fledged	Annual Productivity (both sexes)
2015	1	1	1
2016	4	2	0.5
2017	0	0	0
2018	5	9	1.8
2019	7	4	0.57

4. Lewis Peatlands SPA: golden eagle

4.1 Introduction

4.1.1 During the determination of the original Consented Stornoway Wind Farm, five turbine positions in the north-west of the application area were removed from the scheme following concerns raised by Comhairle nan Eilean Siar (CnES), Scottish Natural Heritage (SNH) and RSPB Scotland (RSPB). These turbines, known in the original application as T1, T5, T10, T11 and T15, were in an area that had been shown to be used by a breeding pair of golden eagles known as the Beinn Bharbhais pair, resulting in concerns that displacement effects and losses to collision may ensue should these locations be developed. The Bein Bharvas pair is known to have made nesting attempts in two locations, although they are thought to have failed to produce fledged young for a considerable period (over 20 years). This pair has shown signs of breeding regularly, although reaching the egg laying phase has been sporadic. One of these nesting locations is historic and has not been built up in many years (over 10 years); nothing now remains of the nest previously constructed at this location. The nearest nest location is approximately 3.9 km from the Proposed Development Site boundary. No breeding activity took place at this nest in 2017, 2018 or 2019.

4.1.2 These five turbines are now in an area where golden eagle activity has reduced due to the construction and operation of two wind farms, Pentland Road Wind Farm (six turbines to the north-west of the Stornoway Wind Farm) and the Beinn Ghrideag Wind Farm (three turbines to the west of the Stornoway Wind Farm).

4.1.3 Additionally, a further single turbine, T38 located in the extreme south-west of the application area was removed from the original application as it was in an area shown to be used by a breeding pair of golden eagles known as the Achmore pair. This pair is known to have made breeding attempts in three distinct areas; two of these locations have been used historically, whilst the final location was the site of a new nest built in 2015, that lies approximately 1,190m from the nearest turbine. A single chick was fledged successfully from this new nest location in 2016, whilst in 2017 the pair reverted to one of the original areas. There was no evidence of breeding from this pair in 2018, whilst in 2019, a single chick was reared at one of the historic locations, approximately 1.7km from the nearest turbine.

4.1.4 SNH have requested that further clarification is provided to support the Proposed Development that seeks to position a number of turbines back in these two areas. Specifically, turbines T24, T25, T26, T27, T28 and T32 to the north-west and T1 to the south-west (as illustrated on AI Figure 4.1).

4.2 Comparison of flight activity

4.2.1 In order to provide a direct comparison of flight activity recorded in 2009-10 with activity recorded in the period 2017-2019, study areas were created based on a 500m buffer of turbines T24, T25, T26, T27, T28 and T32 in the north-west and T1 in the south-west. All flights were clipped to this buffer and an assessment of flight activity by adults for each study area was carried out, the assumption being that adult activity would be associated with the adult birds from the two territories. **Figures 4.1 and 4.2** present the distribution of the clipped flights within each study area.

Table 4.1 Golden eagle flight activity

Study Area	Survey period	Total number of flights	Total number of adult flights	Total number of seconds – all flights	Total number of seconds – adult flights
South-west	2009-2010	3	3	153	153
	2017-2018	2	2	48	48
	2018-2019	4	1	234	81
North-west	2009-2010	83	21	9747	2347
	2017-2018	12	7	1213	463
	2018-2019	26	15	2699	1288

4.2.2 Within the south-west study area, adult flight activity levels remained low for all study periods, with a peak in 2009-2010 of three flights. By 2018-19, the number of adult flights had dropped to 33% of the 2009-2010 levels. The total number of seconds for adult flights in 2018-2019 accounted for 34% of all flights recorded during that survey period and had dropped to 50% of the 2009-2010 levels.

4.2.3 Within the north-west study area, **Figure 4.2** indicates that the spatial patterns of flight recorded in 2018-2019 had shifted since data was collected in 2009-2010, becoming more widely distributed within the study area. Adult flight activity levels peaked in 2009-10, with a total of 21 flights. The total number of seconds for adult flights also peaked in 2009-10, accounting for 24% of all flights recorded during that survey period. By 2018-19, the number of adult flights had dropped to 71% of the 2009-2010 levels. The total number of seconds for adult flights in 2018-2019 accounted for 47% of all flights recorded during that survey period and had dropped to 54% of the 2009-2010 levels.

4.3 Collision Risk Assessment

4.3.1 Collision risk was calculated annually for all adult birds recorded in flight within each study area using the same basic approach and parameters as that presented in the AI Appendix 8E. The 2009-2010 data were modelled against the turbine parameters presented within the Consented 2016 Stornoway Variation EIA, whilst the 2017-2018 and 2018-2019 data were modelled against the turbine parameters presented in AI Appendix 8E.

4.3.2 The study areas were considered to be the collision risk zones (CRZ) (the south-west study area for the Achmore pair, and the north-west study area for the Beinn Bharbhais pair). Only flights recorded from vantage point (VP) locations that overlapped with the CRZ were included, and the flight risk area (FRA) calculated for each VP was based on the area of each VP viewshed that was visible at 20m above ground level within the CRZ.

4.3.3 The south-west study area fell within the visible viewshed of three VP locations (VP5, VP6 and VP7) whilst the north-west study area fell within the visible viewshed of four VP locations (VP1, VP2, VP3 and VP4). **Table 4.2** presents data on flight data included in the modelling (i.e. flight time at Potential Collision Height (PCH)) – note that total flight time differs from that presented in **Table 4.1** as it excludes flight data within the CRZ recorded from VP locations whose viewsheds did not cover the CRZ. Full details of these flights are presented in **Appendix B**.

Table 4.2 Golden eagle: flight activity

Study Area	Survey Period	Total number of flights	Total seconds at PCH
South-west	2009-2010	2	98
	2017-2018	2	48
	2018-2019	1	81
North-west	2009-2010	12	588
	2017-2018	6	353
	2018-2019	9	860

Results

4.3.4 Results of the collision risk modelling are presented in Table 5.2. Collision risk calculations are presented in **Appendix B**.

Table 4.3 Golden eagle: predicted annual collision rates

Study Area	Survey Period	Predicted annual collision	Predicted annual collision as % of SPA population
South-west	2009-2010	0.002	0.02
	2017-2018	0.001	0.01
	2018-2019	0.002	0.02
North-west	2009-2010	0.015	0.15
	2017-2018	0.020	0.20
	2018-2019	0.047	0.47

4.4 Conclusion

South-west Study Area

4.4.1 Recoded flight activity across all three survey years was very low, and no real spatial pattern of flight distribution was evident. The number of adult flights in 2018-2019 dropped to 33% of those recorded in 2009-2010, and the total amount of recorded adult flight seconds had dropped by 50%.

4.4.2 Collision risk modelling indicated that predicted collisions were very low for all three years included in the modelling and was not significant in terms of impacts on the golden eagle Lewis Peatlands SPA population (5 pairs).

North-west Study Area

4.4.3 There is some evidence that the presence of the Pentland Road wind farm has had an influence on the spatial distribution of flight activity in the north-west study area. In 2009-2010, before the Pentland Road turbines had been constructed, the pattern indicated an intensive focus in the area around Beinn Hulabaidh. Flight data recorded in 2017-2018 and 2018-2019 would indicate that Beinn Hulabaidh had ceased to be a focus of activity for adult golden eagle. The number of flights in 2018-2019 dropped to 71% of those recorded in 2009-2010 and were more widely distributed across the study area, and the total amount of recorded adult flight seconds had dropped by 54%.

4.4.4 Collision risk modelling indicated that predicted collisions were very low for all three years included in the modelling and was not significant in terms of impacts on the golden eagle Lewis Peatlands SPA population (5 pairs).

5. Breeding Bird Protection Plan

5.1.1 See separate document

6. Herring gull: Collision Risk Assessment

6.1 Introduction

Background

6.1.1 SNH requested that an assessment of collision risk be undertaken, given that data provided from breeding season surveys in 2018 (EIA Appendix 8C) and 2019 (AI Appendix 8B) indicates that the survey area supports up to 615 territories. Based on the data provided the survey area supports approximately 49% of the Natural Heritage Zone regional breeding population and the survey area is considered to be of regional importance for this species.

6.1.2 Herring gull breed in loose colonies, and the distribution of the colonies recorded within the survey area in 2018 and 2019 are shown in Figure 8C.4.1h (EIA Appendix 8C) and Figure 8B.3.9 (AI Appendix 8B) (attached in **Appendix A** of this Technical Note). Numbers of apparently occupied nests (AON) were estimated at 210 in 2018 and 615 in 2019.

6.1.3 In addition, numbers were observed roosting and loafing in locations to the north and east of the Bennadrove Landfill and Civic Amenity Site, Loch Leadharain (NB 387 933) and Loch Airigh na Lic

(NB 401 341) whilst the species contributed to a maximum mixed herring / great black-backed gull count of c.500 individuals recorded utilising the area and c.750 individuals were recorded roosting on roof tops at the Creed Industrial Park just outside of the south-eastern Site boundary.

Approach to Collision Risk Modelling

6.1.4 The risk of herring gull colliding with the turbine rotors has been assessed based upon a model developed by Band, which estimates the number of bird collisions with the turbine rotors during a specified time period (Band et al. 2007; SNH 2000).

6.1.5 The 'Band model' uses a two-stage approach, whereby the number of birds or flights passing through the air space swept by the rotors is determined at Stage 1 and the probability of a bird strike occurring is calculated at Stage 2. The product of Stage 1 and Stage 2 gives a theoretical annual collision mortality rate on the assumption that birds make no attempt to avoid collision.

6.1.6 The model requires input data based on species biometrics and flight characteristics, turbine specification and data on flights observed at the Site. However, no data on flight activity for herring gull was collected during the 2018 and 2019 breeding seasons. Instead, an alternative theoretical approach is taken, based on activity budgets and natural history of herring gull, which permits an assessment of likely collision numbers where empirical flight activity data is missing.

6.2 Choice of Model

6.2.1 Although the second stage is identical for both methods, the Stage 1 calculation of the Band Model varies depending on whether flight activity follows a regular predictable pattern or is random. Given that there is no flight data available for herring gull within the study area, the modelling method for birds with predictable (Regular) flight activity was chosen. This is suitable for central place foragers[1] such as herring gull, where flights follow a regular pattern, travelling from breeding locations to feed elsewhere[2] and returning to the nest with food resources to provision nest-mates and chicks. This approach requires the calculation of the number of birds flying through the turbine rotor swept area each year or season.

6.3 Model Parameters

Turbines

6.3.1 Turbine parameters included in the model are the same as those presented in AI Appendix 8E.

Estimating the Number of Flights at Potential Collision Height

6.3.2 In order to calculate the number of herring gull flying through the turbine rotor swept area each breeding season, the following steps were undertaken.

[1] Animals that carry resources back to a particular site are called central place foragers (CPFs), and they generally have a nest to which they bring resources. Central place foragers differ from the rest in that their activities include an outbound journey, a period of searching, and then a return journey.

[2] Herring gull are opportunistic feeders, foraging primarily in intertidal habitats, refuse dumps and ploughed fields, although foraging birds are increasingly found in urban coastal environments. A few birds will forage on breeding colonies by taking eggs and young of conspecifics and other seabirds.

Step1: Calculating the Number of Individuals at Risk

6.3.3 Firstly, an assessment was made on the number of AON (and hence individuals) that were likely to be at risk of collision based on their distribution was undertaken. In both 2018 and 2019, a colony was located at the edge of the 500m site boundary buffer in the south-east. The nearest proposed turbine location is approximately 1km north west of the colony, and it is considered that there would be no risk of potential collision to members of this breeding colony. Therefore, the numbers of AON located in this colony were not included in the modelling (40 AON in 2018 and 235 AON in 2019). The remaining colonies were all located within the central part of the Proposed Development and it is considered that individuals associated with these colonies would be at risk of potential collision. Hence, the numbers of AON (and individuals) at risk of potential collision in 2018 and 2019 were 170 (340 individuals) and 380 (760 individuals) respectively.

Step 2: Calculating the Number of Flights per Day

6.3.4 In order to provide an estimate of the number of flights likely to take place, a review of time activity budgets during the breeding season was undertaken.

6.3.5 Although both male and female share parental duties during incubation, the female spends more time incubating than the male does and also incubating at night. The male spends more time away from the nest, procuring food for the female, typically leaving to forage before dawn, returning by mid-morning, when female leaves to forage and the male takes over parental duties at the nest. The female then generally returns by early to mid-afternoon when the male leaves on his second foraging trip. Males return in late afternoon, allowing the female a final foraging trip before taking over incubation duties overnight. The male generally sleeps next to the incubating/brooding female (Pierotti & Good, 1994[3]).

6.3.6 This pattern is similar during the chick-rearing; male and female are present similar amounts of time, except in habitats where great black-backed gulls nest, where males may spend more time present guarding chicks from attacks (Pierotti, 1987[4]).

6.3.7 In summary this pattern indicates that both male and female birds make two outgoing and two incoming flights to the nest location each day. As a precautionary measure an additional incoming and outgoing flight was attributed to each individual to take account of local movements to loafing/preening sites away from the colony, bringing the total number of flights per day per individual to six.

Step 3: Calculating the Number of Days Active

6.3.8 The herring gull breeding season commences in spring, with pairing during April and laying eggs by mid-May. Incubation lasts around 30 days and chicks are fully fledged after a further 40-50 days. Fledged chicks remain on the nesting territory and are fed by the parent birds until 12-15 weeks of age. Overall, the number of days active on site was assumed to cover 154 days.

Step 4: Calculating the % of Flights at Potential Collision Risk Height

6.3.9 In order to provide an estimate of the percentage of flights occurring at potential collision height (PCH), a review of published flight height data collected during the breeding season was undertaken.

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[3] Pierotti, R. }., and T. P. Good. 1994. Herring Gull (Lams argentatus). In The Birds of North America, No. 124 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
[4] Pierotti, R. 1987. Behavioral consequences of habitat selection in the Herring Gull. Stud. Avian Biol. 10: 119-128.

6.3.10 Previous studies have estimated mean flight heights for herring gulls at 33m although there is wide variation between 1m-300m (Walls et al. 2004[5]; Parnell et al. 2005[6]; Sadoti et al. 2005[7]). Data from boat-based surveys indicated that approximately 32% of herring gull flights occurred between 30-150m (Johnston et al, 2014[8]). Cook et al (2012[9]) undertook a review of current literature to identify the mean proportion of birds predicted to fly at a generic risk window (20-150m above sea-level) for off-shore wind farms, and based on data collected during boat-based surveys at a number of off-shore sites, approximately 28% of herring gull flights were within potential collision height.

6.3.11 It should be noted that these height ranges were all recorded off-shore, and it has been recognised that it is inappropriate to use flight height distributions for gulls observed at sea in relation to flight over land as gulls tend to fly much lower over the sea than they do over land (Corman & Garthe, 2014[10]).

6.3.12 A review of flight height datasets by Thaxter *et al*[11] (2015) included data collected from a breeding colony of herring and lesser black-backed gulls fitted with GPS PTT tags (able to record location, height, heading and speed) by Ens *et al* [12](2008) that indicated that approximately 10% of gull flights occurred at 25m or above.

6.3.13 Corman and Garthe (2014) studied flight height distribution at two lesser black-backed gull breeding colonies during the breeding season using GPS PTT tags, and although a different species provides further insight. Overall, and similar to the findings of Eans *et al,* 89% of all flights were recorded below 20m, albeit flights over land were recorded at a higher level than those over sea (10-40m overland compared to -1-8m at sea). There was no difference in the heights of inbound and out-bound flights to the breeding colonies, but flight height increased with increasing distance from the nest.

6.3.14 Based on the proposed turbines, the PCH for the Proposed Development is between the range 20-180m. Given the wide range of values within the literature reviewed, it was considered appropriate to run several iterations of the model using a range of percentage values for flights at PCH:

- 10% of all flights at PCH to reflect data collected by GPS PTT data from breeding colonies;
- 30% of all flights at PCH to reflect data collected from boat-based surveys; and

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[5] Walls, R.J., Brown, M. B., Budgey, R., Parnell, M. & Thorpe, L. 2004. The remote monitoring of offshore avian movement using bird detection radar at Skegness, Lincolnshire. Central Science Laboratory, York, UK.
[6] Parnell, M., Walls, R. J., Brown, M. D. & Brown, S. 2005. The remote monitoring of offshore avian movement using bird detection radar at Weybourne, North Norfolk. Central Science Laboratory, York, UK.
[7] Sadoti, G., Allison, T., Perkins, S. & Jones, A. 2005. A survey of tern activity within Nantucket sound, Massachusetts, during the 2004 breeding period. Final Report for Massachusetts Technology Collaborative. Massachusetts Audubon Society, Lincoln, MA, USA.
[8] Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M. & Burton, N.H.K. 2014. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51: 1126-1130. doi:10.1111/1365-2664.12191
[9] Cook, A.S.C.P., Johnston, A. Wright, L.J. & Burton, N.H.K. 2012. A review of flight heights and avoidance rates of birds in relation to offshore wind farms. British Trust for Ornithology.
[10] Corman, A.M. & Garthe, S. 2014. What flight heights tell us about foraging and potential conflicts with wind farms: a case study in lesser black-backed gulls (Larus fuscus). Journal of Ornithology, 155, 1037-1043.
[11] Thaxter, C.B., Ross-Smith, V.H. & Cook, A.S.C.P. 2015. How high do birds fly? A review of current datasets and an appraisal of current methodologies for collecting flight height data. British Trust for Ornithology.
[12] Ens B.J., Bairlein F., Camphuysen C.J., Boer P. de, Exo K.-M., Gallego N., Hoye B., Klaassen R., Oosterbeek K., Shamoun-Baranes J., Jeugd H. van der & Gasteren H. van 2008. Tracking of individual birds. Report on WP 3230 (bird tracking sensor characterization) and WP 4130 (sensor adaptation and calibration for bird tracking system) of the FlySafe basic activities project. SOVON-onderzoeksrapport 2008/10. SOVON Vogelonderzoek Nederland, Beek-Ubbergen.

- 60%, 80% and 100% of all flights at PCH to present a range of precautionary values over and above those highlighted above.

Bird Parameters

6.3.15 **Table 6.1** presents the bird parameters used for herring gull in the model, which are based on those in Cook *et al* [13](2014). Avoidance rates were taken from current guidance (Furness, 2019[14]).

Table 6.1 Herring gull parameters

Species	Avoidance Rate %	Length (m)	Wing Span (m)	Flight Speed (m/s)	Flight Style
Herring gull	99.5	0.6	1.4	12.8	Flapping

Defining the Risk Window

6.3.16 This is defined as 'a window of width equal to the width of the wind farm perpendicular to the general flight direction of the birds' (SNH, 2000[15]). Although there is no flight activity data to help inform the extent or position of the risk window, it has been assumed that the predominant direction of flight for those colonies included in the modelling would be in a geographical spectrum covering the north east, east, southwest and south (**Figure 6.1a and b**).

6.3.17 The length of the risk window also allows for a 50m micro-siting allowance plus an additional 75m either side to allow for the radius of the rotor blade.

6.3.18 For the Proposed Development, the risk window for herring gull is 4,920m covering nine turbines. For the consented development, the length is 5,490m covering 11 turbines.

6.4 Results

6.4.1 Results of the collision risk modelling are presented in **Table 6.2**. An example of the collision risk calculations is presented in **Appendix C** (10% of flights at PCH Year 1).

[13] Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. & Burton, N.H.K. 2014. The avoidance rates of collision between birds and offshore turbines. British Trust for Ornithology.
[14] Furness, R.W. 2019. Avoidance rates of herring gull, great black-backed gull and common gull for use in the assessment of terrestrial wind farms in Scotland. Scottish Natural Heritage Research Report No. 1019.
[15] Scottish Natural Heritage. 2000. Windfarms and Birds: Calculating a theoretical collision risk assuming no avoiding action. SNH Guidance Note. Scottish Natural Heritage.

Table 6.2 Herring gull: predicted collision rates during the breeding season

% of flights at PCH within risk window	Proposed Development			Predicted annual collision as % of NHZ population	Consented Development			Predicted annual collision as % of NHZ population
	Year 1	Year 2	Combined average		Year 1	Year 2	Combined average	
10%	1.77	3.63	**2.7**	0.11	1.71	3.52	**2.61**	0.10
30%	5.31	11.89	**8.1**	0.32	5.13	10.55	**7.84**	0.31
60%	10.61	21.79	**16.2**	0.65	10.27	21.09	**15.68**	0.63
80%	14.15	29.01	**21.6**	0.86	13.69	28.12	**20.91**	0.84
100%	17.68	36.32	**27.0**	1.08	17.11	35.15	**26.13**	1.04

6.5 Conclusion

6.5.1 The average annual predicted collision rates for the Proposed and Consented Development models based on 10% and 30% of flights at PCH both fall below 0.5% of the NHZ population and it is considered that there would be no detectable effect on the NHZ population.

6.5.2 The average annual predicted collision rates for two of the three precautionary models, 30% and 80% of flights at PCH fall above 0.5% but still below a 1% threshold[16] of the NHZ population, and it also considered that there would be no detectable effect on the NHZ population.

6.5.3 Only at an assumed 100% of flights falling within PCH does the annual predicted collision rate fall above 1%, and it is considered extremely unlikely that such a situation would occur.

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[16] There is no fundamental biological reason to take 1% of a population as the threshold level for evaluating the level of impact on a population. Nevertheless, this percentage is widely considered to be of value in developing measures that give an appropriate level of protection to populations and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention 1971. Thereafter, the 1% level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud, Mudge & Pienkowski, 1990).

Appendix A Figures

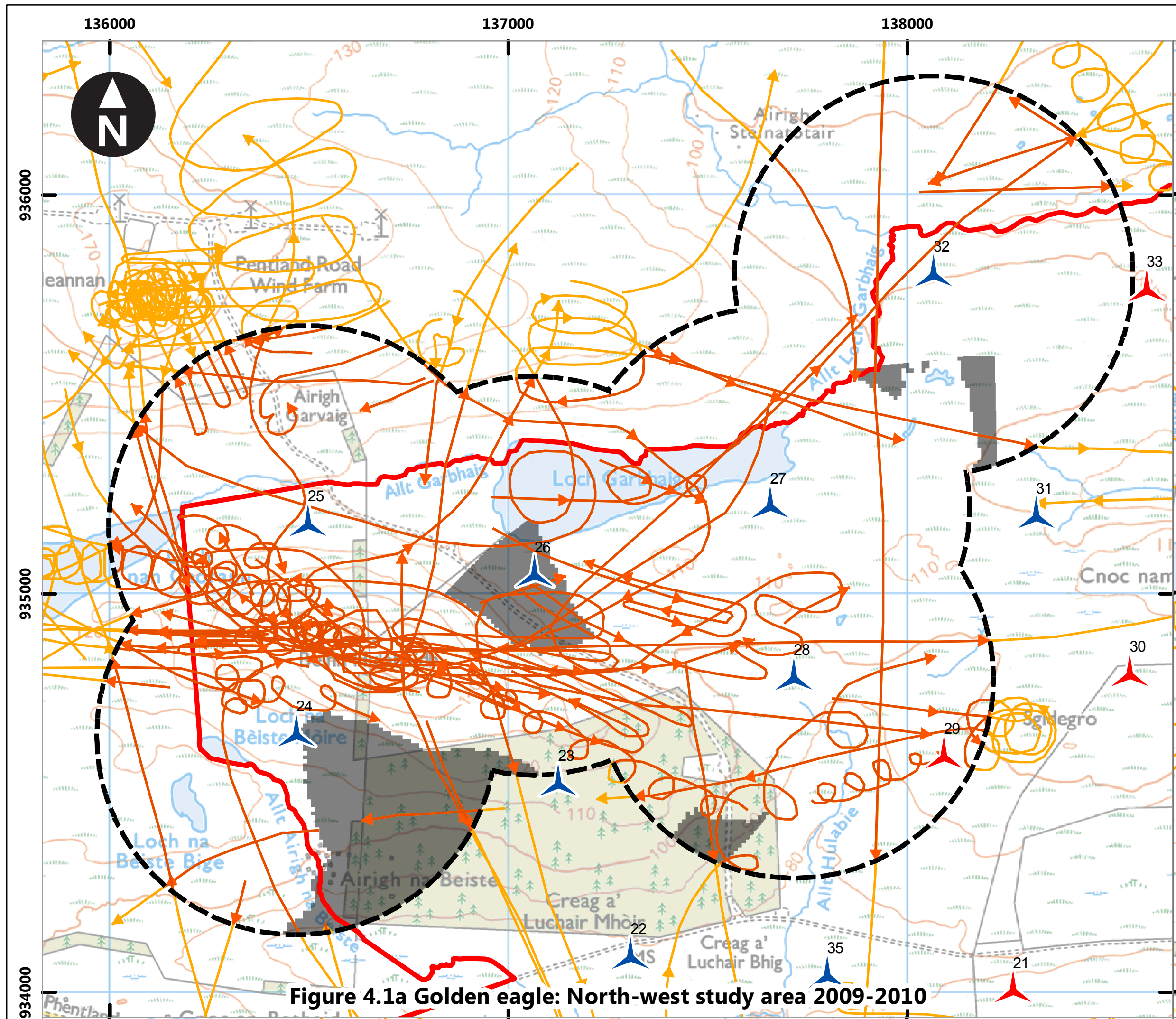

Figure 4.1a Golden eagle: North-west study area 2009-2010

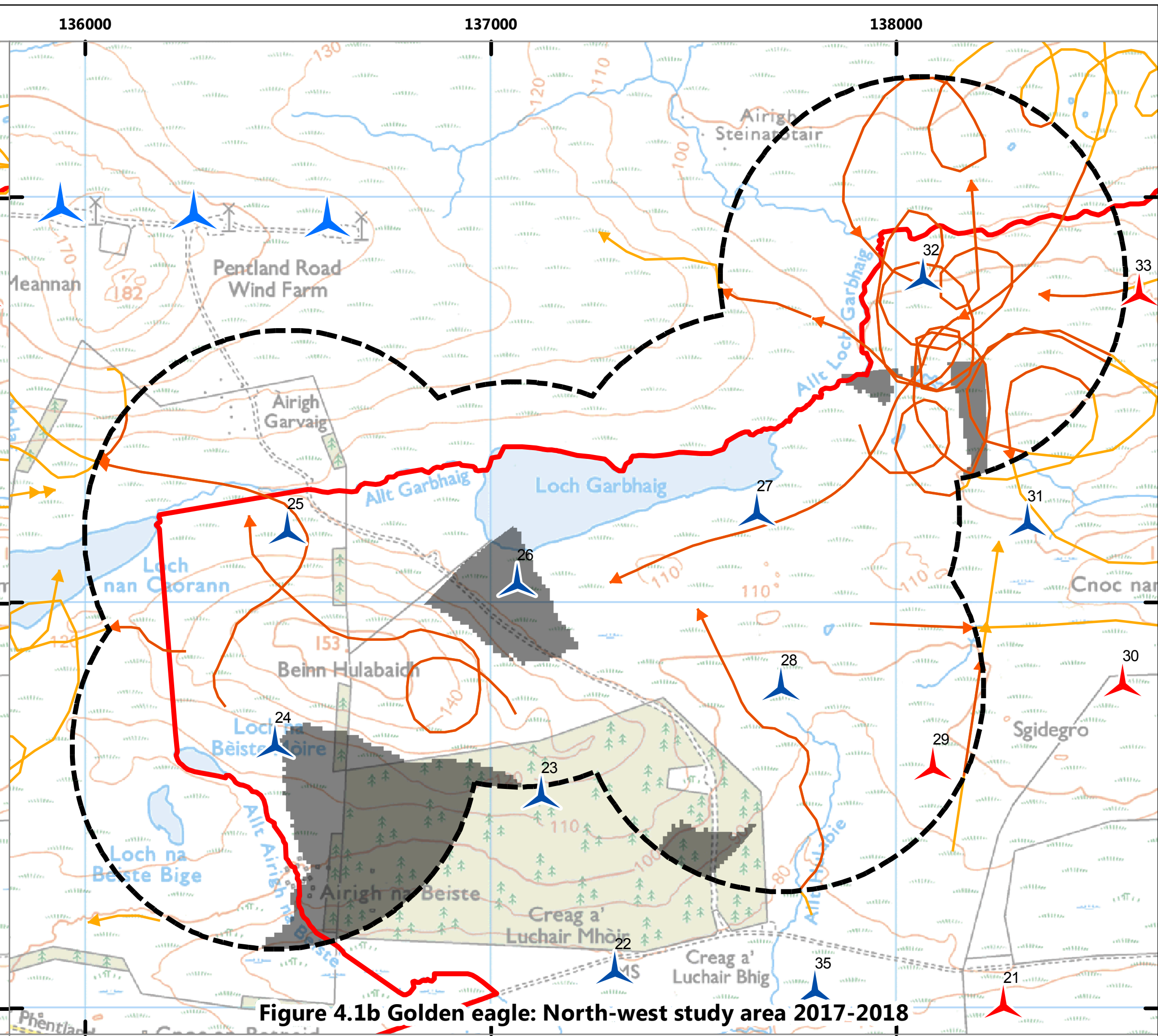

Figure 4.1b Golden eagle: North-west study area 2017-2018

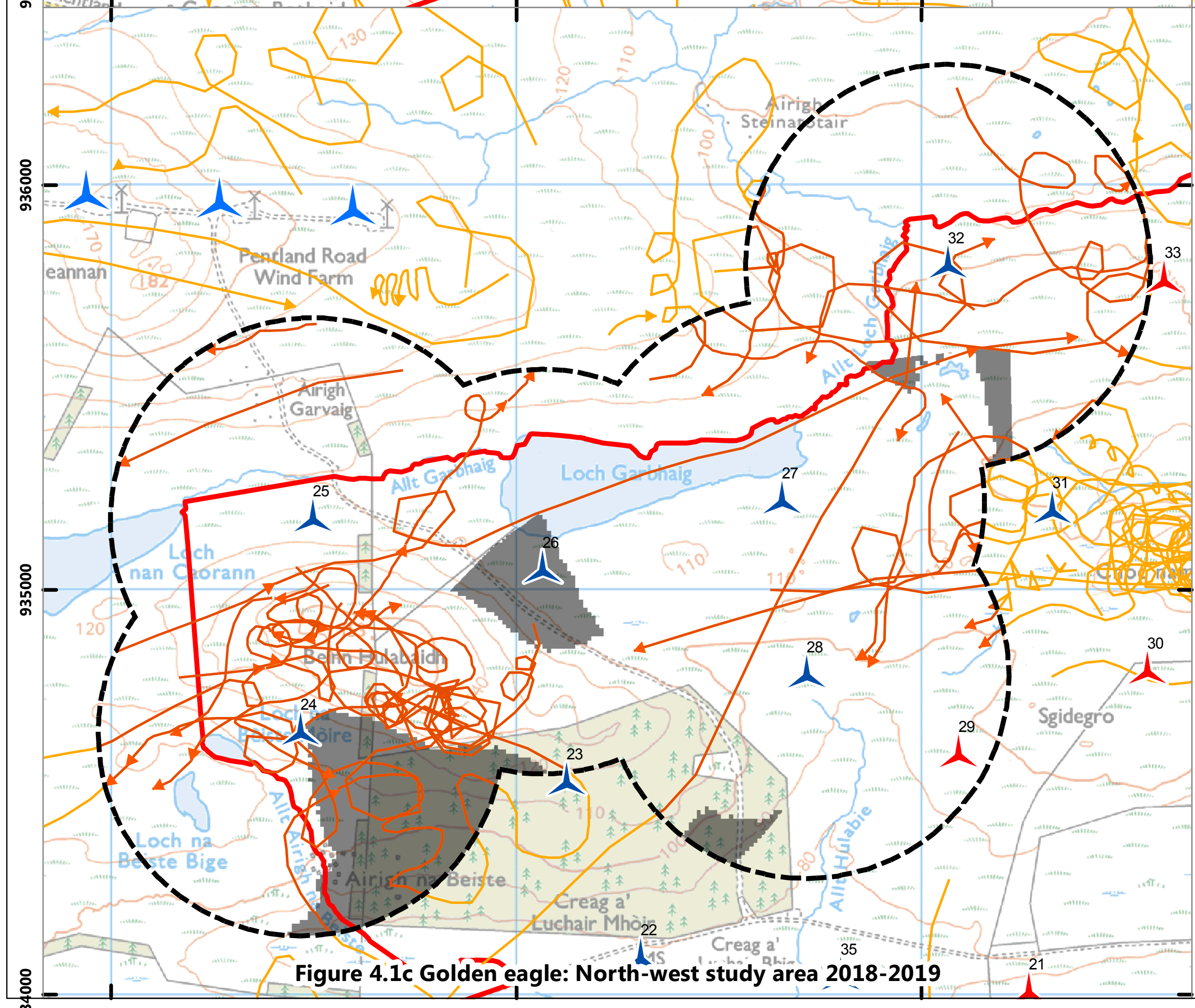

Figure 4.1c Golden eagle: North-west study area 2018-2019

Key

- Development site boundary
- Wind turbine 180m to blade tip
- Wind turbine 156m to blade tip
- Beinn Grideag wind turbine
- Pentland road wind turbine
- Study area
- Area of viewshed not visible at 20m
- Clipped flights within study area
- All flights

0 250 500 750 1,000 m

Scale at A3: 1:18,000

Client

Lewis Wind Power
Cumhachd Gaoithe

Stornoway Wind Farm
SNH Clarification Technical Note

Figure 4.1
Golden eagle: North-west study area

May 2020

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40001-Gos585

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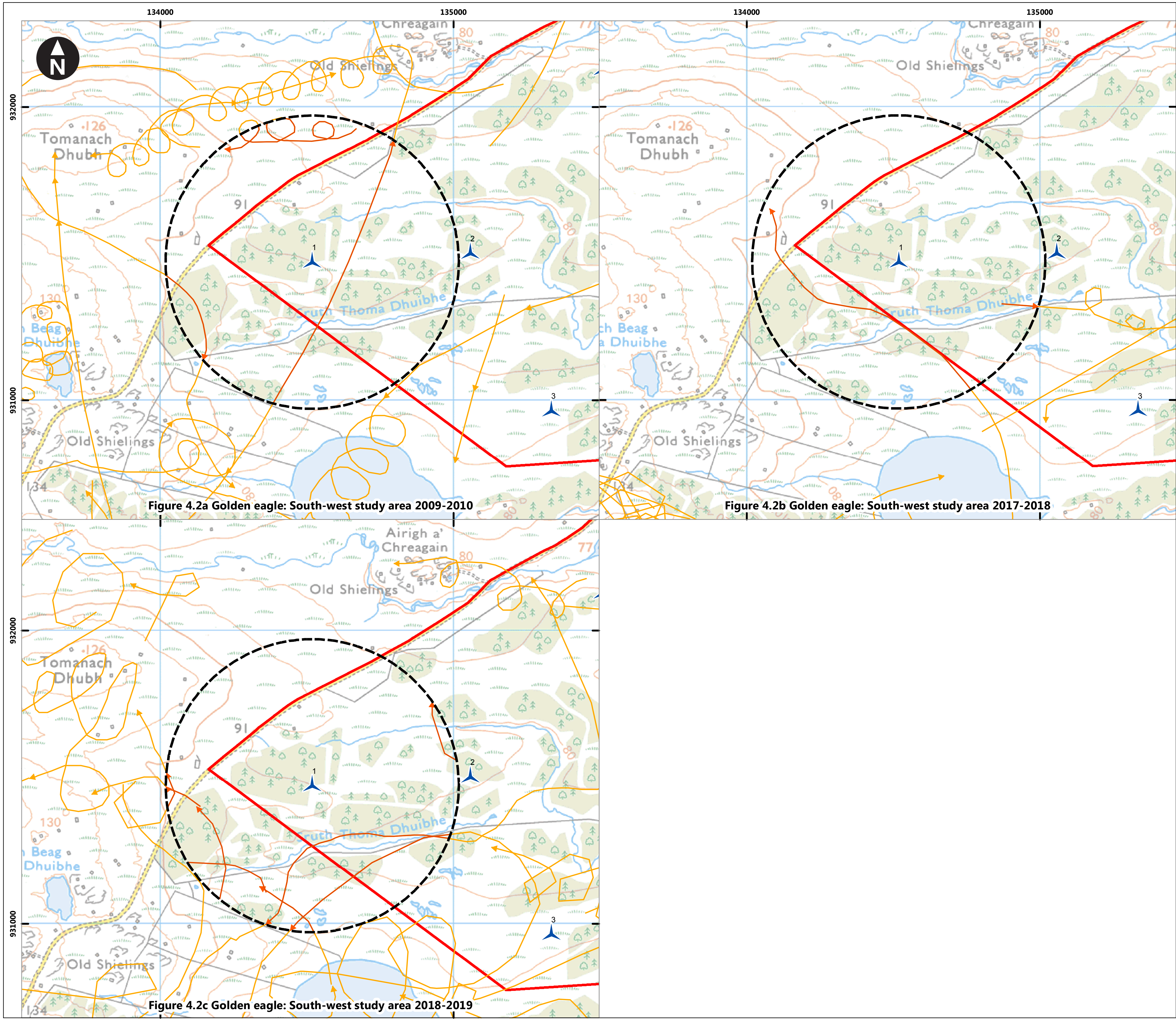

Figure 4.2a Golden eagle: South-west study area 2009-2010

Figure 4.2b Golden eagle: South-west study area 2017-2018

Figure 4.2c Golden eagle: South-west study area 2018-2019

Key

- Development site boundary
- Wind turbine 180m to blade tip
- Wind turbine 156m to blade tip
- Beinn Grideag wind turbine
- Pentland road wind turbine
- Study area
- Area of viewshed not visible at 20m
- Clipped flights within study area
- All flights

0 100 200 300 400 500 m

Scale at A3: 1:12,500

Client

Lewis Wind Power
Cumhachd Gaoithe

Stornoway Wind Farm
SNH Clarification Technical note

Figure 4.2
Golden eagle: South-west study area

May 2020

wood.

40001-Gos586

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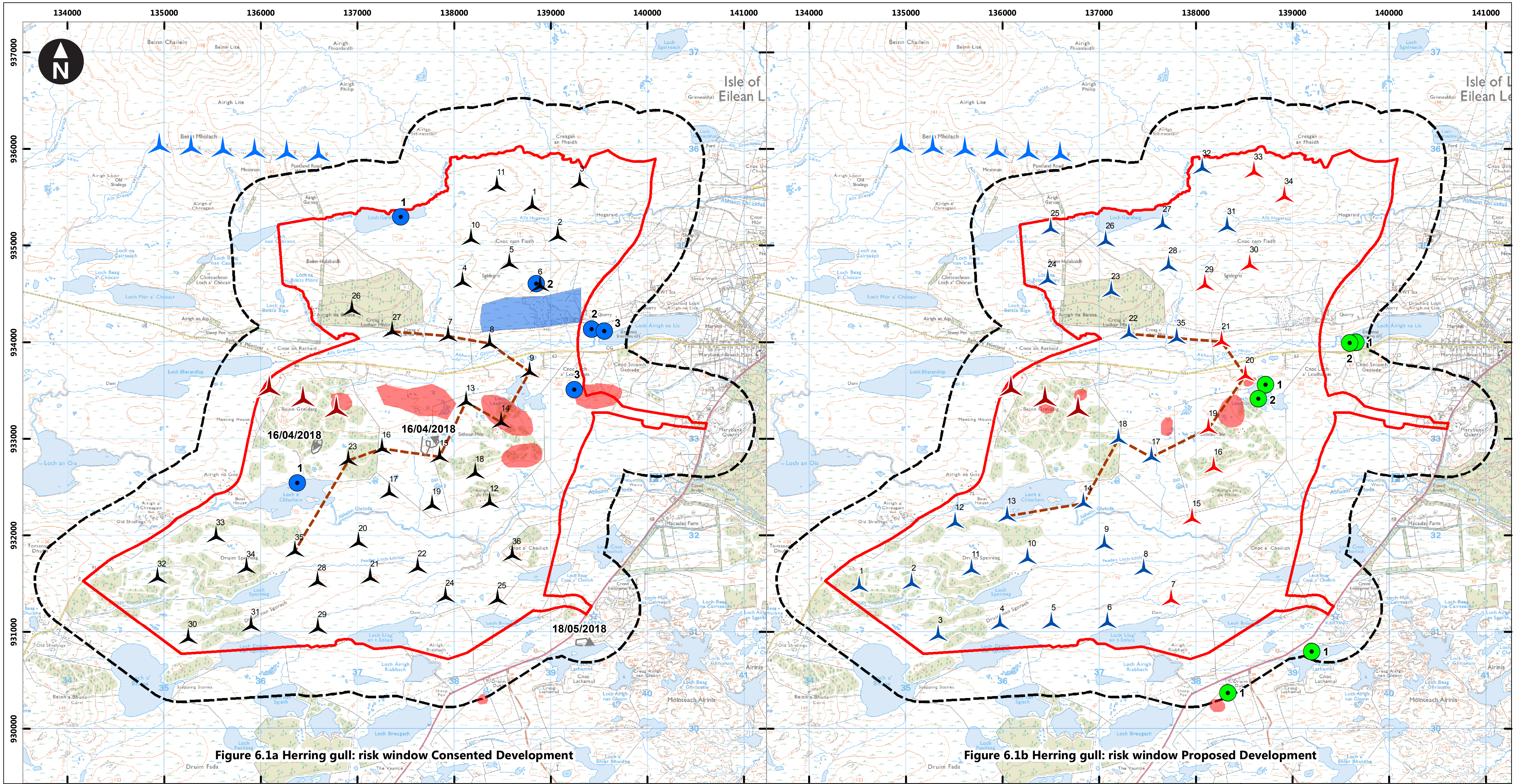

Client

Lewis Wind Power
Cumhachd Gaoithe

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Figure 6.1
Herring gull: risk window

May 2020

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Appendix B Lewis Peatlands SPA: golden eagle

Table B.1 Golden eagle: 2009-2010 flight data included in models

OBJECTID	FLIGHT_NO	DATE_	TIME_	VP	FLOCK	HEIGHT	Length	Adult	Study Area	cliplength	%CLIPLENGTH	Total time
60	AW	16/07/2009	91100	1	1	30- 40m	387.316	1	North-west	387.316	100	15
66	BA	03/08/2009	121200	1	1	30-40m	621.24	1	North-west	287.366	46	21
1	BR	04/11/2009	142000	3	1	>130m	2181.703	1	North-west	505.039	23	59
2	BY	04/11/2009	142100	1	1	40- 130m	2002.535	1	North-west	294.796	15	42
5	CG	05/11/2009	120100	2	1	40- 130m	2746.848	1	North-west	2190.978	80	106
33	DP	05/12/2009	131700	1	1	40- 130m	542.99	1	North-west	347.996	64	85
32	DO	05/12/2009	130900	1	1	40- 130m	1055.148	1	North-west	598.636	57	83
49	EN	05/02/2010	144100	2	1	40- 150m	1129.828	1	North-west	1129.828	100	60
82	FJ	16/03/2010	104400	2	1	30-40m	1064.624	1	North-west	1064.624	100	30
137	FJ	16/03/2010	104400	2	1	20- 30m	1350.981	1	North-west	862.742	64	29
136	FJ	16/03/2010	104400	2	1	20- 30m	197.314	1	North-west	197.314	100	15
145	GD	06/04/2010	134500	2	1	20- 30m	200.772	1	North-west	200.772	100	15
133	FU	15/04/2010	110300	2	1	20- 30m	225.765	1	North-west	225.765	100	15
131	FT	15/04/2010	105800	2	1	20- 30m	83.198	1	North-west	83.198	100	13
27	DJ	15/10/2009	160700	5	1	40- 130m	5678.281	1	South-west	990.44	17	81
107	BK	01/07/2009	185400	6	1	20- 30m	2403.879	1	South-west	339.174	14	17

Table B.2 Golden eagle: 2017-2018 flight data included in models

Flight_ref	Time	Species	Count	Heightband	Seconds	VP_	length	Date	Adult	Survey area	cliplength	%cliplength	Total time
BS_SW_0161_a	16:48	EA	1	B	180	7	3164.074	15/05/2018	1	South-west	125.859	4	7
BS_SW_0420_a	09:50	EA	1	B	30	1	827.184	03/04/2018	1	North-west	519.704	63	19

Flight_ref	Time	Species	Count	Heightband	Seconds	VP_	length	Date	Adult	Survey area	cliplength	%cliplength	Total time
BS_SW_0420_b	09:50	EA	1	C	45	1	1140.145	03/04/2018	1	North-west	1140.145	100	45
BS_SW_0518_a	12:09	EA	1	C	75	1	2880.36	11/05/2018	1	North-west	1539.349	53	40
BS_SW_0518_b	12:09	EA	1	B	15	1	610.285	11/05/2018	1	North-west	237.238	39	6
BS_SW_0696_b	16:55	EA	1	C	30	3	574.598	10/08/2018	1	North-west	293.16	51	15
SW_050	12:15	EA	1	B	210	2	2003.72002	16/10/2017	1	North-west	1090.481	54	114
SW_059	13:10	EA	1	C	375	1	2437.24999	21/10/2017	1	North-west	257.503	11	40
SW_128	09:25	EA	1	B	88	6	2145.80249	12/02/2018	1	South-west	996.997	46	41
SW_187	12:36	EA	1	B	75	3	1531.02092	28/03/2018	1	North-west	1531.021	100	75

Table B.3 Golden eagle: 2018-2019 flight data included in models

GISID	Date	VP	Observer	Flight sta	Species	Count	Height Ban	Seconds	Length	Adult	Survey area	cliplength	%cliplength	Total time
40001_VP_0011_b	26/10/2018	2	PRO	08:57	EA	1	B	30	649.898	1	North-west	649.898	100	30
40001_VP_0073	18/11/2018	3	YBR	14:22	EA	1	B	210	3205.537	1	North-west	1485.527	46	97
40001_VP_0094_b	05/12/2018	2	PRO	09:16	EA	1	B	45	2290.332	1	North-west	2290.332	100	45
40001_VP_0134	25/01/2019	1	YBR	14:46	EA	1	B	135	2838.001	1	North-west	1003.714	35	48
40001_VP_0139	30/01/2019	2	YBR	10:46	EA	1	B	270	6552.114	1	North-west	514.728	8	21
40001_VP_0143	31/01/2019	1	YBR	11:14	EA	2	B	135	4205.796	1	North-west	853.11	20	55
40001_VP_0195_c	18/03/2019	3	NRO	13:58	EA	1	B	75	1596.757	1	North-west	456.35	29	21
40001_VP_0195_d	18/03/2019	3	NRO	13:58	EA	1	C	210	2414.746	1	North-west	1561.484	65	136
40001_VP_0207_a	21/03/2019	2	NRO	15:35	EA	1	B	300	1978.855	1	North-west	1978.855	100	300
40001_VP_0207_b	21/03/2019	2	NRO	15:35	EA	1	C	60	462.378	1	North-west	462.378	100	60
40001_VP_0207_c	21/03/2019	2	NRO	15:35	EA	1	B	30	526.789	1	North-west	72.342	14	4
40001_VP_1044	13/08/2019	5	YBR	14:27	EA	1	C	270	2677.307	1	South-west	800.6	30	81
40001_VP_1265_b	13/09/2019	4	YBR	12:10	EA	2	C	150	956.395	1	North-west	132.619	14	42

wood.

Table B.4 Golden eagle: 2009-2010 Collision Risk Model: South-west

Band Model - Random Flights Consented Development	
Species: Golden eagle - South-west	
Season: Annual 2009-2010	

Wind Farm Parameters	
WFP (ha)	177
Number turbines	1
Rotor diameter	128
Hub height (m)	81
Max chord (m)	3.5
Rotor depth	3.5
Pitch (degrees)	7.5
Rotation period (secs)	4.6
Turbine operation time 85%	0.85
Avoidance Rate 99%	0.01
Rotor radius^2	4096.00
Combined rotor swept area	12867.96
Collision Risk volume 'Vw' (m^3)	226,560,000
Rotor swept volume 'V_r' (m^3)	55,590

Bird Parameters	
length (m)	0.82
wingspan (m)	2.03
flapping (0)or gliding (1)	1
Assumed flight speed (m/s)	11.9
Number daylight hours available	5697
Maximum recording height (m)	150
Minimum recording height (m)	20

Survey Data									
VP	1	2	3	4	5	6	7		
FRA (ha)					53	72	39		
Observation Time (hours)					195	87	72		
Total Time at PCH					81	17	0		

Flight activity per unit time and area		1	2	3	4	5					Total
Observation effort	Obsevation time (seconds) * hectare					37206000	22550400	10108800			69865200.0
Flying time at risk height	Effort at each VP / FRA					2.18E-06	7.54E-07	0.00E+00			2.93E-06
Weighted by observation effort											
Weighted obs effort	Effort at each VP / sum of all effort at all VP's					5.33E-01	3.23E-01	1.45E-01			1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height					1.16E-06	2.43E-07	0.00E+00			1.40E-06
Occupancy Rate											
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000001403									
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	1.41									
FRAw	Estimated bird time*(rotor diameter/recording height band)	1.39									
Rotor Transits											
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	1.23									
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.36									
Number of transits 'ntr'	'n'/'t'	3.39									
E											
Probability of collision (Band model		0.078									

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	0.23	0.002
Equivalent to 1 bird every *x* (years)	4.43	443.1
Over 25 years	5.6	0.06

Table B.5 Golden eagle: 2017-2018 Collision Risk Model: South-west

Band Model - Random Flights Consented Development

Species: Golden eagle - South-west

Season: Annual 2017-2018

Wind Farm Parameters	
WFP (ha)	177
Number turbines	1
Rotor diameter	150
Hub height (m)	105
Max chord (m)	4.2
Rotor depth	4.2
Pitch (degrees)	12
Rotation period (secs)	4.7
Turbine operation time 85%	0.85
Avoidance Rate 99%	0.01
Rotor radius^2	5625.00
Combined rotor swept area	17671.46
Collision Risk volume 'Vw' (m^3)	265,500,000
Rotor swept volume 'V_r' (m^3)	88,711

Bird Parameters	
length (m)	0.82
wingspan (m)	2.03
flapping (0)or gliding (1)	1
Assumed flight speed (m/s)	11.9
Number daylight hours available	5697
Maximum recording height (m)	200
Minimum recording height (m)	20

Survey Data										
VP	1	2	3	4	5	6	7	8	14	
FRA (ha)					53	72	39			
Observation Time (hours)					99	99	99			
Total Time at PCH					0	41	7			

Flight activity per unit time and area		1	2	3	4	5			8			Total
Observation effort	Obsevation time (seconds) * hectare					18889200	25660800	13899600				58449600.0
Flying time at risk height	Effort at each VP / FRA					0.00E+00	1.60E-06	5.04E-07				2.10E-06
Weighted by observation effort												
Weighted obs effort	Effort at each VP / sum of all effort at all VP's					3.23E-01	4.39E-01	2.38E-01				1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height					0.00E+00	7.01E-07	1.20E-07				8.21E-07

Occupancy Rate		
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000000821
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	0.83
FRAw	Estimated bird time*(rotor diameter/recording height band)	0.69
Rotor Transits		
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	0.83
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42
Number of transits 'ntr'	'n'/'t'	1.97
E		
Probability of collision (Band model		0.078

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	0.13	0.001
Equivalent to 1 bird every *x* (years)	7.63	763.2
Over 25 years	3.3	0.03

Table B.6 Golden eagle: 2018-2019 Collision Risk Model: South-west

Band Model - Random Flights Consented Development

Species: Golden eagle - South-west

Season: Annual 2018-20198

Wind Farm Parameters		**Bird Parameters**	
WFP (ha)	177	length (m)	0.82
Number turbines	1	wingspan (m)	2.03
Rotor diameter	150	flapping (0)or gliding (1)	1
Hub height (m)	105	Assumed flight speed (m/s)	11.9
Max chord (m)	4.2	Number daylight hours available	5697
Rotor depth	4.2	Maximum recording height (m)	200
Pitch (degrees)	12	Minimum recording height (m)	20
Rotation period (secs)	4.7		
Turbine operation time 85%	0.85		
Avoidance Rate 99%	0.01		
Rotor radius^2	5625.00		
Combined rotor swept area	17671.46		
Collision Risk volume 'Vw' (m^3)	265,500,000		
Rotor swept volume 'V$_r$' (m^3)	88,711		

Survey Data										
VP	1	2	3	4	5	6	7			
FRA (ha)					53	72	39			
Observation Time (hours)					114	99	99			
Total Time at PCH					81	0	0			

Flight activity per unit time and area		1	2	3	4	5						Total
Observation effort	Obsevation time (seconds) * hectare					21751200	25660800	13899600				61311600.0
Flying time at risk height	Effort at each VP / FRA					3.72E-06	0.00E+00	0.00E+00				3.72E-06
Weighted by observation effort												
Weighted obs effort	Effort at each VP / sum of all effort at all VP's					3.55E-01	4.19E-01	2.27E-01				1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height					1.32E-06	0.00E+00	0.00E+00				1.32E-06
Occupancy Rate												
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000001321										
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	1.33										
FRAw	Estimated bird time*(rotor diameter/recording height band)	1.11										
Rotor Transits												
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	1.34										
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42										
Number of transits 'ntr'	'n'/'t'	3.17										
E												
Probability of collision (Band model		0.078										

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	0.21	0.002
Equivalent to 1 bird every *x* (years)	4.74	474.4
Over 25 years	5.3	0.05

Table B.7 Golden eagle: 2009-2010 Collision Risk Model: North-west

Band Model - Random Flights Consented Development

Species: Golden eagle - North-west

Season: Annual 2009-2010

Wind Farm Parameters	
WFP (ha)	568
Number turbines	5
Rotor diameter	128
Hub height (m)	81
Max chord (m)	3.5
Rotor depth	3.5
Pitch (degrees)	7.5
Rotation period (secs)	4.6
Turbine operation time 85%	0.85
Avoidance Rate 99%	0.01
Rotor radius^2	4096.00
Combined rotor swept area	64339.80
Collision Risk volume 'Vw' (m^3)	727,040,000
Rotor swept volume 'V_r' (m^3)	277,948

Bird Parameters	
length (m)	0.82
wingspan (m)	2.03
flapping (0)or gliding (1)	1
Assumed flight speed (m/s)	11.9
Number daylight hours available	5697
Maximum recording height (m)	150
Minimum recording height (m)	20

Survey Data				
VP	1	2	3	4
FRA (ha)	81	240	148	4
Observation Time (hours)	198	183	192	192
Total Time at PCH	246	283	59	0

Flight activity per unit time and area		1	2	3	4	Total
Observation effort	Obsevation time (seconds) * hectare	57736800	158112000	102297600	2764800	320911200.0
Flying time at risk height	Effort at each VP / FRA	4.26E-06	1.79E-06	5.77E-07	0.00E+00	6.63E-06
Weighted by observation effort						
Weighted obs effort	Effort at each VP / sum of all effort at all VP's	1.80E-01	4.93E-01	3.19E-01	8.62E-03	1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height	7.67E-07	8.82E-07	1.84E-07	0.00E+00	1.83E-06
Occupancy Rate						
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000001832				
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	5.93				
FRAw	Estimated bird time*(rotor diameter/recording height band)	5.84				
Rotor Transits						
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	8.03				
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.36				
Number of transits 'ntr'	'n'/'t'	22.13				
E						
Probability of collision (Band model		0.078				

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	1.47	0.015
Equivalent to 1 bird every *x* (years)	0.68	67.8
Over 25 years	36.8	0.37

Table B.8 Golden eagle: 2017-2018 Collision Risk Model: North-west

Band Model - Random Flights Consented Development

Species: Golden eagle - North-west

Season: Annual 2017-2018

Wind Farm Parameters	
WFP (ha)	568
Number turbines	6
Rotor diameter	150
Hub height (m)	105
Max chord (m)	4.2
Rotor depth	4.2
Pitch (degrees)	12
Rotation period (secs)	4.7
Turbine operation time 85%	0.85
Avoidance Rate 99%	0.01
Rotor radius^2	5625.00
Combined rotor swept area	106028.73
Collision Risk volume 'Vw' (m^3)	852,000,000
Rotor swept volume 'V$_r$' (m^3)	532,264

Bird Parameters	
length (m)	0.82
wingspan (m)	2.03
flapping (0)or gliding (1)	1
Assumed flight speed (m/s)	11.9
Number daylight hours available	5697
Maximum recording height (m)	200
Minimum recording height (m)	20

Survey Data				
VP	1	2	3	4
FRA (ha)	81	240	148	4
Observation Time (hours)	99	99	99	99
Total Time at PCH	149	114	90	0

Flight activity per unit time and area		1	2	3	4	Total
Observation effort	Obsevation time (seconds) * hectare	28868400	85536000	52747200	1425600	168577200.0
Flying time at risk height	Effort at each VP / FRA	5.16E-06	1.33E-06	1.71E-06	0.00E+00	8.20E-06
Weighted by observation effort						
Weighted obs effort	Effort at each VP / sum of all effort at all VP's	1.71E-01	5.07E-01	3.13E-01	8.46E-03	1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height	8.84E-07	6.76E-07	5.34E-07	0.00E+00	2.09E-06
Occupancy Rate						
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000002094				
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	6.78				
FRAw	Estimated bird time*(rotor diameter/recording height band)	5.65				
Rotor Transits						
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	12.70				
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42				
Number of transits 'ntr'	'n'/'t'	30.10				
E						
Probability of collision (Band model		0.078				

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	2.00	0.020
Equivalent to 1 bird every *x* (years)	0.50	49.9
Over 25 years	50.1	0.50

Table B.9 Golden eagle: 2017-2018 Collision Risk Model: North-west

Band Model - Random Flights Consented Development	
Species: Golden eagle - North-west	
Season: Annual 2018-20198	

Wind Farm Parameters	
WFP (ha)	568
Number turbines	6
Rotor diameter	150
Hub height (m)	105
Max chord (m)	4.2
Rotor depth	4.2
Pitch (degrees)	12
Rotation period (secs)	4.7
Turbine operation time 85%	0.85
Avoidance Rate 99%	0.01
Rotor radius^2	5625.00
Combined rotor swept area	106028.73
Collision Risk volume 'Vw' (m^3)	852,000,000
Rotor swept volume 'V_r' (m^3)	532,264

Bird Parameters	
length (m)	0.82
wingspan (m)	2.03
flapping (0)or gliding (1)	1
Assumed flight speed (m/s)	11.9
Number daylight hours available	5697
Maximum recording height (m)	200
Minimum recording height (m)	20

Survey Data				
VP	1	2	3	4
FRA (ha)	81	240	148	4
Observation Time (hours)	75	108	111	108
Total Time at PCH	103	460	255	42

Flight activity per unit time and area		1	2	3	4	Total
Observation effort	Obsevation time (seconds) * hectare	21870000	93312000	59140800	1555200	175878000.0
Flying time at risk height	Effort at each VP / FRA	4.71E-06	4.93E-06	4.31E-06	2.70E-05	4.10E-05
Weighted by observation effort						
Weighted obs effort	Effort at each VP / sum of all effort at all VP's	1.24E-01	5.31E-01	3.36E-01	8.84E-03	1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height	5.86E-07	2.62E-06	1.45E-06	2.39E-07	4.89E-06
Occupancy Rate						
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000004890				
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	15.82				
FRAw	Estimated bird time*(rotor diameter/recording height band)	13.19				
Rotor Transits						
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*	29.65				
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42				
Number of transits 'ntr'	'n'/'t'	70.30				
E						
Probability of collision (Band model		0.078				

Calculation of number collisions	**No avoidance**	**Avoidance 99%**
Collisions per year	4.68	0.047
Equivalent to 1 bird every *x* (years)	0.21	21.4
Over 25 years	117.0	1.17

Appendix C Theoretical Collision Risk Modelling: herring gull

Table C.1 Year 1 10% at PCH

Band Model: Regular Flights Proposed Development Year 1		
Species: Herring gull		
Season: Breeding season 2018 (April - August)		
Bird Parameters		
length (m)	0.6	
wingspan (m)	1.4	
flapping (0)or gliding (1)	0	
Assumed flight speed (m/s)	12.8	
Number of birds	370	
Overall number flights per day x6	2220	
Number days active	154	
Total number flights in risk window	341880	
% of flights at PCH	10	
Avoidance Rate 99.5%	0.005	
Wind Farm Parameters		
Max height of turbines (m)	180	
Number turbines	9	
Rotor diameter (m)	150	
Hub height (m)	105	
Max chord (m)	4.2	
Pitch (degrees)	12	
Rotation period (secs)	4.7	
Turbine operation time 85%	0.85	
Risk window width (m)	4920	
Calculations		
Risk window area (m2)	885600	
Area occupied by rotors	159043	
Rotor area as a proportion of risk window area	0.180	
Total number flights at PCH over active period	34188	
Number birds through rotors	6139.75	
Stage 2 Probability of collision	0.068	
Calculation of number collisions	**No avoidance**	**Avoidance 99.5%**
Collisions per year	353.67	1.768
Years per collision	0.003	0.57
Over 25 years	8841.78	44.21