

File With _____

SECTION 131 FORM

Substitute Consent Application NO: _____

Defer Re O/H ☐Having considered the contents of the submission received 320487-24 from Eco Advocacy

I recommend that section 131 of the Planning and Development Act, 2000

be/not be invoked at this stage for the following reason(s): no new material
planning issues raisedE.O.: Karen HickeyDate: 24/10/24

For further consideration by SEO/SAO

Section 131 not to be invoked at this stage. ☐Section 131 to be invoked – allow 2/4 weeks for reply. ☐

S.E.O.: _____

Date: _____

S.A.O.: _____

Date: _____

M _____

Please prepare SC _____ - Section 131 notice enclosing a copy of the attached submission

to: _____ Task No: _____

Allow 2/3/4weeks – BP _____

EO: _____

Date: _____

AA: _____

Date: _____

File With _____

CORRESPONDENCE FORMSubstitute Consent Application No: ABP- 320487-24

M _____

Please treat correspondence received on 30/9/24 as follows:

1. Update database with new agent for Applicant/Appellant _____

2. Acknowledge with SC 403. Keep copy of Board's Letter ☐

1. RETURN TO SENDER with SC _____

2. Keep Envelope: ☐3. Keep Copy of Board's letter ☐**Amendments/Comments**observation rec'd from Eco Advocacy
by email.Case NarrativeTask 404635-24 to Eco Advocacy SC 40LD 30/9/24**4. Attach to file**(a) R/S ☒(d) Screening ☐(b) GIS Processing ☐(e) Inspectorate ☐(c) Processing ☐RETURN TO EO ☐

	Plans Date Stamped ☐
	Date Stamped Filled in ☐
EO: <u>Karen Hickey</u>	AA: <u>David Moore</u>
Date: <u>11/10/24</u>	Date: <u>2-10-24</u>

Validation Checklist

Lodgement Number : **LDG-075220-24**
Case Number: **ABP-320487-24**
Customer: **Eco Advocacy**
Lodgement Date: **30/09/2024 16:30:00**
Validation Officer: **Karen Hickey**
PA Name: **Meath County Council**
PA Reg Ref:
Case Type: **Application**
Lodgement Type: **Observation / Submission**



An
Bord
Pleanála

observation

Validation Checklist		Value
Confirm Classification		Confirmed - Correct
Confirm ABP Case Link		Confirmed-Correct
Fee/Payment		Valid – Correct
Name and Address available		Yes
Agent Name and Address available (if engaged)		Not Applicable
Subject Matter available		Yes
Grounds		Yes
Sufficient Fee Received		Yes
Received On time		Yes
Eligible to make lodgement		Yes
Completeness Check of Documentation		Yes

SC40 - DM 2.10.24

n at: 01/10/2024 16:35

n by: Karen Hickey

From: Bord
Sent: Monday 30 September 2024 15:30
To: Appeals2
Subject: FW: SU17.320487 - Substitute Consent - Bord na Mona
Attachments: 2024-09-28-EA to ABP-BnaM-SU17.320487.pdf; Fernandez Bellon et al.,
Reproduction output of Hen Harriers Circus cyaneus in relation to wind turbine
proximity.pdf; Hen Harrier Threat Response Plan 2024-2028.pdf; HHTRP Wind
Energy for circulation 22 June 2021.pdf

From: Eco Advocacy <info@ecoadvocacy.ie>
Sent: Monday, September 30, 2024 3:23 PM
To: Bord <bord@pleanala.ie>
Subject: SU17.320487 - Substitute Consent - Bord na Mona

Caution: This is an **External Email** and may have malicious content. Please take care when clicking links or opening attachments. When in doubt, contact the ICT Helpdesk.

SUBMISSION re **SU17.320487**

Dear Sirs

Please find attached 4 page submission together with 3 attachments in respect of a substitute consent application by Bord na Mona

With kind regards,

Kieran



Contact reference: Our Ref. 01_8588100, 1890_275175,
Public Access Desk: 01_8737104: from 10 to 12:30 & from 2 to 4:30
Email: bord@pleanala.ie and sids@pleanala.ie

The Secretary,
An Bord Pleanála,
64 Marlborough Street,
Dublin 1

27th September 2024

Application for Substitute Consent

Planning Ref.: SU17.320487 (An Bord Pleanála)
Received Date: 06/08/2024
Submissions By: 30/09/2024 (8 Weeks)
Applicant: Bord na Móna LTD.
Dev. Address: at the Ballivor Bog Group, County Meath and County Westmeath
Brief Description: 'Substitute Consent'
URL: <https://www.pleanala.ie/en-ie/case/320487>
Submission Fee: N/A

Dear Sir/ Madam

We make the within submission on the recent application for substitute consent, described on your web portal as: -

'Application for substitute consent for peat extraction and bog development work from 1988 to June 2020 within the Ballivor Bog Group at Ballivor, Carranstown, Bracklin, Lisclogher and Lisclogher West Bogs in Counties Meath and Westmeath. This application is accompanied by an Environmental Impact Assessment Report and a Natura Impact Statement.'

Note that there are **4 pages** in total to this submission inclusive of the cover page.

Yours sincerely,

A handwritten signature in blue ink that reads 'Kieran Cummins'.

Kieran Cummins,

SUBMISSION re Planning File ref. no. SU17.320487

Bord na Móna LTD

SUBSTITUTE CONSENT

1. **3rd July 2020:** the Irish Supreme Court in *AN TAISCE, PETER SWEETMAN & Others v. AN BORD PLEANÁLA and Others* [9/19, 42/19 and 43/19], Mr. Justice William M. McKechnie stated that the public should have an input at the earlier s.177 (c) stage and specifically cited the Aarhus Convention. They also stated that where substitute consent is applied for that the exceptionality test must be applied.
2. We refer to EU case reference: **C-215/06:** Commission v. Ireland: Failure of a Member State to fulfill obligations – No assessment of the environmental effects of projects within the scope of Directive 85/337/EEC – Regularisation after the event not permissible under EU law where E.I.A. and A.A. should have been prepared prior to development. By failing to adopt all measures necessary to ensure that the development consents given for and the execution of wind-farm developments and associated works at Derrybrien; County Galway were preceded by an assessment with regard to their effects in accordance with Articles 5 to 10 of Directive 85/337/EEC, Ireland has failed to comply with the obligations that it has under Articles 2, 4 and 5 to 10 of the said Directive 85/337/EEC.
3. This case was delivered in or about 2008. It is our understanding that this gave rise to the substitute consent process. That being the case, please consider: -
 - a. Whether the extraction of peat after the determination **C-215/06** is permissible?
 - b. We refer you to Appendix 10-1 Carbon Calculations. It is noted for example that extraction reached 108,605 tonnes. That was well after the **C-215/06**. Please also assess whether this extraction can be considered exceptional?
 - c. Would the applicants not have been expected to have applied for planning consent after **C-215/06** and conducted the requisite EIA/ AA?
 - d. Is the current application regularisation after the event (retrospective consent) and as such be contrary to EU law?

PARALLEL APPLICATION

4. A parallel application was also lodged with *An Bord Pleanála* on the 5th April 2023 for the erection of 26 no. wind turbines. This application was by a related company; *Bord na Móna Powergen LTD*. One would have thought that this is a cart before horse scenario and that Substitute Consent should first have been addressed. It is therefore submitted that consideration of the parallel wind farm application should at the very least be suspended until the Substitute consent application herein has been determined. It may also be the case that the wind farm application should be declined altogether and a fresh application submitted AFTER the substitute the within referenced consent has been determined.
5. The reference for the earlier wind farm application is: PA25M.316212
Referenced: <https://www.pleanala.ie/en-ie/case/316212>
6. Notwithstanding the above, it is submitted that, that application is premature until the **substitute consent** issues on the applicant site have been resolved. Notwithstanding, it is considered that, that application is **premature** pending long awaited **guidelines** for utility scale WIND instillations. It is further considered that this premature pending a full **national led SEA assessment** of utility scale wind instillations together with the loss of finite agricultural land together with natural habitat.

7. We are aware that a national policy was recently launched in Co. Laois (**September 2024**) to save the endangered Hen Harrier species. We enclose a copy of the report herewith. We are now much more aware of the importance of the Hen Harrier to this area and note that the applicants mention it only twice in the section re Biodiversity of the EIAR and no mention at all in the Non-Technical Summary [SU17.320487]
8. We had a brief look at the EIAR for the parallel application ref. PA25M.316212 and identified some important information which we have read in conjunction with the within application. It's our opinion that further surveys are required.
9. Excerpts from application ref. PA25M.316212: -

7.4.3

Vantage Point Surveys

Hen harrier were observed on 15 occasions during vantage point surveys between April 2020 and September 2022 (see Appendix 7-4, Figure 7.1.35). All observations were during the winter/migration period (September to March). Nine of these observations were of birds hunting, with the remaining observations of birds commuting within the Wind Farm Site. Fourteen observations were within 500m of the proposed turbine layout. There were six observations at the potential collision height.

Hen Harrier Roost Surveys

Hen harrier were observed on three occasions during the hen harrier roost surveys, two of which were within the Wind Farm Site (see Appendix 7-4, Figure 7.10.1). All observations were of individuals hunting or commuting. There was no evidence of roosting hen harrier observed during surveys.

7.5.1.3 Hen Harrier

Wintering

As per NPWS Article 12 Reporting (2013-2018), the estimated national wintering population of hen harrier in Ireland is 311-435 therefore 1% of the ROI National wintering population is 3-4 birds. A regularly occurring wintering population of 3-4 hen harrier is required for classification as Nationally/Internationally Importance.

There are no published figures for the Counties Meath and Westmeath population of hen harrier. Taking a precautionary approach, a regularly occurring population of just one bird is required for classification of County Importance.

Hen harrier were observed on 16 occasions during the winter season. All of these observations were of individuals hunting and commuting. There were no observations of roosting hen harrier during surveys at the Wind Farm Site.

Given that there was a regularly occurring winter population of at least one bird at the Wind

Breeding

Based on the latest Breeding Hen Harrier Survey (NPWS 2015), the ROI National breeding population is in the range of 108-157 pairs. Therefore, a single breeding pair in Ireland conforms to National/International Importance as per NRA criteria.

This species was recorded on only one occasion during the breeding season, two observations of a female on the same day. As previously discussed in Section 7.4.3, this bird was observed in September and is likely a bird that had completed breeding and is utilising the Wind Farm Site on passage or as wintering grounds.

The Wind Farm Site is of No Ecological Importance to this species during the breeding season, given that the species was not recorded during the core breeding months.

7.5.2 Identification of Key Ornithological Receptors

Table 7-11 Avifaunal Receptor Evaluation and Selection Criteria Rational

Hen Harrier

Annex I, EU Birds

Directive; BoCCI
Amber List & Irish
Wildlife Act.

Wintering

National Importance

Hen harrier were occasionally observed hunting within the Wind Farm Site. An assessment of direct habitat loss is required. Birds were recorded within the Wind Farm Site. The potential for displacement exists. This species was recorded flying over the Wind Farm Site within the potential collision risk zone. A collision risk assessment is required.

Breeding

No population of ecological importance recorded

Hen harrier was recorded infrequently and in low numbers during the breeding season. There were no observations during the core breeding months for this species (April to August). There is no evidence to suggest that the Wind Farm Site is of significance to this species for breeding.

Please refer to Section 7.5.1.3 for further detailed discussion.

No pathways for significant effects were identified

7.5.3 Key Ornithological Receptor Sensitivity

Determination

High Sensitivity KORs include:

Hen Harrier (ecologically sensitive species)"

CONCLUSIONS

10. One of our principle concerns is the lack of a robust winter roost survey for the Hen Harrier (*Circus cyaneus*). In previous years several Hen Harriers were observed by numerous bird watchers in the area and it is considered that the bog may well be an important communal Hen Harrier winter roost both locally and nationally. It is noted by local observers that this site is difficult to survey owing to dense vegetation and the sheer vastness of the site, which would require numerous elevated vantage points. We strongly advise that an additional full winter roost survey is carried out, with a minimum of one roost watch being conducted every month between October and March, inclusive, and with a minimum of 16 observers simultaneously surveying the roost from separate vantage points to ensure that no Hen Harriers are missed coming into roost.
11. Note that Hen Harriers roost on the ground, often amongst the heather and other dense vegetation. Flight lines of birds going into roost can often be obstructed by taller scrub vegetation and trees. Furthermore, the average foraging distance from winter roosts (5.4km; McCarthy, 2022- PhD Thesis) should be considered when designing bird surveys as part of ecological assessments for large-scale developments, such as wind farms, in Hen Harrier wintering areas. It should also be considered that Hen Harrier roost watches are best conducted from one hour before sunset until fading light makes observing birds coming into roost not possible (approx. 40 mins after sunset). In addition to the operation of the wind turbines, the amount of human disturbance, loss of vegetation, and easier access for mammalian predators which would result from the current proposals due to the construction of access roads together with the construction of wind turbines would also denigrate this important habitat.

ENDS

ENCLOSURES

1. Appendix 10-1 Carbon Calculations
2. Hen Harrier Threat Response Plan 2024-2028
3. Fernandez Bellon et al., Reproduction output of Hen Harriers *Circus cyaneus* in relation to wind turbine proximity
4. HHTRP Wind Energy for circulation 22 June 2021

Reproductive output of Hen Harriers *Circus cyaneus* in relation to wind turbine proximity

**Darío Fernández-Bellon, Sandra Irwin,
Mark Wilson and John O'Halloran**

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Keywords: *Circus cyaneus*, Hen Harrier, reproductive output,
wind energy



Despite the growing importance of wind energy development in Ireland, and concerns about its potential ecological impact on birds, there is a notable lack of published scientific information in this area. As a bird of conservation concern, the Hen Harrier *Circus cyaneus* inhabits upland areas with potential for wind energy resources. This study assessed the breeding performance of Hen Harriers across Ireland in relation to wind farm development by analysing the breeding output from 84 nests located at varying distances from wind turbines. Three measures of breeding performance were investigated: (a) nest success (the proportion of nests that fledged one or more young), (b) fledged brood size (the average number of fledged chicks per successful nest), and (c) overall productivity of breeding pairs (the average number of fledged chicks across all nesting attempts). No statistically significant relationships were found between these breeding parameters and distance of the nest from the nearest wind turbine. However, lower nest success within 1 km of wind turbines than at greater distances was sufficiently close to statistical significance, and with a sufficiently small sample size, that this difference may be of biological relevance. Nests within 1 km of wind turbines which were successful had similar fledged brood sizes to those of nests at greater distances from turbines. These findings support previous research which highlighted the importance of areas within a 1 km radius of raptor nests. Our results provide the first insight into the potential effects of wind turbines for breeding success of Hen Harriers, which should be taken into consideration in assessments of wind farm impacts on this vulnerable species. Further work is required to quantify (a) direct Hen Harrier mortality through collisions, (b) habitat loss and displacement caused by wind turbines and (c) to continue ongoing monitoring of breeding success in order to confirm whether the effect of wind farm proximity suggested here is consistent. This work will support the development of an integrated management strategy for Hen Harriers in Ireland.

Introduction

The Hen Harrier *Circus cyaneus* is a territorial bird of prey that breeds in upland areas in Ireland. It is an Annex I species on the European Birds Directive 2009/147/EC (OJEU 2010)

and is on the Amber List of Birds of Conservation Concern in Ireland (Colhoun & Cummins 2013), where an increase in breeding numbers has been reported in recent years

Plate 66. Female Hen Harrier (Shay Connolly).

(Ruddock *et al.* 2012). However, this increase is possibly an artefact of increased survey effort, and with a population estimate of 128–172 breeding pairs the species remains vulnerable and is rare in the Republic of Ireland (Ruddock *et al.* 2012).

Once common across the Irish uplands, Hen Harrier populations have shown significant fluctuations over time in response to human-related pressures, particularly habitat modification and loss (O'Flynn 1983). Extensive afforestation over the past 60 years has resulted in the loss of large areas of open habitat traditionally used by breeding Hen Harriers (O'Leary *et al.* 2000, Avery & Leslie 2010). This species has responded to these habitat modifications across its range by nesting in young conifer plantations (Norriss *et al.* 2002, Barton *et al.* 2006, Wilson *et al.* 2009). Although this apparent ability to adjust to a changing landscape may allow the species to persist in the short term, research suggests that in some instances these new habitats may prove to be an 'ecological trap' where Hen Harrier productivity is too low to maintain populations in the longer term (Wilson *et al.* 2012). Young conifer plantations provide dense vegetation cover suitable for nesting, but may be associated with higher rates of nest predation or with lower prey availability in areas surrounding the nest, leading to lower breeding output and a mismatch between the species' habitat preferences and the actual value of these habitats (Wilson *et al.* 2012). This complex ecological relationship between Hen Harriers and their surroundings, with continuing changes in availability and suitability of their preferred habitats, is further complicated with the recent expansion of wind energy across many upland areas in Ireland.

Renewable energy is a growing component of Ireland's energy supply and wind power in particular is central to the Irish Government's energy production strategy (DCENR 2012). This sector has developed rapidly in recent years with the construction of over 200 onshore wind farms (more than 1,600 individual turbines) across the island of Ireland (IWEA 2014). The contribution of wind energy to the total energy consumption in Ireland increased from 1% in 2000 to 15% in 2012 (Howley *et al.* 2014). Wind energy is commonly recognised as a 'green' power technology that can reduce our dependence on fossil fuels (Leung & Yang 2012). However, there are growing concerns that it may carry an ecological cost, particularly for birds, and there is a pressing need for information on the ecological impacts of wind farms (Drewitt & Langston 2006, De Lucas *et al.* 2007, Stewart *et al.* 2007, Rourke *et al.* 2009). In Ireland, concerns about the effects of wind farms on birds, as well as on other taxa and on the abiotic environment, combined with a lack of robust data have been identified as significant barriers to on-going wind energy development (Rourke *et al.* 2009, Scannell 2011). Despite this, relatively few studies to date have assessed the impacts of

wind farms on birds in Ireland (Percival 2003, Madden & Porter 2007). There is an urgent need to evaluate the potential effects of wind farms on bird populations, particularly Hen Harriers (Irwin *et al.* 2011, Ruddock *et al.* 2012), in order to inform conservation and mitigation measures.

The impacts of wind turbines on birds are not yet fully understood, but it is clear that there is considerable variation across regions and between species (Pearce-Higgins *et al.* 2012, Northrup & Wittemyer 2013, May *et al.* 2015). The potential negative effects of wind turbines on birds include direct mortality caused by collision with turbine blades, and indirect effects such as displacement due to disturbance, loss of foraging or nesting habitat, and barrier effects (Stewart *et al.* 2007, Campedelli *et al.* 2014). Impacts appear to be more significant for populations of long-lived, large bird species with low productivity, particularly rare birds of conservation importance (Drewitt & Langston 2006, Pearce-Higgins *et al.* 2009a). Due to their distribution in habitats that are optimal for wind energy production, Hen Harriers are considered to be highly sensitive to wind farm developments (McCluskie 2015, McGuinness *et al.* 2015). Foraging Hen Harriers have been shown to avoid wind farm infrastructures with displacements of up to 0.5 km from turbines reported (Madders & Whitfield 2006, Pearce-Higgins *et al.* 2009b, Garvin *et al.* 2011). However, wind turbines are reported not to cause displacement of Hen Harrier nests (Madden & Porter 2007, Robson 2011). Similarly, wind turbines are reported not to influence the location of Montagu's Harrier *Circus pygargus* nests (Hernández-Pliego *et al.* 2015). Although Hen Harrier ecology and behaviour makes for a low level of collision risk, direct mortality resulting from collision with turbines has been recorded in some studies (Whitfield & Madders 2006, Fennelly 2015, McCluskie 2015). While individual effects of wind farms may have only minor ecological effects on a bird species, collectively, a number of effects may be significant and potentially greater than the sum of the individual effects (Masden 2010). Although these impacts have the potential to affect breeding output of some bird species (Martínez-Abraín *et al.* 2012, Northrup & Wittemyer 2013), no work has been published to date, in Ireland or elsewhere, on the effects of wind farm developments on Hen Harrier breeding productivity. Here we study the breeding performance of Hen Harriers in relation to wind farms at sites across Ireland. By analysing data from Hen Harrier territories, located at a range of distances from active wind farms, we aim to (i) assess whether nests located in proximity to wind turbines suffer reduced productivity and, if so, (ii) determine the maximum distance from turbines at which this effect is significant. To our knowledge, this is the first study to assess the effects of wind farms on the breeding performance of Hen Harriers.

Methods

Data were collected each year between 2007 and 2013 during the Hen Harrier breeding season (April–August) at a selection of sites across the species' Irish range (counties Kerry, Limerick, Tipperary, Clare, Galway, Tyrone and Roscommon). During this period, vantage point watches overlooking areas of suitable habitat were carried out to locate active territories by recording Hen Harrier courtship and territorial behaviours. Further observations of birds engaging in nest building, prey delivery and other nest-associated behaviours were used to identify nest locations. Nests were then regularly monitored by remote observation until the conclusion of the breeding season in order to determine breeding outcome and check for fledged young. All fieldwork was carried out under licence issued by National Parks and Wildlife Service (NPWS).

The distance to the nearest wind turbine was calculated for all nests in order to analyse the effect of wind farms on breeding Hen Harriers using ArcMap 10.2 (ESRI). Previous research has indicated that avoidance of wind farms by breeding Hen Harriers may occur within 1 km of turbines (Pearce-Higgins *et al.* 2009b) and that foraging behaviour of breeding pairs can be influenced by habitat changes at varying distances of 1, 2 and 3 km from the nest (Arroyo *et al.* 2009). To allow for detection of different processes occurring at these scales, nests were grouped according to their distance to the nearest turbine into the following distance bands: 0–1 km, 1–2 km, 2–3 km and >3 km.

Three measures of breeding performance were calculated for each distance band: (a) nest success (the proportion of nests that fledged one or more young); (b) fledged brood size (the average number of fledged chicks per successful nest); and (c) overall productivity of breeding pairs (the average number of fledged chicks across all nesting attempts). Differences in measures of breeding performance between the different distance bands were analysed using fixed-effect one-way ANOVAs and one-tailed T-tests following examination of the distributions of data to ensure that assumptions of normality and homogeneity of variance were met. Minitab was used for all statistical analyses.

Results

Between 2007 and 2013 a total of 84 Hen Harrier territories across Ireland were monitored, and their breeding outcome determined. Linear distances from these nests to the nearest wind turbine ranged from 0.4 km to 7.0 km. Nest success for all territories monitored was 53.6%, with 45 successful and 39 failed nests. The mean fledged brood size was 2.4 (± 0.1 se) chicks per successful nest and mean nest productivity was 1.3 (± 0.2 se) chicks per nesting attempt.

When grouped according to distance from the nearest turbine, nest success was lowest (33.3%) at nests located in



Plate 67. Male Hen Harrier (Andy Hay, rspb-images.com).

the 0–1 km band ($n = 9$). Nest success was 60.0% in both the 1–2 km ($n = 20$) and 2–3 km ($n = 20$) bands, and 51.4% for nests located at more than 3 km from wind turbines ($n = 35$) (Figure 1). However, differences between the four distance bands were not statistically significant ($F_{3,80} = 0.72$, $P = 0.542$). When the success of nests in the 0–1 km band (nest success = 33.3%) was compared with the success of all nests more than 1 km from wind turbines (nest success = 56.0%), the difference approached statistical significance (one-tailed T-value = 1.29, $df = 82$, $P = 0.10$).

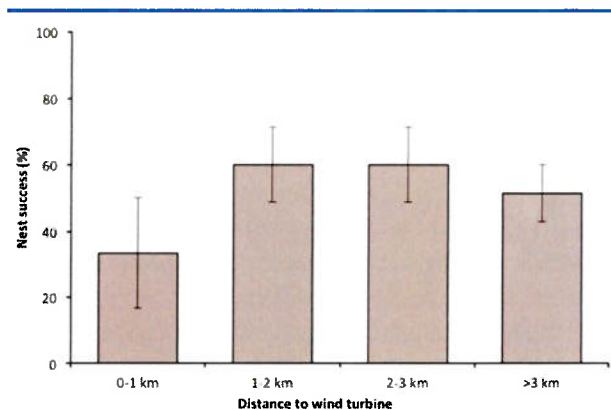


Figure 1. Mean Hen Harrier nest success rates ($\pm$ se) from 2007 to 2013 across Ireland, classified by the distance of nests to the nearest wind turbine. Nest success is defined as the proportion of nests that fledged one or more young. Sample sizes in each distance band are 9, 20, 20 and 35, respectively.

There was no significant difference in fledged brood size which ranged from 2.33 to 2.58 chicks per successful nest, between distance bands ($F_{3,80} = 0.26$, $P = 0.853$) (Figure 2). Productivity was lowest for nests closest to wind turbines (0–1 km, 0.78 chicks per nesting attempt) but not statistically different from those nests in the other bands (1.55, 1.35 and 1.23 chicks per nesting attempt at 1–2 km, 2–3 km and >3 km respectively) (F -value = 0.68, $df = 3$, $P = 0.566$).

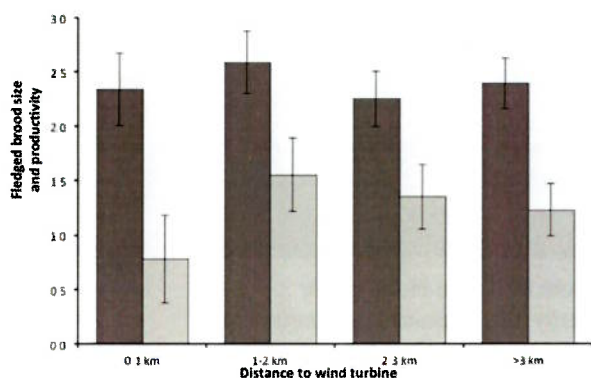


Figure 2. Mean Hen Harrier fledged brood size (dark bars; the average number of fledged chicks per successful nest) and productivity (light bars; the average number of fledged chicks across all recorded nesting attempts) ($\pm$ se) from 2007 to 2013 across Ireland, classified by the distance of nests to the nearest wind turbine. For sample sizes see Figure 1.

Discussion

We found no significant differences between three measures of breeding output from Hen Harrier nests located at different distances from wind turbines. However, non-statistically significant lower nest success rates and productivity were observed within 1 km of active wind turbines. Due to limited availability of data, a consequence of the species' rarity and restrictions on research activities, it is not possible to investigate differences in breeding success at a finer scale. Of the nine nests monitored in the 0–1 km band during this study, 33.3% were successful, while nest success in all other distance bands was 56.0% ($n = 75$). Hen Harrier nest success rates vary considerably throughout their range, and are influenced by many external factors, though they are typically similar or greater than the rates observed in this study for nests located more than 1 km from turbines (Baines & Richardson 2013, McMillan 2014). Relationships between the presence of wind turbines and the breeding success of local

bird populations have been the subject of few investigations to date. From the available literature on this topic it appears that such relationships are species and/or area specific (Dahl *et al.* 2012, Martínez-Abraín *et al.* 2012, Hatchett *et al.* 2013). Even where impacts on reproductive success are reported, these do not necessarily translate into negative population level effects (Martínez-Abraín *et al.* 2012). However, impacts which of themselves do not impact significantly on a bird species may, when combined with other effects, lead to cumulative negative impacts (Masden 2010, Schaub 2012).

No trend in fledged brood size with increasing distance from wind farms was observed, suggesting that any potential impact of wind turbines on Hen Harrier breeding output is mediated through nest success rather than clutch or brood sizes. The apparent lower productivity (average number of fledglings per nesting attempt) close to turbines in this study, although not statistically significant, may be the result of failed nesting attempts (66.7%), rather than reduced performance of those nests producing fledglings. A similar phenomenon has been reported for a wind farm in Norway in an area occupied by breeding White-tailed Eagles *Haliaeetus albicilla*, where reduced breeding success within 0.5 km of wind turbines was the result of abandonment of territories rather than a reduction in fledged brood size at nests close to turbines (Dahl *et al.* 2012). Although the impacts of wind farms on breeding productivity are recognised as being a crucial determinant of a population level impact (Drewitt & Langston 2006), the scientific literature currently available relates only to impacts on abundance and distribution, while the current study is the first of its kind on the effects on breeding output. Human activities (such as recreation, forestry operations and wind farm development) have been reported to impact on Hen Harriers at distances ranging between 0.5 km and 1 km (Ruddock & Whitfield 2007), while reduced densities of Hen Harriers have sometimes been reported within 0.5 km of operational wind turbines (Pearce-Higgins *et al.* 2009b). Research on the spatial ecology of Hen Harriers has shown that foraging females spend most of their time within 1 km of the nest, while males hunt mostly within 2 km of the nest (Arroyo *et al.* 2009, Irwin *et al.* 2012). Therefore, landscape and habitat changes within 1 km of the nest may influence the foraging behaviour of both male and female Hen Harriers, while changes up to 2 km from the nest are more likely to affect males only (Arroyo *et al.* 2014). In the context of the current study this suggests that, if wind farm presence does have an effect on breeding Hen Harriers, this is most likely to affect nests located within 1 km of wind farms, where the overlap between turbines (and associated infrastructure) and the areas used for foraging by breeding birds is likely to be greatest.

Nest success, productivity and fledged brood size observed in the current study are consistent with those



Plate 68. Female Hen Harrier (Neill O'Reilly).

reported for Hen Harriers in other parts of the species' range (Fielding *et al.* 2011, McMillan 2014). However, considerable variation has been reported in the breeding output of Hen Harrier populations in Scotland (Etheridge *et al.* 1997, Amar *et al.* 2008, Baines *et al.* 2008), England (Natural England 2008), and Ireland (Irwin *et al.* 2011). As a result, establishing clear cause-and-effect relationships regarding Hen Harrier population parameters presents a considerable challenge. In Ireland, geographic variation in breeding output (Irwin *et al.* 2011) and on-going regional declines (Ruddock *et al.* 2012) may hinder attempts to understand the effects of single variables such as wind farm development. A further constraint in research on rare species, and raptors in particular, which occur at low densities is that the sample sizes required for robust statistical analysis are often difficult to achieve (Morrison 1988). Although ecological research benefits from studying abundant species or frequent events to understand natural processes, rare species are often of higher ecological, conservation, management and policy interest. This is particularly true of the interaction between Hen Harriers and

existing and planned wind farms in the Irish landscape. As the study of such interactions will typically be based on small sample sizes, the use of a standard set of statistical tools may be difficult or inappropriate, making statistical analyses difficult to obtain where they are most needed (Ellison & Agrawal 2005). Despite using the largest existing data set on breeding Hen Harriers in Ireland, the sample size available for some distance bands in this study was notably small, calling for precautionary interpretation of results. This is of particular importance when interpreting observed differences which, although not statistically significant, may be biologically meaningful (Martínez-Abraín 2008).

Over most of terrestrial Ireland, wind farms tend to be situated at higher elevations than the majority of the surrounding land. This means that their placement is non-random with respect to other land uses and habitat types that have been associated with Hen Harrier distribution, breeding activity and nest success. These include commercial forestry (Madders 2003, Wilson *et al.* 2012), heather-dominated habitats (Arroyo *et al.* 2009, Redpath *et al.* 1998) and intensive



Plate 69. Hen Harriers (Usna Keating).

farmland (Arroyo *et al.* 2009, Wilson *et al.* 2009). It is possible, therefore, that any observed relationships between wind farm proximity and Hen Harrier breeding success, such as those discussed here, may be wholly or partly due to the influence of landscape elements which may be linked to wind farm developments (e.g. changes in land use associated with wind farm construction) (Nayak *et al.* 2010) or to other unrelated practices (e.g. agricultural intensification, afforestation or peat extraction) (O'Leary *et al.* 2000, Amar & Redpath 2005).

The information presented here relates to established operational wind turbines, and it should be noted that the impacts of wind farm construction on breeding Hen Harriers may be of a substantially different nature. Research on other bird species indicates that the construction phase is probably the most critical aspect of wind farm development, and that effects on bird populations reported at operational wind farms may in fact be the result of declines occurring during the construction period (Douglas *et al.* 2011, Pearce-Higgins *et al.* 2012). Little information is available on the effects of wind farm construction activities on breeding Hen Harriers, although disruption at distances of up to 1 km has been reported (Ruddock & Whitfield 2007). The Bird Sensitivity Mapping tool recently developed by BirdWatch Ireland, provides detailed guidance on conservation and an indication of the areas where Hen Harriers are most sensitive to wind energy development (McGuinness *et al.* 2015).

Implications for conservation

Although no statistically significant impact of wind turbines on Hen Harrier breeding performance was detected in the current study, a pattern of reduced nest success and productivity was observed within a 1 km radius of wind turbines. Careful location of wind farms and turbines could mitigate potential negative effects (De Lucas *et al.* 2007), and the findings of this study suggest that the location of Hen Harrier breeding sites should be taken into account at the planning stage of wind farms.

Notwithstanding the limitations discussed above, this study draws upon the most extensive data set available on breeding Hen Harriers in Ireland and improves our understanding of the effects that wind energy development may have on breeding Hen Harriers. However, further work is needed to confirm the extent of these effects. Other lines of research necessary to gain a comprehensive understanding of the overall effects of wind farms on Hen Harriers include studies on the impacts of wind farm construction activities, potential displacement of foraging and nesting Hen Harriers by wind turbines, effects of wind farm developments on Hen Harrier prey availability and abundance, risks of direct mortality by collision with wind turbines, relationships between Hen Harrier breeding success and other potentially confounding landscape variables, and analysis of the effects of wind farm developments at a meta-population scale.

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References

- Amar, A., Arroyo, B., Meek, E., Redpath, S. & Riley, H. 2008. Influence of habitat on breeding performance of Hen Harriers *Circus cyaneus* in Orkney. *Ibis* 150: 400-404.
- Amar, A. & Redpath, S. 2005. Habitat use by Hen Harriers *Circus cyaneus* on Orkney: implications of land use change on this declining population. *Ibis* 147: 37-47.
- Arroyo, B., Amar, A., Leckie, F., Buchanan, G.M., Wilson, J.D. & Redpath, S. 2009. Hunting habitat selection by Hen Harriers on moorland: implications for conservation management. *Biological Conservation* 142: 586-596.
- Arroyo, B., Leckie, F., Amar, A., McCluskie, A. & Redpath, S. 2014. Ranging behaviour of Hen Harriers breeding in Special Protection Areas in Scotland. *Bird Study* 61: 48-55.
- Avery, M. & Leslie, R. 2010. *Birds and Forestry*. Poyser, London.
- Baines, D., Redpath, S., Richardson, M. & Thirgood, S. 2008. The direct and indirect effects of predation by Hen Harriers *Circus cyaneus* on trends in breeding birds on a Scottish grouse moor. *Ibis* 150: 27-36.
- Baines, D. & Richardson, M. 2013. Hen Harriers on a Scottish grouse moor: multiple factors predict breeding density and productivity. *Journal of Applied Ecology* 50: 1397-1405.

- Barton, C., Pollock, C., Norriss, D.W., Nagle, T., Oliver, G.A. & Newton, S. 2006. The second national survey of breeding Hen Harriers *Circus cyaneus* in Ireland 2005. *Irish Birds* 8: 1-20.
- Campedelli, T., Londi, G., Cutini, S., Sorace, A. & Tellini Florenzano, G. 2014. Raptor displacement due to the construction of a wind farm: preliminary results after the first 2 years since the construction. *Ethology, Ecology and Evolution* 26: 376-391.
- Colhoun, K. & Cummins, S. 2013. Birds of Conservation Concern in Ireland 2014-2019. *Irish Birds* 9: 523-544.
- Dahl, E.L., Bevanger, K., Nygård, T., Røskft, E. & Stokke, B.G. 2012. Reduced breeding success in White-tailed Eagles at Smøla windfarm, western Norway, is caused by mortality and displacement. *Biological Conservation* 145: 79-85.
- DCENR. 2012. *Strategy for renewable energy: 2012–2020*. Department of Communications, Energy and Natural Resources, Dublin.
- De Lucas, M., Janss, G.F.E. & Ferrer, M. 2007. *Birds and Wind Farms: risk assessment and mitigation*. Quercus, Madrid.
- Douglas, D.J.T., Bellamy, P.E. & Pearce-Higgins, J.W. 2011. Changes in the abundance and distribution of upland breeding birds at an operational wind farm. *Bird Study* 58: 37-43.
- Drewitt, A.L. & Langston, R.H.W. 2006. Assessing the impacts of wind farms on birds. *Ibis* 148: 29-42.
- Ellison, A.M. & Agrawal, A.A. 2005. The statistics of rarity. *Ecology* 86: 1079-1163.
- Etheridge, B., Summers, R. & Green, R. 1997. The effects of illegal killing and destruction of nests by humans on the population dynamics of the Hen Harrier *Circus cyaneus* in Scotland. *Journal of Applied Ecology*: 1081-1105.
- Fennelly, R. 2015. A review of bird strike mortality at Irish onshore windfarms. In *Practice: Bulletin of the Chartered Institute of Ecology and Environmental Management* 88 (June 2015): 24-28.
- Fielding, A., Haworth, P., Whitfield, P., McLeod, D. & Riley, H. 2011. *A Conservation Framework for Hen Harriers in the United Kingdom*. JNCC Report No. 441. Joint Nature Conservation Committee, Peterborough.
- Garvin, J.C., Jennelle, C.S., Drake, D. & Grodsky, S.M. 2011. Response of raptors to a windfarm. *Journal of Applied Ecology* 48: 199-209.
- Hatchett, E.S., Hale, A.M., Bennett, V.J. & Karsten, K.B. 2013. Wind turbines do not negatively affect nest success in the Dickcissel (*Spiza americana*). *Auk* 130: 520-528.
- Hernández-Pliego, J., de Lucas, M., Muñoz, A-R. & Ferrer, M. 2015. Effects of wind farms on Montagu's Harrier (*Circus pygargus*) in southern Spain. *Biological Conservation* 191: 452-458.
- Howley, M., Holland, M. & O'Rourke, K. 2014. *Renewable energy in Ireland 2012*. Sustainable Energy Authority of Ireland, Dublin.
- Irwin, S., Wilson, M.W., Kelly, T.C., O'Mahony, B., Oliver, G., Troake, P., Ryan, B., Cullen, C., O'Donoghue, B. & O'Halloran, J. 2011. The breeding biology of Hen Harriers *Circus cyaneus* in Ireland over a five year period. *Irish Birds* 9: 165-172.
- Irwin, S., Wilson, M.W., O'Donoghue, B., O'Mahony, B., Kelly, T.C. & O'Halloran, J. 2012. *Optimum scenarios for Hen Harrier conservation in Ireland*. Final Project Report. Prepared for Deptment of Agriculture, Food and the Marine, Dublin.
- IWEA. 2014. Wind farm details by country. <http://www.iwea.com/index.cfm/page/bycounty/id/6>. Accessed on 10th September 014.
- Leung, D.Y.C. & Yang, Y. 2012. Wind energy development and its environmental impact: a review. *Renewable and Sustainable Energy Reviews* 16: 1031-1039.
- Madden, B. & Porter, B. 2007. Do wind turbines displace Hen Harriers *Circus cyaneus* from foraging habitat? Preliminary results of a case study at Derrybrien wind farm, County Galway. *Irish Birds* 8: 231-236.
- Madders, M. 2003. Hen Harrier *Circus cyaneus* foraging activity in relation to habitat and prey. *Bird Study* 50: 55-60.
- Madders, M. & Whitfield, D.P. 2006. Upland raptors and the assessment of wind farm impacts. *Ibis* 148: 43-56.
- Martínez-Abraín, A. 2008. Statistical significance and biological relevance: a call for a more cautious interpretation of results in ecology. *Acta Oecologia* 34: 9-11.
- Martínez-Abraín, A., Tavecchia, G., Regan, H.M., Jiménez, J., Surroca, M. & Oro, D. 2012. Effects of wind farms and food scarcity on a large scavenging bird species following an epidemic of bovine spongiform encephalopathy. *Journal of Applied Ecology* 49: 109-117.
- Masden, E.A. 2010. *Assessing the cumulative impacts of wind farms on birds*. Ph.D. thesis, University of Glasgow, Glasgow.
- May, R., Reitan, O., Bevanger, K., Lorentsen, S.H. & Nygård, T. 2015. Mitigating wind-turbine induced avian mortality: sensory, aerodynamic and cognitive constraints and options. *Renewable and Sustainable Energy Reviews* 42: 170-181.
- McCluskie, A. 2015. Raptors and wind farms in Scotland. In Redpath, S.M., Gutiérrez, R.J., Wood, K.A., Evely, A. & Young, J.C. (eds). *Conflicts in Conservation*. pp 149-151. Cambridge University Press, Cambridge.
- McGuinness, S., Muldoon, C., Tierney, N., Cummins, S., Murray, A., Egan, S. & Crowe, O. 2015. *Bird sensitivity mapping for wind energy developments and associated infrastructure in the Republic of Ireland*. BirdWatch Ireland, Kilcoole.
- McMillan, R.L. 2014. Hen Harriers; nest failures and predation on Skye. *Scottish Birds* 34: 30-39.
- Morrison, M.L. 1988. Minireview: on sample sizes and reliable information. *Condor*: 275-278.
- Natural England. 2008. *A future for the Hen Harrier in England?* Natural England, United Kingdom.
- Nayak, D., Miller, D., Nolan, A., Smith, P. & Smith, J. 2010. Calculating carbon budgets of wind farms on Scottish peatlands. *Mires and Peat* 4: 1-23.
- Norriss, D.W., Marsh, J., McMahon, D. & Oliver, G.A. 2002. A national survey of breeding Hen Harriers *Circus cyaneus* in Ireland 1998-2000. *Irish Birds* 7: 1-10.
- Northrup, J.M. & Wittemyer, G. 2013. Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation. *Ecology Letters* 16: 112-125.
- O'Flynn, W.J. 1983. Population changes of the Hen Harrier in Ireland. *Irish Birds* 2: 337-343.
- OJEU. 2010. EC Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. *Official Journal of the European Union* L 20 (26 January 2010): 7-25.
- O'Leary, T.N., McCormack, A.G. & Peter Clinch, J. 2000. Afforestation in Ireland—regional differences in attitude. *Land Use Policy* 17: 39-48.

- Pearce-Higgins, J.W., Grand, M.C., Beale, C.M., Buchanan, G.M. & Sim, I.M.W. 2009a. International importance and rivers of change of upland bird populations. In Bonn, A., Allott, T., Hubacek, K. & Stewart, J. (eds). *Drivers of environmental change in the uplands*. pp 209-227. Routledge, Abingdon.
- Pearce-Higgins, J.W., Stephen, L., Langston, R.H., Bainbridge, I.P. & Bullman, R. 2009b. The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology* 46: 1323-1331.
- Pearce-Higgins, J.W., Stephen, L., Douse, A. & Langston, R.H.W. 2012. Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. *Journal of Applied Ecology* 49: 386-394.
- Percival, S.M. 2003. *Birds and wind farms in Ireland: a review of potential issues and impact assessment*. Ecology Consulting. http://www.seai.ie/Archive1/Files_Misc/AssessmentMethodologyBirdsIreland.pdf.
- Redpath, S., Madders, M., Donnelly, E., Anderson, B., Thirgood, S., Martin, A. & McLeod, D. 1998. Nest site selection by Hen Harriers in Scotland. *Bird Study* 45: 51-61.
- Robson, P. 2011. Review of Hen Harrier breeding and flight activity near a windfarm in Argyll. In *Conference on Wind Energy and Wildlife Impacts*. Trondheim, Norway. May 2011.
- Rourke, F.O., Boyle, F. & Reynolds, A. 2009. Renewable energy resources and technologies applicable to Ireland. *Renewable and Sustainable Energy Reviews* 13: 1975-1984.
- Ruddock, M., Dunlop, B.J., O'Toole, L., Mee, A. & Nagle, T. 2012. *Republic of Ireland National Hen Harrier survey 2010*. Irish Wildlife Manual, No. 59. National Parks and Wildlife Service, Dublin.
- Ruddock, M. & Whitfield, D. 2007. A review of disturbance distances in selected bird species. A report from Natural Research (Projects) Ltd. to Scottish Natural Heritage.
- Scannell, Y. 2011. Renewable energy policies, programmes and progress in Ireland. *Journal of Energy and Natural Resources* 155: 155-176.
- Schaub, M. 2012. Spatial distributions of wind turbines is crucial for the survival of Red Kite populations. *Biological Conservation* 155: 111-118.
- Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. *Environmental Conservation* 34: 1-11.
- Whitfield, D.P. & Madders, M. 2006. *A review of the impacts of wind farms on Hen Harriers Circus cyaneus and an estimation of collision avoidance rates*. Natural Research Information Note 1 (revised). Natural Research Ltd., Banchory.
- Wilson, M.W., Irwin, S., Norriss, D.W., Newton, S.F., Collins, K., Kelly, T.C. & O'Halloran, J. 2009. The importance of pre-thicket conifer plantations for nesting Hen Harriers *Circus cyaneus* in Ireland. *Ibis* 151: 332-343.
- Wilson, M.W., O'Donoghue, B., O'Mahony, B., Cullen, C., O'Donoghue, T., Oliver, G., Ryan, B., Troake, P., Irwin, S., Kelly, T.C., Rotella, J.J. & O'Halloran, J. 2012. Mismatches between breeding success and habitat preferences in Hen Harriers *Circus cyaneus* breeding in forested landscapes. *Ibis* 154: 578-589.



Rialtas na hÉireann
Government of Ireland

Hen Harrier Threat Response Plan 2024-2028

Prepared by
National Parks and Wildlife Service,
Department of Housing, Local Government and Heritage,
Department of Agriculture, Food and the Marine, and
Department of Environment, Climate and Communications

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Foreword



Malcolm Noonan T.D.

Minister of State for Nature, Heritage and Electoral Reform

In March of this year, the National Parks and Wildlife Service published the most recent estimates of the Hen Harrier population in Ireland. The figures were stark, showing it having declined by a third in just 7 years, and sending a clear signal, if it were still needed, that significant action needs to be taken urgently to halt and reverse this decline. Any other alternative may well mean that the Hen Harrier, the skydancer, may become extinct here in my lifetime. The plight of this iconic species, which is of value in its own right, is also symptomatic of the wider challenge we face, nationally and globally, to address the biodiversity and climate change crises while simultaneously evolving more sustainable development models in key sectors.

The Hen Harrier Threat Response Plan was initially instigated a decade ago to tackle the species' decline with an ambition to tackle the three primary pressures and threats acting on it: agriculture, forestry and renewable energy. These pressures act at the landscape scale and in a cumulative manner; collective action is required across these sectors in a coordinated and collaborative manner if real improvements are to be made to the Hen Harrier's fortunes. The species cannot countenance any further delay in the adoption of this Plan and its rapid implementation, if it is to be effective.

A public consultation was conducted to garner views on the actions needed in the Plan to achieve its ambition. Over 2,200 responses were received, and perhaps unsurprisingly, some respondents called for actions to which other respondents were diametrically opposed. In adopting this Plan, Government is making clear its

commitment to putting its obligations to this species, and to biodiversity more generally, at the heart of decision-making.

The Plan includes clear actions to be taken across the public sector, both within Hen Harrier Special Protection Areas and outside them, commencing immediately. The implementation of the Plan will be monitored, reviewed and updated as needed at the mid-term point, and while the Plan covers a five-year period, longer term action over the coming decades will be essential for its success.

Landowner engagement and supports will also be critical in defining the Plan's success, and is recognised within it. Over the years, there have been various initiatives at different scales to build collaborative conservation management models and this area will need to continue to evolve and expand with key stakeholders across the sectors. While this is a challenging moment in the natural history of the species, it is also an opportunity to deliver meaningful change to the management of our landscape and our natural heritage, while supporting stakeholders to engage in a mutually beneficial and collaborative manner. I would like to conclude by thanking all those who have engaged with the development of this Plan since its inception and look forward to working together to deliver it successfully.

1 Context

1.1 The Hen Harrier in Ireland

The Hen Harrier (*Circus cyaneus*) is a territorial ground-nesting bird of prey that typically breeds in open upland bog, heather moorland, and their associated habitats, and is in decline. The 2015 National Hen Harrier Survey estimated the breeding population to be between 108 and 157 pairs in the Republic of Ireland. The 2022 survey has reported further population declines and a diminished range, with the breeding population now estimated to be between 85 and 106 pairs. Outside the breeding season, it ranges more widely across both upland and lowland areas. See Section 4 for more detail on population status.



Photo 1: A male Hen Harrier in flight. Credit: Mark Carmody.

The species is listed in Annex I of the EU Birds Directive (2009/147/EC) and as a result of obligations arising from it, six SPAs (Special Protection Areas) have been designated here for the conservation of its breeding habitat and population, covering a large area (169,118 ha). Two further SPAs have been designated for the wintering population (See Figure 1). The 2022 survey documents reduced range for the species in both the wider countryside and within SPAs.

Along with a number of other species and habitats, the Hen Harrier's decline is due to a number of factors, but primarily the loss of suitable habitat through afforestation/forest maturation, agricultural reclamation and intensification, and wind energy development. Some of these land-use changes may also cause unsustainable rates of nest loss, due to increased levels of associated predation. In addition, there is a very low survival rate for juvenile birds through their first winter.



Photo 2: A foraging Hen Harrier. Credit: Mark Carmody.

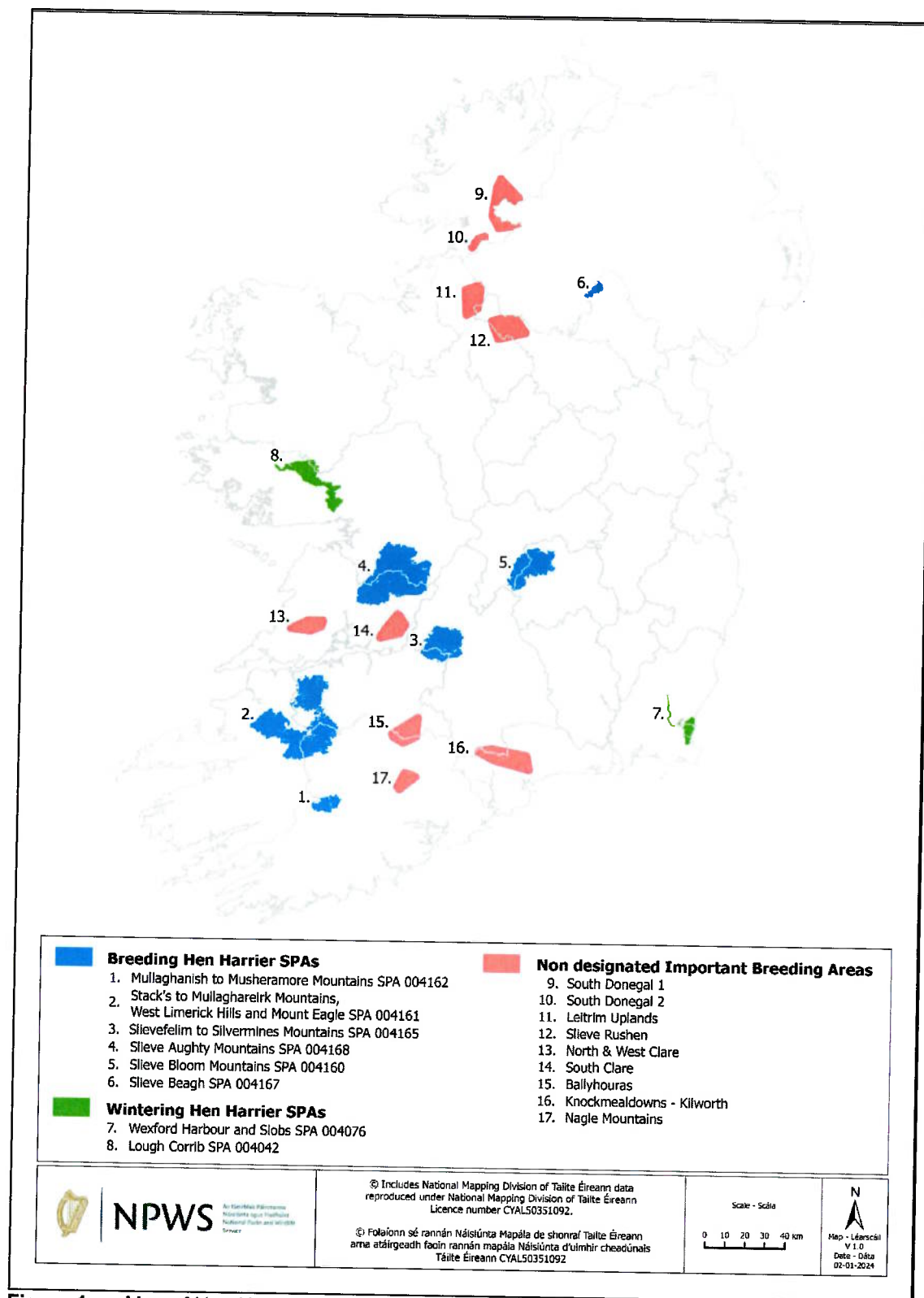


Figure 1. Map of Hen Harrier breeding and wintering SPAs, and non-designated regionally important breeding areas.

The overall aim of the Birds and Habitats Directives (under which Special Areas of Conservation are designated) is to maintain or restore the favourable conservation status of the most threatened species and habitats across the EU. Ireland's SPAs and SACs are referred to as "**European sites**"¹ and contribute to an EU-wide network known as "**Natura 2000**". The restoration and maintenance of habitats and species within Natura 2000 sites at favourable conservation condition is to contribute to the overall achievement and maintenance of favourable conservation status of those habitats and species at a national and EU level.

Article 6 of the Habitats Directive sets out a number of provisions that govern the management of SACs, and through Article 7, the provisions of Articles 6(2), (3) and (4) extend to the SPAs. Specifically, Article 6(2) makes provision for the avoidance of habitat deterioration and significant disturbance of species and Article 6(3) sets out the requirement for safeguards governing plans and projects likely to have a significant effect on a Natura 2000 site. Article 6(4) sets out the conditions under which a plan or project may proceed, even if it has negative implications for the integrity of a Natura 2000 site/s. These obligations are transposed in Ireland through a range of legal instruments, including the European Communities (Birds and Natural Habitats) Regulations 2011–2021², as well as associated Acts and Regulations governing planning (including wind energy development), forestry and agricultural development. These afford protections to the Hen Harrier and its habitats within the SPAs.

Furthermore, the Hen Harrier is afforded a level of protection in the wider countryside by Article 4 (4) of the Birds Directive, which states that, outside SPAs, "**Member States shall also strive to avoid pollution or deterioration of habitats**". This requirement is reflective of the fact that although areas may not be identified as appropriate for classification as SPAs for particular bird species, birds rely on movement throughout the countryside to support a range of important behaviours and ecological requirements. In its findings against Ireland on the Birds Case (418/04)³, the European Court of justice found that Ireland had failed to both transpose and apply this requirement fully and correctly. Since 2011, this obligation has been transposed in

¹ European Communities (Birds and Natural Habitats) Regulations 2011-2021.

² Hereafter, "the Regulations".

³ For further information on the Birds Case judgment and Ireland's Programme of Measures to reach compliance, please see <https://www.npws.ie/legislation/eu-directives/birds-directive>

Ireland to all public authorities when carrying out their functions or responsibilities through the Regulations (Regulation 27) i.e. to strive to avoid pollution or deterioration of habitats, outside SPAs. Thus, there is an obligation on public authorities to take steps in their decision-making to **strive to avoid pollution or deterioration of [Hen Harrier] habitats, outside SPAs when making their decisions and providing consents.**

Following the designation of the six breeding Hen Harrier SPAs in 2007, an agreement (the “Hen Harrier Protocol”) was reached between the Department of Agriculture, Food and the Marine–Forestry (DAFM–Forestry), NPWS, landowner representatives and forest industry interests, on the management of afforestation within the SPAs. However, the European Commission considered the protocol to be a “plan”, and as such, it could not lawfully be applied in the absence of a strategic environmental assessment. On foot of that and other concerns, the Protocol was suspended. It was then agreed that a Threat Response Plan (under Regulation 39 of the Regulations, Appendix 1) (see Section 2) would be prepared that would address issues that had been identified as affecting land use in the Hen Harrier SPAs, as well as affecting the conservation status of the species. The three key sectoral pressures (agriculture, wind energy development and forestry) were prioritised for attention in the development of this Threat Response Plan.

This Threat Response Plan recognises that landowners who depend on the land within Hen Harrier SPAs for their livelihood, and upon whom the Hen Harrier depends for its habitat, must be supported and incentivised implement management measures relating to Hen Harrier conservation, whether the land is farmed or afforested. This will be taken into consideration in the design of agri-environmental or similar schemes. Regulation 39 recognises that threat response plans, such as this, may need to be supported by sectoral incentive measures.

In order for this Plan to be effective, it will be important that landowners can benefit from taking action to improve the condition of Hen Harrier habitat, and thus, the potential for increasing the number of birds that use their lands. This can only be successful if adequate support (financial and otherwise) is in place to enable farmers and other landowners to manage their land appropriately for Hen Harrier. Such efforts will likely deliver benefits across a range of ecological interests, if planned

appropriately, improving the conservation status of bog and grassland habitats, associated species and delivering benefits to carbon sequestration, water storage/flood attenuation and other ecosystem services

1.2 Policy Context

In growing recognition of the importance of reversing biodiversity decline and its interactions with climate change adaptation and mitigation, international and EU biodiversity policies are being strengthened. At the UN High-Level Summit for Biodiversity in September 2020, An Taoiseach signed up to the Leaders' Pledge for Nature which supports the 30/30 targets and calls for an ambitious and meaningful post-2020 global agreement that will address the biodiversity crisis and help bring about the transformative change needed to halt biodiversity loss on a global level.

In order to achieve the above, and to deliver the ambition of this Threat Response Plan, its objectives will need to be closely aligned with and considered in the development of other government plans and policies, including for example, the River Basin Management Plans, Climate Action Plans, the National Restoration Plan and the National Land Use Review. Some of the most pertinent policy and plan commitments are set out in more detail below.

1.2.1 Biodiversity and Nature:

At the international level, the Convention on Biological Diversity has agreed the post-2020 global biodiversity framework, with four goals and 23 targets for achievement by 2030. These include

- To have effective conservation and management of at least 30% of the world's lands, inland waters, coastal areas and oceans, with emphasis on areas of particular importance for biodiversity and ecosystem functioning and services
- To have restoration completed or underway on at least 30% of degraded terrestrial, inland waters, and coastal and marine ecosystems

and a goal of

- Halting of human-induced extinction of known threatened species, increasing the abundance of native wild species to healthy and resilient levels.

The EU has published its European Green Deal and its constituent element, the EU Biodiversity Strategy to 2030, which is intended to support a green recovery following the Covid-19 pandemic. The Strategy's objective is to put the EU's biodiversity on the path to recovery by 2030 and that by 2050, all of the EU's ecosystems are restored, resilient and adequately protected. It contains specific actions and commitments, including:

- Establishing a larger EU wide network of protected areas on land and at sea by 2030 (30% on both land and sea, 10% of both being strictly protected)
- Establishing a Nature Restoration Plan, with legally-binding restoration targets
- Unlocking funding for transformative change and a strengthened governance framework.

The Biodiversity Strategy also includes a requirement that Member States ensure that at least 30% of species and habitats not currently in favourable conservation status achieve that status or show a strong positive trend by 2030, and that none show further signs of deterioration. The Nature Restoration Regulation aims to complement existing EU environmental policy and legislation. It is intended to work effectively in synergy with other EU environmental laws, primarily the Habitats Directive, but also the Birds Directive, the Water Framework Directive, the Marine Strategy Framework Directive and the Invasive Alien Species Regulation. It also will align with the Common Fisheries Policy, the Common Agricultural Policy, the EU Soils Strategy, the EU Green Infrastructure Strategy and the new EU Forest Strategy for 2030.

Restoring ecosystems is also necessary for the EU to meet its commitments under the United Nations Framework Convention on Climate Change, and the Paris Agreement. The links between biodiversity-rich environments and climate resilience are recognised in our National Climate Objective under the Climate Action and Low Carbon Development (Amendment) Act 2021. The regulation requires Member States to establish and implement measures to restore at least 20% of the EU's land and sea areas by 2030. Member States will also be required to develop national restoration plans and report on progress made.

Ireland's 4th National Biodiversity Action Plan was published in January 2024, and reflects these changing global, European and national contexts. The Plan sets the national biodiversity agenda up until 2030 and aims to deliver transformative changes

in how we value and protect nature. It strives for a “whole of government, whole of society” approach to the governance.

The Nature Restoration Regulation has been adopted by the EU level and it sets specific, legally binding targets and obligations for nature restoration, and aims to mitigate climate change and the impacts of natural disasters. Ireland’s 4th National Biodiversity Plan commits to the publication of a National Restoration Plan by 2026, to ensure there are synergies within that Plan between nature restoration, that climate change mitigation/adaptation and disaster prevention that will be prioritised, and to ensure implementation of the Plan has commenced by 2027. Furthermore, the publication of this Plan contributes to the delivery of Action 2A5, concerning the publication and implementation of Threat Response Plans for species that are in decline. As such, measures included in the Plan will be eligible for funding under the Climate and Nature Fund.

1.2.2 Renewable energy

European energy policy context is also rapidly evolving, particularly in view of the conflict in Ukraine and energy security pressures, with the EU deciding in early 2023 on targeted amendments to the renewable energy directive⁴. Dedicated areas are to be identified at the Member State level to facilitate accelerated permitting of renewable energy developments in areas that are particularly suitable for specific renewable energy technologies and that present lower risks for the environment; these areas are to exclude Natura 2000 sites⁴. In addition, the revised Directive sets out that renewable energy projects are to be presumed to be of overriding public interest, as per Article 6(4) of the Habitats Directive, serving public health and safety, and contains provisions intended to expedite the permitting processes⁵ for renewables in certain instances.

The 2006 Wind Energy Development Guidelines are being updated to provide guidance in line with renewable energy and climate targets, including the revised 2030 target to generate 80% of Ireland’s electricity from renewable sources, whilst having

⁴ For further details, see Proposed Amendments to the EU Renewable Energy Directive 2018/2001 of the European Parliament and of the Council (Update June 2023)
<https://www.consilium.europa.eu/media/65109/st10794-en23.pdf>

⁵ For further detail, please see [Renewable energy roll-out ahead of REPowerEU anniversary](#) (europa.eu), available as of 24th May 2024

appropriate regard to the impacts of wind energy development. The changing and continuously evolving policy and technical context reinforces the need to ensure that the finalised Guidelines, once issued, are up-to-date and fit for purpose.

1.2.3 Climate Action

Ireland's Climate Action Plan (CAP) lays out a roadmap of actions to deliver the national climate objective of transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy. The 2024 updated CAP sets out a roadmap to halve emissions by 2030 and reach net zero no later than 2050. CAP2024 recognises the need to safeguard natural habitats and biodiversity, the threat posed to them by climate change and the importance of protecting biodiversity as a fundamental part of climate-resilient development, and the importance of nature-based solutions. It is important to recognise that many areas that are important for hen harrier also have potential for delivering renewable energy development, including through the repowering of existing developments. The implications of these for the hen harrier are to be considered in view of protections afforded to it by Article 6(3) and 6(4) of the Habitats Directive and those afforded to it in the wider countryside by Article 4(4) of the Birds Directive.

1.2.4 Land use

The Programme for Government: Our Shared Future committed to 'undertaking a national land use review, including farmland, forest and peatlands, so that optimal land-use options inform all relevant Government decisions'. The Department for the Environment, Climate and Communications are the lead Government Department for the Land-use Review, along with the Department of Agriculture, Food and the Marine and the Department of Housing, Local Government and Heritage. The review is being undertaken in two phases. Phase 1 of the Review, compiling the evidence base to determine the environmental, ecological and economic characteristics of land types across the State was completed in March 2023⁶. Phase 2 following on from the first shall further develop the knowledge, analysis and shared understanding necessary for consideration of how Ireland's land can be used in a way that meets the Government objective of improving socioeconomic, climate, biodiversity, water, and air quality

⁶ Further information and publications available at <https://www.gov.ie/en/publication/f272c-land-use-review-phase-1/>, as accessed 27th March 2024.

outcomes. The first phase incorporated full consideration of European sites (SACs and SPAs), and therefore will inform Phase 2. Given the ecology of the Hen Harrier, obligations to protect birds in the wider countryside and the nature of the pressures and threats facing them, consideration of this Threat Response Plan and its objectives are highly relevant to the Land Use Review. Phase 2 will be completed by the end of Q1 2025.

1.2.5 Forestry

Coillte, the State forestry company, is the majority forestry owner with the breeding Hen Harrier SPAs, with its estate amounting to approximately 40% of their total land area, or 68,000 hectares (ha). It is envisioned that the majority of forestry actions will be undertaken on State-owned (i.e. Coillte) lands, in order to minimise effects on private landowners, while still achieving the necessary benefits for Hen Harrier.

Coillte's purpose is now to deliver multiple benefits from its forests in relation to climate, nature, word and people, and to enable a vibrant forestry sector⁷. Forestry is also part of Ireland's response to climate change, with forestry being a component of the Climate Action Strategy, e.g. to replace more energy and carbon-intensive steel. Coillte is committed to extending the area of its estate that is managed primarily for biodiversity. These commitments include:

- Enhancing and restoring biodiversity by increasing the area of the estate managed primarily for nature from 20% to 30% by 2025.
- Redesigning 30,000 hectares of peatland forest for climate and ecological benefits by 2050
- Transforming areas of its forests so that 50% of its estate is managed primarily for nature in the long term.

There is significant scope within these commitments to initiate habitat restoration measures for the Hen Harrier. However, the implementation of the forestry actions needed to reverse the decline of Hen Harrier and the achievement of the conservation objectives will be challenging and potentially give rise to conflicts with the management of forestry practices that are aimed at minimising the effect on other sensitive

⁷ Coillte (2023). Strategic Vision for our Future Forest Estate. Coillte, Newtownmountkennedy, Wicklow.

environmental receptors, and for carbon storage. Coillte have started undertaking feasibility studies and research to assess the implications of these for its forestry management in the SPAs in the coming years, as the objectives require significant restructuring of the forest to achieve optimal forest design at the landscape level for this species. Collaboration between NPWS and Coillte will be progressed in the Coillte estate in the Slieve Bloom Mountains SPA, with a view to improving the management of these lands for biodiversity and for Hen Harrier. Consideration will be given to forest redesign and improving and restoring habitat for the species in strategically important areas of the estate. This pilot approach will provide a roadmap for similar approaches in other SPAs in due course.

2 Threat Response Plans

Regulation 9 of the Regulations obliges the Minister to identify threats to bird species referred to in Article 1 of the Birds Directive (including Hen Harrier) and to the integrity of European sites, **“for the purpose of developing such measures as he or she considers necessary including, where appropriate, threat response plans under Regulation 39”**. Regulation 39 provides for the preparation and implementation of such Threat Response Plans, and sets out how such a Plan is to be developed in order to meet the obligations of the Birds Directive (see Appendix 1). All public authorities must take account of relevant Threat Response Plans relevant to their functions, in the undertaking of those functions and responsibilities (Regulation 27) and the Minister may request a public authority to take such steps as the Minister considers are necessary to ensure compliance with the Plan.

The aim of the Hen Harrier Threat Response Plan is to improve the long-term prospects for the species and to meet the objectives of the Birds Directive by

- **synthesising the key scientific evidence for the Hen Harrier population decline,**
- **outlining the views and concerns presented by the relevant sectors,**
- **laying out a coordinated set of targeted actions and measures to cease, avoid, reverse, reduce, eliminate or prevent the identified threats, pressures and hazards.**

An interdepartmental Steering Group (IDSG), comprising representatives from the government departments responsible for policies concerning wind energy development, planning, forestry and agriculture (now the Department of Housing, Local Government and Heritage; Department of Environment, Climate and Communications, and Department of Agriculture, Food and the Marine), was established in 2014 to oversee the preparation of the Plan. The Terms of Reference of the IDSG are set out in Appendix 2.

In order to effectively reverse the ongoing decline of the Hen Harrier and achieve the objective of the Threat Response Plan, all efforts to do so must be undertaken in conjunction with relevant landowners and stakeholders. A Consultative Committee, with representation from key sectors (forestry, agriculture, wind energy, landowners

and environmental NGOs), was subsequently convened in 2015 to facilitate stakeholder engagement and provide cross-sectoral insights to support the Plan's development. The membership of this Committee is set out in Appendix 3.

In accordance with the Regulations, the approach taken to develop and implement the Threat Response Plan with both the Inter-Departmental Steering Group and Consultative Committee was as follows:

- establish the threats that affect the survival of Hen Harrier,
- understand the context of the activities that may impact Hen Harrier, and the concerns of stakeholders affected (see Appendix 4),
- develop a shared understanding of conflicts and the conservation requirements of Hen Harrier,
- build a consensus on how to reach those requirements,
- set out and implement the necessary measures,
- monitor the outcomes.

Three sector-specific reports on forestry, agriculture and wind energy development were commissioned by NPWS (NPWS 2015a, 2015b and 2022), and reviewed by the relevant members of the Inter-Departmental Steering Group, to inform the development of the Threat Response Plan and the measures needed to “**cease, avoid, reverse, reduce, eliminate or prevent the threat, pressure, hazard, combination of threats, pressures or hazards, adverse effect, pollution, deterioration or disturbance**”. These reports are available on the NPWS website and should be consulted for further information on each sector and their interactions with Hen Harrier.

NPWS also commissioned the “Hen Harrier Special Protection Area Habitat Mapping Project” in 2014 to further support the Plan's development. Its purpose was to provide mapping at a scale adequate for its use as a tool for conservation management and appropriate assessment, as well as providing a baseline for monitoring habitat change within the breeding Hen Harrier SPAs (Department of Arts, Heritage and the Gaeltacht, 2015). Digital habitat maps of the six breeding Hen Harrier SPAs were produced, using

remote sensing and existing spatial datasets. The outputs of this project are available for viewing online on the Hen Harrier SPA Habitat Map Online Viewer⁸.

More recently, recreational pressure has been raised by stakeholders as an increasing pressure, particularly due to changing recreation patterns arising from the Covid 19 pandemic as well as the development of recreational plans and infrastructure in areas important for Hen Harrier. Others have raised the issues of burning and peat extraction.

2.1 Public Consultation

As set out in Regulations 39 and 21 of the Regulations, the Minister was required to carry out a public consultation on this Threat Response Plan. It was also determined that a Strategic Environmental Assessment (SEA) was required of the draft Plan, as well as an Appropriate Assessment (AA) (pursuant to Regulation 42a of the Regulations). A public consultation on the draft Plan, Natura Impact Statement, SEA Non-Technical Summary and Environmental Report was undertaken in January and February 2024.

Over 2,500 responses to the public consultation were received from the general public, public authorities, conservation non-governmental organisations, private individuals (including landowners and farmers), community and development groups, professional ecologists and representatives of the wind energy development, forestry, agriculture and recreational sectors. Further details are available on www.gov.ie.

⁸ As of December 2023

<http://dahg.maps.arcgis.com/apps/webappviewer/index.html?id=a964809ffbad4c16ae2c4ec72f5d3921>.

3 Hen Harrier Conservation Objectives

Article 1 of the Habitats Directive states that:

“The conservation status of a species will be taken as “favourable” when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.”

Favourable conservation status is assessed at the national level, rather than at the level of the SPA network i.e. it is not assessed solely on the basis of the population and range that occurs within the SPAs, but on the basis of the entire national population, occurring both within and outside the SPAs (i.e. its full natural range).

Site-specific conservation objectives have been published for the six breeding and two wintering Hen Harrier SPAs. Using the parameters that define favourable conservation status of species, specific attributes for the species and its supporting habitat are set, along with targets that define the favourable reference value for that attribute. Following the conclusion of relevant research outputs from the Hen Harrier Programme and the mid-term review of this Plan in 2026, the conservation objectives will be reviewed with a view to their update, if deemed necessary.

An SPA-network-level conservation objective has also been set, informed by the site-level objectives, so that the breeding SPA network will operate as a coherent whole, and effects that may arise on one SPA can be considered in the context of the whole network.

Due to the proportion of the Hen Harrier population that occurs outside the SPA network, it is also the Department’s intention to commence development of a national conservation objective for the species, and to explore the establishment of an all-Ireland objective with Northern Ireland. In order to better understand and assess the biogeographical importance of the Irish population, the national objective will consider the 2023 population estimate results for Great Britain.

4 The Population Status of Hen Harrier

National population surveys were carried out in 1998–2000, 2005, 2010, 2015 and 2022 (having been postponed in 2020 due to the Covid-19 pandemic) (See Figure 2). The 2015 survey estimated a breeding population of between 108 and 157 pairs in the Republic of Ireland, and based on a sub-set analyses (Ruddock *et al.*, 2016), an estimated decrease of 16% since the 2010 national survey and 34% since the 1998–2000 survey. As of 2022, and based on comparison with totals presented in Ruddock *et al.* (2016), the total SPA population had declined by 10.1% since 2015, 19.5% since 2010 and by 34% since 2005 (see Figure 2, Table 1). The 2015 survey showed that breeding Hen Harrier still occurred in all six breeding population SPAs. It also identified nine other non-designated areas as being important breeding locations for the species (referred to as “non-designated regionally important breeding areas”, see Figure 1).

Published 2021 figures from the Hen Harrier Programme indicate that the then total population in the SPAs stood at 62 territorial pairs, with an average of 66 territorial pairs since 2017 for the SPAs. The Hen Harrier population in Ireland was estimated at 85 confirmed and 21 possible breeding pairs (85–106) in 2022. This is a decline of one third (33%) in the total population since the previous national survey in 2015 and a 27% contraction in their breeding range for the same period. The data also indicates that declines in both range and population have occurred in the short-term (since 2015); medium term (since 2010/2005) and long-term (since 1998–2000).

The populations of five of the SPAs have declined by between 20% and 80% since 2007, when they were identified for designation. In the same period, the population for only one SPA has increased (12%). Overall, the SPA populations have declined by more than half (54%) in the same period.

The breeding population continues to be Amber-listed on BirdWatch Ireland’s most recent Birds of Conservation Concern Ireland (BOCCI) (2020–2026).

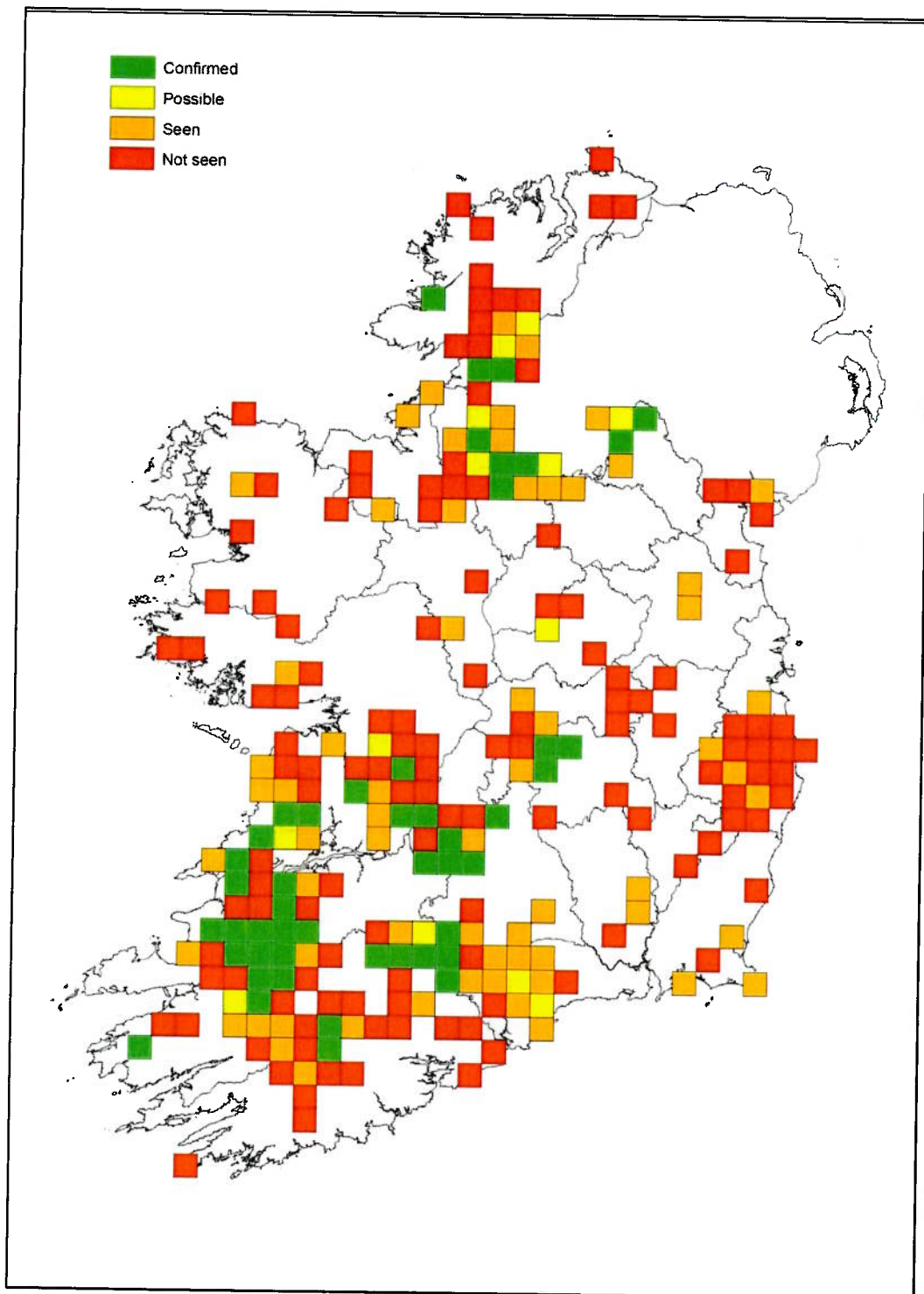


Figure 2. 2022 distribution of breeding Hen Harrier in Ireland in 10 km squares, classified by breeding status. From Ruddock *et al.* (2024).

Table 1. National (minimum, maximum and mid-point) population estimates between 1998–2000 (Norris *et al.*, 2002); 2005 (Barton *et al.*, 2006); 2010 (Ruddock *et al.*, 2012), 2015 (Ruddock *et al.*, 2016) and 2022 (Ruddock *et al.*, 2024).

Breeding Status	1998–2000	2005	2010	2015	2022	% change 2015–2022
Confirmed	102	132	128	108	85	-21%
Possible	27	21	44	49	21	-57%
Confirmed + Possible	129	153	172	157	106	-33%
Mid-Point	11.5	142.5	150	132.5	95.5	-28%
Range	102–129	132–153	128–172	108–157	85–106	-

The most recent available survey data for the breeding Hen Harrier population in Northern Ireland estimated that the 2016 population was 46 territorial pairs. There was a population decline of 22% from 59 pairs, recorded in the previous survey in 2010.

During that same period, numbers in Scotland, which holds the largest share of the UK population, declined by over 8% while the total UK breeding population estimate declined by almost 14%. The 2023 survey results show the Scottish population as having increased by 15% since 2016, and Scotland now holds 77% of the breeding UK and Isle of man population. At the UK level, the decline was more pronounced over the longer term i.e. from 2004 to 2016, where the estimated population dropped by 204 pairs, from 749 to an estimated 545 pairs (27%), and then increasing to 653 in 2023 (20% increase since 2016). It is currently Red-listed on the UK's most recent Birds of Conservation Concern list (BOCC 5, 2021).

Some Hen Harrier are known to move between the UK and the island of Ireland, though the precise level of interaction is unknown; thus, the populations may be considered to form a meta-population. At the European level, the species' breeding population has recently been assessed for the European Red List of Birds, as being of Least Concern (2021) in Europe and Vulnerable in the EU 28, having previously (2015) been considered as Near Threatened.

There is much overlap in the distribution of breeding and wintering Hen Harrier in Ireland, with the wintering distribution more dispersed and encompassing a wider range, throughout the uplands and lowlands. In the winter, non-breeding Hen Harrier predominantly roost in heath/bog habitats (53%), settling to rest on the ground at night,

and often roost communally. The Hen Harrier typically forages over ground that is rich in prey (e.g. medium and small-sized birds, small mammals), such as grasslands and winter stubble. As mentioned previously, juvenile survival overwinter is poor, and recruitment into the breeding population is thus lower than needed to maintain a stable population. There are a number of significant information gaps with respect to the ecology of wintering Hen Harrier. While progress has been made in recent years, more remains to be done.

5 Main Threats and Pressures Affecting Hen Harrier

The primary potential threats and pressures to breeding Hen Harrier, as identified through the consultation process⁹ for this Plan, concern forestry, agriculture and wind energy development. As previously mentioned, detailed reports on each of these sectors and their interactions with Hen Harrier have been produced to support the Plan's development; these are summarised below.

Other potential threats to Hen Harrier include disturbance from recreational activities, persecution, wildfires and turf cutting, predation and climate change, all of which can affect other species and habitats. Ammonia deposition can also contribute to habitat degradation, by causing a reduction in heather dominance, a decline in lichens and mosses, while increasing graminoids and nitrogen leaching. The Department will keep the relative importance of these pressures and threats under review as part of the Threat Response Plan implementation process.



Photo 3. A fragmented Hen Harrier landscape with agricultural intensification, wind energy development and afforestation. Credit: Sinéad Cummins.

⁹ See Appendix 4 for more detail.

5.1 Forestry

The breeding Hen Harrier SPAs include commercial coniferous forest plantations (more than 50% by area). These were included in the SPAs during the designation process, as surveys at that time showed that a large proportion of the national Hen Harrier population was using parts of the plantations for nesting and foraging. Notwithstanding that, the natural habitat of the Hen Harrier is open bog and heather moorland, with rough grassland also favoured.

Hen Harrier find young forest plantations attractive to breed in, and the population is thought to have increased in Ireland in the 1960s and 1970s due to new afforestation. However, breeding success is compromised by the loss of open space as forest canopies close. By 10 years or so after planting, a forest is of little habitat value for Hen Harrier until clear-felling takes place. In a balanced, mixed-age forest landscape, approximately one-quarter of the forest estate is in pre-thicket stage at any one time. Currently, however, forests within the Hen Harrier SPAs lack this mixed-age balance.

A study of breeding success in forested landscapes (Wilson *et al.*, 2012) did not find a statistical relationship between breeding productivity and total forest cover or with the percentage cover of closed canopy. However, in one of the four areas studied (*i.e.* Slieve Aughties), there was a clear negative relationship between the area of second rotation pre-thicket forest within 2 km of a nest, and nest success. This may be due to factors related to predation, disturbance or prey availability. This negative relationship was not observed in the other areas studied (*i.e.* West Clare, Kerry, and the Ballyhouras in Co. Cork). Caravaggi *et al.* (2019), using national survey data collected in 2010 and 2015, examined the landscape-scale associations of Hen Harrier within its breeding range. The study found a positive association between breeding success and heath/shrub habitat at the 1 km scale, and with bog habitat at the 2 km scale, *i.e.* open habitats that can support nesting Hen Harrier.

Pre-thicket forests were not observed to have an effect on breeding success by Caravaggi *et al.*, (2019), which does not fully accord with the findings of Wilson *et al.*, (2012) above. However, there is a strong evidence-base from other studies including Sheridan *et al.* (2020) and Wilson *et al.* (2014) that shows the negative impacts of afforestation on ground-nesting birds, including the Hen Harrier, with both significant

'edge effects', where 'edge to area of forested habitats' is higher in the landscape, and associated increased predation risks for ground-nesting birds.

The above research findings pose the following questions:

- i. how much forest cover, and what forest footprint, is optimal for the Hen Harrier within each SPA and within other important areas for the species?
- ii. can a rebalancing of forest age-structures and other measures provide a feasible form of habitat improvement within the short-, medium- and long-term?
- iii. how costly might this be to achieve?

The Slieve Blooms SPA showed the highest Hen Harrier population increase for the period 2005–2020 and has maintained a broadly stable breeding population since 2005. The SPA is comprised of nearly 60% coniferous plantation cover, and 40% almost entirely heather moorland that has been managed optimally for Hen Harrier. In 2015, 90% of Hen Harrier nests within this SPA were in heather, rather than afforested, areas. This suggests that improved management of non-afforested lands in other SPAs, alongside measures within forests themselves, may provide opportunities for providing more suitable habitat. However, recent monitoring (2017–2020) by the Hen Harrier Programme EIP has shown that productivity of pairs in the Slieve Blooms SPA has been lower than the SPA network average for the same period. Possible causes include significant drought and wildfires in 2018 and predation in 2020. This SPA held three successful nest sites and fledged a total of six chicks in 2022.

As referenced earlier, in 2007, an agreement between DAFM-Forestry and NPWS was reached (*i.e.* the Hen Harrier Protocol), that set out various conditions, including annual limits for afforestation rates at each of the SPAs. Based on the scientific data available at the time and using expert judgement, thresholds for annual afforestation were agreed in principle for a 15-year period (NPWS, 2015a), in order that each SPA contained at least 55% suitable habitat. Approximately 1,000 hectares of afforestation occurred between 2007 and 2012, mainly on private land and mostly not on open moorland.

For reasons outlined in Irwin *et al.*(2012) and NPWS(2015, 2022), this protocol for further afforestation was modified and eventually suspended, with DAFM ruling out approval for afforestation in the SPAs until the completion of this Plan, through its Circular 13 (2011). DAFM-Forestry's position is that there will be no further afforestation within these SPAs until such time that the conservation status of the species is generally restored and the requirements of Article 6(3) can be met.

A range of measures are proposed in this draft Plan in order to achieve the maximum possible contribution of afforested lands to Hen Harrier conservation. These include:

- Re-balancing of age class distribution within the forest network
- Strategic use of more open space
- Avoidance of disturbance to breeding and roosting birds
- Joint measures (with other sectors) to reduce the impact of fire and predators.

The locations for permanent forest removal will be strategic, and will be agreed both spatially (where they are to be removed) and temporally (when they are to be removed) through interactions between DAFM-Forestry, NPWS and forest owners (Coillte in the first instance, being a public authority). This identification process will have regard to other biodiversity interests, carbon, water and operational constraints. It is intended that this removal will expand core Hen Harrier habitats, especially around the margins of existing open moorland. It will also create and increase connectivity from these core habitats to other areas of suitable foraging habitat.

Other forestry measures include the application of wider setbacks and corridors within the forest resource, delayed and premature felling to alleviate habitat "bottlenecks" where pre-thicket forest habitat would close over. DAFM-Forestry has also extended the period during which protections against disturbance from forestry operations will be applied early in the breeding season (*i.e.* changing the application date of those measures from 1st April to 1st March for future licences).

In addition, site-specific measures are set out to protect breeding sites and important breeding and foraging habitats within the non-designated regionally important breeding areas, as supported by DAFM-Forestry (see its report "Exploring Synergies", referenced in Appendix 5).

5.2 Agriculture

Lightly grazed heath/bog, with some scrub, is the most suitable habitat for nesting Hen Harrier. Lowland tillage, in combination with open heath/bog and rough grasslands, is important for both foraging and roosting outside the breeding season, which constitutes a significant portion of the year. The quality of rough grassland, or indeed improved grassland, for Hen Harrier can be influenced by a range of agricultural practices, including grazing intensity, grazing periods, grazing types, fertiliser/slurry usage, rush control etc. Hedgerows are also important, providing foraging networks throughout the year.

Habitat loss, fragmentation, and degradation due to agricultural intensification have already significantly reduced the availability and quality of open heath/bog and open grazed wet grassland habitats in areas important for breeding Hen Harrier. There are also significant concerns about the low survival rate of young Hen Harrier, particularly over winter. Appropriate grazing of these open habitats is an effective means to deliver suitable farmland habitats for Hen Harrier. Areas of abandoned land with scrub, though not considered extensive at a landscape-scale, can be utilised by nesting and/or roosting Hen Harrier in particular. It is also important to retain natural and semi-natural habitats in the landscape, as well as to ensure that the quality of appropriately-grazed habitats is not negatively affected by other pressures.

While heather, rush and scrub are among the most important habitats for Hen Harrier, the eligibility of such land for entry to the Basic Payment Scheme (and subsequently ANC and GLAS) has been problematic, and there have been many instances where area or payment reductions were applied due to their presence. In parallel, many landowners have cleared or burned extensive areas of such habitats to maximise eligibility for payments. Such habitats may even be seen as a hindrance to the earning potential of land under schemes such as BPS, ANC and GLAS. Under the current CAP Strategic Plan (2023–2027), beneficial features *i.e.* those that help to deliver benefits in terms of biodiversity, habitat retention, space for nature and carbon sequestration, can occupy up to 50% of a land parcel without affecting the eligibility of a parcel. Such features include natural elements such as scrub, marsh or rock. Where these occur on 50-70% of a parcel, the reduction applied to the eligible hectare is equal to the area

of the beneficial feature. If the cover is greater than 70%, a 100% reduction is applied as the areas are not defined as “actively farmed”.¹⁰

The CAP 2023–2027 has incorporated Hen Harrier SPAs (and some other important Hen Harrier breeding sites) into a new Cooperation Project approach (also known as CPs, under the Agri-Climate Rural Environment Scheme (ACRES) 2023–2027), where it is intended that multiple biodiversity interests will be addressed at a landscape scale (See Section 6 for more detail).

5.3 Wind energy development

There is considerable overlap between the breeding range of Hen Harriers and the upland areas in which wind energy development has been concentrated in Ireland. As of 2016, over 250 wind turbines occurred within the Hen Harrier SPA network.

The Windharrier project carried out by University College Cork (UCC) between 2012 and 2014, with funding from the wind energy industry, examined a range of potential impacts of wind energy development on Hen Harrier (Wilson *et al.*, 2015). The low numbers and density of Hen Harrier makes it difficult to carry out scientific work at a sufficient scale to provide strong statistical evidence, and such work may only provide indications of effects rather than certainty. That said, in relation to Hen Harrier breeding parameters, the study found:

- i. that breeding success was statistically non-significantly lower within 1000 m of wind turbines, although sample sizes were relatively small; and
- ii. that, based on composite considerations of findings, it is possible that lower breeding success recorded within 1000 m of wind turbines reflects a biologically relevant pattern.

In addition, the density of all bird species, including likely prey species for Hen Harrier, was lower at wind energy development sites than control sites, and lower again closer to turbines. Windharrier also found that the risk of direct collision with wind turbine rotors was low. However, since its conclusion in 2015, NPWS has received evidence

¹⁰ There are exemptions to this rule for karst limestone areas.

of one “possible”¹¹ and three “probable/confirmed”¹² incidences of Hen Harrier mortality caused by turbine strike.

In summary, there is published evidence that Hen Harrier breeding productivity may be impacted by wind turbine development close to nesting areas. This is particularly relevant as the Habitats Directive requires that planning decisions must ensure that there are no adverse effects on the integrity of European, or Natura, sites, for a project or plan to be consented to under Article 6(3) of the Habitats Directive. Furthermore, judgments of the European Court of Justice and the Irish courts have set out that appropriate assessments should “**include complete, precise and definitive findings and conclusions that are capable of removing all scientific doubt as to the effects of the proposed development on ... [sites] concerned**” (High Court, 2014).

5.4 Summary Assessment of Pressures and Threats

EU Member States are required to report on the implementation of the EU Birds Directive (under Article 12) every six years. The most recent reporting in 2019 included a species-specific report for Hen Harrier. A comprehensive list of anthropogenic pressures and threats were assessed in terms of their importance for both breeding and wintering Hen Harrier populations, including those linked to forestry, agriculture and wind energy development.¹³ Summary details are provided in Table 2 below, with full details available online at the Central Data Repository of the European Environment Agency. The 2022 National Survey Report (NPWS, 2024) also details pressures and threats observed during that survey.

¹¹ A determination of cause of death of any remains discovered near a turbine or wind energy development footprint is made based on a review of the available evidence. This includes: proximity of the specimen when found, relative to a wind turbine; and a detailed physical examination of the remains by an expert e.g. veterinary surgeon, and x-rays, to ascertain whether injuries sustained would be consistent with a turbine collision. Where a turbine strike cannot be discounted as cause of death, such incidents are recorded as ‘possible’.

¹² In such cases where the nature of the physical trauma to a specimen *i.e.* fractures and/or severed body parts, are consistent with a turbine strike are deemed ‘probable/confirmed’ for reporting purposes.

¹³ Pressures are considered to be factors that are acting now or that were acting during the reporting period (2012-2018), while threats are factors that are expected to act in the future (*i.e.* future two reporting periods). Pressures and threats are the principal factors responsible for causing individual species to decline, suppressing their numbers or restricting their ranges. Each pressure and/or threat was ranked as high, medium or low importance based on a number of criteria. ‘High importance’ includes factors that have important direct or immediate influence and/or act over a large area; ‘medium importance’ includes direct or immediate influence, mainly indirect influence and/or act over a moderate part of the area/act only regionally; ‘low importance’ includes pressures and/or threats deemed to be acting at a more local scale.

Table 2. List of factors considered to be acting as pressures and/or threats (of H=high; M=medium; L=low importance) to breeding and wintering Hen Harrier populations in Ireland, as per Ireland's 2019 Article 12 Report for the Birds Directive. Please note for 'Season' below, B=Breeding and W=Wintering.

N.B. The number of factors on which reporting could be undertaken was capped at ten. Therefore, only those factors considered to be of the highest ranking for each season are listed.

Summary description	Article 12 Code	Explanation	Season	Ranking
Agricultural intensification	A02	Conversion from mixed farming and agroforestry systems to specialised (e.g. single crop) production. Habitat degradation and loss due to agricultural intensification is considered to be a significant pressure, having reduced the area of suitable habitats for harriers. Reseeding of grasslands and other semi-natural habitats, leading to a monoculture of rye grass, is not likely to benefit harriers which are known not to favour intensively managed grasslands.	B & W	M
Removal of hedges, scrub etc.	A05		B	M
Abandoned pastoral systems	A07		B	M
Burning for agriculture	A11		B	M
Reseeding of grasslands and other semi-natural habitats	A13		B & W	M
Drainage for use as agricultural lands	A31	Drainage and land reclamation can result in loss of suitable roosting habitats for wintering birds in particular, with almost a third of winter roost sites (O'Donoghue, 2010) at risk. This is significant in the national context.	W	H
Afforestation (conversion to forest and other land uses)	B01	Although the species can forage and nest in pre-thicket forests, this habitat becomes largely unsuitable as the forest plantation matures and with current legal requirements to replant. The transition from non-forest to forest habitat is essentially a permanent one.	B & W	H
Reforestation (includes re-planting with non-native or non-typical species)	B03	Second rotation forestry is only suitable for the species for a minority of its life cycle, and as the plantation matures, its suitability declines.	B & W	H
Wood transport (includes construction & maintenance of logging roads, wood transport within the forest & poor management of wood transport)	B16	Disturbance of nesting pairs from wood transport-related activities. Protocols (i.e. Red Zones) in place in the SPAs to alleviate pressure, but not outside the SPAs. Other forestry-related activities (not specifically reported here) but included in codes B01 and B03 listed above take cognisance of the following pressures: B06–Logging of individual	B	M

Summary description	Article 12 Code	Explanation	Season	Ranking
		trees; B07–Removal of dead and dying trees; B08–Removal of old trees; B09–Clear-cutting removal of trees, B12–Thinning of tree layer; B19 application of synthetic fertilisers).		
Wind Energy Production	D01	Disturbance, displacement and collision risk are the potential effects of wind power on Hen Harriers. Since 2015, there have been one “possible” and three “probable/confirmed” incidences of Hen Harrier mortality caused by turbine strike in Ireland. While collision risk is not considered to be a high threat to the species, a reduction in the abundance of some prey species can result (Wilson <i>et al.</i> , 2015).	B & W	M
Peat Extraction	C05	Related activities can cause disturbance to breeding Hen Harriers and affect the quality and extent of foraging habitat on breeding grounds.	B	M
Problematic native plants & animals. ‘Problematic’ refers to species which are out of balance directly/indirectly due to human activities.	I04	A total of 20% of breeding failures were attributed to predation (includes predation by foxes and hooded crows) during the 2015 National Hen Harrier Survey (Ruddock <i>et al.</i> , 2016). Encroaching scrub is also a concern at wintering roost sites (O'Donoghue, 2010).	B	M
Predation by native predators	L06	Includes the Pine Marten, which has expanded in range by a third since 2012 (Lawton <i>et al.</i> , 2020).	B	M
Climate change impacts on timing of prey availability*	N03	Increases and changes in precipitation due to climate change e.g. wetter springs and drier summers affect the timing of prey availability, and can negatively impact subsequent breeding success.	B	M
Recreational disturbance**	F07	Human-related disturbance from sports, tourism and leisure activities.	B/W	L
Persecution (illegal killing/poisoning)	G10	For the reporting period (2013–2018), three confirmed cases (all related to illegal shooting) under the NPWS RAPTOR Protocol	B/W	L
Burning for agriculture	A11	Poorly planned or poorly executed burning can cause long-term	B/W	M

Summary description	Article 12 Code	Explanation	Season	Ranking
		damage and negative impacts on vegetation, invertebrates, soil structure and hydrology, water quality and carbon storage. Accidental, uncontrolled and illegal fires can potentially damage large areas of scrub and peatland habitats supporting nesting and foraging Hen Harrier (Ruddock <i>et al.</i> , 2016).		

**Future threat to Hen Harrier populations.

As evident from Table 2, pressures and threats associated with agriculture, forestry and wind energy development were amongst the highest-ranking. These, and others listed, have impacted across significant tracts of the Hen Harrier's landscape in recent decades and have affected the overall population, both breeding and wintering, of Hen Harrier in Ireland.

Climate change was also identified as a pressure and threat, but of 'medium importance'. All actions that serve to restore the species and improve its habitat at the site-level will increase its resilience in the face of a changing climate; the changing climate also makes it all the more important to achieve that resilience, in order to mitigate the effects of climate change on biodiversity. The effects of climate change on biodiversity, more broadly, are addressed in the Biodiversity Climate Change Sectoral Adaptation Plan, prepared under the National Adaptation Framework, and published in 2019, but research that considers how the changing climate may affect the Hen Harrier and its habitats could be useful in informing appropriate conservation measures.

While wind energy production is identified as one of the key pressures on the species, wind energy development is also, more generally, a key part of the global and national response to alleviating climate change. Biodiversity and climate change commitments have equal standing, and creating opportunities to achieve both, without compromising each other, is critical, particularly as biodiversity can assist in climate change mitigation and adaptation.

6 Previous and Existing Measures to Address Hen Harrier Conservation Requirements

This Section sets the current range of conservation measures in place to address the needs of the Hen Harrier. These include both regulatory measures as well as contractual, voluntary and on-the-ground measures.

6.1 Current restrictions on activities arising from the designation of Hen Harrier SPAs

Restrictions or additional duties that arise on lands designated as SPAs fall into two main categories:

- a. Requirements of planning and licensing authorities (including DAFM-Forestry)
- b. Activities requiring consent (ARCs)

6.1.1 Requirements of planning and licensing authorities

As mentioned earlier, the Birds and Habitats Directives, the Regulations, the Planning Acts and regulations governing forestry, agriculture and development require planning and licensing authorities to consider the possible implications of any plan or project on the integrity of a European site before any decision is made to allow it to proceed. In practice, this means there must be a screening for appropriate assessment carried out to determine if the activity may have a significant effect on site integrity, and if that is the case, an appropriate assessment must also be undertaken. An appropriate assessment requires that a scientific examination of the implications of the plan or project on the integrity of the site/s in question, in combination with other projects, plans and programmes, be undertaken; this analysis is to be presented in a Natura Impact Statement (NIS)¹⁴.

¹⁴ An NIS is defined in the Regulations as 'a report comprising the scientific examination of a plan or project and the relevant European Site or European Sites, to identify and characterise any possible implications of the plan or project individually or in combination with other plans or projects in view of the conservation objectives of the site or sites, and any further information including, but not limited to, any plans, maps or drawings, scientific information or data required to enable the carrying out of an Appropriate Assessment'.

Ecological specialists are required to undertake surveys, research and analysis, with input from other experts (e.g. hydrologists or engineers) as may be necessary to prepare an NIS. It is normally the responsibility of the proponent of the plan or project to have the NIS prepared for submission to the competent authority, *i.e.* the consent or decision-making authority. It is then for the decision-making authority to conclude the appropriate assessment by making a determination as to whether the plan or project will adversely affect the integrity of a European site/s. This assessment must be completed before any decision is taken to approve the plan or project.

Under the EU Nature Directives, and as interpreted through the Irish Courts and the European Court of Justice, consenting authorities can only consent to activities in an SPA if they are clear that there will not be an adverse impact on the species for which the SPA has been designated. In practice, this has led to, for example, decisions to restrict afforestation and forestry operations in the breeding Hen Harrier SPAs during the breeding season.

6.1.2 Activities Requiring Consent

Activities Requiring Consent (ARCs) are set out for each SPA and SAC in the Statutory Instrument for each site, pursuant to the Regulations. These activities may be damaging to a Natura 2000 site but do not require planning permission or another form of consent. Consent is needed from the Minister for Housing, Local Government and Heritage, prior to their undertaking. Obligations in relation to screening for appropriate assessment, and appropriate assessment as necessary, also apply to ARCs. It also is a requirement of DAFM's Basic Payment Scheme that farmers must not undertake these activities without prior consent from the Minister.

There are currently three ARCs relevant to Hen Harrier SPAs:

- Agricultural improvement of heath or bog.
- Construction, removal or alteration of fences, stone walls, hedgerows, banks or any field boundary other than temporary electric fencing (consent is not required for normal maintenance).
- Off-road recreational use of mechanically propelled vehicles.

Regulation 41 of the Regulations provides for compensation where the Minister refuses consent to an activity that had been carried out within the previous five years.

The Regulations do not give the Minister powers to make payments for reduced land value *per se*, nor for any loss of collateral value. The Joint Oireachtas Committee on Agriculture, Food and the Marine (see Appendix 6) recommended that payments should apply only to the curtailment of current or past activities and current or past income foregone. Furthermore, payments should not apply to potential or future income; and payment should not be made for failure to secure either planning permission or a grant for new development.

6.2 Previous and current agri-environment schemes relevant to Hen Harrier

In recent years, a range of agri-environment schemes have been implemented to benefit the Hen Harrier, as well as other species and habitats, and to deliver its conservation requirements. These are set out below

6.2.1 NPWS Farm Plan Scheme

The NPWS Farm Plan Scheme was first launched in 2006. The main purpose of the scheme is to promote a focused, targeted and innovative approach to farming for the conservation of habitats and species of conservation concern, where they were not adequately covered by other national agri-environment schemes. Three hundred and seventy-seven NPWS farm plans, based on five-year contracts, were put in place with farmers in Hen Harrier SPAs. Following the financial crisis of 2008, and subsequent budgetary cutbacks, the NPWS farm plan scheme was closed to new applicants in April 2010 and most plans reached their end-of-life by 2015. Over €14 million was paid to the participating farmers, with an average payment of €7,347 per annum. This scheme was funded solely from the national exchequer, i.e. no EU funding was allocated. The NPWS farm plan scheme was never resourced to the extent that it could provide suitable habitat at a landscape scale for Hen Harrier, with less than 10% of the farmers in the SPAs participating.

6.2.2 GLAS

The Green Low Carbon Agri Environment Scheme (GLAS) was the agri-environment scheme of the Rural Development Programme (RDP) 2014–2020 (extended to 2023). The GLAS standard ‘package’ was up to €5,000 for eligible farmers per annum, with an additional package of €2,000 per annum for those in GLAS+, in return for

exceptional environmental commitment. Farmers in Hen Harrier areas (SPAs and other relevant areas identified in the national 2015 survey) were eligible for GLAS and GLAS+. DAFM has estimated that more than €23m per annum was available for Hen Harrier actions alone in GLAS and GLAS+. There were 2,476 farmers taking up Hen Harrier actions in GLAS (as of August 2022); 1,350 of these were also in GLAS+.

6.2.3 Hen Harrier Programme EIP

The Hen Harrier Programme, a €25m European Innovation Partnership (EIP), operated between 2018 and 2023. The Programme was overseen by a Steering Group, comprised of representatives from DAFM, NPWS, Teagasc, participating farmers and Hen Harrier Programme Advisors.

The Hen Harrier Programme has been pivotal in piloting measures for the Hen Harrier and associated conservation interests, including habitats, wider biodiversity, water and carbon, as well as delivering community buy-in. The primary objectives of the Hen Harrier Programme were:

- 1: To ensure the sustainable management of High Nature Value farmland in the most important breeding areas for Hen Harrier in Ireland.
- 2: To promote a stronger socio-economic outlook for marginally agriculturally productive upland areas that are generally difficult to manage.
- 3: To develop an effective model for future sustainable management of Hen Harrier areas.
- 4: To foster continued positive relations through locally-led solutions between the people who have managed these landscapes for generations and the relevant Government Departments. This relationship is central to maintaining and enhancing the biodiversity that exists on these lands.

It targeted approximately 24% of the land area of the Hen Harrier SPAs and paid farmers to undertake actions to reach the Programme's goals, the success of which was measured in the field. It was delivered on the ground by a specialist locally-based intermediary team (between DAFM and the landowners), which was appointed through competitive tender (hereafter 'the Hen Harrier Programme Team').

The Hen Harrier Programme operated on the basis that payments are for the habitat and support actions delivered during each breeding season. All payments under the

Programme were made “in arrears” and were based on the habitat quality and actions delivered by the farmer by August 15th each year, i.e. the latest date for submitting a claim for payment to the Hen Harrier Programme Team. The delivery of the Hen Harrier Programme was supported at farm level by three types of payments:

- A Results-based Habitat Payment
- A Supporting Actions Payment
- A Hen Harrier Payment.

The Hen Harrier Programme acted in parallel to GLAS. Participation in the Programme was not linked to GLAS participation, and all payments through the Hen Harrier Programme were separate from GLAS. It formed part of a package of supports available to farmers in Hen Harrier SPAs that also included the Basic Payment Scheme (BPS), Areas of Natural Constraint (ANC) and GLAS schemes.

6.2.4 CSP 2023–2027 and Cooperation Projects

To retain habitats and biodiversity on farmland, and to ensure as much coherence as possible between Pillar I and Pillar II of the CAP, Ireland included in its CAP Strategic Plan 2023–2027 (hereafter the CSP), that, in defining the eligible hectare, other landscape features, such as scrub, copse and woodland are allowed to occupy up to 50% of the reference parcel without a deduction to the eligible area being required. The effectiveness of the new rules in supporting landscape features will be monitored in the early stages and throughout the CAP Strategic Plan 2023–2027, in parallel to ongoing communications between NPWS and DAFM on the types of habitats required by Hen Harrier for nesting, roosting and hunting. These features are typically beneficial for Hen Harrier.

Building on EIPs and locally-led approaches, the Agri-Environment Climate Measure (AECM) Co-operative Projects (CPs) that have replaced GLAS in the CSP have responsibility for devising their own approach to the identification of priority needs and conservation requirements of their CP area. Each CP team is identifying local priorities and actions that can best address the key environmental needs of the area, including the conservation of Hen Harrier, where relevant. Such needs are being identified to the habitat and species level, and are to reflect the requirements of Ireland’s Prioritised

Action Framework (PAF)¹⁵, and other environmental policy targets (such as this draft Plan). This has been done in association and consultation with key stakeholders to integrate the lessons learned from earlier and current programmes. The CPs will advise participants on the most appropriate management actions to support these targets.

6.3 LIFE Projects

6.3.1 Raptor LIFE

IRD Duhallow, a community-based Rural Development Company, secured €3 million LIFE+ funding for Raptor LIFE 2015 to 2019, after an 85% decline was recorded in the local Hen Harrier population. It sought to connect and restore habitats for priority species, including the Hen Harrier, within the River Blackwater (Cork/Waterford) SAC and the Stacks to Mullaghareirk Mountains, West Limerick Hills and Mount Nagle Special Protection Area (SPA). The latter is the most important SPA site for Hen Harrier. From 2016–2019, its monitoring showed that this sub-population has had poor productivity (overall fledging rate of less than 1.2 young fledged per breeding attempt). The RaptorLIFE project drafted a Management Plan for the Stacks to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA. Hen Harrier-specific actions within the plan include:

- management of forests in the SPA with a target of 23 pairs or more for the SPA by 2025, along with a stable/increasing population trend.
- a reduction in nest losses to predators,
- no nest failures to disturbance or fire,
- no losses of adults or nests to persecution, along with
- maintaining or increasing the area/quality of HNV farmland, hedgerows, retaining important nesting areas in scrub, and restoring degraded heath/bog habitats.

¹⁵ Prioritised Action Framework for the Implementation of the Birds and Habitats Directive in Ireland, 2021-2027. Available at www.npws.ie

6.4 Joint Oireachtas Committee Hearing

In 2015, the Joint Committee on Agriculture, Food and the Marine (JOC) published its report on the “Designation of Lands as SPAs for the Conservation of Breeding Hen Harriers”. The Committee met with representatives of “Irish Farmers with Designated Lands”. The JOC’s report contains 18 recommendations, reproduced in Appendix 6; these have been used to inform the Threat Response Plan, and many of them have been incorporated into actions in this Plan.

7 HHTRP Actions 2024–2028

This Section sets out the actions that public authorities need to implement to achieve the objectives of the Hen Harrier Threat Response Plan. As set out in Regulation 39(7), Threat Response Plans are intended to set out the actions that are required of public authorities for its implementation. Hence, the following table identifies those public authorities who are responsible for the implementation of each action. As noted earlier in the report, collaboration with non-governmental stakeholders will be key to its delivery but these are not identified below, because of this specific requirement of a Threat Response Plan.

The actions are divided into a number of categories – Overarching and Cross-Cutting, Forestry, Agriculture, Wind Energy Development, Plan Mitigation, Review and Update.

In Sections 7.2 and 7.3 (agriculture and forestry actions), the actions for each sector are set out in a predominantly (but not entirely) sequential manner setting out actions to be targeted at the breeding Hen Harrier SPAs, the wider countryside where Hen Harrier breeds, and the wider countryside where it overwinters, building conservation action outwards from the SPAs.

7.1 Overarching and Cross-Cutting Actions

Action		Public Authority	Timeline
Topic	Continuation of national surveys to ensure fit for purpose data		
Issue	Contemporary data on the Hen Harrier at the national level is required to put in context the relative importance of site level populations and to report on Birds Directive implementation.		
CC1	Continue to undertake national Hen Harrier surveys at regular intervals (currently 5 yearly intervals)	NPWS	2027
CC2	Establish a Data Group to improve safe and secure levels of access to data to better inform decision-making	NPWS	2024
Topic	Conservation Objectives		
Issue	A national conservation objective for the Hen Harrier will help to more fully inform appropriate assessment of plans and projects and to identify the necessary conservation measures for the species. These will take into account the best available scientific information. An all-island conservation objective would be of value to increase the species' resilience.		
CC3	Prepare and publish a national conservation objective for the Hen Harrier	NPWS-DHLGH	2025
CC4	Explore the establishment of an all-island conservation objective with Northern Ireland	NPWS-DHLGH	2025
CC5	Review the SSCOs with a view to updating them, in light of HHP research outputs and other research, as relevant, following the mid-term review of the Plan	NPWS-DHLGH	2026
Topic	Minimising impacts on Hen Harrier outside of the breeding season		
Issue	Further dedicated work to gain a better understanding on the ecology of Hen Harrier outside of the breeding season is needed, and the impact of various pressures and threats. NPWS has supported a PhD to contribute to this understanding, completed in 2022 and publications are in train.		
CC6	Attain more comprehensive and centralised knowledge on the characterisation and distribution of roost sites and wintering habitat use, through the commissioning of appropriate research.	NPWS	2024-2028

Topic	Increasing knowledge of Hen Harrier habitat outside of the SPA network		
Issue	The availability of a higher resolution habitat map for Ireland could inform Hen Harrier habitat suitability modelling work at the national level as well as the production of more robust assessments and spatial planning.		
CC7	Review the National Landcover Map and identify its usefulness for habitat suitability modelling, spatial planning for the purposes of this Plan.	NPWS	2024
Topic	Establishing a mechanism to deliver integrated management of the Hen Harrier SPAs		
Issue	The threats and pressures facing the Hen Harrier are complex and interlinked. Many authorities hold decision-making responsibilities that can and may affect the integrity of the sites. The IDSG and other bodies with oversight for the implementation of the Birds and Habitats Directives will explore the most appropriate mechanism for achieving integrated management of the sites, in order to achieve their conservation objectives. A clear timeline for delivery is difficult to identify, as the precise mechanism required is not yet clear.		
CC8	Identify the most appropriate mechanism for the delivery of integrated management of the Hen Harrier SPAs, and take steps to implement same.	IDSG	2024-2028
Topic	Explore opportunities for collaboration to facilitate restoration of the Hen Harrier SPAs		
Issue	In order to restore the Hen Harrier population, relevant authorities and stakeholders will need to come together to collaborate. This will need to occur, independently of the action above, as that may take more time to deliver. Opportunities for collaboration with the Just Transition Wetlands Restoration programme, and NPWS Blanket Bog Restoration Programme will be explored. Opportunities will also be explored with Coillte, specifically with regard to the Slieve Blooms.		
CC9	Explore opportunities for collaboration to facilitate restoration of the Hen Harrier SPAs.	IDSG Consultative Committee	2024-2028

Integrate Hen Harrier conservation requirements into national policies and programmes			
Topic			
Issue	Hen harrier conservation needs to be integrated into broader national policies, plans and programmes as they are developed in order to be achieved, given the nature of its distribution and behaviour. Due to its nature, this action does not have a specific timeline but needs to be achieved as these policies, plans and programmes are developed and so is subject to their timelines.		
CC10	Ensure the objectives of the Hen Harrier Threat Response Plan are integrated into the Land Use Review and the National Restoration Plan, and others as relevant.	IDSG and relevant Departments	2024, 2025, 2026
Topic	Research		
Issue	An ongoing research programme is required to expand the knowledge base and to underpin Hen Harrier conservation measures, as well as future updates to this Plan. A number of research needs are set out in the Sectoral Actions below and research capacity needs to be built and strengthened to ensure knowledge gaps are filled.		
CC11	Develop research agreements with academic institutions to build Hen Harrier research capacity.	NPWS	2024, 2025, 2026, 2027
Topic	Other Pressures and Threats		
Issue	Other pressures and threats may influence the conservation status of the Hen Harrier, and these should be kept under review in order to ensure the recovery of the species and the success of the Threat Response Plan. NPWS will continue to review the ongoing pressures, including recreation, and those identified through the national and other surveys, and define actions that may be taken to address them, in consultation with IDSG members as relevant. This may include, for example, incorporating relevant biodiversity considerations into outdoor recreation strategies (see NBP Action 3B1).		
CC12	NPWS to review the pressures and threats, specifically recreation, identified in the consultation process and 2022 survey and identify follow-on actions that may be required.	NPWS, in consultation with other public authorities as relevant	2024-2025

7.2 Agriculture

Action		Public Authority	Timeline
Topic	Agricultural lands, eligibility and the Birds Directive		
Issue	Heather, rush and scrub are among the most important habitats for Hen Harrier. However, the eligibility of such land for entry to the Basic Payment Scheme (and subsequently ANC and GLAS) in the past has been problematic. In addition, many landowners have cleared or burned extensive areas of such habitats to maximise eligibility for payments.		
AG1	Monitor the effectiveness of the new rules in ensuring landscape features (that are typically beneficial for Hen Harrier) are supported throughout the CAP Strategic Plan 2023-27.	DAFM, NPWS and Co-operative Projects	2023-2027 (CSP duration)
AG2	Continue to engage and communicate with farmers (e.g. via farm advisors) on the year-round ecological needs of Hen Harrier for nesting, roosting and foraging.	DAFM, NPWS and Co-operative Projects	2023-2028
Topic	Conserving Hen Harrier breeding habitat within and outside the SPA Network through an appropriate agri-environment scheme		
Issue	GLAS aimed to encourage farmers to farm in an environmentally friendly manner, through annual payments. This included the management of lands for the benefit of prioritised habitats and species. The current Agri-Climate Rural Environment Scheme (ACRES) 2023-2027, and specifically the Co-operation Projects (CPs) within defined high priority geographical areas, offer results based payments for supporting actions for priority habitats and species, including Hen Harriers, where appropriate. The ACRES CPs are the most significant agri-environment scheme (in terms of potential overall area) that can deliver positive impacts at the population level.		
AG3	Maintain, improve and expand the existing suitable Hen Harrier habitat within and outside the breeding SPAs by expanding on the experience gained by the NPWS Farm Plan Scheme, GLAS and in particular the Hen Harrier Programme in the CAP programme post 2022 (i.e. ACRES CPs).	DAFM, Support: NPWS	2023-2027 (CSP dates)

AG4	Continue to provide incentives, awareness and education to support areas where habitat is suitable for Hen Harrier, particularly in the Hen Harrier SPAs, focusing on ecological and/or environmental challenges and delivering effective, results-based and long-lasting improvements.	DAFM, Support: NPWS	2023-2027 (CSP dates)
AG5	Continue consultation with stakeholders to identify opportunities for support under the CAP Strategic Plan 2023-2027.	DAFM, Support: NPWS	2023-2027 (CSP dates)
AG6	Undertake an end-of-cycle critical assessment of the efficacy of the Hen Harrier Programme with a view to producing recommendations for Hen Harrier conservation, both inside and outside SPAs.	DAFM, Support: NPWS	2024
Topic	EIA (Agriculture) Regulations 2011 (as amended) and the protection of habitat within the SPA Network		
Issue	Under these Regulations, where it is intended to undertake one of the three regulated on-farm activities and where the proposed works exceed a specific threshold, or where the activity is likely to have a significant effect on a European site, an application to DAFM for screening must be submitted. Due to the relatively recent pressure on habitats in relation to the interpretation of Pillar I eligibility criteria, assessment of cumulative impact of individual cases along with sub-threshold activities is constrained by available relevant data. It is also an action in the 4th National Biodiversity Action Plan for DAFM to complete a review of the EIA (Agriculture) Regulations in 2024 which provides an opportunity to strengthen their implementation.		
AG7	Update the NPWS breeding Hen Harrier SPA habitat map (or taking a statistically robust subsampling approach to the SPA Network) based on most up-to-date aerial images to determine changes in the gross availability of habitats through time.	NPWS	2025
AG8	Use the NPWS breeding Hen Harrier SPA habitat maps as a significant resource when undertaking EIAs, and in reviews of agri-environment measures.	DAFM	2024, 2025, 2026, 2027
AG9	Seek to strengthen the implementation of the EIA (Agriculture) Regulations, which currently consider potential impacts on Natura sites, SSCOs and the status of relevant QIs and implement relevant changes to improve the process, where gaps are identified, as committed under Food Vision 2030.	DAFM	2024

Topic	Wider countryside breeding season measures (including non-designated regionally important breeding areas)		
Issue	The 2005 national Hen Harrier survey showed that the SPA network then supported over 60% of the national breeding population (Barton <i>et al.</i>, 2006). The 2015 survey showed that the majority of breeding birds then occurred outside of the network. In 2022, the six breeding SPAs held just 41% of the national population, with the consequence that the protection of birds in the wider countryside is increasingly important for the conservation of this species. There is insufficient data available to examine if the cumulative impact of sub-threshold agricultural activities is having a significant negative impact on the Hen Harrier population.		
AG10	When building on existing Hen Harrier supports (see AG4), include those non-designated regionally important breeding areas that are currently targeted for ACRES CP measures (where still relevant, based on the most up-to-date available information).	DAFM, Support: NPWS	2024, 2025, 2026, 2027
AG11	Continue to support non-designated regionally important breeding areas outside of SPAs through appropriate and targeted Agri-Environmental Schemes (i.e. under ACRES CPs).	DAFM, Support: NPWS	2024, 2025, 2026, 2027
AG12	Ensure that the conservation requirements of Hen Harrier are taken into consideration in the development of measures for commonage areas within the CSP.	DAFM, and Co-operative Projects Support: NPWS	2024, 2025, 2026, 2027
AG13	Using most recent national survey results, continue to update the "non-designated regionally important breeding areas" outside the SPA Network.	NPWS	2024 and subsequent to each national survey
AG14	Estimate the rate of change of Hen Harrier breeding habitat caused by intensification of farming and scrub removal in non-designated regionally important breeding areas (to be done in tandem with the AG7 on the Hen Harrier habitat map)	NPWS	2025

Topic	Wider countryside wintering season measures		
Issue	It is evident that there is very high mortality of birds over their first winter, which has implications for the overall viability of the national population. There is a pressing need to support Hen Harriers during August-March, both in terms of direct protection from damaging activities and supportive conservation actions. In the 5th Nitrates Action Programme (NAP) and the Straw Incorporation Measure, sufficient uncultivated cover must be retained through the winter period to support seed-eating birds, their predators (e.g. Hen Harrier) and mitigate against any potential adverse impacts on biodiversity. Any measure(s) introduced must seek to avoid any adverse impacts on either water quality or biodiversity.		
AG15	Informed by DAFM stakeholder consultation, pursue the opportunity to include a specific themed call for non-breeding Hen Harrier within the EIP model.	DAFM Support: NPWS	2024, 2025, 2026, 2027
AG16	With respect to the 5 th NAP, a National Expert Group will review practices and outcomes from research such as the Agri-Birds project, and advise the Minister on the most appropriate measure(s) to support seed-eating birds during the winter period while also mitigating any potential adverse impacts on water quality, in this instance.	DAFM, DHLGH, Support: NPWS, Teagasc	2024, 2025, 2026, 2027
Issue	There is a knowledge deficit in regard to land use and how this affects survival of Hen Harrier outside the breeding season. A focused programme of work including research on the ecology of wintering Hen Harrier using satellite-tracking technology and continued monitoring of the population was undertaken, but further research is required.		
AG17	Carry out research to build on existing research and surveys to improve understanding and provide more robust data on: a) the population dynamics of Hen Harrier in Ireland, including juvenile overwinter survival rates and population trends. b) how the species uses the agricultural landscape and how the constituent agricultural activities (e.g. intensification, changing patterns of cereal farming, scrub clearance) are impacting on the conservation status of Hen Harrier in Ireland. c) improving the evidence base to inform future habitat management measures and agri-environment prescriptions that would lead to positive impacts at the population level. d) the degree of risk of secondary poisoning of harriers by rodenticides.	NPWS	2024, 2025, 2026, 2027

7.3 Forestry

Topic	Optimising the extent and increasing the quality of breeding habitat in the SPAs		
Issue	Projections show that the extent of forest areas potentially used by Hen Harrier during the breeding season will continue to decline within all SPAs over the coming years, due to (inter alia) forest maturation. An appropriate long-term forest management strategy covering all six SPAs is therefore required in order to reduce the impact of the closed canopy forest bottleneck, to increase the quality of foraging resources within the forest estate, to promote habitat linkage and to reduce the risks of depressed breeding productivity rates. DAFM recognises that open moorland is prime Hen Harrier habitat and is committed, for Hen Harrier conservation purposes, to reducing forest cover and thereby increasing habitat area and creating linkages within between open areas in the SPAs.		
F1	Identify and critique methods to reduce the forest maturation bottleneck, including premature felling, delayed replanting and targeted forest removal, to produce an appropriate set of options to be employed in the long-term forest management strategy for Hen Harrier SPAs.	DAFM-Forestry, Coillte Support: NPWS	2024
F2	For each SPA, update the work of the NPWS Hen Harrier Habitat Mapping Project, with maps of the forest areas including key forest parameters such as location, ownership, age.	DAFM-Forestry Support: Coillte	2024, 2025
F3	Informed by the mapping work, the existing forest inventory information and other relevant sources, identify the strategic areas in the SPA network where maintenance/achievement of the appropriate age structure, reduction of the forest footprint and application of appropriate follow-up management are most likely to bring conservation benefits for breeding Hen Harrier, in terms of breeding sites, increased foraging efficiencies and linkages, and reduced potential risk of nest predation events.	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026
F4	In light of Actions F2 and F3, engage with Coillte to develop a plan for managing their estate within each Hen Harrier SPA, in line with the requirements of the SEA, Birds and Habitats Directives, utilising the options identified in Action F1.	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026, 2027, 2028

F5	Assessment of applications for private felling licences will take into account the results of Action F3.	DAFM-Forestry Support: NPWS	2024, 2025, 2026, 2027, 2028
F6	Informed by ongoing research and trialling, amend the Coillte plan for each SPA where necessary, to optimise outcomes for Hen Harrier.	Coillte and DAFM-Forestry	2024-2028
F7	Informed by ongoing research, desk-review and trialling, the management prescriptions for felling and reforestation will be reviewed, and if necessary, updated, including the introduction of setbacks and open spaces for biodiversity, water protection and other sensitivities, with a view to improving or increasing Hen Harrier breeding habitat.	DAFM-Forestry Support: Coillte	Pending publication of relevant research
F8	Promote the application of these management measures for uptake in areas earmarked for reforestation within the SPAs.	DAFM-Forestry Support: Coillte	When forestry decisions are made
F9	Develop and implement a programme of targeted forest removal in the SPAs focused on strategically important areas for Hen Harrier, adjoining open moorland habitat and elsewhere to expand and link prime Hen Harrier habitat.	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026, 2027, 2028
F10	Analyse Hen Harrier habitat mapping and Coillte's inventory to identify SPA forest areas for removal, as well as through workshops that will scrutinise the available spatial data at an appropriate scale and propose optimal management measures.	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026, 2027, 2028
F11	Facilitate the permanent forest removal referenced above within the context of overriding environmental considerations, as set out in Section 5.2 of the DAFM-Forestry Felling & Reforestation Policy document	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026, 2027, 2028
F12	DAFM-Forestry, following consultation with NPWS-DHLGH, will not impose a replanting obligation on the forests referenced above in the SPAs, to facilitate such measures.	DAFM-Forestry and Coillte Support: NPWS	2024, 2025, 2026, 2027, 2028
F13	Define areas that have a higher likelihood of containing nesting Hen Harrier (HLNAs), using the most recent available survey data and to inform Action F14.	NPWS	After each national survey, or annually if annual data available

F14	Continue to minimise the impacts of forestry-related disturbance operations in sensitive breeding areas of the SPA, through appropriate procedures.	DAFM-Forestry Support: Coillte, NPWS	2024- 2028
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Topic	Wider Countryside Breeding Measures		
Issue	Based on 2005 survey data, the SPA network supported over 60% of the national breeding population of Hen Harrier. In 2015, the population proportion was greater outside the SPA network than within, with the consequence that the 'Wider Countryside' element is becoming more relevant to the conservation of this species at the national scale. In 2022, the 6 breeding SPAs held just 41% of the national population. During the non-breeding season, Hen Harrier roosts and forages over areas across Ireland in both designated and undesignated habitats.		
F17	Ensure that procedures are in place to minimise disturbance that may be caused by forestry-related activities to nesting Hen Harriers within non-designated regionally important breeding areas.	DAFM-Forestry Support: NPWS, Coillte	2024-2028
F15	Within non-designated regionally important breeding areas, assess felling applications with a view to improving Hen Harrier breeding habitat.	DAFM-Forestry	2024-2028
F16	Extend relevant restructuring and design measures regarding reforestation (including the strategic use of setbacks and open space) to forests within non-designated regionally important breeding areas.	DAFM-Forestry Support: NPWS, Coillte	2024-2028
Topic	Wider Countryside Non-breeding Measures		
Issues	During the non-breeding season, Hen Harrier roosts and forages over areas across Ireland in both designated and undesignated habitats.		
F18	Obtain data on locations of important Hen Harrier winter roost sites	DAFM-Forestry	2024-2028
F19	Using data obtained through F18, avoid the afforestation and disturbance of important winter roost sites.	DAFM-Forestry Support: NPWS	2024-2028

F20	In line with Action F2, publish peer-reviewed research on the ecology and population dynamics of Hen Harrier during the non-breeding / overwintering period in Ireland.	NPWS and collaborators	As research is completed
F21	Informed by Actions AG17 and F20, support research/study on the potential impacts of land use change (including but not only afforestation) on the harrier's overwinter foraging resources.	DAFM-Forestry, DAFM-Agri and NPWS	2024 -2028

7.4 Wind Energy

Action		Public Authority	Timeline
Topic	Informing assessment procedures with fit for purpose data		
Issue	In order for wind energy development data from different developments to be comparable and aggregated for efficient strategic level analysis, the data collected needs to conform to particular standards. This would lead to an increase in the availability of comparable pre- and post-construction studies including carcass searches occurring across Ireland.		
W1	Produce and adopt best practice guidance documents in relation to Hen Harrier survey work in Ireland at appropriate scales to inform fit-for-purpose assessment processes and post-construction monitoring actions.	NPWS	2025-2026
Topic	Improving access to data		
Issue	Efficient access to project level assessment documentation (including pre- and post-construction monitoring data) would further help in the assessments of in-combination and cumulative effects on Hen Harrier populations. The development of a facility to receive, store and report out on suspected bird collisions could also be a useful resource with regard to providing data from both monitored (with formal carcass searches) and unmonitored (i.e. ad hoc carcass recoveries) wind energy development.		
W2	Inter-Departmental Steering Group to decide on an appropriate mechanism for the establishment and maintenance of a central repository for relevant reports in order to facilitate: - Identification of effective mitigation measures - Adaptive management and - Cumulative effects assessments.	IDSG Members	2024-2025

Topic	Promoting effective cumulative level assessments, including collision risk modelling, at various scales		
Issue	SEAI will maintain the Wind Atlas, a publicly available digital map of Ireland's wind resources, which includes data and spatial information regarding wind energy development Ireland. The Wind Atlas is underpinned by a spatial turbine database held by the SEAI, which includes data and spatial information on a turbine by turbine basis. To, inter alia, promote effective cumulative level assessments, including collision risk modelling at various scales, this database and maintained into the future through the addition of locations of recently developed turbines.		
W3	Continue to develop and maintain the Wind Atlas and turbine database of wind turbines in Ireland.	SEAI	2024-2028
Topic	Efficacy of adaptive management measures, including for offsetting purposes		
Issue	Many wind energy developments have a requirement for ongoing monitoring of their effects on protected habitats and species, and some undertake proactive habitat management measures, including for offsetting purposes. There are gaps in knowledge regarding the efficacy and impact of these techniques in managing the interaction of wind energy developments with Hen Harrier populations.		
W4	Review the efficacy of adaptive management measures, and offsetting, with respect to wind energy developments and Hen Harriers in Ireland.	SEAI Support: NPWS	2024-2028
Topic	Robustness of Environmental Assessments		
Issue	Wind energy policy statements, strategies or frameworks that are developed, and their associated necessary environmental assessments (i.e. SEA, AA), should reference and address the findings of this Threat Response Plans and the supporting report on Hen Harrier Conservation and the Wind Energy Sector in Ireland.		
W5	Have regard to the findings of this Plan and supporting reports in relevant environmental assessments (e.g. SEA, AA).	All relevant plan-making authorities	2024-2028

Topic	Wind Energy Development Guidelines			
Issue	Finalisation of the revised Wind Energy Development Guidelines following completion of its SEA and AA			
W6	Finalise and publish the Wind Energy Development Guidelines.	DHLGH		2024
Topic	Early identification of potential problems			
Issue	Pre-application discussions may be requested by applicants. The early identification of potential nature conservation conflicts including implications for non-designated regionally important breeding areas, may minimise cost and time implications for all parties. Requests for such meetings are at the discretion of the applicant.			
W7	Facilitate, where and when feasible, pre-application meetings when requested by developers.	NPWS		On request
Topic	Collation of relevant planning documents			
Issue	Several Local Authorities have developed wind energy strategies within the Local Authority Development Plan process that include defined areas where potential wind energy development may be favoured or not. A centralised web and GIS resource that collates such strategies and maps would be of value to accommodate any geospatial layer that is in the appropriate format, and into which, emerging data sets relating to birds, including Hen Harrier, can be integrated.			
W8	Inter-Departmental Steering Group to decide on an appropriate mechanism to establish and maintain a centralised web and GIS resource that collates local authority wind energy strategies and maps of areas where wind energy development may be less favoured.	IDSG		2025
Topic	Promoting high quality assessments			
Issue	Sectoral-specific guidance to inform the assessment of Hen Harrier with regard to proposed wind energy developments (including repowering) and the adoption of a tool-box approach to avoiding or offsetting negative impacts is warranted. Guidance should consider the implications of developments for SPAs and non-designated regionally important breeding areas.			

W9	Produce assessment guidelines for Hen Harrier and proposed wind energy development and repowering.	NPWS, DHGLH Support: SEAI	2025
W10	Liaise with Planning Authorities on the implications for Hen Harrier conservation objectives in view of proposals for re-powering of wind energy development.	NPWS	2024, and as applications arise

7.5 HHTRP Mitigation

Action		Public Authority
CC1-national surveys	Prior to any on-site Hen Harrier surveys, a desktop ecological review is conducted to understand which QIs/SCIs may experience disturbance by the proposed survey work through the movement of people and vehicles. Survey methodology for all Hen Harrier national survey, appended to SEA Environmental report, shall be followed. This includes standardised fieldwork methods, online workshops and avoidance of disturbance.	NPWS
CC6-winter roosts	Prior to any on-site Hen Harrier surveys, a desktop ecological review should be conducted to understand which QIs/SCIs may experience disturbance by the proposed survey work through the movement of people and vehicles. Survey methodology should be developed with safeguards in place to avoid the low-level disturbance that would result in adverse effects on a European site. A risk assessment method statement for researchers is to be agreed and signed off by NPWS prior to the facilitation of this action.	NPWS
AG4-incentives, awareness and education	Prior to the implementation of any projects and/or activities arising from this action, a desktop review of all available ecological information pertaining to any area identified as suitable for Hen Harrier is conducted. Prior to the implementation of any measures arising from this actions, the conservation objectives those QIs/SCIs is incorporated within any measures so as to achieve the objective of this action insofar as to avoid disturbance to QIs/SCIs, changes in hydrology, risk of sedimentation or pollution to watercourses.	Relevant public authority undertaking the activities
AG17-research	Prior to any on-site activities, a desktop ecological study of areas to be surveyed is conducted. The findings of such a desktop study shall inform the survey methodology and shall be conducted in favour of the conservation objectives of any European site that overlaps or is connected to an area identified for Hen Harrier survey. It shall be required that survey methodology is annually updated in keeping with best practice guidance, as necessary, to avoid disturbance	NPWS

7.6 Review and Update

Action		Public Authority	Timeline
Topic	Monitoring, Reviewing and Updating the Threat Response Plan		
Issue	Under Regulation 39, the Minister may establish a group for the monitoring, co-ordination, implementation and review of a threat response plan. It is proposed to continue the IDSG and Consultative Committee for these purposes, with updated terms of reference		
R1	The implementation of the Plan will be monitored and reviewed by the IDSG in consultation with the Consultative Committee.	IDSG	Annually
R2	A mid-term review of the Plan will be undertaken and actions <i>etc.</i> updated as necessary to respond to pressures and threats	IDSG	2026
R3	Integrate findings arising from future national Hen Harrier surveys into future iterations of this Plan/its successors.	IDSG	At review stages

Appendix 1. Threat Response Plans (Regulation 39 of the EC (Birds and Natural Habitats) Regulations 2011-2021)

Regulation 39 states that

(2) The Minister shall, where he or she considers it necessary for the purposes of meeting the objectives of the Birds Directive—

(a) pursuant to Article 2 of the Birds Directive, develop and implement a threat response plan or plans incorporating the requisite measures to maintain the population of one or more species of naturally occurring birds in the wild state at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level,

(b) pursuant to Article 3 of the Birds Directive, develop and implement a threat response plan or plans incorporating the requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for one or more species of naturally occurring birds in the wild state including the creation of protected areas, as appropriate, the upkeep and management in accordance with the ecological needs of habitats inside and outside the protected zones, the re-establishment of destroyed biotopes and the creation of biotopes, and

(c) in developing a threat response plan under subparagraphs (a) or (b), consult with any public authority that he or she considers likely to have a role in the development or implementation of such a plan.

(3) Public authorities shall, at the Minister's request—

(a) engage in consultations regarding the development and implementation of a threat response plan,

(b) provide such information as is relevant to the development and implementation of the threat response plan,

(c) exercise their functions relating to the development and implementation of the threat response plan insofar as the requirements of the Habitats Directive and Birds Directive apply to those functions, and

- (d) co-ordinate their functions referred to in subparagraph (c) with other public authorities.
- (4) The Minister may invite such persons or organisations as he considers appropriate to contribute to the development and/ or implementation of a threat response plan.
- (5) Where appropriate, a threat response plan may be supported by sectoral incentive measures.
- (6) A draft threat response plan shall be made available for public comment under Regulation 21 and, upon adoption, a threat response plan shall be made available to the public.
- (7) For the purposes of this Regulation, a threat response plan shall—
- (a) identify the actions required of public authorities for its implementation,
 - (b) specify timelines for the achievement of its objectives,
 - (c) specify a date for the publication of a review of the plan, and
 - (d) be published by the Minister on the Department's website in a readily accessible format.
- (8) Notwithstanding Section 40 of the Principal Act, the Minister may, as part of a threat response plan, authorise the destruction of vegetation on uncultivated land at any time and Section 40(1) of that Act shall not apply in relation to any destruction of vegetation on uncultivated land so authorised.
- (9) The Minister may establish a group of persons for the monitoring, co-ordination, implementation and review of a threat response plan.

Appendix 2. Terms of Reference for the Inter-Departmental Steering Group

The Department of Arts, Heritage and the Gaeltacht is developing a Threat Response Plan for Hen harriers in Ireland. The development of this Plan has been initiated under Regulation 39 of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477 of 2011. The Department, with input from other Departments, Agencies and Stakeholders, will draft the Hen Harrier Threat Response Plan for public consultation. The Department will be responsible for the final sign off and publication of the Threat Response Plan taking into account the views expressed in the public consultation process.

The Department has convened a Steering Group to assist in the development of the Plan. The roles of the Steering Group are to:

1. Advise the Department on the plan development process, in accordance with best practise and with the relevant legislation;
2. Ensure that all relevant aspects of the environment, including the interests of all stakeholders, are taken into consideration in the plan development process;
3. Support and facilitate the carrying out of the underlying ecological work programme, including the provision of advice and expertise to the Department and its advisers;
4. Consider and advise whether proposed management measures are sufficiently SMART (specific, measurable, achievable, realistic, timebound);
5. Review the draft Plan and public consultation responses;
6. Promote awareness of the Plan development process.

Appendix 3. Membership of the Hen Harrier Threat Response Consultative Committee

Consultative Committee as at January 2024

Kevin Collins	DAFM-Forestry
Caoimhin O'Neill	DAFM Forestry
Orla Fahy	DAFM-Forestry
Ted Massey	DAFM
Pamela Boyle	DAFM
Hannah Denniston	DAFM
Philip Newsome	DECC
Adam Fowler	DECC
John McCann	SEAI - Sustainable Energy Authority of Ireland
John Lusby	BWI - BirdWatch Ireland
Fintan Kelly	IEN - Irish Environmental Network
Elaine McGoff	IEN - Irish Environmental Network
Mechteld Schuler	ITGA - Irish Timber Growers Association
Fergal Monaghan	Hen Harrier EIP
John Landy	Coillte
Sakinah Brennan	Coillte
Aileen O Sullivan	Coillte
Tim Farrell	ICSA - Irish Cattle & Sheep Farmers Association
Eddie Punch	ICSA - Irish Cattle & Sheep Farmers Association
Mairead Longe	ICMSA - Irish Creamery Milk Suppliers Association
Eamonn Carroll	ICMSA - Irish Creamery Milk Suppliers Association
James Moran	GMIT - Galway-Mayo Institute of Technology
Brian Keville	WEI - Wind Energy Ireland (Formerly IWEA)
Noel Cunneiffe	WEI - Wind Energy Ireland (Formerly IWEA)
Eabhin Byrne	WEI - Wind Energy Ireland (Formerly IWEA)
Lorcan O'Toole	IRSG Irish Raptor Study Group
Jason Fleming	IFA Forestry Committee chair
Denis Griffin	IFA Rural Development Committee
Geraldine O'Sullivan	IFA Environment Committee
Niamh Twomey	CCMA -County and City Management Association
Conor O'Sullivan	DHLGH - Planning
Andy Bleasdale	NPWS Chair
Cliona OBrien	NPWS
Sinéad Cummins	NPWS
Catherine Vernor	NPWS
Barry O'Donoghue	NPWS
Lorna Grehan	NPWS HHTRP Secretary

Appendix 4. Reports written and received during the TRP process

The following reports and submissions, amongst others, were considered in the development of the final Threat Response Plan:

- NPWS Published Reports
 - Republic of Ireland National Hen Harrier Survey 2010
 - Ruddock, M. & Dunlop, B.J., O'Toole, L., Mee, A., Nagle, T. (2012) Republic of Ireland National Hen Harrier Survey 2010. *Irish Wildlife Manuals*, No. 59. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/IWM59.pdf>
 - NPWS Hen Harrier Special Protection Area (SPA) Habitat Mapping Project 2014
 - Moran, P. & Wilson-Parr, R. (2015). Hen Harrier Special Protection Area (SPA) Habitat Mapping Project 2014. *Irish Wildlife Manuals*, No. 83. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/IWM83.pdf>
 - The 2015 National Survey of Breeding Hen Harrier in Ireland
 - Ruddock, M., Mee, A., Lusby, J., Nagle, A., O'Neill, S. & O'Toole, L. (2016). The 2015 National Survey of Breeding Hen Harrier in Ireland. *Irish Wildlife Manuals*, No. 93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/IWM93.pdf>
 - The 2022 National Survey of breeding Hen Harrier in Ireland
 - Ruddock, M., Wilson-Parr, R., Lusby, J., Connolly, F., J. Bailey, & O'Toole, L. (2024). The 2022 National Survey of breeding Hen Harrier in Ireland. Report prepared by Irish Raptor Study Group (IRSG), BirdWatch Ireland (BWI), Golden Eagle Trust (GET) for National Parks & Wildlife Service (NPWS). *Irish Wildlife Manuals*, No. 147. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/IWM147.pdf>
- Hen Harrier Conservation and the Forestry Sector in Ireland
 - NPWS, (2015a). *Hen Harrier Conservation and the Forestry Sector in Ireland*. Report prepared by NPWS to inform the Hen Harrier Threat Response Plan (HHTRP) Version 3.2. 1-50.
<https://www.npws.ie/sites/default/files/publications/pdf/HHTRP%20-%20Forestry%20-%20V3.2.pdf>
- Hen Harrier Conservation and the Agricultural Sector in Ireland
 - NPWS (2015b) *Hen Harrier Conservation and the Agricultural Sector in Ireland*. Report prepared by NPWS to inform the Hen Harrier Threat Response Plan (HHTRP) Version 1.1. 1-74.

<https://www.npws.ie/sites/default/files/publications/pdf/hen-harrier-conservation-and-the-agricultural-sector-in-ireland.pdf>

- Hen Harrier and the Wind Energy Sector
 - NPWS (2022). *Hen Harrier Conservation and the Wind Energy Sector in Ireland*. Supporting document to the Hen Harrier Threat Response Plan. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage. 1-102.
<https://www.npws.ie/sites/default/files/publications/pdf/hen-harrier-and-the-wind-energy-sector.pdf>
- All-Ireland Squirrel and Pine Marten Survey 2019
 - Lawton C., Hanniffy, R., Molloy, V., Guilfoyle, C., Stinson, M. & Reilly, E. (2020) All-Ireland Squirrel and Pine Marten Survey 2019. *Irish Wildlife Manuals*, No. 121. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.
<https://www.npws.ie/sites/default/files/publications/pdf/IWM121.pdf>

Submissions and reports received from stakeholders

- Hen Harrier Threat Response Plan submission by the IRSG
- *Forestry and Hen Harrier: Exploring Synergies*. Response of, Department of Agriculture, Food & the Marine- Forestry, to the report entitled *Hen Harrier Conservation and the Forestry Sector in Ireland*
- Forest Sector Response to the NPWS Draft Document *Hen Harrier Conservation and the Forestry Sector in Ireland*
- ICMSA Comments on the *Hen Harrier Conservation and the Agricultural Sector and the Forestry Sector reports in Ireland*
- ICSA Submission on *Hen Harrier Conservation and the Agriculture Sector in Ireland*
- IFA Response to the *Hen Harrier Conservation and the Agricultural Sector in Ireland*
- *Hen Harrier Conservation and the Forestry Sector in Ireland*. Response by Irish Raptor Study Group.
- Report by the Joint Oireachtas Committee on Agriculture, Food and the Marine on *Designation of lands as Special Protection Areas for the conservation of breeding Hen Harriers*
- *Hen Harrier Conservation and the Forestry Sector in Ireland* – Statement on behalf of the Environmental NGOs
- Submissions from Consultative Committee members, January and February 2022
- Responses received to the Public Consultation undertaken in 2024.

Other Relevant Publications

- A national survey of breeding hen harriers in Ireland
 - Norriss, D.W., Marsh, J., McMahon, D. & Oliver, G.A. (2002). A national survey of breeding hen harriers *Circus cyaneus* in Ireland 1998-2000. *Irish Birds* 7, 1–10.

- The second national survey of breeding Hen Harriers in Ireland
 - Barton, C., Pollock, C., Norriss, D.W., Nagle, T., Oliver, G.A. & Newton, S. (2006). The second national survey of breeding hen harriers *Circus cyaneus* in Ireland 2005. *Irish Birds* **8**, 1-20.
- “Mismatches between breeding success and habitat preferences in Hen Harriers *Circus cyaneus* breeding in forested landscapes” (further details below)
 - Wilson, M. W., O'Donoghue, B., O'Mahony, B., Cullen, C., O'Donoghue, T., Oliver, G., Ryan, B., Troake, P., Irwin, S., Kelly, T. C., Rotella, J.J. and O'Halloran, J. (2012). Mismatches between breeding success and habitat preferences in Hen Harrier *Circus cyaneus* breeding in forested landscapes. *Ibis* **154**: 578-589.
- “Reproductive output of Hen Harriers *Circus cyaneus* in relation to wind turbine proximity” (further details below) ¹⁶
 - Fernández-Bellon, D., Irwin, S., Wilson, M. and O'Halloran, J. (2015). Reproductive output of Hen Harriers *Circus cyaneus* in relation to wind turbine proximity. *Irish Birds*. **10**: 143-150.
- WINDHARRIER Final Project Report (further details below)
 - Wilson, M, Fernández-Bellon, D., Irwin, S. and O'Halloran, J. (2015). The interactions between Hen Harriers and wind turbines. WINDHARRIER. Final project report, prepared by School of Biological, Earth and Environmental Sciences, University College Cork, Ireland. PP95.
<https://www.ucc.ie/en/media/research/planforbio/forestecology/WINDHARRIERFinalProjectReport.pdf>
- O'Donoghue, B.G. (2010). The Ecology and Conservation of Hen Harriers (*Circus cyaneus*) in Ireland. PhD Thesis submitted to University College Cork.
- Wilson, J.D., Anderson, R., Bailey, S., Chetcuti, J., Cowie, N.R., Hancock, M.H., Quine, C.P., Russell, N., Stephen, L. & Thompson, D.B. (2014) Modelling edge effects of mature forest plantations on peatland waders informs landscape-scale conservation. *Journal of Applied Ecology*, **51**(1), 204–213.
- Caravaggi, A., Irwin, S., Lusby, J., Ruddock, M., O'Toole, L., Mee, A., Nagle, T., O'Toole, L., O'Neill, S. & O'Halloran, J. (2019) Factors influencing Hen Harrier *Circus cyaneus* territory site selection and breeding success. *Bird Study*, **66**(3), 366–377.
- Sheridan, K., Monaghan, J., Tierney, T.D., Doyle, S., Tweney, C., Redpath, S. M., & McMahon, B.J. (2020) The influence of habitat edge on a ground nesting bird species: Hen Harrier *Circus cyaneus*. *Wildlife Biology*, (2) 1–10.

¹⁶ Further information on research by UCC was presented orally at the Consultative Committee meeting on 2nd March 2016

Appendix 5. Recommendations of the Joint Committee on Agriculture, Food and the Marine

The Joint Committee on Agriculture, Food and the Marine published a report on the designation of lands as SPAs for the conservation of breeding Hen Harriers in 2015. Its recommendations are as follows:

JOC Recommendation	
No. 01	The Committee considers that the obligations imposed on the Hen Harrier SPA farmers effectively make them 'custodians of the environment', and therefore recommends that this principle be accepted so that the farmers are paid for carrying out this duty.
No. 02	The Committee recommends that a separate, dedicated payment program be established for the purposes of financing a Hen Harrier SPA scheme. These payments should be framed as payments to farmers for work carried out on their land to protect the Hen Harrier, as well as compensatory payments for being debarred from conducting traditional agricultural activity. The work carried out by farmers to maintain the designated areas in favourable condition for the Hen Harrier is for the public good.
No. 03	The Committee recommends that payments apply only to the curtailment of current or past activities and current or past income foregone. Payments should not apply to potential or future income.
No. 04	The Committee does not recommend that payment be made for failure to secure planning permission or a grant for new development.
No. 05	The Committee believes that the LAES is not the proper vehicle for the Hen Harrier SPA network, which needs one countrywide solution. Furthermore, the €70 million budget allocation for the LAES programme would not be sufficient, when shared with Burren and Fresh Water Pearl Mussels projects over the period of the current RDP round.
No. 06	The compensation scheme proposed for farmers with Hen Harrier SPAs should be a long term scheme and not tied to the EU financing cycles, which normally last 7 years.
No. 07	The Committee recommends that the RDP Axis 2 scheme for ANC (formerly known as DAS and LFA) be examined as a potentially suitable vehicle for a Hen Harrier SPA Scheme subsidy. The rate of payment from the ANC Scheme should be relative to the constraint imposed and there should be no hectare limit to the eligibility of the designated land under the scheme.
No. 08	The Committee notes that funds secured under the RDP 2007-2013 were re-allocated over time. The Committee therefore recommends that re-allocation of funds under the current RDP be examined to alleviate the Hen Harrier difficulties.
No. 09	The Committee recommends that farmers and farming groups be more involved in the entire process of protecting the Hen Harrier.

No. 10	The NPWS under the Department of Arts, Heritage and the Gaeltacht should be the lead department for any national Hen Harrier scheme and there should be constant co-operation between the different relevant departments. DAHG should be responsible for ensuring adequate pay out to farmers to ensure proper protection and maintenance of the habitat.
No. 11	The Committee recommends implementing a consistent monitoring system to evaluate how the management of the Hen Harrier SPA network has been working thus far, and to ascertain whether the desired conservation outputs are being achieved.
No. 12	The Committee recommends that the relevant bodies conduct Hen Harrier population surveys at regular intervals.
No. 13	The Committee recommends that an optimum time scale must be estimated for re-instating the Hen Harrier population, in order to set the duration on a Hen Harrier SPA subsidy scheme.
No. 14	The length of time of any scheme aiming to protect the Hen Harrier must be clear and definite and should be devised in consultation with ornithological experts to ensure that any such schemes will benefit the Hen Harrier.
No. 15	The Committee recommends that new methods of thinning, harvesting and rotation be adopted to reduce the extent of closed canopy areas.
No. 16	The Committee recommends that an impact assessment report be conducted in ascertaining the effect of the increasing rate of windfarm development in upland areas.
No. 17	The Committee recommends that the possibility of a tax credit scheme be explored in order to restore appropriate land value to designated land and therefore facilitate land mobility.
No. 18	The Committee recommends that the effect of designation on eligibility for agricultural relief be examined and appropriate steps be taken to ensure that farmers are not disadvantaged by designation in qualifying for agricultural relief on land transfer. This would be of particular assistance in cases of inheritance.

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The Department of
Housing, Local Government and Heritage



Rialtas na hÉireann
Government of Ireland

Hen Harrier Conservation and the Wind Energy Sector in Ireland

2021



1st June 2021
For circulation

Preparation of this Report:

The first draft of this report was commissioned by NPWS (now of the Department of Housing, Heritage and Local Government) to inform the development of the Hen Harrier Threat Response Plan (HHTRP) and was prepared by Marc Ruddock. Information on the distribution and characteristics of turbines installed in Ireland up to June 2016 was analysed for the purposes of this report; meanwhile, policy changes and developments up to the time of publication (early 2021) were detailed. Due to the time required to finalise the HHTRP, these final additions and updates were made to the report by NPWS.

Members of the HHTRP Interdepartmental Steering Group and Consultative Committee were also consulted on earlier drafts and their comments taken into consideration.

Through the course of the document's preparation, the Departments referenced within it were re-configured a number of times, so their names change throughout. For the purposes of clarity for the reader, these changes are set out below.

- The Department in which the National Parks and Wildlife Service sits changed from the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs (DAHRRGA) to the Department of Culture, Heritage and the Gaeltacht (DCHG), and, finally, in 2020, to the Department of Housing, Local Government and Heritage (DHLGH).
- The Department of Communications, Energy and Natural Resources (DCENR) changed to the Department of Communications, Climate Action and Environment (DCCAE) and then, in 2020, to the Department of the Environment, Climate and Communications (DECC).
- The Department of the Environment, Community and Local Government (DECLG) changed to the Department of Housing, Planning, Community and Local Government (DHPCLG), then to the Department of Housing, Planning and Local Government (DHPLG) and then to the Department of Housing, Local Government and Heritage (DHLGH) in 2020, (incorporating NPWS at this time).
- The Department of Agriculture, Food and the Marine remained the same throughout.

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National Parks and Wildlife Service 2021

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Directive 2009/147/EC (the Birds Directive) provides a comprehensive regime of protection for all wild birds naturally occurring in the European Union. The Directive instructs Member States to maintain their populations of wild bird species at a level that corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements. In light of this requirement, Ireland, along with other Member States, shall take the requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for its wild bird species.

The Directive also requires the classification of suitable areas as Special Protection Areas (SPAs) for the protection of certain bird species, including the Hen Harrier. Under Article 6 (2)-(4) of the Habitats Directive, which also applies to SPAs, Ireland is obliged to prevent the deterioration of these SPAs (as suitable areas for the species) and only to consent to projects where there is clear scientific evidence that such projects will not lead to an adverse effect on the integrity of the SPA or its qualifying features. The Court of Justice of the European Union, in a number of its findings regarding the interpretation of these Directives, has emphasised the importance of scientific understanding of the impact of proposed interventions, and where there is scientific doubt as to the potential effects on the species or habitats, the precautionary principle must apply.

In growing recognition of the importance of reversing biodiversity decline and its interactions with climate change adaptation and mitigation, international and EU biodiversity policies are being strengthened and Ireland's next National Biodiversity Plan, to be developed in 2022, will reflect these global, European and national contexts.

The Convention on Biological Diversity is currently undertaking negotiations with its Parties to develop the post-2020 global biodiversity framework and move towards achievement of the 2050 Vision of "Living in Harmony with Nature". The EU has also recently adopted its European Green Deal and its constituent element, the EU Biodiversity Strategy to 2030, which is intended to support a green recovery following the Covid-19 pandemic. The Strategy's objective is to put the EU's biodiversity on the path to recovery by 2030 and contains specific actions and commitments, including:

- Establishing a larger EU wide network of protected areas on land and at sea by 2030 (30% on both land and sea, 10% of both being strictly protected)
- Establishing a Nature Restoration Plan, with legally-binding restoration targets
- Unlocking funding for transformative change and a strengthened governance framework.

The Biodiversity Strategy also includes a requirement that Member States ensure that at least 30% of species and habitats not currently in favourable conservation status achieve that status or show a strong positive trend by 2030, and that none show further signs of deterioration.

At the UN High-Level Summit for Biodiversity in September 2020, An Taoiseach signed up to the Leaders' Pledge for Nature which supports the 30/30 targets and calls for an ambitious and

meaningful post-2020 global agreement that will address the biodiversity crisis and help bring about the transformative change needed to halt biodiversity loss on a global level.

Under the revised 2018 Renewable Energy Directive, Ireland has committed to delivering 34% of gross final consumption of energy from renewable sources by 2030, as part of the EU objective of reducing greenhouse gas emissions by 40% (based on 1990 levels) by 2030. In December 2020, the European Council agreed to increase the greenhouse gas emissions reduction target to 55% by 2030. In 2021, the European Commission will bring forward a range of legislative proposals to give effect to this step-change in ambition, including a revision to the 2018 Renewable Energy Directive to increase the binding renewable energy target.

The Programme for Government commits Ireland to reducing greenhouse gas emissions by 51% over the decade (2021 – 2030), to achieving net-zero emissions by 2030, and to reaching a target of generating at least 70% of electricity from renewable sources by 2030. The 2019 Climate Action Plan outlined an indicative target of 8.2 GW of onshore wind capacity by 2030, an increase of 4GW on 2019 installed capacity (DCCAE, 2019). In addition, up to 900MW of installed onshore wind capacity may be required to be repowered or renewed over the coming decade. The 2021 Climate Action Plan, to be completed mid-2021, will contain new policies and measures to take account of Ireland's increased climate ambition.

The transition to renewable electricity will be key to successfully meeting the ambitious renewable energy and greenhouse gas emission reduction targets outlined in the European Green Deal and Programme for Government. Onshore wind energy will continue to be one of the leading cost-effective technologies to achieve these targets.

This report specifically examines the interactions between the wind energy sector and Hen Harrier conservation in Ireland. The purpose of this report is to inform the Hen Harrier Threat Response Plan (HHTRP), and its findings will be integrated with those from reports on other key sectors, *i.e.* agriculture and forestry, in order to develop a collaborative cross-sectoral way forward for the conservation of this species.

Disclaimer: Some data utilised in the preparation of this report has been compiled from third-party data sources. Whilst every attempt has been made to verify these data and, although the data have been produced and processed from sources believed to be reliable, no warranty expressed or implied is made regarding accuracy, adequacy, completeness, legality, reliability or usefulness of any information. This disclaimer applies to both isolated and aggregate uses of the information.

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Acknowledgments

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CHAPTER 1: INTRODUCTION

Background

The National Parks and Wildlife Service (NPWS) of the Department of Housing, Local Government and Heritage (DHLGH) is responsible for co-ordinating the conservation of natural habitats and species and the protection of biological diversity in Ireland.

Under Regulation 39 of the European Communities (Birds and Natural Habitats) Regulations 2011-2015, provision is made for the development and implementation of appropriate threat response plans. The purpose of such plans is to cease, avoid, reduce or prevent threats, pressures or hazards that may be having an adverse effect on the conservation status of a species of bird referred to in Article 1 of the Birds Directive, and/or may be causing the deterioration of the habitats of species for which a European Site (or Natura site) has been classified pursuant to the Birds Directive (Directive 2009/ 147/EC).

The Hen Harrier (*Circus cyaneus*) is listed on Annex 1 of the Birds Directive. In 2007, six European Sites (Special Protection Areas (SPAs)) were designated for the conservation of this breeding species. Hen Harriers are also listed for two other SPAs that support important roost sites outside of the breeding season (*i.e.* Lough Corrib SPA and Wexford Harbour and Slobbs SPA). A survey of breeding Hen Harrier in 2010 recorded 128 to 172 breeding pairs (Ruddock *et al.*, 2012); this was broadly similar to the totals recorded in the previous survey in 2005 (Barton *et al.*, 2006). However, notable declines were recorded in some of the stronghold SPA sites (Ruddock *et al.*, 2012). The 2015 survey of breeding Hen Harrier (Ruddock *et al.*, 2016a) recorded further national declines with 108 to 157 breeding pairs estimated. Further declines were noted within four of the six of the SPAs and overall, the total SPA breeding population of Hen Harriers was shown to have declined by approximately 10% since the 2010 survey and 27% since the 2005 survey.

The results of recent research has raised the possibility that the Hen Harrier may be subject to an ecological trap in Ireland because of its habitat preferences and potential interactions with other land management and land uses. This, coupled with concerns that the extent and rate of change to the Hen Harrier's habitat (due to factors such as continued afforestation, increases in wind energy development and agricultural intensification) were linked to the recently recorded declines, led to the decision to develop a Hen Harrier Threat Response Plan (HHTRP). This document was prepared as part of the HHTRP process and specifically reviews the interactions between the wind energy sector and the conservation of the Hen Harrier population here. Similar reports have been prepared for the forestry and agricultural sectors (NPWS, 2015a and 2015b).

The Hen Harrier in Ireland

A history of the Irish Hen Harrier population (1800s – 1980s)

The Hen Harrier is a widespread, but patchily-distributed, breeding bird across much of northern and central Europe. This European breeding range equates to less than one quarter of its global range (Cramp and Simmons, 1980; Simmons, 2000). The European breeding population is considered to be relatively small (estimated at 32,000 – 59,000 breeding pairs (Birdlife International, 2004)). As the Hen Harrier underwent a large decline between 1970 and 1990, its European conservation status was regarded as 'unfavourable' (BirdLife International, 2004) but it has since been categorised on the European Red List of Birds as 'Least Concern' (BirdLife International, 2015). In Ireland, it is Amber-listed on the Birds of Conservation Concern (Gilbert, Stanbury and Lewis, 2021). It is migratory in the northern parts of its range in north and northeast Europe and Asia, and partially migratory and dispersive in the rest of its breeding range (del Hoyo *et al.*, 1992). Until recent genomic studies, the (Eurasian) Hen Harrier and the (American) Northern Harrier were understood to be the same species.

From the earliest documented records in the 1850s, Hen Harriers were generally distributed throughout Ireland, with breeding strongholds in Kerry, Wicklow and the Tipperary/Waterford border in the south, and Derry and Antrim in the north (Thompson, 1849). The Hen Harrier was also found breeding in Connemara (Shawe-Taylor in Watson, 1977). By 1900, this species was recorded in counties Kerry, Cork, Limerick, Tipperary, Waterford, Wicklow, Dublin, Offaly, Laois, Galway, Mayo, Fermanagh, Donegal, Derry, Antrim and Down. However, it was noted that the population was in decline and no longer present in some historical breeding areas (Ussher and Warren, 1900). At this time, Hen Harriers were considered to have been widely persecuted in Ireland (primarily through the destruction of young and eggs) throughout the latter half of the 19th century (Usher and Warren, 1900; O'Flynn, 1983). Indeed, this species was considered by some to have become extinct as a breeding species in Ireland altogether by the early 1950s (Kennedy *et al.*, 1954; Bannerman and Lodge, 1956). However, small numbers continued to breed in a few areas such as the Slieve Bloom Mountains in Laois, the Tipperary/Waterford border and the Cork/Kerry border (Watson, 1977). There is no accurate historical estimate of Ireland's total breeding population during the early 1950s but it is considered that the Irish population was at historically low levels with regard to numbers and breeding distribution at that time.

It is considered that a recovery in the population started in the 1950s (Andrews, 1964). In 1956, breeding pairs were found in Waterford, south Kilkenny and Cork (O'Flynn, 1983), re-colonising Wicklow soon after, with seven breeding pairs recorded in the county in 1961 (Scott, 1995). By 1964, at least 35 pairs were known to be breeding in six southern counties (O'Flynn, 1983). In the Atlas of Breeding Birds in Britain and Ireland (Sharrock, 1976), an all-Ireland breeding population estimate of 200 – 300 pairs is given, with confirmed or probable breeding records from 17 counties. The distribution was based on fieldwork which was undertaken during the period 1968 – 72. A slightly increased estimate of 250 – 300 pairs is reported for the period 1973-75 (Watson, 1977).

O'Flynn (1983) considered that the recovery of the Hen Harrier breeding population from the 1950s onwards appeared to have been due to an increased availability of secure nest sites and

passerine prey species. O'Flynn (1983) cites the government's adoption of a long-term afforestation plan in 1947 of circa 400,000ha to be planted over 40 years as the likely driver of this change, with Hen Harriers using the recently afforested (*i.e.* pre-thicket) areas to both nest in and forage over.

In the latter half of the 1970s, O'Flynn (1983) suspected that the population was no longer increasing. After further investigation, he concluded that the population had declined significantly in some areas (*e.g.* Wicklow from over 20 pairs in 1965 to two or three pairs in 1982), with apparent local extinctions occurring in other areas (*e.g.* Slieve Aughty Mountains, the Ballyhoura Mountains, hills of north Tipperary, hills of south Kilkenny and the Comeragh Mountains in Waterford). O'Flynn (1983) noted that, by the mid-1970s, the earlier-planted conifer forests had grown to maturity, resulting in a direct negative impact on the availability of suitable prey. Coincident changes to open, non-forested habitats in Hen Harrier breeding areas were also occurring at this time. These were partly attributed to Ireland's entry into the European Economic Community (EEC) in 1973 and through subsequent changes in land use initiated by significant investment through the Common Agricultural Policy. O'Flynn (1983) considered that tracts of scrub- and gorse-covered marginal land, which had provided a productive hunting habitat for the Hen Harrier, were cleared and transformed into improved grassland. The combination of the maturation of forest estate and the clearance of marginal land was considered by O'Flynn (1983) to be the main reason for the Hen Harrier breeding population decline of the late 1970s.

Hen harrier in Ireland 1980s to present

O'Donoghue (2004) described the modern landscape of the Irish-breeding Hen Harrier as:

- upland, typically above 100m above sea level (asl) and dominated by pastoral-based livestock farming, with holdings often covered in rushes and bordered by hedgerows;
- active and degraded peatland;
- scrub; and
- commercial forestry plantations of different ages.

Breeding:

Adult birds begin to occupy breeding areas in the uplands in March, with a view to forming pair bonds and to begin nesting. In a two-year study, O'Donoghue (2010) recorded that eggs were laid as early as the 16th of April and as late as the 10th of June, with the median occurring in the first week of May. Incubation per egg is estimated to last 29 – 31 days (del Hoyo *et al.*, 1992). O'Donoghue (2010) noted that the date when chicks fledged ranged from the 18-24th of June to the 6-12th of August, with the fledging peak occurring during the 9-22nd of July.

Nesting Habitat:

The main nesting habitats selected by Hen Harriers in Ireland are:

- pre-thicket stage of first and, particularly, second rotation plantations;
- heather moorland; and
- scrub habitats (see Norriss *et al.*, 2002; Barton *et al.*, 2006; Wilson *et al.*, 2009; O'Donoghue, 2010; Ruddock *et al.*, 2012; Ruddock *et al.*, 2016a).

Harriers will often nest in rides (typically in heather) between plantation blocks or in gaps within mature plantations where there is a suitable dense growth of mature heather or scrub (Ruddock *et al.*, 2012). Hen Harriers have been recorded nesting in mature trees in Northern Ireland (Scott *et al.*, 1991; Ruddock *et al.*, 2008) but incidences of tree-nesting Hen Harriers have not been documented in the Republic of Ireland (O'Donoghue, 2010). Tree-nesting has been less frequently recorded in Northern Ireland in recent years (Scott *et al.*, 1991; Ruddock *et al.*, 2008; Hayhow *et al.*, 2013).

O'Donoghue (2010) found that the three main habitat categories used by Hen Harriers for nesting were restocked forest (47%), heather/bog (30%), and scrub (23%). Ruddock *et al.* (2016a) indicated that the majority of Hen Harrier breeding pairs occur in second rotation forest (59%); heather moorland (26%); scrub (8%); first rotation forest (6%) and failed forest (1%).

Hen Harrier nesting preferences in Ireland range between 36m and 385m in altitude (O'Donoghue, 2010), are typically between 100m to 400m (Wilson *et al.*, 2009; Ruddock *et al.*, 2012), with the majority recorded between 200m and 400m (63%) and the remaining between 100m to 200m (33%).

Breeding Hen Harriers in Ireland typically avoid agriculturally-improved land for nesting (Wilson *et al.*, 2009), although the species will forage along hedgerows and linear features (Madders, 2000; 2003a). Hen Harrier populations in Ireland are now breeding predominantly in forested landscapes (Barton *et al.*, 2006; O'Donoghue, 2010; Ruddock *et al.*, 2012; Ruddock *et al.*, 2016a). These have replaced open heath-dominated upland habitats (O'Flynn, 1983). Conversely, in the UK, the Hen Harrier is recorded more frequently nesting in moorland (Redpath *et al.*, 1998; Sim *et al.*, 2007; Hayhow *et al.*, 2013).

Foraging habitat and diet during the breeding season

The foraging habitat preferences of Hen Harriers in Ireland are generally biased towards moorland, grassland mosaics and pre-thicket forest habitats (see O'Donoghue, 2004; 2010; Barton *et al.*, 2006; Irwin *et al.*, 2012). Post-thicket or mature forest is generally avoided by Hen Harriers for hunting (Madders, 2000; O'Donoghue, 2004). Several studies (see above) have noted that Hen Harriers in Ireland show a preference for nesting in pre-thicket forest habitats. However, observations of foraging behaviour (Madders, 2003; O'Donoghue, 2012) and pellet analysis of breeding pairs, including those in forested landscapes, show that Hen Harriers also use open heath, scrub and farmland habitats for foraging during the breeding season (O'Donoghue, 2010) and in some cases, preferentially use these open, natural habitats (Barton *et al.*, 2006; Ruddock *et al.*, 2012; 2016).

In Ireland, the diet of Hen Harrier is more restricted than that of birds in Britain due to the absence and/or sparse distribution of some small mammal prey species (Ruddock *et al.*, 2008). In the UK, Hen Harrier breeding numbers are typically correlated with the abundance of small mammals (Redpath *et al.*, 2002a; 2002b; Thirgood *et al.*, 2003). However, this relationship does not appear to exist in Ireland, perhaps due to the absence of short-tailed vole (*Microtus agrestis*) (see O'Donoghue, 2010). Preferred prey species in Ireland are Wood Mouse (*Apodemus*

sylvaticus) and small passerines such as Meadow Pipit (*Anthus pratensis*) and Skylark (*Alauda arvensis*) during the breeding season, whilst Meadow Pipit, Brown Rat (*Rattus norvegicus*) and wintering thrushes predominate in winter (O'Donoghue, 2010). Therefore, comparisons of diet between Ireland and elsewhere need to be undertaken with caution.

There are substantial amounts of Irish-based evidence that show the selection and avoidance of habitats used by foraging Hen Harrier:

- Barton *et al.* (2006) found that foraging adult Hen Harriers did not use habitats in proportion to availability. This study found that heath/bog had the highest selection ratio and so was the preferred habitat for foraging. Pre-thicket forest and scrub were important habitats, with rough grassland having a lower selection ratio. Improved grassland and post-thicket forests had the lowest frequency of use by Hen Harrier, although forested habitats accounted for 53% of the total foraging records.
- Ruddock *et al.* (2012) found that almost 40% of all foraging events observed by surveyors and recorded as part of the 2010 national survey were associated with pre-thicket forests and that 49% of foraging was recorded within open habitats (moorland, grassland and scrub), compared to 43% over forested habitats.
- In a study of Hen Harrier in the Duhallow region of north County Cork and east County Kerry, O'Donoghue (2012) recorded that almost 25% of all foraging flight-lines observed were in pre-thicket forest, with a preference (25% of hunting observations) along linear features (hedgerows) and scrub, as well as moorland (23%) and rough grassland (11%). There was apparent avoidance of mature forest habitats and intensively-managed grasslands.
- Using remote tracking technology, Irwin *et al.* (2012) found that Hen Harriers were more frequently recorded in forested (65%) rather than open habitats (35%), although the study area was biased towards forested habitats. Within forested areas, foraging Hen Harriers showed a preference for second-rotation pre-thicket forest, particularly forest that was 6 - 11 years old, with reduced use of forest 12 - 15 years old. This study also corroborated their preference for foraging along linear features (up to 3-4m wide) and their avoidance of intensively-managed grasslands and forests less than 3 years old and greater than 15 years of age.
- Ruddock *et al.* (2016a) reported that Hen Harriers were more frequently recorded in open habitats (51%) compared to forested habitats (41%). Foraging was most frequently recorded over heather moorland (30.0%) and second-rotation forest (18.7%), rough grassland (12.4%) and thicket stage forest (12.4%).

Population trends since 1990

A second Breeding Bird Atlas was undertaken during the period 1988-91 and an all-Ireland population of 180 breeding pairs was estimated, based on an extrapolation of density estimates across the areas of confirmed or probable breeding (Gibbons *et al.*, 1993). The first national Hen Harrier survey in the Republic of Ireland was conducted during the breeding seasons of 1998 - 2000 and estimated a breeding population of 102 - 129 pairs (Norris *et al.*, 2002 as described in Barton *et al.*, 2006). A second national survey was undertaken in 2005 and

established that its range was within 66 10km squares, as well as a national population estimate of 132 – 153 territorial pairs. This was an increase in numbers of pairs of over 18% from the first national survey; and could be partially explained by increased survey coverage in 2005 (Barton *et al.*, 2006). Combining the results with comparable surveys undertaken in Northern Ireland (Sim *et al.*, 2001; Sim *et al.*, 2007), Barton *et al.* (2006) established all-Ireland estimates of 130-167 and 190-221 territorial pairs in 1998-2000 and 2005 respectively, equivalent to an increase of over 24% in that period.

The third national survey, undertaken in 2010, estimated a breeding population of between 128 to 172 territorial pairs occurring in 69 10km grid squares. A separate survey in Northern Ireland estimated 59 proven and probable territorial pairs (Hayhow *et al.*, 2013), providing an all-Ireland estimate of 158 to 205 pairs (Ruddock *et al.*, 2012). These results indicated that the Hen Harrier population appeared to be stable. However, the ability to directly compare the 2005 and 2010 national estimates was complicated by the more than doubling of the surveyor effort in the 2010 survey (Ruddock *et al.*, 2012). The coverage of the 2010 national survey included the 10km squares surveyed in 2005 and therefore, a more accurate comparison was derived by Ruddock *et al.* (2012) by comparing the number of breeding pairs in this subset. The analysis of 113 10km grid squares surveyed in both survey years indicated a population decrease of 6.4% over that five-year period.

A similar sub-sample approach for 84 10km squares surveyed in 1998-2000 and 2010 showed a short-term national population decline of 11 – 14% and 6% reduction in breeding range over this period (see NPWS, 2013a). The 2007 – 2011 Bird Atlas (Balmer *et al.*, 2013) presents the breeding distribution of Hen Harrier within 99 10km squares in the Republic of Ireland but differences in survey methodology and survey effort complicate the interpretation. A large proportion of the records submitted to this Bird Atlas were derived from the 2010 national survey.

The most recent survey data, from 2015 (Ruddock *et al.*, 2016a), with 108 – 157 breeding pairs, revealed a further national population decline. This represents a total population decline of 8.7% since 2010. The overall breeding range was observed to have increased, but only for 'possible' breeding pairs, and Hen Harriers were recorded within 83 10km squares (Figure 1), which was a 20.3% increase from 2010 (69 squares).

Supplementary sub-set analyses of data from 139 10km squares that were surveyed in 2010 and 2015 showed a decline of 21.2% in numbers of confirmed breeding pairs (Ruddock *et al.*, 2016a). A further sub-set of 110 squares surveyed in 2005, 2010 and 2015 showed a decline of 9.7% in total numbers of territorial pairs from 2005 to 2015 and 16.7% from 2010 to 2015. There was an 8.3% increase recorded in total numbers of territorial pairs between 2005 and 2010 (see also Barton *et al.*, 2006). To establish a long-term trend, Ruddock *et al.*, (2016a) examined 78 10km squares covered in all national surveys (1998-2000, 2005, 2010 and 2015). This shows an overall decline of 33.5% in numbers of territorial pairs between the first national survey (1998-2000) and most recent survey (2015). The proposed 2020 national survey was unavoidably delayed due to the Covid-19 pandemic, and so the 2015 results remain the most recent.

The observed declines in the abundance of breeding birds in the Hen Harrier strongholds, several of which are designated as SPAs, are of particular concern. Six sites have been designated as SPAs for breeding Hen Harriers in Ireland (Figure 2). The SPAs comprise a combined area of some 167,000 hectares (ha) and consist mainly of non-native coniferous plantation forests, open upland peatland habitats, and a spectrum of agricultural grasslands (from unimproved to improved) (NPWS, 2007; Moran and Wilson-Parr, 2015). It is estimated that approximately 52% of the total land area in these six SPAs is afforested. As of June 2016, there were 308 connected wind turbines within or close to (*i.e.* within 500m of) the Hen Harrier SPAs (NPWS, unpublished). The combined breeding Hen Harrier populations within these SPAs during the 2010 national survey (Ruddock *et al.*, 2012) was 77 territories, a decline of 18.1% compared to the 94 territories recorded in the 2005 survey. In 2015, the SPA population accounted for 44-47% of the national population, with between 51 and 69 breeding pairs recorded (Ruddock *et al.*, 2016a). This represents a decline of up to 26.6% in numbers of territorial pairs since 2005. In 2015, whilst the overall SPA network population had declined since 2005, the populations of two of the individual SPAs were recorded to have increased whilst the remaining four had declined (see Table 14 in Ruddock *et al.*, 2016a).

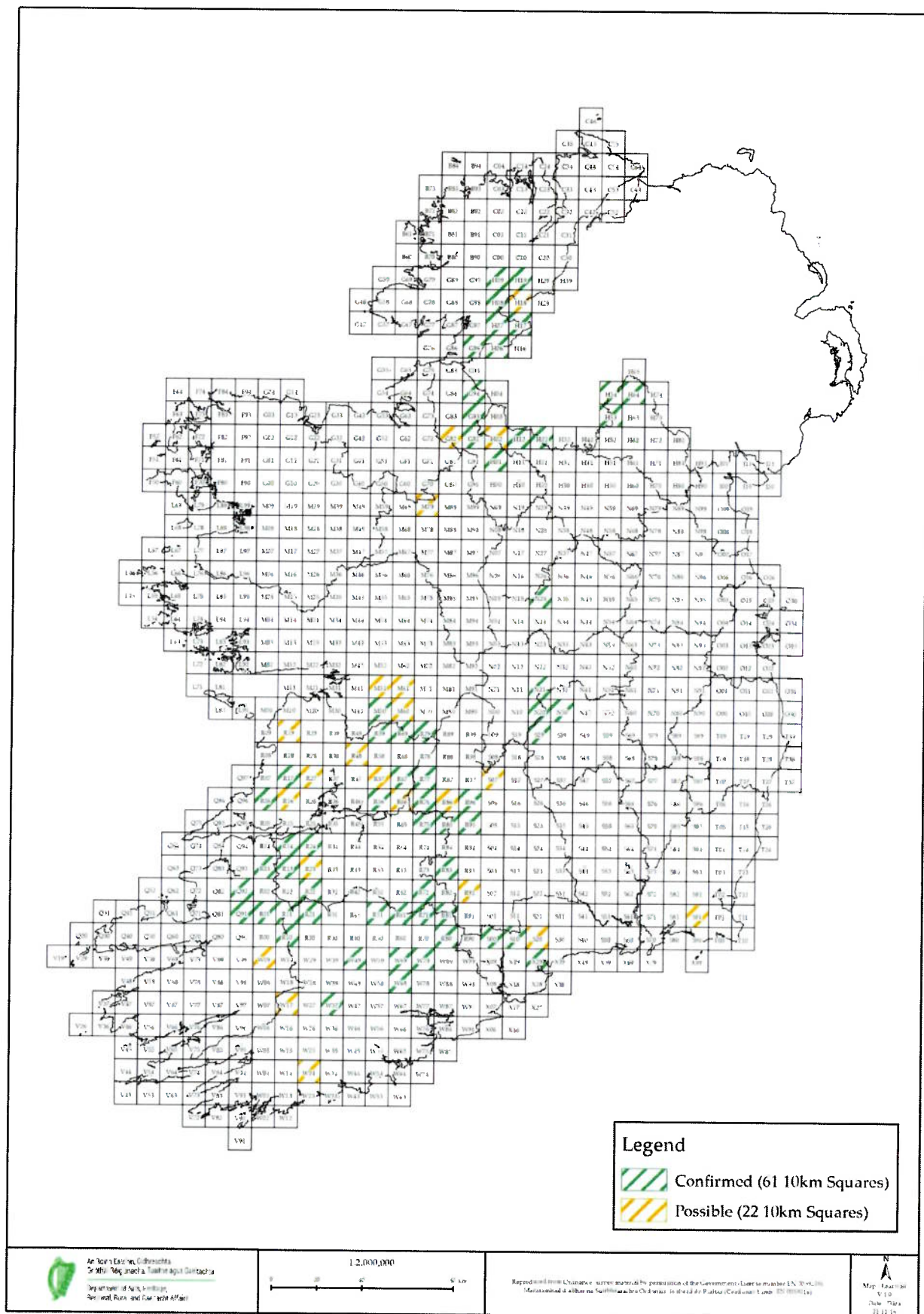


Figure 1. Distribution of Breeding Hen Harrier in 2015

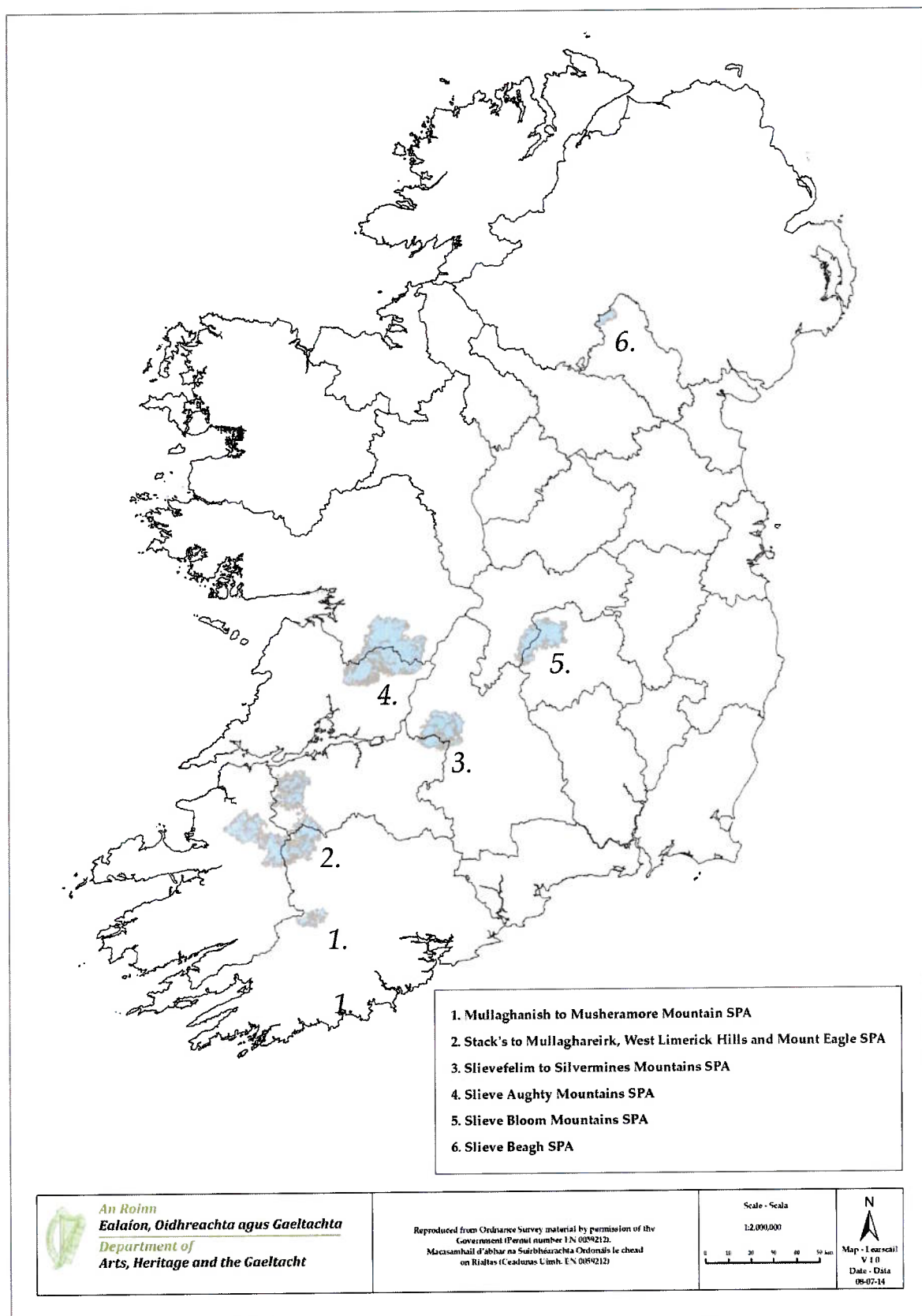


Figure 2. The SPA Network for breeding Hen Harrier.

Outside the Breeding Season (or the Wintering Season)

The winter distribution of Hen Harriers in Ireland differs from that of the breeding season (Figure 3). During the non-breeding season, which can be broadly defined as mid-August to mid-March, Hen Harriers may disperse from the breeding sites, with the majority of marked young birds born in Ireland re-sighted within 150km of their natal site (O'Donoghue, 2010). O'Donoghue (2010) also indicated that Irish Hen Harriers were largely resident, rather than migratory. There are evident population links between Ireland and Britain with records of Scottish-bred birds being re-sighted in Ireland, but the level of cross-over of birds during the breeding and non-breeding periods has yet to be established with certainty (Etheridge and Summers, 2006; O'Donoghue, 2010).

Hen Harrier wintering grounds are reported to typically occur in lowland sites below 100m (Clarke and Watson, 1990; 1997; O'Donoghue, 2010). During the winter, Hen Harrier can gather at communal (frequently used by several birds and other raptors) roost sites at night (Watson and Dickson, 1972). Roost sites may also be solitary (used by individual birds regularly or infrequently) (see Clarke and Watson, 1990). Hen Harriers select roost sites that have suitable cover, low ambient levels of disturbance and are presumably close to suitable foraging areas to roost (O'Donoghue, 2010). In Ireland, the majority of known roosts are located in reedbeds, heather/bog and rank/rough grassland but also in fen, bracken, gorse and saltmarsh (Watson, 1977; O'Donoghue, 2010). Approximately 20% of known roost sites here occur within close proximity to core nesting areas. Only a small number of known roosts are found in forested habitats (O'Donoghue, 2010). The numbers of individual birds occupying each roost site at any one time outside the breeding period are highly variable and patterns of roost site use are poorly understood. In 2014, approximately 96 confirmed winter solitary and communal roosts were known in Ireland, and they were estimated to support between 219 – 313 individuals (B. O'Donoghue, personal communication; see also NPWS, 2015a).

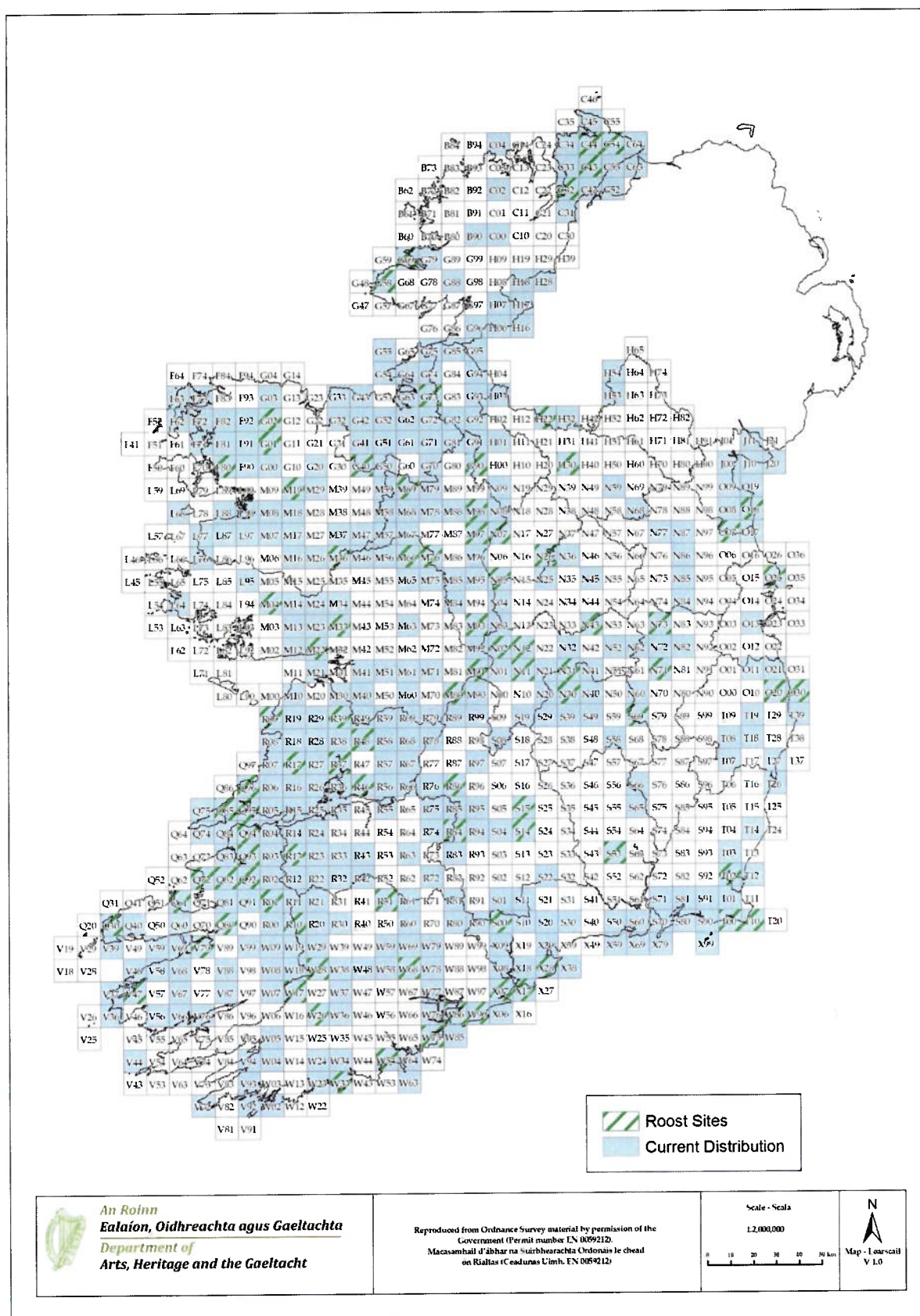


Figure 3. The distribution of wintering Hen Harrier (Distribution data from the 2007-11 Bird Atlas; Roost site locations from unpublished Irish Winter Hen Harrier Survey data).

The Wind Energy Sector in Ireland

The renewable energy sector includes a diverse range of technologies that harness natural energy sources, including solar energy, wind energy, hydro-power (rivers, wave, tidal) energy, geothermal energy and biomass (wood, waste, crops) energy (SEAI, 2016a). Many of these technologies are not considered to be ecologically relevant to Hen Harrier (*i.e.* there are no interactions between them) and thus, are not considered in this review to any degree. This review examines the wind energy sector only (see also Chapters 2 & 3).

Stakeholders in the Wind Energy Sector

Since 2016, DECC (or DCCAE, as it was then) has been responsible for policy and management of wind energy as directed by international and EU obligations. There are a number of commercial, non-commercial and regulatory State bodies under the aegis of DECC that are relevant to the development of wind energy, including the Electricity Supply Board (ESB), EirGrid, Bord na Móna (BNM), the Commission for Regulation of Utilities, and Sustainable Energy Authority of Ireland (SEAI).

SEAI was established as Ireland's national energy authority under the Sustainable Energy Act 2002 and it is central to the delivery of Ireland's renewable energy portfolio, policy and targets. SEAI also has responsibilities with respect to energy efficiency; its "energy efficiency first" philosophy ensures that the reduction of energy demand is considered first in national energy policy, as an alternative to increasing energy supply (*e.g.* SEAI, 2016b).

SEAI has worked in recent years to maintain a database of connected wind turbines and wind energy developments to inform delivery, reporting and analysis of the industry. SEAI also undertakes regular reviews and assessment of energy targets, performance and policy (*e.g.* SEAI, 2011; 2016a) in order to inform government policy, as well as engaging with stakeholders.

SEAI supports also supports relevant research, *e.g.* it has supported BirdWatch Ireland to facilitate work with the International Energy Agency Wind Technology Collaboration Programme (IEA Wind TCP) on WREN (*i.e.* Working Together to Resolve Environmental Effects of Wind Energy). WREN is the leading international forum for supporting the deployment of wind energy technology around the globe, through an improved understanding of environmental issues, efficient monitoring programmes and effective mitigation strategies.

Other Government Departments and agencies may also be considered to be stakeholders in the wind energy sector as their plans, programmes, policies and areas of responsibility may be affected by its plans and programmes etc. These include, for example, those bodies identified as prescribed bodies in the planning system, such as the National Parks and Wildlife Service (NPWS now sits within the Department of Housing, Local Government and Heritage). NPWS is also an environmental authority, in accordance with the meaning prescribed by the SEA Regulations, and is the lead authority with respect to nature conservation and policy. It is also responsible for the designation of sites for the purposes of nature conservation, including pursuant to the Habitats and Birds Directives, as well as the setting of conservation objectives for same.

DHLGH, through its Planning Section, is also responsible for the development of planning policy and legislation, including the overarching National Planning Framework (NPF) for Ireland's social, economic and cultural development. Local authorities and An Bord Pleanála are also key stakeholders as planning authorities.

The Forest Service of the Department of Agriculture Food and Marine (DAFM) has also become involved in the wind energy sector due to the development of wind energy within afforested sites.

Similarly, academic institutions and non-governmental bodies are involved in undertaking research and providing guidance (*e.g.* Wilson *et al.*, 2015; McGuinness *et al.*, 2015). There are also a significant number of ecologists and environmental scientists engaged in preparing planning applications and the associated ecological assessments for wind energy developments, as well as for relevant plans, programmes and strategies.

Various entities are involved in developing, constructing, operating and maintaining wind turbines or wind energy developments. These include the utility sector, large serial developers, small serial developers, single project developers and asset management companies (International Energy Association, 2015). Examples include State bodies, such as Coillte and Bord na Móna, that develop and operate wind energy developments on state-owned lands, as well as individual landowners or business owners, that may install one turbine in and around their own premises or land-holdings.

There are two representative bodies for the wind energy industry in Ireland:

- Wind Energy Ireland (WEI) (previously the Irish Wind Energy Association or IWEA) has over 150 members and engages laterally with counterparts in the British Wind Energy Association (BWEA; Renewable UK) and the European Wind Energy Association (EWEA). There are also extensive north-south co-operation mechanisms within WEI for consideration of All-Ireland industry issues, as well as an Ireland-UK working group for Northern Ireland, RenewableNI, facilitated by WEI and Renewable UK;
- Meitheal na Gaoithe, the Irish Wind Farmers' Association which is a representative body and lobby group for independent wind energy developers. It has over 70 members.

Policy and legislative context for the development of wind energy developments in Ireland:

The wind energy sector is governed and influenced by a wide range of policy and legislative drivers, including those of the energy sector itself, but also those concerning planning, climate change, biodiversity and the wider environment, heritage as well as other land-use sectors, such as forestry and agriculture. This broad context is described in more detail below.

-Renewable energy context

The primary global framework governing the development of renewable energy began at the United Nations (UN) Framework Convention on Climate Change (1994). Subsequently, amendments to the UNFCCC were adopted through the Kyoto Protocol (1997), the Integrated

Energy and Climate Change Package (2007), and more recently, the Paris Agreement (2016). The Paris Agreement sets out a global framework for the avoidance of dangerous climate change, by the limitation of global warming to well-below 2°C, and by the pursuance of efforts to limit warming to 1.5°C. The EU's contribution, adopted for all Member States under the Paris Agreement, is to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990.

The EU 2030 Climate and Energy Framework, adopted in 2018, incorporates EU legislative measures to achieve three EU-level key targets:

- at least a 40% reduction in greenhouse gas emissions;
- at least a 32% share for renewable energy; and;
- at least a 32.5% improvement in energy efficiency.

The 32% EU-wide renewable energy target is given effect through the recast Renewable Energy Directive (2018/2001/EU) and the Regulation on the Governance of the Energy Union and Climate Action (EU) 2018/1999 (the Governance Regulation). As part of the Governance Regulation, Member States prepared National Energy and Climate Plans (NECPs) for 2021-2030, outlining the measures they will take to meet the 2030 targets for, *inter alia*, renewable energy and energy efficiency. Ireland's first NECP 2021-2030 (DCCAE, 2020) outlined the policies adopted to deliver on a national target of 34% of gross final consumption of energy from renewable sources by 2030, including a 70% renewable share in electricity production. The first NECP does not take into account the increased climate ambitions – for a 51% reduction in greenhouse gas emissions over 2021–2030 – that are outlined in the 2020 Programme for Government.

In December 2019, the European Commission issued a communication on the European Green Deal (EGD), which set an ambition to achieve climate neutrality – or net-zero greenhouse gas emissions – by 2050 and, as an intermediate step, a 50-55% reduction in EU-wide GHG emissions by 2030 (on 1990 baseline levels) (European Commission, 2019). In December 2020, the European Council agreed to adopt a 55% target for 2030. On foot of the EGD Communication and Council's agreement, the Commission will bring forward a range of legislative proposals in 2021 to give effect to this step change in ambition, including a revision to 2018 Renewable Energy Directive to increase the binding renewable energy target. Any increase in the renewable energy target will require the additional deployment of renewable electricity as one of the key mechanisms to decarbonise the wider energy sector (*i.e.* heat and cooling and transport) in the electrification of those sectors.

EU legislation also provides the framework for the regulation and design of the EU internal market in electricity, which was most recently updated through the *Clean Energy for all Europeans* package of legislative measures, including the Directive on Common Rules for the Internal Market for Electricity (EU) 2019/944, the Regulation on the Internal Market for Electricity (EU) 2019/943, the Regulation on Risk Preparedness in the Electricity Eector (EU) 2019/941 and Regulation (EU) 2019/942 which establishes an EU Agency for the cooperation of energy regulators.

Renewable energy, including wind, is a key part of the Irish Government's commitments to a secure, sustainable energy strategy (DCENR, 2012a; 2014a and 2014b; 2016), energy transmission infrastructure (DCENR, 2012b) and low carbon policy (DCENR, 2015). The present policy context is shaped by the 2019 Climate Action Plan (DCCAE, 2019), which sets out the indicative renewable electricity capacity required to meet the policy of achieving a 70% renewable share in electricity by 2030, including an increase in onshore wind capacity from 4.2 GW to 8.2 GW over the decade 2021 – 2030.

The key Irish legislative instruments governing the renewable electricity sector include the Electricity Regulation Act 1999, which outlines domestic regulatory arrangements for the electricity sector; the Sustainable Energy Act 2002; the Energy Efficiency Directive 2012/27/EU implemented via SI 426/2014 and SI 131/2014; the 2009 Renewable Energy Directive (2009/28/EC), implemented via SI 483/2014 (which will be superseded by the 2018 Renewable Energy Directive from July 2021); and the EU Services Directive 2006/32/EU (via SI 542/2009).

Future policy development

Further expansion of renewable electricity will be required to meet Ireland's contribution to the 2030 renewable energy target, particularly in the context of the 2020 Programme for Government commitment to a 7% per annum reduction in greenhouse gases for the period 2021-2030 and the revised EGD greenhouse gas target. The deployment of renewable electricity technologies will be driven by technology costs and competitive auctions under the Renewable Electricity Support Scheme (RESS) as well as major private sector funding through Corporate Power Purchase Agreements.

To date, onshore wind has been the largest driver of growth in renewable energy electricity, primarily due to its cost-effectiveness when compared to other renewable technologies. In order to support the target to generate 40% electricity from renewable sources by 2020, DECC facilitates financial incentivisation of renewable energy generation via the Renewable Energy Feed in Tariff (REFIT). This scheme, funded by the Public Service Obligation (PSO) and paid via electricity consumers, subsidises renewable electricity generators based on electricity output (per kilowatt hour). DECC is currently operating the new Renewable Electricity Support Scheme (RESS). It is aimed at ensuring Ireland meets its 2030 renewable electricity target, providing support to renewable electricity projects and aiming to increase technology diversity and energy sustainability, amongst other things.

SEAI also provides grants and subsidies to encourage renewable energy research development, demonstration, and energy efficiency.

- Biodiversity and Nature policy context

The renewable energy industry, its policies, planning and implementation, is also subject to and requires compliance with a number of EU Directives such as the Strategic Environmental Assessment (SEA) Directive (2001/42/EC); Environmental Impact Assessment Directive (2014/52/EU); Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC) (see also

EPA, 2001; 2004a; 2004b; SI 435/2004; SI 436/2004). Under the SEA Directive, an SEA is mandatory for all energy plans and programmes. The sector must also comply with any and all relevant national transposing legislation, such as the European Communities (Birds and Natural Habitats) Regulations 2011- 2015 as well as relevant national biodiversity and nature conservation legislation including the Wildlife Act, 1976 and the Wildlife (Amendment) Act, 2000.

Developing policy and legislative context:

Biodiversity policy is rapidly developing at the international and European levels to respond to the biodiversity and climate emergency (Dáil Éireann, 2019), and Ireland's next National Biodiversity Plan, to be developed in 2022, will reflect these global, European and national contexts.

The Convention on Biological Diversity is currently undertaking negotiations with its Parties to develop the post-2020 global biodiversity framework and to move towards achievement of the 2050 Vision of "Living in Harmony with Nature". The EU has also recently made calls for a Paris-style (*i.e.* target-driven, legally binding) agreement for biodiversity (European Commission, 2021), and as part of its Green Deal, has adopted its Biodiversity Strategy to 2030, which is intended to support a green recovery following the Covid-19 pandemic. The Strategy's objective is to put Europe's biodiversity on the path to recovery by 2030 and so contains specific actions and commitments, including:

- Establishing a larger EU wide network of protected areas on land and at sea by 2030 (30% on both land and sea, 10% of both being strictly protected)
- Establishing a Nature Restoration Plan, with legally-binding restoration targets
- Unlocking funding for transformative change and a strengthened governance framework.

The Biodiversity Strategy also includes a requirement that Member States ensure that at least 30% of species and habitats not currently in favourable conservation status achieve that status or show a strong positive trend by 2030, and that none show further signs of deterioration.

To support the EU Biodiversity Strategy 2030 and to complement the Protected Areas targets, the European Commission is developing overarching restoration targets which would be legally binding for all Member States. These targets are to enable tangible, measurable and concrete actions that contribute to achieving the overarching goal of halting biodiversity loss and restore degraded ecosystems. Such measurable and time-specific targets for restoration to favourable conservation status for protected habitats and species are not explicit in the Nature Directives; these targets will also encompass habitats and species not protected under the Nature Directives. It is expected that long-term protection of the restored areas will be necessary. These restored areas could therefore contribute towards the EU targets on protected areas.

At the UN High-Level Summit for Biodiversity in September 2020, An Taoiseach signed up to the Leaders' Pledge for Nature which supports the 30/30 targets and calls for an ambitious and meaningful post-2020 global agreement that will address the biodiversity crisis and help bring about the transformative change needed to halt biodiversity loss on a global level.

Ireland has also signed up to the High Ambition Coalition for Nature and People (HAC). The HAC, chaired by France and Costa Rica, builds on the UN Summit for Biodiversity and aims to maintain momentum in mobilizing political will for biodiversity in the lead-up to the next CBD Conference of the Parties (COP15, October 2021). One of the key aims supported by the HAC is the 30/30 target.

- Planning and Development context

This section sets out relevant planning and development policies, legislation and guidance to the wind development sector.

Spatial planning and policy

Adopted in 2018, the National Planning Framework (NPF) is a national planning policy framework that guides Ireland's high-level strategic planning and development, with the aim that population growth will be sustainable, environmentally, socially and economically. Together with the National Development Plan, it guides strategic development and infrastructure development nationally and set the context for the development of the Regional Spatial and Economic Strategies (RSES) by the three Regional Assemblies. These, in turn, take account of and co-ordinate local authority Development Plans, so that all three levels (national, regional and local) align. Local Authority Development Plans, in turn, are required to include Wind Energy Strategies and Local Authority Renewable Energy Strategies. Following the adoption of all three RSES by January 2020, the statutory review process of local authorities' County or City Development Plans was commenced, overseen by the Office of the Planning Regulator. When complete, this process will ensure that all City or County Development Plans are consistent with the national and regional development objectives of the NPF and the relevant RSES.

The Planning and Development Act 2000 (as amended) is the primary planning legislation that influences the sector, setting requirements for regional guidelines, forward planning at the local authority level and development control. The Act sets out requirements for:

- (i) regional planning guidelines;
- (ii) development plans;
- (iii) local area plans;
- (iv) Ministerial guidelines;
- (v) the process of applying for and obtaining planning permission;
- (vi) special requirements for protected structures, conservation areas and areas of special planning control;
- (vii) housing supply;
- (viii) the Office of the Planning Regulator
- (ix) An Bord Pleanála and the planning appeals process;
- (x) planning enforcement processes;
- (xi) strategic development zones and processes;
- (xii) requirements for Environmental Impact Assessment (EIA);
- (xiii) requirements for appropriate assessments;
- (xiv) substitute consent;

- (xv) local and State development processes;
- (xvi) compensation,
- (xvii) amenities;
- (xviii) acquisition of land and
- (xix) other particular types of development, *inter alia*.

In accordance with section 28 of the Planning Acts, local authorities are required to have regard to any Guidelines issued by the Minister under that section. The Wind Energy Development Guidelines 2006, issued under section 28 of the Planning Acts, advise local authorities to plan for wind energy through the development plan process and to include a statement of its "*policies and objectives in relation to wind energy development and matters it will take into account in assessing planning applications for specific wind energy development proposals*". This plan-led approach also requires the identification of areas considered suitable or unsuitable for wind energy development, and is to be used to inform decisions on such applications.

The guidelines also provide advice on the determination of applications for planning permission (addressed below). In 2013, with input from a range of government department and bodies, SEAI published its Methodology for Local Authority Renewable Energy Strategies (LARES) (SEAI, 2013a) to assist local authorities in the preparation of their renewable energy strategies. The aim of the methodology was to facilitate a consistency of approach in the preparation of LARES, and to assist local authorities in developing robust, co-ordinated and sustainable strategies in accordance with national and European obligations.

Development plans can help to avoid or minimise conflicts, and in particular, to encourage appropriate siting of wind energy developments in areas of potentially low or no conflicts for wildlife, including Hen Harrier strongholds and protected sites. As part of the plan process, local authorities may identify European 2000 sites as "*less favoured areas*" or areas of high sensitivity for wind development in their Wind Energy Strategies, and may discourage wind energy development or consider it to be "*not normally permissible*" within the sites. It should be noted that these categories are indicative and that every wind energy development planning application is to be assessed on its merit, regardless of the categorisation that has been applied to the area within which the development is proposed.

As a result of the consideration of suitable areas for wind energy developments as part of the development plan process, information has been generated regarding the relative sensitivity of constituent parts of each county, as well as county-by-county maps for favoured and less favoured zones for wind energy developments (see individual Local Authority Development Plans). DHLGH has developed Myplan.ie, in collaboration with all planning authorities, to make a wide range of spatial information related to the planning process available to all, including census data, heritage sites and patterns of housing development. SEAI have also funded AIRO (All-Island Research Observatory at NUI Maynooth) to consolidate wind energy maps into an online interactive mapping toolkit, and at the time of writing, a follow-on project is being explored by SEAI to incorporate this resource within a LARES mapping web tool and online viewer.

The Planning Acts also require local authorities, when varying or reviewing Development Plans and the associated land-use/zoning policies, to carry out Strategic Environmental Assessments (SEA) and Appropriate Assessments (AA) of the Plans, as may be required. They transpose the obligations of the EU Habitats Directive (Articles 6(3) and 6(4)) for an Appropriate Assessment (AA) to be carried out where a plan or project is likely to have a significant impact on a European 2000 site. Guidelines on Habitats Directive Articles 6(3) and 6(4) were published by the European Commission (EC, 2001; EC, 2010; EC, 2007/2012) and on the appropriate assessment process by the then Department of Environment, Heritage and Local Government (DoEHLG, 2009; updated in 2011).

Development Control (i.e. planning for individual wind energy developments)

As mentioned above, the Planning Acts and Regulations set out the legislative context for planning permissions for individual wind energy developments.

To obtain consent for individual wind energy developments, applicants need to submit a Natura Impact Statement (NIS) (DoEHLG, 2009), if one is deemed necessary by the planning authority. *i.e.* if they have determined that significant effects may arise on a European site as a result of the proposed development. An NIS is to be prepared by ecological experts in order to allow the planning authority to complete the AA process and their determination as to whether adverse effects on the integrity of European sites may or will arise.

The need to apply the precautionary principle in appropriate assessments has been enshrined in ECJ case law (*e.g.* where effects may arise but have not been proven) (*e.g.* Waddenzee Judgment (ECJ, 2004). Public authorities shall give consent to a plan or project, or adopt a plan or project, under Article 6 (3) of the Habitats Directive, only after having determined that it shall not adversely affect the integrity of a European site; furthermore, appropriate assessments should “*include complete, precise and definitive findings and conclusions that are capable of removing all scientific doubt as to the effects of the proposed development on ... [sites] concerned*” (High Court, 2014).

If adverse effects are predicted or cannot be excluded, (even with proposed mitigation), the plan or project may proceed under Article 6(4) of the Habitats Directive, but only where there are Imperative Reasons of Over-riding Public Interest (IROPI), where there is an absence of alternative solutions, and where compensation measures for the adverse effects arising have been identified and put in place (DoEHLG, 2009).

Decisions of the local planning authorities to grant permission for wind energy development may be appealed to An Bord Pleanála. For developments that are considered ‘strategic’ (which may include some wind energy developments), all such developments must seek planning consent directly from An Bord Pleanála, through the Strategic Infrastructure Development (SID) process, rather than from the relevant local authority, *e.g.* installation of a wind energy development with more than 25 turbines or having a total output greater than 50MW (Schedule 7 of the Planning and Development Regulations, 2001).

On those occasions where planning permission or development consent is not required for the construction or reconstruction of a generating station to supply electricity to final customers, the Commission for Regulation of Utilities (CRU) grant or refuse authorisations, following the assessment of an associated application. In such cases, the CRU is responsible for the undertaking of any required appropriate assessment (CRU, 2020).

Guidance to support the development and assessment of wind energy developments

The then Department of Environment, Heritage and Local Government published extensive guidelines for the development of wind energy developments (DoEHLG, 2006) which includes natural heritage considerations. The guidelines set out a framework for wind energy development and planning related matters including, among other things, environmental impacts, and recommend early identification (via GIS mapping) of natural heritage designations. Such designations do not necessarily preclude wind energy development applications, but require that obligations under the EU Birds and Habitats Directives must be met, including that the planning authority is satisfied that there will be no adverse effects on the integrity or conservation objectives of any designated site from any proposed development, prior to consent.

In accordance with planning legislation, it is also requirement for an EIA to be undertaken for wind energy developments that will have more than five turbines, or a total output greater than 5MW. Certain sub-threshold developments also require an EIA wherever the planning authority or An Bord Pleanála considers that the development would be likely to have significant effects on the environment. In 2018, the then Department of Housing, Planning and Local Government published updated section 28 Guidelines for planning authorities and An Bord Pleanála on carrying out EIAs (DHPLG, 2018), to take account of the 2014 amendments to the EIA Directive (Directive 2014/52/EU). The 2014 EIA Directive retained wind energy development in its Annex II which means that the requirement for an EIA is determined at the national level, either on the basis of thresholds/criteria or a case by case examination, having regard to the criteria set out in Annex III. In addition, Recitals 7 and 13 of the EIA Directive now oblige the consideration of the impacts of climate change on a project as well as the impacts of a project on climate, as well as on biodiversity.

In June 2017, DHPLG and DCCAE published a “preferred draft approach” to the Review of the 2006 Wind Energy Development Guidelines. This approach focused on issues relating to Sound/ Noise, Visual Amenity Setback, Shadow Flicker, Consultation Obligations, Community Dividend and Grid Connections. DHPLG and DCCAE then published draft Wind Energy Development Guidelines, incorporating the “preferred draft approach”, for public consultation in December 2019. Following consideration of the submissions received, and any further revisions to the draft as required, the finalised Guidelines will be published.

Informed by the DoEHLG guidelines (2006), WEI (then IWEA) produced their own industry guidelines for the sector which focus on all stages of the development process from initial feasibility studies to operational, decommissioning and repowering (IWEA, 2012). These guidelines are not required to be taken into consideration by a developer or a consenting authority.

Locally and at a European level, additional supporting guidance on the preparation of EIA and AA has also been published which ensures regular updates to practitioners (*e.g.* EPA, 2002; EPA, 2003; EU, 2010 – 2016). Most recently, the European Commission has produced an extensive revision of its guidance document on wind energy developments and EU nature legislation, in recognition of the need to tackle climate change, to address growing pressures on and loss of biodiversity, to reflect most recent insights and to develop good practice so that respective policy goals and targets can be reconciled (European Commission, 2020b).

In Ireland, the Forest Service (2011) has also published ancillary guidance for wind energy development in afforested sites, and departmental policy statements show general support for renewable energy policy; *e.g.* the Department of Agriculture, Food and the Marine has published its Climate Change Sectoral Adaptation Plan for the Agriculture and Forest sectors (*e.g.* DAFM, 2019a and 2019b).

There are no specifically Irish-prepared ornithology guidelines to inform surveys for the development of wind energy in Ireland. Specific direction has been provided by NPWS (2002) for Hen Harrier surveys to inform impact assessments for wind energy development. This included the recommendations for 500m wind energy development buffers and wider hinterland surveys up to 5km for Hen Harriers. Furthermore, recommendations for systematic sampling to quantify site usage between April and August via vantage point observations were given (based on Madders, 2002), as well as consideration of cumulative effect of other wind energy developments in the area. Further guidance will be prepared by NPWS as an action of the HHTRP.

Percival (2003) reviewed available knowledge on the effects of wind energy developments on birds, particularly in relation to potential issues in Ireland, including disturbance-related research. This work also set out to provide a methodology for assessing the effects of wind energy developments on bird species. It addressed: baseline data collection, evaluation of sensitivities, establishing the magnitude of possible impacts, determination of significance of possible impacts, mitigation and cumulative assessment. The review recommended the adoption of British Wind Energy Association (BWEA) and Scottish Natural Heritage (SNH, now known as NatureScot) guidance with Ireland-specific adaptations. This study also set out a number of criteria which could be used to assess the ornithological sensitivity the site being assessed and the species involved *e.g.* it considered that SPA selection species (or Species of Conservation Interest/SCI) should be considered 'very high' sensitivity. On the basis of its ecological characteristics (where it is not an SCI species), Hen Harrier was classified as 'high' sensitivity. Thus, in Ireland, in the SPAs for which Hen Harrier is an SCI species, it would be considered to be 'very high' sensitivity, and where it occurs outside the SPA Network, 'high' sensitivity.

There is also a suite of published research on wind energy developments and birds (see Chapter 2) and Wilson *et al.* (2015) has reviewed guidelines in use in the UK and elsewhere in Europe. In Scotland, a detailed framework for ornithological interactions has been set out (SNH, 2000; 2006; 2011) and frequently, independent ecologists operating in other jurisdictions, including

other constituent parts of the UK (England, Wales and Northern Ireland) and in Ireland, may use or adapt SNH (now known as NatureScot) guidelines during their assessment and implementation of wind energy development planning processes. In addition to best practice guides for construction and decommissioning, these guidelines include recommendations on specific surveys, methods, seasons, assessment, avoidance, disturbance, repowering, habitat management, cumulative assessment, SPA connectivity, carcass searches, power lines, meteorological masts and are available online on the NatureScot website (see also review in Wilson *et al.*, 2015).

In the absence of specific Hen Harrier (or ornithological) guidelines in Ireland, the generic ornithology guidance provided by DoEHLG (2006) and IWEA (2012) and on appropriate assessments required for development within SPAs (DoEHLG, 2009; EU, 2011), along with the EU's guidance on wind energy developments and Natura 2000 (European Commission (EC), 2010), most recently updated in late 2020 (European Commission, 2020b) comprise best available guidance in Ireland.

Further to statutory and other guidance, there are also ancillary guidance tools available that can be used to inform wind energy development planning and associated ornithological requirements. These include the wind energy development sensitivity mapping tool, available via the National Biodiversity Data Centre's Biodiversity Maps portal and funded by SEAI. The primary research for this tool was undertaken in 2012, with an outline method and policy development protocol (Tierney *et al.*, 2012). The more detailed secondary report and assessment tool (McGuinness *et al.*, 2015) also provided a research output (and spatial planning tool) to inform wind energy development sensitivity for Hen Harriers and 21 other bird species for which spatial data were available. It has been developed into an AA and SEA screening tool by AIRO/NIRSA at NUI Maynooth, and SEAI is also funding its further development into the LARES data viewer and web tool.

Ireland's wind energy resource

Ireland has a relatively high wind resource that typically increases with increasing altitude (SEAI, 2013b; SEAI online Wind Atlas). Therefore, turbines have perhaps, historically, been more likely to be located in upland areas. Wind energy developments can theoretically be developed spatially anywhere in Ireland although spatial optimisation, particularly for wind output (Rasuo and Bengin, 2010) and other environmental constraints, is desirable. Because of dispersed historical development in Ireland and rural settlement patterns in particular, as well as related considerations that require wind energy development to be set away from settlements, very large swathes of the country are considered to be effectively unsuitable for wind energy development.

Newer and larger turbines may be less restricted by altitudinal requirements (*i.e.* installation in windier, upland areas) as they are now larger and can exploit wind resources at lower levels more easily. Thus, they can (theoretically) be installed at lower elevations and still harvest wind resources previously only obtained at higher elevations. However, similarly-sized turbines at lower levels will, on average, deliver lower energy yields than those in upland locations (SEAI online Wind Atlas; J. McCann, pers. comm.).

At the time of designation (2006), wind energy developments were located within the boundaries of four of the six Hen Harrier SPAs) and as of 2016, turbines had also been permitted in or in proximity to three SPAs post-designation (see Chapter 3). There are currently no explicit prohibitions on wind energy development within SPAs. However, as already mentioned, there is a requirement to undertake an appropriate assessment to ensure the development does not affect the integrity of the SPA.

A database of spatial and descriptive statistics of wind turbines greater than 0.1MW in Ireland (SEAI, unpublished; J. McCann, pers. comm.) confirms that the first wind energy development was erected in Ireland in 1992 (Co. Mayo; Figure 4). After a short hiatus between 1993 and 1996, the number of turbines increased annually, although the numbers of turbines connected varies between years (Figure 5). The average capacity installed annually between 2008 and 2017 was 258 MW. More recently, in 2019 alone, 461 MW was installed, bringing the total installed wind capacity to 4,137 MW (SEAI, 2020).

There are two databases available which collate information on wind energy in Ireland, namely the Transmission System Operator (TSO) database held by Eirgrid and the Distribution System Operator (DSO) database held at ESB Networks. WEI and SEAI present information on wind power in Ireland, informed, in part, by these databases. At the global level, there are also sources of relevant data (*e.g.* The Wind Power website). Both the TSO and DSO databases have two separate sub-databases for the connected (or energised) wind energy projects, as well as the contracted projects that have grid connection offers but have not yet been constructed, energised or connected. These databases do not necessarily provide information on the numbers of installed turbines or individual turbine capacity but rather the Maximum Export Capacity (MEC) upon which connection agreements are made. A single wind energy development may have several connection agreements and associated reference numbers for

energy export. Figure 5 illustrates the connected wind-energy resources in Ireland up until 2016 (2,780MW).

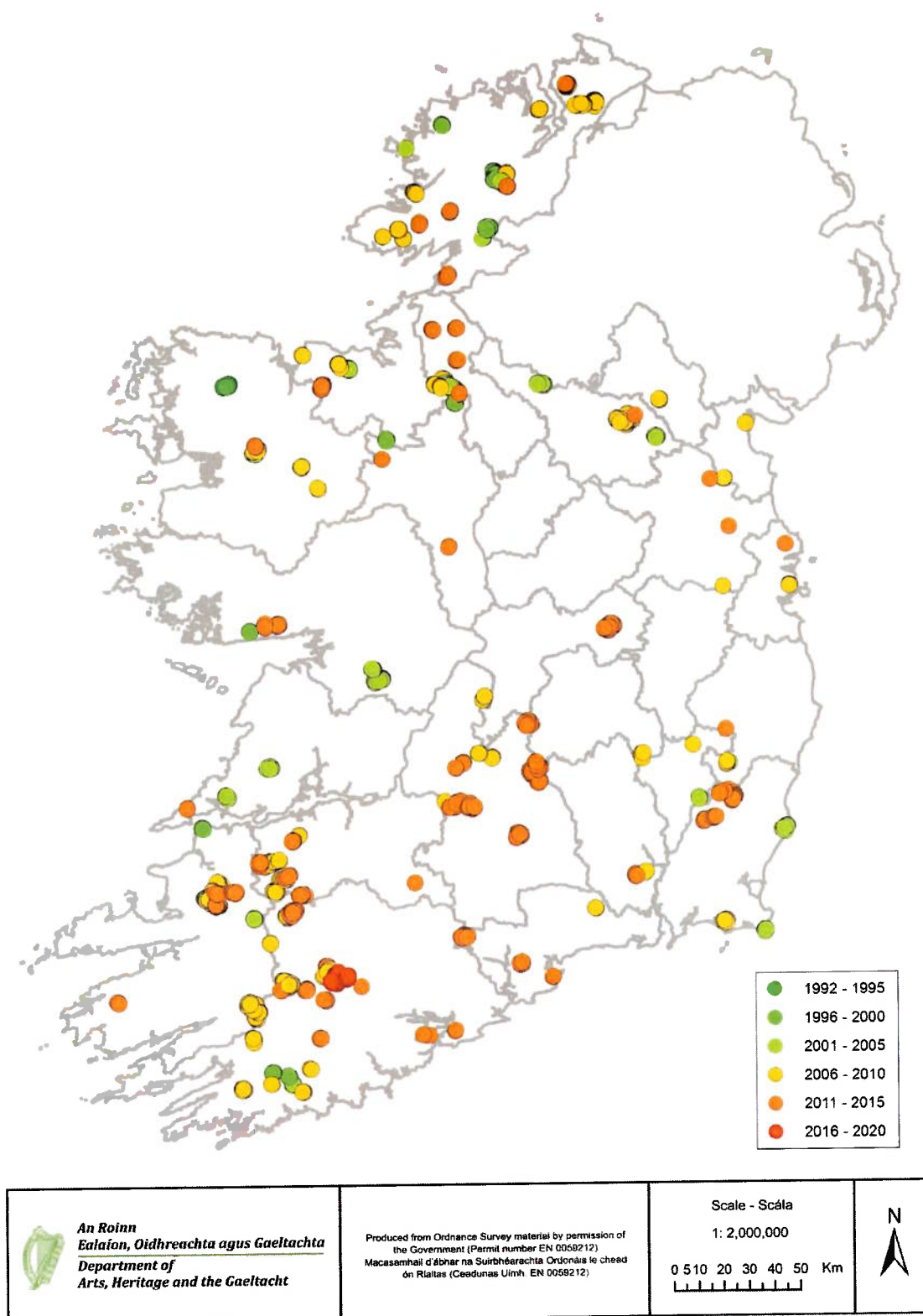


Figure 4. The cumulative distribution of terrestrial turbines connected in Ireland (1992 - 2016).
NB: Legend in box to be corrected before publication to refer to just 2016; not 2016-2020.

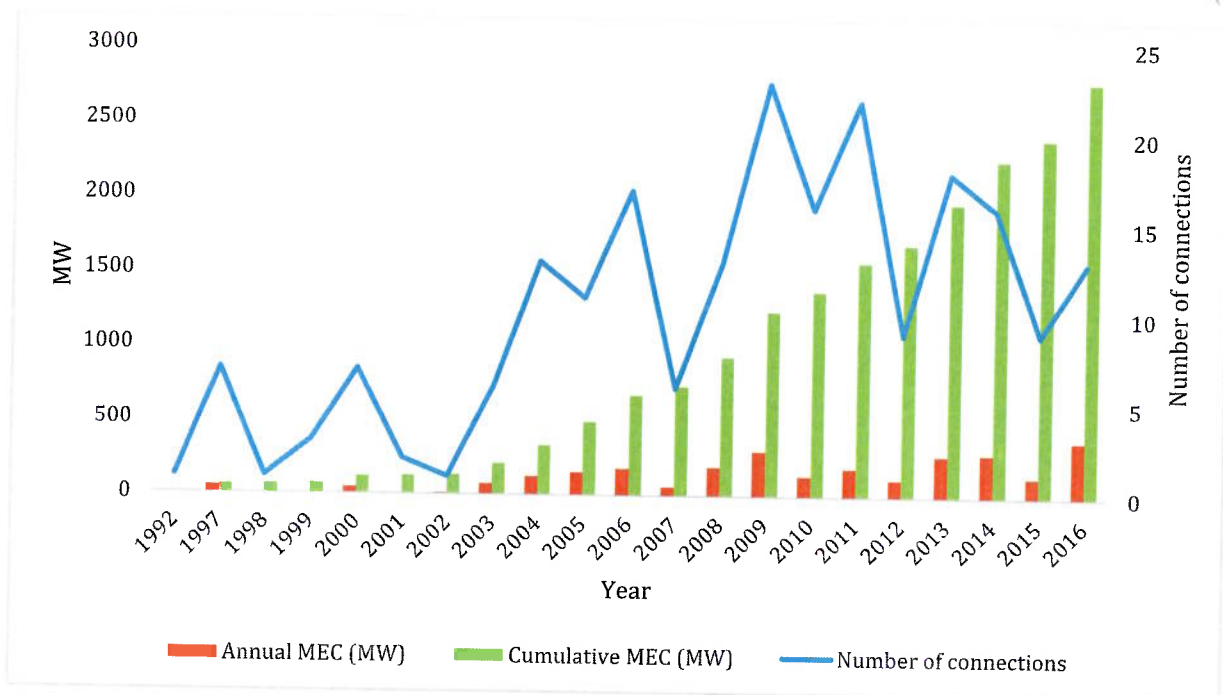


Figure 5. The annual and cumulative connected MW in Ireland between 1992 and 2016 (derived from statistics collated by ESB and TSO).

The NECP, submitted in Summer 2020, outlines estimated trajectories for the deployment of renewable energy technologies in Ireland, including renewable electricity technologies, taking into account the policies outlined in the 2019 Climate Action Plan (the With Additional Measures, or WAM, scenario) (DCCAE, 2020). In this scenario, the deployment of onshore wind is estimated to increase to 7.5GW by 2030 and to 8GW by 2040. The NECP trajectories will be reviewed in light of the policies adopted pursuant to the 2020 Programme of Government and ambitions of the European Green Deal, particularly the commitment to increased deployment of offshore wind and the increased ambition for greenhouse gas reductions and renewable energy penetration.

The overall trend of increasing power supply to meet renewable electricity targets takes into account the repowering of existing onshore wind energy developments (SEAI, 2011). The repowering of wind energy developments is expected to become increasingly relevant in coming years given the 20-30 year life-span of earliest developments. It also receives particular attention in the recast Renewable Energy Directive (2018/2001/EU) and the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, which requires Member States to facilitate the repowering of existing renewable energy plants with simplified and swift permitting processes that take no longer than one year (Article 16 (6)).

Wind energy development performance declines with age, and the rate of decline may be influenced by a number of factors, including terrain, weather, fleet vintage, as well as regulatory, policy and contractual factors (Hamilton *et al.*, 2020). The repowering of existing sites, where permissible, will be able to capitalise on recent technological advances, efficiency and increased power output of newer turbines (Herbert *et al.*, 2007; Sarkar and Behera, 2012). This will likely mean installation of larger and greater-output turbines over time, although the

largest turbines (>7.5MW, with the largest offshore turbine 12MW, as of 2020) are proposed primarily for offshore use. Maximum onshore turbine height will be influenced by the establishment of a setback distance, set at four times tip height, subject to a mandatory minimum of 500m, as set out in the “preferred draft approach” and the Draft Wind Energy Development Guidelines (DHPLG, 2019).

Developing a Wind Energy Development Application

The installation of wind energy development in Ireland typically involves several phases:

- (i) pre-application feasibility and suitability;
- (ii) research and assessment;
- (iii) planning application and decision-making;
- (iv) construction;
- (v) operation and
- (vi) decommissioning, renewal (*i.e.* life extension) or repowering.

Stage (i) Pre-application feasibility and suitability: It is recommended that an extensive suitability and feasibility assessment be undertaken before a planning application is submitted (known as the “pre-application stage”) (DoEHLG, 2006). Such assessments are a judicious use of resources to explore technical, economic and site-specific options, and involve early screening of high-risk or poorly-sited developments before any further financial investment is committed.

Stage (ii) Research and assessment: It is likely to be necessary to undertake research, survey and assessment in order to prepare for, amongst other things, the requirements of an Environmental Impact Assessment (EIA) and/or for an Appropriate Assessment.

Stage (iii) Planning application and decision-making: The applicant submits their application to the relevant planning authority, along with the Environmental Impact Assessment Report and Natura Impact Statement, if required. Applications are examined with reference to, *inter alia*, their impact on designated sites, nature conservation and taking into account the provisions of domestic and European legislation. The planning authority must refer all planning applications that might have significant effects in relation to nature conservation to NPWS-DHLGH. NPWS prepares and submits observations to the planning authority, which then concludes its Appropriate Assessment, and makes a decision on the application. The findings of the Appropriate Assessment must be taken into account in its decision-making.

The planning authority may set a series of planning conditions, including risk mitigation measures as part of the planning consent. Provided sufficiently robust information is available to inform the assessment and review by the planning authority, these conditions should provide for mitigation for any residual risk at all stages of wind energy development construction, operation and decommissioning.

In addition to planning consent, it is necessary to secure a grid connection (in order for a wind energy development to be able to export power to the national grid) and to agree the route and type of transmission (*e.g.* underground cables or overhead power lines). Details of the grid

connection must also form part of the planning approval process, where EIA/AA is required, in order to ensure that the impact of the whole project is considered. Connection offers from grid operators can be obtained prior to planning consent. Grid connection contracts are typically in place prior to commencement of construction.

Stage (iv) Construction: Construction can involve the creation of roads (typically hard-fill or floating road designs); turbine bases and hard-standings; erection of turbine towers, nacelles and blades; construction of operation/control rooms; construction/erection of grid connection infrastructure (*e.g.* underground cabling or overhead power lines). Planning consents also have specific requirements pertaining to the management of environmental risk during construction. For example, there may be a requirement to manage temporal constraints such as bad winter weather, with the elevated risk of siltation (run-off), or disturbance to breeding birds during the summer, or to have an Ecological Clerk of Works on site, to oversee the works and to ensure compliance with ecological mitigation measures.

Construction activities typically involve a relatively large work force and associated vehicles, cranes and other machinery to build the necessary infrastructure. Construction activities may also require the creation of borrow-pits, quarries, sediment ponds and temporary compounds; road widening and improvement works on the approaches to the site; installation of drainage infrastructure and waste disposal locations for material such as spoil from excavation works. Construction activities may also include habitat modification such as felling of trees (*e.g.* key-hole felling), habitat creation or restoration. Direct land-take by wind turbines may be relatively small compared to the entire wind energy development site, but the ecological impacts arising from the entirety of the development, *e.g.* through construction activities *etc.*, may affect a much wider area. The impacts of all these activities are to be assessed in the relevant ecological assessments.

Stage (v) Operation: The primary operational phase of a wind turbine or wind energy development may extend to 20-30 years, as directed by the planning consent. The scope of a full operation and maintenance contract includes the generating plant (*i.e.* turbines) and the entire wind energy development site, including access tracks, auxiliary buildings and electrical infrastructure. For the most-part, day-to-day maintenance and operation of the site is undertaken either remotely and/or by a small number of site personnel and associated vehicles. Site operation involves one or a limited number of personnel attending the site on a daily basis, or occasionally, in order to undertake routine site and/or infrastructure inspections or condition assessments. Some site compounds may be used as operational bases for regional staff and thus, regular activity may occur. This may present other novel sources of disturbance to wildlife. For many wind energy developments, controls rooms are located at the electrical substation, commonly close to the entry point to the development, at a lower elevation, and not within the wind array. Remote monitoring involves only intermittent visits by personnel, when operational issues require their attendance.

Operations staff or technicians may need to respond either remotely or locally to maintenance notifications in order to diagnose the cause of the notification and reset, if needed. Such responses may be required around the clock, depending on its cause, though it is understood

that most can be addressed remotely. There may be human and vehicular activity associated with scheduled (*e.g.* quarterly or annual) maintenance inspections, service monitoring and repairs. There may also be a requirement for attendance of heavy goods vehicles or cranes in order to undertake more substantial repairs or maintenance; these are most likely to be required when major turbine components reach “end-of-life” (typically, more than 10 years into service). Larger scale operations, *e.g.* to remove/ replace turbines or extensive road repairs, may cause disturbance to species or habitats outside the primary construction periods.

The operational phase may also include ongoing or intermittent monitoring, reporting and management activities *e.g.* bird surveys, collision mortality (carcass searches), environmental management (*e.g.* habitat management). This phase may also be subject to environmental, health and safety and operational guidelines, which may vary between sites and operators.

Stage (vi) Decommissioning, Renewal or Repowering: Decommissioning may be included as a planning condition for a wind energy development but increasingly, repowering of existing sites may extend its lifetime. Factors that may drive the requirement for decommissioning include time-bound constraints on manufacturer warranties (and the associated risks), reliability (which may decrease over time), maintenance issues and efficiency (Verma *et al.*, 2015).

Following the cessation of a wind energy development operation, decommissioning involves the dismantling and removal of above-ground equipment (masts, turbines and foundations) from the site and all associated structures (including any access roads) are removed and vegetation reinstated. These activities are usually conditioned to be undertaken within three months of decommissioning (*e.g.* An Bord Pleanála, 2016). There is, as yet, little experience of this in Ireland but more detailed studies and reviews have been undertaken in Scotland (Welstead *et al.*, 2013).

Wind energy developers may also apply for permission to renew permission for a wind energy development. Renewal entails the seeking of planning permission to continue using the wind energy development as constructed, beyond the time limit specified in the original planning permission (if such a condition is in place) and may include replacing components (up to and including a wind turbine/s) of the wind energy development on a like-for-like basis.

Repowering entails the removal of the existing equipment and the seeking of planning permission for the installation of new wind turbines and any ancillary works required within the wind energy development site. As existing wind energy developments near the end of their operating lives, applications for repowering are steadily increasing. In some cases, the wind energy developments will be repowered due to rapidly evolving technology and changing financial incentives. In many cases, applicants will seek to install larger turbines when repowering an existing site.

Applications for repowering will need to be accompanied by further and more up-to-date surveys and ecological/environmental assessments in order to inform the associated planning decisions. The effects arising may differ to those of the original project as risks may shift from

one receptor group to another (European Commission, 2020b). Specific guidance on the approach to be used in the ecological assessment of repowering to inform AAs and EIAs may also be of benefit. Applications for repowering should be considered on a case-by-case basis by the planning authority taking into account all relevant legislation, policy and guidance, including the updated Wind Energy Development Guidelines to be issued by DHLGH.

CHAPTER 2: INTERACTIONS BETWEEN WIND ENERGY DEVELOPMENT & THE HEN HARRIER IN IRELAND

Introduction

This chapter outlines the potential interactions between wind energy development and the Hen Harrier in Ireland. It provides an overview of such interactions with birds generally, as well as the breeding and non-breeding Irish Hen Harrier population, within and outside the SPA network. It sets out the variety of interactions that may arise and then relates these to various aspects of Hen Harrier ecology. This review is largely based on scientific publications and reports, the majority of which are from peer-reviewed sources.

Wind energy development -bird interactions

Wind energy development interactions with birds can have lethal or non-lethal effects. Wind turbine construction and/or development work present three main risks to birds (Desholm, 2006), namely:

- 1) direct mortality due to collision with the turbine blades, nacelles, towers and/or ancillary wind energy development infrastructure (*e.g.* overhead power lines, if used; meteorological masts) (Barrios and Rodriguez, 2004; Band *et al.*, 2007; Drewitt and Langston, 2008; Bellebaum *et al.*, 2013);
- (2) loss of breeding and/or foraging habitat, due to the footprint of construction, or fragmentation of breeding, wintering or foraging habitats (de Lucas *et al.*, 2008; Pearce-Higgins *et al.*, 2009a; Fijn *et al.*, 2012; Zimmerling *et al.*, 2013), and
- (3) displacement of birds as a result of increased disturbance (Devereaux *et al.*, 2008; Fielding and Haworth, 2010; Fijn *et al.*, 2012), and/or loss of suitable habitat, and barrier effects caused by turbine arrays (Barrios and Rodriguez, 2004; Desholm and Kahlert, 2005; Masden *et al.*, 2009).

These potential effects are not mutually exclusive and may interact with one another to increase or decrease the severity of the overall effect. For example, reduced occurrence of a species on a site, caused by habitat loss, may decrease their risk of collision. Similarly, the absence of an avoidance response in some species or in individual birds may increase their collision risk (Drewitt and Langston, 2006; McGuinness *et al.*, 2015), and subsequent mortality.

There are a number of research studies and reviews available on the interactions between wind energy developments and raptors, in particular arising from studies over the last 25 years in Spain, USA, the Netherlands, Germany and Belgium (Crockford, 1992; Langston and Pullan, 2003; Stewart *et al.*, 2007; Carrete *et al.*, 2009; Wang and Wang, 2015; Schaub *et al.*, 2020).

Wind energy developments and collisions

The key concern of direct mortality and injury to birds through wind energy development-mediated collision is widely studied. The mortality effects on birds can be variable and may be affected by:

- season (Barclay *et al.*, 2007; Minderman *et al.*, 2012);
- topography (de Lucas *et al.*, 2012; Katzner *et al.*, 2012);

- turbine metrics such as height, design and age (Orloff and Flannery, 1992; Osborn *et al.*, 2000; Smallwood & Thelander, 2004; de Lucas *et al.*, 2008);
- spatial arrangement of the wind energy development (Ferrer *et al.*, 2012; Zwart *et al.*, 2016; Schaub *et al.*, 2020);
- weather conditions (Winkelman 1992; Drewitt and Langston, 2006; Kunz *et al.*, 2007; Larsen and Guillemette, 2007; Lawrence *et al.*, 2007; Drewitt and Langston, 2008; Farfán *et al.*, 2009);
- repowering (SNH, 2014);
- specific species' vulnerability or morphology (Barrios and Rodriguez, 2004; Smallwood *et al.*, 2009);
- species' abundance and distribution (Fielding *et al.*, 2006; Douglas *et al.*, 2011; Carrete *et al.*, 2012); and
- value or attractiveness of surrounding habitats (Larsen and Madsen, 2000; Walker *et al.*, 2005; Martinez-Abrain *et al.*, 2012).

The statistical relationship between bird mortality and turbine design is complex (Hötter *et al.*, 2006; Barclay *et al.*, 2007; Stewart *et al.*, 2007; Pearce-Higgins *et al.*, 2009a; 2012; Ferrer *et al.*, 2012; Thaxter *et al.*, 2017). It is also widely recognised that a species' population dynamics can be affected by mortality that may be additive (*i.e.* adding to natural mortality) or compensatory (*i.e.* substituting for natural mortality) (Cole and Dahl, 2013; Dahl *et al.*, 2013). Wind energy development collisions may operate in combination with other mortality factors, thereby exacerbating population declines or low/declining rates of population growth. This is of particular concern given the likelihood of extensive increases in numbers of turbines, both nationally and globally, in order to meet growing renewable energy targets.

Overhead lines may also elevate collision risk and/or occurrence of collisions (Hagen *et al.*, 2007; Doherty *et al.*, 2008) and may cause avoidance or displacement over a wider area *e.g.* declining habitat use over 600m, as recorded by Braun (1998). Overhead power lines and associated infrastructure (*i.e.* pylons or poles) may also act as perching locations for some species (Manosa, 2001; Smallie and Virani, 2010), including nest predators such as corvids (Lammers and Collopy, 2005), as well as causing electrocution (Tryjanowski *et al.*, 2013).

Poorly-sited developments can result in extensive mortality *e.g.* Smóla (Norway), Altamont Pass (California) and Tarifa (Spain) (Osborn and Schillinger, 1996; Hunt, 2002; Follestad *et al.*, 2007; de Lucas *et al.*, 2008; Telleria, 2009a; b). Whilst site-specific mortality can be increased by poorly-sited turbines, it may be lower than other types of mortality such as persecution (*e.g.* shooting or poisoning), predation or other types of collisions (*e.g.* vehicles, towers, buildings, power lines) (Langston and Pullan, 2003). However, impacts at the population level may be more marked in the cases of poorly-manoeuvrable, rare, long-lived species (Carrete *et al.*, 2009; Cole and Dahl, 2013). Effects may be particularly marked in those species which have low breeding productivity (Carrete *et al.*, 2009; Cruz-Delgado *et al.*, 2010), of which the Hen Harrier is one. There may also be a higher likelihood of effects on migrants (Masden *et al.*, 2009; Telleria, 2009b), particularly where mortality occurs in one part of the migratory or seasonal

range. This, then, may have effects well beyond the site of the actual collision (Katzner *et al.*, 2015).

The potential effects of repowering on bird mortality rates appears to be variable (Stewart *et al.*, 2007; Drewitt and Langston, 2008 contra Smallwood and Thelander, 2004; Barclay *et al.*, 2007). Some studies have concluded that there is no compelling evidence that repowering (*i.e.* increasing the capacity) of older turbines will change the collision risk for birds (Stewart *et al.*, 2007; Drewitt and Langston, 2008). Thaxter *et al.* (2017) conclude from their review study across a range of bird species, that, per energy output, collision risk may be reduced, if fewer larger turbines are installed, rather than many smaller ones. They highlighted that more research is needed to understand the relationship between collision risk and turbine size, and its variation between the habitats in which the turbines are located. The ecological effects of repowering will need to be considered on a site-by-site and species-by-species basis (European Commission, 2020b) as to whether it would result in a change to predicted collision risk.

Collision risk at wind energy developments is therefore a complex interaction between various species' characteristics and occurrence, and environmental and wind turbine/wind energy development factors (see Wilson *et al.*, 2015).

Hen Harriers and collisions

While low-medium risks of collision mortality has been identified by Whitfield and Madders (2006), Hen Harrier collisions have been reported, including in Spain (Lekuona and Ursúa, 2007 (n = 1); Northern Ireland (Scott and McHaffie, 2008; Co. Antrim; n = 1); Scotland (RSPB, 2012, Perthshire; n = 2) and Ireland.

In Ireland, as part of their review and study of flights behaviour, Wilson *et al.* (2015) recorded that:

- (i) during sky dancing displays, Hen Harriers achieved flight heights that put them at potential risk from wind turbines;
- (ii) average flight heights of adult Hen Harriers did not change in response to wind turbine presence, although it is possible that birds altered their flight height in the proximity of individual turbines;
- (iii) adult male Hen Harriers spent up to 12% of their flight time at wind turbine rotor swept height; and
- (iv) newly-fledged juvenile Hen Harriers spent the majority of their time below turbine rotor sweep height, in and around the nest area.

Overall, it was concluded that the risk of direct collision with wind turbine rotors was low (Wilson *et al.*, 2015). However, since that study's conclusion in 2015 and even in the absence of robust carcass searches, NPWS-DHLGH has received reports (including photographic evidence)

of one “possible” case and three “probable/confirmed”¹ incidences of Hen Harrier mortality caused by turbine strike.

Mortality of the allied Northern Harrier (*Circus hudsonius*) (Etherington and Mobley, 2016), (which was until recently considered to be the same species as the Hen Harrier) has also been recorded, with six collisions reported at Altamont Pass Wind Resource Area (APWRA), California (situated on a major bird migratory route with high concentrations of raptors) and Foote Creek Rim, Wyoming (Erickson *et al.*, 2001; Johnson *et al.*, 2001; Kingsley and Whittam, 2005). There were three recorded by Smallwood and Thelander (2004) over five years, and seven reported between 1989 and 2007 by Smallwood and Karas (2008), although some of these studies appear to report on the same data over different time periods. Three Northern Harrier collisions were also reported by Derby *et al.* (2008) at Buffalo Ridge, Dakota, USA.

In addition to the relatively small number of collisions occurring, many studies show that there does not appear to be a link between Hen Harrier abundance and collision levels, or those of Northern Harriers (Johnson *et al.*, 2000; Stewart *et al.*, 2005; Mabey and Paul, 2007; Whitfield and Madders, 2006). Mortality of harriers may also be disproportionately lower than other raptors (Drewitt and Langston, 2008). Hen Harriers may be at lower risk of collision due to the majority of low-elevation flights undertaken by the species (Madders, 2000; Whitfield and Madders, 2006; Band *et al.*, 2007), which does not normally predispose them to flying within the rotor swept zone, and avoidance responses (Garvin *et al.*, 2011). Wilson *et al.* (2015) suggested that collision risk may be affected by the proximity of the nest and during breeding displays.

A recent study examining flight behaviours of Montagu’s Harriers, using three-dimensional GPS tracking data to investigate collision risk of breeding males with wind turbines, found that only 7.1% of flights were within the average rotor height range (RHR; 45-125m), with birds spending as much as 8.2 h per day in flight, more than Hen Harriers in the same study area (4-6 h/day for males during the breeding season) (Schaub *et al.*, 2020). Avoidance of turbine towers was demonstrated, with a distinct reduction of flight activity near turbines. This analysis estimated that any repowering of wind energy developments in the study area (where tracked birds visited nine wind energy developments in total), using low-reaching modern turbines (RHR 36-150m), could more than double the risk of collision for Montagu’s Harriers.

With respect to Hen Harrier, repowering of old wind turbines with larger models may move the rotor swept area above their typical foraging altitude. Between 1992 and 2014, the average height of the lower edge of the rotor swept area doubled. Thaxter *et al.*’s (2017) review study

¹ A determination of cause of death of any remains discovered near a turbine or wind energy development footprint is made based on a review of the available evidence. This includes:

- proximity of the specimen when found, relative to a wind turbine;
- a detailed physical examination of the remains by an expert *e.g.* veterinary surgeon and x-rays to ascertain whether injuries sustained would be consistent with a turbine collision.

Such cases where the nature of the physical trauma *i.e.* fractures and/or severed body parts are consistent with a turbine strike are deemed ‘probable/confirmed’ for reporting purposes. Where a turbine strike cannot be discounted as cause of death, such incidents are recorded as ‘possible’.

identified a strong positive correlation between turbine capacity (MW) and bird collisions per turbine, indicating that fewer larger turbines should be installed to minimize collisions.

Wind energy developments and habitat loss and fragmentation

Construction of hard surfaces, *e.g.* for roads and turbine foundations *etc.*, cause direct habitat loss. The construction of access roads may also increase fragmentation of habitats (Trombulak & Frissel, 2000) that may be important for bird species but it may also attract other species *e.g.* by providing novel linear features which harriers may utilise for foraging (M. Ruddock, personal observation). Overhead power lines and any associated vegetation clearance can similarly influence small mammal (prey) populations (Osbourne *et al.*, 2005) and create fragmentation or barriers to movement (Andrews, 1990; Pruett *et al.*, 2009a and 2009b; Hagen *et al.*, 2011).

Wind energy developments and displacement of bird species, including Hen Harrier

Displacement and/or disturbance can potentially occur in three phases of the wind energy development's lifespan: firstly, during construction phase; secondly, during the post-construction phase and finally, in the decommissioning or repowering phase. The former and latter will occur over a short temporal period (weeks – 18 months) whilst the operational phase will occur over several years *i.e.* the period for which it is operational (20-25 years). Issues are also most likely to arise where spatial and/or temporal interactions occur between nesting, foraging or roosting habitats and wind energy developments and activities.

Displacement from breeding, wintering or foraging areas (effectively, a loss of habitat) can occur as a result of both direct and indirect effects at wind energy developments. Direct bird displacement may be caused either through direct habitat loss, perturbation or changes to habitats *i.e.* loss of nesting or roosting habitat. Indirect displacement by wind energy development can be manifested through behavioural avoidance by birds because of associated disturbance (Langston and Pullan, 2003; Dahl *et al.*, 2013) and/or modification of foraging habitats, thereby affecting their utility (Arroyo *et al.*, 2009).

Operations (once-off or recurring) that have the potential to disturb nesting Hen Harrier (see Chapter 1) during pre-construction, construction and operational phases of wind energy developments include the following, though not every wind energy development will involve all those listed (*e.g.* tree felling, overhead power lines):

- (i) mechanical site (vegetation) clearance;
- (ii) timber felling (clearfell), extraction and removal;
- (iii) mechanical extraction and drilling for cabling;
- (iv) mechanical extraction for creation of foundations;
- (v) road construction (and associated developments);
- (vi) mechanical piling / drilling for turbine bases;
- (vii) the erection of fences;
- (viii) the erection of power lines, poles and associated rigging;
- (ix) operational site monitoring activities;
- (x) operational site maintenance activities; and
- (xi) operational habitat management activities.

Indirect effects can also be due to behavioural avoidance of actual turbines at a small scale (*i.e.* individual turbine) or a wider 'barrier effect' at wind energy development(s) level (Hotker *et al.*, 2006; de Lucas *et al.*, 2004; Sugimoto and Matsuda, 2011; Plonczhier and Simms, 2012; Humphreys *et al.*, 2015), where preferred flyway routes may be altered, particularly for migrating birds (Masden *et al.*, 2009; Telleria, 2009a).

A wide range of conclusions have been drawn in relation to wind energy developments and their displacement effects on birds, including that:

- it does not occur or its effects are negligible, acting at a small-scale (Madders and Whitfield, 2006; Devereux *et al.*, 2008; Douglas *et al.*, 2011; Haworth and Fielding, 2012);
- it has negative impacts (Pearce-Higgins *et al.*, 2009b); and
- the direction of observed or predicted effects are complex interactions between site-specific and species-specific metrics (Drewitt and Langston, 2006; Pearce-Higgins *et al.*, 2009a; 2012; Garvin *et al.*, 2011; Dahl *et al.*, 2013; Thaxter *et al.*, 2015).

The direct habitat loss due to the footprint of construction is likely to be a relatively small area of land, with a wider behavioural effect caused by avoidance likely across a greater area (*i.e.* the zone of influence). The key metric for displacement is a spatial response *i.e.* avoidance of wind energy developments or turbines by a specified distance (Whitfield *et al.*, 2008), although it is recognised that this spatial response can be highly variable between species (Marques *et al.*, 2014) and may be highly individualistic.

Reviews and empirical studies, measuring pre- and post-construction abundance and distribution, show that displacement exhibits considerable intra-specific variation, and where it does occur, it may range from 50m to 1,000m. Some species may not be affected (Douglas *et al.*, 2011) but the effects on others may, however, extend to a much greater distance (see Ruddock and Whitfield, 2007; Whitfield *et al.*, 2008).

In their field study, Fernández-Bellón *et al.* (2019) found that total bird densities were lower at wind energy developments than at control sites, and that the greatest differences occurred close to turbines. In addition, it was found that the scale and intensity of the displacement effects of wind energy development on upland birds depends on bird species' habitat associations and that the observed effects are mediated by changes in land use associated with wind energy development construction.

Pearce-Higgins *et al.* (2009) found in field experiments that there was no relationship between displacement and turbine size (range 30m – 70m; 8.4 MW – 97 MW) or power, whilst in their meta-analysis review, Stewart *et al.* (2005, 2007) found that there does not seem to be an inter-relationship between bird abundance and wind turbine number; only a weak, but statistically significant, relationship with power output was observed, with lower power-rated turbines resulting in greater declines in bird abundance than higher-rated turbines. This study also found that bird abundance was significantly affected by the life-span of the wind energy

development operation, with those that had been operational for longer time periods having higher effects on abundance.

Spatial avoidance can operate at the individual bird level, where an individual foraging or nesting bird locates itself further from the wind energy development and, subsequently, at a localised population level *i.e.* reduction in abundance and/or density (Pearce-Higgins *et al.*, 2009a; Marques *et al.* 2014). Displacement may have associated indirect 'cascade' responses (Schmidt and Ostfeld, 2003; Salo *et al.*, 2010), whereby some species are affected and that, in turn, affects other species. For example, wind energy development-mediated changes in prey species density or abundance may affect foraging predators, such as raptors (Pearce-Higgins *et al.*, 2009a; Wilson *et al.*, 2015). That is, habitat quality may be compromised to such an extent that indirect changes result in the avoidance of those habitats because of a reduction in their suitability and/or profitability for the species in question.

It has been suggested that displacement may affect breeding success in raptors (Bright *et al.*, 2008a; Carrete *et al.*, 2009) and displacement from suitable habitat has been suggested as causing a decline in the breeding success of two large raptors, White-Tailed Eagles and Griffon Vultures (Dahl *et al.*, 2012), although several studies show no detectable effects (see review in Wilson *et al.*, 2015). There is mixed evidence of habituation, with some reviews (Stewart *et al.*, 2005, 2007) suggesting that effects will persist throughout the operational period. Others suggest that this may vary between species (Marques *et al.*, 2014), but few studies have demonstrated this empirically (see Madsen and Boertmann, 2008).

Several studies attribute much of the perturbation caused by wind energy developments to the construction phase (Garvin *et al.*, 2011; Pearce-Higgins *et al.*, 2012; Campedelli *et al.*, 2013; Hull *et al.*, 2013; Stevens *et al.*, 2013) and associated disturbance and displacement effects. However, for some species (particularly seabirds, waders and raptors), long-term population effects have been shown to be more likely (Bevanger *et al.*, 2010; Nygard *et al.*, 2010; Dahl *et al.*, 2012). Conversely, some studies show that there are no detectable population level impacts (Devereaux *et al.*, 2008; Pearce-Higgins *et al.*, 2009a; Fielding and Haworth, 2010; Haworth and Fielding, 2012; Douglas *et al.*, 2011), particularly during the operational phase, although some species may be vulnerable to longer-term effects than others (Pearce-Higgins *et al.*, 2012).

The WINDHARRIER project reviewed wind energy interactions with Hen Harriers, as well as carrying out a series of Hen Harrier/wind energy development research packages in Ireland (Wilson *et al.*, 2015). It examined:

- population trends in relation to wind energy developments;
- the effects of wind energy developments on breeding bird communities;
- interactions with Hen Harrier breeding parameters;
- Hen Harrier flight behaviour in relation to wind energy development;
- Hen Harrier foraging behaviour; as well as
- wind energy development assessment guidance and recommendations for mitigation.

In its review of bird communities in and around wind energy developments, it was found that:

- (i) bird densities were lower within 100m of wind turbines compared to control areas, particularly forest bird species;
- (ii) differences in bird densities (within 100m) were related to habitat changes caused by wind energy development construction;
- (iii) the extent of differences in bird densities depends on the extent of areas affected by changes in habitat during wind energy development construction;
- (iv) the species of birds affected by these differences depends on which habitats are modified during wind energy development construction; and
- (v) open-country bird species' densities were lower at wind energy development sites.

These may be due to large-scale effects of wind energy developments, landscape differences in habitats, or differences in management practices, but further research is required to determine the cause of these patterns.

The infrastructure associated with wind energy developments may also have additive effects. In particular, the requirement for both access (*i.e.* roads) and a distribution network (*i.e.* overhead power lines, if used) may cause other effects for birds (Drewitt and Langston, 2008; Martin and Shaw, 2010). Wind energy developments may also facilitate recreational access to previously inaccessible areas (Andrews, 1990; Trombulak and Frissel, 2000) via wind energy development roads and tracks, for vehicles such as scramblers or motorbikes, or for other activities such as turf extraction (see Ruddock *et al.*, 2016a).

Displacement may occur where birds avoid areas around wind energy developments; they may also be affected by habitat modifications that consequently decrease their abundance in the area. Stewart *et al.*, (2005) and Whitfield and Madders (2006) indicated that nesting Hen Harriers are one of the least affected bird species with respect to displacement, and have one of the highest rates of avoidance in raptors (Garvin *et al.*, 2011). That is, this species will avoid wind turbines generally and they are considered to be less vulnerable to displacement. Madders and Whitfield (2006) reviewed several studies and found little evidence of large-scale displacement, ultimately suggesting that foraging avoidance mostly extended to approximately 100m, while nest displacement was reported at 200m to 300m. Bright *et al.* (2008a) and McGuinness *et al.* (2015) both considered in their respective sensitivity models that Hen Harriers were sensitive to wind energy developments at 2km.

Displacement of Hen Harrier can occur through displacement from nesting or roosting locations, and/or displacement from foraging areas. The key field study that examined displacement in Hen Harriers (Pearce-Higgins *et al.*, 2009a) found that avoidance extended to 250m from turbines, with reduced flight activity, and that breeding density would be consequently reduced by 52.5% (range -1.2% to 74.2%). This study also found that risk exposure of Hen Harriers was unrelated to flying height and that there was no significant reduction in abundance from wind energy development tracks or transmission lines. Pearce-Higgins *et al.* (2009a) have recognised that the avoidance rates recorded in their study may be highly site-specific. Haworth and Fielding (2012) concluded from a review of UK wind energy developments that harriers are displaced at relatively small scales of between 0-100/200m.

In Scotland, nests have been recorded at one site, Cruach Mhor, where there was an inclusive habitat 'enhancement area', between 131m and 476m (average = 284m) from turbines (SPR, 2009; Robson, 2011). Elsewhere in Scotland, nests have been recorded 110m from turbines, where disturbance exclusion zones were used (Forrest *et al.*, 2011, as cited in Wilson *et al.*, 2015), with a similar density of nesting pairs recorded in pre- and post-construction (2.6 pairs pre-construction phase; 2.4 pairs operational phase; with 4.5 pairs construction phase) (Forrest *et al.*, 2011, as cited in AEC, 2012). Both of these sites also recorded Hen Harriers nesting within a few hundred metres during construction phases. McMillan (2014) reports that, whilst breeding activity was recorded close to turbines in the year of construction (following cessation of construction in March), a nest was located at around 800m away from the wind energy development, although it is not clear if this refers to the same breeding pair (*i.e.* which would indicate displacement). This same study reports nesting Hen Harriers 500m from turbines and less than 200m from access tracks. During wind energy development construction, displacement has been suggested to potentially occur for up to 500m around construction sites, with some disruption up to 1km, depending on the line of visibility (Madders, 2004; Bright *et al.* 2006).

These studies show that individual responses vary (see review in Wilson *et al.*, 2015) but typically extend from 50m to 800m. Several reviews have recommendations for set-back distances. For instance, in their reviews of Hen Harrier disturbance zones, Currie and Elliot (1997), Petty (1998) and Ruddock and Whitfield (2007) suggested buffers of 500–600m, 500–1000m and 500–750m respectively. Such metrics are frequently applied to wind energy development developments (Obermeyer *et al.*, 2011).

Johnson *et al.* (2000) recorded relatively high abundance of Northern Harrier utilising a Before-After-Control-Impact (BACI) study and found that there was a decline in abundance in the first year after construction but that this displacement was different between years. This study also found that avoidance was small-scale, less than 100m from turbines, and may have been related to the associated habitat changes (Madders and Whitfield, 2006; Whitfield and Madders, 2006). Garvin *et al.*, (2011) found from observations of abundance that, for Northern Harriers, there was a temporal lag in observed displacement (*i.e.* later in the operational phase) with 100% avoidance observed, which extended to around 100m from turbines.

Studies in Ireland show that Hen Harriers may relocate their breeding sites at increasing distances from turbines following construction, *e.g.* a 200–300m average increase in distance away from turbines was observed at a site that had been a Hen Harrier territory for more than 20 years (O'Donoghue *et al.*, 2011). That study observed total displacement during the year of construction; after construction, average set-back distance of nests was 501m (range 140m – 760m) from nearest turbines. O'Donoghue *et al.* (2011) also noted that the breeding Hen Harrier territories examined had significantly different breeding success, with 79.2% breeding success in areas where there were no proposed wind energy developments, compared to 16.7% in areas with energy development proposals - this was not directly linked to extant wind energy development sites but may be indicative of (unconfirmed) persecution or accidental disturbance during the early/pre-construction phases of wind energy development.

In a study at Derrybrien (Co. Galway), Madden and Porter (2007) compared pre- and post-construction survey results and found that one pair of Hen Harriers was recorded nesting within 1km of the wind energy development in the two years after construction, although most pairs were located between 1km and 5km away (9 – 10 pairs). The study also showed that Hen Harriers continued foraging near operational turbines and were recorded between 10m and 100m away from turbine bases. They concluded that absolute or total displacement was not evident, at least in the short-term, post-construction.

In certain circumstances, noise disturbance can originate from wind turbines, including mechanical noise derived from turbine components such as the gearbox and generator in the nacelle, as well as aerodynamic noise caused by the rotation of turbine blades. There are few studies of wind energy developments and the impacts of noise (see Ruddock and Reid, 2010). However, since Hen Harriers hunt largely by auditory means (Simmons, 2000), it is conceivable that foraging efficiency and prey detection may be compromised when they are in close proximity to turbines (see Wilson *et al.*, 2015). The width of the zone of influence may vary, depending on how far the noise travels. Noise modelling, which takes the turbine model into account, can be carried out to inform the scale and extent of increases to noise that can be anticipated around operational turbines.

Another study, Madders (2004), (cited in Wilson *et al.*, 2015), reports that some disruption may occur up to 1km from a construction disturbance, along the Hen Harrier's line of sight.

Volunteer surveyors conducted field observations as part of the 2010 National Hen Harrier Survey; subsequently, Ruddock *et al.*, 2012 reported wind energy development-related disturbance as the suspected reason for Hen Harrier breeding failure at five separate locations in Co. Cavan, Co. Kerry, Co. Cork and Co. Limerick. In the 2015 survey (Ruddock *et al.*, 2016a), disturbance was examined in greater detail; at the national level, reports of wind energy developments as pressures were relatively infrequently recorded (*i.e.* the 11th most frequently recorded pressure within 500m and 2km of Hen Harrier territories). However, it was the 4th most frequently recorded pressure within four of the six SPAs.

Fieldworkers did not record any wind energy development pressures in the Slieve Blooms or Slieve Beagh SPAs in the most recent (2015) national survey but Ruddock *et al.* (2016) outlined that wind energy developments may have been a causal factor in recent declines in Mullaghanish to Musheramore Mountains SPA and also in West Limerick. Ruddock *et al.* (2016a) recommended that further spatial analyses of wind energy developments and Hen Harriers within the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA complex and the Slieve Aughty Mountains SPA be undertaken, as these sites have a relatively large number of turbines within the SPAs (see Chapter 3).

Comparing data from 36 of the 10km squares with breeding pairs during the 2000 survey revealed a marginally non-significant negative relationship between wind energy development presence and changes in the number of breeding pairs between 2000 and 2010 (Wilson *et al.*, 2016). There was a 28% spatial overlap of the 69 10km squares which held breeding Hen Harriers in the 2010 national survey and the presence of wind energy developments (Ruddock

et al., 2012). In areas between 200m and 400m asl, a considerable overlap exists (28% in the 69 10km squares which held breeding pairs in 2010) between Hen Harrier breeding distribution and the location of wind energy developments in Ireland (Wilson *et al.*, 2016). This relationship was found to be only weakly significant and linked to the interaction between wind energy developments, Hen Harriers and altitude (200 – 400m) but interactions with other factors (*e.g.* habitat, disturbance, persecution) could not be excluded.

In relation to Hen Harrier breeding parameters, Wilson *et al.* (2015) and Fernández-Bellon *et al.* (2015) conducted a field study as part of the WINDHARRIER project. The field study examined the proximity of turbines in relation to breeding parameters of Irish Hen Harriers, including metrics for:

- (i) nest success (the proportion of nests that fledged one or more young);
- (ii) fledged brood size (*i.e.* the average number of fledged chicks per successful nest); and
- (iii) over-all productivity of breeding pairs (*i.e.* the average number of fledged chicks across all nesting attempts).

There were no statistically significant relationships found between these breeding parameters and nest distance from the nearest wind turbine. However, observed lower nest success within 1 km of wind turbines, compared to the success of all nests more than 1km from wind turbines, was close to statistical significance, *i.e.*

- breeding success was statistically non-significantly lower within 1000m of wind turbines, although sample sizes were relatively small; and
- based on composite considerations of findings, it is possible that lower breeding success recorded within 1000m of wind turbines reflects a biologically relevant pattern.

These findings concur with similar maximum direct disturbance or indirect displacement distances recorded in other field studies (Ruddock and Whitfield 2007; Pearce-Higgins *et al.*, 2009a).

Cumulative Effects and mitigation

As outlined above, during the various phases of wind energy development, risks may arise to Hen Harrier for a variety of reasons. In addition to individual or population-level effects, there may also be cumulative effects, with the effects arising from any one wind energy developments combining with those arising from others to create a much more significant effect. There have been numerous concerns raised about this in the scientific literature, but few studies have found explicit results or negative associations (Fielding *et al.*, 2006; Telleria, 2009a).

Effects of wind energy developments on Hen Harriers

The impacts described above could affect both Hen Harrier breeding (nesting and foraging) or wintering (roosting and foraging) habitats. The severity of such impacts may be more pronounced during the breeding season (O'Donoghue *et al.*, 2011), particularly when there are dependent young in a nest, compared with during the non-breeding/winter season, when

individual birds can move away from adverse impacts that arise. Depending on the scale and direction of impacts, if any, there may be wider cumulative or population-level effects arising.

It is a conceivable risk that wind energy development mortality and/or displacement is additive to existing habitat displacement (*e.g.* via forestry related habitat constraints or recreational disturbance) and other mortality factors (*e.g.* illegal killing or disease). The Hen Harrier has also been noted to be at risk of collision mortality during migratory (passage) movements at offshore wind energy developments (Wright *et al.*, 2012; see Katzner *et al.*, 2016).

Impacts on Hen Harrier Ecology from Wind Energy Development

The impacts as they relate to various aspects of Hen Harrier ecology are set out below.

Potential impacts on foraging habitat and behaviour

As noted previously, generally, foraging Hen Harriers prefer open habitats. In particular, heath/bog, low intensively farmed grassland and semi-natural open habitats with well-established hedgerows, pre-thicket forest and areas of scrub are the main habitats used by foraging harriers (Irwin *et al.*, 2012; O'Donoghue, 2012). Therefore, loss, change, degradation or fragmentation of these types of habitats as a result of wind energy developments, particularly the preferred habitats, could affect foraging Hen Harriers through direct loss or changes to habitats.

- Wilson *et al.* (2015) completed a strategic vantage point study of Hen Harrier habitat usage at wind energy developments and control sites. This found that Hen Harriers foraged preferentially over peatland and pre-thicket habitats, while avoiding closed canopy and natural and semi-natural open habitats. At wind energy development sites, Hen Harriers preferentially foraged in peatland and also avoided closed canopy forest. Hen Harriers at wind energy developments did not use thicket areas for hunting, but preferentially used areas of natural and semi-natural open habitats. The study highlights the importance of open habitats (rough grassland, natural grasslands, scrub and peatland) for foraging Hen Harriers in Ireland.
- Further GPS tracking of a single female (Wilson *et al.*, 2015) found that habitat selection in relation to wind energy developments indicates that natural and semi-natural open habitats, peatland and clear fell were flown over more frequently than expected, and improved grassland was used less frequently than expected.

Direct foraging habitat losses could result from the footprint of development but also if wider habitat alteration is undertaken (Wilson *et al.*, 2015; SNH, 2016). Further to this, indirect effects could occur whereby prey species are affected (*e.g.* reduced density of prey species near wind energy developments (Pearce-Higgins *et al.*, 2009a; Wilson *et al.*, 2015; Fernández-Bellón *et al.*, 2019)) or during key periods of activity, such as construction (Pearce-Higgins *et al.*, 2012), which may have consequential effects on harrier foraging efficiency and subsequent breeding success and/or productivity. However, contrary to potential negative impacts, the reduced suitability of wind energy development areas may lead to avoidance and therefore, a reduced collision risk (SNH, 2016).

Previous research has indicated that avoidance of wind energy developments by breeding Hen Harriers may occur within 1km of turbines (Pearce-Higgins *et al.*, 2009a) and that foraging behaviour of breeding pairs can be influenced by habitat changes at distances up to 3km from the nest (Amar *et al.*, 2004, Arroyo *et al.*, 2009). Based on an analysis of foraging spatial data derived from the remote tracking of three individuals from one study site (the Ballyhouras), Irwin *et al.* (2012) noted that the maximum distance travelled from the nest was 7.5km (female) and 11.4km (male). These are significantly further than the estimates for Scottish breeding birds (2.5km (female) and 9km (male)) (Arroyo *et al.*, 2009; Arroyo *et al.*, 2014). This may be because Irish Hen Harriers breeding in forested landscapes have to forage over larger areas in order to provision broods (at least, in the Ballyhouras) or it may be a reflection of the relatively lower potential prey availability in Ireland (O'Donoghue, 2010; Ruddock *et al.*, 2012; Wilson *et al.*, 2015). These larger potential foraging ranges of Hen Harriers in Ireland mean that the potential for wind energy development-induced habitat management or changes may impact Hen Harriers at a relatively greater range (distance) than is predicted elsewhere.

Potential impacts at the nest site

A disturbance event that causes the incubating female to flee the nest or that deters the return of provisioning parents can expose eggs and chicks to cold, rain or lack of food (Hamerstrom, 1969; Scharf and Balfour, 1971; Picozzi, 1980). Mammalian predators may be attracted to nests by visual cues such as the presence of humans, trampling of vegetation, increasing activity of parent birds in response to disturbance events, as well as by olfactory cues (Whelan *et al.*, 1994; Skagen *et al.*, 1999).

Potential impacts at winter roost sites

As already mentioned, birds frequent roost sites outside the breeding season (broadly defined as mid-August to mid-March), probably for shelter and protection (O'Donoghue, 2010). Roosts function as foci from which the Hen Harriers radiate out and forage in the local landscape (O'Donoghue, 2010). Currently, two SPAs are listed for non-breeding Hen Harrier and, based on the published data available, the majority of the known wintering roost sites occur outside of the SPA Network (Figure 3).

The main threats and pressures on Hen Harriers at winter roost sites have been identified to be predominantly agricultural reclamation (roost loss and associated habitat loss); timing of cultivation practices such as ploughing and spraying (reduction in prey availability and disturbance); renewable wind energy development (displacement and direct disturbance); and human disturbance (NPWS, 2013). Forestry-related activities may potentially cause disturbance events at a small number of known roosts (NPWS, 2015a).

Where there is a requirement to avoid disturbance to breeding birds, the construction activity is more likely to be undertaken during the wintering season. This temporal consideration may thus have a greater potential impact on winter roosts rather than nests. In those breeding sites, and indeed outside of breeding sites, where suitable winter roost habitats also occur, it is important that impacts are mitigated to also avoid disturbance and prevent loss of winter roost sites.

Potential impacts on winter foraging habitat

Wilson *et al.* (2015) focused on the breeding season and there are no documented studies of Hen Harrier foraging behaviour in the non-breeding seasons. It is conceivable that, where wind turbines occur in foraging habitats used by Hen Harriers during the non-breeding period, these may influence their use by the bird. Similarly, loss or changes to habitats that hold abundant food supplies for prey species may affect Hen Harrier foraging efficiency, as has been noted for breeding season foraging habitats. That is, since passerine bird species, particularly thrush species, have been identified to be a frequently-recorded prey-item in the winter diet of Hen Harriers (see O'Donoghue, 2004; 2010), habitats with high abundance of such prey species will be a valuable resource to the birds and they may be impacted by any associated changes.

O'Donoghue (2010), however, found that Hen Harrier diet varied geographically, with more wading birds and small mammals recorded in the diet of birds associated with the lowlands of southern and eastern areas; therefore, diet could be affected in the wider countryside in different ways. There is little detailed information available on the types of habitats utilised by Hen Harriers for foraging over the winter season, but the species is generally more widespread then and thus, may be vulnerable to disturbance over a wider area during the winter. This vulnerability may be increased if construction takes place during the winter, but also in the long-term, they may be vulnerable to indirect displacement due to their avoidance of wind energy development sites in the wider countryside.

Mitigating the Effects from Wind Energy Developments

Mitigation measures to reduce direct mortality to birds from wind energy developments have included various methods including:

- temporal cessation of turbines during high risk periods (de Lucas *et al.*, 2012; Smallwood, 2013; European Commission, 2020b),
- removal of specific turbines (Martinez Abrain *et al.*, 2013; Smallwood, 2013),
- changing turbine design and spacing (European Commission, 2020b) and
- repowering to reduce overall number of turbines and risk (Smallwood, 2013; Warren and Birnie, 2009).

Mitigation to reduce the effects of disturbance to bird species have been suggested, though with varying levels of supporting evidence. They include:

- restricting construction during the breeding season (Pearce-Higgins *et al.*, 2012; European Commission, 2020b),
- erection of physical screens during the construction phase (Pearce-Higgins *et al.*, 2012);
- use of alternative construction methods (European Commission, 2020b).

The creation of habitat to offset Hen Harrier habitat loss has been determined not to be mitigation (in the meaning of a Habitats Directive Article 6(3) assessment), but is rather a measure to be assessed pursuant to Article 6(4) (*i.e.* compensation) (Supreme Court, 2016; ECJ, 2018).

There are a number of identified research priorities (Wang and Wang, 2015) that, if fulfilled, would enable a better understanding of the sector and its interactions with birds, in light of developing technologies, equipment and particularly, with regard to repowering operations in the future (Hotker, 2006; Smallwood and Karas, 2008; Warren and Birnie, 2009; SNH, 2014; Northrup and Wittemayer, 2016).

CHAPTER 3: POTENTIAL POPULATION LEVEL IMPACTS OF WIND ENERGY-RELATED ACTIVITIES ON THE HEN HARRIER IN IRELAND

Introduction

This chapter builds on the description of the overlaps and potential interactions between wind energy developments, their associated management and the ecology of Hen Harrier. This examination of the potential population level impacts on Hen Harrier by the wind energy sector in Ireland is framed by first quantifying the spatial and temporal extent of these interactions.

This review obtained a database from SEAI of individual turbines from 1992 to (June) 2016 for analysis. SEAI have been systematically obtaining details of individual wind turbines (>100kW) from planning files and ortho-photography sources across Ireland for a number of years (J. McCann, pers. comm.). The database captures information on individual turbines and includes site name, spatial co-ordinates (easting/northing), power output (MW), hub height (m), rotor diameter (m), county and connection reference number.

As part of this review, the SEAI database was standardised, and spatially checked and verified against ortho-photographs. The connection year and month were derived from separate publicly available databases (Eirgrid's TSO & ESB respectively) using the unique connection reference numbers. A number of spatial anomalies were rectified and a number of additional turbines were digitised from the ortho-photographs. Altitudes (metres above sea level) were calculated for each individual turbine from a digital elevation model (ASTER) of Ireland. This resource is now known and referred to as the Review Turbine Database 2016 or RTD (NPWS, unpublished) throughout this report.

Potential interactions of wind energy and Irish Hen Harrier breeding populations

As previously discussed, where there is a contiguous spatial overlap between wind energy developments and Hen Harrier breeding habitats, there may be both a direct loss of habitat (Madders and Whitfield, 2006) and a displacement effect (Pearce-Higgins *et al.*, 2009a; Pearce-Higgins *et al.*, 2012) which may occur spatially at the small (wind energy development) scale and within a wider associated zone of influence (Madders and Whitfield, 2006; Pearce-Higgins *et al.*, 2009a; O'Donoghue *et al.*, 2011; Fernández-Bellon *et al.*, 2015; Wilson *et al.*, 2015).

Similarly, Hen Harriers are known to be affected by direct collision mortality (Lekuona and Ursúa, 2007; Scott and McHaffie, 2008; RSPB, 2012; this study). All of these impacts may have consequences for individual birds but they also, depending on the number of collisions, may have wider population level effects. It is conceivable too that the occurrence of wind turbines may affect breeding parameters such as:

- abundance (Usgaard *et al.*, 1997; Pearce-Higgins *et al.*, 2009a);
- density close to turbines <500m (Pearce-Higgins *et al.*, 2009a);
- breeding success (Fernández-Bellon, 2015);
- brood sizes; and/or
- productivity (O'Donoghue *et al.*, 2011; Hatchet *et al.*, 2013; Bennett *et al.*, 2014); and
- mortality (Carrete *et al.*, 2009).

Co-occurrence of wind turbines and breeding Hen Harriers

Wilson *et al.* (2015; 2016) quantified the spatial overlap with wind energy developments (up to and including 2012) at 10km resolution, using WEI data on wind energy developments, and Hen Harrier data from the 2000 and 2010 breeding surveys (Norris *et al.*, 2002 and Ruddock *et al.*, 2012 respectively). This study found that there was a 28% overlap ($n = 19$ of 69 squares) at the 10km resolution, based on 2010 breeding data (Ruddock *et al.*, 2012); there are similar metrics recorded for elevation data of breeding Hen Harriers and wind energy developments, with the majority of wind turbines (67%) and Hen Harriers (62%) occurring at 200m to 400m asl.

These studies indicated that there was a weak negative relationship between wind energy development presence and Hen Harrier breeding populations between 2000 and 2010, with an approximate average loss of one pair in squares with turbines, compared to squares without turbines. This was more strongly observed at 200m to 400m elevations. There were no observed relationships in that study between the number of turbines built and population changes (Wilson *et al.*, 2015). The WINDHARRIER study also indicated that other factors (*e.g.* forest habitat changes) may also be interacting with the observed pattern of Hen Harrier declines and that further research was required.

Wilson *et al.* (2015; 2016) analysed data at a 10km resolution, including for altitudinal data and interpretation of ortho-photography for analysis of change between surveys. The RTD (NPWS, unpublished) now enables a more fine-scale resolution for this review so that spatial interactions with Hen Harriers and wind turbines can be further examined.

As explained earlier in the report, the analysis reported on here was undertaken in 2017, based on available wind turbine data (up to June 2016). The timing of this analysis was designed to allow contemporaneous analysis with the results of the 2015 National Hen Harrier Survey (Ruddock *et al.*, 2016). Due to the Covid-19 pandemic, the anticipated 2020 National Hen Harrier Survey was not undertaken and so, turbine data presented here has not been updated, as there is no corresponding update of Hen Harrier data. As of 2016, there were 1,502 turbines recorded in the database as having been connected since 1992 (*i.e.* 1992-2016) (Figure 6). Those turbines connected in 2016 ($n = 25$) were not excluded since these were commissioned in 2015 and were considered to have been present at the time of the 2015 Hen Harrier survey. Turbines in the database (*i.e.* from that time period 1992-2016) range in size from 0.05MW to 3MW, with the majority of turbines in Ireland being 0.85MW (22.1%) and 2.3MW (15.3%) machines. Hub heights ranged from 25m to 100m and blade diameters from 15m to 117m (NPWS, unpublished). Generally, the lower rotor-swept areas ranged from 19 to 50m above ground level (with a small number of "outlier" turbines with a lower rotor-swept height of just 10m), whilst the rotor swept heights ranged from 25 to 156m above ground level (NPWS, unpublished). More recent information is available from IWEA's online data viewer.

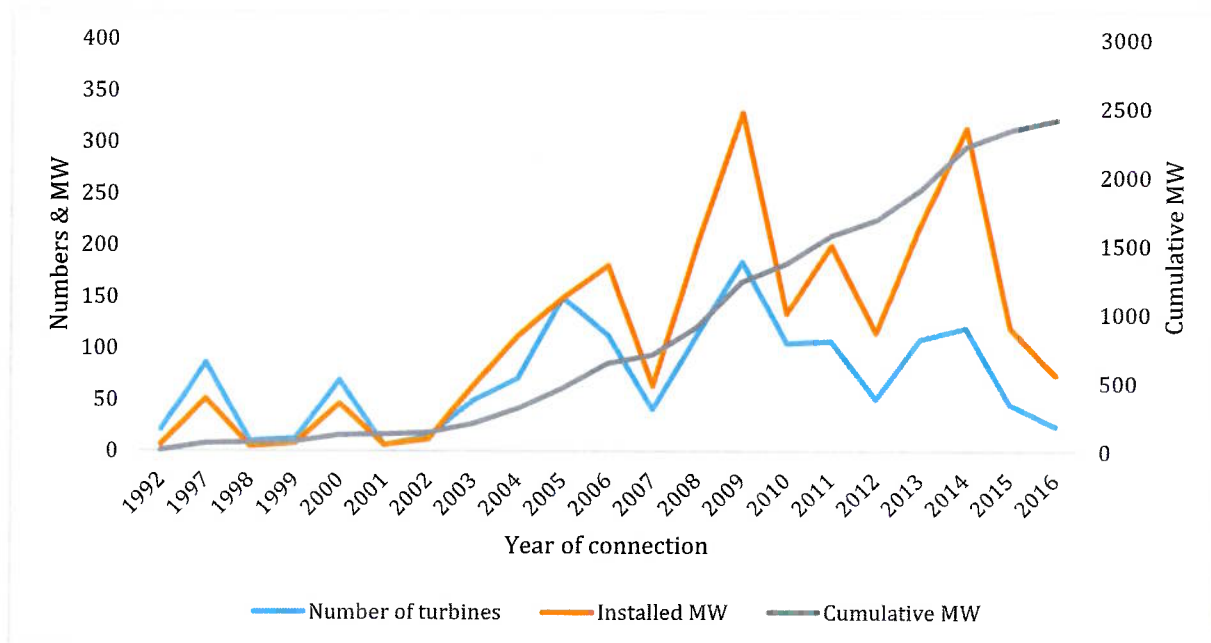


Figure 6. Numbers of turbines installed and power output 1992 - 2016

These 1,502 turbines were recorded in 120 10km squares across Ireland, which equates to 13.8% of the 869 10km squares that cover the national land territory. Between one and 75 turbines have been installed per 10km square, ranging in cumulative power from 0.16MW to 111.8MW per 10km square. Turbines in Ireland were recorded at altitudes ranging from 2.9m asl and 510m asl (average $253\text{m} \pm 108.7\text{m}$). Turbines were most frequently located in the 300 – 350m and 200 – 250m ranges (Figure 7).

Confirmed 2010 breeding Hen Harriers territories (see Ruddock *et al.*, 2016a for definitions) were located between 71m and 452m asl (average $243.8\text{m} \pm 88.5\text{m}$) and were most frequently located between 150m and 300m *i.e.* 22% were located between 150 and 200m, 19% between 200 and 250m, and 20% between 250 and 300m (Figure 7). 81.9% of turbines were located in the 100 – 400m range whilst 92.6% Hen Harriers were located in the same range. 66.7% of turbines and 59.3% of Hen Harriers occurred between 200 – 400m. Earlier survey data (Table 1) found a similar range of altitudes for confirmed pairs during 1998-2004 (range 72 – 495m, average 257.1m); 2005 (range 87 – 401m, average 227.9m) and 2010 (61 – 423m, average 239.6m).

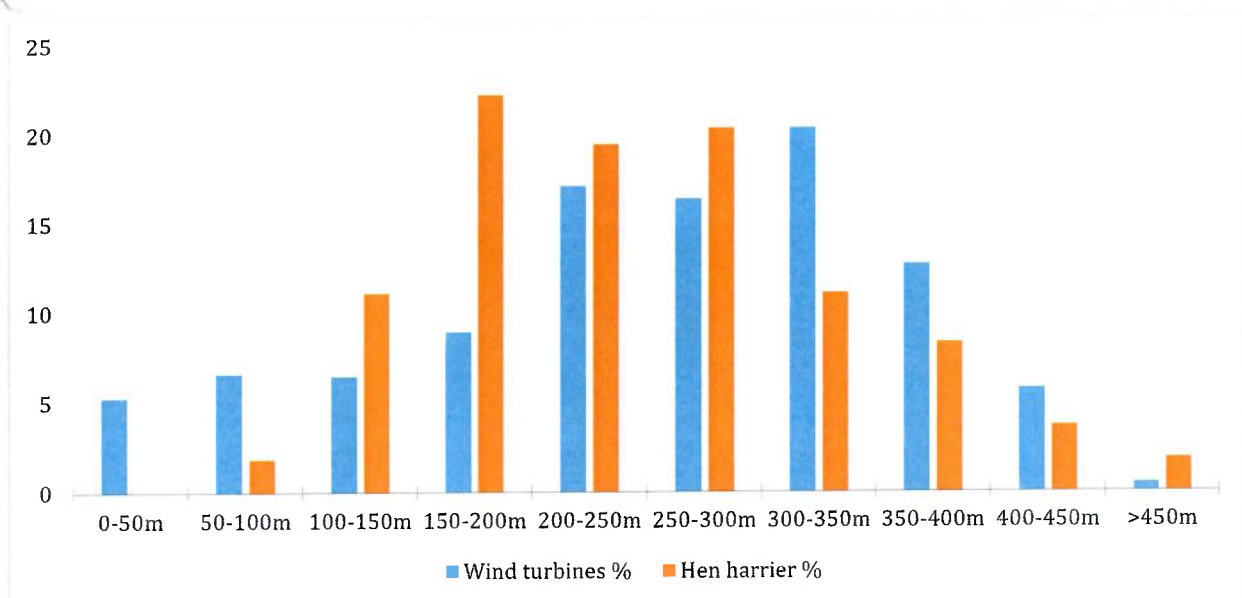


Figure 7. The elevation (m asl) of both wind turbines and % (y axis) of confirmed breeding Hen Harriers territories in Ireland, 2015.

From the 2015 Hen Harrier survey data, turbines were recorded in 21.6% of the 10km squares surveyed ($n = 58$ of 269 squares); and turbines were present in 32.5% ($n = 27$) of the 10km squares with either confirmed or possible breeding territories ($n = 83$) (Figure 8). Most turbines ($n = 420$) were recorded in the 10km squares that had *confirmed* breeding Hen Harriers (Table 1 and Figure 9).

Table 1. Hen Harrier 10km survey squares in 2015 and their spatial overlap with wind turbines.

Details from 2015 survey (Ruddock <i>et al.</i> 2016a)	Confirmed breeding	Possible breeding	Seen	Not seen/Vacant
Number of survey squares	61	22	55	130
Number of squares with turbines	22	5	13	18
Percentage of squares with turbines	36.1	22.7	23.6	13.8
Total number of turbines	420	100	150	196

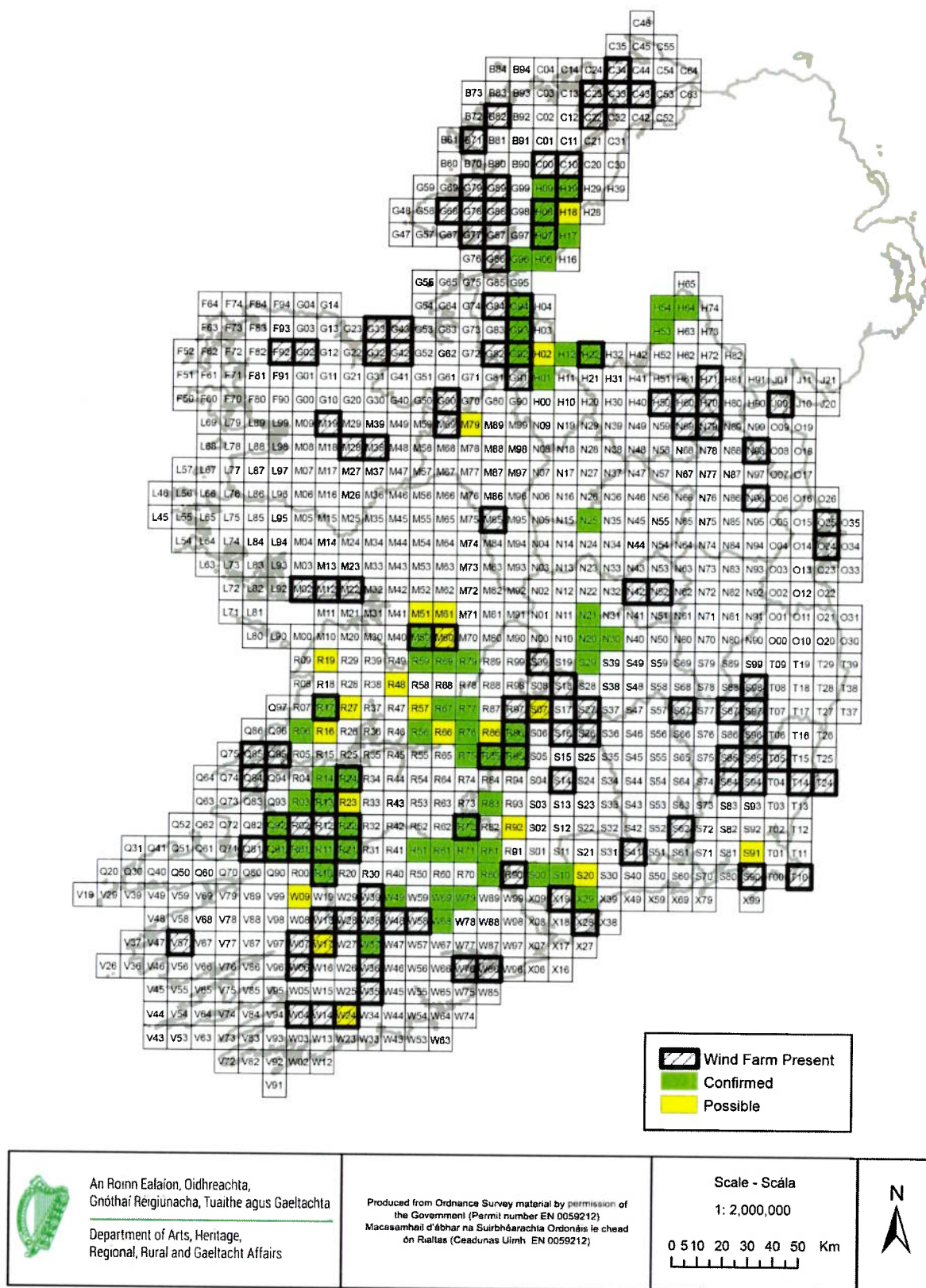


Figure 8. The distribution of wind turbines from 1992 – 2016 and Hen Harrier confirmed and possible breeding 10km distribution in 2015 (Ruddock *et al.*, 2016a).

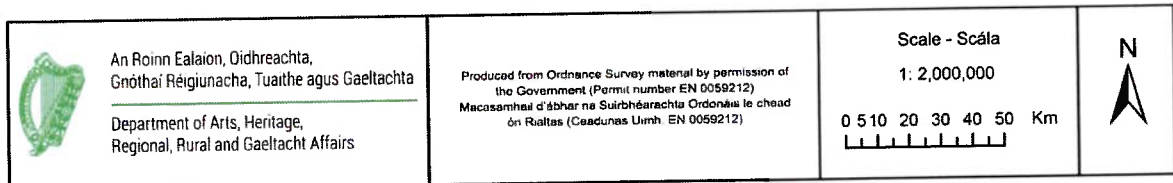
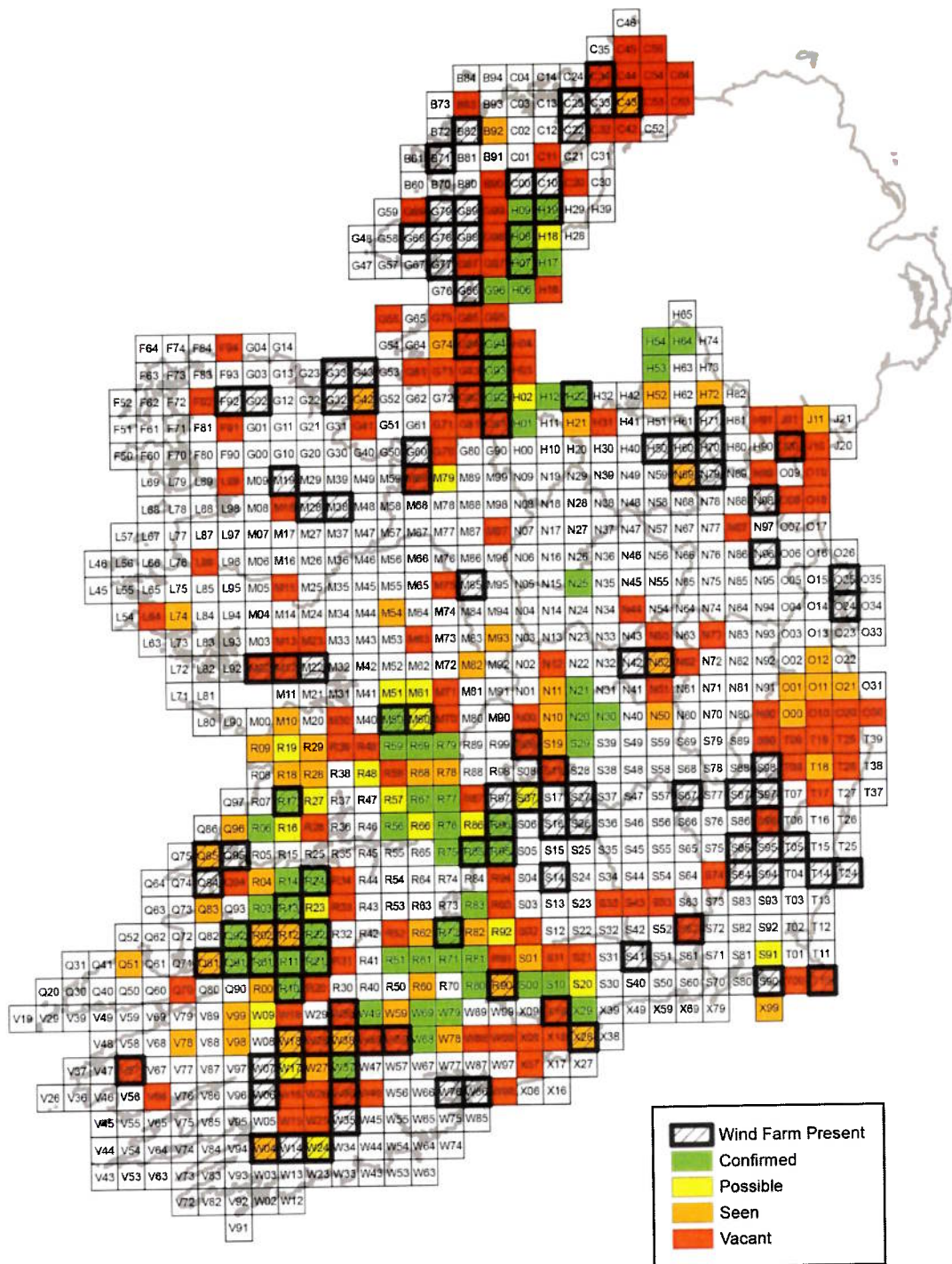


Figure 9. The distribution of wind turbines from 1992 – 2016 and Hen Harrier Confirmed, Possible, Seen and Vacant 10km breeding distribution in 2015 (Ruddock *et al.*, 2016a).

Since the first national survey, the proportion of spatial overlap with wind energy development has increased, particularly within the confirmed Hen Harrier breeding range (Table 2).

Table 2. The results of breeding 10km survey squares in 1998-2000, 2005 & 2010 and spatial overlap with wind turbines.

Details from national survey	1998 - 2000		2005		2010	
	Confirmed	Possible	Confirmed	Possible	Confirmed	Possible
Number of squares	42	17	60	6	62	7
Number of squares with turbines	3	1	11	2	18	0
Percentage of squares with turbines	7.1	5.9	18.3	33.3	29.0	0
Total number of turbines	54	10	168	29	313	0

Displacement of Hen Harriers and wind energy in Ireland

Using details of all turbines (up to and including 2016) and historical Hen Harrier databases (1998 – 2004; 2005; 2010 and 2015), there is a decreasing number of confirmed and possible Hen Harrier territories located within 500m and 1km of turbines over time (Figures 10 and 11). This may be suggestive of some small-scale avoidance by Hen Harriers close to turbines (up to 500m as described in Pearce-Higgins *et al.*, 2009a; up to 1km from turbines as described in Fernández-Bellón *et al.*, 2015). As detailed earlier in Chapter 2, this may be an artefact of the decreasing Hen Harrier population as well as being compounded by other factors not examined in this desk-review *e.g.* habitat composition or changes (see Wilson *et al.*, 2015; 2016). However, it may also indicate genuine avoidance behaviour of Hen Harriers with respect to wind turbines in Ireland (as in other harrier species – see Schaub *et al.*, 2020) and warrants further statistical examination, alongside other potential compounding factors.

This analysis of turbine distances also indicates that turbines have been built within 1km of at least 50 historically confirmed or possible breeding territories since 1998. Over time, the distance from turbines to confirmed breeding sites has decreased (Figure 12; Table 3). The average distances in 2015 were 10.7km to 9.3km for confirmed and possible pairs respectively (Table 3) which may concur with the possible displacement of 5km to 10km (Figure 10 and 11). Whilst some pairs of Hen Harriers will nest close to turbines (see minimum distances in Table 3), these locations almost exclusively occur within the Stack's SPA which has a relatively high number of turbines.

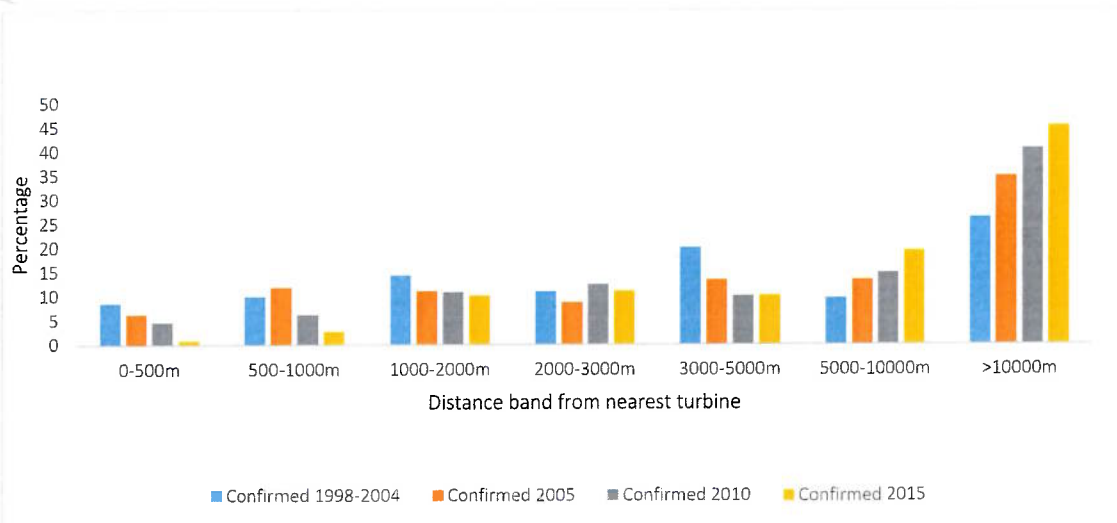


Figure 10. The percentage of confirmed breeding Hen Harrier territories occurring per distance band from nearest turbine (from national surveys 1998-2004, 2005, 2010 and 2015).

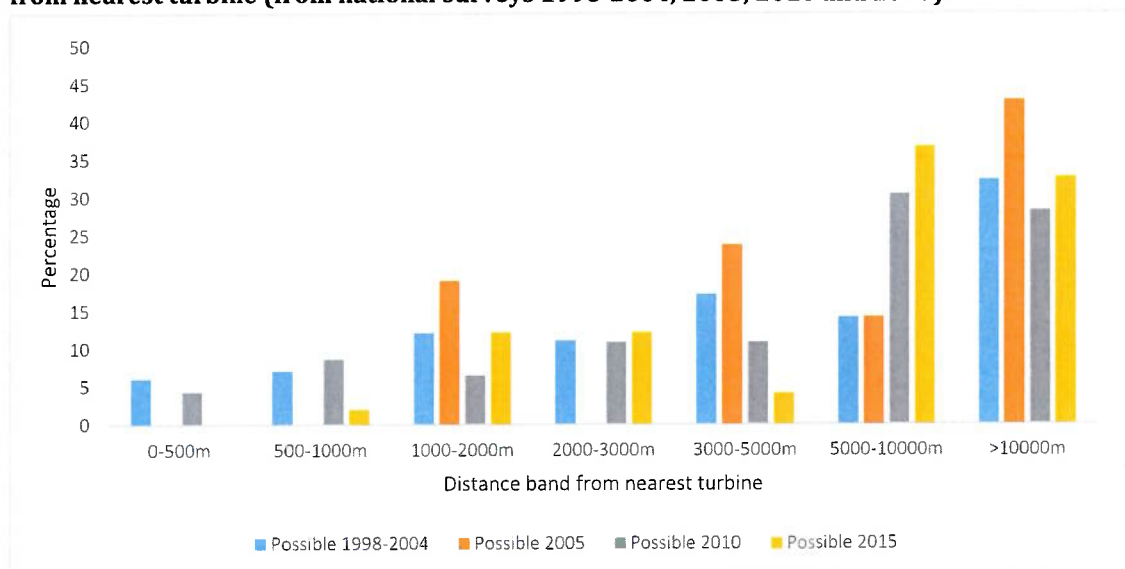


Figure 11. The percentage of possible breeding Hen Harrier nests occurring per distance band from nearest turbine (from national surveys 1998-2004, 2005, 2010 and 2015).

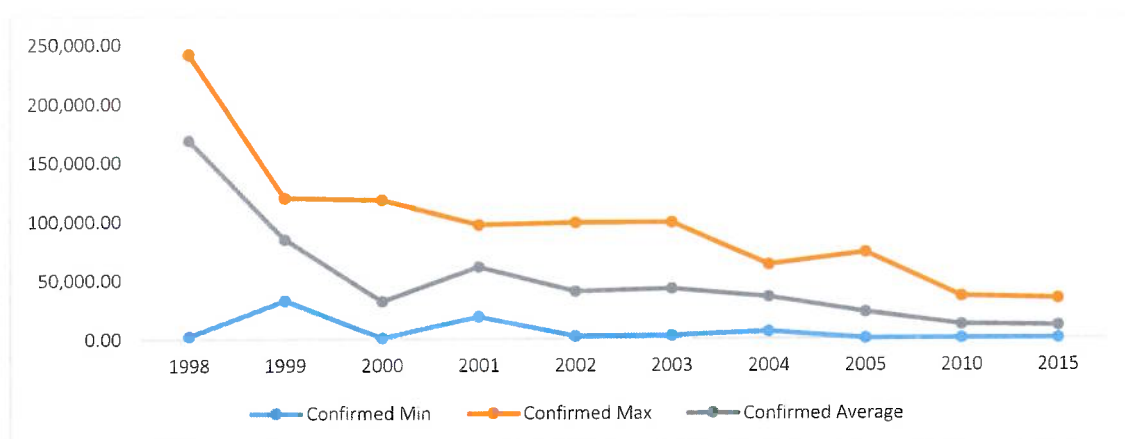


Figure 12. Turbine distance (m; y-axis) from confirmed breeding Hen Harrier territories in national survey years 1998 - 2015.

Table 3. Turbine distances from locations of breeding Hen Harriers in national survey years, based on all turbine data, up to and including 2015.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2010	2015
Confirmed	39	48	26	11	31	29	25	132	128	108
Possible	16	17	12	6	13	24	11	21	46	49
Total	55	65	38	17	44	53	36	153	174	157
Min	2,400.4	32447.6	770.9	18,744.1	1,972.4	2628.8	6128.8	252.4	300.6	231.0
Max	241,924.6	119,825.2	117,910.6	97,073.0	98,734.8	98,997.3	63,057.6	73,400.9	35,897.3	33,786.9
Average	168,557.9	84,427.8	31,746.7	60,782.4	39,954.7	42,365.5	35,391.1	22,308.7	11,705.2	10,714.0
<1km	0	0	3	0	0	0	0	17	41	16
1-2km	0	0	33	0	1	0	0	98	195	90
2-3km	8	0	62	0	16	16	0	202	426	257
3-5km	25	0	100	0	25	36	0	654	943	732
>5km	25	0	203	0	63	116	1	1781	2025	2116
Altitude min	22	22	97	34	123	76	161	87	61	71.2
Altitude max	495	495	361	432	418	422	388	401	423	452.4
Altitude ave	274.3	275.1	242	232.2	249.5	221.4	272.7	238.8	239.6	243.8
Min	118,239.30	57,969.30	22,152.7	31,813.3	20,630.7	6,579.2	2,536.3	1,972.4	316.4	959.8
Max	240,584.3	118,502.8	70,465.8	88,771.3	100,994.0	99,995.7	56,794.9	50,343.3	32,257.6	33,231.2
Average	189,895.4	80,999.9	51,864.8	59,735.4	62,744.6	35,857.2	25,134.8	25,709.3	9,410.2	9,330.6
<1km	0	0	0	0	0	0	0	0	6	1
1-2km	0	0	0	0	0	0	0	1	39	43
2-3km	0	0	0	0	0	0	1	16	65	141
3-5km	0	0	0	0	0	0	2	66	205	358
>5km	0	0	0	0	0	62	3	127	1129	1094
Altitude min	229.2	99	35	133	76	13	185	69	49	67.5
Altitude max	13	378	287	374	360	392	422	471	431	488.3
Altitude ave	409	235	189	213	252.9	203	309.5	259.2	234.1	252.9

Pressure records in Hen Harrier breeding areas from wind energy in Ireland

Fieldworkers for the 2015 national survey were requested to record the threats or pressures observed, if any, within 500m and within 2km of the survey area in order to facilitate a strategic assessment of these metrics at the regional and national levels, using the EU's Birds Directive Article 12 pressures and threats (further details in Ruddock *et al.*, 2016a). "Pressures" are current, while "threats" are in the future, and include the collection of information on wind energy production (see European Environment Agency (2018) for more information on pressure codes) (Figure 13).

At the time of the survey, wind energy developments were present in 120 10km squares across Ireland, while wind energy development pressures were recorded in 33 10km squares, of which only 63.6% are noted to actually contain wind turbines (Figure 13). Therefore, it appears that fieldworkers were either aware of impending wind turbines, perhaps from wind energy road development, and/or that they considered the pressure arose from turbines they could observe within adjacent squares (and within 2km of the survey area as per the methodology), and reported accordingly. There were also power line (D3) pressures recorded at 26 squares, 57.7% (n = 15) of which also had wind energy development (C3) pressures recorded, and 38.5% (n = 10) of which had wind turbines present. This indicates that power lines occur more widely than wind energy developments, but also that they may not be located in and/or around existing wind turbines, as underground cables may be used by wind energy developments instead, and, in fact, the power lines may not be related to the wind energy development at all.

Breeding population changes and wind energy in Ireland

Ruddock *et al.* (2012; 2016a) suggested that wind turbines and associated mortality and displacement warranted further investigation. As noted above, Ruddock *et al.* (2016a) also reported that, in some areas, Hen Harriers were perceived by surveyors to be under pressure from wind energy developments. Based on data derived from the 2000 and 2010 national surveys, Wilson *et al.* (2015; 2016) found evidence that population decline may be associated with the presence of wind turbines. However, that study found that there were also interactions evident with both altitude and habitat changes and wind energy developments. The mechanism for this decline is not clearly defined and could relate to either direct or indirect disturbance sources that result in displacement of territorial birds during the breeding season. The relationship between wind turbines and Hen Harriers may therefore be a complex one, and minimization of spatial conflict in order to reduce the likelihood of effects would be desirable (see Chapter 4).

The number of turbines in those squares in which Hen Harrier declines (1 to 6 pairs) had been recorded between 2010 and 2015 increased by 131 (281 turbines to 412; 46.6%). Conversely, for squares where population increases were recorded (+1 to +3 pairs), turbines increased by 51 (109 to 160; 46.8%). This indicates that the proportional increase of turbines may not affect rates of population change, since both percentage increases in turbines were similar. Rather, the density of existing and installed turbines may be driving the change. However, it is recognised that other factors may also be interacting (such as forestry and agricultural activities) and they are not analysed further here (see NPWS reports on Hen Harrier and these sectors- NPWS, 2015a and 2015b).

Similarly, between 2005 and 2010, in those squares where Hen Harrier numbers declined (by 1 to 4 pairs), turbine numbers increased from 109 to 194 (70.2% increase), whereas for squares in which Hen Harriers increased (by 1 to 6 pairs), there was an increase of 56 to 119 turbines (112% increase). This further indicates that the rate of turbine increase may not be driving population change since there was a higher proportional increase in turbines in squares where Hen Harriers increased. It is therefore conceivable that a turbine density threshold may be a driver of population change.

Breeding parameters and wind energy in Ireland

Fernández-Bellon *et al.*'s (2015) analysis showed no significant differences between the breeding outputs of Hen Harrier nests that were located at different distances from wind turbines. However, non-statistically-significant lower nest success rates and productivity were observed within 1km of active wind turbines. Thus, there may be a negative effect on nest success extending to approximately 1km (see also Wilson *et al.*, 2015).

Monitoring carried out between 2008 and 2010 revealed a breeding success rate of 79.2% for Hen Harriers in territories where no wind energy developments were planned (n=53), compared with a success rate of just 16.7% in territories where wind energy developments were planned (n=18) (O'Donoghue *et al.*, 2011). The outcome of this research suggests that harriers associated with wind energy development proposal areas have a significantly higher failure rate than harriers nesting elsewhere. Productivity may also be reduced, as shown by O'Donoghue *et al.* (2011), at a single Hen Harrier territory when comparisons are made between pre- and post-construction periods (average of 2.63 young reduced to 1.27 young) over a 22 year period.

Breeding outcome (nest success or failure) may be impacted by the occurrence of turbines, as indicated by Fernández-Bellon *et al.* (2015), although the mechanisms for this are not clear. Empirical data from the RTD (NPWS, unpublished) and outcomes of breeding records from national surveys in 2005, 2010 and 2015 indicate that successful nests were up to 20% (average 12.9%; range 0.3 – 20.1%) further away from turbines than failed nests (Table 4). This also indicates that only a small number of either failed or successful nests are located within 1km of a turbine in each survey year (Table 4), which means that effects, if any, are either occurring at greater distances or, perhaps, are unrelated to turbines in the landscape. It is notable perhaps that nearly 14% of failures in 2010 surveys were within 1km of turbines (average 5.9%; range 0 – 13.6%) (Table 4).

Table 4. Turbine distance from breeding Hen Harrier locations in recent national survey years, based on all turbine data up to and including 2015 and breeding outcomes

	Survey year	2005	2010	2015
Successful pairs	Average distance (metres)	23,551.50	13,432.60	11,054.20
	Number of records	56	50	49
	Number within 1km	2 (3.6%)	3 (6.0%)	1 (2.1%)
Failed pairs	Average distance (m)	18,790.10	10,990.90	11,019.10
	Number of records	6	44	48

	Number within 1km	0 (0%)	6 (13.6%)	2 (4.2%)
	Proportional difference in distance between successful and failed pairs	20.1%	18.2%	0.3%

Note: Survey data in 1998-2000 was extracted on a year-by-year basis as examination of trends with multi-year data is confounded by the repeated sampling of same locations in different years.

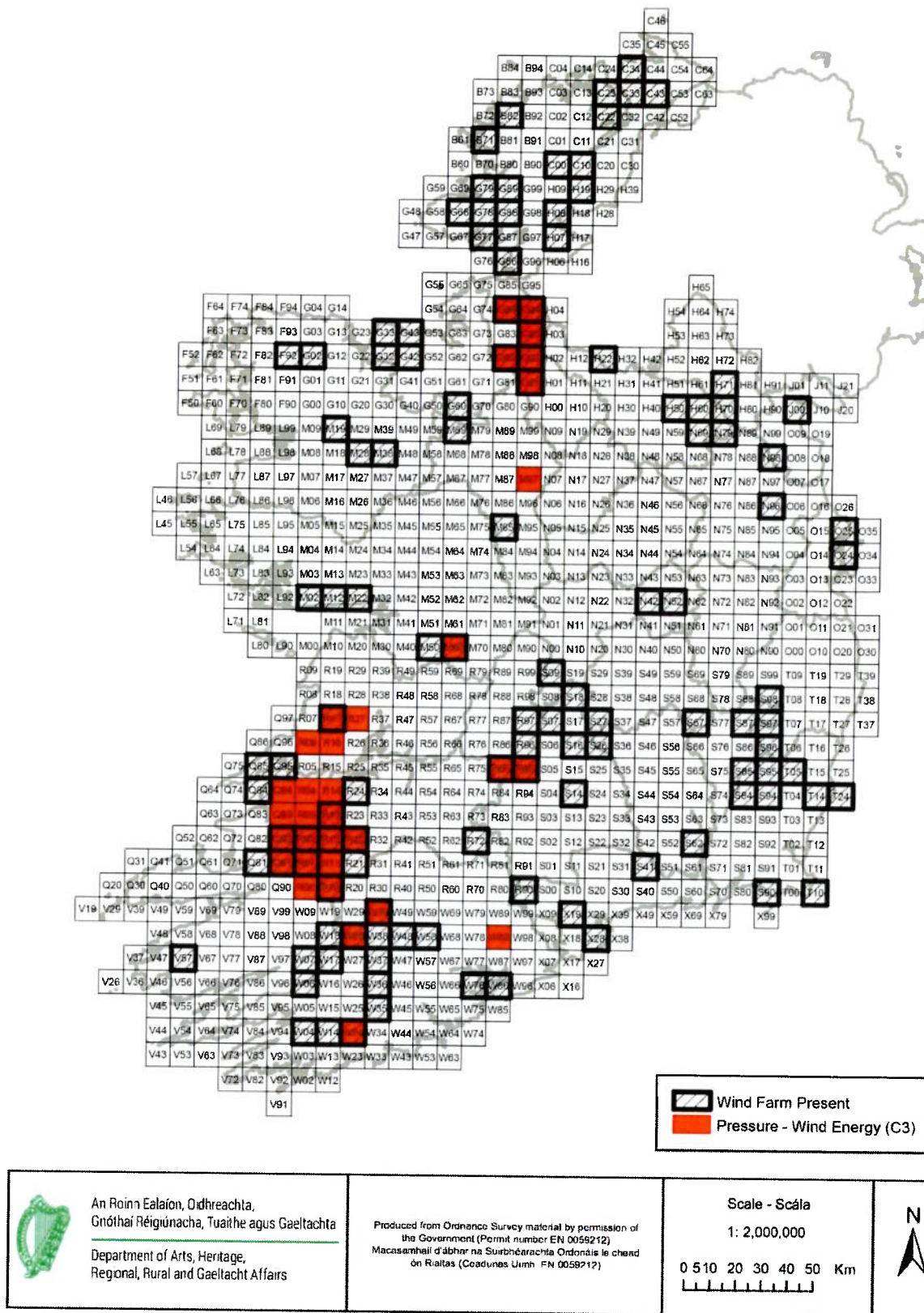


Figure 13. The presence of wind turbines (as derived from the RTD (NPWS, unpublished) and wind energy development pressure (C3, in accordance with Birds Directive Article 12 reporting) as recorded by surveyors (Ruddock *et al.*, 2016a)).

Collision risk and wind energy in Ireland

A small number of suspected Hen Harrier collisions have been documented in Ireland, (see Chapter 2) although it is also recognised that relatively few wind energy developments in Ireland have formal carcass-searching protocols (Fennelly, 2015). Therefore, collision incidences may well be under-recorded. Several studies elsewhere indicate that harrier species mortality at wind energy developments is relatively low (Smallwood and Thelander, 2004; Madders and Whitfield, 2006; Derby *et al.*, 2008) and not typically linked to bird abundance (Johnson *et al.*, 2000; Stewart *et al.*, 2005; Madders and Whitfield, 2006; Mabey and Paul, 2007), although Wilson *et al.* (2015) suggest that collision risk may be affected by proximity to nest sites. The spatial distribution of wind energy developments has a larger influence on the estimated number of collisions compared with the design of turbines, and therefore precluding wind energy developments from core breeding areas remains the most important mitigation measure (Schaub *et al.*, 2020). The cumulative effect of the existing turbine network as well as potential future wind energy development in Ireland (SEAI, 2011) may lead to an increasing collision risk over coming years; this will be influenced by a range of factors including the level, nature and effects of repowering, and the scale of ambition for the expansion of the sector

Wilson *et al.* (2015) used observed Hen Harrier flight data to calculate an arbitrary 'typical' collision risk and estimated mortality for the 'average' wind turbine in Ireland with a rotor swept range of 25m (floor height) to 125m (ceiling height). The average breeding season collision estimate of Wilson *et al.* (2015) was between 0.778 and 2.477 birds over a 25 year wind energy development lifespan. It is not currently possible to draw a more robust generic conclusion for a national collision estimate using estimates of the number of wind energy developments or numbers of turbines since it is recognised that:

- (i) not all turbines occur in Hen Harrier areas which may lead to an over-estimation of collision; but also
- (ii) no estimates are available for the non-breeding season which may under-estimate mortality; and
- (iii) collision risk can be highly site-specific and may be related to proximity of nest sites (Wilson *et al.*, 2015). There are 520 turbines (34.6% of 1,502 turbines) within the 2015 Hen Harrier breeding range and therefore, this would reduce overall estimated collision during the breeding season.

Wilson *et al.* (2015) reported Hen Harrier observations were below rotor height (25m) 83% of the time but within rotor-swept areas (25m – 125m) for 11.8% and above rotor height (>125m) for 5.4% of the time. Based on RTD (NPWS, unpublished), there were no recorded turbines of 25m floor and 125m ceiling height, and average floor height was 29.7m and ceiling 96.3m. 0.6% of turbines (n = 10) have a 25m rotor floor and 7.2% of turbines (n = 109) have a 125m ceiling height. Therefore, the rotor-swept area of Wilson *et al.* (2015) is larger than actual average rotor-swept areas and may be overly precautionary, although rotor swept areas generally ranged from 19m to 156m. Estimates of cumulative mortality in Ireland, based on the height bands of Wilson *et al.* (2015), may require re-analysis on the basis of observed flying heights from that study, actual turbine metrics now available (NPWS, unpublished; this study; and

installations since 2016) and preferably, the inclusion of site-specific collision estimates (see Chapter 4).

A composite review of all available data may facilitate further analysis of cumulative collision mortality risk estimates for Ireland. By utilising and updating the turbine database now available (NPWS, unpublished; this review), it would be possible to produce a national collision risk model to establish the level of wind energy development -mediated mortality (see O'Donoghue, 2011; Ruddock *et al.*, 2012; 2016). It is noted, however, that collision mortality and risk estimates can be highly site-specific and may not be linked to abundance or detection rates from pre-construction surveys (Haworth and Fielding, 2012; see also Chapter 2), although such an estimate would be useful to inform indicative cumulative risk in Ireland and also allow assessment of future projects. Two suspected collisions in Ireland have occurred in the non-breeding season and there is an absence of flight data available for that time of the year, although it is suspected that flights may be routinely lower during it, due to the lack of higher elevation display flights that occur in the breeding season (O'Donoghue 2011; Wilson *et al.*, 2015).

Potential interactions of wind energy and Irish Hen Harrier SPA breeding populations

It has previously been reported that there were 17 extant wind energy developments within the SPAs, with a further 10 proposed in 2015 (Wilson *et al.*, 2015). Ruddock *et al.*, 2016a reported that four of the six SPAs held a total of 236 turbines within the boundaries and a further 44 were located within 500m of them. As noted earlier, wind energy development (C3) and power line (D3) pressures were reported (Figure 13) for four of the SPAs, Mullaghanish to Musheramore; Stacks, Stack's to Mullaghareirk, West Limerick Hills & Mount Eagle; Slievefelims to Silvermines Mountains and Slieve Aughties had. In the Slieve Blooms SPA, whilst no turbines were recorded within it, power lines (D3) were recorded as a pressure (Ruddock *et al.*, 2016a).

This review estimates that, as of 2016, there were 319 turbines inside four of the six SPAs and 58 turbines within 1km of the SPAs (Table 4). Two SPAs, Slieve Beagh and Slieve Blooms, did not have any turbines in 2016 nor are there turbines within 1km of their boundaries. Neither were there turbines within 28.7km and 2.1km distance of these two SPAs, respectively, but there has been an increasing number of turbines within the other four SPAs over time (Table 4).

Prior to the Hen Harrier SPA designation process in 2007, there were already turbines located within the boundaries of two of the SPAs, namely Slieve Aughty Mountains SPA and Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle. Mullaghanish to Musheramore Mountains SPA had no turbines present until after 2010 (Table 4), although three turbines were located within 1km of the boundary between 2005 and 2010. As of 2016, there remain a small number of turbines within the SPA boundary and there have been an increasing number of turbines adjacent to it (within 1km of its boundary). Despite only a small number of turbines inside the boundary, nearly 10% of the SPA area was within a kilometre of one, at that time.

The Slieve Aughty Mountains have had the same number of turbines present from 2005 to 2016 *i.e.* prior to SPA designation. Therefore, it is unlikely that Hen Harrier declines in the Slieve Aughties in recent years (2005 – 2010 = 14.8% decline; 2010 – 2015 = 39.1% decline) are related to pressure from increasing numbers of turbines, although those present were installed in close proximity to a number of Hen Harriers territories at the time (Madden and Porter, 2007). A spatial redistribution and avoidance of this general area by Hen Harrier may have consequently occurred but further analysis is required to understand the reason/s behind the observed decline in numbers of breeding pairs in this area.

Similarly to Mullaghanish to Musheramore SPA, in the Slievefelim to Silvermines SPA there were a small, but increasing, number of turbines, both inside the boundary (covering a relatively small area of the site) and within 1km of it (Table 5), as of 2016. Between 2010 and 2015, there was an increase from four to 11 turbines within this SPA and an increase from one to six turbines within 1km of the boundary. With regard to the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA, nearly 20% of the area within the SPA boundary was within 1km of a turbine (Table 5) by 2016. There was also a 428% increase in the number of turbines between 2005 (pre-designation) and 2015 (post-designation), with a total of 227 turbines inside the boundary and a further 39 turbines within 1km.

As indicated by Fernández-Bellon (2015) and Wilson *et al.* (2015; 2016), if effects on Hen Harrier breeding success or breeding numbers may occur up to 1km from the nest site, then turbines beyond the SPA boundaries may be affecting the species within the designated sites, if there is suitable nesting habitat within this distance. Therefore, consideration of such *ex-situ* impacts is necessary. As of 2016, this *ex-situ* impact could be occurring at three SPAs, Mullaghanish to Musheramore; Slievefelims to Silvermines and at the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle complex (Table 5).

3

Also as of 2016, one hundred and sixteen other turbines occurred across 14 other designated sites in Ireland. This includes six Natural Heritage Areas (NHAs; 83 turbines), one potential or potential NHA (3 turbines), and six SACs (30 turbines). Several other turbines occur in close proximity to some wetland SPAs (*e.g.* Cork Harbour SPA and Cahore Marshes SPA).

Table 5. The zone of potential influence & number of turbines at Hen Harrier SPAs at the time of National Surveys

Special Protection Area	2000		2005		2010		2015	
	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines (%)	Number of turbines within SPA
Mullaghanish to Musheramore Mountains 004162 (4,975.6ha)	0	0	0	0	7 (0.1%)	0 (3)	485 (9.7%)	2 (13)

	2000		2005		2010		2015	
Special Protection Area	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines	Number of turbines within SPA	Area (ha) of SPA within 1km of turbines (%)	Number of turbines within SPA
Slieve Aughty Mountains 004168 (59,435.65ha)	0	0	2,059 (3.5%)	79	2,059 (3.5%)	79	2,059 (3.5%)	79
Slieve Beagh 004167 (3,455ha)	0	0	0	0	0	0	0	0
Slieve Bloom Mountains 004160 (21,761.25ha)	0	0	0	0	0	0	0	0
Slievefelim to Silvermines Mountains 004165 (20,909ha)	0	0	12 (0.1%)	0 (1)	323 (1.5%)	4 (1)	752 (3.6%)	11 (6)
Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle 004161 (56,627.2ha)	1,139 (2.0%)	29	1,765 (3.1%)	43	6,201 (10.9%)	131 (23)	10,895 (19.2%)	227 (39)
Inside SPA	1,139 (0.7%)	29 (0)	3,836 (2.3%)	122 (1)	8,590 (5.1%)	214 (27)	14,191 (8.5%)	319 (58)
Outside SPA	8,806	169	22,115	365	54,829	830	86,268	1,183
Total	9,945	198	25,951	487	63,419	1,044	100,459	1,502

Ruddock *et al.* (2016a) identified areas in which wind energy development pressures were recorded across 268 surveyed 10km squares. Of the 55 10km squares within which the SPAs occur, there are 21 (38.2%) that contain wind turbines (NPWS, unpublished) and 16 (29.1%) that were considered to be under pressure from wind energy developments (Figure 13; Table 6). Four of these latter squares do not contain turbines (Figure 13) and as noted earlier, fieldworkers may have taken into account pressure from turbines in adjacent squares and near the SPA boundaries and/or may been aware of proposed wind turbines in those areas during their field surveys, potentially from preparatory works.

Table 6. The no. and % of 2015 10km survey squares and their breeding status with regard to turbine presence.

	SPA Status	Confirmed	Possible	Seen	Not seen	Total
Turbines	SPA	13 (61.9%)	2 (14.3%)	5 (23.8%)	1 (4.8%)	21

C3 Pressure	SPA	11 (68.8%)	1 (6.3%)	3 (18.8%)	1 (6.3%)	16

Potential interactions of wind energy and Irish Hen Harrier breeding populations outside of SPAs

Wilson *et al.* (2015; 2016) quantified the spatial overlap at the 10km square resolution based on the 2010 breeding survey (Ruddock *et al.*, 2012) and found that 28% of the range overlapped with Hen Harriers' breeding range, but no distinction was made between designated and non-designated areas. The majority of wind turbines (n = 1,183; 78.8%) in Ireland (NPWS, unpublished) are located outside the SPAs (Table 5; Figure 8).

Potential interactions of wind energy across the wider countryside

NPWS (2015a) defined a method by which important spatial clusters (or regional zones) of breeding Hen Harriers were identified, using the 2010 Hen Harrier survey data. These were subsequently updated by Ruddock *et al.* (2016b), using 2015 Hen Harrier locations (Figure 14). This method defined a series of polygons that were classified as either designated (contiguous with SPAs) or non-designated (beyond SPAs) regional breeding populations. There were fewer turbines (n = 42) recorded within the non-designated areas than the designated areas (n = 250; Table 7), with between 0% and 6.8% (average 1.7%) of the non-designated areas within 1km of turbines compared to 0% to 16.7% (average 6.9%) at SPAs (Table 7).

Within some of the SPAs, a relatively high percentage of turbines were noted (Table 7). Consequently, a relatively lower percentage of turbine coverage within non-designated areas and a greater number of pairs of Hen Harriers in these zones, when compared to the proportional turbine coverage, is noted (Table 7; Figure 15).

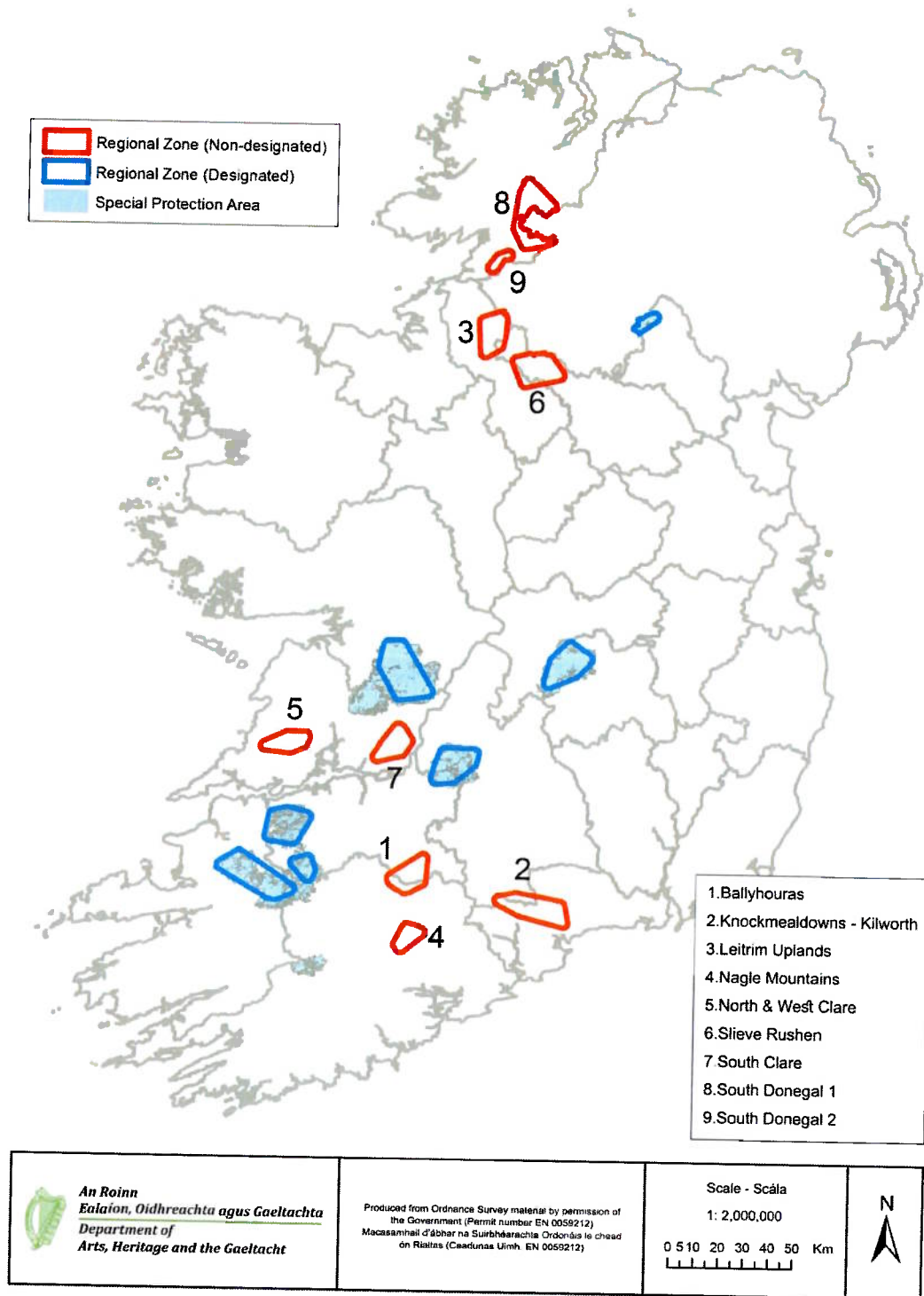


Figure 14. The distribution of relatively important breeding populations of Hen Harriers (*i.e.* designated and non-designated regional zones), as defined by Ruddock *et al.* (2016b), using 2010 and 2015 survey data.

Table 7. The characteristics of turbines located within the 2015 Hen Harrier important breeding population areas (or zones), and size (ha) of associated turbine buffers.

Zone (number of pairs)	Zone Area (ha)	Turbine Count	Sum Mw	Ave Mw	Ave Hub Height (m)	Ave Rotor Diameter (m)	Area (ha) covered by 2015 Turbine 1km Buffer	% of Regional Zone Covered
SPAs								
Aughty 1 (12)	33677.6	79	67.2	0.9	49.0	52.0	2059.6	6.1
Slieve Beagh (3)	4439.3	0	0.0	0.0	0.0	0.0	0.0	0.0
Slieve Blooms (12)	21564.7	0	0.0	0.0	0.0	0.0	0.0	0.0
Slievefelim 1 (10)	20821.9	0	0.0	0.0	0.0	0.0	171.4	0.8
Stacks North 1 (14)	21163.1	41	91.5	2.2	65.7	72.9	3210.0	15.2
Stacks North 2 (5)	7322.5	6	12.5	2.1	78.0	81.7	685.8	9.4
Stacks West & South (12)	30171.5	124	147.9	1.2	58.8	56.7	5035.2	16.7
Non-designated								
Ballyhouras (12)	16801.4	2	4.6	2.3	64.0	71.0	200.5	1.2
Knockmealdowns – Kilworth (7)	25234.3	0	0.0	0.0	0.0	0.0	0.0	0.0
Leitrim Uplands (7)	16443.9	4	9.2	2.3	64.0	71.0	521.2	3.2
Nagle Mountains (5)	9175.4	0	0.0	0.0	0.0	0.0	0.0	0.0
North & West Clare (8)	13154.0	13	11.1	0.9	65.0	70.0	893.2	6.8
Slieve Rushen (7)	21302.1	2	3.0	1.5	65.0	70.0	314.1	1.5
South Clare (7)	14952.3	0	0.0	0.0	0.0	0.0	0.0	0.0
South Donegal 1 (11)	24337.2	21	12.6	0.6	40.0	39.0	735.1	3.0
South Donegal 2 (3)	4532.4	0	0.0	0.0	0.0	0.0	0.0	0.0



Figure 15. The number (y axis) of breeding Hen Harrier within designated and non-designated important regional breeding areas and the proportional areas within 1km of turbines.

Direct disturbance during the breeding season

During the 2010 and 2015 National Hen Harrier Surveys, both wind energy developments and power lines (which may or may not be related to the wind energy developments) were recorded by surveyors as sources of disturbance to breeding Hen Harrier. In 2010, there were five records of disturbance attributed to wind energy developments by surveyors in Cavan, Kerry, Limerick and Cork, and implicated in the outcome of those territories (Ruddock *et al.*, 2012). None of these five territories were reported as successful and two pairs were explicitly reported to have failed due to wind energy development-related factors. Construction, operational or decommissioning works may cause disturbance to Hen Harriers (see Chapter 2). O'Donoghue *et al.* (2011) also report disturbance (and displacement) due to wind energy developments.

Using empirical data, best practice and/or expert recommendations, avoidance distances have been defined with a view to minimising effects of wind energy developments and other potential sources of disturbance (see review by Ruddock and Whitfield, 2007). They ranged from <10m to 1,500m, indicating a wide variation in individual responses by Hen Harriers. It was also recognised that close-range reactions may be a result of Hen Harriers only flushing at close range to an observer but that the disturbance may have been detected by the harrier in advance of flushing; also, that some birds, *e.g.* non-habituated pairs or individuals, may respond to disturbance at very large distances.

There are a number of studies that recorded empirical data or made disturbance buffer recommendations for Hen Harriers, which ranged from 30m to 1,000m (Table 2). A summary of these studies is provided in Table 8 below. The majority of expert opinions (80%) suggested

that significant disturbance responses were likely to occur within than 750m and thus, recommended a buffer of 500 – 750m. Taking the mean of these minimum and maximum figures equates to 475m – 670m and a median of 500 – 750m. Therefore, the recommendations of Whitfield *et al.* (2008) for a buffer of 500 – 750m seem pragmatic in order to provide protection from direct disturbance, although a wider buffer, >1km, to avoid direct disturbance may be practicable in order to reduce long-term effects on breeding parameters (Fernández-Bellon *et al.*, 2015) and mitigate potential population effects (Wilson *et al.*, 2015; 2016). Buffer distances should also take into account lines of sight from a nest and areas of flight activity, rather than being applied solely as radii from the possible sources of disturbance.

Table 8. Summary of literature that identifies displacement or disturbance distances and/or buffer recommendations for Hen Harrier.

Disturbance source	Distance (range) (m)	Effect	Reference
Forestry activities	500-1000m	Buffer recommendation	Currie and Elliott, 1997
Forestry activities	500-600m	Buffer recommendation	Petty, 1998
Observer	300-1000m	Disturbance	Garcia and Arroyo, 2002
Observer	100m	Mobbing	Garcia, 2003
Wind energy development	500-1000m	Displacement	Madders, 2004
Wind energy development	200-300m	Displacement	Madders and Whitfield, 2006
Wind energy development	500-1000m	Displacement	Bright <i>et al.</i> , 2006
Various	500-750m	Disturbance/buffer recommendation	Ruddock and Whitfield, 2007; Whitfield <i>et al.</i> , 2008
Wind energy development	500-1000m	Disturbance	Bright <i>et al.</i> , 2008a
Wind energy development	500m (52%)/ c1000m	Displacement (foraging)	Pearce-Higgins <i>et al.</i> , 2009a
Observer	30 -120m	Mobbing	Irwin <i>et al.</i> , 2012
Wind energy development	140 – 1,280 (median 537m)	Displacement (1 pair)	O'Donoghue <i>et al.</i> , 2011
Wind energy development	2,000m	Wind energy development sensitivity	Bright <i>et al.</i> , 2008a
Wind energy development	2,000m	Wind energy development sensitivity	McGuinness <i>et al.</i> , 2015

There are only a small number of analyses that examine or report on the effects of specific construction, operational or decommissioning wind energy development activities on Hen

Harriers. O'Donoghue *et al.* (2011) reports that a single territory was abandoned during the year of construction, that breeding success and breeding activity were reduced post-construction, and that avoidance distance increased.

Potential interactions of wind energy developments and Hen Harrier populations outside the breeding season

Habitat loss and disturbance at roost sites

There are few studies of the interactions between wind energy developments and wintering species (Devereux *et al.*, 2008), and particularly for Hen Harriers, although such an interaction may cause direct disturbance and/or indirect displacement and/or collision, similar to those that may occur during the breeding season. Human activities can cause abandonment of Hen Harrier roosts (Clarke and Watson, 1990; O'Donoghue, 2010).

The Irish Winter Hen Harrier Survey (IWHHS) is the main source of survey and monitoring data for Hen Harrier during the non-breeding period in Ireland, collecting information on the distribution and occupancy of roosts across the country since 2005. O'Donoghue (2010) reports a predominance of reedbeds and heather/bog habitats for winter roost sites up to 238m asl but the majority were less than 100m asl and more than half (53%) were less than 30m asl. O'Donoghue (2010) also reports a mean of 44.3 ± 8.3 m asl for winter roost sites which is considerably lower than the turbine altitudes found in this review (253 ± 108.7 m asl). There were 82 turbines (5.4%) recorded at less than 53m asl which indicates a relatively low altitudinal overlap with roost sites. It is also recognised that many of the breeding sites may remain occupied as wintering roost sites (B. O'Donoghue, pers. comm.) and the recent mean altitudes at which turbines occur may now be higher since winter roost data was last published (O'Donoghue, 2010). That study did not explicitly identify wind energy developments or turbines as a threat or pressure on roosts at that time, although they were listed as a general threat to Hen Harriers in Ireland (see also O'Donoghue *et al.*, 2011).

Wintering harriers were recorded across 403 10km squares (Balmer *et al.*, 2013) which equates to 46.4% of the 869 squares in Ireland. 88 of these 10km squares were known to contain winter roost sites (NPWS, 2015). An analysis of the RTD (NPWS, unpublished) shows that 1,036 turbines occur within 66 squares (16.4% of squares) within the species' known wintering range. Of the 88 squares known to contain winter roost sites, 22.7% of these contained between two and 43 individual turbines. That is, at the 10km grid level, nearly a quarter of the known winter roost distribution in Ireland contains wind turbines (Table 9; Figure 16).

NPWS (2015a) reports that the IWHHS had identified 96 confirmed roost sites and a further 13 suspected roost sites at that time. A more detailed analysis of roost sites would provide more relevant metrics to aid understanding of the interactions between wind turbines and wintering Hen Harriers. There would be particular value in the following:

- (i) a spatial analysis of turbine proximity to winter roost sites and
- (ii) establishment of the altitudinal overlap of winter roost sites with turbines; and
- (iii) a comparison of winter roost and turbine habitats.



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Gnóthai Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage,
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Scale - Scála
1: 2,000,000

0 5 10 20 30 40 50 Km



Figure 16. The distribution of wind turbines (2016), Hen Harrier winter roost sites and Hen Harrier winter records (Balmer *et al.*, 2013).

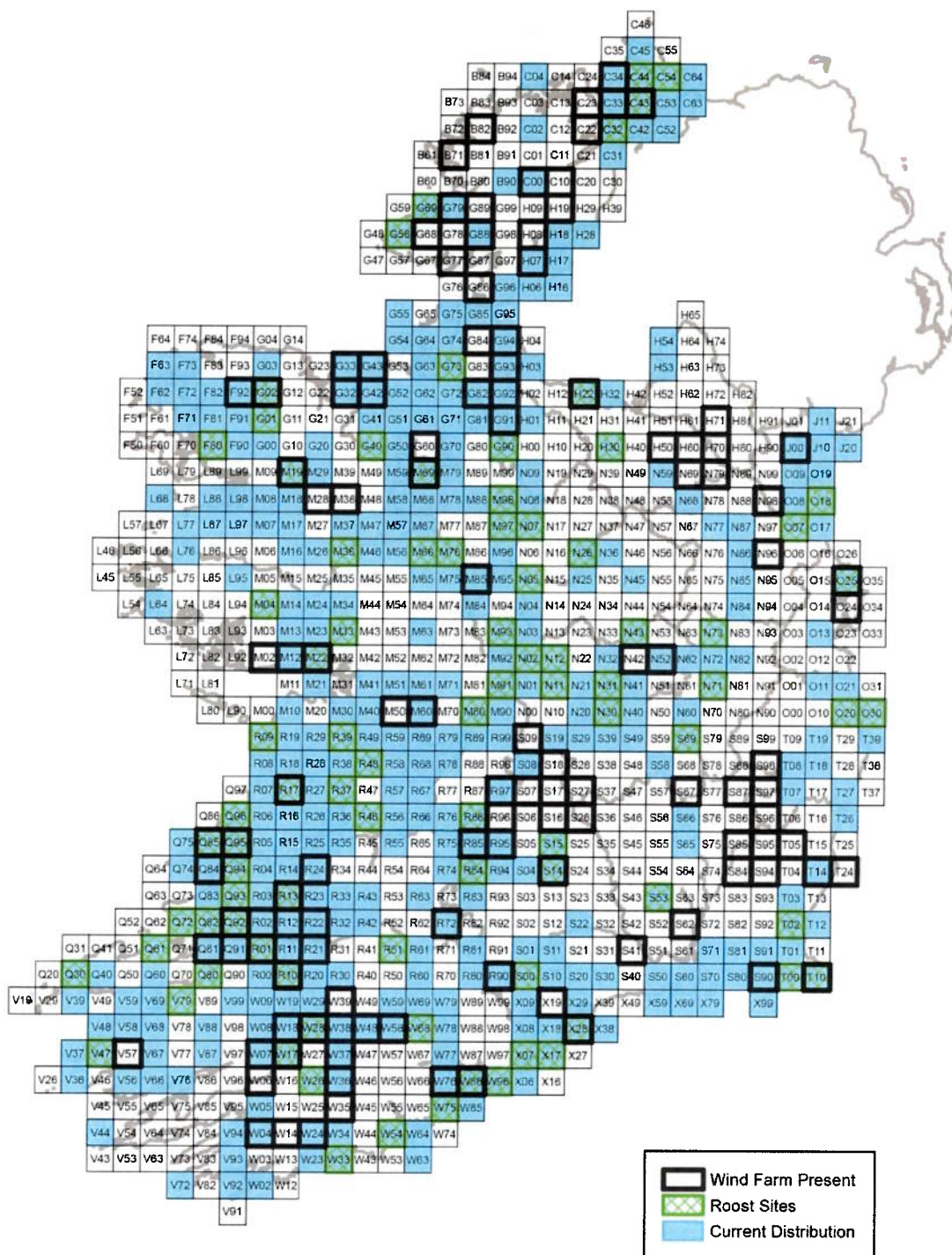


Table 9. Spatial overlap of Hen Harriers and numbers of turbines per 10km resolution, within winter distribution and winter roost range.

	Number of squares	Number of squares with turbines	Percentage of squares with turbines	Number of turbines	Average number of turbines	Min	Max	MW
Within winter range	403	66	16.4	1036	15.7	1	75	1698.9
Within winter roost range	88	20	22.7	306	15.3	1	43	446.1
Outside winter range	466	54	11.6	466	8.6	1	61	716.8

Loss of foraging habitat outside the breeding period

It is known that a proportion of the overwintering population of Hen Harrier in Ireland either remain on or transiently use the breeding uplands for foraging and roosting. Therefore, similar sources of habitat loss that have been identified for the breeding population (*e.g.* displacement from foraging habitat; see Pearce-Higgins *et al.*, 2009a) are also relevant to the species during the winter season, although they can more readily move away from the affected area during the winter.

Although studies that examine winter foraging habitat preferences are limited, it is likely that closed canopy forest and improved pastures that are actively avoided by foraging Hen Harrier during the breeding season are also of negligible importance for this species outside the breeding season. The pressure caused by wind energy developments on individual Hen Harriers outside the breeding season may be less obvious due to the perceived movement of birds to less exposed and lowland areas in winter, where fewer turbines occur (Figure 7). The magnitude of this pressure may not be as severe because (i) Hen Harrier are more widely distributed in the winter (Figure 3) and may be less dependent upon the breeding sites; and (ii) Hen Harrier are known to use a wider variety of habitats, including tillage, during the winter months. Further analysis of altitudinal overlap of wintering Hen Harriers and turbines would allow for an examination of the levels of spatial conflict.

While these pressures may be less pronounced outside the breeding season, the higher occurrence of turbines in non-breeding areas, or in habitats used in the winter, may still affect Hen Harrier. Satellite-tracking studies in Ireland and the UK have shown that birds will disperse up to 20km from roost sites during the day to forage on upland heath and rough grassland, often returning to the same areas frequently over a period of days, weeks and months (B. O'Donoghue and S. Murphy, pers. comm., cited in NPWS, 2015a). These patterns of dispersal may indicate that the dependence on foraging quality away from roosts, in areas of lowland and upland heaths, and marginal farmland, could be as important for winter survival as they are for reproductive success during the breeding season. Therefore, the avoidance of, or barrier effect response to, optimal habitats due to the presence of turbines may compromise winter foraging

efficiency and thus over-winter survival. The effects of disturbance are likely, however, to be less constrained than they would be during the nesting period, although this could be exacerbated by disturbance at the roost sites.

Other potential interactions of wind energy and Hen Harrier populations

Habitats in which wind turbines are installed in Ireland

Research studies and national surveys have increased our knowledge of the importance of various habitats and their use by Hen Harrier during the breeding period (Wilson *et al.*, 2012; Irwin *et al.*, 2012; Barton *et al.*, 2006; Ruddock *et al.*, 2012; 2016). Although several studies report that Hen Harrier continue to utilise wind energy developments for foraging in Ireland (Madden and Porter, 2007; O'Donoghue *et al.*, 2011; Wilson *et al.*, 2015) and that a small number will nest within a few hundred metres (O'Donoghue *et al.*, 2011; this review), other research indicates potential avoidance of habitats due to wind energy developments (Pearce-Higgins *et al.*, 2009a). In order to examine wind turbine interactions with habitats, two analyses were undertaken as part of this review. Firstly, the turbine databases were compared to the SPA habitat database available from Moran and Wilson-Parr (2014), and then a wider analysis was undertaken, utilising CORINE (EPA, 2012) habitat data at the national scale.

Moran and Wilson-Parr (2014) data is relatively high resolution but is only available for the SPAs. An analysis of this data with the RTD (NPWS, unpublished) identifies that the majority of the 319 turbines within the SPAs are located within five main habitat types (Table 10). These five main habitats are:

- cutover bog;
- conifer plantations (>15 years old);
- conifer plantations (of unknown planting year);
- combined wet/dry heath; and
- rough grassland.

Moran and Wilson-Parr (2014) categorised the different habitat types as currently suitable for nesting or for foraging. Forty four point five - 62.7% of the SPA turbines occur in habitats which could be suitable for nesting Hen Harrier. Similarly, 60.2% -78.4% of turbines are located in habitats that are classified as suitable for foraging. Patterns of occurrence within different habitats varied within individual SPAs (Table 11); the most influential SPA driving the pattern was the Stacks complex, as it contains relatively higher numbers of turbines (Table 5).

Table 10. Habitats in which turbines are recorded within Hen Harrier SPAs, based on Moran and Wilson-Parr (2014).

Habitat Description	Habitat Code	Frequency of occurrence (n)	Percentage composition (%)	Suitable for nesting	Suitable for foraging
CUTOVER BOG	PB4	79	24.8	Yes	Yes
CONIFER PLANTATION 15 YEARS PLUS	FOR>15YR	63	19.7	No	No
CONIFER PLANTATION	FOR_UNK	58	18.2	Possible	Possible

Habitat Description	Habitat Code	Frequency of occurrence (n)	Percentage composition (%)	Suitable for nesting	Suitable for foraging
UNKNOWN PLANTING					
COMBINED WET DRY HEATH	HH	45	14.1	Yes	Yes
ROUGH GRASSLAND 50%PLUS COVER JUNCUS	RG	42	13.2	No	Yes
UNPRODUCTIVE CONIFER PLANTATION	UNPRO	10	3.1	Yes	Yes
IMPROVED AGRICULTURAL GRASSLAND	GA1	6	1.9	No	No
CONIFER PLANTATION 9 - 12 YEARS	FOR9_12YR	5	1.6	Yes	Yes
MOSAIC GRASSLAND CLUSTERED 30 - 39%	MG_C3	4	1.3	No	Yes
DRY/HUMID ACID GRASSLAND	GS3	2	0.6	No	Yes
CONIFER PLANTATION 13 - 14 YEARS	FOR13_14YR	1	0.3	No	Yes
CONIFER PLANTATION 4 - 8 YEARS	FOR4_8YR	1	0.3	Yes	Yes
FRESHWATER MARSH	GM1	1	0.3	No	Yes
SCRUB	WS1	1	0.3	Yes	Yes
UPLAND BLANKET BOG	PB2	1	0.3	Yes	Yes
TOTAL		319	100%		

Table 11. Habitats in which turbines are recorded within individual Hen Harrier SPAs in Ireland, based on Moran and Wilson-Parr (2014).

Habitat description	Mullaghanish Musheramore Mountain SPA		Slieve Aughty Mountain SPA		Slievefelim Silvermines Mountains SPA		Stack's - Mullaghareirks SPA	
	n	%	n	%	n	%	n	%
CUTOVER BOG			15	19.0			62	27.7
CONIFER PLANTATION 15 YEARS PLUS			24	30.4	4	36.4	34	15.2
CONIFER PLANTATION UNKNOWN PLANTING			38	48.1	1	9.1	18	8.0
COMBINED WET DRY HEATH	1	20.0	2	2.5			41	18.3
ROUGH GRASSLAND 50%PLUS COVER JUNCUS					4	36.4	39	17.4
UNPRODUCTIVE CONIFER PLANTATION							10	4.5

Habitat description	Mullaghanish Musheramore Mountain SPA		Slieve Aughty Mountain SPA		Slievefelim Silvermines Mountains SPA		Stack's - Mullaghareirks SPA	
	n	%	n	%	n	%	n	%
IMPROVED AGRICULTURAL GRASSLAND	2	40.0					7	3.1
CONIFER PLANTATION 9 - 12 YEARS							5	2.2
MOSAIC GRASSLAND CLUSTERED 30 - 39%					1	9.1	3	1.3
DRY/HUMID ACID GRASSLAND	2	40.0					1	0.4
CONIFER PLANTATION 13 - 14 YEARS							1	0.4
CONIFER PLANTATION 4 - 8 YEARS							1	0.4
FRESHWATER MARSH					1	9.1		
SCRUB							1	0.4
UPLAND BLANKET BOG							1	0.4
TOTAL	5		79		11		224	

This review also utilised the most recently available CORINE (EPA, 2012; Lydon & Smith, 2014) habitat data, at the time of the analysis, to examine the broad types of habitats where turbines are installed across Ireland, both within and without the Hen Harrier SPA Network. Similarly to within the SPAs alone, the majority of turbines have been installed in peat bog habitats (48.1%) (Table 12) and a minority of turbines in the wider area occur within urban or more densely human-occupied habitats. All of the key seven habitats in which turbines most frequently occur (Table 12) could be useful to breeding or wintering Hen Harriers, although the resolution of these data and the quality of such habitats cannot be examined from these data sources. O'Donoghue (2010) reports the usage of reedbeds and upland (heath) areas for roosting, but further analysis of habitat co-occurrence would enable a more detailed examination of wintering roost areas and wintering foraging areas.

Table 12. CORINE Habitats (EPA, 2012) in which turbines are recorded in the wider countryside

CORINE habitat description	CORINE Code	Number of turbines	Percentage of turbines (%)
Peat Bogs	412	722	48.1
Pastures	231	311	20.7
Transitional woodland shrub	324	242	16.1
Conifer forests	312	93	6.2
Land principally occupied by agriculture	243	64	4.3
Non-irrigated arable land	211	32	2.1
Moors and heathland	322	26	1.7
Green urban areas	141	5	0.3
Beaches, dunes and sand plains	331	2	0.1
Industrial or commercial units	121	2	0.1
Discontinuous urban fabric	112	1	0.1
Complex cultivation pattern	242	1	0.1
Mixed forest	313	1	0.1

The erection of turbines within suitable nesting habitat (either within SPAs or in the wider countryside) may cause displacement of Hen Harriers from suitable habitat. Similarly, the placement of turbines within suitable foraging habitats may cause avoidance (Pearce-Higgins *et al.*, 2009a) and create barriers to movement. The indirect loss of usable breeding habitat due to proximity to wind turbines can be a result of displacement or avoidance behaviour. That is, Pearce-Higgins *et al.* (2009b) found that an average avoidance of 52.5% occurred at 500m resolution, although this ranged from -1.2% to 74.2% which would indicate that no avoidance, theoretically, would occur at 1km and thus, avoidance around turbines for foraging birds would extend to approximately 1km.

The reduction of habitat suitability by the construction and/or operation of a wind energy development within Hen Harrier ranges could lead to a reduction in food supply and such changes may reflect the indicative changes in breeding parameters observed by Fernández-Bellon *et al.* (2015) and Wilson *et al.* (2015) at 1km distance. Whilst Wilson *et al.* (2015) only observed small changes in prey abundance (at circa 100m from turbines), the wider avoidance of foraging habitats could have consequential effects on breeding success or productivity and may lead to gradual population declines over time.

As provisioning Hen Harriers forage greater distances in forested landscapes in Ireland compared to distances indicated by studies from other countries (Arroyo, 2006; Irwin *et al.*, 2012; Arroyo *et al.*, 2014), habitat connectivity is therefore likely to be an important consideration in wind energy development management and spatial planning for Hen Harriers in Ireland. Habitat fragmentation could also occur, as manifested by the barrier effect of wind turbines and/or overhead power lines (OHLs) and associated wind energy development infrastructure, though OHLs are used much less frequently in wind energy developments in Ireland, than previously (Eirgrid, pers.comm and ESB Networks, pers. comm.). This may affect provisioning Hen Harriers that are nesting in landscapes with high proportions of wind turbines and that are actively being avoided. Consequently, Hen Harriers may have to increase foraging periods to meet their own nutritional demands or those of their nestlings. Pearce-Higgins *et al.* (2009b) found a significant distributional effect of turbines on Hen Harriers but no significant effects of distribution of tracks or transmission (power line) infrastructure were noted.

The prevalence of wind turbines within foraging habitats may affect their profitability and hen harrier may have to travel larger distances to access other habitats, possibly increasing foraging time, energetic expenditure and range (see Ruddock *et al.*, 2008). Wind turbines can result in reduced habitat quality and extent (*e.g.* WINDHARRIER findings in relation to small bird abundances (Wilson *et al.*, 2015)), thereby limiting foraging, nesting or even roosting resources. This could explain the indicative negative associations observed by Wilson *et al.* (2015; 2016) on both breeding parameters and population decline, albeit there are other potential confounding factors. Whilst Fernández-Bellon *et al.* (2015) indicates that some breeding parameters may be affected at 1km, other research indicates that foraging behaviour of breeding pairs can be influenced by habitat changes at distances up to 3km from the nest (Amar

et al., 2004; Arroyo *et al.*, 2009) and this could conceivably be larger based on average avoidance distances of 5-10km from extant turbines in 2015 (this review).

Arroyo *et al.* (2009) reported that human-wildlife conflict between the conservation of Hen Harriers, and the location of wind turbines for renewable energy generation, had increased (see also Madders and Whitfield, 2006). An understanding of foraging range and habitat selection can be useful in reducing this conflict by guiding the placement of turbines into areas that have the lowest quality habitat for foraging harriers, or managing habitats within existing wind energy developments to reduce collision risk (SNH, 2016).

Wind Energy Development Sensitivity Analysis

The examination of species sensitivity to wind energy developments in order to inform spatial planning is a recognised tool for minimising conflict (Bright *et al.*, 2008a and 2008b). In Ireland, Tierney *et al.* (2012) and McGuinness *et al.* (2015) produced a sensitivity map that included consideration of Hen Harriers. This map was compared to the turbine database (1,502 turbines; RTD, 2016):

- three turbines (0.2%) were identified within the high risk category;
- 246 turbines (16.4%) within the medium sensitivity category and
- 564 turbines (37.5%) within the low sensitivity category (Figure 17).

The remainder of turbines were in areas with no data available *i.e.* no known sensitivities for the species analysed. There were 574 turbines (38.2%) located within the areas that had been identified as either medium or low sensitivity specifically for Hen Harrier, within 11 counties (Cavan, Clare, Cork, Donegal, Galway, Kerry, Leitrim, Limerick, Roscommon, Tipperary and Waterford) (See Tierney *et al.* (2012) for further details on the methodology used).

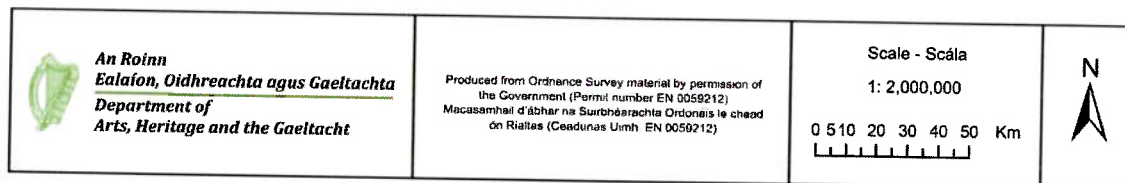
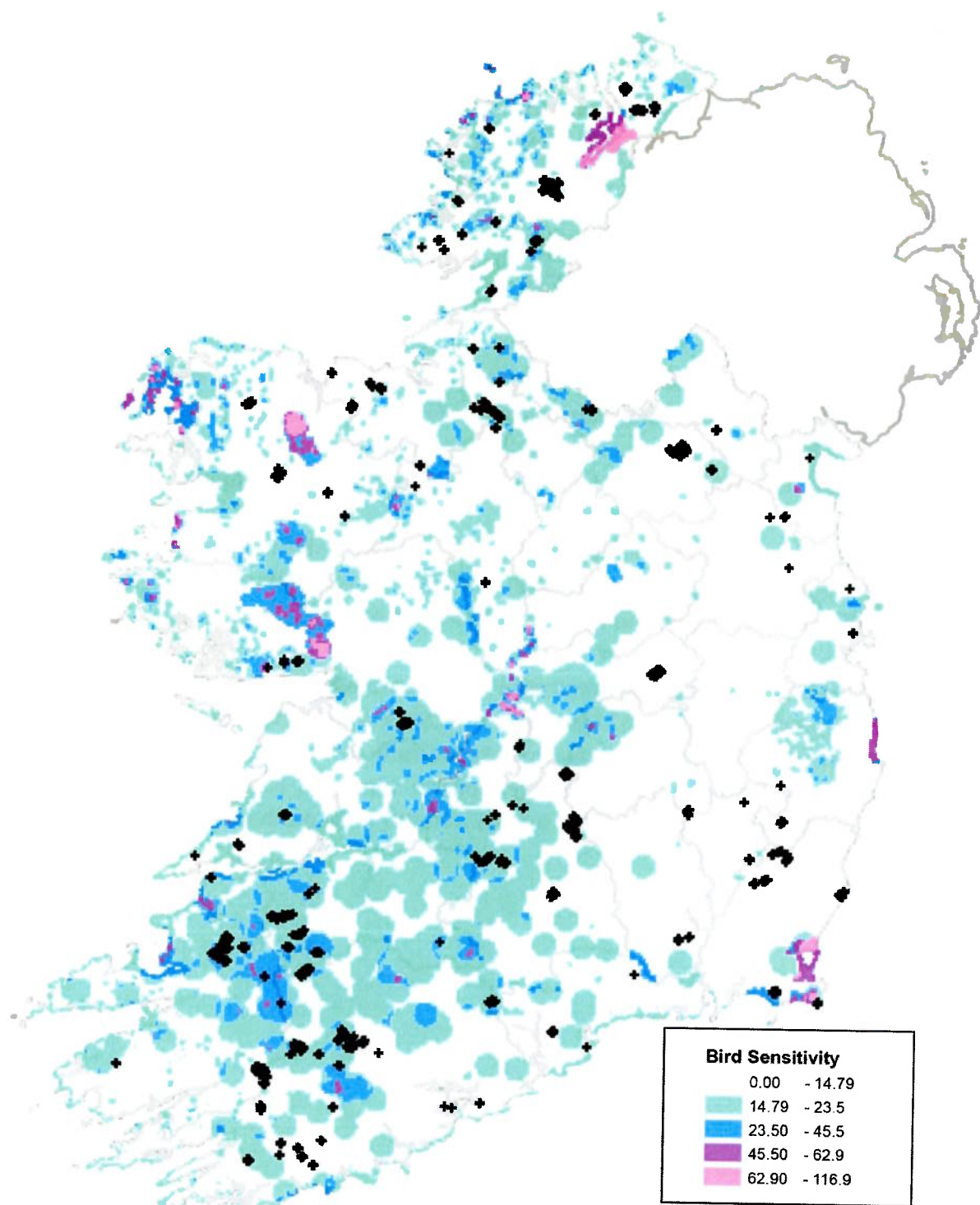


Figure 17. Wind turbine distribution (+) and wind turbine sensitivity areas (derived from McGuinness *et al.*, 2015).

CHAPTER 4: SUMMARY OF INTERACTIONS & FUTURE CONSERVATION MANAGEMENT OPTIONS

Introduction

This final chapter summarises the potential effects of wind energy development on Hen Harrier in Ireland and also sets out a series of options for the conservation of the Irish Hen Harrier population that are relevant to the wind energy sector. These options have been developed further through discussions with the Inter-Departmental Steering and have been integrated into the cross-sectoral Hen Harrier Threat Response Plan (NPWS-DHLGH, 2021).

The previous chapters have set out how the ambitious targets relevant to Ireland's renewable energy policy have resulted in an unprecedented level of wind energy development construction since 2000 and how demand for this development is likely to continue. The previous chapters have also detailed how such developments, at the project level or cumulatively, could affect individual Hen Harriers as well as site, regional and national population levels.

Summary of interactions

With regard to the conservation management of the Irish Hen Harrier population, there are several effects that may arise as a result of potential interactions with the wind energy sector. These are as follows:

- (i) loss of, or displacement from, foraging and nesting habitat during the breeding season;
- (ii) direct disturbance of nesting and roosting birds;
- (iii) loss of, or displacement from, winter foraging resources and roosting habitat; and
- (iv) risk of bird mortalities through collisions with turbines.

While these will be expanded on below, it is first useful to summarise the pattern of wind energy development and the habitats within which they are installed, the recorded distribution of the Hen Harrier across Ireland, and possible associated population-level responses.

Overlapping distributions and population level impacts

In 2015, breeding Hen Harrier territories (*i.e.* confirmed and possible breeding records) were recorded across 83 10km grid squares in Ireland. Over 32% of these squares overlapped with at least one wind energy development. This percentage overlap has increased nearly fivefold since the original national survey was conducted in 2000; meanwhile, the breeding harrier population is estimated to have declined over this period.

Using the RTD (NPWS, unpublished), it is calculated that almost 82% of turbines were located in the 100–400m altitudinal range; 92% of Hen Harrier territories recorded in 2015 were located in the same range. Over 66% of turbines and almost 60% of Hen Harriers occurred between the 200 and 400m contours. As described earlier, as of 2016, 44.5% - 62.7% of the SPA turbines occurred in habitats that could be suitable for nesting Hen Harrier. Similarly, 60.2% - 78.4% of turbines are located in habitats that are classified as suitable for foraging.

The most recent Bird Atlas (2007-2011) recorded harriers during the winter period across 403 10km squares; 88 of these 10km squares are known to contain winter roost sites (Balmer *et al.*, 2013; NPWS, 2015a). It has also been calculated that, as of 2016, over 1,000 turbines had been installed across over 16% of the known wintering range of the Hen Harrier (NPWS, unpublished).

For the WINDHARRIER study, Fernández-Bellon *et al.* (2015) assessed the breeding performance of Hen Harriers across Ireland in relation to wind energy development. Several measures of breeding performance were investigated and no statistically significant relationships were found between these breeding parameters and distance of the nest from the nearest wind turbine, although for those nests observed, nest success was lower within the closest distance band (0-1km) to turbines. Fernández-Bellon *et al.* (2015) conclude that these findings support earlier research that highlighted the importance of areas within a 1 km radius of raptor nests to breeding success.

Also for the WINDHARRIER study, Wilson *et al.* (2015) examined Hen Harrier population trends in relation to wind energy development in Ireland from 2000 to 2010, and noted that considerable overlap occurs between Hen Harrier breeding distribution and the location of wind energy developments. They reported *"A weak negative relationship was identified between wind farm presence and change in the number of breeding Hen Harrier pairs in survey squares between 2000 and 2010. However, the available evidence suggests that this was not a causative relationship but that local factors not included in the current study may have been responsible for the observed changes in Hen Harrier numbers within the survey squares. Furthermore, Hen Harrier population trends were negatively affected by a complex interaction between wind farm developments and the proportion of land between 200m and 400m above sea level"*.

Loss of, or displacement from, foraging and nesting habitat during the breeding season

During the breeding season and beyond, the diet of Hen Harrier consists of small birds and small mammals. Wilson *et al.* (2015) identified that the densities of forest birds were significantly lower within 100m of wind turbines; and that densities of open-country bird species were also found to be lower at wind energy development sites, but that these differences were independent of distance to wind turbines. Therefore, lower densities may be due to larger-scale effects of wind energy developments.

Examining the foraging preferences of adult birds during the breeding season and differences between wind energy development and control sites, Wilson *et al.* (2015) highlighted the importance for Hen Harriers of open habitats that hold high diversity and densities of prey species (rough grassland, natural grasslands, scrub and peatland).

Pearce-Higgins *et al.* (2009b) provide evidence of significant Hen Harrier avoidance of apparently suitable habitat within 250m of turbines, with a predicted 53% reduction of Hen Harrier flight activity within 500m of turbines, assuming that modelled habitat usage is proportional to breeding density. However, Haworth and Fielding (2012) examined Harrier flight activity data from five wind energy developments and a more limited level of avoidance

is suggested, concluding that Harriers are displaced at relatively smaller scales of between 0-100/200m (Haworth and Fielding, 2012).

The wider implications of these findings of displacement or avoidance effects need to be considered in relation to their potential effects on the Hen Harrier population at the national level. It is estimated that, as of 2016, 21% of all turbines in Ireland occurred within the breeding Hen Harrier SPA Network. The number of turbines within 1km of the boundaries of these SPAs had also increased, as set out earlier. Turbines have also been permitted in undesignated areas that have previously or continue to support breeding Hen Harrier. The review also indicates that, as of 2016, turbines outside the SPA network were predominantly located across peat bogs (48%), as well as there being a predominance of turbine installation in open habitats over which harriers are known to forage. Within the SPAs, as of 2016, over 50% of the turbines were installed over heath-bog and/or rough grassland.

Direct disturbance of nesting and roosting birds

The presence of operating wind turbines can exert a displacement pressure on foraging and nesting harriers. The presence of ancillary activities, including construction and maintenance activities, near nest and roost sites can elicit direct responses from birds. This disturbance may manifest itself in the temporary abandonment of the area by nesting or roosting birds. Depending on the timing, intensity and recurring/chronic nature of the source of the disturbance, birds may abandon the nesting and/or roosting site entirely. For Hen Harrier, Ruddock and Whitfield (2007) suggests the implementation of a minimum set-back distance of 500 - 750m in order to minimise the potential impacts of human activity on nesting attempts.

Loss of, or displacement from, winter foraging resources and roosting habitat

An examination of available data at the 10km level shows that almost one quarter of the known winter range of Hen Harrier in Ireland overlaps with wind energy developments. Although research on the impacts of wind energy developments on harriers outside of the breeding season is very limited, it is likely that some level of turbine avoidance by foraging birds occurs and therefore, some level of foraging habitat loss has occurred as a result of the development.

Risk of bird mortalities through collisions with turbines

A review of the relevant scientific literature on the collision risk of harriers with turbines indicates that the species is probably at low risk of collision generally, given the low altitude of the majority of its flight activity. The WINDHARRIER report noted that harriers at wind energy developments spent 12% of their flight time within wind turbine rotor-sweep height, while the amount of time spent by juveniles flying at this height was negligible; thus, it was concluded that the overall collision risk to harriers during the breeding period season was low. However, as noted earlier, since 2015, and even in the absence of a robust system for carcass searches on wind energy developments, there have been three probable/confirmed incidences of Hen Harrier mortality caused by turbine strike and one possible case reported to NPWS-DHLGH. This suggests that collision risk for this long-lived species, with a low reproductive output, may increase along with any increase in wind energy developments.

Wind Energy and Hen Harrier Conservation

Through the HHTRP process, various conservation actions can be recommended with a view to reducing pressures and threats on the Hen Harrier in Ireland. Specifically with regard to wind energy development, it is important to ensure that the integrity of Hen Harrier SPAs are not adversely affected by the individual and cumulative effects of wind energy developments and other plans, projects and pressures, *e.g.* by the reduction of the extent and/or quality of the habitats necessary to support the breeding Hen Harrier population.

In the planning of future wind energy developments, appropriate attention also needs to be given to allowing for a sufficiency of suitable breeding Hen Harrier habitat outside of the SPA network. The non-breeding/overwintering aspects of the species' life cycle also need to be considered in order to ensure that winter roosts and adequate foraging areas are maintained.

Improving the available evidence base for the assessment of future wind energy developments

Projections show that an increase in both new development and repowering of onshore wind energy developments is both likely and necessary in order to meet renewable energy targets (SEAI, 2018). Therefore, it can be anticipated that there is likely to be ongoing, and possibly increasing, interest in the development of wind energy in areas that also happen to be important for Hen Harrier, both outside and within SPAs. A greater understanding of the use and suitability of habitats in these areas for Hen Harriers is necessary to improve understanding of the ongoing and future risks to the population.

The WINDHARRIER report (Wilson *et al.*, 2015) provides an extensive suite of research on wind energy developments in Ireland that has been used to both inform this report and widen understanding of Hen Harrier and wind energy development interactions. It also sets out useful recommendations, some of which are similar to the management options set out in this chapter. In particular, it provides a useful review of ornithology survey guidelines and recommendations for the implementation of standardised guidance for surveys.

In order for proposed wind energy developments, or the repowering of existing wind energy development, to be assessed for potential impact on the Hen Harrier population, it is important that sufficient levels of robust data and knowledge are collected by, and available and accessible to, developers and agents acting on their behalf, so that fit-for-purpose assessment documents can be produced (*e.g.* Environmental Impact Assessment Reports, Natura Impact Statements and Environmental Reports). It is also important that these data are readily available and standardised so that decision-making authorities can conclude the various assessment processes, to the standard required.

Recommendations are as follows:

- In order for ecological data from different wind energy developments to be comparable and aggregated for efficient strategic level analysis, the data collected needs to conform to particular standards. The production and adoption of best practice guidance in relation to the design and undertaking of bird surveys at the appropriate scales, in order

to inform fit-for purpose assessments and post-construction monitoring actions, would be of significant benefit. This would lead to an increase in the availability of data from comparable pre- and post-construction studies, including any carcass searches that are occurring.

- Easy access to project-level assessment documentation, including pre- and post-construction monitoring data, would further help in the assessment of in-combination and cumulative effects on Hen Harrier populations. The development of a facility to receive, store and report out on suspected bird collisions would also be a useful resource, with regard to providing data from both monitored (with formal carcass searches) and unmonitored (*i.e.* ad-hoc carcass recoveries) wind energy development.
- National Hen Harrier breeding surveys at five-yearly intervals need to continue for, at least, the medium term. The data derived from these surveys provides contemporary population estimates at both the SPA and national levels. It also enables the updating of other resources *e.g.* the production of updated maps of areas that have a higher likelihood of holding nesting pairs (*i.e.* HLNAs). These can be used as a tool to minimise potential disturbance events during the breeding season.
- The information presented in this report, and its implications for Hen Harrier breeding success, displacement *etc.* should be taken into account by parties involved in the ecological assessment (*i.e.* SEAs, AAs, and EIAs) of proposed wind energy developments, their repowering and associated or supporting policies, plans and programmes. This should include consideration of their potential effects on Hen Harrier outside the SPA network, particularly in non-designated regionally important zones, as required by Article 5 of the Birds Directive.
- Building on the work done by the SEAI, a spatial turbine database (RTD) has been further developed to support the development of this report (NPWS, unpublished). To promote effective cumulative level assessments, including collision risk modelling at various scales, the RTD needs to be further validated and maintained into the future, including through the addition of locations of recently-installed turbines. The RTD would be further strengthened if information relating to proposed, contracted or planned future wind energy developments was integrated.
- Further work is needed to gain a better understanding of the ecology of Hen Harrier outside the breeding season. More comprehensive and centralised knowledge on the characterisation and distribution of roost sites and wintering habitat use is also warranted. The fact that the possible Hen Harrier collision events occurred during the autumn/winter period is of particular relevance here.
- Hen Harrier habitat-offsetting works have been permitted as part of several wind energy developments. Focused research on the efficacy of such works would not only increase the planning authorities' confidence as to whether such works are effective in supporting the Hen Harrier, but furthermore, such research may also provide opportunity to provide guidance for the development of the most effective measures to minimise effects of wind energy developments on Hen Harrier.
- The production of a high-resolution habitat map for Ireland would help to inform Hen Harrier habitat suitability modelling work at the national level, as well as the production of more robust assessments and spatial planning.

- The implications of this review's findings, for the availability and quality of Hen Harrier habitat in the SPAs, should be reflected appropriately in the site-specific conservation objectives for those sites, and their associated conservation measures, as required under the Birds Directive.

Spatial Planning Policy Development and the Wind Energy Sector

In parallel with the need to increase the evidence-base to inform future wind energy development proposals, further clarity should be brought to bear on spatial planning and land-use policy.

The HHTRP forestry sector report (NPWS, 2015a) shows that, as of 2015, over 50% of the six breeding Hen Harrier SPAs was under forestry management. The report also estimates that, for the subsequent 10 to 15 years, the extent of the forest that will be usable by Hen Harrier is likely to decline. The HHTRP agricultural sector report (NPWS, 2015b) highlights that various drivers are increasing the likelihood that the extent of farmed high quality Hen Harrier habitats will not increase in the near future unless there is direct intervention. For instance, within the SPA network, the establishment of conservation initiatives (such as the Hen Harrier European Innovation Partnership (EIP)), as well as the implementation of rotational forest management processes, should result in a redistribution of Hen Harrier breeding locations (both nesting and foraging) in the medium term.

As set out previously, some Hen Harrier SPAs contain relatively large numbers of wind turbines and there will be a considerable demand for, and acceleration of, wind energy developments over the coming years in order to meet renewable energy targets. Because of their interactions, the installation of wind energy developments in areas important for Hen Harriers may constrain opportunities for the co-location of the targeted conservation measures that are needed to restore sufficient suitable habitat for a stable and adequately-sized breeding population in the SPA Network, *i.e.* because the presence of the wind energy development may undermine the efficacy of the conservation measures.

As mentioned earlier, the creation of habitat to offset the effects referred to above has been determined not to be mitigation (in the meaning of a Habitats Directive Article 6(3) assessment), but is rather a measure to be assessed pursuant to Article 6(4) (*i.e.* compensation) (Supreme Court, 2016; ECJ, 2018). The Advocate General considered the question arising as providing a valuable opportunity to clarify its Article 6 case law "*given the need to reconcile the Member States' increasing use of renewable energy sources, such as wind power, and the protections afforded to habitats and species, such as the hen harrier*" and acknowledged the importance of both ambitions (Advocate General Tanchev, 2018). The need to apply the precautionary principle in appropriate assessments has also been enshrined in ECJ case law (*e.g.* where effects may arise but have not been proven) (*e.g.* Waddenzee Judgment (ECJ, 2004). Public authorities shall give consent to a plan or project, or adopt a plan or project, under Article 6 (3) of the Habitats Directive, only after having determined that it shall not adversely affect the integrity of a European site; furthermore, appropriate assessments should "*include complete,*

precise and definitive findings and conclusions that are capable of removing all scientific doubt as to the effects of the proposed development on ... [sites] concerned" (High Court, 2014).

Based on this report's review of available studies and best available knowledge, it can be concluded that the development of a wind energy development in, or immediately adjacent to, Hen Harrier habitat will result in some loss and/or reduction in quality of existing or current breeding habitat, through effects on, for example, breeding success and prey availability, which may result in negative changes to breeding productivity.

Thus, in line with the requirements of Article 6(3) and current case law concerning its application, project proposals (*e.g.* a proposal for new wind energy development, a proposal to repower an existing wind energy development, or a proposal to extend the operational life of a wind energy development through a new planning permission), that may affect the integrity of a Hen Harrier SPA will need to be able to demonstrate, with good quality, objective and reliable scientific evidence, that they will not adversely affect site integrity and its conservation objectives (*e.g.* result in significant mortality, displacement or affect the quality or availability of Hen Harrier breeding habitat, prey availability, and breeding success), including by taking into account the population status and trends for the species. This needs to be done in a manner that removes scientific doubt as to the effects that may arise, in combination with other plans and projects.

Relevant projects, plans or programmes, such as wind energy policy statements, strategies or frameworks that are developed, and their associated necessary environmental assessments (*i.e.* SEA, AA), should also reference and address the findings of this report.

Stakeholders could positively contribute to the robust assessment of the effects of wind energy development on Hen Harrier through a number of actions, including the following:

- Pre-application discussions with relevant stakeholders can identify potential nature conservation conflicts at an early stage and prevent/reduce both cost and time implications for all parties.
- Use and build on tools already developed to improve and to inform spatial planning and appropriate wind energy development siting, such as those referenced earlier in the report. This includes the long term maintenance and updating of the web resource that collates local authority wind energy strategies, the LARES methodology, map viewer and online tool.
- The production of sector-specific guidance on the assessment of the implications of proposed wind energy developments and repowering for Hen Harrier would be beneficial to inform the planning application process and decision-making. This would assist wind energy developers and operators, their ecologists, contractors and consultants, as well as competent authorities.
- In addition, in order to improve the effectiveness of avoidance and/or offsetting measures, a tool-box approach could be developed, following the undertaking of any

necessary research (see earlier Recommendations). Such avoidance and/or offsetting measures *could* include:

- The avoidance of turbine installation on areas of open heath/bog habitat as such habitats are likely to be of more long-term benefit to harriers than conifer plantations would be. This would preferably be informed by Irish Hen Harrier habitat modelling work and/or a national habitat map to enable specific targeting.
- The avoidance of wind energy development on or immediately adjacent to important winter roost sites.
- Consideration of how best to minimise collision risk, *e.g.* to manage the habitat in the immediate footprint of turbines in a way that reduces its residual attractiveness for use by Hen Harrier, as well as turbine design *etc.*
- Development of a methodology for best practice in post-construction monitoring (including the setting of a minimum level required) and application of results to inform and adapt ongoing post-construction mitigation measures.
- Avoidance of disturbance stimuli to breeding and/or roosting birds.

These measures could also be usefully supported by:

- Optimisation of the effectiveness of Construction Environmental Management Planning (CEMP) and the use of on-site Ecological Clerk of Works (ECoW) to oversee the implementation of mitigation measures, where appropriate.
- Development and implementation of Wind Energy Development Standard Operating Procedures designed to minimise and avoid Hen Harrier disturbance events that may arise from day-to-day wind energy development activities and scheduled maintenance operations, along with associated outreach activities to relevant professionals.

REFERENCES

Note: Key references are highlighted in grey

- AEC (2012). Freasdale Wind Farm Environmental Statement 2012 Chapter 8. Arcus Renewable Energy Consulting Ltd., 507-511 Baltic Chambers, 50 Wellington Street, Glasgow.
- Advocate General Tanchev (2018). Case C-164/17 Edel Grace & Peter Sweetman v An Bord Pleanála. Reference for a preliminary ruling Environment Directive 92/43/EEC Article 6(3) Directive 2009/147/EC: *Assessment of the implications of a wind farm project for a special protection area Hen harrier (Circus cyaneus) Mitigation measures.*
- Amar, A., Arroyo, B., Redpath, S. and Thirgood, S. (2004). Habitat predicts losses of red grouse to individual hen harriers. *Journal of Applied Ecology* 41: 305-314.
- Andrews, D.G. (1964). Birds in Ireland 1960-62. *British Birds* 57 (Issue 1): 1-10.
- Andrews, A. (1990). Fragmentation of habitat by roads and utility corridors: a review. *Australian Zoologist* 26: 130-141.
- Arroyo, B., Leckie, F. and Redpath, S. (2006). Habitat use and range management on priority areas for hen harriers: final report. Report to Scottish Natural Heritage. 57pp. Edinburgh, UK.
- Arroyo, B., Amar, A., Leckie, F., Buchanan, G. M., Wilson, J. and Redpath, S. (2009). Hunting habitat selection by hen Harriers on moorland: Implications for conservation management. *Biological Conservation* 142: 586-596.
- Arroyo, B., Leckie, F., Amar, A., McCluskie, A. and Redpath, S. (2014). Ranging behaviour of Hen Harriers breeding in Special Protection Areas in Scotland. *Bird Study* 61: 48-55.
- Balmer, D., Gillings, S., Caffrey, B., Swan, B., Downie, I. and Fuller, R. (2013). *Birds Atlas 2007-11: The breeding and wintering birds of Britain and Ireland*. British Trust for Ornithology.
- Band, W., Madders, M. and Whitfield, D. P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In de Lucas, M., Hanss, G. and Ferrer, M. (eds). *Birds and wind farms: Risk assessment and mitigation*. pp Quercus.
- Bannerman, D.A. and Lodge, G.E. (1956). *The Birds of the British Isles*, Volume 5. Oliver and Boyd, Edinburgh.
- Barclay, R. M. R., Baerwald, E. F. and Gruver, J. C. (2007). Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85: 381-387.
- Barclay, C. (2010). Wind Farms - Distance from housing. Standard Note: SN/SC/5221: Science and Environment. House of Commons Library November 2010.
- Barrios, L. and Rodriguez, A. (2004). Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41: 72-81.
- Barton, C., Pollock, C., Norriss, D.W., Nagle, T., Oliver, G.A. and Newton, S. (2006). The second national survey of breeding hen harriers *Circus cyaneus* in Ireland 2005. *Irish Birds* 8: 1-20.
- Bellebaum, J., Korner-Nievergelt, F., Dürr, T. Mammen, U. (2013). Wind turbine fatalities approach a level of concern in a raptor population. *Journal for Nature Conservation* 21: 394-400.
- Bennett, V. J., Hale, A. M., Karsten, K. B., Gordon, C. E. and Suson, B. J. (2014). Effect of wind turbine proximity on nesting success in shrub-nesting birds. *The American Midland Naturalist* 172: 317-328.
- Bevanger, K., Berntsen, F., Clausen, S., Dahl, E. L., Flagstad, Ø., Follestad, A., Halley D., Hanssen, F., Johnsen, L., Lund-Hoel, P., May, R., Nygård, T., Pedersen, H. C., Reitan, O., Røskoft, E., Steinheim, Y., Stokke, B. and Vang, R. (2010). Pre- and post-construction studies of conflicts between birds and wind turbines in coastal Norway (Bird-Wind). Report on findings 2007-2010. – NINA Report 620: 152 pp. Norwegian Institute for Nature Research, Trondheim.
- BirdLife International. (2004). Birds in Europe: population estimates, trends and conservation status. Cambridge, UK. BirdLife International.
- BirdLife International (2015). European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities.
- Braun, C.E. (1998). Sage Grouse declines in western North America: What are the problems? *Proceedings of the Western Association of State Fish and Wildlife Agencies*. 78:139-156.
- Bright, J. A., Langston, R. H. W., J. E. R., Gardner, S., Pearce-Higgins, J. and Wilson, E. (2006). Bird sensitivity map to provide locational guidance for onshore wind farms. A report by the Royal Society for the Protection of Birds, as part of a programme of work jointly funded by the RSPB and Scottish Natural Heritage. *RSPB Report No. 20*. 136pp.
- Bright, J. A., Langston, R. H. W., Bullman, R., Evans, R., Gardner, S. and Pearce-Higgins, J. W. (2008a). Map of bird sensitivities to wind farms in Scotland: A tool to aid planning and conservation. *Biological Conservation* 141: 2342-2356.
- Bright, J. A., Langston, R. H. W., Pearce-Higgins, J. W., Bullman, R., Evans, R. and Gardner, S. (2008b). Spatial overlap of wind farms on peatland with sensitive areas for birds. *Mires and Peat* 4: 1-12.

- Campedelli, T., Londi, G., Cutini, S., Sorace, A. and Tellini Florenzano, G. (2013). Raptor displacement due to the construction of a wind farm: preliminary results after the first 2 years since the construction. *Ethology Ecology and Evolution* 26: 376-391.
- Carrete, M., Sánchez-Zapata, J. A., Benítez, J. R., Lobón, M. and Donazar, J. A. (2009). Large scale risk-assessment of wind-farms on population viability of a globally endangered long-lived raptor. *Biological Conservation* 142: 2954-2961.
- Carrete, M., Sánchez-Zapata, J.A., Benítez, J.R., Lobón, M., Montoya, F., Donazar, J.A., (2012). Mortality at wind-farms is positively related to large-scale distribution and aggregation in griffon vultures. *Biological Conservation* 145: 102-108.
- Clarke, R. and Watson, D. (1990). The Hen Harrier *Circus cyaneus* winter roost survey in Britain and Ireland. *Bird Study* 37: 84-100.
- Clarke, R. and Watson, D. (1997). The Hen Harrier Winter Roost Survey. Thirteen winters' data reveal serious declines. *Raptor* 1996/7, 41-45.
- Cole, S. G. and Dahl, E. L. (2013). Compensating white-tailed eagles mortality at the Smøla wind-power plant using electrocution prevention measures. *Wildlife Society Bulletin* 37: 84-93.
- Glibert, G., Stanbury, A. and Lewis, L. (2021) Birds of Conservation Concern in Ireland 4: 2020-2026. *Irish Birds*, 43: 1-22.
- CRU, (2020). Guidance Notes: Applying for an Authorisation to Construct or Reconstruct a Generating Station. 13pp. Commission for Regulation of Utilities, Dublin, Ireland.
- Cramp, S. and Simmons, K.E.L. (1980). *The Birds of the Western Palearctic*. Oxford University Press, Oxford.
- Crockford, N. J. (1992). A review of the possible impacts of wind farms on birds and other wildlife. *Report for Countryside Council for Wales and English Nature*, 65 pp.
- Cruz-Delgado, F., Wiedenfeld, D. and González, J. A. (2010). Assessing the potential impact of wind turbines on the endangered Galapagos Petrel *Pterodroma phaeopygia* at San Cristbal Island, Galapagos. *Biodiversity and Conservation* 19.
- Currie, F. and Elliott, G. (1997). *Forests and birds: a guide to managing forests for rare birds*. Cambridge: Forestry Authority and Royal Society for the Protection of Birds.
- DAFM (2019a). Agriculture, Forest and Seafood: Climate Change Sectoral Adaptation Plan. Department of Agriculture, Food and the Marine.
- DAFM, (2019b). The A to Z of Climate Change and Agriculture. Department of Agriculture, Food and Marine.
- Dahl, E. L., Bevanger, K., Nygård, T., Røskft, E. and Stokke, B. G. (2012). Reduced breeding success in white-tailed eagles at Smøla windfarm, western Norway, is caused by mortality and displacement. *Biological Conservation* 145: 79-85.
- Dahl, E. L., May, R., Hoel, P. L., Bevanger, K., Pedersen, H. C., Røskft, E. and Stokke, B. G. (2013). White-tailed eagles (*Haliaeetus albicilla*) at the Smøla wind-power plant, Central Norway, lack behavioural flight responses to wind turbines. *Wildlife Society Bulletin* 37: 66-74.
- Dáil Éireann (2019). Houses of the Oireachtas, 2019, Committee on Climate Action, 32nd Dáil. *Report of the Joint Committee on Climate Action Climate Change: A Cross Party Consensus for Action*. Dublin, Ireland.
- DCCAE, (2015). Ireland's Transition to a Low Carbon Energy Future 2015-2030. Prepared by DCENR. 122 pp.
- DCCAE, (2016a). Energy Innovation Ireland: A strategy document produced by the Energy Research Strategy Group for the Minister for Communications, Energy and Natural Resources. 75 pp.
- DCCAE, (2016b). Draft Renewable Electricity Policy and Development Framework. Draft strategic environmental assessment scoping report 2016. 80pp.
- DCCAE, (2019). Climate Action Plan 2019: To Tackle Climate Breakdown. Government of Ireland.
- DCCAE, (2020). National Energy and Climate Plan 2021-2030. Department of Communications, Climate Action and Environment.
- DCENR (2009). National Energy Efficiency Action Plan 2009. Department of Communications, Energy and Natural Resources. 158 pp.
- DCENR (2011). National Energy Efficiency Action Plan 2011. Department of Communications, Energy and Natural Resources. 99 pp.
- DCENR. (2012a). Strategy for renewable energy: 2012-2020. Department of Communications, Energy and Natural Resources. 23pp.
- DCENR (2012b). Government Policy Statement on the Strategic Importance of Transmission and Other Energy Infrastructure. Department of Communications, Energy and Natural Resources. 8 pp.
- DCENR. (2014a). Green Paper on Energy Policy in Ireland. Department of Communications, Energy and Natural Resources. 76pp.
- DCENR. (2014b). National Energy Efficiency Action Plan 2014. Department of Communications, Energy and Natural Resources. 136 pp.

DCENR. (2015). Ireland's Transition to a Low Carbon Energy Future 2015-2030. Department of Communications, Energy and Natural Resources. 122 pp.

DCENR. (2016). Draft renewable electricity policy and development framework. Draft Strategic Environmental Assessment Scoping Report. Department of Communications, Energy and Natural Resources. 80 pp.

Del Hoyo, J., Elliot, A., Sargatal, J. (1992). *Handbook of the Birds of the World, vol. 1: Ostrich to Ducks*. Lynx Edicions, Barcelona, Spain.

De Lucas, M., Janss, G. E. and Ferrer, M. (2004). The effects of a wind farm on birds in a migration point: The Strait of Gibraltar. *Biodiversity and Conservation* 13: 395-407.

De Lucas, M., Janss, G. F. E., Whitfield, D. P. and Ferrer, M. (2008). Collision fatality of raptors in wind farms does not depend on raptor abundance. *Journal of Applied Ecology* 45: 1695-1703.

De Lucas, M., Ferrer, M., Bechard, M. J. and Muñoz, A. R. (2012). Griffon vulture mortality at wind farms in southern Spain: Distribution of fatalities and active mitigation measures. *Biological Conservation* 147: 184-189.

Derby, C., Seginak, K., Dahl, A. and Bay, K. (2008). Wildlife Baseline Studies for the Buffalo Ridge II Wind Resource Area Brookings and Deuel Counties, South Dakota. Final Report March 2008 – November 2008. Prepared for: HDR Engineering, Inc. and Iberdrola Renewables by Western EcoSystems Technology, Inc., North Dakota.

Desholm, M. (2006). Wind farm related mortality among avian migrants – a remote sensing study and model analysis. National Environmental Research Institute. 132 pp.

Desholm, M. and Kahlert, J. (2005). Avian collision risk at an offshore wind farm. *Biology Letters* 1: 296-298.

Devereux, C. L., Denny, M. J. H. and Whittingham, M. J. (2008). Minimal effects of wind turbines on the distribution of wintering farmland birds. *Journal of Applied Ecology* 45: 1689-1694.

Dineen, D and Howley, M. (2016). Energy Efficiency in Ireland 2016 Report prepared by Energy Policy Statistical Support Unit on behalf of Sustainable Energy Authority Ireland (SEAI, March 2016).

DoEHLG. (2000). National Climate Change Strategy Ireland. Department of Environment, Heritage and Local Government. 89 pp.

DoEHLG. (2006). Wind energy development guidelines revision. Department of Environment, Heritage and Local Government. 113pp.

DoEHLG. (2007). Ireland National Climate Change Strategy 2007-2012. Department of Environment, Heritage and Local Government, 60 pp.

DoEHLG. (2009). Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities. Department of Environment, Heritage and Local Government, 83pp.

DoEHLG. (2010). Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities (as revised 2010). Department of Environment, Heritage and Local Government.

DoEHLG. (2011). Updated Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities. Department of Environment, Heritage and Local Government, 83pp.

DHPLG, (2018). Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. 119 pp. Department of Housing, Planning and Local Government, Dublin.

DHPLG, (2019). Draft Revised Wind Energy Development Guidelines December 2019. 215 pp. Department of Housing, Planning and Local Government, Dublin.

Doherty, K. E., Naugle, D. E., Walker, B. L. and Graham, J. M. (2008). Greater sage-grouse winter habitat selection and energy development. *Journal of Wildlife Management* 72: 187-195.

Douglas, D. J. T., Bellamy, P. E. and Pearce-Higgins, J. W. (2011). Changes in the abundance and distribution of upland breeding birds at an operational windfarm *Bird Study* 58: 37-43.

Drewitt, A. L. and Langston, R. H. W. (2006). Assessing the impacts of wind farms on birds *Ibis* 148: 29-42.

Drewitt, A. L. and Langston, R. H. W. (2008). Collision effects of wind-power generators and other obstacles on birds. *Annals of the New York Academy of Sciences* 1134: 233-266.

European Commission (EC), (2001). Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and 6(4) of the Habitats Directive 92/43/EEC. Luxembourg. 81 pp.

EC. (2007/2012). Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC. 30pp. Brussels.

EC. (2010). Guidance Document: Wind energy developments and Natura 2000. 116 pp, Brussels.

ECJ, (2004). Landelijke Vereniging tot Behoud van de Waddenzee vs Nederlandse Vereniging tot Bescherming van Vogels. Case-127/02. European Court of Justice, Judgment of the Court, Luxembourg.

ECJ, (2018). *Grace and Sweetman vs An Bord Pleanála*. Case-164/17. European Court of Justice, Judgment of the Court, Luxembourg.

EirGrid and SONI (2016). All-Island Generation Capacity Statement 2016-2025, Report prepared by EirGrid and SONI which incorporates the Generation Capacity Statement for Northern Ireland and the Generation Adequacy Report for Ireland.

EPA (2001). Development of Strategic Environmental Assessment (SEA) Methodologies for Plans and Programmes in Ireland (2001-DS-EEP-2/5) Synthesis Report Prepared for the Environmental Protection Agency by ERM Environmental Resources Management Ireland Limited by Scott, P. and Marsden, P.

EPA (2002). Guidelines on the information to be contained in Environmental Impact Statements. 33pp.

EPA (2003). Advice notes on current practice (in the preparation of Environmental Impact Statements). 28pp.

EPA (2004a). Planning and development (Strategic Environmental Assessment) Regulations 2004. S.I. No. 436 of 2004. Dublin Published by the Stationery Office. 45pp.

EPA (2004b). European Communities (Environmental Assessment of certain plans and programmes) Regulations 2004. S.I. No. 435 of 2004. Dublin Published by the Stationery Office. 23pp.

EPA, (2012). Environmental Protection Agency. (2012). Irish Corine Land Cover 2012 National vegetation mapping programme.

Erickson, W. P., Johnson, G. D., Strickland, M. D., Young Jr, D. P., Sernka, K. J. and Good, R. E. (2001). Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee (NWCC) Resource Document.

Etheridge, B. and Summers, R. W. (2006). Movements of British Hen Harriers *Circus cyaneus* outside the breeding season. *Ringling and Migration*, 23: 6–14.

Etherington, G.J. and Mobley, J.A. (2016). Molecular phylogeny, morphology and life-history comparisons within *Circus cyaneus* reveal the presence of two distinct evolutionary lineages. *Avian Research* 7: 17. doi: 10.1186/s40657-016-0052-3.

EU, (2011). Guidance Document. Wind Energy Developments and Natura 2000. Report prepared by the European Union. 116 pp.

European Environment Agency (2018). List of Pressures and Threats - corresponding measures from 2007-2013 reporting. EIONET Central Data Repository: Reference Portal for Reporting under Article 12 of the Birds Directive.

European Commission, (2019). Communication from the Commission: The European Green Deal. COM (2019) 640 final. Brussels.

European Commission, (2020a). Communication from the Commission: Powering a climate-neutral economy: An EU Strategy for Energy System Integration. COM/2020/299 final. Brussels.

European Commission, (2020b). Commission Notice: Guidance document on wind energy developments and EU nature legislation. C(2020) 7730 final. 181 pp. Brussels.

Farfán, M. A., Vargas, J. M., Duarte, J. and Real, R. (2009). What is the impact of wind farms on birds? A case study in southern Spain. *Biodiversity and Conservation* 18: 3743-3758.

Fennelly, R. (2015). A review of bird strike mortality at Irish onshore windfarms. In Practice: *Bulletin of the Chartered Institute of Ecology and Environmental Management* 88 (June 2015): 24-28.

Fernández-Bellon, D., Irwin, S., Wilson, M. and O'Halloran, J. (2015). Reproductive output of Hen Harriers *Circus cyaneus* in relation to wind turbine proximity. *Irish Birds*. 10: 143-150.

Fernández-Bellon, D., Wilson, M.W., Irwin, S. and O'Halloran, J., (2019.) Effects of development of wind energy and associated changes in land use on bird densities in upland areas. *Conservation Biology*, 33(2), pp.413-422.

Ferrer, M., de Lucas, M., Janss, G. F. E., Casado, E., Muños, A. R., Bechard, M. J. and Calabuig, C. (2012). Weak relationship between risk assessment studies and recorded mortality in wind farms. *Journal of Applied Ecology*. 49: 38-46.

Fielding, A.H., Whitfield, D.P. and Mcleod, D.R.A. (2006). Spatial association as an indicator of the potential for future interactions between wind energy developments and golden eagles *Aquila chrysaetos* in Scotland. *Biological Conservation* 131: 359-369.

Fielding, A.H. and Haworth, P.F. (2010). Golden eagles and wind farms. A report created under an SNH Call-of-Contract arrangement 56 pp.

Fijn, R.C., Krijgsveld, K.L., Tijssen, W., Prinsen, H.A.M. and Dirksen, S. (2012). Habitat use, disturbance and collision risks for Bewick's Swans *Cygnus columbianus bewickii* wintering near a wind farm in the Netherlands. *Wildfowl*. 62: 97-116.

Follestad, A., Flagstad, Ø., Nygård, T., Reitan, O. and Schulze, J. (2007). Wind Power and Birds at Smøla 2003-2006. Report by Norwegian Institute for Nature Research (NINA). pp 82.

Forest Service. (2011). Forest Service Policy on the Granting of Felling Licences for Wind Farm Development. 6 pp.

Forrest, J., Robinson, C., Hommel, C. and Craib, J. (2011). Flight activity and breeding success of Hen Harrier at Paul's Hill wind farm in north east Scotland. Poster presented at 2011 Conference on Wind Energy and Wildlife Impacts, Trondheim, Norway.

Garvin, J. C., Jennelle, C. S., Drake, D. and Grodsky, S. M. (2011). Response of raptors to a windfarm. *Journal of Applied Ecology* 48: 199-209.

Gibbons, D.W., Reid, J.B. and Chapman, R.A. (1993). *The new atlas of breeding birds in Britain and Ireland: 1988 - 1991*. Poyser, London.

Green, R.E. and Etheridge, B. (1999). Breeding success of the hen harrier in relation to the distribution of grouse moors and the red fox. *Journal of Applied Ecology* 36: 472-483.

Government of Ireland, (2020). Programme for Government: Our Shared Future, 126 pp. Ireland.

Hagen, C.A., Pitman, J.C., Sandercock, B.K., Robel, R.J. and Applegate, R.D. (2007). Age-specific survival and probable causes of mortality in female lesser prairie-chickens. *Journal of Wildlife Management*, 71, 518-525.

Hagen, C. A., Pitman, J. C., Loughin, T. M., Sandercock, B. K., Robel, R. J. and Applegate, R. D. (2011). Impact of Anthropogenic Features on Habitat Use by Lesser Prairie-Chickens. Pp. 63-75 in Sandercock, B. J., Martin, K. and Segelbacher, G. (editors). Ecology, conservation, and management of grouse. *Studies in Avian Biology* (no. 39) University of California Press, Berkeley, CA.

Hamerstrom, F. (1969). A Harrier population study. Pages 367-83 in J.J. Hickey, editor. *Peregrine falcon populations: their biology and decline*. University of Wisconsin Press, Madison, WI.

Hamilton, S.D., Millstein, D., Bolinger, M., Wiser, R. and Jeong, S. (2020). How does Wind Project Performance Change with Age in the United States? *Joule*, Volume 4: (5), 1004-1020.

Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (2013). *Raptors: a field guide for surveys and monitoring*. Edinburgh: The Stationery Office.

Hatchett, E. S., Hale, A. M., Bennett, V. J. and Karsten, K. B. (2013). Wind Turbines do not Negatively Affect Nest Success in the Dickcissel (*Spiza americana*). *The Auk* 130: 520-528.

Haworth, P. F. and Fielding, A. H. (2012). A review of the impacts of terrestrial wind farms on breeding and wintering hen harriers. Report prepared for Scottish Natural Heritage. 39pp.

Hayhow, D. B., Eaton, M. A., Bladwell, S., Etheridge, B., Ewing, S. R., Ruddock, M., Saunders, R., Sharpe, C., Sim, I. M. W. and Stevenson, A. (2013). The status of the Hen

Harrier, *Circus cyaneus*, in the UK and Isle of Man in 2010. *Bird Study* 60: 446-458.

Herbert, J.G.M., Iniyan, S., Sreevalsan, E. and Rajapandian, S. (2007). A review in wind energy technologies. *Renewable and Sustainable Energy Reviews* 11: 1117-1145.

High Court, 2014. Judgment of Ms. Justice Finlay Geoghegan, 25th July, 2014. Eamon Kelly vs An Bord Pleanála. Judicial Review No. 802 2013, Dublin, Ireland.

Hötter, H. (2006). The Impact of Repowering of Wind Farms on Birds and Bats. Michael-Otto Institute within NABU - Research and Education Centre for Wetlands and Bird Protection. Bergenhusen: NABU.

Hötter, H., Thomsen, K. and Jeromin, H. (2006). Impacts of biodiversity of exploitation of renewable energy sources: the example of birds and bats – facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation. Bergenhusen: Michael-Otto-Institut im NABU.

Hull, C. L., Stark, E. M., Peruzzo, S. and Sims, C. C. (2013). Avian collisions at two wind farms in Tasmania. Australia: taxonomic and ecological characteristics of colliders versus non-colliders. *New Zealand Journal of Zoology* 40: 47-62.

Humphreys, E. M., Cook, A. S. C. P. and Burton, N. H. K. (2015). Collision, Displacement and Barrier Effect Concept Note. *BTO Research Report* No. 669. 37 pp.

Hunt, G. (2002). Golden eagles in a perilous landscape: Predicting the effects of mitigation for wind turbine blade-strike mortality. Santa Cruz: California Energy Commission. Public Interest Energy Research (PIER) Program, Contract Number 500-97-4033, P500-02-043F 72 pp.

Irwin, S., Wilson, M. W., O'Donoghue, B., O'Mahony, B., Kelly, T. C. and O'Halloran, J. (2012). Optimum scenarios for Hen Harrier conservation in Ireland. Report to the Dept. of Agriculture, Food and the Marine. 47pp.

International Energy Association (2015). IEA WIND: 2014 Annual Report. Executive Committee of the Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems of the International Energy Agency. 200pp.

IWEA (2008). Wind Energy Development Best Practice Guidelines. Irish Wind Energy Association. 72pp.

IWEA (2012). Best practice guidelines for the Irish Wind Energy Industry. 87pp. Irish Wind Energy Association.

IWEA (2020). More Power to You: A Guide to Repowering in Ireland. 21pp. Irish Wind Energy Association,

- Johnson, G. D., Erickson, W. P., Strickland, M. D., Shepherd, M. F. and Shepherd, D. A. (2000). Avian monitoring studies at the Buffalo Ridge, Minnesota wind resource area: results of a 4-year study. Prepared for Northern States Power Company by WEST Inc. Wyoming.
- Johnson, G. D., Erickson, W. P., Strickland, M. D., Good, R. E. and Becker, P. (2001). Avian and bat mortality associated with the initial phase of the Foote Creek Rim Windpower Project, Carbon County, Wyoming. Technical Report prepared by WEST, Inc. 32pp.
- Katzner, T. E., Brandes, D., Miller, T., Lanzone, M., Maisonneuve, C., Tremblay, J. A., Mulvihill, R. and Merovich, G. T. (2012). Topography drives migratory flight altitude of golden eagles: implications for on-shore wind energy development. *Journal of Applied Ecology* 49: 1178-1186.
- Katzner, E. T., Turk, P. J., Duerr, A. E., Miller, T. A., Lanzone, M. J., Cooper, J. L., Brandes, D., Tremblay, J. A. and Lemaître, J. (2015). Use of multiple modes of flight subsidy by a soaring terrestrial bird, the golden eagle *Aquila chrysaetos*, when on migration. *Journal of the Royal Society Interface*. DOI: 10.1098/rsif.2015.0530.
- Katzner, T. E., Nelson, D. M., Braham, M. A., Doyle, J. M., Fernandez, N. B., Duerr, A. E., Bloom, P. H., Fitzpatrick, M. C., Miller, T. A., Culver, R. C. E., Braswell, L. and DeWoody, J. A. (2016). Golden Eagle fatalities and the continental-scale consequences of local wind-energy generation. *Conservation Biology*. DOI: 10.1111/cobi.12836.
- Kennedy, P.G., Ruttledge, R.F. and Scroope, C.F. (1954). *The Birds of Ireland*. Oliver and Boyd, London.
- Kingsley, A. and Whittam, B. (2005). Wind turbines and birds a background review for environmental assessment. A report prepared for Environment Canada / Canadian Wildlife Service.
- Kitzing, L., Jensen, M. K., Telsnig, T., and Lantz, E. (2020). Multifaceted drivers for onshore wind energy repowering and their implications for energy transition. *Nature Energy*. 5, pp 1012-1021.
- Kunz, T. H., Arnett, E. B., Cooper, B. M., Erickson, W. P., Larkin, R. P., Mabee, T., Morrison, M. L., Strickland, M. D. and Szwczak, J. M. (2007). Assessing impacts of wind-energy development on nocturnally active birds and bats: A guidance document. *The Journal of Wildlife Management* 71: 2449-2486.
- Lacal Arantegui, R., Uihlein, A. and Yusta Loyo, J. (2020). Technology effects in repowering wind turbines, WIND ENERGY, ISSN 1095-4244 (online), 23 (3), p. 660-675.
- Lammers, W. M. and Collopy, M. W. (2005). Effectiveness of avian predator perch deterrents on electric transmission lines. *The Journal of Wildlife Management* 2752-2758.
- Langston, R., and Pullan, J. (2003). Windfarms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues. Report T-PVS/Inf (2003) 12, by BirdLife International to the Council of Europe, Bern Convention on the Conservation of European Wildlife and Natural habitats. RSPB/BirdLife in the UK.
- Lantz, E., Leventhal, M. and Baring-Gould, I. (2013). Wind Power Project Repowering: Financial Feasibility, Decision Drivers, and Supply Chain Effects. Technical Report NREL/TP-6A20-60535 December 2013.
- Larsen, J. K. and Guillemette, M. (2007). Effects of wind turbines on light behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology* 44: 516-522.
- Larsen, J. K. and Madsen, J. (2000) Effects of wind turbines and other physical elements on field utilization by pink-footed geese (*Anser brachyrhynchus*): A landscape perspective. *Landscape Ecology*. 15: 755. doi: 10.1023/A:1008127702944.
- Lawrence, E. S., Painter, S. and Little, B. (2007). Responses of birds to the wind farm at Blythe harbour, Northumberland, UK. In De Lucas, M., Janss, G. and Ferrer, M. (eds). Birds and wind farms: Risk assessment and mitigation. pp 47-69. Quercus.
- Lekuona, J.M and Ursúa, C. (2007). Avian mortality in wind power plants of Navarra (Northern Spain). In: De Lucas M, Janss GFE, Ferrer M (eds) Birds and wind farms: risk assessment and mitigation. Editorial Quercus, Madrid, pp 177-192.
- Lydon, K., and Smith, G. (2014). CORINE Landcover 2012 Ireland. Final Report. Environmental Protection Agency, Johnstown Castle, Co. Wexford, Ireland, 55 pp.
- Mabey, S. and Paul, E. (2007). Critical Literature Review Impact of Wind Energy and Related Human Activities on Grassland and Shrub-Steppe Birds. Report prepared for the National Wind Coordinating Collaborative by the Ornithological Council. The National Wind Coordinating Collaborative, Resolve, Inc., Washington, D.C. 183 pp.
- Madden, B. and Porter, B. (2007). Do wind turbines displace Hen Harriers *Circus cyaneus* from foraging habitat? Preliminary results of a case study at the Derrybrien wind farm, County Galway. *Irish Birds* 8: 231-236.
- Madders, M. (2000). Habitat selection and foraging success of Hen Harriers *Circus cyaneus* in west Scotland. *Bird Study* 47: 32-40.
- Madders, M. (2002). Method statement for Vantage Point watches. In: Survey methods to assess windfarm impacts on upland bird communities. Scottish Natural Heritage.
- Madders, M. (2003). Hen Harrier *Circus cyaneus* foraging activity in relation to habitat and prey. *Bird Study* 50: 55-60.

Madders, M. (2004). The ecology of hen harriers in Scotland in relation to windfarms. Report on Penbreck and Carmacoup proposed windfarm.

Madders, M. and Whitfield, D. P. (2006). Upland raptors and the assessment of wind farm impacts. *Ibis* 148: 43-56.

Masden, E. A., Haydon, D. T., Fox, A. D., Furness, R. W., Bullman, R. and Desholm, M. (2009). Barriers to movement: impacts of wind farms on migrating birds. – *ICES Journal of Marine Science* 66: 746–753.

Madsen, J. and Boertmann, D. (2008). Animal behavioural adaptation to changing landscapes: spring-staging geese habituate to wind farms. *Landscape Ecology* 23: 1007-1011.

Mañosa, S. (2001). Strategies to identify dangerous electricity pylons for birds. *Biodiversity and Conservation* 10: 1997-2012.

Marques, A. T., Batalha, H., Rodrigues, S., Costa, H., Pereira, M. J. R., Fonseca, C., Mascarenhas, M. and Bernardino, J. (2014). Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies. *Biological Conservation* 179: 40-52.

Martin, G. R. and Shaw, J. M. (2010). Bird collision with power lines: Failing to see the way ahead? *Biological Conservation* 143:2695-2702.

Martinez-Abraín, A., Tavecchia, G., Regan, H.M., Jimenez, J., Surroca, M. and Oro, D. (2012). Effects of wind farms and food scarcity on a large scavenging bird species following an epidemic of bovine spongiform encephalopathy. *Journal of Applied Ecology* 49: 109-117.

Martínez-Abraín, A., Crespo, J., Berdugo, M., Gutiérrez, L., Lafuente, A., Mañas, A. and de Miguel, J.M. (2013). Causes of human impact to protected vertebrate wildlife parallel long-term socio-economical changes in Spain. *Animal Conservation* 16: 286-294.

Masden, E.A., Haydon, D.T., Fox, A.D., Furness, R.W., Bullman, R. and Desholm, M. (2009). Barriers to movement: impacts of wind farms on migrating birds. *ICES Journal of Marine Science* 66: 746-753.

McGuinness, S., Muldoon, C., Tierney, N., Cummins, S., Murray, A., Egan, S. and Crowe, O. (2015). Bird sensitivity mapping for wind energy developments and associated infrastructure in the Republic of Ireland. BirdWatch Ireland, Kilcoole.

McMillan, R.L. (2014). Hen harriers on Skye, 2000–12: nest failures and predation. *Scottish Birds* 34: 30-39.

Minderman, J., Pendlebury, C. J., Pearce-Higgins, J. W. and Park, K. J. (2012). Experimental Evidence for the Effect of Small Wind Turbine Proximity and Operation on Bird and Bat Activity. *PLoS ONE*. Volume 7: e41177. Doi:10.1371/journal.pone.0041177.

Moran, P. and Wilson-Parr, R. (2015). Hen Harrier Special Protection Area (SPA) Habitat Mapping Project 2014. Irish Wildlife Manuals, No. 83. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

National Renewable Energy Laboratory (2013). Technical Report NREL/TP-6A20-60535 December 2013 "Wind Power Project Repowering: Financial Feasibility, Decision Drivers, and Supply Chain Effects" Eric Lantz, Michael Leventhal, and Ian Baring-Gould.

Norriss, D. W., Marsh, J., McMahon, D. and Oliver, G. A. (2002). A national survey of breeding Hen Harriers *Circus cyaneus* in Ireland 1998-2000. *Irish Birds* 7: 1-10.

Northrup, J.M. and Wittemayer, G. (2016). Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation. *Ecology Letters* 16: 112–125.

NPWS (2002). Recommended methodology for assessment of impacts of proposed windfarms on breeding hen harrier within the known range of the species in Ireland. Report prepared by NPWS. 3pp.

NPWS (2007). Rationale for the selection of SPAs for breeding Hen Harrier in Ireland. Information Note. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

NPWS. (2013). Birds Directive Article 12 Species Reports. EIONET.

NPWS (2015a). Hen Harrier Conservation and the Forestry Sector in Ireland. Report prepared by NPWS to inform the Hen Harrier Threat Response Plan (HHTRP) Version 3.2. 1-50.

NPWS (2015b). Hen Harrier Conservation and the Agricultural Sector in Ireland. Report prepared by NPWS to inform the Hen Harrier Threat Response Plan (HHTRP).

NPWS (2016). Review Turbine Database. Dublin, Ireland.

Nygård, T., Bevanger, K., Dahl, L., Flagstad, Ø., Follestad, A., Hoel, P. L., May, R. and Reltan, O. (2010). A study of White-tailed Eagle *Haliaeetus albicilla* movements and mortality at a wind farm in Norway. *BOU Proceedings – Climate Change and Birds* 1-4.

Obermeyer, B., Manes, R., Kiesecker, J., Fargione, J. and Sochi, K. (2011). Development by Design: Mitigating Wind Development's Impacts on Wildlife in Kansas. *PLoS One* 6: e2669. doi: 10.1371/journal.pone.0026698.

O'Donoghue, B.G. (2004). The Hen Harrier in Ireland. Master's Thesis. National University of Ireland, Dublin.

O'Donoghue, B. G. (2010). The Ecology and Conservation of Hen Harriers (*Circus cyaneus*) in

- Ireland. PhD Thesis submitted to University College Cork.
- O'Donoghue, B., O'Donoghue, T. A. and King, F. (2011). The Hen Harrier in Ireland: conservation issues for the 21st Century. *Biology and Environment: Proceedings of the Royal Irish Academy* 111: 1-11.
- O'Donoghue, B. G. (2012). Duhallow Hen Harriers *Circus cyaneus* - from stronghold to just holding on. *Irish Birds* 9: 349-356.
- O'Flynn, W. J. (1983). Population changes of the Hen Harrier in Ireland. *Irish Birds* 2: 337-343.
- Orlaff, S. and Flannery, A. (1992). Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas 1989-1991. Biosystems Analysis Inc. *California Energy Commission*. 160 pp.
- Osborn, J.G. and Shillinger, G.L. (1996). Wind turbines and raptor mortality: risk reduction through the application of GIS and remote sensing technologies. *Bulletin of the Ecological Society of America* 77: 336.
- Osborn, R. G., Higgins, K. F., Usgaard, R. E., Dieter, C. D. and Neiger, R. D. (2000). Bird Mortality Associated with Wind Turbines at the Buffalo Ridge Wind Resource Area, Minnesota. *American Midland Naturalist* 143: 31-52.
- Osbourne, J. D., Anderson, J. T., and Spurgeon, A. B. (2005). Effects of habitat on small mammal abundance in West Virginia. *Wildlife Society Bulletin*, 33, 814-822.
- Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. and Bullman, R. (2009a). The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology* 46: 1323-1331.
- Pearce-Higgins, J.W., Grand, M. C., Beale, C.M., Buchanan, G.M. and Sim, I. M. W. (2009b). International importance and drivers of change of upland bird populations. In Bonn, A., Allott, T., Hubacek, K. and Stewart, J. (eds). *Drivers of environmental change in the uplands*. pp 209-227. Routledge, Abingdon, UK.
- Pearce-Higgins, J. W., Stephen, L., Douse, A. and Langston, R. H. W. (2012). Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. *Journal of Applied Ecology* 49: 386-394.
- Percival, S. M. (2003). Birds and wind farms in Ireland: A review of potential issues and impact assessment. *Ecology Consulting*. 25pp.
- Petty, S.J. (1998). Ecology and conservation of raptors in forests. *Forestry Commission Bulletin* 118. HMSO, London.
- Picozzi, N. (1980). Food, growth, survival and sex ratio of nestling Hen Harriers *Circus cyaneus* in Orkney. *Ornis Scandinavia* 11: 1-11.
- Plonczhier, P. and Simms, I. C. (2012). Radar monitoring of migrating pink-footed geese: behavioural responses to offshore wind farm development. *Journal of Applied Ecology*, 49: 1187-1194.
- Pruett, C. L., Patten, M. A. and Wolfe, D. H. (2009a). It's not easy being green: wind energy and a declining grassland bird. *Bioscience* 59: 257-262.
- Pruett, C. L., Patten, M. A. and Wolfe, D. H. (2009b). Avoidance behaviour by Prairie grouse: implications for development of wind energy. *Conservation Biology* 23: 1253-1259.
- Rasuo, B. and Bengin, A.C. (2010). Optimization of wind farm layout. *FME Transactions* 38: 107-114.
- Redpath, S., Madders, M., Donnelly, E., Anderson, B., Thirgood, S., Martin, A. and McLeod, D. (1998). Nest site selection by Hen Harriers in Scotland. *Bird Study* 45: 51 - 61.
- Redpath, S., Amar, A., Madders, M., Leckie, F. and Thirgood, S. (2002a). Hen Harrier foraging success in relation to land use in Scotland. *Animal Conservation* 5: 113-118.
- Redpath, S., Arroyo, B., Etheridge, B., Leckie, F., Bouwman, K. and Thirgood, S. (2002b). Temperature and hen harrier productivity: from local mechanisms to geographical patterns. *Ecography* 25: 533-540.
- Robson, P. (2011). Hen Harrier activity at Cruach Mhor windfarm: Review of monitoring data 2001 - 2011. ScottishPower Renewables. 13pp.
- RSPB (2012). Two hen harriers killed at Perthshire windfarm. RSPB Press Release December 2012.
- Ruddock, M. and Reid, N. (2010) Review of windfarms and their impact on biodiversity: Guidance for developments in Northern Ireland. Report by the Natural Heritage Research Partnership, Quercus for the Northern Ireland Environment Agency, Northern Ireland, UK.
- Ruddock, M. and Whitfield, D. (2007). A review of disturbance **distances** in selected bird species. **A report from Natural Research (Projects) Ltd to Scottish Natural Heritage**. 181pp.
- Ruddock, M., Madders, M., McEvoy, P. and Montgomery, I. (2008). Ecological and breeding parameters of the hen harrier (*Circus cyaneus*) with particular reference to the Antrim Hills and Slieve Beagh-Mullaghfad-Lisnaskea SPAs. *An unpublished Quercus report to Environment and Heritage Service*.
- Ruddock, M., Dunlop, B. J., O'Toole, L., Mee, A. and Nagle, T. (2012). Republic of Ireland Hen Harrier Survey 2010. Irish Wildlife Manual No. 59. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. 90pp.

- Ruddock, M., Mee, A., Lusby, J., Nagle, A., O'Neill, S. and O'Toole, L. (2016a). The 2015 National Survey of Breeding Hen Harriers in Ireland. Irish Wildlife Manuals, No. 93. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.
- Ruddock, M., Mee, A., Lusby, J., Nagle, A., O'Neill, S. and O'Toole, L. (2016b). 2015 Irish Hen Harrier survey post hoc analysis unpublished report prepared for National Parks and Wildlife Service of the Department of Arts, Heritage and the Gaeltacht.
- Salo, P., Banks, P.B., Dickman, C.R. and Korpimäki, E. (2010). Predator manipulation experiments: impacts on populations of terrestrial vertebrate prey. *Ecological Monographs* 80: 531-546.
- Sarkar, A. and Behera, K. (2012). Wind turbine blade efficiency and power calculation with electrical analogy. *International Journal of Scientific and Research Publications* 2: 2250-3153.
- Scharf, W.C. and Balfour, E. (1971). Growth and development of nestling Hen Harriers. *Ibis* 113: 323-329.
- Schaub, T., Klaassen, R.H., Bouten, W., Schlaich, A.E. and Koks, B.J. (2020). Collision risk of Montagu's Harriers *Circus pygargus* with wind turbines derived from high-resolution GPS tracking. *Ibis*, 162: 520-534.
- Schmidt, K.A. and Ostfeld, R.S. (2003). Songbird populations in fluctuating environments: predator responses to pulsed resources. *Ecology* 84: 406-415.
- Scott, D. (1995). Hen Harriers in County Wicklow, 1961. Irish East Coast Bird Report 1995.
- Scott, D., Clarke, R. and Shawyer, C.R. (1991). Hen harriers breeding in a tree nest. *Irish Birds* 4: 413-417.
- Scott, D. and McHaffie, P. (2008). Hen Harrier *Circus cyaneus* killed at windfarm site in County Antrim. *Irish Birds* 8: 436-437.
- SEAI, (2011). Wind Energy Roadmap to 2050. Sustainable Energy Authority of Ireland. 10pp.
- SEAI, (2013a). Methodology for Local Authority Renewable Energy Strategies. 72 pp. Sustainable Energy Authority of Ireland.
- SEAI, (2013b). Remodelling the Irish national onshore and offshore wind atlas. A report prepared by the Met Office by Standen, J., Wilson, C. and Vosper, S. for the Sustainable Energy Authority of Ireland.
- SEAI, (2016a). Annual Report 2016 on Public Sector Energy Efficiency Performance. Sustainable Energy Authority of Ireland. 117pp.
- SEAI, (2016b). Ireland's Energy Targets: Progress, Ambition and Impacts. Summary for Policy-Makers. Sustainable Energy Authority of Ireland. 30pp.
- SEAI (2018). National Energy Projections to 2030. Understanding Ireland's Energy Transition. Sustainable Energy Authority of Ireland, Dublin. 28 pp.
- SEAI, (2020). Renewable Energy in Ireland. 2020 Report. 48pp. Sustainable Energy Authority of Ireland.
- Sharrock, J.T.R. (1976). *The Atlas of Breeding Birds in Britain and Ireland*. Poyser, Berkhamsted.
- Sim, I.M.W., Gibbons, D.W., Bainbridge, I.P. and Mattingley, W.A. (2001). Status of the Hen Harrier *Circus cyaneus* in the UK and the Isle of Man in 1998. *Bird Study* 48: 341-353.
- Sim, I.M.W., Dillon, I.A., Eaton, M.A., Etheridge, B., Lindley, P., Riley, H., Saunders, R., Sharpe, C. and Tickner, M. (2007). Status of the Hen Harrier *Circus cyaneus* in the UK and Isle of Man in 2004, and a comparison with the 1988/89 and 1998 surveys. *Bird Study* 54: 256-267.
- Simmons, R.E. (2000). *Harriers of the World: Their Behaviour and Ecology*. Oxford University Press, Oxford.
- Skagen, S.K., Stanley, T.R., and Dillon, M.B. (1999). Do mammalian nest predators follow human scent trails in the shortgrass prairie? *The Wilson Bulletin* 415-420.
- Smallie, J. and Virani, M.Z. (2010). A preliminary assessment of the potential risks from electrical infrastructure to large birds in Kenya. *Scopus* 30: 32-39.
- Smallwood, K.S. (2013). Comparing bird and bat fatality-rate estimates among North American wind-energy projects. *Wildlife Society Bulletin* 37: 19-33.
- Smallwood, K.S. and Karas, B. (2008). Avian and bat fatality rates at old-generation and repowered wind turbines in California. *The Journal of Wildlife Management* 73: 1062-1071.
- Smallwood, K.S., Ruge, L. and Morrison, M.L. (2009). Influence of behaviour on bird mortality in wind energy developments. *Journal of Wildlife Management* 73: 1082-1098.
- Smallwood, K.S. and Thelander, C.G. (2004). Developing methods to reduce bird mortality in the Altamont Pass Wind Resource Area. Final Report by Bio Resource Consultants to the California Energy Commission, Public Interest Energy Research-Environmental Area, Contract No. 500-01-019. 363pp.
- SNH, (2000). Windfarms and birds: calculating a theoretical collision risk assuming no avoiding action. Scottish Natural Heritage.
- SNH, (2006). Assessing significance of impacts from onshore windfarms on birds outwith designated areas. July 2006. Scottish Natural Heritage.

- SNH, (2011). Guidance on assessing connectivity with Special Protection Areas (SPAs). Scottish Natural Heritage.
- SNH, (2014). Repowering onshore wind farms: bird survey requirements. November 2014. 3pp. Scottish Natural Heritage
- SNH, (2016). Wind farm proposals on afforested sites – advice on reducing suitability for hen harrier, merlin and short-eared owl. Scottish Natural Heritage.
- SPR (2009). Cruach Mhor: Ornithological Monitoring Results 2001-2009. Unpublished report by ScottishPower Renewables.
- Stevens, T. K., Hale, A. M., Karsten, K. B. and Bennett, V. J. (2013). An analysis of displacement from wind turbines in a wintering grassland bird community. *Biodiversity and Conservation* 22: 1755-1767.
- Stewart, G.B., Pullin, A.S. and Coles, C.F. (2005). Effects of wind turbines on bird abundance. CEE review 04-002 (SR4). Collaboration for Environmental Evidence.
- Stewart, G.B., Pullin, A.S. and Coles, C.F. (2007). Poor evidence-base for assessment of windfarm impacts on birds. *Environmental Conservation* 34: 1-11.
- Sugimoto, H. and Matsuda, H. (2011). Collision risk of White-fronted geese with wind turbines. *Ornithological Science* 10:61-71.
- Supreme Court, (2016). Grace and Sweetman v An Bord Pleanála and ESB Wind Development Ltd. Supreme Court Ref: S:AP:IE:2016:000002. Ireland.
- Tellería, J. (2009a). Wind power plants and the conservation of birds and bats in Spain: a geographical assessment. *Biodiversity and Conservation* 18: 1781-1791.
- Tellería, J. L. (2009b). Overlap between wind power plants and Griffon Vultures *Gyps fulvus* in Spain. *Bird Study* 56: 268-271.
- Thaxter, C.B., Ross-Smith, V.H., Bouton, W., Clark, N.A., Conway, G.J., Rehfish, M.M. and Burton, N.H.K. (2015). Seabird-wind farm interactions during the breeding season vary within and between years: A case study of lesser black-backed gull *Larus fuscus* in the UK. *Biological Conservation* 186: 347-358.
- Thirgood, S., Redpath, S. and Graham, I. M. (2003). What determines the foraging distribution of raptors on heather moorland? *Oikos* 100: 15-24.
- Thompson, W. (1849). *The Natural History of Ireland, Volume 1*. Bohn, London.
- Tierney, N., Murray, A., Cummins, S., Egan, S. and Lauder, A. (2012). Bird Sensitivity Map for Ireland: a tool to aid planning and conservation in relation to Wind energy. 62 pp.
- Trombulak, S. C. and Frissell, C. A. (2000). Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. *Conservation Biology* 14: 18-30.
- Tryjanowski, P., Sparks, T.H., Jerzak, L., Rosin, Z.M. and Skórka, P. (2013). A paradox for conservation: electricity pylons may benefit avian diversity in intensive farmland. *Conservation Letters* 7: 34-40.
- Usgaard, R.; Naugle, D.; Osborn, R.; Higgins, K. (1997). Effects of wind turbines on nesting raptors at Buffalo Ridge in Southwestern Minnesota. *Proceedings of the South Dakota Academy of Science* 76: 113-117.
- Ussher, R.J. and Warren, R. (1900). *Birds of Ireland*. Gurney and Jackson, London.
- Verma, M., Ahmed, S. and Bhagoria, J. L. (2015). A Review: Repowering of Indian Wind Farms. Department of Mechanical Engineering, Maulana Azad National Institute of Technology, Bhopal, (MP), India.
- Walker, D., Mcgrady, M., Mccluskie, A., Madders, M. and Mcleod, D. R. A. (2005). Resident golden eagle ranging behaviour before and after construction of a windfarm in Argyll. *Scottish Birds* 25: 24-40.
- Wang, S. and Wang, S. (2015). Impacts of wind energy on environment: a review. *Science Direct* 49: 437-443.
- Wang, L., Kolios, A., Luengo, M.M. and Liu, X. (2016). Structural optimisation of wind turbine towers based on finite element analysis and genetic algorithm. *Wind Energy Science Discussions*, doi:10.5194/wes-2016-41, 2016.
- Warren, C.R. and Birnie, R.V. (2009). Re-powering Scotland: Wind Farms and the 'Energy or Environment?' Debate. *Scottish Geographical Journal* 125: 97-126.
- Watson, D. (1977). *The Hen Harrier*. T and A D Poyser. 312pp.
- Watson, A.D. and Dickson, R.C. (1972). Communal roosting of Hen Harriers in south-west Scotland. *Scottish Birds* 7: 24-49.
- Welstead, J., Hirst, R., Keogh, D., Robb, G. and Bainsfair, R. (2013). Research and guidance on restoration and decommissioning of onshore wind farms. *Scottish Natural Heritage Commissioned Report No. 591*.
- Whelan, C. J., Dilger, M. L., Robson, D., Hallyn, N., and Dilger, S. (1994). Effects of olfactory cues on artificial-nest experiments. *The Auk* 945-952.
- Whitfield, D.P., Ruddock, M. and Bullman, R. (2008). Expert opinion as a tool for quantifying bird tolerance to human disturbance. *Biological Conservation* 141: 2708-2717.
- Whitfield, D. P. and Madders, M. (2006). A review of the impacts of wind farms on Hen Harriers *Circus cyaneus*. Natural Research Information Note 1 (revised). Banchory, UK: Natural Research Ltd. 32pp.

Wilson, M. W., O'Donoghue, B., O'Mahony, B., Cullen, C., O'Donoghue, T., Oliver, G., Ryan, B., Troake, P., Irwin, S., Kelly, T. C., Rotella, J.J. and O'Halloran, J. (2012). Mismatches between breeding success and habitat preferences in Hen Harrier *Circus cyaneus* breeding in forested landscapes. *Ibis* 154: 578-589.

Wilson, M. W., Irwin, S., Norriss, D. W., Newton, S. F., Collins, K., Kelly, T. C. and O'Halloran, J. (2009). The importance of pre-thicket conifer plantations for nesting Hen Harriers *Circus cyaneus* in Ireland. *Ibis* 151: 332-343.

Wilson, M., Fernández-Bellon, D., Irwin, S. and O'Halloran, J. (2015). The interactions between Hen Harriers and wind turbines. *WINDHARRIER*. Final project report, prepared by School of Biological, Earth and Environmental Sciences, University College Cork, Ireland. PP95.

Wilson, M.W., Fernández-Bellon, D., Irwin, S. and O'Halloran, J. (2016). Hen Harrier *Circus cyaneus* population trends in relation to wind farms. *Bird Study*, Vol. 64, No.1, 20-29.

Winkelman, J. E. (1992). The impact of the Sep Wind park near Oosterbierum, The Netherlands, on birds, 1: collision risk. RIN Report No. 92/2.

Wright, L. J., Ross-Smith, V. H., Massimino, D., Dadam, D., Cook, A. S. C. P., and Burton, N. H. K. (2012). Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species). BTO report to the Strategic Ornithological Support Service (SOSS), Thetford.

Zimmerling, J. R., Pomeroy, A. C., d'Entremont, M. V. and Francis, C. M. (2013). Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments. *Avian Conservation and Ecology* 8: 10-22.

Zwart, M. C., Dunn, J. C., McGowan, P. J. K. and Whittingham, M. J. (2016). Wind farm noise suppresses territorial defence behaviour in a songbird. *Behavioural Ecology* 27:101-108.

