



## Review of mitigation measures for the protection of Hen Harrier and Merlin from forest management disturbances and recommendations for improvements to protection procedures



### Final Report

Prepared by BirdWatch Ireland  
April 2024

---

**Citation:** Lusby, J., Fernández-Bellon, D. & Kavanagh, L. (2024). *Review of mitigation measures for the protection of Hen Harrier and Merlin from forest management disturbances and recommendations for improvements to protection procedures.* Final Report. BirdWatch Ireland.

**Funding:** This review was carried out by BirdWatch Ireland under contract to Coillte GCA who commissioned a review of mitigation measures for the protection of Hen Harrier and Merlin from forest management disturbances to identify recommendations for improvements. Darío Fernández-Bellon conducted the evaluation of the effectiveness of red area procedures (Section 2.1) which forms an important component of this review.

---

### **Acknowledgements:**

We wish to acknowledge and are grateful to Aileen O’Sullivan, Coillte, who provided support throughout and to Úna Nealon for her guidance and assistance with all aspects of the project. Paul Jordan, Coillte provided valuable input and an insight into forest operations, and we thank Deborah Meghen, as well as Coillte staff who helped with specific aspects of this project, including: Eamonn Kenny, Mark O’Loughlin, Ken Sweeney, Gerard Buckley and the Coillte Forest ecology team, Sinéad Brady, Saoirse McGrath, Katie Pender and Rob Dunniece. We are grateful to Kevin Collins and Orla Fahy of the Forest Service who provided representation on the Consultation Committee and to David Tierney, Sinéad Cummins and Cliona O’Brien of the National Parks and Wildlife Service who provided input through the Consultation Committee. Data on Hen Harrier was provided by the National Parks and Wildlife Service for which we are grateful, and we wish to thank John O’Halloran and Sandra Irwin of University College Cork who generously provided datasets on Hen Harrier which were integral to the analysis conducted as part of this review. This review would not have been possible without the dedication and expertise of the surveyors who conducted surveys for both Merlin and Hen Harrier, including Allan Mee, Alan McCarthy, Daelyn Purcell, Geoff Oliver and Pdraig Cregg. We are grateful to the Hen Harrier Project, in particular Marc Ruddock, Ryan Wilson-Parr and Shane O’Neill, with whom we coordinated surveys to ensure no overlap in survey effort to minimise the potential for disturbance and we thank them for their excellent communication throughout. We are also grateful to the NPWS staff in the areas where we conducted surveys, specifically Robert Edge in the Slieve Bloom Mountains SPA and Sinead Biggane, Jacinta Murphy and Raymond Stephens in the Slieve Aughty Mountains SPA and to Helen Carty and Rebecca Teesdale for accommodating the surveys and their communication throughout. Alan Lauder, Allan Mee and Alan McCarthy provided valuable input and reviewed earlier drafts of the review and recommendations. Thanks to Dervla O’Dowd and Pdraig Cregg of MKO. We thank colleagues in BirdWatch Ireland, specifically Oonagh Duggan, Brian Caffrey, Niall Hatch and Linda Lennon for their support and guidance and to Annette Lambkin, Valerie Lowth and Susana Izcue for administration assistance.

---

**Images:** Hen Harrier, front cover: Mike Brown; Merlin, front cover: Shay Connolly; Merlin young in nest, front cover; Darío Fernández-Bellon.

All other images used throughout are by the authors unless otherwise stated.

Address for correspondence: BirdWatch Ireland, Unit 20, Kilcoole, County Wicklow

Corresponding author: John Lusby, email: [jlusby@birdwatchireland.ie](mailto:jlusby@birdwatchireland.ie)

## Table of Contents

Executive summary.....	1
List of main findings.....	2
<b>1. Introduction.....</b>	<b>9</b>
<b>1.1 Background.....</b>	<b>9</b>
1.1.1 Scope.....	9
1.1.2 Limitations.....	10
<b>1.2 The forestry sector in Ireland.....</b>	<b>11</b>
1.2.1 Forest management activities and the risk of disturbance to breeding birds.....	12
1.2.2 Mitigation measures for the protection of breeding birds from forest management related disturbance.....	13
<b>1.3 The Hen Harrier in Ireland.....</b>	<b>14</b>
1.3.1 Interactions and potential effects of forest management activities on Hen Harrier.....	15
1.3.2 Mitigation measures for the protection of Hen Harrier from forest management related disturbances.....	15
<b>1.4 The Merlin in Ireland.....</b>	<b>16</b>
1.4.1 Interactions and potential effects of forest management activities on Merlin.....	17
1.4.2 Mitigation measures for the protection of Merlin from forest management related disturbances.....	18
<b>2. Review of mitigation measures to protect Hen Harrier from forestry-related disturbances.....</b>	<b>19</b>
<b>2.1 Evaluation of the effectiveness of red area procedures.....</b>	<b>19</b>
2.1.1 Background.....	19
2.1.2 Methods.....	20
2.1.3 Results.....	28
2.1.4 Conclusions.....	39
<b>2.2 Critical review of the implementation of red area procedures.....</b>	<b>40</b>
2.2.1 Background.....	40
2.2.2 Methods.....	40
2.2.3 Results.....	42
<b>3. Review of mitigation measures to protect Merlin from forestry related disturbances.....</b>	<b>47</b>
<b>3.1 Critical review of the implementation of Merlin mitigation measures.....</b>	<b>47</b>
3.1.1 Background.....	47
3.1.2 Methods.....	48
3.1.3 Results.....	49
<b>4. Targeted surveys to assess the presence of breeding Hen Harrier to inform forest management... 53</b>	<b>53</b>
4.1 Background.....	53
4.2 Methods.....	54
4.3 Results.....	60
4.4 Conclusions.....	65
<b>5. Targeted surveys to assess the presence of breeding Merlin to inform forest management.....</b>	<b>67</b>
5.1 Background.....	67
5.2 Methods.....	68
5.3 Results.....	74
5.4 Conclusions.....	77
<b>6. Recommendations.....</b>	<b>78</b>
6.1 Recommendations for mitigation measures for the protection of Hen Harrier and Merlin..	78
6.2 Recommended approach for the protection of Hen Harrier and Merlin during forest operations.....	82
6.3 General recommendations.....	87

<b>7. References</b> .....	92
<b>Appendices</b> .....	96
<b>Appendix A</b> .....	96
<b>Appendix B</b> .....	97
<b>Appendix C</b> .....	103
<b>Appendix D</b> .....	112
<b>Appendix E</b> .....	116
<b>Appendix F</b> .....	122
<b>Appendix G</b> .....	134

## Executive summary

BirdWatch Ireland was commissioned by Coillte CGA to conduct an independent review of the mitigation measures for the protection of Hen Harrier and Merlin from forest management disturbances and informed by this review, to provide recommendations for improvements to these mitigation strategies to afford appropriate protection to Hen Harrier and Merlin. This report sets out a critical review of the current mitigation measures for Hen Harrier and Merlin and outlines a series of recommendations for improvements to these mitigations. This review was carried out independently and the contents and views expressed in this report are solely those of BirdWatch Ireland.

Mitigation measures are specified by the Forest Service in Ireland to minimise the effects of forestry activities on Hen Harrier (see Appendix 21 in DAFM, 2015) and Merlin (see Appendix A of this report). These measures, which are primarily confined to the Special Protection Areas (SPAs) for which breeding Hen Harrier and Merlin are listed as Species of Conservation Interest (SCI), impose seasonal restrictions on forestry activities within protective disturbance-free zones based on the known and predicted spatial distribution of Hen Harrier nest/territory locations and on the likely suitability of habitat for breeding Merlin. These measures have undoubtedly been successful in providing protections for Hen Harrier and Merlin from forest management related disturbances within the relevant SPAs since their implementation in 2012 and 2019, respectively. The effectiveness of these measures in ensuring protection of all nests, and the design of these mitigation strategies and their targeting, has not been assessed and warrants critical review and improvement where required, to ensure that negative impacts of forestry activities are minimised or removed, for these sensitive species, and that these mitigation measures meet the legislative requirements.

The structure of the review is framed within six sections, as outlined below, and each of these informs the recommendations detailed in Section 6. The introduction (**Section 1**) provides the context and requirement for the review and sets out information on the ecology of Hen Harrier and Merlin, the ecological evidence of the effects of forest management practices on these species, as well as best practice mitigation measures to minimise the effects of disturbance and the legal requirements to do so. This is integral to informing the effectiveness of the current procedures as well as the recommendations for improved protocols. This is followed by a critical assessment of the current mitigation strategies for the protection of Hen Harrier and Merlin (**Section 2 and Section 3**) to determine their effectiveness and assess any required improvement. The following sections report on trials to assess the practicalities and merits of alternative approaches to collect real-time data on Hen Harrier and Merlin specifically in relation to areas where forest management operations are planned, to ensure risk of disturbance is minimised or removed (**Section 4 and Section 5**). Finally, all sections of the review inform the recommendations (**Section 6**), that outline the proposed amendments to the current mitigation strategies to increase data sharing and collection capabilities and confidence in the protection of Hen Harrier and Merlin and facilitate improved forest management planning in this regard.

## List of main findings

### Forest management and the potential effects on Hen Harrier and Merlin

- **Forest management operations** (e.g. thinning, clearfelling, replanting, road construction) **have the potential to cause disturbance to breeding birds and the destruction of nests, eggs and young in or surrounding plantation forests**, especially when these activities are carried out during the breeding season, over prolonged periods and involve significant disruption and habitat alteration.
- **These disturbances can impact birds by directly or indirectly disrupting breeding activities**, restricting access to nest sites or foraging areas and reducing habitat suitability, which can affect the behaviour and breeding success of birds and **consequently impact the long-term viability of populations**.
- With particular reference to the potential for disturbance to birds from forest management activities, **Article 5 of the Birds Directive states that Member States shall take the requisite measures to establish a general system of protection for all species of birds** (referred to in Article 1 of the Birds Directive), prohibiting in particular: deliberate killing or capture by any methods; deliberate destruction of, or damage to, their nests and eggs; removal of their nests and deliberate disturbance of these birds particularly during the period of breeding and rearing, in so far as disturbance would be significant having regard to the objectives of this Directive.
- **Regulation 27 of the Birds and Habitats Regulations 2011 (S. I. No. 477 of 2011) provides that all public authorities have a responsibility to avoid the deterioration of natural habitats and species protected under the Birds and Natural Habitats Directives**, and to exercise their functions and statutory powers in compliance with the Directives' requirements.
- **Mitigation measures are required to prevent or minimise negative impacts on breeding birds from forestry operations**. Avoiding forestry activities in sensitive areas at sensitive times, and/or **establishing protective disturbance-free zones surrounding nest sites where forestry operations are restricted**, are widely used tools to mitigate potential threats to birds during sensitive periods. The effectiveness of these measures requires an understanding of the species present and their distribution in/around forests (e.g. up to date information on nest locations) and the appropriate measures (e.g. size and location of disturbance-free zone) needed to avoid negative impacts.
- **There is extensive forest cover within the breeding range of Hen Harrier and Merlin in Ireland**. Hen Harrier and Merlin nest in (and in proximity to) plantation forests at different stages of the forest cycle and therefore are **at risk of disturbance from forest management operations**.
- Assessment of any activity, plan or project (in this case forest management activities) **under Article 6(3) of the Habitats Directive must have complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed** on the protected site concerned.
- **Mitigation measures to minimise the effects of forestry activities on Hen Harrier and Merlin are implemented by the Forest Service in Ireland** and are described in Appendix 21 of the Forestry Standards Manual (DAFM, 2015) for Hen Harrier and the Forest Service information note on AA stage mitigation for Merlin (see Appendix A of this document). These measures, which are applied to the SPAs for which breeding Hen Harrier and Merlin are listed as Species of Conservation Interest (SCI), set out sensitive areas within the relevant SPAs, in which certain forestry activities are prohibited during a defined breeding period. These sensitive areas are defined based on the known or predicted spatial

distribution of Hen Harrier nest/territory locations and the likely suitability of habitat for breeding Merlin. These measures have undoubtedly been successful in providing protection to some Hen Harrier and Merlin nest sites within the breeding Hen Harrier and Merlin SPAs since their implementation in 2012 and 2019, respectively, particularly given the constraints on information on the spatial distribution of these species. **The effectiveness of these measures in ensuring protection of all nests, and the design of these mitigation strategies, and their targeting, has not been assessed** and warrants critical review to inform improvements where required, to ensure that negative impacts to these sensitive species are minimised or removed.

---

## Assessing the effectiveness of mitigation measures for Hen Harrier

- **Current Hen Harrier mitigation measures are based on information on Hen Harrier nest/territory locations, used by the Forest Service to generate 'red areas'. New red areas typically come into effect in the following breeding season (the year after Hen Harrier nest/territory locations have been identified) and remain in place in subsequent years.** Red areas are 1.2km radius areas centred on previously known or current Hen Harrier nest/territory locations. This radius is designed to include a protective buffer around the nest of 500m and an additional 700m to cater for interannual movements, within which certain forestry activities are restricted between 1<sup>st</sup> March to 15<sup>th</sup> August (note the timing of restrictions was extended from 1<sup>st</sup> April to 1<sup>st</sup> March in May 2022).
- **Red areas are mostly based on historical information on Hen Harrier nest/territory locations. Therefore, the red areas may not accurately reflect the current distribution of Hen Harrier** (as nest locations can change from year to year) and **this places Hen Harrier at risk of unintentional disturbance.** Our review (which is informed by data on 791 Hen Harrier nest/territory locations inside and outside the breeding Hen Harrier SPAs between 1998 – 2015) indicates that this time lag between detection of Hen Harrier nest/territories and the implementation of protection measures reduces the effectiveness of this mitigation strategy, as Hen Harrier that nest in new or previously unrecorded areas and those experiencing significant inter-year movements may not receive appropriate protection from forest management related disturbances.
- Our review indicates that **the spatial application of the red areas may not provide for the appropriate protection of all Hen Harrier nest/territory locations in the SPA network.** Hen Harrier can nest outside or at the edge of existing red areas in the SPA network, where there is risk of disturbance from forestry activities. Through the red area procedures, **mitigations are retrospectively applied to Hen Harrier nest/territory locations where they are detected outside existing red areas, at which time the potential for disturbance to Hen Harrier has already occurred.**
- Assessment of the effectiveness of the red area procedures based on known Hen Harrier nest/territory locations (n = 791) indicates that **the percentage of nests that would be effectively protected by the red areas ranges from 0% to 100%.** The red area procedure is most effective when informed by nest/territory locations in the previous two years, with an average of 50% of nests effectively protected (range of 15-75%). As the time since information on Hen Harrier nest/territory was collected increased, red area effectiveness decreased.
- Analysis of the effectiveness of the red area procedures based on known Hen Harrier nest/territory locations (n = 791) indicates that red area effectiveness is region-specific. **The percentage of nests effectively protected was higher in regions with high nest density. The percentage of nests protected was higher in cases where the number of pairs in an area had declined and therefore may be constraining population growth** by not protecting Hen Harrier where they nest in new areas which are

outside of red areas (*i.e.* if Hen Harrier nest in an area where they have not previously nested and therefore is not defined as a red area, they may be prone to unintentional disturbance).

- **The red area procedures are not sufficiently targeted.** This is evidenced by the fact that not all nests may receive protection and that a large portion of red areas are not occupied by Hen Harrier (e.g. in 2020, there were 41 red areas in the Slieve Aughty Mountains SPA but six confirmed Hen Harrier territories and one possible territory in the same year).
  - Although the 1.2km radius **red areas implement the largest disturbance-free zone for Hen Harrier throughout their range, the nest protection buffer (500m) is at the lower scale of recommended protection distances.** Our review indicates that the 700m which is designed to cater for interannual movements is insufficient based on the spatial distribution of Hen Harrier nests over time.
  - The timing of restrictions on forestry operations implemented through the red area procedures were extended (May 2022), to start on the 1<sup>st</sup> March rather than the 1<sup>st</sup> April as was the previously the case, **this new timing of restrictions (1<sup>st</sup> March to 15<sup>th</sup> August) should ensure appropriate protection to Hen Harrier in the early stages of the breeding season,** however we recommend review of the end date of the timing of restrictions to ensure the required protection is provided at the latter stages of the breeding season.
  - **Mitigation measures for the protection of Hen Harrier and specifically the red area procedures are confined to the breeding Hen Harrier SPA network.** There are no formal procedures in place to protect breeding Hen Harrier from disturbances from forest management activities outside of the SPAs where protection is based on a less robust and ad hoc approach, **placing Hen Harrier at risk outside of the SPA network.**
- 

## Assessing the effectiveness of mitigation measures for Merlin

- **The Merlin mitigation measures implement a disturbance-free zone of 100m from the forest edge between 1<sup>st</sup> of March to 31<sup>st</sup> of August,** if the area where forest operations are planned contains mature forest at least 10 years of age; is within or adjacent to a breeding Merlin SPA and adjoins or is immediately adjacent to moors, heathland, peat bogs or natural grassland.
- The disturbance-free zone (100m from the forest edge) is informed by the nesting ecology of Merlin in Ireland, which predominantly nest close to the forest edge. However, **the scale of this disturbance-free zone (100m) is not supported by the evidence-base,** is less than the disturbance-free distances recommended for breeding Merlin across all other studies reviewed **and is not likely to be providing adequate protection to breeding Merlin in the SPA network.**
- **The spatial application of the Merlin mitigation measures** (excluding the size of the disturbance-free zone) within the breeding Merlin SPAs **is deemed to be appropriate in providing protection to Merlin** as it applies to all areas of potentially suitable breeding habitat for Merlin where forestry operations are scheduled (*i.e.* if mitigation is applied to all areas where Merlin can nest, then all nests should receive protection).
- **The timing of restrictions on forestry operations (1<sup>st</sup> March to 31<sup>st</sup> August) implemented through the Merlin mitigation measures is appropriate and should ensure appropriate protection.**
- **The Merlin mitigation measures are confined to the breeding Merlin SPA network** and immediate surrounds. There are no formal procedures in place to protect breeding Merlin from disturbances from

forest management activities outside of these areas. Currently, **outside the breeding Merlin SPA network, protection measures for Merlin are less robust and *ad hoc*, placing Merlin populations at risk.**

---

## Testing targeted Hen Harrier surveys to inform mitigation measures to reduce risk of disturbance from forest management activities

- **We tested the effectiveness and efficiency of pre-operational surveys targeting areas of planned/intended forest management activity as an alternative methodology to the current red area procedure.** Surveys to determine the presence of breeding Hen Harrier (within a 750m buffer surrounding harvest units scheduled for felling or thinning) were conducted to inform the potential impacts of forest operations to Hen Harrier and to increase confidence in protection measures to ensure no negative impacts to Hen Harrier.
  - **We tested the pre-operational survey approach in 26 individual survey areas** (harvest units inclusive of a 750m buffer), selected at random in the Slieve Aughty Mountains SPA (n = 12) and the Slieve Bloom Mountains SPA (n = 14). **We confirmed the presence of Hen Harrier in ten survey areas (38.5%). Evidence of breeding was confirmed in four survey areas (15.4%),** three in the Slieve Aughty Mountains SPA and one in the Slieve Bloom Mountains SPA. There were no observations of Hen Harrier in 16 (61.5%) survey areas.
  - **We demonstrated that targeted pre-operational surveys are a reliable and effective means to determine the presence or absence of breeding Hen Harrier** in areas where forest management operations are scheduled, and that these surveys can be used to inform the operations **to ensure there is no risk of disturbance to Hen Harrier** (forest operations cannot proceed until it is confirmed that Hen Harrier are not present and therefore will not be impacted). This follows a similar approach that is successfully implemented in other countries to collect information on priority bird species to inform risks associated with specific forest management operations.
  - Based on the findings of **these survey trials** and informed by our review of the existing measures (red area procedures), we suggest that employing pre-operational surveys to collect information on breeding Hen Harrier and/or utilising contemporary data on Hen Harrier distribution (collected in the same season) is **more reliable and more effective in minimising the potential effects of forest management related disturbances to the species than the current red area approach,** primarily because with the recommended approach, forest operations cannot proceed unless it is confirmed that Hen Harrier are not present and breeding in an affected area.
  - We trialled **surveys employing a drone with thermal sensor (under Section 22(9)(d)) as a means of improving efficiency and accuracy of pre-operational surveys to detect Hen Harrier and to locate nest sites** in the Slieve Blooms Mountains SPA and showed that this survey approach could be integrated within pre-operational surveys to improve confidence in survey findings and accuracy in nest detection.
- 

## Testing targeted Merlin surveys to inform mitigation measures to reduce risk of disturbance from forest management activities

- **We tested the effectiveness and efficiency of pre-operational surveys targeting areas of planned/intended forest management activity as an alternative methodology to the current mitigation strategy which takes a habitat-based approach.** Surveys to determine the presence of breeding Merlin in relation to forest areas (500m buffer surrounding harvest units scheduled for felling or thinning) were conducted to inform forest operations to inform protection measures and to ensure no negative impacts on Merlin.
- **We tested the pre-operational survey approach in 15 individual survey areas** (harvest units inclusive of a 500m buffer) in the Slieve Aughty Mountains SPA (n = 14) and the Connemara Bog Complex SPA (n = 1). There was an average of 22 hours spent per survey area ranging from 9 hours to 48 hours, and an average of 3.1 vantage points per survey area. **We confirmed the presence of Merlin in one survey area (6.6%) in the Slieve Aughty Mountains SPA. Evidence of breeding was not confirmed in any survey area**, and 14 survey areas (93.3%) were unoccupied.
- **We demonstrated that targeted pre-operational surveys can be carried out to determine the presence or absence of breeding Merlin** in areas where forest management operations are planned. However, the challenges and resources required to undertake surveys for Merlin are recognised. Further trials to improve survey efficiency and accuracy are recommended and until such time as a more reliable survey method is in place **the current habitat-based approach to applying mitigation is deemed to be the most appropriate to minimise risk to breeding Merlin from forest management related disturbances.**
- We trialled **surveys employing a drone with thermal sensor (under Section 22(9)(d)) as a means of improving efficiency and accuracy of pre-operational surveys to detect Merlin and to locate nest sites** in the Wicklow Mountains SPA and showed that further tests are required before this survey approach could be integrated within targeted surveys to improve confidence in survey findings and accuracy in nest detection.

---

## Recommendations for mitigation measures for the protection of Hen Harrier

- Our review highlights that the spatial application of the existing mitigation measures (red area procedures) can be improved to provide protection to Hen Harrier. In order to improve protections for Hen Harrier it is **recommended that forestry activities should not proceed in areas where Hen Harrier have the potential to nest (areas of suitable breeding habitat for Hen Harrier) until it is confirmed that there will be no disturbance impacts to Hen Harrier** (informed by robust and contemporary data on Hen Harrier distribution and nest locations and/or pre-operational surveys). This differs from the existing mitigation measures which apply mitigations retrospectively based on information on Hen Harrier nest or territory locations in the SPAs and therefore may be placing Hen Harrier at risk of disturbance in these areas where Hen Harrier nest in new or previously unrecorded areas or at the edge of existing red areas. The implementation of this recommended approach requires utilisation of robust and contemporary data on Hen Harrier distribution and/or conducting pre-operational surveys and should ensure appropriate protection of all Hen Harrier nesting attempts during the relevant breeding period and regardless of their location with respect to existing red areas.
- To support the appropriate targeting of the Hen Harrier mitigation measures, we propose **the development of a standard methodology for conducting and reporting on habitat suitability for Hen Harrier** to ensure a high standard in the planning, preparing, conducting, and reporting of Hen Harrier habitat assessments, which are open to review and which are effective in identifying all areas of potentially suitable breeding habitat for Hen Harrier.

- **We recommend that the nest protection buffer should be increased from the current 500m to 750m** (Ruddock and Whitfield, 2007; Goodship and Furness, 2022) to ensure protection to breeding Hen Harrier from high impact forestry activities. This 750m buffer should be centred around known Hen Harrier nest / territory locations or surrounding planned forest operations in the case of pre-operational surveys, to ensure risks to Hen Harrier are minimised or removed.
  - **The mitigation measures for Hen Harrier as recommended should be applied to non-designated regionally important breeding areas.** The lack of formal protection in these areas is placing Hen Harrier at risk of disturbance and this should be rectified to provide appropriate protections to Hen Harrier outside of the SPA network to disturbances from forestry activities during the breeding season. The non-designated regionally important breeding areas for Hen Harrier should be formally defined.
  - **We recommend that all forestry activities should be reviewed to define the potential risks they present to Hen Harrier and the requirements for protection.** This includes providing clarification on the specific forestry activities that are permitted and those that are not within or in proximity to Hen Harrier breeding territories (i.e., define the activities that are currently listed by the Forest Service as ‘other operation(s) the Forest Service may deem as potentially creating disturbance’).
  - **We propose that the current period that Hen Harrier mitigation measures are implemented (from 1<sup>st</sup> March to 15<sup>th</sup> August) should be maintained.** This timing may be further refined based on the review of the timing of breeding of Hen Harrier in Ireland (see Section 6.3) including assessing whether the timing of protection measures should be extended in late summer to provide protection to juvenile Hen Harrier in the pre-dispersal or early dispersal period.
- 

## Recommendations for mitigation measures for the protection of Merlin

- Informed by our review, we propose that **the current habitat-based approach to applying the Merlin mitigation measures is the most appropriate to minimise the risks to breeding Merlin from forest management related disturbances and should be maintained** until such a time as a robust and reliable system for collecting data on Merlin distribution and nest locations and/or pre-operational surveys is established.
- To support the appropriate targeting of the Merlin mitigation measures, it is necessary **to develop a standard methodology for conducting and reporting on habitat suitability for Merlin** to ensure a high standard in the planning, preparing, conducting, and reporting of Merlin habitat assessments, which are open to review and which are effective in identifying all areas of potentially suitable breeding habitat for Merlin.
- **We recommend that the nest protection buffer should be increased from the current 100m to 500m** (Ruddock and Whitfield, 2007; Goodship and Furness, 2022) to ensure protection to breeding Merlin from high impact forestry activities.
- **The Merlin mitigation measures for Merlin should be applied to non-designated regionally important breeding areas** for the species. The lack of formal protection in these areas is placing Merlin at risk of disturbance and this needs to be rectified to provide appropriate protections to Merlin outside of the SPA network to disturbances from forestry activities during the breeding season. The non-designated regionally important breeding areas for Merlin should be formally defined.
- **We recommend that all forestry activities should be reviewed to define the potential risks they present to Merlin and the requirements for protection.** This includes providing clarification on the specific

forestry activities that are permitted and those that are not within or in proximity to Merlin breeding territories (i.e., define the activities that are currently listed by the Forest Service as 'other forestry operations).

- We propose that **the current period that Merlin mitigation measures are implemented (from 1<sup>st</sup> March to 31<sup>st</sup> August) should be maintained**. This timing may be further refined based on the review of the timing of breeding of Merlin in Ireland (see Section 6.3).

---

## General recommendations to enhance the proposed measures for the protection of Hen Harrier and Merlin

- **Establish a Working Group with representation from all relevant stakeholders** to improve communication, data sharing, and as the vehicle to improve and review forest management mitigation strategies, including the implementation and review of the recommended improvements to mitigation measures for Hen Harrier and Merlin as outlined in this report.
- **Improve the application of data to inform forest planning for the protection of priority species.** We recommend that improved systems for data sharing are established with robust data sharing agreements in place to provide confidence to data collectors in relation to the sensitivities, ownership and use of the data, while allowing the data to be specifically used to inform forest planning at the earliest stages to avoid areas where priority bird species are present or are likely to be present, and to ensure that protection measures are targeted to the areas where they are required.
- **Design and implement a system for collating data on disturbance events and effects on Hen Harrier and Merlin** to build the evidence base and improve our understanding of the direct and indirect effects of forest management operations on Hen Harrier and Merlin in order to refine and improve mitigation strategies accordingly.
- **Conduct a review to provide information on the timing of breeding of Hen Harrier and Merlin in the Irish context** to improve our understanding and the evidence base on the timing of breeding of Hen Harrier and Merlin in Ireland to inform and refine mitigation strategies based on robust scientific data.
- **Develop a robust and reliable system for conducting targeted surveys to determine the presence of Merlin** to inform forest management and mitigation and ensure disturbance to breeding Merlin is avoided. This should include trials to assess the effectiveness of aerial thermal imaging surveys to increase efficiency and effectiveness of the detection of breeding Merlin.
- **Integrate Hen Harrier and Merlin conservation requirements to forest planning and management** including assessing the requirement for structured forest removal, enhancing connectivity of open habitats, ensuring a well-balanced age structure of forest and maintaining disturbance-free zones in wider areas identified as important for Hen Harrier and Merlin, and assessing the merits of continuous cover forest in areas identified as important for breeding Merlin and/or maintain selected forest stands which are used by breeding Merlin for nesting.
- **Develop clear and comprehensive guidance on minimising the disturbance to breeding birds from forestry operations** and the legislative requirements for same, to improve protection, consistency of approach and awareness of best practice and the legislative requirements in minimising disturbance to breeding birds from forestry activities.

## 1. Introduction

### 1.1 Background

This review was carried out by BirdWatch Ireland, under contract to Coillte CGA, to review mitigation measures for the protection of Hen Harrier (*Circus cyaneus*) and Merlin (*Falco columbarius*) from disturbances and impacts related to forestry activities. The review was carried out independently and the views expressed in this report are solely those of BirdWatch Ireland.

Since 2012, measures have been introduced by the Forest Service of the Department of Agriculture, Food and the Marine (DAFM), designed to minimise the risk of disturbance to Hen Harrier (DAFM 2012, 2015) and Merlin (Appendix A) within the SPA network, in relation to specific forestry activities, including:

- Tree-felling (clearfelling, thinning), and the extraction and loading of felled timber
- Forest road construction and upgrade
- Restocking or replanting trees after felling
- Other operations associated with forestry

In recent years, some limitations of the current procedures have become apparent. These are discussed in this review (e.g. the spatial application of Hen Harrier mitigation measures being insufficient to provide protection to all breeding pairs, the extent of the disturbance free zone being insufficient to provide adequate protection to breeding Merlin etc.). These may result in affording inadequate protection to breeding Hen Harrier and Merlin as detailed in this review. It is therefore timely to undertake a critical assessment of the current procedures with a view to identifying improvements, to ensure appropriate protection to breeding Hen Harrier and Merlin, such measures being practical from both a conservation and forest management perspective.

Specifically, the objectives of the project were:

- To critically review the current mitigation measures for the protection of Hen Harrier and Merlin from disturbances from forestry activities;
- To design any required improvements to these mitigation measures; and
- To pilot the implementation of these recommendations including alternative approaches to improving protections for Hen Harrier and Merlin

This report presents the outputs of the first two of these objectives. The pilot implementation of alternative approaches to improve protections for Hen Harrier and Merlin will be reported on separately.

#### 1.1.2 Scope

The remit of this review is to determine the effectiveness of current mitigation measures for the protection of Hen Harrier and Merlin from disturbance effects from forestry activities during the breeding season in Ireland, and informed by this review, to outline practical recommendations to minimise the effects of forestry activities on Hen Harrier and Merlin, in line with the ecological evidence-base, sustainable forest management and the legislative requirements under the Birds and Habitats Directives. This includes compliance with Regulation 27 of the Birds and Natural Habitats Regulations 2011 (S. I. No. 477 of 2011) which provides that all

public authorities have a responsibility to avoid the deterioration of natural habitats and species protected under the Birds and Habitats Directives, and to exercise their functions and statutory powers in compliance with the Directives' requirements.

Hen Harrier and Merlin show a strong preference for nesting in plantation forests of different age classes, placing them at risk of disturbance from forest management activities. There is extensive forest cover within the breeding range of Hen Harrier and Merlin in Ireland. Forest management operations, with the potential to impact Hen Harrier and Merlin, are set to continue (informed by the increasing age profile of forests, with more of the forest estate approaching or at the stage of thinning or clearfell and increased planting to meet afforestation targets). Current mitigation strategies implement seasonal restrictions on forestry activities in areas known or considered to be important for breeding Hen Harrier and Merlin, within the SPAs for which these species are listed as SCI. As with any mitigation strategy, it is important to assess the effectiveness of these measures, to ensure they are achieving their intended outcomes. In this context this review is framed, to assess the effectiveness of these mitigation measures and to make recommendations for any improvements to ensure that the mitigation measures: a) meet the ecological and conservation requirements of the species; b) are scientifically and legally robust to minimise negative impacts, and c) are practical and can realistically be implemented by policy-makers, conservationists and forestry practitioners.

Implementing or improving forest management practices to remove or minimise the risk of disturbance to sensitive species associated with forests is challenging. This is highlighted by the limited evidence on the responses of individual species to forestry disturbances and the wide range of mitigation measures recommended and implemented across many different countries. For this reason, the scope of this review is focused solely on the impacts of forest management operations on Hen Harrier and Merlin and the required mitigation actions. Assessing the impacts of afforestation on Hen Harrier and Merlin, is outside the scope of this review and warrants separate attention. While the primary objective is ensuring the protection of Hen Harrier and Merlin, achieving this through a well-designed, targeted and transparent mitigation strategy will also facilitate more efficient forest planning with respect to mitigation measures. In this regard, although this review is targeted at Hen Harrier and Merlin, the principles and practices outlined can be applied to other sensitive species and will be integral in informing biodiversity enhancement measures, such as forest removal, habitat restoration and continuous cover forestry, as part of sustainable forest management.

### 1.1.3 Limitations

There were certain constraints encountered over the course of this review, which are important to recognise, and which inform the approach taken and where it was necessary to deviate from standard analytical methods. Specifically, the assessment of the effectiveness of the Hen Harrier mitigation measures was constrained by data accessibility and availability in relation to the mitigation strategy protocols and the mitigation strategy implementation details.

- We did not have access to the most recent data on the spatial application of Hen Harrier mitigation measures and there were several limitations with the data that was available to us, such as information lacking on the source or timeframe of the data which informed the mitigation measures (e.g. red area areas without information on when the red area was defined or source of information leading to the red area being defined). The difficulties associated with obtaining comprehensive and accurate data highlight existing issues in current procedures which can hinder the effectiveness of this or other mitigation strategies. In light of these constraints, we designed a methodology to assess the effectiveness of Hen Harrier mitigation measures that would ensure the robustness and applicability of our findings and would not be compromised by these limitations.

- While this review collated and analysed one of the largest data sets used for any study on breeding Hen Harrier ecology in Ireland to date (n = 791 nests), more recent data on Hen Harrier nest locations which have been used to generate the red areas since 2016 was not available for this review. Although having a larger data set would be optimal, the absence of this unavailable data in our analysis does not impact the assessment or conclusions presented in this report. In brief, the shortcomings of current procedures in effectively protecting the 791 nest locations analysed in this report would not be overcome even if all unavailable data corresponded to effectively protected nests.
- We are aware that certain amendments to the Hen Harrier mitigation measures were enacted during the course of this review, specifically the removal of mitigation measures from specific locations (red areas) by the Forest Service where it has been deemed, they are no longer required. As we do not have specific detail on these amendments it is not appropriate to alter or exclude our specific recommendation in relation to this issue. In the absence of information on the specific amendments made, the recommendations in this report refer to the procedures prior to their amendment. A separate study requiring access to detailed information on the changes to procedures and monitoring data in the relevant areas would be necessary to determine the effectiveness of the amended approach.
- There are certain constraints also associated with the assessment of the effectiveness of the Merlin mitigation measures, which is related to the fact that these mitigation measures are still in their infancy and therefore there is insufficient data to conduct a detailed analysis of the performance of these measures in providing protection to breeding Merlin, as was possible for the Hen Harrier measures.

For all the constraints listed above, we amended our approach accordingly in cognisance of the data limitations and as a result we propose that these constraints did not affect the integrity of the review or confidence in the conclusions.

It is also important to note the different nomenclature used for the same or similar terms and to describe mitigation measures, further highlighting the complexities encountered in this review. In particular the mitigation measures are referred to using several different descriptions, for example the Hen Harrier mitigation measures implemented by the Forest Service are known as red areas or red area procedures and also red zones. These are distinct from the Higher Likelihood of Nesting Area's (HLNAs) which is a spatial layer prepared by the National Parks and Wildlife Service and provided to the Forest Service which they use to generate the red areas. Finally, to protect sensitive nest locations and data sensitivities, we have not shown the location of nest sites (or red areas) within this review. In relation to the data on the Hen Harrier nest/territory locations provided to us by the National Parks and Wildlife Service (NPWS), we have not disclosed these locations, however we have specified whether particular survey areas, forest areas or harvest units of interest are within or outside a red area, which we think this protects the nest locations and the data appropriately, particularly given the fact that the data on red areas is from 2016 and therefore quite outdated at the time of this review.

## 1.2 The forestry sector in Ireland

Ireland has the lowest forest cover in Europe, however afforestation in the state is progressing at one of the fastest rates in the world (Wilson *et al.*, 2012). The recent and on-going forest cover expansion is primarily driven by the commercial planting of non-native conifers, constituting the majority of the forest estate nationally (DAFM, 2022). This is a dramatic change from the period after the last ice age when forests of native tree and shrub species covered an estimated 80% of the island of Ireland (Mitchell, 1995). Extensive clearance and exploitation of forests began approx. 6,500 years ago, with the clearance of land for farming. In the

sixteenth and early seventeenth centuries significant forest exploitation occurred to produce timber for ship construction, iron and glass works and for charcoal. By the early 1700's all but the least accessible forests had been cleared (Anon, 1979). At the beginning of the twentieth century, less than 1% of Ireland's land area comprised of woodland. The 1946 Forestry Act and the policy decision of 1948 to plant a million acres was the start of a resurgence in planting activity. By 1951, forest cover in the Republic of Ireland amounted to 1.8% of the land area and was comprised mainly of conifer species (O'Carroll, 2004). Until the 1980s, the Irish State, with support from the EU was responsible for almost all annual forest planting in Ireland, dominated by non-native conifers on publicly owned peatland areas (Wilson *et al.*, 2012). Private afforestation came to the fore in the mid-1980's following the introduction of a grant and particularly an annual premium scheme for afforestation (DAFM, 2020). Forest cover is now estimated to be 808,848 ha or 11.6% of the total land area of Ireland (DAFM, 2022), the highest level in over 350 years. The forest estate is predominantly non-native conifers (69.4%), with Sitka Spruce the most common species, making up over half of the total forest estate and 30.6% broadleaves. Half (49.1%) of the total forest area is in public ownership, mainly managed by Coillte (DAFM, 2022). Although the planting of state forests in Ireland is decreasing, planting of small forest stands by private landowners is set to continue, with a national target to reach 18% forest cover in Ireland by 2046 (DAFM, 2014).

The principal approach to management within commercial conifer forests in Ireland revolves around a 40- to 60-year rotation comprising afforestation, thinning, clearfelling and replanting. Thinning is undertaken to primarily enhance the quality of the final crop, and also to provide intermediate yields of timber. Clearfelling involves the harvesting of all trees in a stand at the end of the rotation. Replanting is subsequently undertaken to replace the harvested trees, which is a requirement of licensing (Forest Service, 2000). The Forest Service of the Department of Agriculture Food and the Marine is responsible for regulating forestry activities, including afforestation and forest road construction (under S.I.558 / 2010), thinning, felling and replanting under the Forestry Act 2014 and the Forestry Regulations 2017 (S.I. 191 of 2017) and aerial fertilisation of forests (under S.I. 125/2012) undertaken by the private sector as well as by Coillte (NPWS, 2015). Nearly three quarters (70%) of the stocked forest area is under 30 years of age (DAFM, 2022) approaching or at the stage of thinning or clearfell. The scale of forest management operations within the existing forest estate is therefore set to continue, which in addition to afforestation targets, represents a significant and on-going land use change and habitat alteration on a national scale.

### 1.2.1 Forest management activities and the risk of disturbance to breeding birds

Forest management operations (thinning, clearfelling, replanting, haulage, road construction and use etc.) have the potential to cause disturbance to breeding birds in commercial forests and especially when such activities are carried out during the breeding season, over prolonged periods and involve significant disruption and alteration to the habitat (Naylor, 2009; Ruffino, 2016). These disturbances can impact birds in a number of ways, including directly or indirectly disrupting breeding activities, restricting access to nest sites or food resources and reducing habitat suitability (Richardson and Miller, 2007; Naylor, 2009). The magnitude of disturbance effects is likely to be influenced by several factors, including the scale, timing and frequency of forest management operations and particularly the distance of the disturbance source to nest sites. Under certain conditions forest management operations therefore pose a real risk of substantially affecting the behaviour and breeding success of birds and consequently affecting the long-term viability of populations (Forestry Commission Scotland, 2006). Despite the documented risks to breeding birds associated with forestry activities, knowledge on the effects of specific forest management operations on nesting birds is

limited (Ruddock and Whitfield 2007; Naylor 2009; Livezey *et al.*, 2016). This is compounded by the significant variation in the responses of birds to forest activities, which can differ between species, individuals and in relation to a range of biotic and abiotic factors and this is reflected in the wide range of mitigation measures recommended and/or applied in different countries to protect sensitive bird species (Ruffino, 2016).

## 1.2.2 Mitigation measures for the protection of breeding birds from forest management related disturbance

Sensitive planning and management of commercial forests can be used to reduce or minimise negative impacts on species conservation (e.g., Kortland *et al.*, 2011). To prevent negative impacts on breeding birds, the most effective method is to avoid forestry activities or other disturbances in sensitive areas during the breeding period. This may not always be possible due to other environmental and forest management considerations, in which case effective protection of sensitive bird species can be achieved by managing the distance between nesting sites and the disturbance source and restricting forestry activities during periods when bird populations are most vulnerable (Ruffino, 2016). This requires an understanding of the species present, their breeding ecology and their distribution within or in proximity to the forest (*i.e.* the location of nest sites) and needs to be built into forest planning and management. When this information is available, the establishment of protective buffer zones surrounding nests or centres of activity (also referred as exclusion zones), where human encroachment is strictly forbidden or temporally restricted, is a widely used tool by land managers and policy makers to mitigate potential threats to birds during periods of extreme sensitivity (e.g. Richardson and Miller 2007; Ruffino, 2016). The size of the protective buffer zone is typically informed by either the alert distances (*i.e.* the distance between the disturbance source and the bird at the point where the bird changes its behaviour in response to the approaching disturbance source) or flushing distances (*i.e.* the point at which the bird flushes from the approaching disturbance source), although those involving alert distances are thought to be a more conservative indicator of birds' tolerance (e.g. Fernandez-Juricic *et al.*, 2001; Fernandez-Juricic *et al.*, 2005). Several studies have established recommended alert distances for birds which are based on expert opinion (e.g. Ruddock and Whitfield, 2007; Goodship and Furness, 2022). These disturbance distances provide a useful starting point, however in practice the disturbance distances are difficult to determine with precision and vary widely depending on a range of factors. Forest management needs therefore to rely on average responses by species, and most importantly, practitioners should adjust their strategies (*i.e.* disturbance distances) on a case-by-case basis, depending on the level of disturbance tolerance of some breeding pairs (Ruffino, 2016). In the absence of information on these effects, the precautionary principle should be applied to ensure that there are no negative effects, and until there are sufficient data available to inform more appropriate management.

In many situations, there are not sufficient data readily available on the distribution of species in forests which may be at risk of disturbance, in which case dedicated surveys or pre-operational surveys are employed to obtain this information and to inform the mitigation requirements. This is the case in Scotland for example, where it is recommended that forest areas due for thinning or felling from mid-April to mid-July are checked for nests of sensitive bird species at least two weeks before forest management operations commence (Currie and Elliot, 1997; Forestry Commission Scotland, 2006). If forest management operations cannot be suspended or diverted to another area then an appropriate disturbance-free zone is established around the nest or nest area where the specific nest location is not known (Currie and Elliot, 1997). These recommendations may be revised upward or downward on the advice of skilled ornithologists with specialist knowledge of the exact

circumstances. These recommended disturbance distances take into account dependent young, which after fledgling will frequent areas some distance from the nest itself (Currie and Elliot, 1997; Forestry Commission Scotland, 2006). A similar approach is adopted by Natural Resources Wales, whereby forest coupes (areas of forest that have been identified for works) are surveyed prior to forest management operations. Depending on the survey findings and species present, these surveys inform whether works in that area can proceed or whether the operations are postponed. Where data are not readily available to inform the presence of species, and where pre-operational surveys are not routinely carried out, a habitat-based approach is sometimes applied, to inform the requirement for protection measures based on the potential presence of bird species. Although implementing protective buffers can be an effective conservation management tool for ensuring protection of individual species, it is limited by the data available and knowledge of the appropriate disturbance distances, and undoubtedly a more effective means of avoiding disturbance to breeding birds is to avoid undertaking works during the breeding period. Such seasonal restrictions are implemented in Belgium (in Flanders and Wallonia) where harvesting operations must not take place from 1<sup>st</sup> April to 30<sup>th</sup> June during the period of nesting for birds (NEPCon, 2017).

### 1.3 The Hen Harrier in Ireland

Hen Harriers *Circus cyaneus* are medium sized, ground-nesting birds of prey that are widely distributed throughout Eurasia, including the UK and Ireland (Ruddock *et al.*, 2016; Staneva and Burfield, 2017; Redpath *et al.*, 2002). Populations have declined across the species' range, and they are now a Species of European Conservation Concern (SPEC; Staneva and Burfield, 2017). They are listed under Annex I of the European Union (EU) Birds Directive (European Council Directive 79/409/EEC) which requires that EU member states protect them where they occur within national boundaries. This includes the designation of Natura 2000 sites, or Special Protected Areas (SPAs), as directed in Article 4 (Directive 2009/147/EC). In 2007, six Special Protection Areas were designated for the conservation of Hen Harrier in Ireland which include upland areas containing suitable breeding and foraging habitat for the species.

Hen Harrier populations in Ireland have shown long-term fluctuations (O'Flynn 1983, Ruddock *et al.*, 2016). Hen Harriers in Ireland were almost driven to extinction by widespread persecution between the late 19<sup>th</sup> century and the first half of the 20<sup>th</sup> century. A recovery in the Hen Harrier populations began in the 1950s, with estimates that the population increased to as many as 300 pairs by the 1970s (Sharrock 1976, O'Flynn, 1983). Towards the end of the 1970s, however, the population began to decline once again, and this decline continued through the 1980s (O'Flynn, 1983; Balmer *et al.*, 2013). Since 1998 there have been five national surveys of the Hen Harrier breeding population in Ireland, coordinated by the National Parks and Wildlife Service (NPWS). The Hen Harrier population in Ireland was estimated at 85 confirmed and 21 possible breeding pairs (85-106) by the fifth national survey in 2022 (Ruddock *et al.*, 2024). 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. A review of data for those squares covered in all surveys (long-term change), and squares covered consistently between consecutive surveys (i.e. a subset analyses), indicates that declines in both range and population have occurred in the short-term (from 2015 to 2022); medium term (from 2010/2005 to 2022) and long-term (from 1998-2000 to 2022). Overall, since the first national survey of 1998/2000 to the fifth national survey in 2022, the population has decreased by up to 59% across those consistently surveyed areas and includes losses across most regional populations. The populations of five of the SPAs have declined by between 20% and 80% since 2007, when they were identified for designation. Overall, the SPA populations have declined by more than half (54 %) in the same period (Ruddock *et al.*, 2024).

In recognition of the fact that Hen Harrier is under threat in Ireland due to a number of factors, but primarily due to the loss of suitable habitat through afforestation/forest maturation, agricultural reclamation and intensification, and wind energy development, the Irish Government have set out to prepare a Threat Response Plan to 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. Regulation 9 of the Regulations obliges the State 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” (NPWS, 2024). In January 2024, the Minister for Housing Local Government and Heritage and the Minister of State for Heritage and Electoral Reform published the draft Hen Harrier Threat Response Plan for public consultation. 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 and laying out a coordinated set of targeted actions and measures to cease, avoid, reverse, reduce, eliminate or prevent the identified threats, pressures and hazards and the draft Plan includes a number of actions pertaining to reducing the negative impacts of forestry activities to Hen Harrier (NPWS, 2024). At the time of writing, the draft Plan was pending adoption by government.

### 1.3.1 Interactions and potential effects of forest management activities on Hen Harrier

Hen Harriers are an open country species and use a variety of habitats including peat bogs, moorland, natural and unimproved grasslands, wetlands including reedbeds and marshes, and young conifer forests (Watson, 1977). Hen Harriers typically use upland habitats such as heather moorland and bog during the summer breeding season but will also use pre-thicket coniferous forest. Despite the persistence of Hen Harriers in forested landscapes across upland areas in Ireland, their population continues to decline (Ruddock *et al.*, 2024). Research suggests that while breeding Hen Harriers are often associated with pre-thicket coniferous forests, upland habitat mosaics that include a substantial amount of forest may in fact be sub-optimal for the species and may negatively impact breeding success (Wilson *et al.*, 2012; Caravaggi *et al.*, 2020). Loss of suitable habitat in upland areas through agricultural intensification, including afforestation, is one of the main concerns for Hen Harrier populations. Over 50% of Ireland’s Hen Harrier SPA network consists of commercial forest, compared to 11% nationally. Afforestation and forest maturation is one of the primary threats to the Hen Harrier. Moreover, forest management activities are among the human impacts most commonly associated with Hen Harrier territories (Ruddock *et al.*, 2016; Carravaggi *et al.*, 2020) and presents a risk of disturbance to breeding Hen Harrier where forest management operations are undertaken in close proximity to nesting sites and can cause direct disturbance and displacement of breeding Hen Harrier.

### 1.3.2 Mitigation measures for the protection of Hen Harrier from forest management related disturbances

As required under the European Habitats Directive (Council Directive 92/43/EEC) and the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011), the Forest Service is required to undertake a screening, and where necessary, an appropriate assessment, in relation to applications for consent, grant approval and licensing for various forestry activities, in order to evaluate the project within the context of any potential impact on a Natura site.

Specific procedures apply in relation to applications for consent / grant approval / licences involving certain forest management operations which have the potential to disturb Hen Harrier breeding activity within and surrounding SPAs designated for the species. These procedures, agreed with NPWS (NPWS, 2015), focus on disturbance operations within so-called 'red areas' during the Hen Harrier breeding season, 1st March to 15th August, inclusive.

Red areas are 1.2km radius areas centred on known or predicted Hen Harrier nesting areas in the SPA network. The 1.2km radius is based on half the maximum separation distance of annual nest locations within territories observed in the Slieve Aughty Mountains SPA within the 2005-2010 period (which is 700m), plus an additional 500m buffer. Depending on the location of their centre point, red areas may encapsulate land outside the boundary of the SPA. The remainder of the SPA is referred to as 'green areas'. New red areas may be generated in the future, as new Hen Harrier nesting sites are identified.

A disturbance operation as defined by the Forest Service is a forestry operation which has the potential, through excessive noise, vibration, mechanical movement, etc., to disturb the breeding activity of Hen Harriers. Disturbance operations include:

- timber felling (thinning, clearfell);
- timber extraction to roadside;
- timber loading at roadside;
- mechanical cultivation for both afforestation and reforestation;
- forest road construction (and associated developments);
- the driving of fencing posts; and
- any other operation(s) the Forest Service may deem as creating disturbance.

Currently, the red area procedures as described above are applied to the SPA network, reducing the risks or reacting to forestry related disturbances to Hen Harrier breeding in non-designated areas is dependent upon a less robust and ad hoc approach (NPWS, 2015). The 2022 national survey of Hen Harriers showed that the majority of the Hen Harrier population in Ireland nest outside of the SPA network (Ruddock *et al.*, 2024) where they may be at risk of disturbance from forestry activities.

## 1.4 The Merlin in Ireland

Merlin (*Falco columbarius*) is a small, agile species of falcon and breeds throughout the northern latitudes of Europe, Asia and North America (Sale, 2015). Throughout this circumpolar range, Merlin typically breed in low densities in habitats in or adjacent to open country (i.e. heath and bog) and specialise on small, open-country passerines (Ewing *et al.*, 2011; Fernández-Bellon & Lusby, 2011; Sale, 2015). Due to their extensive breeding range and population size, Merlin are listed as Least Concern globally and Secure in Europe, although information on populations vary throughout the region and trends are not known (Staneva and Burfield, 2017). In Ireland, which is at the western and southern limit of its European range, Merlin has a widespread but sporadic distribution across upland habitats and lowland bogs (Balmer *et al.*, 2013; Lusby *et al.*, 2017). The species is of national conservation concern due to a small population and reported declines in breeding range (Gilbert *et al.*, 2021). As an Annex I species on the European Birds Directive 2009/147/EC (European Council Directive 2009/147/EC), Member States are obliged to take appropriate measures to conserve Merlin populations, which includes the designation of Special Protection Areas (SPAs). In Ireland, Merlin is listed as a Species of Conservation Interest (SCI) in seven SPAs. It is a requirement under the Birds Directive that Merlin "*shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their*

area of distribution" and with respect to designated sites. The first survey of breeding Merlin to determine the population size across those sites listed for the species and to allow future changes in the population to be measured was undertaken in 2018 (Lusby *et al.*, 2022). Overall, the total Merlin population for the six breeding Merlin SPAs was estimated to be 28 to 41 pairs extrapolated using the total numbers of confirmed and possible pairs recorded in the area surveyed.

### 1.4.1 Interactions and potential effects of forest management activities on Merlin

The upland landscape within the breeding range of Merlin in Ireland has been significantly altered over recent decades and this has had a profound effect on the nesting ecology of the species. The substantial decrease in heather cover (Bleasdale, 1998) and overgrazing by sheep in particular in marginal upland areas (Fuller and Gough, 1999) has reduced the availability of Merlin's preferred habitats (Hardey *et al.*, 2009), which has coincided with the extensive afforestation of previously open moorland (DAFM, 2018). Likely in response to the long-term degradation of heath and bog habitats and increases in the extent of commercial forest cover across same, the majority of breeding Merlin in Ireland now nest in the abandoned nests of other bird species (primarily Hooded Crow) in forest plantations. In the absence of other available and traditional nesting sites (*i.e.* deep heather), the population may be now largely reliant on this managed commercial resource (Lusby *et al.*, 2017). Lusby *et al.* (2017) assessed nest site selection by Merlin using data collated from regional monitoring studies spanning over 30 years (1982-2014). This study confirmed that Merlin now predominantly nest in trees (99.5%), mostly selecting nests at the edge (within 10 m) of mature conifer plantations (80.8%), but having a strong association with, and higher breeding success, where the presence of open habitats suitable for hunting are in close proximity to forest nests. The majority of nest sites in forest plantations were located adjacent to moors and heathland and peat bogs (*i.e.* Land Classes as defined by CORINE LandCover). Merlin showed positive selection for moors and heathland, peat bogs and natural grasslands within breeding territories, and breeding success was positively related to the proportion of these land-uses surrounding nests. Merlin had a breeding success rate of 74% (n = 300), and productivity of 2.1 young per breeding attempt (n = 265) between 1982 and 2014. These estimates of breeding success of Merlin in Ireland are higher than reported for most populations in the UK, although the number of fledged young per successful pair, and overall productivity, were either lower or similar (Newton *et al.*, 1978; Roberts and Green, 1983; Bibby and Nattrass, 1986; Newton *et al.*, 1986; Meek, 1988; Ellis and Okill, 1990; Rebecca *et al.*, 1992; Wright, 1997; Rebecca, 2011). The breeding performance of Merlin in Ireland has remained constant over the past three decades, which suggests that the increase in forest cover over this period has not negatively affected their overall breeding output per se. However, overall, knowledge gaps with respect to the current national population size, national distribution and trends and densities remain (Lusby *et al.*, 2017).

Afforestation in Ireland has progressed at one of the highest rates in Europe (Forest Service, 2013), and planting has been primarily concentrated in upland habitats (Wilson *et al.*, 2012). Therefore, the upland landscape within the breeding range of Merlin has been rapidly altered, and as a result, Merlin now predominantly occur in landscapes where there is substantial forest cover (Lusby *et al.*, 2017). This is a recent and significant ecological shift across their breeding range. Merlin have adapted their nesting behaviour in response to these ecological changes, as planted forest has become the most used nesting habitat (Norriss *et al.*, 2010; Lusby *et al.*, 2017). As Merlin now predominantly nest in mature conifer plantations, which are within the age range for felling and thinning, they are vulnerable to direct disturbance from forest management operations (Lusby *et al.*, 2017). The extent to which breeding Merlin are affected by forest management operations is not known, however it is likely that disturbance incidents are under-recorded due to the lack of information on the distribution of breeding Merlin and the difficulties associated with detecting the species.

## 1.4.2 Mitigation measures for the protection of Merlin from forest management related disturbances

Mitigation measures to protect breeding Merlin from the negative effects of forest management operations have been introduced by the Forest Service within the breeding Merlin SPA network in late 2019 (Appendix A). These mitigation measures are based on the habitat suitability for breeding Merlin and restrict forestry activities during the period 1<sup>st</sup> March to 31<sup>st</sup> August inclusive within 100m of forest edge where it is immediately adjacent to suitable foraging habitat.

The mitigation measures are applied as a condition to the licence issued within the breeding Merlin SPAs, where the relevant project area:

- contains mature conifer forest of at least 10 years of age; and
- is within or adjacent to a Special Protection Area for which the Merlin is a special conservation interest; and
- adjoins or is immediately adjacent to the following habitats: moors, heathland, peat bogs or natural grassland; then
- No felling, thinning or other forestry operations associated with this licence shall take place during the period 1<sup>st</sup> March to 31<sup>st</sup> August inclusive, within 100 metres of the forest edge, where such forest edge is immediately adjacent to moors, heathland, peat bogs or natural grassland; or within 100 metres of a clearing in the forest of larger than one hectare.

Such operations can commence in sections of the project area furthest away from the 100 metre exclusion zone. Such operations can progress towards this exclusion zone but can only enter it during the period 1<sup>st</sup> September to 29<sup>th</sup> February inclusive.

At present, these mitigation measures are applied within the breeding Merlin SPAs and in some cases in the immediate area surrounding the SPA, whereas there are no such measures in place for the protection of breeding Merlin outside of the SPA network.

## 2. Review of mitigation measures to protect Hen Harrier from forestry-related disturbances

Detail on the mitigation measures (red area procedures) to prevent or minimise disturbance to Hen Harrier from forest management activities are described in Section 1.3.2. For reference, we use the term ‘red area’ procedures to describe these mitigation measures currently in place and note that they have been referred to as ‘red areas’ (NPWS, 2015). We employed two approaches to test the effectiveness of this mitigation strategy. Firstly, we performed a robust analysis to assess the effectiveness of the red area procedures in minimising disturbance to breeding Hen Harrier from forest management operations using data on known Hen Harrier nest locations (Section 2.1). This evidence-based review tests the effectiveness of the red area procedures based on their current implementation under a number of different scenarios (*i.e.* to determine if the red area procedures are successful in protecting breeding Hen Harrier based on their current design). Secondly, we performed a systematic review to collate and appraise available evidence on the design and implementation of the red area procedures (Section 2.2). The conclusions from these reviews in combination are used to inform the recommendations (Section 6).

### 2.1 Evaluation of the effectiveness of red area procedures

#### 2.1.1 Background

Here we set out to evaluate the effectiveness of the red area procedures as a mitigation strategy to minimise or prevent disturbance to Hen Harrier from forestry management activities (*i.e.* are the red area procedures effective in providing protection to breeding Hen Harrier). A comprehensive and accurate analysis of the effectiveness of the red area procedures (or any mitigation strategy) requires detailed data on:

- Strategy protocols (*i.e.* how and when red areas are designated)
- Strategy implementation details (*i.e.* which specific areas are designated as red areas)
- Species monitoring data (*i.e.* Hen Harrier population monitoring)

This assessment of the red area procedures in Ireland was constrained by data accessibility and availability in relation to the strategy protocols and the strategy implementation details. Specifically, we did not have access to the most recent data on red areas. The most recent red area data available to us was based on the 2015 national survey, therefore the red area data for the five years preceding this review (2016 to 2020 inclusive) was not available and not possible to include within the analysis. In addition, there were limitations with the red area data provided, as it was not possible to determine the date a particular red area was defined, and the source used to define each red area.

Due to these constraints, a methodology was developed to evaluate the effectiveness of the red area approach using existing and available data. This approach focused on testing the red area procedures (*i.e.* how the red areas are applied) based on actual Hen Harrier nest locations, *e.g.* testing whether red areas defined based on information on the location of breeding Hen Harrier in one year would be effective in protecting nest locations in the following year and in subsequent years. This provides an evidence-based evaluation of the effectiveness of the red area procedure under different scenarios in the Irish context (without using the actual red area spatial data which was not available to us or lacking in sufficient detail). The data constraints therefore did not affect our assessment of the effectiveness of the red area procedures but do serve to highlight existing issues which

can hinder the effectiveness of this or other mitigation strategies. Although it was not possible to use the red area data in this assessment, all of the nest locations used which are within the SPA network would have been used to define active red areas. This assessment was not confined to the SPA network (to which the red area procedures are primarily confined), but also included areas in the wider countryside which are important for breeding Hen Harrier. This was done in order to increase the sample size and to test the effectiveness of the red area approach in a wider range of situations (geographical, population size, population trend etc.) that are more biologically meaningful and applicable to the national Irish Hen Harrier population. A summary of this approach and key terms used are outlined below.

- Forestry metrics include the area in square km (km<sup>2</sup>) of red area effective, empty red area, and areas lacking protection. Red area effective areas are those areas of land defined as within a red area which in reference year 2 hold or are within 1.2 km of at least one Hen Harrier nest (i.e. red areas which are deemed to appropriately protect Hen Harrier nests). Empty red areas are those areas that despite being defined as a red area, do not hold a Hen Harrier nest and are more than 1.2 km from the nearest Hen Harrier nest in reference year 2. Areas lacking protection are those which are not defined as red areas but are within 1.2km of at least one Hen Harrier nest in reference year 2.

## 2.1.2 Methods

### Data collation

Breeding Hen Harrier data was collated to generate one of the largest data sets used for any study on breeding Hen Harrier ecology in Ireland to date (n = 791 nests). Data on Hen Harrier nesting locations was obtained from the following sources:

- Hen Harrier national survey 2000 (Norriss *et al.*, 2002, provided by NPWS).
- Hen Harrier national survey 2005 (Barton *et al.*, 2006, provided by NPWS).
- Hen Harrier national survey 2010 (Ruddock *et al.*, 2012, provided by NPWS).
- Hen Harrier national survey 2015 (Ruddock *et al.*, 2016, provided by NPWS).
- Planforbio project 2007-2011 (Irwin *et al.*, 2012, provided by UCC).
- WindHarrier project 2012-2013 (Wilson *et al.*, 2015, provided by UCC).
- Hen Harrier survey in the Mullaghareirks 2015 (Provided by Coillte).

Data collation and validation was adapted to the data format provided by each source.

- For national surveys, information was collated into a single file on all breeding records reported as “possible” or “confirmed breeding” for 2005, 2010 and 2015 surveys. For the 2000 survey, only confirmed breeding sites were collated. Sites with low spatial resolution (*i.e.* grid references of four digits or less in the Irish National Grid coordinate system) were discarded (low spatial resolution was only an issue for data from the 2000 and 2005 surveys).
- Data provided by UCC was collated into a single file.
- Data provided by Coillte was extracted from maps by mapping all “approximate nest locations” using ArcGIS 10.2.

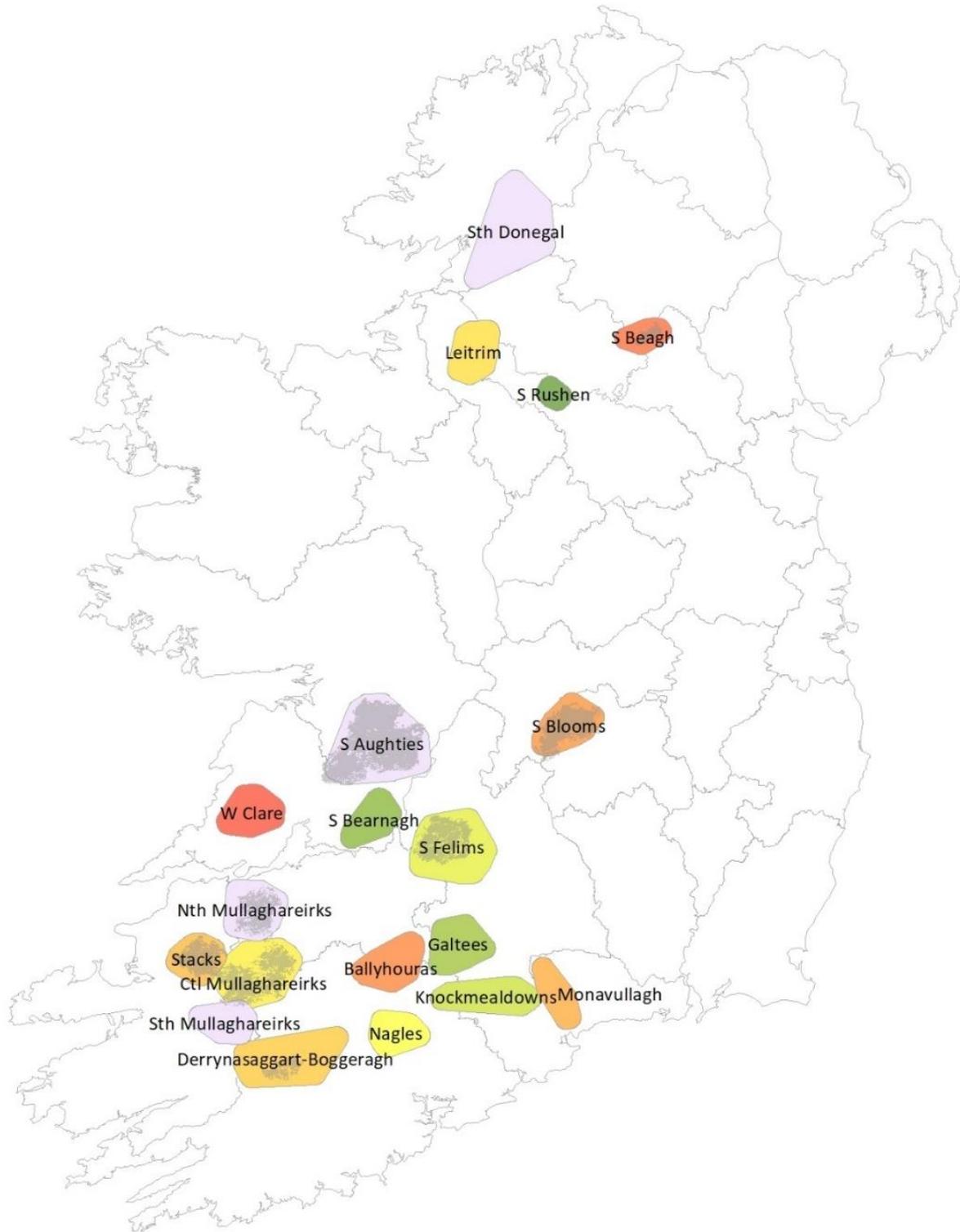
Once all data was collated, all nest sites were mapped using ArcGIS 10.2. As some records included duplicates (*i.e.* some 2010 data from the Planforbio UCC project and 2015 data from the Coillte red area project overlapped with the corresponding national surveys), where multiple records for the same nest had been collated, the record with the lowest resolution grid reference was discarded.

### Definition of study regions

Once all nest data had been collated and validated, a visual assessment of nest clusters combined with geographical information (e.g. upland areas, mountain ranges) and conservation areas (SPA's) was used to define study regions (Table 2.1 and Fig. 2.1). *Note that where regions overlap with SPA's, regions cover a larger area (based on location of nest data).*

**Table 2.1.** Regions defined in this study. Numbers indicate the total number of nests and number of nests by year. Note that not all nests/years were used in subsequent analyses (see below).

Area	N	1998	1999	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2015
<i>S Donegal</i>	22								3				5				14
<i>Sl. Beagh*</i>	18	3							4				6		2		3
<i>Leitrim</i>	14								1				5		1		7
<i>Sl. Rushen</i>	10								1				7				2
<i>Sl. Aughties*</i>	123	1		3	4	2	8		24	9	12	12	25	7		2	14
<i>Sl. Blooms*</i>	33		7						5				9				12
<i>W Clare</i>	74					1				10	12	12	17	6	6	2	8
<i>Sl. Bearnagh</i>	11	1							1				2				7
<i>Sl. Felims*</i>	54	3	3		2	2			7				14		5	6	12
<i>N Mullaghareirks*</i>	58	2	7		1	5	2		9		1		15				16
<i>Stacks*</i>	62	5	5	5					11	6	6	4	8		3	3	6
<i>C Mullaghareirks*</i>	108	9	8	10	1	3	3	11	20	3	3	3	12		5	1	16
<i>S Mullaghareirks</i>	12									2	4	2	3				1
<i>Ballyhouras</i>	99	3	4	1				6	17	11	14	10	15	6			12
<i>Galtees</i>	12								3				6				3
<i>Knockmealdowns</i>	12	1	1						2				2				6
<i>Monavullagh</i>	7		1	1					1				1				3
<i>Boggeraghs</i>	24	2	4			1		1	5				8				3
<i>Nagles</i>	38	2	3		2	2		4	9				11				5



**Figure 2.1.** Regions defined in this study. Note that where regions overlap with SPA's (in grey), regions cover a larger area (based on location of nest data).

## Analysis

Analysis of the effectiveness of red areas was based on dyads, comparing red areas designated from nest locations in a given year (reference year 1), to the locations of nests in a subsequent year (reference year 2). From all the available data (Table 1), dyads were chosen based on sufficient sample sizes to enable informative comparisons (*i.e.* sufficient number of nests in both years compared). In this sense, pre-2005 data were largely

discarded, due to the random nature of survey effort, inconsistencies in survey coverage, and anecdotal nature of many of the records during this period. After 2005, regions or years with small numbers of recorded nests (e.g. regions with records for 2012 and 2013 in Table 1) were also discarded from further analyses.

After initial assessment, 14 separate analyses were defined as possible (Tables 2.2 and 2.3). Dyads for analysis could be categorised in two ways. Firstly, based on temporal scale, five analyses were possible using large-scale data from national survey (lags of 5, 10, or 15 years between red area designation and comparison with active nest locations) and nine analyses were possible using finer-scale data from UCC projects (lags of 1 or 2 years between red area designation and comparison with active nest locations). Secondly, dyads could also be categorised as ‘single’ or ‘cumulative’, depending on whether red areas were designated based on data from a single year, or an accumulation of data from multiple years. Following this categorisation, there were four single and one cumulative analysis with 5-year lag national survey data, and six single and three cumulative analyses with 1 or 2-year lag UCC data.

**Table 2.2.** Based on the quality and availability of nest location data, the following dyads were defined for analysis based on national survey data with 5, 10 or 15 year lags between red area designation and comparison with active nest locations.

<i>Area</i>	<i>Single Lag: 15yr 2000-2015</i>	<i>Single Lag: 10yr 2005-2015</i>	<i>Single Lag: 5yr 2005-2010</i>	<i>Single Lag: 5yr 2010-2015</i>	<i>Cumulative Lag: 5 yr 05/10-2015</i>
<i>S Donegal</i>		X	X	X	X
<i>Sl. Beagh*</i>		X	X	X	X
<i>Leitrim</i>		X		X	
<i>Sl. Rushen</i>		X	X	X	X
<i>Sl. Aughties*</i>		X	X	X	X
<i>Sl. Blooms*</i>		X	X	X	X
<i>W Clare</i>				X	
<i>Sl. Bearnagh</i>		X	X	X	X
<i>Sl. Felims*</i>		X	X	X	X
<i>N Mullaghareirks*</i>		X	X	X	X
<i>Stacks*</i>		X	X	X	X
<i>C Mullaghareirks*</i>	X	X	X	X	X
<i>S Mullaghareirks</i>				X	
<i>Ballyhouras</i>		X	X	X	X
<i>Galtees</i>		X	X	X	X
<i>Knockmealdowns</i>		X	X	X	X
<i>Monavullagh</i>		X	X	X	X
<i>Boggeraghs</i>		X	X	X	X
<i>Nagles</i>		X	X	X	X

**Table 2.3.** Based on the quality and availability of nest location data, the following dyads were defined for analysis based on UCC project data with 1 or 2 year lags between red area designation and comparison with active nest locations.

<i>Area</i>	<i>Single Lag: 2 yr 2007- 2009</i>	<i>Single Lag: 2 yr 2009- 2011</i>	<i>Single Lag: 1 yr 2007- 2008</i>	<i>Single Lag: 1 yr 2008- 2009</i>	<i>Single Lag: 1 yr 2009- 2010</i>	<i>Single Lag: 1 yr 2010- 2011</i>	<i>Cumulative Lag: 1 yr 07/08-2009</i>	<i>Cumulative Lag: 1 yr 07/09-2010</i>	<i>Cumulative Lag: 1 yr 07/10-2011</i>
<i>S Donegal</i>									
<i>Sl. Beagh*</i>									
<i>Leitrim</i>									
<i>Sl. Rushen</i>									
<i>Sl. Aughties*</i>	X	X	X	X	X	X	X	X	X
<i>Sl. Blooms*</i>									
<i>W Clare</i>	X	X	X	X	X	X	X	X	X
<i>Sl. Bearnagh</i>									
<i>Sl. Felims*</i>									
<i>N Mullaghareirks*</i>									
<i>Stacks*</i>									
<i>C Mullaghareirks*</i>									
<i>S Mullaghareirks</i>									
<i>Ballyhouras</i>	X	X	X	X	X	X	X	X	X
<i>Galtees</i>									
<i>Knockmealdowns</i>									
<i>Monavullagh</i>									
<i>Boggeraghs</i>									
<i>Nagles</i>									

## GIS analysis

All analyses were performed using ARCGIS 10.2. For each of the 14 dyad analyses, separate shapefiles were created for:

- Shapefile 1: nests in reference year 1.
- Shapefile 2: nests in reference year 2.
- Shapefile 3: 1.2 km buffer around nests in reference year 1 (using the ArcGIS “buffer” function). These are the areas designated as red areas.
- Shapefile 4: 1.2 km buffer around nests in reference year 2 (using the ArcGIS “buffer” function). These are the areas that should be protected for effective Hen Harrier conservation.
- Shapefile 5: areas of overlap between shapefile 3 and shapefile 4 (using the ArcGIS “intersection” function). These are the areas correctly protected.
- Shapefile 6: 500m buffer around nests in reference year 2 (using the ArcGIS “buffer” function). These buffers were used to identify nests that were fully protected, partially protected, or not protected (see below).

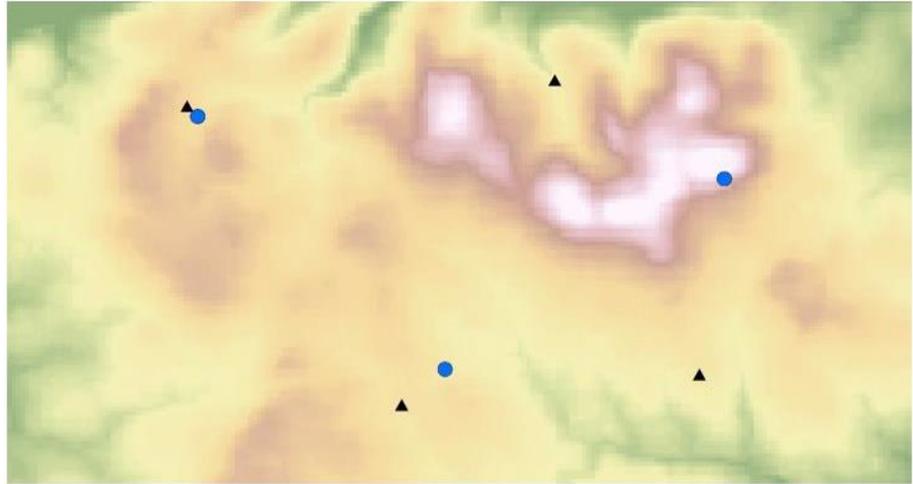
- Shapefile 7. Minimum convex polygon of shapefile 3 and shapefile 4 (using the ArcGIS “minimum bounding geometry” function). This shapefile was used to calculate the nest density (see below).

Once all the above shapefiles were generated for a dyad, a spreadsheet with the following parameters was generated:

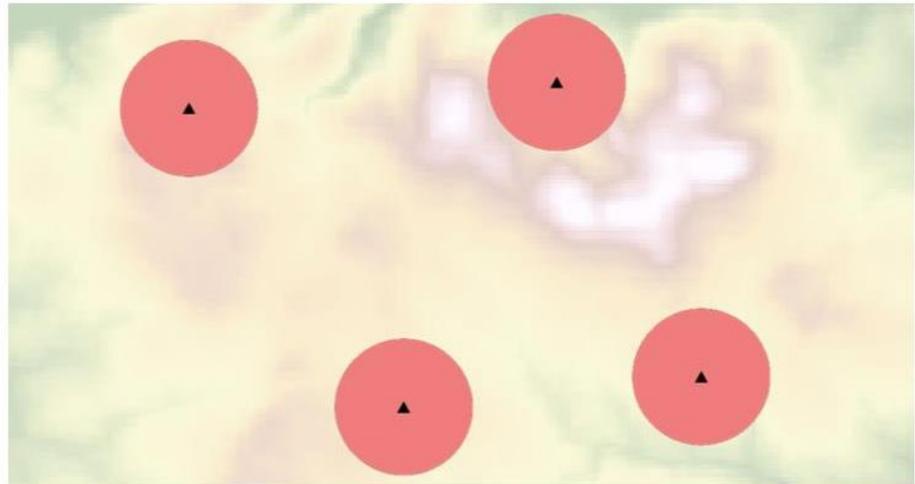
- *Approach*: single/cumulative.
- *Years of data*: number of years’ data used to generate red areas (1 in the case of single analyses, 2-4 in the case of cumulative analyses).
- *Lag*: number of years between reference year 1 and reference year 2. In the case of cumulative analyses, the number of years between the last year used to generate red areas and reference year 2.
- *Year 1*: year used to designate red areas.
- *Year 1b-d*: additional years used in cumulative analyses.
- *Year 2*: year used to assess location of nests.
- *Region*: study region.
- *Nests 1*: nests in reference year 1. In the case of cumulative analyses, nests in the last year used to generate red areas.
- *Nests 2*: nests in reference year 2.
- *Trend*: number of nests in reference year 2 minus number of nests in year 1 divided by number of nests in reference year 1.  $Trend = (Nests\ 1 - Nests\ 2) / Nests\ 1$ .
- *Minimum polygon*: area in km<sup>2</sup> of the minimum convex polygon containing shapefile 3 and shapefile 4.
- *Density*: number of nests in reference year 1 divided by the area of the minimum polygon.  $Density = Nests\ 1 / Minimum\ polygon$ .
- *Protected*: number of nests in reference year 2 (shapefile 2) and corresponding 500m buffers (shapefile 6) fully within red areas (shapefile 3).
- *Part protected*: number of nests in reference year 2 (shapefile 2) within red areas (shapefile 3) with part of their corresponding 500m buffers (shapefile 6) outside of the red area (shapefile 3).
- *Not protected*: number of nests in reference year 2 (shapefile 2) outside red area (shapefile 3).
- *Percentage protected*: percentage of nests fully protected.  $Percentage\ protected = (Protected / Nests\ 2) * 100$ .
- *Percentage part protected*: percentage of nests partially protected.  $Percentage\ part\ protected = (Part\ protected / Nests\ 2) * 100$ .
- *Percentage not protected*: percentage of nests not protected.  $Percentage\ not\ protected = (Not\ protected / Nests\ 2) * 100$ .
- *Red area area*: area of shapefile 3 in km<sup>2</sup>.
- *Nests reference year 2 area*: area of shapefile 4 in km<sup>2</sup>.
- *Red area intersect*: area of shapefile 5 in km<sup>2</sup>.
- *Red area effective*: area of red area in km<sup>2</sup> within 1.2km of one or more Hen Harrier nests in reference year 2.  $Red\ area\ effective = Red\ area\ intersect$ .
- *Red area empty*: area of red area in km<sup>2</sup> further than 1.2km from any Hen Harrier nests in reference year 2.  $Red\ area\ empty = Red\ area\ 1\ area - Red\ area\ intersect$ .
- *Protection lacking*: area in km<sup>2</sup> within 1.2km of Hen Harrier nests in reference year 2 not designated as a red area.  $Red\ area\ lacking = Nests\ year\ 2\ area - Red\ area\ intersect$ .

A graphical representation of the methodology described, using hypothetical nest data is shown below in Figure 2.2.

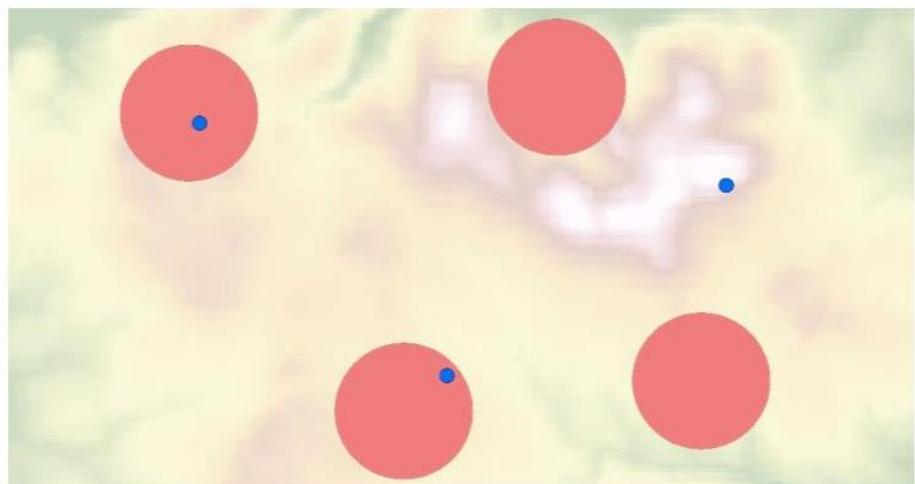
**Step 1.**  
Data is collected on nests recorded in year 1 (black triangles) and year 2 (blue circles).



**Step 2.**  
Red zones (1.2 km buffers) are designated around year 1 nests.

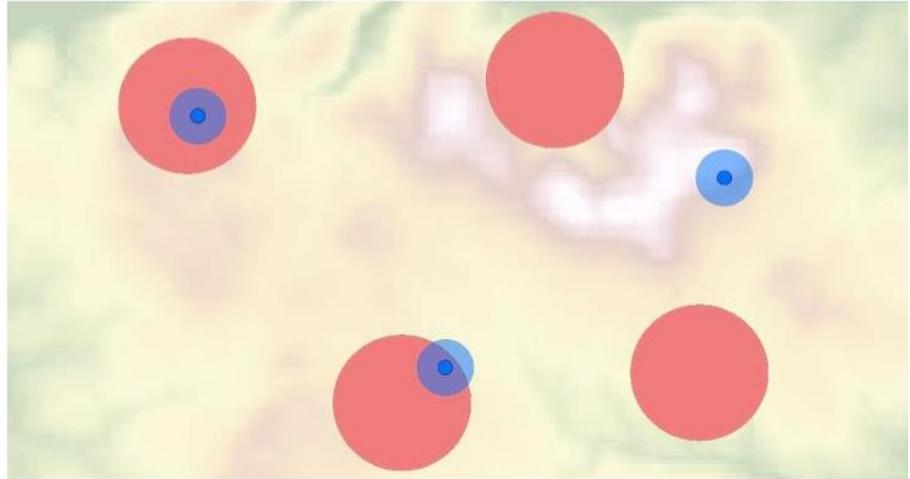


**Step 3.**  
Designated zones are then compared to the location of nests in year 2 (blue circles).



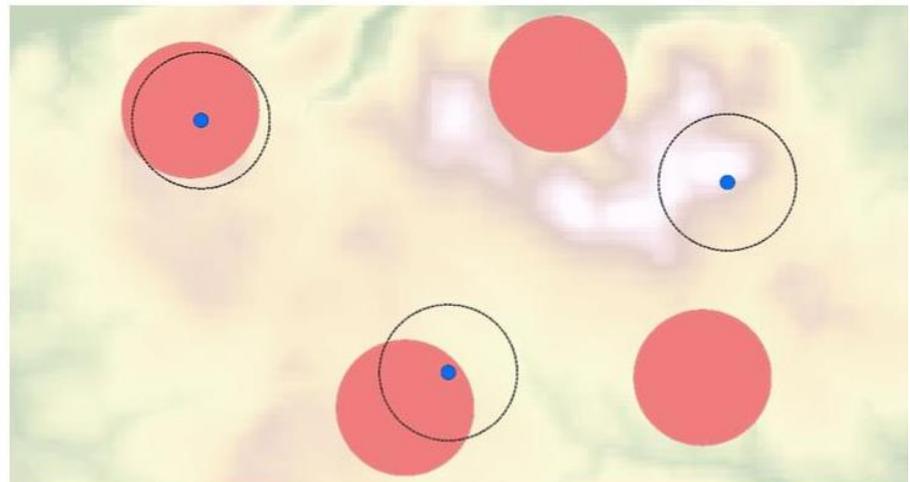
**Step 4.**

Nests (blue circles) are considered to be protected if the nest is at least 500m (blue buffers) from the edge of the red zone (top left corner). Nests are partially protected if the nest lies within 500m of the red zone limit (bottom). Nests are unprotected if they lie outside the red zones (far right).



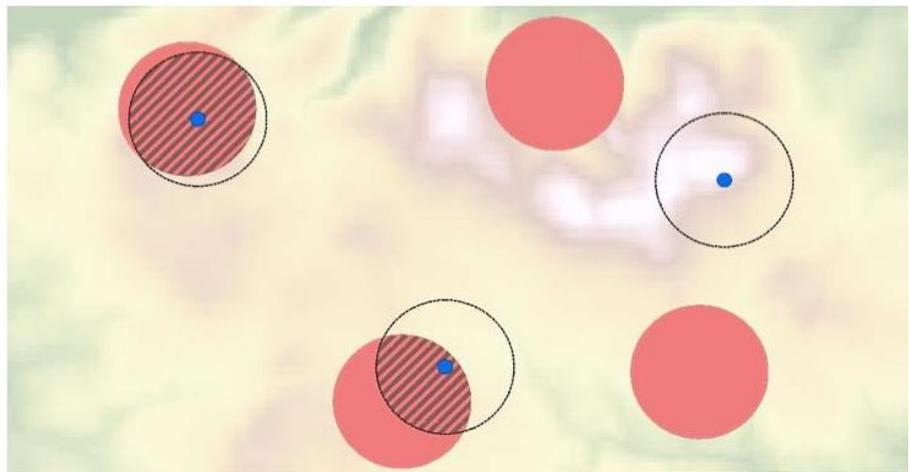
**Step 5.**

By creating a buffer around nests in year 2 (transparent circles), it is possible to evaluate the areas that should have been protected Hen Harrier nests, and compare these to the designated red zones.

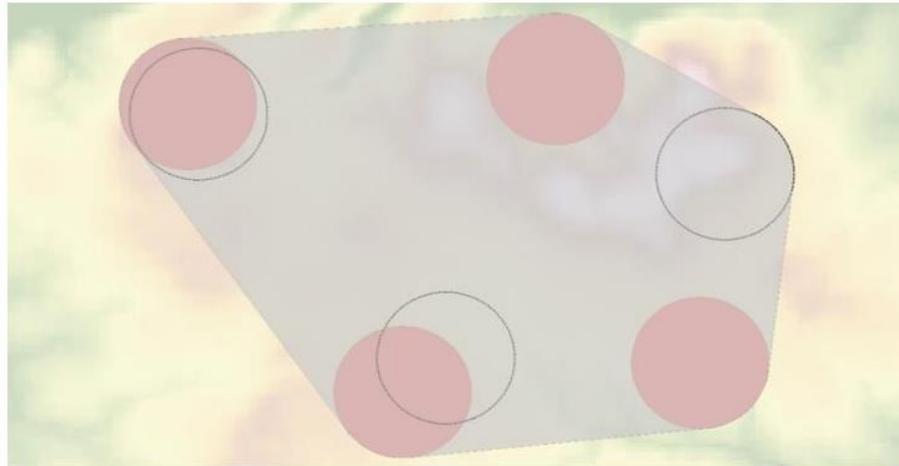


**Step 6.**

Red zone effective areas are those overlapping between both buffers (shaded), empty red zones are areas designated as red zones despite holding no nests (red), and areas lacking protection are those unprotected despite holding nests (transparent).



**Step 7.**  
A minimum convex polygon of all 1.2km buffers in year 1 and year 2 (shaded) was used to calculate a value for the rest of the region area and nest density for that dyad.



**Figure 2.2.** Steps followed during GIS analysis to evaluate effectiveness of the red area procedures (locations of nests depicted in this example are hypothetical)

### 2.1.3 Results

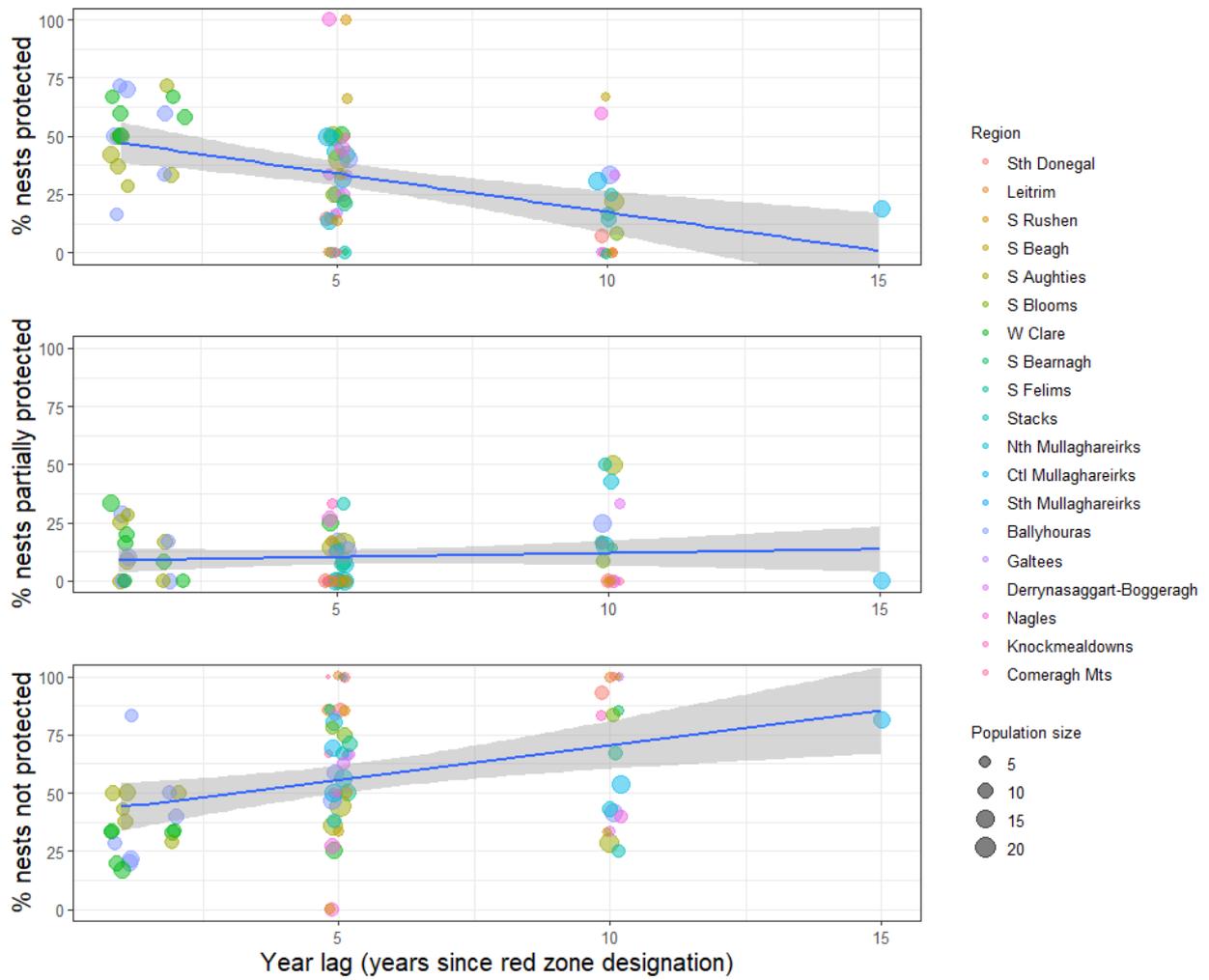
Detailed results from the analyses are available in Appendix B. Summarised findings on mitigation and forestry metrics are presented below.

#### **Red area effectiveness in relation to time since they were defined**

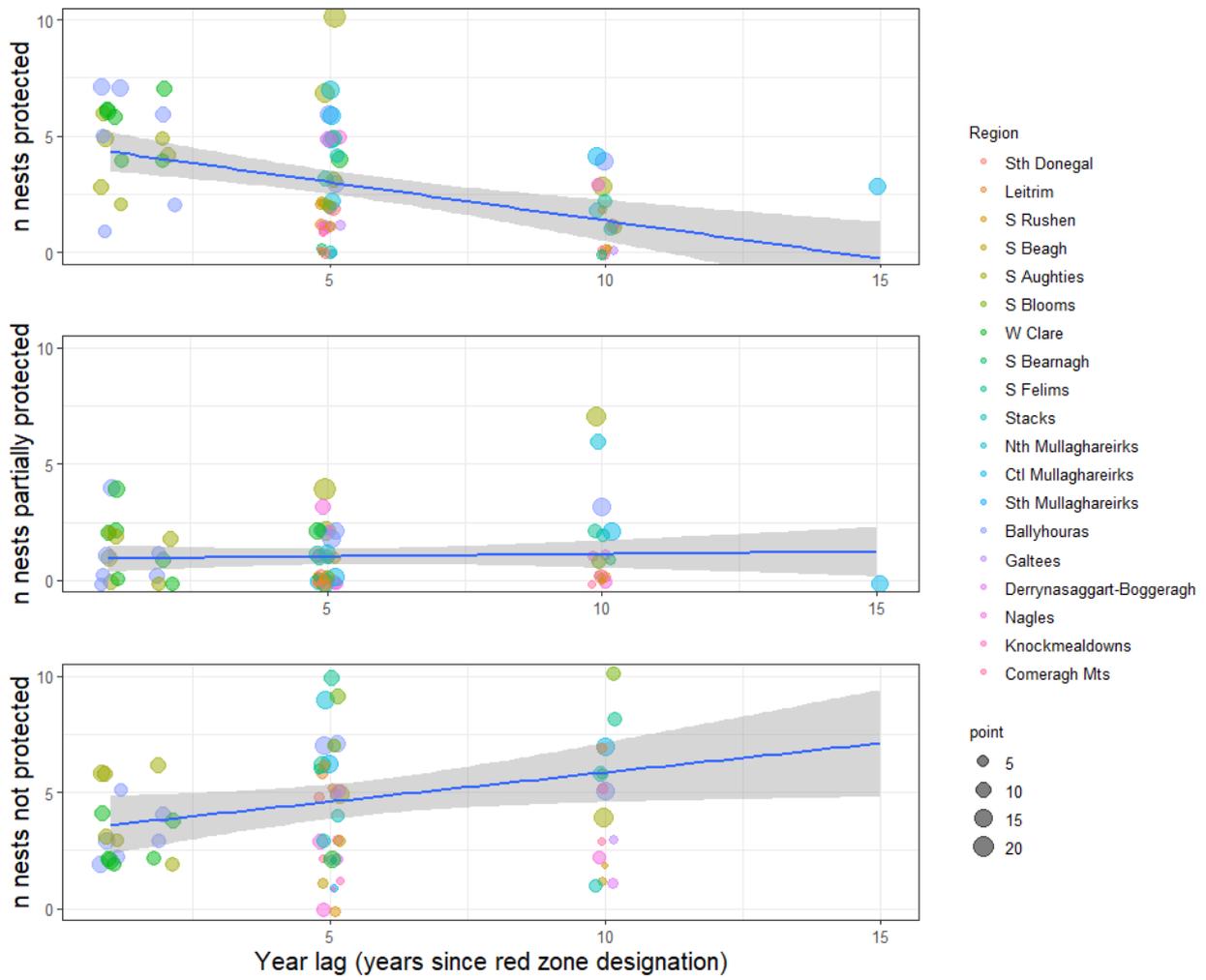
Based on our analysis, the effectiveness of red area procedures in protecting Hen Harrier nest sites decreased with increased time since the red areas were defined. Both the percentage (Fig. 2.3) and number of nests (Fig. 2.4) protected by the red area procedures dropped substantially with time since red area were defined increased. Conversely to this drop in the percentage and number of nests effectively protected, nests lacking protection were found to increase as time since red areas were defined increased. In other words, nests were more likely to be protected when red area were defined based on nest locations from the previous two years.

However, it is worth noting that even for short year lags between red area being defined (1-2 years), red area effectiveness was relatively low and highly variable, with an average of 50% of nests protected depending on the region (range of 15-75%).

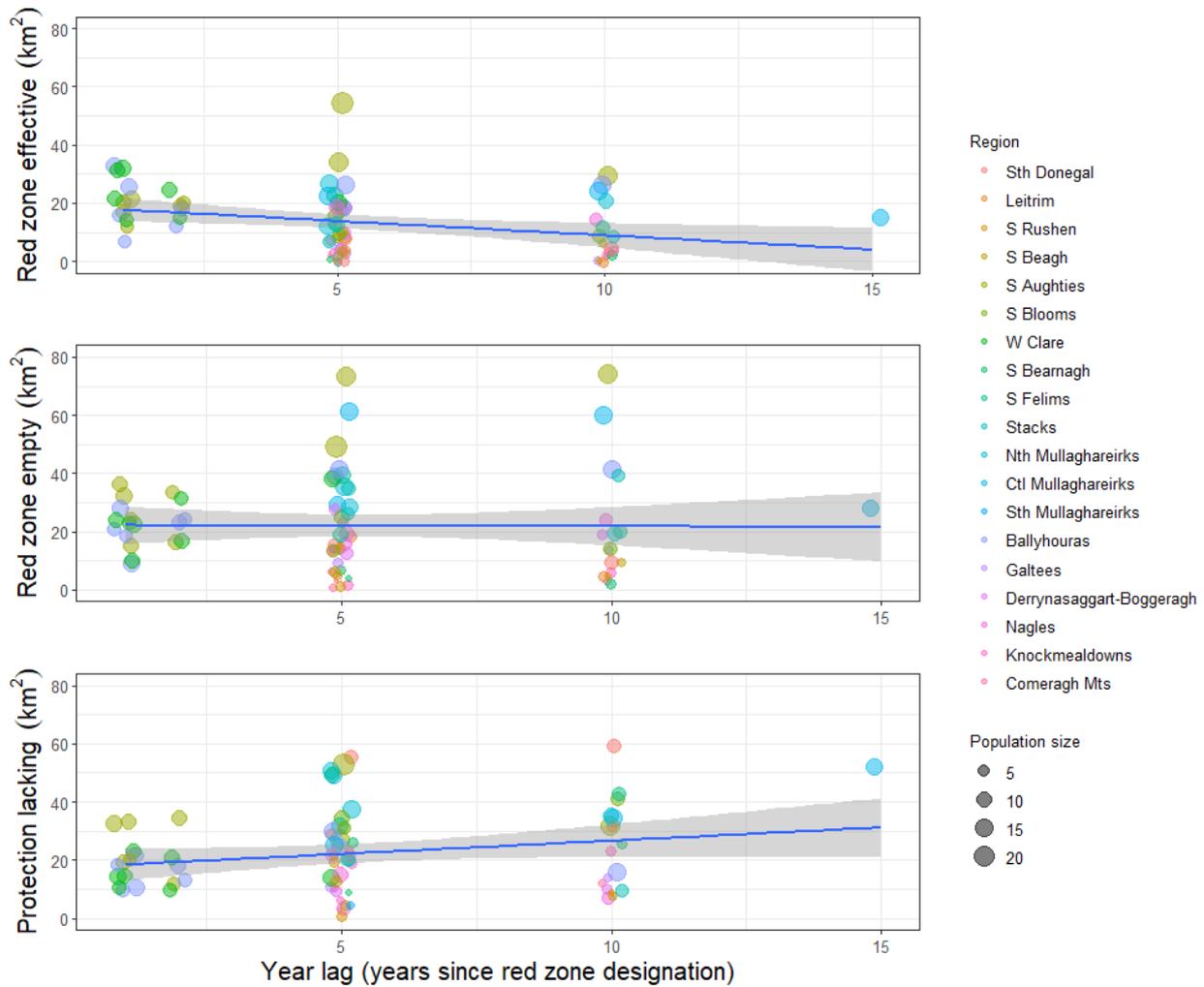
These patterns also hold true for the area (km<sup>2</sup>) effectively protected by the red area procedure (Fig. 2.5), with the areas effectively contributing to active nest protection decreasing with time from when a red area was defined. It is worth noting that the area of empty red area (areas defined as red areas but not holding any nests) are highly variable, but on average remain constant as time since red areas were defined increases.



**Figure 2.3.** Percentage of nests protected, partially protected, and not protected according to year lag (the number of years since red areas were defined). Key points to note are drop in % of nests protected as year lag increases (and red areas are informed by older data); even for short year lags, % of nests protected averages 50% and is highly variable.



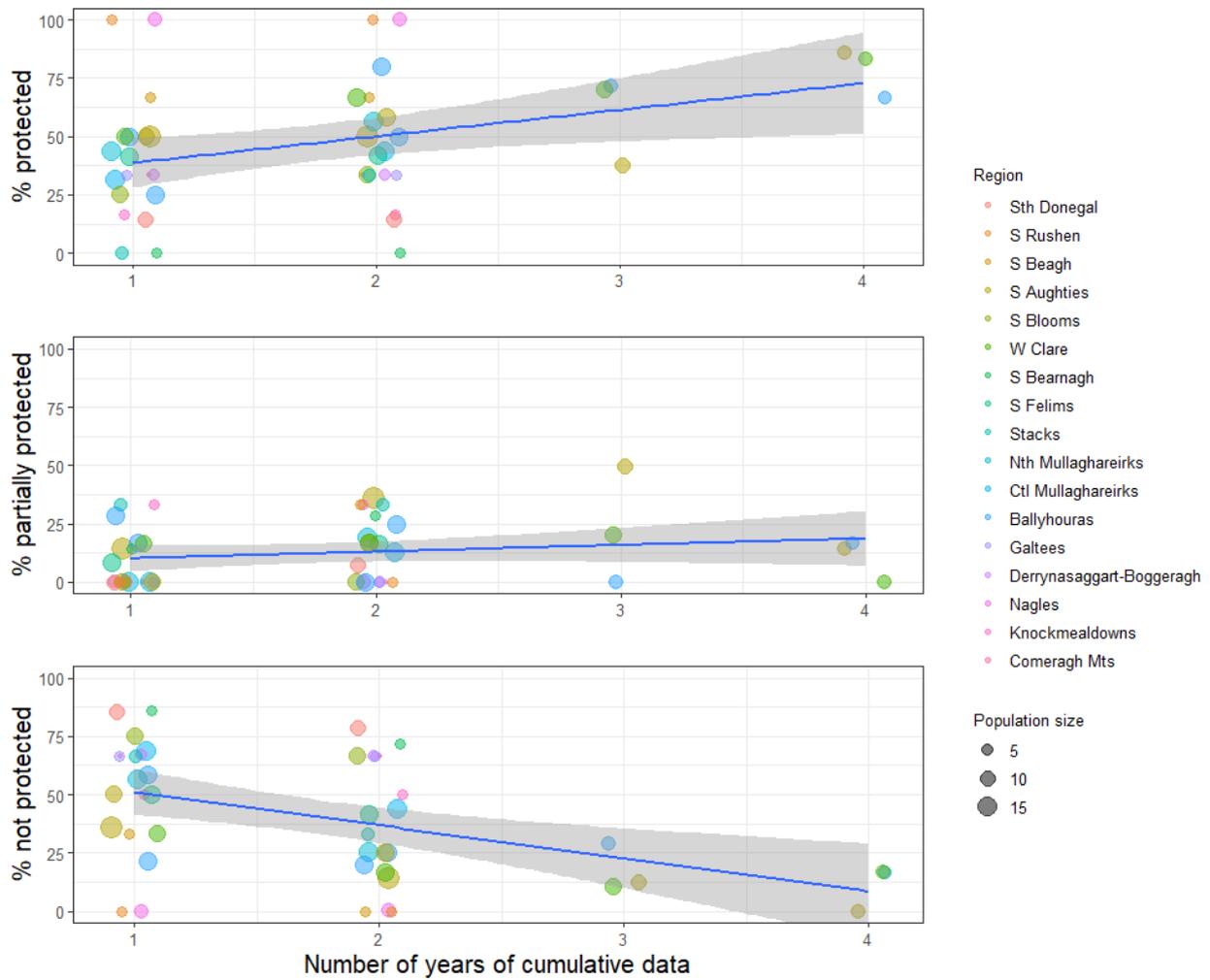
**Figure 2.4.** Number of nests protected, partially protected, and not protected according to year lag (the number of years since red areas were defined). Note this figure represents the same data as Fig. 2.3, but in numbers instead of percentages. Key points to note are that patterns are similar to percentages in Fig. 2.3, indicating that these patterns are not due to differences in population sizes between regions.



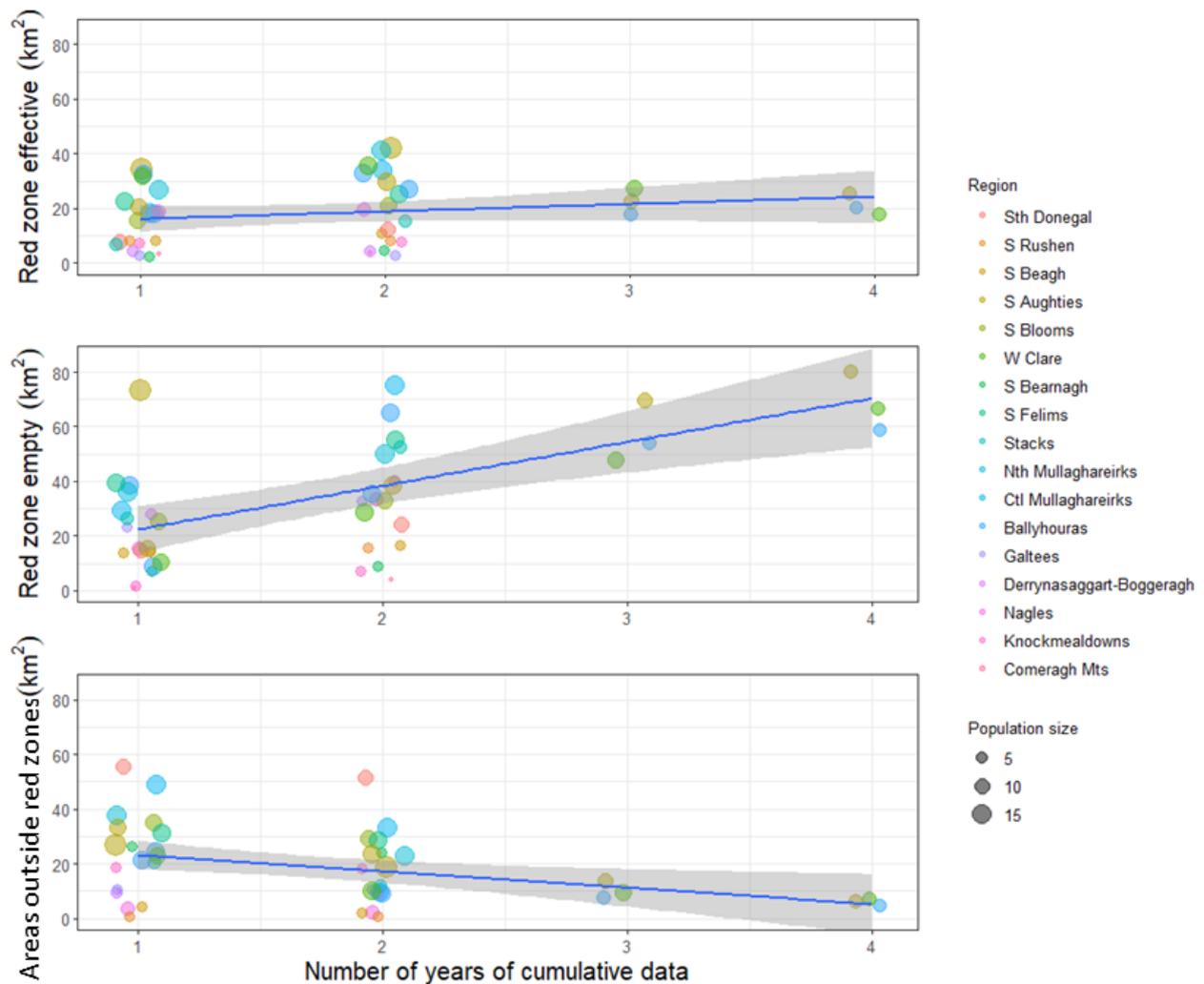
**Figure 2.5.** Areas (in km<sup>2</sup>) effectively protected by red areas, defined as red areas but not holding any nests, and lacking protection in relation to year lag (the number of years since red areas were defined). Key points to note are that patterns are similar to those in Fig. 2.3 and Fig. 2.4.

### Red area effectiveness in relation to number of years' data contributing to the red areas being defined (single vs. cumulative approaches)

Cumulative approaches were more effective as the number of years contributing to red areas being defined increased (Fig. 2.6). This is due to the fact that, as more years' were used to define red areas, increasingly larger areas were protected, and the likelihood of nests being within red areas increased. Despite this trend, this approach still left some nests unprotected, even when combining data from four years.



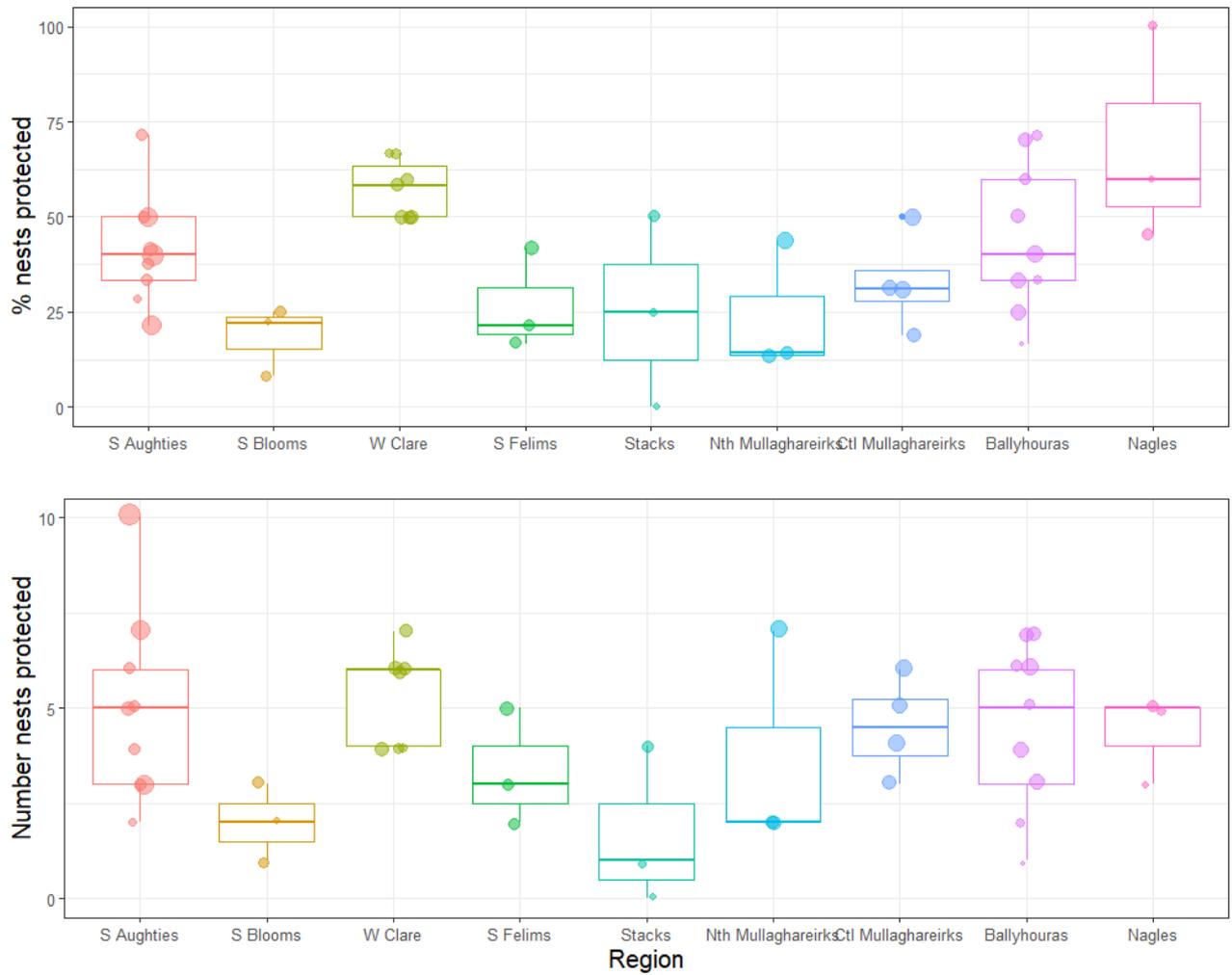
**Figure 2.6.** Percentage of nests protected, partially protected, and not protected in relation to the number of years' contributing data to red areas being defined. Note that values for one year of data (i.e. single) correspond to the same areas in the first year that then contributes to successive cumulative approaches. Key points to note are increase in percentage of protected nests as more years contribute to red areas being defined; high variability despite this trend; some nests still remain unprotected despite this trend.



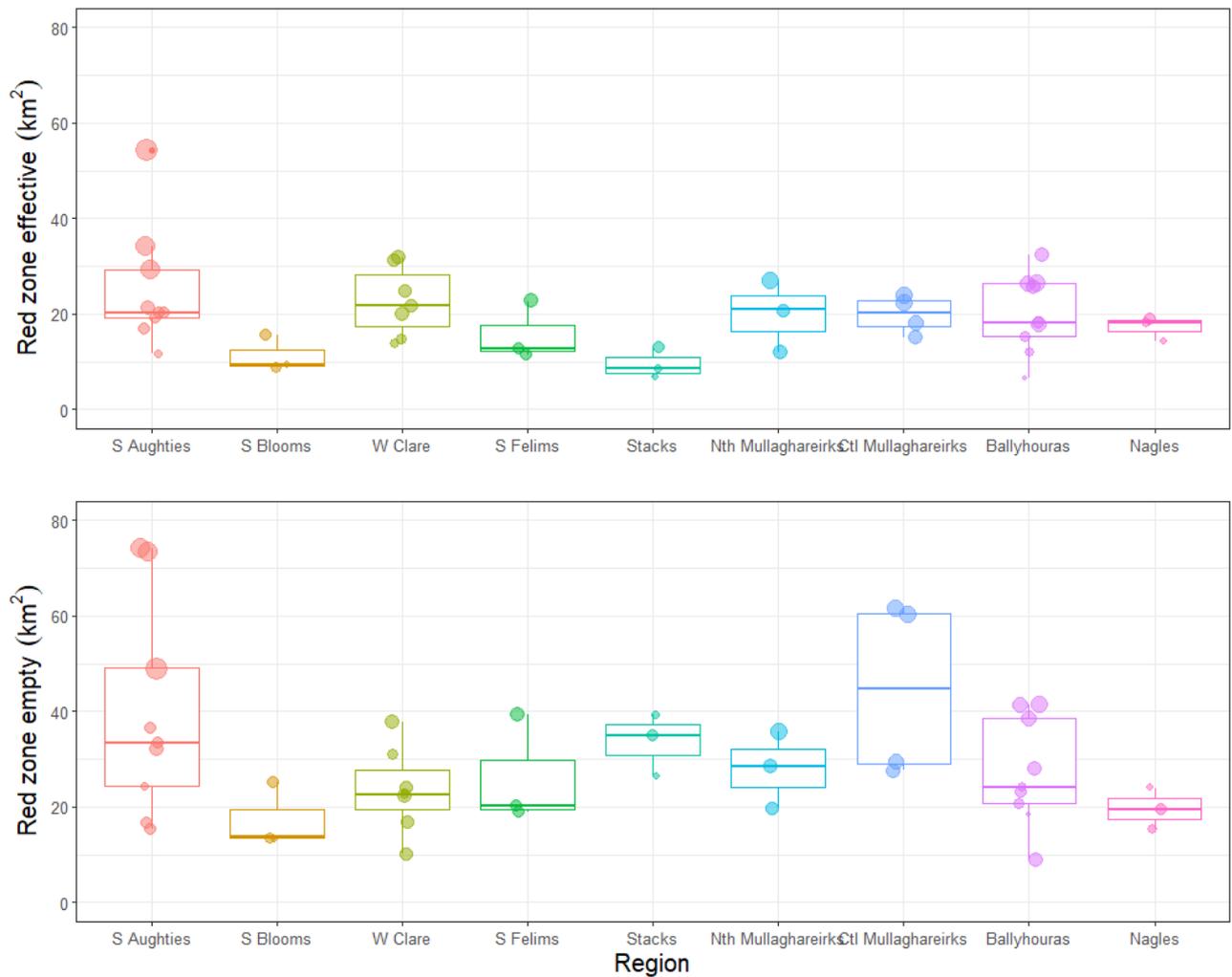
**Figure 2.7.** Areas (in km<sup>2</sup>) effectively protected by red areas, defined as red areas but not holding any nests, and lacking protection in relation to the number of years' contributing data to red areas being defined. Key points to note are that while the total red area area that is effective shows a slight increase as more years' data contribute to red areas being defined, the empty red area area (i.e. areas defined as red areas despite not holding nests) increases substantially as more years' data are used to define red areas.

### Red area effectiveness by region

Determining the patterns of red area effectiveness by region is limited by the sample size available for analyses, even when excluding regions with small numbers of nests (Figs. 2.8 and 2.9). The patterns observed here are largely influenced by the different types of data available (for some regions it was possible to conduct 1-year lag comparisons, whereas for others only 5-year comparisons based on national survey data were possible). Identifying region-specific patterns is therefore likely speculative and would require more detailed data than that available for this analysis. However, it is worth noting that red area effectiveness appears to be variable between regions (red areas were more effective in some regions than others), and that the variation in effectiveness also appears to be region-specific (some regions tended to have more variation in effectiveness metrics than others).



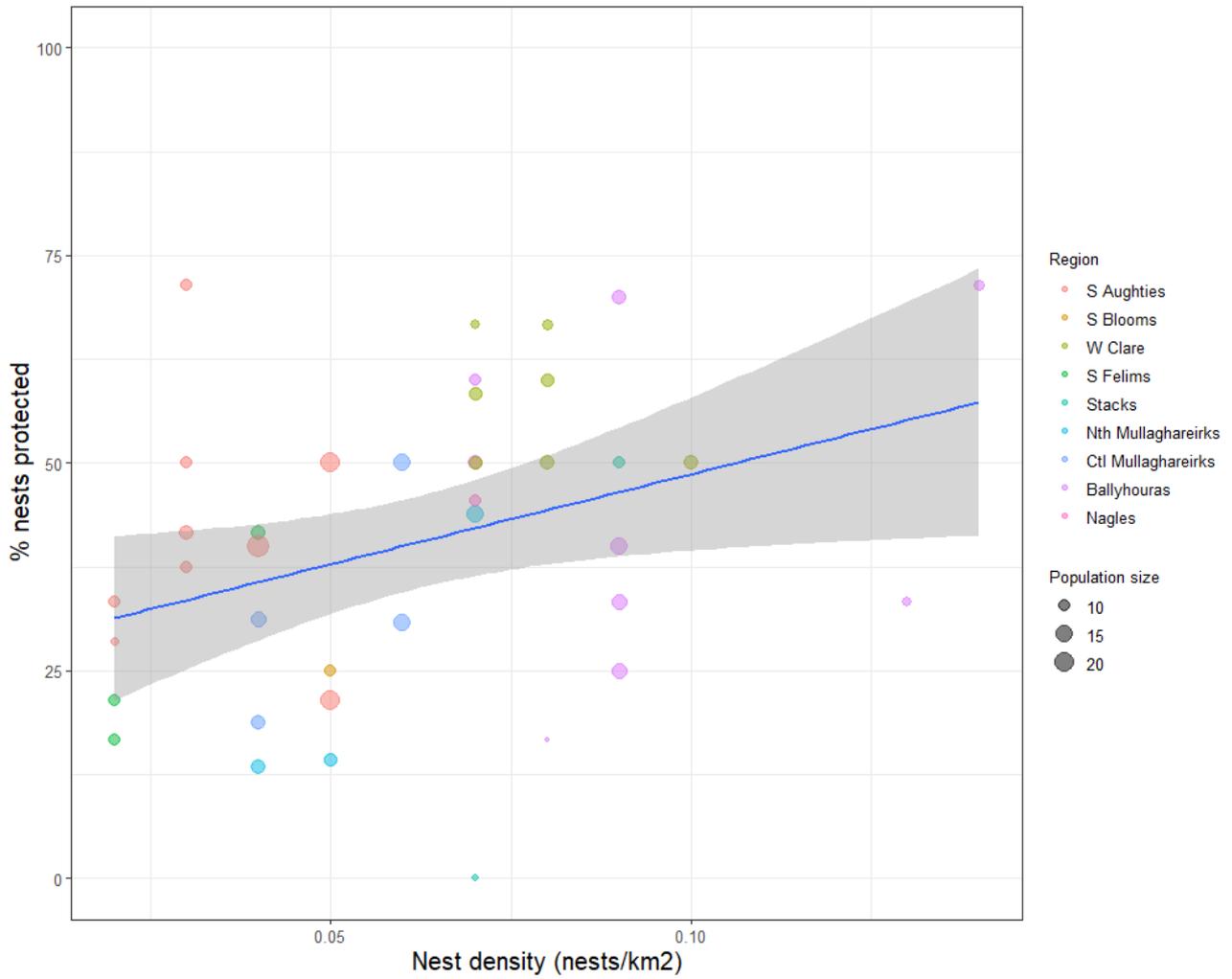
**Figure 2.8.** Percentage and number of nests effectively protected by region. Note that this graph only uses data from single approaches but combines different year lag dyads (e.g. Slieve Blooms data is from 5-year lag comparisons whereas West Clare data also includes 1- and 2-year lag comparisons). Key points to note are that both average values and variation appear to be region specific.



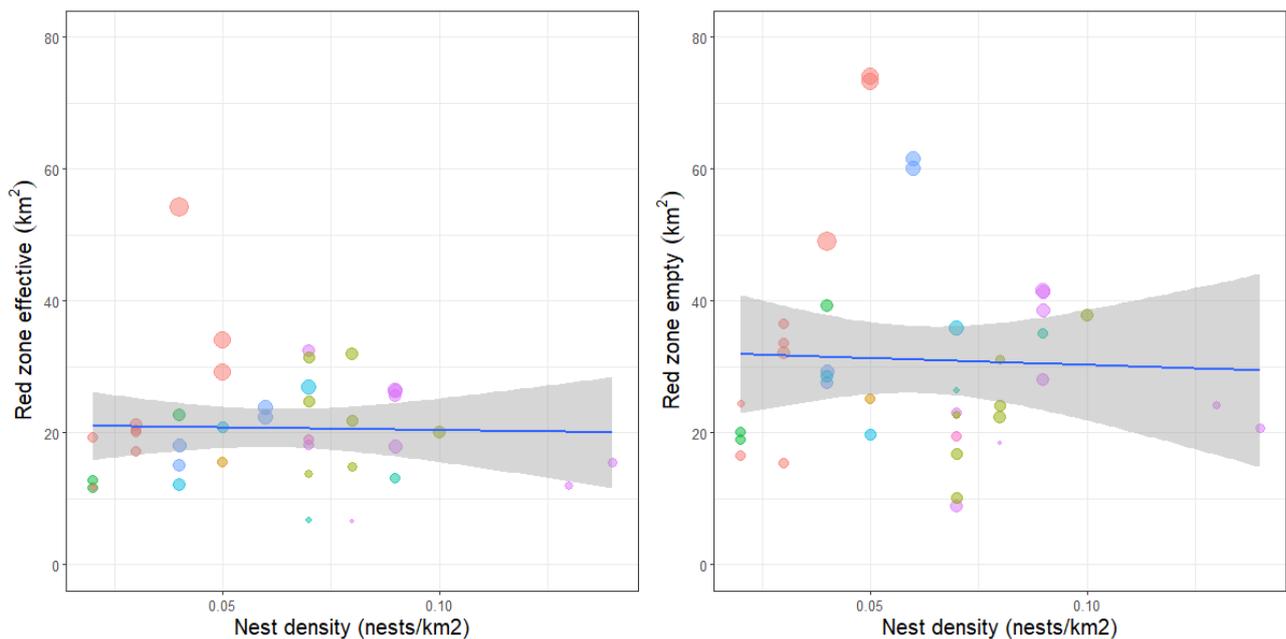
**Figure 2.9.** Area of effective red area and empty red area by region. Note that this graph only uses data from single approaches but combines different year lag dyads (e.g. Slieve Blooms data is from 5-year lag comparisons whereas West Clare data also includes 1- and 2-year lag comparisons). *Key points to note are that both average values and variation appear to be region specific.*

### Red area effectiveness in relation to nest density

Red areas appeared to be more effective in areas with higher nest density (Fig. 2.10), but nest density bore no influence on the areas (km<sup>2</sup>) of effective or empty red area (Fig. 2.11). These patterns are likely related to the geographical configuration of the regions where higher nest densities were recorded, as due to their small sizes (and therefore more limited nesting opportunities), Hen Harrier were more likely to nest in or close to areas they had nested before (i.e. red areas).



**Figure 2.10.** Percentage of nests effectively protected by nest density in reference year 1 (year red area was defined). Note that dyads with less than 5 nests in reference year 1 or reference year 2 were excluded from this analysis. *Key points to note are that the percentage of protected nests appears to be higher for regions with higher nest density.*

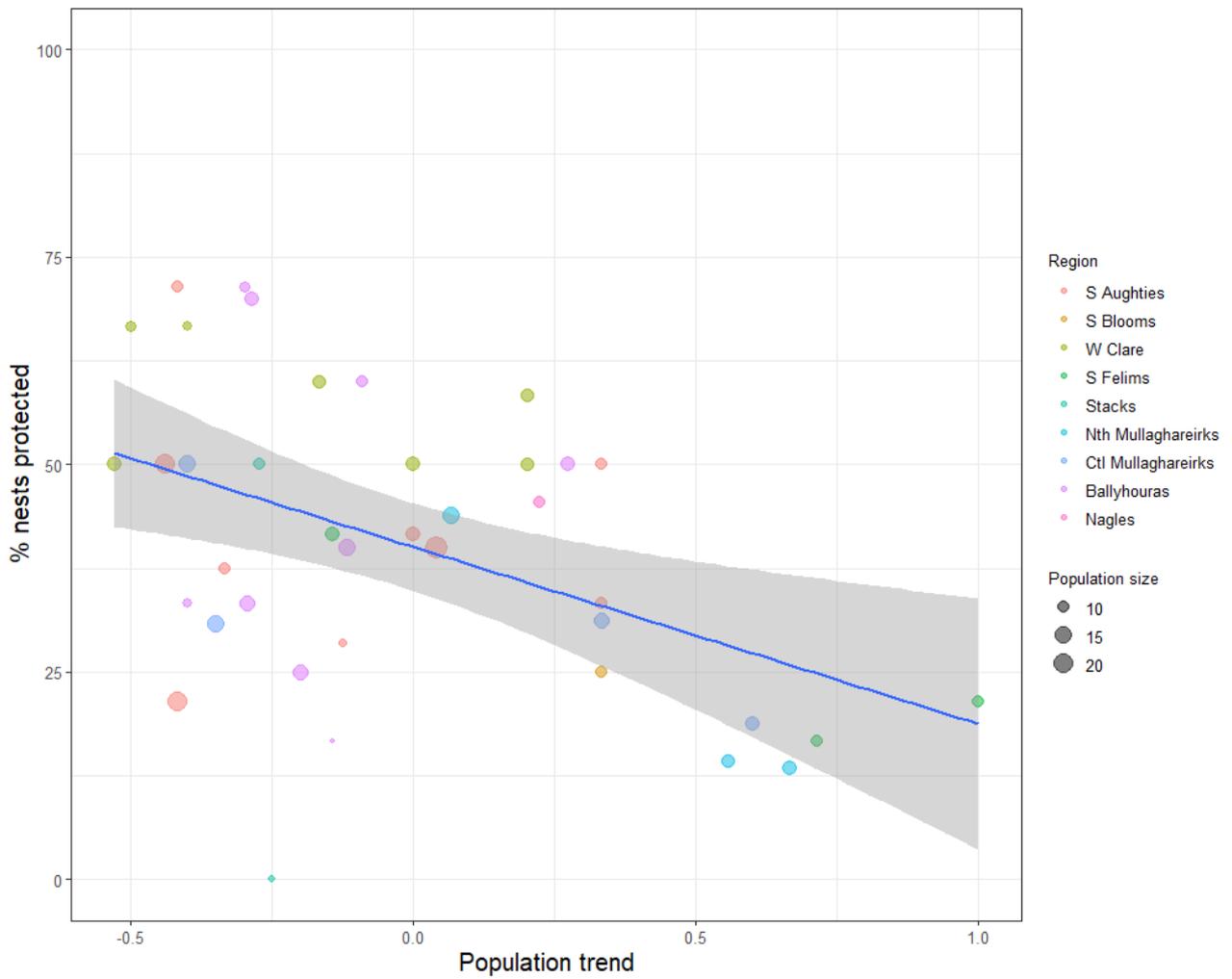


**Figure 2.11.** Area of effective red area and empty red area by nest density in reference year 1 (year red area was defined). Note that dyads with less than 5 nests in reference year 1 or reference year 2 were excluded from this analysis. *Key points to note are that there appear to be no patterns as those observed Fig. 2.10.*

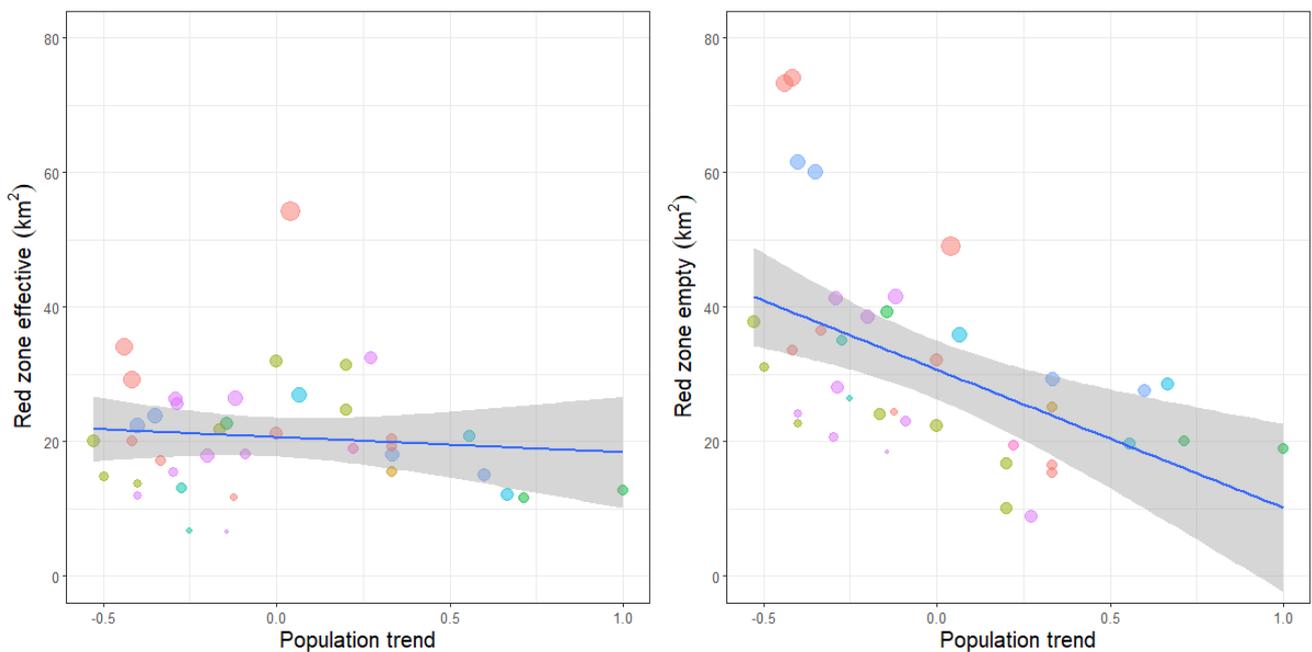
---

### **Red area effectiveness in relation to population trend**

Red areas were less effective for increasing than decreasing populations (Fig. 2.12). However, the total area of empty red areas declined in growing populations (Fig. 2.13). These patterns are explained by the changes in the number of red areas relative to nests as a consequence of population trends. For example, decreasing populations (more nests in reference year 1 than reference year 2) had more red areas than nests when assessed, making it more likely that nests were located with red areas and increasing their effectiveness. However, for growing populations (more nests in reference year 2 than reference year 1), there were less red areas than nests in reference year 2. While this may appear logical (it is impossible to pre-emptively define a red area for a new pair), it may have serious consequences at a population level. For growing populations that have more nests than at the time red areas are defined, these nests are likely to be outside of protected areas, and thus more exposed to disturbance and less likely to successfully fledge young.



**Figure 2.12.** Percentage of nests protected by change in number of pairs between reference year 1 and reference year 2 (population trend). Note that dyads with less than 5 nests in reference year 1 or reference year 2 were excluded from this analysis. Key points to note are that the percentage of nests effectively protected is higher for decreasing populations and lower for growing populations.



**Figure 2.13.** Area of effective red area and empty red area by change in number of pairs between reference year 1 and reference year 2 (population trend). Note that dyads with less than 5 nests in reference year 1 or reference year 2 were excluded from this analysis. Key points to note are that contrary to the lack of patterns observed in Fig. 11, area of empty red area declined for increasing populations.

## 2.1.4 Conclusions

The percentage of Hen Harrier nests that are effectively protected by the red area procedures defined by this analysis ranged between 0% and 100% per study region. Red area effectiveness was highest when informed by nest locations in the previous two years, with an average of 50% of nests effectively protected (range of 15-75%). Red area effectiveness decreased as year lag (years since red areas were defined) increased. Cumulative approaches (multiple years informing red areas) increased the percentage of protected nests by increasing the total area protected, but still left some nests unprotected (i.e. outside red areas). Cumulative approaches increased the number of empty red area areas (areas defined as red areas not holding Hen Harrier nests).

Our analysis also shows that the effectiveness of red areas in protecting Hen Harrier nests appears to be region-specific, with variability in the effectiveness of this mitigation strategy across different regions. The percentage of Hen Harrier nests which were effectively protected by the red area procedure was higher in regions with high nest density, likely due to limited alternative nesting opportunities outside of red areas. The percentage of nests which were protected by the red area procedure was higher for Hen Harrier populations that were declining (*i.e.* a downward trend in numbers over the monitoring period) compared to increasing populations. We showed that the red area procedure may be constraining Hen Harrier population growth by not protecting new nests which appear outside of red areas.

## 2.2 Critical review of the implementation of red area procedures

### 2.2.1 Background

The red area procedures (as detailed in Section 1.3.2) are designed to protect breeding Hen Harrier from forest management related disturbances in the breeding Hen Harrier SPA network (Forest Service, 2012). The red area procedures have undoubtedly provided protection to Hen Harrier breeding attempts and nest sites from disturbance from forest management activities within the breeding Hen Harrier SPAs since their implementation in 2012 (DAFM, 2012; DAFM 2015) and as shown by our review (Section 2.1). The red area procedures implement the largest seasonal disturbance-free zone (or red areas) for Hen Harrier throughout their range (Ruffino, 2016), and the largest disturbance-free zone for any bird species in Ireland in relation to forest management operations. However, the size of the disturbance-free zone does not in itself ensure the effectiveness of a mitigation strategy, as protection measures need to be appropriately targeted spatially and temporally in order to be effective in providing the appropriate protection. All mitigation strategies should be reviewed to assess their effectiveness, to identify where improvements are required and to take into consideration new information available. Devising and implementing effective mitigation for a species which is highly mobile, with a widespread distribution and which is not necessarily faithful to specific nest locations in each year is inherently challenging, and this reinforces the importance of reviewing initial iterations of mitigation strategies to apply lessons and refine accordingly. A previous review of the red area procedures assessed the approach of identifying areas where the probability of containing nesting Hen Harriers was relatively high (informed by 2010 and 2015 national Hen Harrier Survey data) and set out to define areas that have a higher likelihood of containing nesting Hen Harrier during the period 2016 – 2019 (using 2010 and 2015 national Hen Harrier Survey data) (Ruddock *et al.*, 2016). It is therefore timely to now review the performance and design of the red area procedures, particularly in light of the findings of the effectiveness of the red areas (Section 2.1), which highlights that this mitigation strategy does not provide protection to all nests, and therefore it is necessary to assess the design and implementation of the red area procedures to identify where improvements are required.

Here we undertaken a critical review of the design and the implementation of the red areas procedures with a view to inform where improvements are required.

### 2.2.2 Methods

We performed a systematic review to collate and appraise available evidence on the design and implementation of the red area procedures. This review follows a similar process to Multi-criteria Analysis (MCA), which is a method to support decision-making, by exploring the balance between the pros and cons of different alternatives to accomplish a specific goal and is regularly applied in conservation decision making (Esmail and Geneletti, 2018). This structured process aims to maximise transparency and minimise bias and can be used as evidence for decision makers and stakeholders as to whether an intervention works or not, and in what contexts. This approach does not directly assess the outcome of the mitigation intervention (in this case the red area procedures). Instead, this approach evaluates the design and implementation of the mitigation intervention, under the assumption that fit-for-purpose and well-designed and implemented initiatives are more likely to be successful.

We assessed the design and performance of the red area procedures according to six criteria. Each criterion is an essential component of this mitigation intervention (or any mitigation strategy). The rationale for assessing each of these criteria individually, was to facilitate identification of the performance of each component of the mitigation intervention (e.g. a mitigation strategy could be well designed and implemented but if not informed by robust data, it will ultimately not be successful). This is important to identify the specific constraints, where improvements may be required and what those improvements should be, either in the context of revising the current procedures or establishing a new procedure to which these lessons are applied.

The performance of the red area procedures was assessed based on the following criteria:

- **Spatial application of protection measures in the SPA network**  
*Are red areas applied in the appropriate places to protect Hen Harrier in the SPA network*
- **Spatial application of protection measures outside the SPA network**  
*Are red areas applied in the appropriate places to protect Hen Harrier outside the SPA network*
- **Size of the protected area**  
*Is the size of the red areas appropriate for the protection of Hen Harrier*
- **Timing of protection measures**  
*Is the timing of the red areas appropriate for the protection of Hen Harrier*
- **Activities to which are restrictions apply**  
*Are there appropriate restrictions on the relevant activities to protect breeding Hen Harrier*
- **Data used to inform the red area procedures**  
*Is the data used to inform the red areas robust, collected and used effectively to ensure the protection of breeding Hen Harrier*

The performance of the red area procedures according to these six criteria was assessed and a ranking was assigned based on the performance. This ranking was assigned based on a comparison of the design and implementation to the evidence base, literature (peer reviewed literature, open access reports, policy documents), examples of best practice conservation/mitigation interventions in other countries and the legislative requirements. Where the evidence base was lacking, expert opinion was used to provide a qualitative assessment of the performance of the relevant component of the procedures. This expert opinion was provided by five individuals with experience of Hen Harrier and related conservation and policy issues (all of which have published peer-reviewed scientific papers on Hen Harrier and/or Merlin in the Irish context) in order to make a qualitative assessment and assign a score to each relevant component of the procedures based on this experience. The scoring of these components provides an indication of how each performs against the objectives showing their strengths and weaknesses. These rankings can be used to determine whether these individual components require amendments or improvements (e.g. a ranking of 1 – Highly ineffective would indicate that significant improvements are required and that this component of the mitigation strategy is not performing for Hen Harrier conservation, a ranking of 3 – Providing benefits, would indicate that some improvements are required etc.).

Each of the criteria were categorised as follows:

1. Highly ineffective – significant improvements required
2. Not effective – substantial improvements required
3. Providing benefits – improvements required
4. Effective – moderate improvements required
5. Highly effective – no amendments required

### 2.2.3 Results

Here we outline our results of the review.

Criterion	Description	Assessment	Score
<p><b>Spatial application of protection measures (red areas) in the SPA network</b></p> <p><i>Are red areas applied in the appropriate places to protect Hen Harrier in the SPA network</i></p>	<p>Red areas (1.2km radius areas centred on Hen Harrier nests / territories) are typically generated by data on Hen Harrier territory and nest locations provided to NPWS / Forest Service. This information is used to generate red areas which are typically applied in the following year / breeding season. These red areas typically remain in place in future years.</p>	<ul style="list-style-type: none"> <li>• The red area procedures are designed to provide protection to breeding Hen Harrier from forest management related disturbances in the breeding Hen Harrier SPAs, however our review (Section 2.1) indicates that not all Hen Harrier territorial pairs or nest sites may receive protection.</li> <li>• The spatial distribution of the red areas is not reflective of the distribution of Hen Harrier in the same breeding season. Information on Hen Harrier is used to generate red areas which typically come into effect in the following breeding season or if they come into effect in the same breeding season, then it is only after nesting has been initiated, at which time the potential for disturbance has already occurred. This time lag is the main reason that the red areas are not effective in protecting all nests, as the distribution of Hen Harrier and nest locations can change from one season to the next (<i>e.g. the number of territorial pairs may increase in an area/SPA, the location of nest sites may change, Hen Harrier may colonise areas where they were previously not known to occur or nest in an area for the first time, the suitability of habitats and nesting opportunities may change etc.</i>).</li> <li>• The red area procedures are designed to cater for interannual movements of nest locations/pairs. The estimated interannual movement of 700m is based on the nest site movements in the Slieve Aughty Mountains SPA during the period 2005-2010. A more recent review by Ruddock <i>et al.</i> (2016) showed that movement of pairs may be greater than these estimates used to inform the red area procedures. This is supported by our review (Section 2.1) which shows that based on the spatial distribution of known nest sites, and the application of the red areas, not all nest sites receive protection. The 700m buffer to cater for predicted movements of territorial pairs between years is not effective and results in inadequate protection for Hen Harrier.</li> <li>• The current procedures do not provide adequate protection for Hen Harrier where they nest in new areas or areas where they were previously not known to occur, this is based on the fact that the red areas are informed by data on the distribution of Hen Harrier in previous years, therefore if Hen Harrier nest in an area where they have not previously nested or were known to nest, there would be no protections for this pair in that year. The red area procedures provide protection to the areas where Hen Harrier previously nested but not necessarily where Hen Harrier are currently nesting or have the potential to nest (<i>e.g. a basic example would be in an SPA, where there are six pairs present in one year, in the next year if there are eight pairs, then a minimum of two pairs may not be protected appropriately</i>).</li> <li>• In recent years (2017-2022) the red areas (HLNA's) have been generated based largely on data provided by the Hen Harrier Project and based on comprehensive annual monitoring throughout the</li> </ul>	<p>3</p>

		<p>SPA network during this period. Prior to the Hen Harrier Project, the data on the red areas was generated by the national surveys, in the intervening years survey coverage was not as comprehensive and varied from SPA to SPA. Our review showed that the greater the time distance between data being collected the less effective red areas are in protecting Hen Harrier. While our review shows that annual monitoring improves the effectiveness of protection measures, if there remains a time lag between when Hen Harrier nests are identified and when protection measures are implemented, then the risk that Hen Harrier nests will not receive appropriate protection remains (e.g. an example of this is if surveys detect the presence of Hen Harrier in a 'green area' outside of a red area, even if that information is used to inform and implement protection measures in the same season, this breeding pair will still have been at risk of disturbance in the early part of the breeding season because forest management operations will only cease when likely impacts are determined rather than a cessation of forest management operations until it is proven that there will be no impacts etc.).</p> <ul style="list-style-type: none"> <li>The red areas are not spatially targeted to best effect, this is shown by our review which demonstrates that not all Hen Harrier nests within the SPA network receive protection and evidenced by the fact that many red areas (at the time of this review) are not occupied by Hen Harrier (for example in 2020, there were 41 red areas in the Slieve Aughty Mountains SPA but only six confirmed and one possible Hen Harrier territory in that year (Hen Harrier Programme, 2020)).</li> </ul>	
<p><b>Spatial application of protection measures outside the SPA network</b></p> <p><i>Are red areas applied in the appropriate places to protect Hen Harrier outside the SPA network</i></p>	<p>There are no formal procedures in place for the protection of Hen Harrier from forest management related disturbances outside of the SPA network</p>	<ul style="list-style-type: none"> <li>The red areas procedures are confined to the breeding Hen Harrier SPA network. There are no formal procedures in place to protect breeding Hen Harrier from disturbances from forest management activities outside of the breeding Hen Harrier SPAs.</li> <li>Currently, reducing the risks or reacting to forestry related disturbances to Hen Harrier breeding in non-designated areas is dependent upon a less robust and ad hoc approach, which places Hen Harrier at risk.</li> </ul>	<p><b>1</b></p>
<p><b>Size of the protected area</b></p> <p><i>Is the size of the red areas appropriate for the protection of Hen Harrier</i></p>	<p>Red areas are 1.2 km radius areas centred on known Hen Harrier nesting areas. The 1.2 km radius is based on half the maximum separation distance of annual nest locations within territories observed in the Slieve Aughty Mountains within</p>	<ul style="list-style-type: none"> <li>The red areas are a radius of 1.2km radius surrounding known Hen Harrier nest sites, this includes a 500m buffer surrounding the nest and additional 700m to allow for movement of pairs between years.</li> <li>Although this is the largest disturbance-free zone implemented for Hen Harrier throughout their range (Ruffino 2016), the nest protection buffer (500m buffer) is at the lower scale of the distances recommended (Ruddock and Whitfield, 2007; Goodship and Furness, 2022).</li> </ul>	<p><b>3</b></p>

	<p>the 2005-2010 period, plus an additional 500 m buffer. Therefore, the disturbance-free zone surrounding the nest is 500m and the additional 700m is to cater for predicted movements of territorial pairs between years.</p>	<ul style="list-style-type: none"> <li>Ruddock <i>et al.</i>, (2016) in a review of the red areas stated that a more prescriptive (nest) buffer (up to 750m) is supported by the literature provided the risk of inter-annual spatial changes can be integrated and therefore risks can be mitigated by the implementation of annual surveys (<i>e.g. If the nest location is known then a buffer of 750m surrounding the nest would provide greater protection than the current procedures which implement a smaller nest protection buffer</i>).</li> </ul>	
<p><b>Timing of protection measures</b></p> <p><i>Is the timing of the red areas appropriate for the protection of Hen Harrier</i></p>	<p>'Red areas' are implemented during the Hen Harrier breeding season, 1<sup>st</sup> March to 15<sup>th</sup> August</p>	<ul style="list-style-type: none"> <li>O'Donoghue (2010) recorded the earliest Hen Harrier laying date of the 16<sup>th</sup> of April and as late as the 10<sup>th</sup> of June with the median occurring in the first week of May in Ireland. Hen Harrier surveys are typically initiated in late March/early April (Ruddock <i>et al.</i>, 2016, Barton <i>et al.</i>, 2006), to coincide with territorial behaviours, however territory establishment and prospecting is known to occur in March.</li> <li>From the initiation of the red area procedures until May 2022, the timing of restrictions on forestry activities implemented through these procedures was from 1<sup>st</sup> April to 15<sup>th</sup> August. It was considered that the start timing of the restrictions may place Hen Harrier at risk during the early stages of the breeding season. The timing of restrictions was amended in May 2022 to start on 1<sup>st</sup> March to 15<sup>th</sup> August. Despite the limited specific information on the timing of breeding of Hen Harrier on a national scale in Ireland, based on an understanding of the species and its breeding behaviour, it is considered that the current timing of the protection measures is appropriate and should ensure protection of breeding Hen Harrier if applied appropriately in other regards. It is recommended that a more thorough review of the timing of breeding of Hen Harrier in Ireland is undertaken to ensure that the current timing of restrictions afford appropriate protection and particularly during the latter stages of the breeding cycle.</li> </ul>	4
<p><b>Activities to which restrictions apply</b></p> <p><i>Are there appropriate restrictions on the relevant forest management activities to protect breeding Hen Harrier</i></p>	<p>The Forest Service defines 'a disturbance operation is a forest management operation which has the potential, through excessive noise, vibration, mechanical movement, etc., to disturb the breeding activity of Hen Harriers'. The specific disturbance operations which are restricted in red areas (1 March to 15 August inclusive) are listed as: timber felling (thinning, clearfell); timber extraction to roadside; timber loading at</p>	<ul style="list-style-type: none"> <li>The specific activities which are restricted in red areas are clearly defined for the most part. The activities which come under the category of 'any other operation(s) the Forest Service may deem as creating disturbance' should be further clarified (with specific examples and case studies provided) for transparency and to avoid ambiguity.</li> <li>Under the current procedures all activities listed are treated as creating the same risk of disturbance to Hen Harrier. The protection measures should be proportionate to the risk of disturbance of the activity. Timber felling has been identified as the forestry activity which has the greatest risk of disturbance and such activities should be treated as such and the relevant (or maximum) disturbance-free zone applied, whereas activities where there is less risk of disturbance due to the</li> </ul>	4

	<p>roadside; mechanical cultivation for both afforestation and reforestation; forest road construction (and associated developments); the driving of fencing posts; and any other operation(s) the Forest Service may deem as creating disturbance.</p>	<p>scale and timing of the activity should be mitigated for appropriately, such as timber loading at roadside and the driving of fence posts.</p>	
<p><b>Data used to inform the red area procedures</b></p> <p><i>Is the data used to inform the red areas robust, collected and used effectively to ensure the protection of breeding Hen Harrier</i></p>	<p>Previously (up to 2017) the data used to inform and generate the red areas was primarily collected by the national surveys (every five years) and supplemented by the provision of monitoring in the intervening years. It is our understanding that the data on Hen Harrier nest and territory locations provided to NPWS and the Forest Service is used to generate the red areas in the following year. These red areas then remain in place in subsequent years. Between 2017 to 2022, the Hen Harrier Project has carried out monitoring of Hen Harriers in the SPA network on an annual basis, this data is provided to NPWS under a data agreement and provided to the Forest Service and used to generate red areas in the following year).</p>	<ul style="list-style-type: none"> <li>• The national surveys were the main source used to inform the red areas between 2012 to 2017. Ruddock <i>et al.</i>, (2016) stated that ‘<i>quinquennial survey data may lead to unintentional disturbance if protection is not provided to other breeding areas which may appear in the intervening years between surveys</i>’. We confirmed that this is the case through our review of the effectiveness of red areas based on the distribution and movements of Hen Harrier nest locations from year to year (Section 2.1). Between 2017 to 2022, the Hen Harrier Project carried out monitoring on an annual basis in the SPA network. However, regardless of the timing and consistency of monitoring, if there remains a time lag between identifying Hen Harrier nest/territory locations and generating the red areas, then Hen Harrier may be at risk (e.g. where they nest outside or at the edge of existing red areas). It is also the case that Hen Harrier may be at risk even if red areas are created in response to new information on the presence of Hen Harrier in ‘green areas’ in the same season, if the protections are not implemented from the start of the breeding season (e.g. <i>Hen Harrier nesting in a green area may be identified in May and a new red area defined based on this information, however, this nesting attempt will not have received any protection in the early part of the breeding season up to that point (March and April) and may be at risk during this period because forest management operations would be permitted to proceed in this area</i>).</li> <li>• This review has highlighted issues with data accessibility (data on Hen Harrier and data on the red areas) and the transparency of the mitigation strategy. Sensitive planning and management of commercial forests can be used to reduce/minimise negative impacts on species of conservation concern (Kortland <i>et al.</i>, 2011), for example by avoiding operating in certain areas at certain times of the year. The data which is collected on Hen Harrier distribution and nest locations should be used for this purpose under the relevant data sharing agreements.</li> </ul>	<p>3</p>

## 3. Review of mitigation measures to protect Merlin from forestry related disturbances

### 3.1 Critical review of the implementation of Merlin mitigation measures

#### 3.1.1 Background

The risk of disturbance to breeding Merlin from forest management operations in Ireland has been previously identified (Lusby *et al.*, 2017), which is due to the preference shown by Merlin to nest in mature conifer plantations, which are within the age range for forest management operations such as thinning and clearfelling. Recommended measures to avoid disturbance to forest-nesting Merlin throughout their range typically involve implementing a disturbance-free zone surrounding known Merlin nests in which forestry activities are restricted during sensitive periods to minimise the potential for disturbance to Merlin (Ruffino, 2016). The Merlin mitigation procedures (as detailed in Section 1.3.2) were introduced by the Forest Service in December 2019 to protect breeding Merlin from forest management related disturbances in the breeding Merlin SPA network. The mitigation measures are presented in the form of a licence condition that is applied to forest management operations which have the potential to cause disruption that might interfere with and cause impact to breeding Merlin. The mitigation measures are not applied based on the known distribution of breeding Merlin (or the location of individual nest sites), as is the case with the Hen Harrier measures (red area procedures). The main reason for this is the limited data available on Merlin distribution and nesting pairs in the Irish context, which compromises targeting the mitigation measures at the nest site scale. The mitigation measures are instead applied based on the suitability of habitat for breeding Merlin informed by evidence of Merlin nesting ecology and habitat requirements in the Irish context (Norriss *et al.*, 2010; Lusby *et al.*, 2017). As a result, the Merlin mitigation measures are applied across large areas of the breeding Merlin SPA network (essentially where forest management operations are planned in areas deemed to provide suitable breeding habitat for Merlin during the period 1<sup>st</sup> March to 31<sup>st</sup> August inclusive within and including a 5km radius surrounding the breeding Merlin SPAs) and include areas (or harvest units) where it is deemed that the habitat conditions have the potential to support breeding Merlin.

As the Merlin mitigation measures have been recently introduced (December 2019) and due to the limited data on the locations of Merlin breeding pairs in the breeding Merlin SPA network, it is not possible to assess the effectiveness of these measures in protecting breeding Merlin (i.e. replicating the approach taken to assess the effectiveness of Hen Harrier measures). It is important to review the design and implementation of the mitigation measures at this stage, for a number of reasons. Firstly, the Merlin mitigation measures in their current form do not appear to be informed by ecological evidence on the species, specifically in relation to the size of the disturbance-free zone implemented through the measures (which is 100m). Secondly, the spatial application of the measures means that restrictions are imposed over large areas where Merlin may not be present, however there is no information available as to the effectiveness and targeting of these measures in protecting Merlin nests (i.e. are the appropriate habitats identified for protection and are breeding Merlin adequately protected). The application of timing restrictions on forestry activities over large areas for Merlin, but which are not providing benefits for the species across all of these areas may directly conflict with other environmental considerations, such as managing impacts on Fresh Water Pearl Mussel, water

quality and soils and this highlights the need for a holistic approach to mitigation strategies, which are effectively targeted and take into consideration other environmental impacts.

Here we undertaken a critical review of the design and the implementation of the Merlin mitigation procedures with a view to inform where improvements are required.

### 3.1.2 Methods

We performed a systematic review to collate and appraise available evidence on the design and implementation of the Merlin mitigation measures. This review follows a similar process to Multi-criteria Analysis (MCA), which is a method to support decision-making, by exploring the balance between the pros and cons of different alternatives to accomplish a specific goal and is regularly applied in conservation decision making (Esmail and Geneletti, 2018). This structured process aims to maximise transparency and minimise bias and can be used as evidence for decision makers and stakeholders as to whether an intervention works or not, and in what contexts. We do not assess the outcome of the mitigation intervention (in this case the Merlin mitigation measures) directly, but this is based on the assumption that a well-designed and implemented initiative is more likely to be successful.

We assessed the design and performance of the Merlin mitigation measures according to six criteria. Each criterion is an essential component of this conservation intervention. The rationale for assessing each of these criteria individually, was to facilitate identification of the performance of each component of the mitigation intervention (e.g. a mitigation strategy could perform well in most areas but if it falls short in certain aspects it may ultimately be unsuccessful in achieving its core objectives). This is important to identify the specific constraints, where improvements may be required and what those improvements should be, either in the context of the revising the current mitigation measures or establishing a new procedure to which these lessons are applied.

The performance of the Merlin mitigation measures was assessed based on the following criteria:

- **Spatial application of mitigation measures in the SPA network**  
*Are the mitigations applied in the appropriate places to protect Merlin in the SPA network*
- **Spatial application of mitigation measures nationally**  
*Are the mitigations applied in the appropriate places to protect Merlin outside the SPA network*
- **Size of the protected area**  
*Is the size of the protected area (disturbance-free zone) appropriate for the protection of Merlin*
- **Timing of mitigation measures**  
*Is the timing of the mitigation appropriate for the protection of Merlin*
- **Activities to which are restrictions apply**  
*Are there appropriate restrictions on the relevant activities to protect breeding Merlin*
- **Data used to inform the red area procedures**  
*Is the data used to inform the mitigation measures robust, collected and used effectively to ensure the protection of breeding Merlin*

The performance of the Merlin mitigation measures according to these six criteria was assessed and a ranking was assigned based on the performance. This ranking was assigned based on a comparison of the design and implementation of each of the components of the Merlin mitigation measures to the evidence base, literature (peer reviewed literature, open access reports, policy documents), examples of best practice conservation interventions in other countries and the legislative requirements. Where the evidence base was lacking, expert opinion was used to provide a qualitative assessment of the performance of the relevant component of the procedures. This expert opinion was provided by two individuals familiar with breeding Merlin ecology and conservation (both published peer-reviewed scientific papers on Merlin in the Irish context). The scoring of these components provides an indication of how each performs against the objectives showing their strengths and weaknesses. These rankings can be used to determine whether these individual components require amendments or improvements (*e.g.* a ranking of 1 – Highly ineffective, would indicate that significant improvements are required and that this component of the conservation strategy is not performing for Merlin conservation, a ranking of 3 – Providing benefits would indicate that some improvements are required in order for this component of the conservation strategy to perform appropriately).

Each of the criteria were categorised as follows:

1. Highly ineffective – significant improvements required
2. Not effective – substantial improvements required
3. Providing benefits – improvements required
4. Effective – moderate improvements required
5. Highly effective – no amendments required

### 3.1.3 Results

Here we outline our results of the review.

Criterion	Description	Assessment	Score
<p><b>Spatial application of Merlin mitigation measures in the SPA network</b></p> <p><i>Are mitigation measures for Merlin applied in the appropriate places to protect Merlin from disturbance from forest management operations in the SPA network</i></p>	<p>Merlin mitigation measures are applied based on the suitability of habitat for breeding Merlin, where the project area: contains mature forest at least 10 years of age; is within or adjacent to the SPA and adjoins or is immediately adjacent to moors, heathland, peat bogs or natural grassland</p>	<ul style="list-style-type: none"> <li>• The Merlin mitigation measures are designed to provide protection to breeding Merlin from forest management related disturbances in the breeding Merlin SPA network, and in the absence of data available on Merlin distribution and the location of breeding territories, a habitat-based approach to identifying the areas to target mitigation measures is deemed to be suitable.</li> <li>• On the basis that the mitigation measures are applied to all areas which are suitable for breeding Merlin in the SPAs in which they are listed as an SCI, then the spatial application should be appropriate in providing protection to Merlin (i.e. if mitigation applies to all areas where Merlin can nest, then all nests should receive protection) in the breeding Merlin SPAs. In the absence of robust data on the distribution of breeding Merlin within the SPA network or a reliable system to collect such data, this habitat-based approach is deemed to be the most appropriate means of applying the mitigations. However, the habitat-based approach also results in mitigations being applied to areas where Merlin are not present and as Merlin survey methods and data collection are refined, the aim should be to bring the Merlin mitigations in line with the recommended Hen Harrier mitigations which are more targeted in their application.</li> <li>• The Merlin mitigation measures are applied based on likely breeding habitat suitability, however there is insufficient detail and no defined protocols in place to determine habitat suitability for Merlin. A standard protocol to assess habitat suitability and the methods required to determine and report on habitat suitability for Merlin is required to ensure consistency of approach and a high standard in determining habitat suitability and to avoid variation in application.</li> <li>• At present, the Merlin mitigation measures are applied based on the habitat conditions defined within the breeding Merlin SPA network and seemingly within a 5km radius of the breeding Merlin SPA boundaries, this is appropriate given that in certain SPA's Merlin pairs are more likely to nest outside the SPA boundary due to nesting opportunities available (Lusby <i>et al.</i>, 2022). Therefore, extending the mitigation measures to include protection for these pairs which nest outside but are likely associated with the SPA is necessary, but this requires clarification and the</li> </ul>	<p>3</p>

		inclusion in the guidance on these mitigation measures to avoid uncertainty and ensure consistency of approach.	
<p><b>Spatial application of protection measures outside of the SPA network</b></p> <p><i>Are Merlin mitigation measures applied in the appropriate places to protect Merlin outside the SPA network</i></p>	<p>There are no formal procedures in place for the protection of Merlin from forest management related disturbances outside of the SPA network</p>	<ul style="list-style-type: none"> <li>The Merlin mitigation measures are confined to within the breeding Merlin SPA network and a 5km radius surrounding the SPA boundaries. There are no formal procedures in place to protect breeding Merlin from disturbances from forest management activities outside of these areas.</li> <li>Currently, reducing the risks or reacting to forestry related disturbances to Merlin breeding in non-designated areas is dependent upon a less robust and ad hoc approach, which places Merlin at risk, particularly given the limited information on Merlin distribution and nest locations.</li> </ul>	1
<p><b>Size of the protected area</b></p> <p><i>Is the size of the mitigation measures appropriate for the protection of Merlin</i></p>	<p>The Merlin mitigation measures implement a disturbance-free zone of 100m from the forest edge, where such forest edge is immediately adjacent to moors, heathland, peat bogs or natural grassland, or within 100 meters of a clearing in the forest of larger than one hectare</p>	<ul style="list-style-type: none"> <li>The 100m disturbance-free zone is implemented on the basis that most forest-nesting Merlin nest close to the forest edge (Norriss <i>et al.</i>, 2010; Lusby <i>et al.</i>, 2017).</li> <li>The scale of this disturbance-free zone (100m) is not supported by the literature and is the smallest disturbance-free zone recommended for breeding Merlin across all studies assessed (Ruffino, 2016) and is less than the 300 – 500 m recommended by Ruddock and Whitfield (2007) and Goodship and Furness (2022). There is no basis for a disturbance-free zone of this size and no rationale provided for how this distance has been devised or the ecological parameters. Even though the mitigation measures may be implemented across significant areas of the breeding Merlin SPA network, the protection measures will not be effective if the size of the disturbance-free zone is not sufficient to ensure disturbance is prevented or minimised to breeding Merlin.</li> </ul>	1
<p><b>Timing of protection measures</b></p> <p><i>Is the timing of the mitigation measures</i></p>	<p>Merlin mitigation measures are implemented during the Merlin breeding season, 1 March to 31 August inclusive</p>	<ul style="list-style-type: none"> <li>A review of the literature shows that there are limited data on the timing of breeding of Merlin in the Irish context. The timing of the implementation of the protection measures is similar or more extensive than protection measures for the species in other countries, in Scotland for example restrictions on forestry activities are advised from late April for Merlin (Currie and Elliot, 1997). Despite the lack of specific information on the timing of breeding of Merlin on a national scale in Ireland, based</li> </ul>	5

<p><i>appropriate for the protection of Merlin</i></p>		<p>on an understanding of the species and its breeding behaviour, it is considered that the current timing of the protection measures is appropriate and should ensure protection of breeding Merlin throughout all stages of the breeding period if applied appropriately in other regards.</p>	
<p><b>Activities to which are restrictions apply</b></p> <p><i>Are there appropriate restrictions on the relevant activities to protect breeding Merlin</i></p>	<p>The Forest Service states that ‘no felling, thinning or other forestry operations.....shall take place during the period 1<sup>st</sup> March to 31<sup>st</sup> August inclusive’ within the areas as defined above for the protection of breeding Merlin</p>	<ul style="list-style-type: none"> <li>• Specific activities which are likely to impact breeding Merlin are defined (felling, thinning). The activities which come under the category of ‘other forestry operations’ should be further clarified (with specific examples and case studies provided) for transparency and to avoid ambiguity.</li> <li>• Under the current procedures, all activities listed are treated as creating the same risk of disturbance to Merlin. The protection measures should be proportionate to the risk of disturbance of the activity. Timber felling has been identified as the forestry activity which has the greatest risk of disturbance and such activities should be treated as such and the relevant (or maximum) disturbance-free zone applied to such activities, whereas as activities where there is less risk of disturbance due to the scale and timing of the activity should be mitigated for appropriately.</li> </ul>	<p>4</p>
<p><b>Data used to inform Merlin mitigation measures</b></p> <p><i>Is the data used to inform the Merlin mitigation measures robust, collected and used effectively to ensure the protection of breeding Merlin</i></p>	<p>Due to the absence of data on Merlin territory and nest site locations within and surrounding the SPA network, the Merlin mitigation measures are applied on based on assessment of habitat suitability</p>	<ul style="list-style-type: none"> <li>• There is no annual or frequent monitoring of Merlin in the breeding Merlin SPA network (with the exception of the annual monitoring of island-nesting pairs in the Connemara Bog Complex SPA (Lusby, 2023; Dermot Breen, <i>pers comms</i>) and limited data on the distribution of the species in the breeding Merlin SPA network (Lusby <i>et al.</i>, 2022).</li> <li>• In the absence of comprehensive data on Merlin in the breeding Merlin SPA network, a habitat-based approach is used to identify the areas which are potentially suitable for Merlin. This approach is currently the most appropriate means of applying mitigation to minimise the risk of disturbance to Merlin due to the limited data on the distribution of Merlin and constraints with data collection.</li> </ul>	<p>4</p>

## 4. Targeted surveys to assess the presence of breeding Hen Harrier to inform forest management

### 4.1 Background

Mitigation strategies to minimise or prevent disturbances to bird species from forest management operations are typically informed by information on the spatial distribution of the species (Currie and Elliot, 1997). Protection measures or mitigation is targeted to the nest areas to a scale which is deemed appropriate for the species to avoid disturbance. The effectiveness of such measures relies on robust data on the distribution and nest locations in order that the measures are appropriately targeted. For many species however, comprehensive data on their distribution is not readily available and for this reason pre-operational surveys are employed, to determine whether a priority species is present in an area in order to inform the impacts and mitigation requirements for specific operations. These pre-operational surveys have been recommended in the Irish context to obtain real-time information on the presence or absence of priority bird species to inform mitigation, however they have been rarely applied and the effectiveness of this approach has not been tested under conditions in Ireland.

The red area procedures are designed to protect breeding Hen Harrier from disturbance from forest management activities during the nesting season within the breeding Hen Harrier SPA network. Currently, information on Hen Harrier nest locations and territorial pairs is provided by the National Parks and Wildlife Service as a spatial layer (HLNA's) to the Forest Service, which is then used to generate red areas, which are typically applied in the following and subsequent years. This approach is effective in providing protection for some Hen Harrier pairs, however the assessment detailed in this review document has showed that this strategy does not provide protection for all pairs (Section 2.1). The limitations of this approach are due to the fact that the spatial distribution of Hen Harrier nest/breeding locations can change from one season to the next (for example, the numbers and locations of breeding pairs in one season may be different to the previous seasons, yet the protection measures are primarily informed by the data in the previous season or seasons). The effectiveness of the red area procedures can be compromised when data on Hen Harrier distribution and occupancy is out of date. Also, a concern raised by Ruddock *et al.* (2016) is that protection measures are based solely on the areas that Hen Harrier are known to have nested, and therefore does not allow for expansion into new areas. Our review provides evidence of this and indication that red areas are less effective in areas where the number of Hen Harrier pairs is increasing than declining (Section 2.1). It should be noted that even if data on Hen Harrier nest locations is used to generate red areas in the same season (*i.e.* a Hen Harrier pair is confirmed in an area and this information is used by the Forest Service to then define a red area for that location in the same season), Hen Harrier will still be at risk of disturbance if forest management operations are permitted in that area up to the point that the red area is defined.

Here, we set out to trial the effectiveness of surveys (or pre-operational surveys) as a method to collect real time information on Hen Harrier to inform forest management and to increase confidence in ensuring protection for the species and minimising disturbance from forest management activities.

#### Objectives

This survey was carried out on a trial basis to assess the effectiveness of collecting information on Hen Harrier to inform their protection in relation to forest management related disturbances. The objectives of this survey are to:

- (i) Determine the presence and breeding status of Hen Harrier in defined survey areas with respect to forest areas (harvest units) where forest management operations are scheduled;
- (ii) Assess the merits and practicalities of using survey data to inform appropriate mitigation for breeding Hen Harrier;
- (iii) Determine the resources required to undertake the survey trials;
- (iv) Assess the merits of the trial surveys and their role future conservation strategies for the protection of Hen Harrier.

## 4.2 Methods

### Survey design

The survey design is informed by previous surveys of Hen Harrier in Ireland (Barton *et al.*, 2000; Ruddock *et al.*, 2012; Ruddock *et al.*, 2016) and specifically adapted to meet the objectives of this study. Specifically, the survey is designed to test the effectiveness of surveys (or pre-operational surveys) to determine the presence of Hen Harrier in relation to planned forest management operations. To achieve this, survey areas were selected based on harvest units (distinct forest areas of uniform age, structure and management) within the breeding range of Hen Harrier. Survey areas were informed on the basis of harvest units scheduled for thinning and clearfell, as these operations are considered to present the greatest risk of disturbance to breeding Hen Harrier (Ruffino, 2016). These survey areas (formed around harvest units) are therefore representative of forest management operations carried out in the breeding Hen Harrier SPA network, which have the potential to cause disturbance to breeding Hen Harrier. The survey is designed to test the effectiveness of detecting breeding Hen Harrier in these areas to inform appropriate mitigation. It is important to note that the surveys were carried out on a trial basis and did not inform forest management operations during the period of this study.

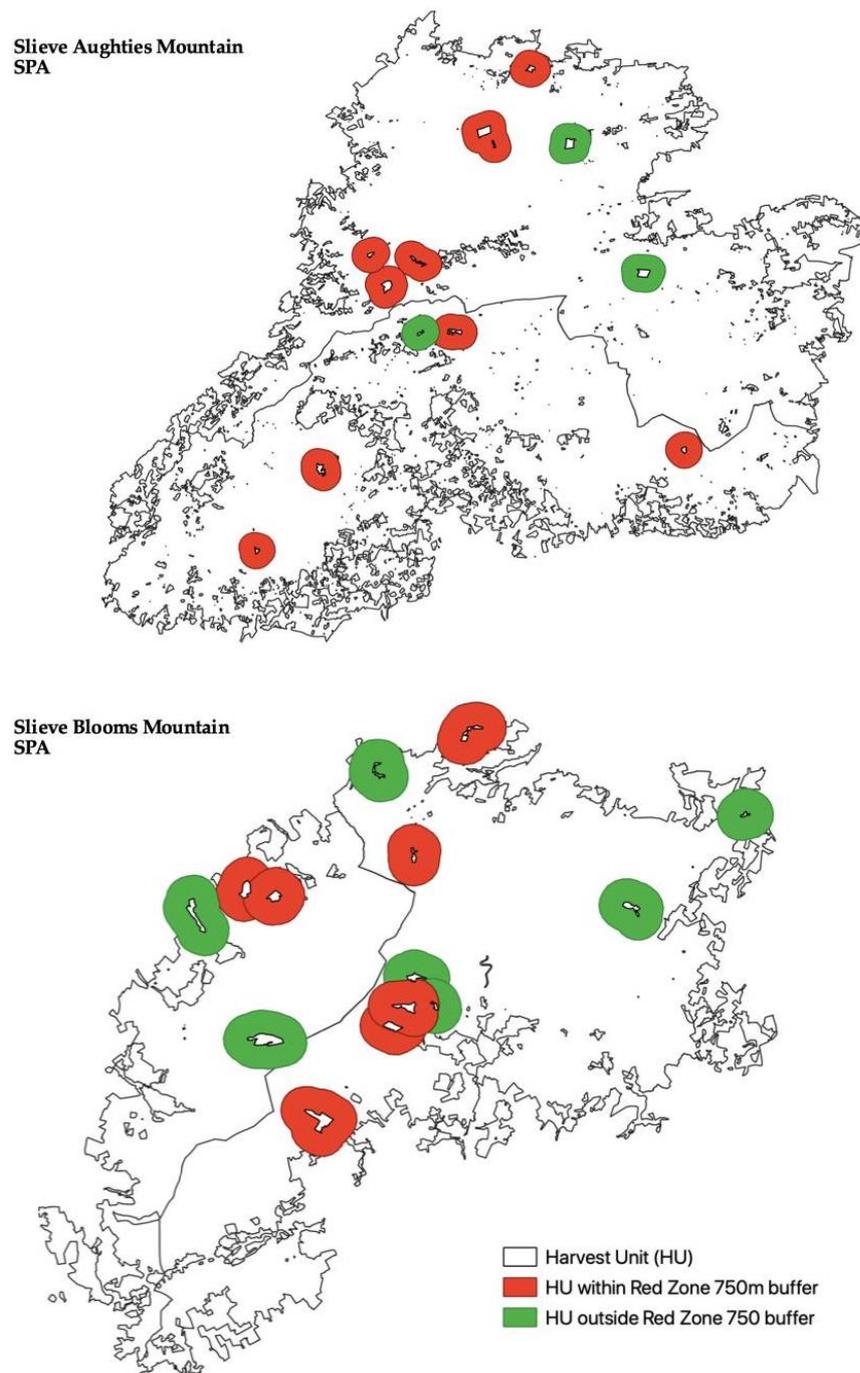
The survey was not designed to census Hen Harrier in individual SPA's, throughout the breeding Hen Harrier SPA network or on a regional scale. This is based on the premise that in order to ensure the protection of Hen Harrier from forest management related disturbances, information on all Hen Harrier territorial pairs in a defined area or region is not required, but rather information on the presence of Hen Harrier specifically in relation to planned forest management operations is needed. Similarly, there was no requirement to determine the outcome of breeding attempts, as is desirable in other surveys (Ruddock *et al.*, 2016). The rationale is that information on the presence of breeding Hen Harrier is sufficient to inform and mitigate the potential effects of forest management, and therefore the surveys were specifically designed to meet this objective.

The survey area was concentrated in two of the six breeding Hen Harrier SPA's, namely the Slieve Aughty Mountains SPA and the Slieve Bloom Mountains SPA. These SPA's combined meet the necessary criteria in relation to Hen Harrier nesting ecology, population size and trends within, to test the effectiveness of the surveys under a range of conditions which are reflective of the breeding Hen Harrier SPA network. Specifically, in the Slieve Aughty Mountains SPA, Hen Harrier predominantly nest in forest habitats (Ruddock *et al.*, 2016) and the population has declined recently (Ruddock *et al.*,

2024), whereas in the Slieve Bloom Mountains SPA, Hen Harrier predominantly nest in open moorland habitats (Ruddock *et al.*, 2016) and the population is stable (Ruddock *et al.*, 2024)).

### **Survey area**

The survey area was defined based on the selection of harvest units scheduled for thinning and clearfell during the period 2021/22 in the Slieve Aughty Mountains SPA and the Slieve Bloom Mountains SPA. A total of 26 harvest units were selected at random, 12 in the Slieve Aughty Mountains SPA and 14 in the Slieve Bloom Mountains SPA. A buffer of 750m was created around the perimeter of each harvest unit, which formed each individual survey area. This 750m buffer is the maximum zone of disturbance for Hen Harrier recommended by Ruddock and Whitfield (2007). Therefore, the survey area consisted of individual survey areas, each with a harvest unit (scheduled for clearfell and thinning) at its centre and surrounded by a 750m buffer, within the Slieve Aughty Mountains SPA and the Slieve Bloom Mountains SPA. The location of all survey areas in each SPA and in relation to red areas is shown in Figure 4.1. Whether a particular red area was within or outside a red area was notified on the felling licence for each harvest unit and through assessing the relevant felling licence it was possible to determine whether the harvest unit was within or outside a red area based on the most recent information available at the time of the surveys (in March 2021).



**Figure 4.1** Distribution of Hen Harrier survey areas in the Slieve Aughties Mountains SPA and the Slieve Bloom Mountain SPA during the current survey.

### Survey coverage

The Hen Harrier surveys were carried out by six surveyors, all of which had previous experience of undertaking surveys for Hen Harrier during the breeding season, which included participation in national surveys (which informed the red areas) and/or undertaking surveys of Hen Harrier on a

professional basis. Each surveyor was allocated one or more survey area, with two surveyors working in the Slieve Aughty Mountains SPA, three surveyors working in the Slieve Bloom Mountains SPA and one surveyor covering survey areas in both the Slieve Aughty Mountains SPA and the Slieve Bloom Mountain SPA.

Each surveyor was provided with the method statement (Appendix C), an aerial image and an OSI 1:50,000 map of each survey area, recording form and the online survey form (Appendix D) to enter and submit the survey data. The OSI 1:50,000 maps included the 1×1 km grid system (Irish National Grid) and were used to record spatially referenced survey data, including the survey area, vantage point locations and view sheds, and observations of Hen Harrier. The aerial images showed further detail on habitat features and provided an additional resource for surveyors to assess habitat suitability. The OSI survey map and aerial image included the harvest unit at the centre of the survey area and the 750m buffer which formed the boundary for the survey area. In addition, an overview map of the relevant SPA was provided to each surveyor showing all survey areas in order to aid navigation.

Regular communication was maintained between the survey coordinators and all surveyors throughout the survey period, which allowed survey coverage to be reviewed on an on-going basis and to make any amendments to the survey methods and data recording as required. Survey data was submitted on an on-going basis throughout the survey season via the online survey forms which allowed validation of the survey data and identification of any issues that may have affected survey coverage or data recording.

The survey schedule (including the survey areas to be visited and timing) was shared with the Hen Harrier Project in advance of all survey visits. This was to ensure that duplication of survey effort was avoided (e.g. two surveyors independently working in the same place at the same time, which could increase the risk of unintentional disturbance to breeding Hen Harrier). There was no information requested or received from the Hen Harrier Project in relation to Hen Harrier occupancy or the distribution of territorial pairs in the SPA network. This was to ensure that our survey findings were independent of all other sources of information. Details of the surveys and the specific survey visits were also shared with the relevant NPWS staff in the survey areas in advance of all survey visits.

### **Defining the search area**

Within each survey area (harvest unit with surrounding 750m buffer) the search area was defined by distinguishing between unsuitable and potentially suitable habitat for breeding Hen Harrier, as defined below. The search area was defined using OSI survey maps and aerial images in addition to ground-truthing (on the first survey visit). Areas of unsuitable habitat for breeding Hen Harrier were marked accordingly on OSI survey maps and excluded from further survey effort. If the suitability of specific areas remained in question, then these areas were considered to be potentially suitable and included in the search area, in order to reduce the risk of overlooking Hen Harrier which may nest in areas where the suitability was in doubt.

**Unsuitable habitat:** Unsuitable habitat was classified as ground above 600m; built-up/urban areas or within 100m of occupied farms and dwellings; improved pasture and arable farmland; the interior of unbroken, closed-canopy forest blocks; sheep-walk; extensive areas of bracken; degraded or overgrazed upland areas without any heather cover and areas within close proximity to sea-cliffs, inland crags,

rocky outcrops, boulder fields and scree slopes (see Hardey *et al.*, 2009; Ruddock *et al.*, 2012; Ruddock *et al.*, 2016).

**Suitable habitat:** Hen Harrier breeding habitat is defined as heather-dominated and/or grass moorland, other open habitats with extensive scrub or bramble cover and developing pre-thicket forest (first and second rotation) (see Hardey *et al.*, 2009; Ruddock *et al.*, 2012; Ruddock *et al.*, 2016).

### Survey techniques

Survey techniques followed those employed by previous Hen Harrier surveys in Ireland (Ruddock *et al.*, 2012; Ruddock *et al.*, 2016). Vantage point watches were carried out over all areas of potentially suitable breeding habitat within the defined survey area, to record Hen Harrier activity and determine occupancy and breeding status. The locations and numbers of vantage points were selected to ensure that all areas of potentially suitable breeding habitat within each survey area could be effectively watched. Vantage point locations could be situated outside the survey area (*i.e.* on an opposite hillside etc.) and were selected to maximise views and coverage of potentially suitable breeding habitat while ensuring that all Hen Harrier activity (observations and/or vocalisations) were recorded.

Vantage point watches were undertaken in the morning or evening where possible (starting before 10:00h or after 16:00h) during suitable weather conditions, defined as visibility of > 1km, no precipitation or just sporadic showers and wind speed of less than Force 5 (fresh to strong breeze).

Hen Harrier nests and/or areas where breeding activity was recorded were not approached, and if birds were accidentally disturbed or flushed, the location details were recorded, and the area was vacated immediately.

All details of the vantage point watches were documented using the recording form (Appendix D), including a 10-figure grid reference (Irish National Grid) of the vantage point locations (using a hand-held GPS unit), the start times and details of all encounters with Hen Harrier according to the specific behaviour and habitat codes. All Hen Harrier encounters were mapped on the relevant OSI survey map or aerial image, according to the encounter number, age and sex and the full extent of flight lines viewed and direction of movement. The approximate or known location of Hen Harrier nest sites were marked on the OSI survey map or aerial image accordingly. The location and number of each vantage point was marked on the OSI survey map or aerial image, alongside the view from each vantage point. The survey area details and name, the SPA name, date, visit number, and start and finish times of the survey were also detailed on each OSI survey map or aerial image (as shown in Appendix D). Any activities/threats or pressures observed within the survey area, were also recorded on the recording form, using the codes listed in Appendix E (as per Ruddock *et al.*, 2016).

### Survey schedule

The Hen Harrier survey was carried out over eleven weeks from 1 April to 15 June 2021. Three visits to survey squares were scheduled over this survey period. If evidence of breeding Hen Harrier was confirmed on the first or second visit, then subsequent visits to that survey area were not required.

Survey visits were spaced by at least one week. The duration of each survey visit could vary from a single day (or single vantage point watch) to several days depending on the size of the defined search

area, the quantity of potentially suitable breeding habitat and the number of vantage point watches required to cover all potentially suitable breeding habitat.

The **first visit** (1 April – 25 April) required becoming familiar with the survey area and the search area within and informed the best approach to undertaking the survey including the resource requirements to effectively survey the area for breeding Hen Harrier. Any further unsuitable habitat recorded on this visit was excluded from the search area and marked on the survey map accordingly. The locations of vantage point watches to overlook all areas of potentially suitable breeding habitat were selected and vantage point watches were conducted. This visit aimed to establish occupancy of Hen Harrier and record any evidence of breeding during the early stage of the breeding cycle.

The **second visit** (26 April – 20 May) aimed to establish occupancy of Hen Harrier within the defined search area and to identify areas of potential breeding activity based on evidence of Hen Harrier encounters and associated behaviour and/or signs. Vantage point watches were carried out as informed by the first visit.

The **third visit** (20 May – 15 June) aimed to establish evidence of breeding, with emphasis on locating active nests, or areas of breeding activity, where these are not already located.

A late season visit was not required as per previous Hen Harrier surveys (Ruddock *et al.*, 2012; Ruddock *et al.*, 2016). The rationale for this is that all breeding Hen Harrier should be established and possible to detect during the survey schedule, it was not necessary to identify the specific nest location or to confirm breeding success or productivity, which is the aim of late season visits (Hardey *et al.*, 2009; Ruddock *et al.*, 2016). In addition, the objective of the survey was to establish the presence or absence of breeding Hen Harrier by the defined period of the season (in this case mid-June at the latest).

### **Data recording**

All survey data was recorded and submitted via the online survey forms and the OSI survey map or aerial images were returned via email. All survey data was collated into a single excel spreadsheet for analysis and interpretation and relevant data (*e.g.* the location of vantage points, Hen Harrier observations etc.) were mapped in QGIS 3.0 to allow visual exploration and to assess Hen Harrier occupancy and breeding status in the survey area as outlined below.

### **Hen Harrier occupancy and breeding evidence**

Each survey area was categorised according to the Hen Harrier observations and behaviours recorded within and based on the criteria below. The criteria used to define occupancy and breeding status was informed by previous Hen Harrier surveys in Ireland to ensure comparability (Ruddock *et al.* 2016) with specific adaptations for the purposes of this survey, as shown below in Table 4.1. Specifically, the criteria used to define 'breeding evidence' includes early-stage breeding season behaviours (*e.g.* prospecting or territory establishment in the early stages of the breeding season). This is a more conservative approach (in terms of defining breeding evidence) than is used in other Hen Harrier surveys, however the aim of our surveys is not to determine the number of Hen Harrier pairs, but rather to determine evidence of breeding within the survey area (harvest unit with surrounding 750m buffer).

**Table 4.1.** Criteria used to define occupancy and breeding status of Hen Harrier in survey area.

<b>Classification</b>	<b>Behaviours, evidence and/or activities observed</b>
<i>Confirmed breeding evidence</i>	<p>Agitated behaviour or calls given by adults</p> <p>Courtship or display behaviour involving either a pair, or single male or female</p> <p>A pair seen visiting a probable nest site</p> <p>Food pass between two adults</p> <p>Adult carrying prey</p> <p>Recently fledged young</p> <p>Nest building or carrying nest material</p> <p>A pair or single female seen in possible nesting habitat during the second and/or third visit</p>
<i>Occupied</i>	A single observation of a male or female (seen outside the second and/or third visit) observed with no evidence of breeding behaviours
<i>Not seen</i>	Survey area contained suitable nesting habitat with no observations of Hen Harrier

*Note.* Adapted from “The 2015 National Survey of Breeding Hen Harrier in Ireland”, by Ruddock *et al.*, 2016, *Irish Wildlife Manuals*, No.93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

## 4.3 Results

### Survey area

The survey area consisted of 26 individual survey areas (harvest units inclusive of a 750m buffer) in the Slieve Aughty Mountains SPA (n = 12) and the Slieve Bloom Mountains SPA (n = 14). Twenty-four survey areas were formed based on harvest units scheduled for clearfell and two on harvest units scheduled for thinning operations. Sixteen (61.5%) harvest units were within red areas and the remainder were not in red areas (based on the most recent information available according to felling licences issued at the time of the surveys in 2021).

A review of aerial images and ground truthing on the first survey visit confirmed that two survey areas did not contain suitable breeding habitat for Hen Harrier. These were excluded from further survey effort. Two other surveys areas were deemed to be unsuitable for breeding Hen Harrier based on the on-site inspections. The details of all survey areas are shown below in Table 4.2.

**Table 4.2.** Details of all Hen Harrier survey areas including the SPA, the harvest unit and planned management, whether they were within a red area and whether or not there was potentially suitable breeding habitat.

SPA	Survey area ID	Management type	Red area (based on DAFM felling licence conditions, 2021)	Potentially suitable breeding habitat
Slieve Aughty	CE02-H0085	Clearfell	Yes	Yes
Slieve Aughty	CE02-H0133	Clearfell	No	Yes
Slieve Aughty	CE02-H0152	Thin	Yes	Yes
Slieve Aughty	CE03-H0132	Clearfell	Yes	Yes
Slieve Aughty	CE04-H0037	Clearfell	Yes	Yes
Slieve Aughty	GY10-H0073	Clearfell	No	No
Slieve Aughty	GY11-H0115	Clearfell	No	Yes
Slieve Aughty	GY11-H0161	Clearfell	Yes	Yes
Slieve Aughty	GY11-H0165	Clearfell	Yes	No
Slieve Aughty	GY12-H0007	Clearfell	Yes	Yes
Slieve Aughty	GY12-H0025	Clearfell	Yes	Yes
Slieve Aughty	GY12-H0077	Clearfell	Yes	Yes
Slieve Bloom	LS01-H0044	Clearfell	Yes	Yes
Slieve Bloom	LS01-H0050	Clearfell	Yes	Yes
Slieve Bloom	LS01-H0072	Clearfell	No	Yes
Slieve Bloom	LS06-H0046	Clearfell	No	Yes
Slieve Bloom	LS06-H0051	Clearfell	No	No
Slieve Bloom	LS08-H0031	Clearfell	No	Yes
Slieve Bloom	LS08-H0043	Thin	Yes	Yes
Slieve Bloom	LS08-H0063	Clearfell	Yes	Yes
Slieve Bloom	LS08-H0073	Clearfell	No	Yes
Slieve Bloom	LS09-H0049	Clearfell	Yes	Yes
Slieve Bloom	OY07-H0011	Clearfell	No	No
Slieve Bloom	OY07-H0022	Clearfell	Yes	Yes
Slieve Bloom	OY07-H0048	Clearfell	Yes	Yes
Slieve Bloom	OY08-H0032	Clearfell	No	Yes

### Survey schedule

Survey visits were undertaken according to the proposed schedule of visits. Twenty-five survey areas (96.1%) received a first visit, 20 survey areas (76.9%) received a second visit, and 16 survey areas (61.5%) received a third visit.

The total survey time was 244 hours 17 minutes. There was an average of 9.5 hours required to effectively survey each survey area, which ranged from 2 to 20 hours per survey area.

### **Survey techniques**

Vantage point watches were undertaken between 0630h and 2035h and ranged in duration from 1 hour 30 minutes to 4 hours, with an average duration of 2 hours 56 minutes and a median of 3 hours. The number of hours of observation at each survey area in each SPA can be seen below in Figures 4.2 and Figure 4.3.

The total number of vantage point locations used to survey all survey areas (n = 26) was 40, the minimum number used was one and the maximum four with an average of 1.5 used per survey area. In the Slieve Aughty Mountains SPA the minimum number of vantage point locations used was one and the maximum four with an average of two used per survey area and in the Slieve Bloom Mountains SPA the minimum number of vantage point locations used was one and the maximum two with an average of 1.14 used per survey area.

There was a total of 35 detections of Hen Harrier, which represents a detection rate of 0.145 Hen Harriers per hour of observation. Hen Harrier observations comprised of 57.9% (n = 23) adult males, 28.9% (n = 11) adult females, the majority of sightings (57.1%, n = 20) were of independent adult males, with 28.6% (n = 10) of sightings of independent females. On one occasion two males and one female were seen simultaneously and two males were observed simultaneously also on one occasion. Immature males were recorded relatively infrequently (5.7%, n = 3).

The key behaviours observed were hunting (36.7%) and flying (31.2%), with sightings most frequently detected in/over heather moorland (29.2%) and second rotation forest (27.1%). The recorded use of habitats for foraging was greater in open habitats (62.5%) than afforested habitats (37.5%).

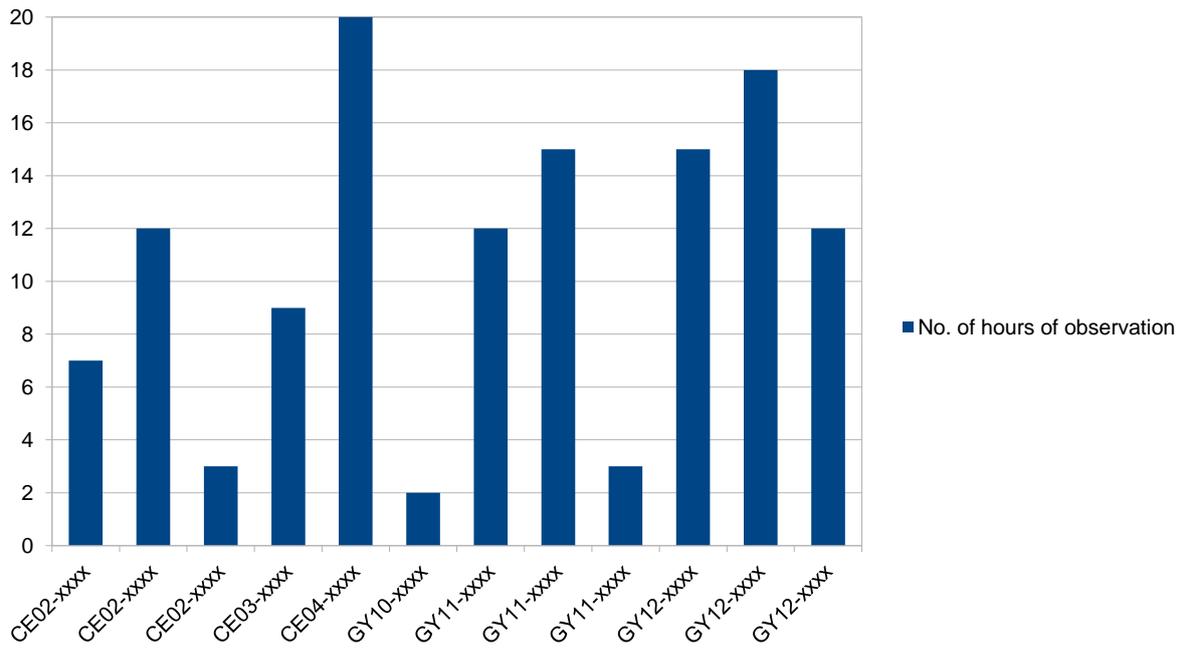


Figure 4.2. Number of hours observation per survey area in the Slieve Aughty Mountains SPA

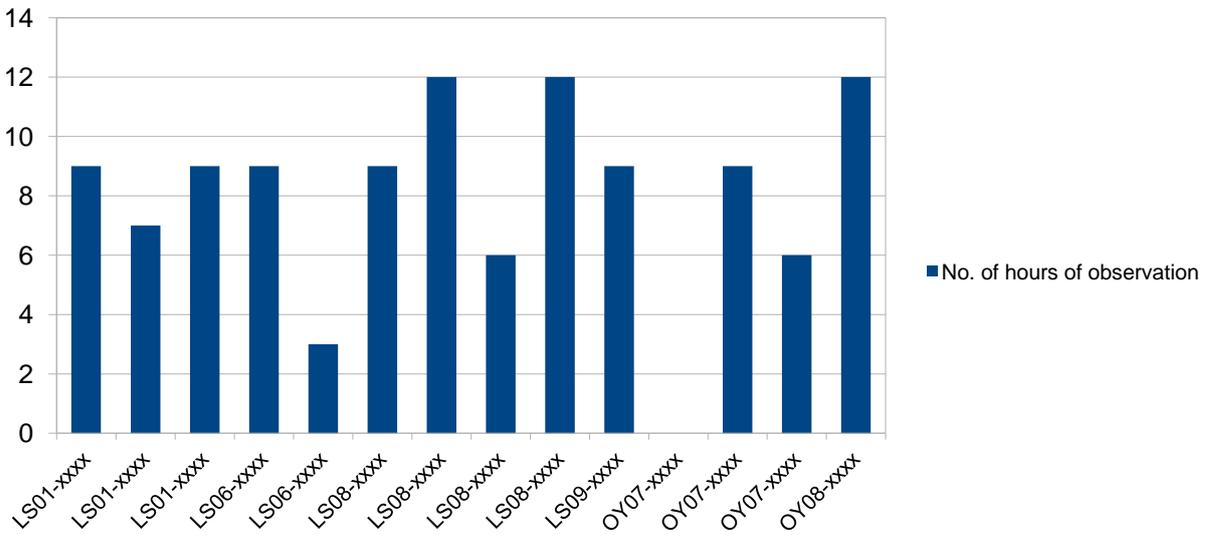


Figure 4.3. Number of hours observation per survey area in the Slieve Bloom Mountains SPA

### Hen Harrier occupancy and breeding evidence

Hen Harrier was recorded in ten survey areas (38.5%), five in the Slieve Aughty Mountains SPA, and five in the Slieve Bloom Mountains SPA. There were no observations of Hen Harrier in 16 (61.5%) survey areas.

Evidence of breeding was confirmed in four survey areas, three in the Slieve Aughty Mountains SPA and one in the Slieve Bloom Mountains SPA. Six survey areas were confirmed to be occupied by Hen Harrier (Table 4.3).

In survey areas where evidence of breeding Hen Harrier was confirmed (n = 4), the key behaviours observed were birds displaying (50%) and alarm calling (50%). In survey areas which were classed as occupied, the main behaviours were hunting/foraging (83.3%, n = 5) and flying (n = 1).

The four survey areas in which breeding evidence was confirmed were within red areas (informed by the most up to date information on red areas available at the time of the surveys in 2021). Of the six survey areas which were occupied by Hen Harrier, two were within red areas and four were not in red areas. Ten survey areas which were not occupied by Hen Harrier were within red areas.

It took a minimum of 3 hours 5 minutes and a maximum of 12 hours of survey time to record breeding evidence in each survey area, with an average of 7.29 hours (median of 7.4 hours) survey time invested per survey area to confirm evidence of breeding (n = 4). Breeding evidence was confirmed on the first visit in two survey areas and on the second visit in two survey areas (Hen Harrier were recorded at these survey areas on the first visit but second visits were required to confirm breeding evidence). It took an average of 1.5 visits to confirm breeding evidence in the four survey areas where breeding evidence was confirmed. There was no confirmation of breeding evidence made on a third visit. Confirmation of occupancy was confirmed on the first visit in four survey areas and on the second visit in two survey areas, taking an average of 1.33 visits to confirm occupancy, there was no confirmation of occupancy made during the third visits.

The survey time invested in survey areas in which Hen Harrier were not observed varied from a minimum of 6 hours to a maximum of 20 hours, with an average of 11.24 hours (median 9 hours).

**Table 4.3.** Details of Hen Harrier survey areas in which Hen Harrier were recorded, including the SPA, the harvest unit and planned management, whether they were within a red area and whether or not there was potentially suitable breeding habitat.

HU	Red area	Status	Behaviour	Habitat	Visit no. confirmed	Survey time
CE02-xxxx	Yes	Breeding evidence	Displaying	Second rotation	1	7hrs 40min
CE02-xxxx	Yes	Breeding evidence	Displaying	Heather moorland	1	3hrs 5min
GY11-xxxx	No	Occupied	Hunting	Grass moorland	2	12hrs
GY11-xxxx	Yes	Occupied	Hunting	Grass moorland	1	15hrs
GY12-xxxx	Yes	Breeding evidence	Alarm	Second rotation	2	12hrs
LS01-xxxx	Yes	Breeding evidence	Alarm	Heather moorland	2	7hrs
LS01-xxxx	No	Occupied	Hunting	Heather moorland	1	9hrs
LS08-xxxx	Yes	Occupied	Hunting	Heather moorland	1	6hrs
LS08-xxxx	No	Occupied	Flying	Thicket	1	12hrs
OY08-xxxx	No	Occupied	Hunting	Heather moorland	2	12hrs

## 4.4 Conclusions

We demonstrated that surveys (replicating pre-operational surveys) are a reliable and effective means to determine the presence of Hen Harrier in areas where forest management operations are scheduled, and that these surveys can be used to inform operations to ensure there is no risk of disturbance to Hen Harrier. This follows the same approach which is successfully implemented in other countries to collect information on priority bird species to inform risk associated with specific forest management operations (Currie and Elliot, 1997).

Based on the findings of the surveys, we suggest that collecting information on breeding Hen Harrier in this way, is more reliable and more effective in minimising the potential effects of forest management related disturbances to the species than the current approach. The rationale for this, is that firstly, the survey trials as executed provide real time data on Hen Harrier to inform forest management in the same season. There is no risk of the data used to inform the mitigation measures being outdated as is the case with the current approach. The pre-operational surveys also allow for population expansion and for the protection of Hen Harrier pairs where they nest in new areas, as the measures are targeted to the areas where Hen Harrier occur and not areas where they were previously present or expected to occur. In addition, another important factor, is that the surveys aim to confirm evidence of breeding Hen Harrier in an area, which is sufficient to inform the requirement for protection measures in that area. This approach is arguably more reliable than the current procedures which require identifying nest locations or the centre point of territories, which is used to generate the red area. The latter approach comes with risk, as often Hen Harrier nest locations are identified from a distance and the location may not be precise. Based on our criteria for defining 'breeding evidence' and our schedule of survey visits (specifically ceasing visits to a survey area once breeding evidence is determined) it is possible that some of the pairs did not breed in the survey areas or may have nested outside the survey area. This is not seen as an issue as it will not negatively affect their conservation (as long as the protection measures are in place wherever breeding Hen Harrier are present), however, for this reason, the information collected by our surveys should not be used to inform the spatial distribution of nesting pairs and breeding densities, unless the methods and survey schedule are amended accordingly.

The timing of the surveys is essential, they should be carried out in the early part of the season to increase chances of recording behaviours indicative of breeding, and also should extend sufficiently to ensure that all late nesting pairs or pairs that may have failed and attempt a second nesting attempt. All breeding evidence was recorded in either the first or second visit, which validates the survey schedule. In the survey areas where breeding evidence was confirmed on the second visit there were multiple observations of Hen Harrier recorded during the first visits, but the subsequent visit was required to acquire breeding evidence. We acknowledge that we are dealing with a small sample of survey areas and a review of survey visits, Hen Harrier observations and confirmation of breeding evidence for other Hen Harrier surveys in the Irish context would be beneficial to inform the timing of any future protocol. We propose that it would be beneficial to increase survey effort in the early part of the season to the end of May and provide further detail in the Recommendations (Section 6).

The survey allowed for important foraging areas to be detected on a site-specific basis and in relation to planned forest management operations. These 'occupied' survey areas, *i.e.*, where Hen Harrier is observed and use the area but are not breeding there, can inform forest management of important territories for potentially nesting birds, therefore increasing the chances of successful nesting outcomes. Also, this approach is applicable to other areas which are important for breeding Hen Harrier outside

the breeding Hen Harrier SPA network and would represent a significant improvement on current protection measures and data collection to inform mitigations in non-designated regionally important breeding areas.

The survey findings also highlight the fact that the current protection measures are not targeted to best effect. The survey did not record Hen Harrier in ten red areas which are in place to protect Hen Harrier from disturbance from forest management operations. Obviously, this does not have a negative effect on Hen Harrier, but it also provides no benefits to Hen Harrier.

Finally, one other benefit of this approach is that it also provides concurrent data on other bird species, which can be impacted by disturbance from forest management operations. For example, in addition to Hen Harrier other species recorded in the survey areas included Red Grouse, Buzzard, Sparrowhawk, Kestrel, Peregrine Falcon, Golden Plover and Snipe.

Despite the merits of this approach, it is undoubtedly resource demanding. In this regard, this approach is particularly suited to Hen Harrier, which are a relatively easy species to survey. This is demonstrated in the number of vantage points used and the survey time required. The resources required should be considered to be the maximum time investment required to effectively cover the survey area. This is due to the fact that this was the first time this trial was undertaken, with greater familiarity with the survey areas and also grouping surveys areas which could be covered by the same vantage point watches would allow for greater coverage and increased efficiency. Recent trials employing drones with thermal sensors to detect Hen Harrier and nest locations have showed that this survey approach can have significant benefits for Hen Harrier and could be used alongside vantage point surveys as described here to improve efficiency, accuracy and to reduce resource requirements and should be considered as part of any survey protocol that is taken forward.

## 5. Targeted surveys to assess the presence of breeding Merlin to inform forest management

### 5.1 Background

Mitigation strategies to minimise or prevent disturbances to bird species from forest management operations are typically informed by information on the spatial distribution of the species (Currie and Elliot, 1997). Protection measures or mitigation is targeted to the likely nesting areas to a scale which is deemed appropriate for the species to avoid disturbance effects. The effectiveness of such measures relies on robust data on the distribution and nest locations in order that the measures are appropriately targeted. For many species however, data is not available on their distribution and for this reason pre-operational surveys are employed, to determine whether a priority species is present and to inform the impacts and mitigation requirements of specific operations. These pre-operational surveys are recommended in the Irish context to obtain real-time information on the presence or absence of priority bird species to inform the effects, however they have been rarely applied and their effectiveness as an approach to inform forest management in the Irish context has not been tested.

The risk of disturbance to breeding Merlin, based on their nesting ecology, to forest management operations have been identified (Lusby *et al.*, 2017). Mitigation measures to protect breeding Merlin from the negative effects of forest management operations have been introduced by the Forest Service within the breeding Merlin SPA network in late 2019. These mitigation measures are based on the habitat suitability for breeding Merlin and restrict forest management operations during the period 1 March to 31 August within 100m of forest edge where it is immediately adjacent to suitable foraging habitat. We reviewed the effectiveness of this mitigation strategy in Section 3.

The gaps in our understanding of Merlin ecology and the difficulties associated with surveying the species have been recognised in our review. Going forward it is beneficial to evaluate other novel approaches to assess the presence of Merlin and how we can protect them from disturbance from forest management related disturbances. Here we set out to trial surveys to determine the presence of Merlin to inform forest management.

#### Objectives

This survey was carried out on a trial basis to assess the effectiveness of surveys to provide real-time data on Merlin and to inform their protection in relation to disturbances from forest management activities. The objectives of this survey are therefore, to:

- (i) Design and implement survey trials to test the effectiveness of determining the presence of Merlin in areas where there is risk;
- (ii) Determine the presence and breeding status of Merlin in defined survey areas with respect to forest areas where management operations are scheduled;
- (iii) Use the survey findings to inform appropriate mitigation for breeding Merlin;
- (iv) Determine the resources required to undertake the survey trials;
- (v) Assess the merits of the trial surveys for the future protection of Merlin.

## 5.2 Methods

### Survey design

The survey design is informed by previous surveys on Merlin in Ireland (Lusby *et al.*, 2011, Lusby *et al.*, 2022) and adapted to meet the specific objectives of this study. The survey is designed to test the effectiveness of surveys (or pre-operational surveys) to determine the presence of Merlin in relation to areas where forest management operations are planned. This is based on the premise that in order to ensure the protection of Merlin from forest management related disturbances, it is not necessary to have information on the distribution of Merlin pairs within a defined area or region, but rather to have information on the presence or absence of Merlin pairs specifically in relation to planned forest management operations. To achieve this, we selected surveys areas based on harvest units (distinct forest areas of uniform age, structure and management) where forest management operations are scheduled during the period 2021/22. Survey areas were informed on the basis of harvest units scheduled for thinning and clearfell, as these operations are considered to present the greatest risk of disturbance to breeding Merlin (Lusby *et al.*, 2017). These survey areas (formed around harvest units) are therefore representative of forest management operations carried out in the breeding Merlin SPA network, which have the potential to cause disturbance to breeding Merlin. It is important to note that the surveys were carried out on a trial basis and did not inform forest management operations during the period of this study.

As outlined, the survey design focuses on obtaining information on the presence or absence of breeding Merlin in the defined survey areas and did not attempt to census Merlin on a wider scale, in individual SPA's or throughout the breeding Merlin SPA network. The survey was not designed to obtain information on the outcome of Merlin breeding attempts. This is based on the objectives of the survey, which were to determine if breeding Merlin were present in a defined survey area, as this level of information is sufficient to inform the potential effects of forest management (*i.e.* whether forest management operations would have an effect based on the presence or absence of breeding Merlin in a defined area).

Integral to the survey design, it was necessary to document the survey resources required (survey effort, time requirements) to effectively determine the presence of breeding Merlin in the survey area, as this information is essential to inform the efficiency and practicalities of these survey trials and to inform future recommendations for the protection of Merlin.

The survey area was concentrated in two of the seven SPAs in which Merlin are listed as a Species of Conservation Interest, namely the Slieve Aughty Mountains SPA and the Connemara Bog Complex SPA.

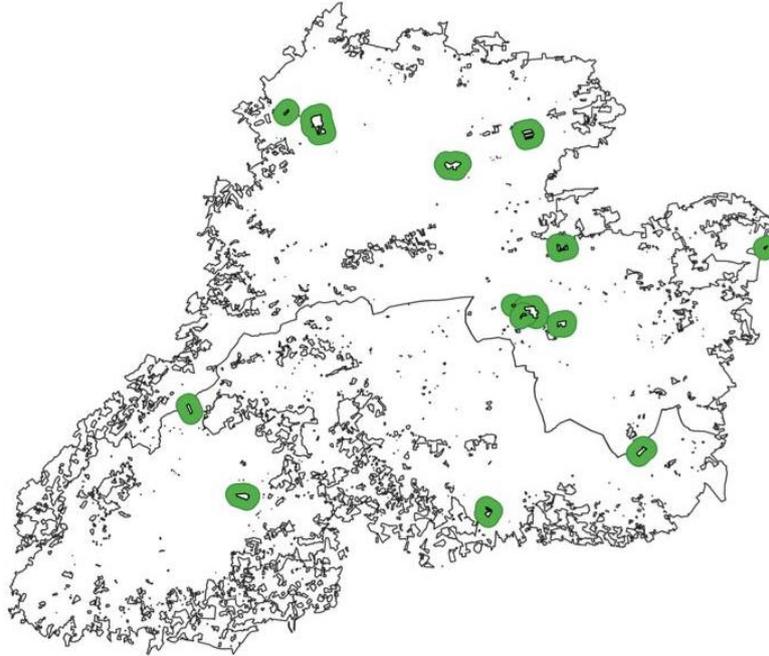
### Survey area

The survey area was defined based on the selection of harvest units scheduled for thinning and clearfell during the period 2021/22 in the Slieve Aughty Mountains SPA, the Connemara Bog Complex SPA and within 5km of these SPAs boundaries as per the recommendations of Lusby *et al.*, (2017). A total of 15 harvest units were selected at random, 14 in the Slieve Aughty Mountains SPA and one in the Connemara Bog Complex SPA. A buffer of 500m was created around the perimeter of each harvest unit, which formed each individual survey area. This 500m buffer is the maximum zone of disturbance for

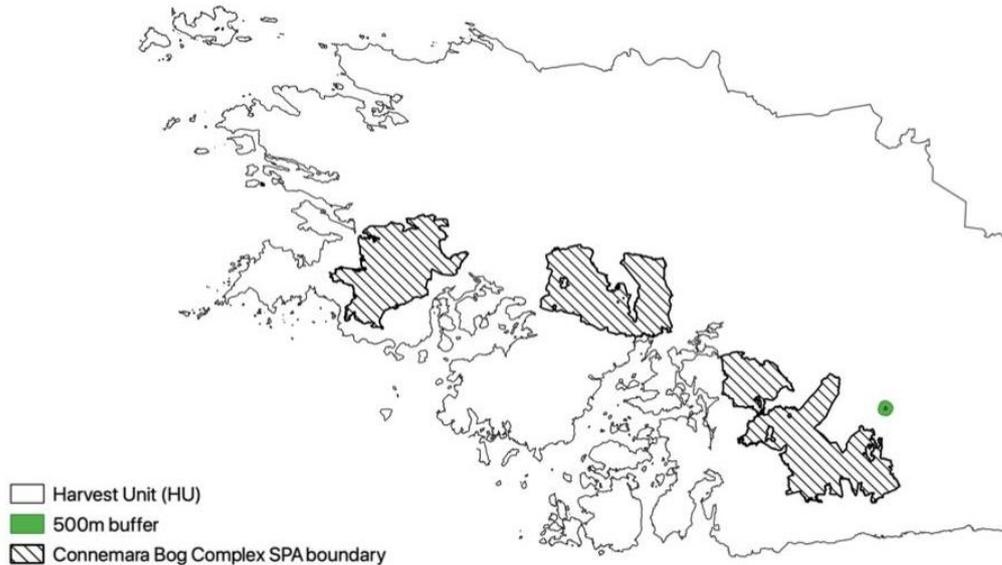
Merlin recommended by Ruddock and Whitfield (2007). Therefore, the survey area consisted of individual survey areas, each with a harvest unit (scheduled for clearfell and thinning) at its centre and surrounded by a 500m buffer, in or within 5km of the Slieve Aughty Mountains SPA, and the Connemara Bog Complex SPA as shown below in Figure 5.1.

---

## Slieve Aughty Mountains



## Connemara



**Figure 5.1.** The distribution of Merlin survey areas in the Slieve Aughty Mountains SPA and Connemara Bog Complex SPA covered during the current survey.

## Survey coverage

The survey was carried out by four surveyors. All surveyors had previous experience of undertaking Merlin surveys during the breeding season, which included participation in the survey of Merlin in the SPAs (Lusby *et al.*, 2022) and/or undertaking surveys of Merlin on a professional basis. Each surveyor was allocated one or more survey areas, with two surveyors working in the Slieve Aughty Mountains SPA and two in the Connemara Bog Complex SPA.

Each surveyor was provided with the method statement (Appendix F), an aerial image and an OSI 1:50,000 map of each survey area, recording form and the online survey form (Appendix G) to enter and submit the survey data. The OSI 1:50,000 maps included the 1×1 km grid system (Irish National Grid) and were used to record spatially referenced survey data, including the survey area, vantage point locations and view sheds, and observations of Merlin. The aerial images showed further detail on habitat features and provided an additional resource for surveyors to assess habitat suitability. The OSI survey map and aerial image included the harvest unit at the centre of the survey area and the 500m buffer which formed the boundary for the survey area. In addition, an overview map of the relevant SPA was provided to each surveyor showing all survey areas in order to aid navigation.

Regular communication was maintained between the survey coordinators and all surveyors throughout the survey, which allowed survey coverage to be reviewed on an on-going basis and to make any amendments required to the survey methods and data recording as required. Survey data was submitted on an on-going basis throughout the survey season via the online survey forms which allowed validation of the survey data and identification of any issues that may have affected survey coverage or data recording.

Survey plans, including the survey area to be visited and the timing of surveys in the Slieve Aughty Mountains SPA were shared with the Hen Harrier Project in advance of all survey visits (either the evening prior or the early morning before the survey was initiated). This was to ensure that duplication of survey effort was avoided (*e.g.* two surveyors independently working in the same place at the same time, which could increase the risk of unintentional disturbance to breeding Merlin or other species). Details of the surveys and the specific survey visits were also shared with the relevant NPWS staff in the survey areas in advance of all survey visits.

## Defining the search area

Within each survey area (harvest unit with surrounding 500m buffer) the search area was defined by distinguishing between unsuitable habitat for breeding Merlin, suitable foraging habitat and potentially suitable breeding habitat for Merlin, as defined below. The search area was defined using OSI survey maps and aerial images in addition to ground-truthing on the first survey visit. Areas of unsuitable habitat for breeding Merlin were marked accordingly on OSI survey maps or aerial images and excluded from further survey effort. If the suitability of specific areas remained in question, then these areas were considered to be potentially suitable and included in the search area, in order to reduce the risk of overlooking Merlin which may nest in areas where the suitability was in doubt.

**Unsuitable habitat:** All areas of open water, urban and built-up areas, semi-improved, improved and enclosed pastures and other enclosed agricultural land-uses and areas above 700 m in altitude (Hardey *et al.*, 2009; Lusby *et al.*, 2017) were considered to be unsuitable breeding habitat for Merlin.

**Suitable foraging habitat:** Unenclosed upland areas which include grass and heather moorland, natural grassland and bog which do not include suitable nesting opportunities for Merlin (as defined below) were considered as suitable foraging habitat.

**Potentially suitable breeding habitat:** All habitats which could be used for nesting by Merlin, as informed by knowledge of their nest site selection and requirements in Ireland (Lusby *et al.*, 2017), were considered to be potentially suitable breeding habitat. This included all trees which could hold a suitable stick nest, which were located in or adjacent to suitable foraging habitats (as defined above), which included conifer plantation, open woodland, shelter belts, copses, tree lines, wooded islands on inland lakes, and isolated trees in open upland areas. The majority of Merlin nests in plantation forest are located within 10m of the forest edge (Lusby *et al.*, 2017), although nests may be located up to 60m from the edge of the plantation, or within the forest interior close to the edge of breaks or clearings (Norriss *et al.*, 2010) and these criteria were used to define the forest areas suitable for breeding Merlin. Where it was possible to assess individual trees and to ascertain with confidence that there are no suitable stick nests present, then these trees were ruled out as unsuitable and did not require further survey effort. Merlin may also nest on the ground in moorland, where heather is 30 – 70 cm high (Hardey *et al.*, 2009; McElheron, 2005), typically on sloping ground, and any areas which provided such opportunities were considered to be potentially suitable breeding habitat. Breeding Merlin have also been recorded using rocky crags and rock faces (David Norriss, personal communication), and boulders with suitable cover (McElheron, 2005) in a small number of cases, and such features were also considered to be suitable.

### Survey techniques

Vantage point watches were the main survey technique used to determine the presence of breeding Merlin in the survey area. Vantage point watches were carried out over all areas of potentially suitable breeding habitat within the defined survey area, to record Merlin activity and determine occupancy and breeding status. The location and number of vantage points were selected to ensure that all areas of potentially suitable breeding habitat within each survey area could be effectively watched. Vantage points were located at a maximum distance of 800m from the area being watched in order to allow reasonable confidence in detecting all Merlin activity associated with that area.

Vantage point watches lasted a minimum of three hours and were undertaken in the morning (starting before 10.00 hours or the evening (after 16.00 hours) where possible, and in suitable weather conditions, defined as visibility greater than 1 km, no precipitation and wind speed of less than Force 5 (fresh to strong breeze). During vantage point watches, particular attention was given to other bird species including corvids, raptors, herons and gulls when passing over or interacting with potentially suitable breeding habitat for Merlin, as these species can elicit a response from breeding Merlin in proximity to nesting sites (Lusby *et al.*, 2011). Merlin nests were not approached, and if birds were accidentally disturbed or flushed, the location details were recorded, and the area was vacated immediately.

Sign-searching was not employed as a survey technique to detect or determine the presence of breeding Merlin as in previous surveys of the species in Ireland (Lusby *et al.*, 2011; Lusby *et al.*, 2022). This was primarily due to the fact that the defined surveys areas in this survey are significantly smaller than the survey units in previous surveys, and therefore allowed for greater coverage and confidence in vantage point watches. In addition, vantage point watches are considered a more reliable method for detecting

the presence of breeding Merlin in the Irish context (Lusby *et al.*, 2011). The Pilot Merlin Survey previously identified the unreliability of sign searching for determining occupancy and for locating nests in certain situations (Lusby *et al.*, 2011). Norriss *et al.*, (2010) also highlighted the unreliability of sign searching particularly for pairs at disturbed sites, or sites bordering grassland, as plucking tended to be carried out in the tree canopy. Without the aid of signs to narrow the search area, Norriss *et al.* (2010) reported that survey efficiency reduced from 87% to 60%. Lusby *et al.*, (2011) reported that in the Irish uplands, sign-searching is a beneficial survey tool for locating certain pairs, but for other pairs this method is significantly less effective.

All details of the vantage point watches were documented using the recording form, including a 10-figure grid reference (Irish National Grid) of the vantage point location (using a hand-held GPS unit), the start and finish times and details of all encounters with Merlin according to the specific behaviour and habitat codes (Appendix H). All Merlin encounters were mapped on the relevant OSI survey map or aerial image, according to the encounter number, age and sex and the full extent of flight lines viewed and direction of movement. The approximate or known location of Merlin nest sites were marked on the OSI survey map or aerial image accordingly. The location and number of each vantage point was marked on the OSI survey map or aerial image, alongside the view from each vantage point. The survey area details and name, the SPA name, date, visit number, and start and finish times of the survey were detailed on each OSI survey map or aerial image (as shown in Appendix G). Any activities/threats or pressures observed within the survey area, were also recorded on the recording form, using the codes listed in Appendix D (as per Ruddock *et al.*, 2016).

### Survey schedule

The Merlin survey was carried out over eleven weeks from 1 April to 15 June 2021. Three visits to survey areas were scheduled over this survey period. If evidence of breeding Merlin was confirmed in a survey area on the first or second visit, then subsequent visits were not required.

Survey visits were spaced by at least one week. The duration of each survey visit could vary from a single day (or single vantage point watch) to several days depending on the size of the defined search area, the quantity of potentially suitable breeding habitat and the number of vantage point watches required to cover all potentially suitable breeding habitat.

The **first visit** (1 April – 25 April) required becoming familiar with the survey square and the search area within and informed the best approach to undertaking the survey including the resource requirements to effectively survey the area for breeding Merlin. Any further unsuitable habitat recorded on this visit was excluded from the search area and marked on the OSI survey map or aerial image accordingly. The locations of vantage point watches to overlook all areas of potentially suitable breeding habitat were selected and vantage point watches were conducted. This visit aimed to establish occupancy of Merlin and identify potential nesting areas.

The **second visit** (26 April – 20 May) aimed to establish occupancy of Merlin within the defined search area and to identify areas of potential breeding activity based on evidence of Merlin encounters and associated behaviour and/or signs. Vantage point watches were carried out as informed by the first visit.

The **third visit** (20 May – 15 June) aimed to establish evidence of breeding, with emphasis on locating active nests, or areas of breeding activity, where these are not already located. Where areas of nesting activity were known or suspected the emphasis was placed on vantage point watches.

A late season visit was not required as per previous Merlin surveys (Lusby *et al.*, 2011; Lusby *et al.*, 2022). The rationale for this is that all breeding Merlin should be established and possible to detect during the survey schedule, it was not necessary to identify the specific nest location or to confirm breeding success or productivity, which is the aim of late season visits (Lusby *et al.*, 2022).

### Data recording

All survey data was recorded and submitted via the online survey forms and the OSI survey map or aerial images were returned via email. All survey data was collated into a single excel spreadsheet for analysis and interpretation and relevant data (e.g. the location of vantage points, Merlin observations etc.) were mapped in QGIS 3.0 to allow visual exploration and to assess Merlin occupancy and breeding status in the survey area as outlined below.

### Merlin occupancy and breeding evidence

Each survey area was categorised according to the Merlin observations and behaviours recorded within, based on the criteria below. The criteria used to define occupancy and breeding status was informed by previous Merlin surveys in Ireland to ensure comparability (Lusby *et al.*, 2022) and adapted for the specific purposes of this survey, as shown below (Table 5.1). Specifically, the criteria used to define ‘breeding evidence’ includes early-stage breeding season behaviours (e.g. prospecting or territory establishment in the early stages of the breeding season). This is a more conservative approach (in terms of defining breeding evidence) than is used in other Merlin surveys, however the aim of our surveys is not to determine the number of Merlin pairs, but rather to determine evidence of breeding within the survey area.

**Table 5.1.** Criteria used to define occupancy and breeding status of Merlin in survey area.

<b>Breeding activity</b>	<b>Behaviours, evidence and/or activities observed</b>
<i>Confirmed breeding evidence</i>	Male and female observed simultaneously Both adults observed individually on at least three occasions in the same area (within 1km) in suitable breeding habitat, Courtship display (including the male bringing food to the female) Copulation, or a single bird showing behaviour indicative of breeding, including entering or leaving a nest, delivering prey to a nest Repeatedly alarm-calling or mobbing, Evidence of a nest, including eggs or eggshells, Young in the nest or recently fledged young seen or heard.

<i>Occupied</i>	A single male or female seen or heard with no evidence of breeding behaviours  Fresh signs of occupation (pluckings, pellets, droppings or moulted feathers) confirmed to be Merlin found on at least two occasions separated by at least one week
<i>Not seen</i>	No evidence of Merlin (fresh signs, sightings or calls) recorded

**Note.** Adapted from “Assessing the effectiveness of monitoring methods for Merlin *Falco columbarius* in Ireland: The Pilot Merlin Survey 2010”, by Lusby *et al.*, 2011, *Irish Birds*, 9: 143 -154

## 5.3 Results

### Survey area

The survey area consisted of 15 individual survey areas (harvest units inclusive of a 500m buffer) in the Slieve Aughty Mountains SPA (n = 14) and the Connemara Bog Complex SPA (n = 1). Twelve survey areas were based on harvest units scheduled for clearfell and two were based on harvest units scheduled for thinning operations.

A review of aerial images and an initial visit confirmed that all survey areas contained potentially suitable breeding habitat for Merlin. The details of all survey areas including the SPA, the harvest unit details and management and whether there was potentially suitable breeding habitat within are shown below in Table 5.2.

**Table 5.2.** Details of all Merlin survey areas including the SPA, the harvest unit and planned management, and whether or not there was potentially suitable breeding habitat.

Location	HU ID	Management type	Suitable habitat
Slieve Aughty Mountains SPA	CE02-H0092	Clearfell	Yes
Slieve Aughty Mountains SPA	CE02-H0105	Clearfell	Yes
Slieve Aughty Mountains SPA	CE03-H0114	Clearfell	Yes
Slieve Aughty Mountains SPA	CE04-H0040	Thin	Yes
Slieve Aughty Mountains SPA	GY10-H0061	Clearfell	Yes
Slieve Aughty Mountains SPA	GY10-H088	Clearfell	Yes
Slieve Aughty Mountains SPA	GY10-H0096	Clearfell	Yes
Slieve Aughty Mountains SPA	GY10-H0100	Clearfell	Yes
Slieve Aughty Mountains SPA	GY10-H0107	Clearfell	Yes
Slieve Aughty Mountains SPA	GY11-H0156	Clearfell	Yes
Slieve Aughty Mountains SPA	GY11-H0173	Thin	Yes
Slieve Aughty Mountains SPA	GY11-H0178	Clearfell	Yes
Slieve Aughty Mountains SPA	GY11-H0179	Clearfell	Yes
Connemara Bog Complex SPA	GY21-H0006	Clearfell	Yes

### Survey schedule

Survey visits were undertaken according to the proposed schedule of visits. All survey areas (n = 15, 100%) received a first visit, 14 survey areas (93.3%) received a second visit, and 15 survey areas (100%) received a third visit.

The total time required to effectively survey all survey areas (n = 15) was survey 332 hours 52 minutes. There was an average of 22 hours spent in each survey area, which ranged from 9 to 48 hours.

### Survey techniques

Vantage point watches were undertaken between 0510h and 1930h and ranged in duration from 1 hours 10 minutes to 5 hours 30 minutes, with an average duration of 3 hours (median of 3 hours). The number of hours of observation at each survey area can be seen below in Figure 5.2.

The total number of vantage point locations used to survey all survey areas (n = 15) was 47. The minimum number of vantage point locations used per survey area was one and the maximum 8 with an average of 3.1.

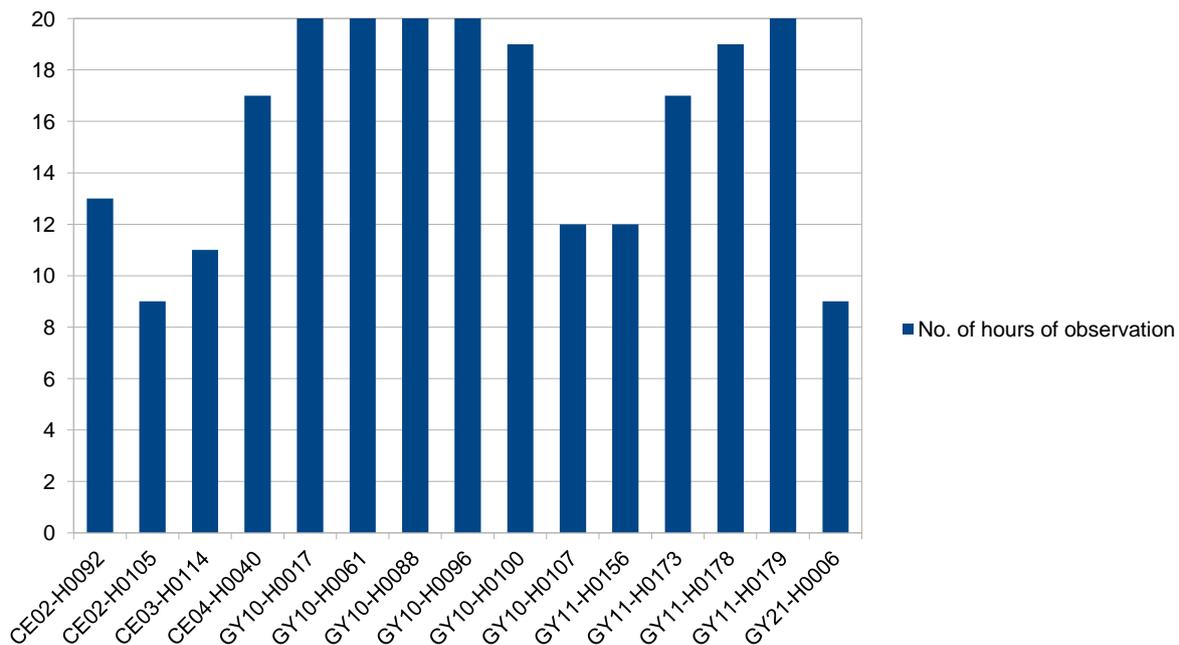


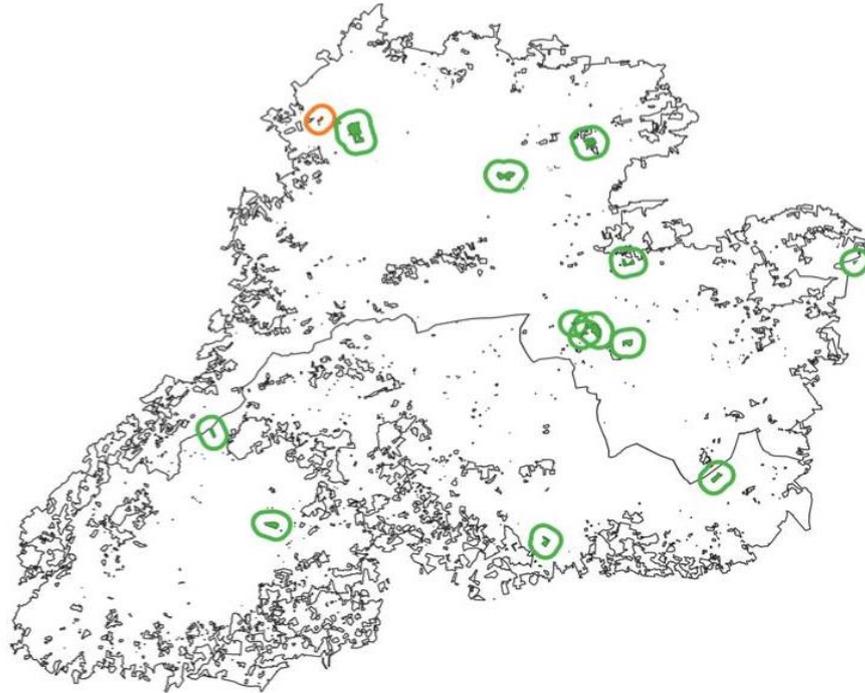
Figure 5.2. Number of hours observation per Merlin survey area in the Slieve Aughty Mountains SPA and Connemara Bog Complex SPA

There was one detection of Merlin, a single adult female was observed in one survey area in the Slieve Aughty Mountains SPA on the first visit in April 2022. The overall detection rate of Merlin was 0.003 per hour of observation.

### Merlin occupancy and breeding evidence

There was no evidence of breeding activity recorded for Merlin. Only one of the 15 survey areas in the north-west of the Slieve Aughty Mountains SPA was classed as 'occupied' based on the single sighting within.

## Slieve Aughty Mountains



## Connemara

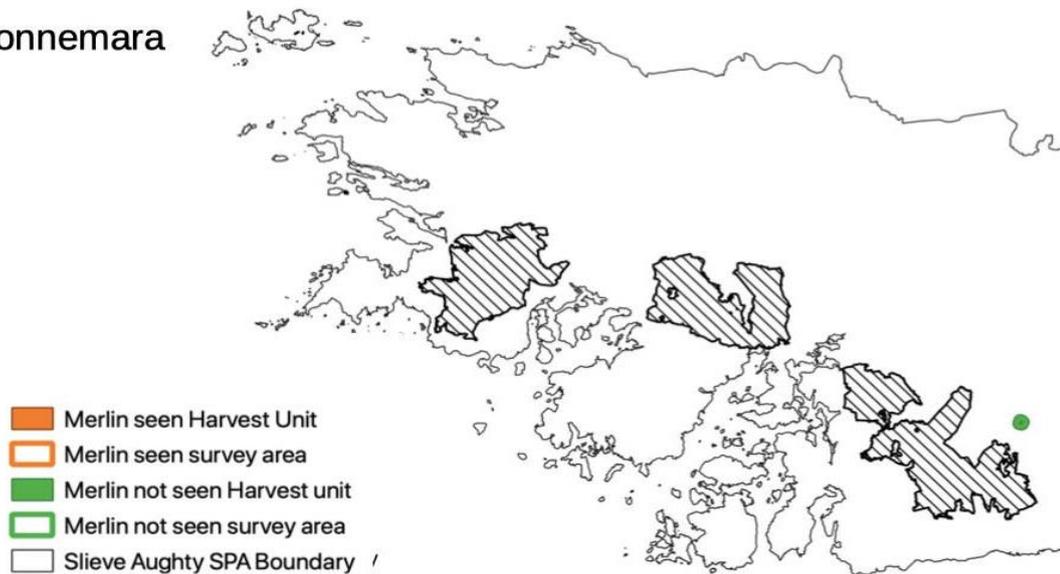


Figure 5.3 Distribution of Merlin observations across the survey areas.

## 5.4 Conclusions

We demonstrated that surveys (or pre-operational surveys) can be carried out to determine the presence of Merlin in areas where forest management operations are planned, and that these surveys can be used to inform the operations to ensure that risk of disturbance to Merlin is minimised or removed. This follows the same approach which is successfully implemented in other countries to collect information on priority bird species to inform risk associated with specific forest management operations (Currie and Elliot, 1997). The challenges and resource demands associated with conducting surveys (or pre-operational surveys) for Merlin are recognised however and this is reflected in the outcome of these trials which required significant resources but produced limited information on Merlin.

Based on the findings of the surveys, we suggest that collecting information on breeding Merlin in this way can help to target mitigation measures to ensure the appropriate protection of breeding Merlin from forest management related disturbances. Although this survey approach is more targeted than the current habitat-based approach, the survey trials also emphasise the resources required to perform this approach to determine the presence of Merlin in relation to harvest units where forest management operations are scheduled. The low observation rate and the fact that only a single bird was confirmed reflects the fact that Merlin seemingly occur in the low densities in the breeding Merlin SPA network, which has also been reported by other studies (Lusby *et al.*, 2022; Lusby *et al.*, 2017). The surveys also highlighted the constraints and challenges with surveying for Merlin, which were significantly more resource demanding compared to Hen Harrier surveys. The Merlin surveys required more vantage point locations and more survey time, even though the survey area for Merlin was substantially smaller (500m buffer used for Merlin survey areas compared to 750m for Hen Harrier) than for Hen Harrier.

Previous Merlin surveys have expressed concern over detection of the species and lack of confidence in negative results (Lusby *et al.*, 2011), however it is considered that these constraints would be reduced for the surveys as described here given that they focus on a significantly smaller survey areas, which increases confidence in the ability to detect Merlin if present. Although vantage point surveys for Merlin are labour intensive, they remain the most reliable method for confirming the presence of Merlin in the Irish context. Despite the constraints, this approach would facilitate increased data collection on breeding Merlin over time, which would have significant benefits in terms of understanding the distribution of the species which would inform forest planning and it is likely that with an increased understanding of the species across the breeding Merlin SPA network and in individual SPAs, the surveys would require less resources and become more efficient over time. This is due to the fact that this was the first time this trial was undertaken, with greater familiarity with the survey areas and also grouping survey areas which could be covered by the same vantage point watches would allow for greater coverage.

We also recommend that other methods are trialled to improve efficiency and accuracy in detecting breeding Merlin as outlined in Section 6.3. These trials are currently underway and until such time as there is a robust and standardised survey methodology available for breeding Merlin in the Irish context that can be integrated to the proposed pre-operation surveys, then it is recommended that the habitat-based approach to identifying areas requiring mitigation is continued, with the necessary amendments and improvements as outlined in this review.

## 6. Recommendations

To prevent negative impacts to breeding birds from forestry activities, the most effective method is to avoid forest management operations or other disturbances in sensitive areas during the breeding period. Based on the information presented in this report, the following recommendations are outlined to improve the protection of breeding Hen Harrier and Merlin from forest management-related disturbances in Ireland.

### 6.1 Recommendations for mitigation measures for the protection of Hen Harrier and Merlin

Criterion	Hen Harrier Mitigation Measures	Merlin Mitigation Measures
<p><b>Data used to inform protection measures</b></p>	<ul style="list-style-type: none"> <li>• <b>Use current information on breeding Hen Harrier to inform protection measures</b> (to include enhanced data sharing capabilities and maximising the use of existing data on Hen Harrier and/or pre-operational surveys). Data on Hen Harrier distribution and nest locations should be collected in the same season as forest management operations are scheduled, to inform mitigation and to ensure no negative impacts. Specifically, <b>forestry activities should not proceed unless and until such time that it can be confirmed that Hen Harrier are not present and as such operations will not negatively impact breeding Hen Harrier.</b> Our review (Section 2) shows that where protection measures are informed by Hen Harrier distribution and nest location data from previous years, this may not provide appropriate protection.</li> <li>• <b>Develop a standard methodology for conducting and reporting on habitat suitability for Hen Harrier</b> to ensure a high standard in the planning, preparing, conducting, and reporting of Hen Harrier habitat assessments.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Develop a standard methodology for conducting and reporting on habitat suitability for Merlin</b> to ensure a high standard in the planning, preparing, conducting, and reporting of Merlin habitat assessments.</li> <li>• <b>Develop a robust and reliable system for surveys (or pre-operational surveys) to determine the presence of Merlin</b> to inform forest management and mitigation and ensure disturbance to breeding Merlin is avoided.</li> </ul>

Criterion	Hen Harrier Mitigation Measures	Merlin Mitigation Measures
<p><b>Spatial application of protection measures</b></p>	<ul style="list-style-type: none"> <li>Our review highlights that the spatial application of the existing mitigation measures (red area procedures) can be improved to provide protection to Hen Harrier within the SPA network. Specifically, we <b>recommend that forest management operations should not proceed in areas where Hen Harrier have the potential to nest</b> (areas of suitable breeding habitat for Hen Harrier) <b>until it is confirmed that there will be no disturbance impacts to Hen Harrier (informed by robust and contemporary data on Hen Harrier distribution and nest locations and/or pre-operational surveys)</b>. This differs from the existing mitigation measures which apply mitigations retrospectively based on information on Hen Harrier nest or territory locations. The implementation of this recommended approach requires access to robust and contemporary data on Hen Harrier distribution and/or conducting pre-operational surveys.</li> <li><b>Apply protection measures to non-designated regionally important breeding areas for Hen Harrier.</b> The lack of formal protection in these areas may be putting breeding Hen Harrier at risk from disturbance from forest management activities.</li> </ul>	<ul style="list-style-type: none"> <li>Our review indicates that <b>the existing habitat-based approach to applying the Merlin mitigation measures is currently the most appropriate to minimise the risks to breeding Merlin from forest management related disturbances</b>. This is based on the limited data available on Merlin distribution and nest locations in the SPA network and the challenges in reliably confirming the presence/absence of Merlin in areas to inform risks and mitigation requirements. It is recommend that further effort is invested in establishing a robust and reliable system for collecting data on Merlin (See Section 6.3) and once in place, the Merlin mitigations can be refined and can be more targeted, in line with the recommended Hen Harrier mitigations.</li> <li><b>Apply protection measures to non-designated regionally important breeding areas for Merlin</b> as the lack of formal protection in these areas may be putting breeding Merlin at risk from disturbance from forest management activities.</li> </ul>
<p><b>Potential risks posed by forestry activities</b></p>	<ul style="list-style-type: none"> <li><b>Review all forestry activities and define the potential risks they present to breeding Hen Harrier</b> and the requirements for protection.</li> <li><b>Clarify the specific forestry activities that are permitted and those that are not</b> within or in proximity to Hen Harrier breeding territories (i.e., define the activities that are currently listed by the Forest Service as ‘other operation(s) the Forest Service may deem as potentially creating disturbance’ (DAFM, 2015)).</li> </ul>	<ul style="list-style-type: none"> <li><b>Review all forestry activities and define the potential risks they present to breeding Merlin</b> and the requirements for protection.</li> <li><b>Clarify the specific activities that are permitted and those that are not</b> within or in proximity to Merlin breeding territories or suitable breeding habitat (i.e., define the activities that are currently listed by the Forest Service as ‘other forestry operations’ (DAFM, 2015)).</li> </ul>

Criterion	Hen Harrier Mitigation Measures	Merlin Mitigation Measures
<p>Size of protected area (disturbance-free zone)</p>	<ul style="list-style-type: none"> <li>We recommend that forest management operations should not proceed in areas where Hen Harrier have the potential to nest (areas of suitable breeding habitat for Hen Harrier) until it is confirmed that there will be no disturbance impacts to Hen Harrier (informed by robust and contemporary data on Hen Harrier distribution and nest locations and/or pre-operational surveys. Where Hen Harrier nest/territory locations are identified, we recommend that the nest protection buffer is increased from the current 500m to 750m (Ruddock and Whitfield, 2007; Goodship and Furness, 2022) to ensure protection of breeding Hen Harrier from high impact forestry activities. This 750m buffer should be centered around known Hen Harrier nest / territory locations or surrounding planned operations where there is potential risk to breeding Hen Harrier from planned forest management operations.</li> <li>Remove the 700m buffer for interannual movements of territorial pairs, where there is reliable and robust information on Hen Harrier nest locations (as above and informed by targeted pre-operation surveys or the provision of contemporary data). The 700m buffer for interannual movements is not effective, as implemented in its current form, as shown by Ruddock <i>et al.</i>, (2016) and our review (Section 2.1).</li> <li>Apply the appropriate disturbance-free zone to each forest activity, proportionate to the level of risk and scale of potential disturbance to Hen Harrier. All activities should be ranked (high impact, medium impact, and low impact) and an appropriate disturbance-free zone applied accordingly (e.g., the highest impact activities such as harvesting require a disturbance-free zone of the maximum 750m and so on). The risk of disturbance and scale of disturbance-free zone for each activity may be refined based on new data on disturbance events and informed by site-specific data.</li> </ul>	<ul style="list-style-type: none"> <li>Increase the disturbance-free zone (or nest protection buffer) from the current 100m to 500m (Ruddock and Whitfield, 2007; Goodship and Furness, 2022) to ensure protection of breeding Merlin from high impact forestry activities. This 500m buffer should be centered around known Merlin nest / territory or surrounding planned operations, where there is potential risk to breeding Merlin from planned forest management operations.</li> <li>Apply the appropriate disturbance-free zone to each activity, proportionate to the level of risk and scale of potential disturbance to Merlin. All activities should be ranked (high impact, medium impact, and low impact) and the disturbance-free zone applied accordingly (e.g., the highest impact activities such as harvesting require a disturbance-free zone of the maximum 500m and so on). The risk of disturbance and scale of the disturbance-free zone for each activity may be refined based on new data on disturbance events.</li> </ul>

Criterion	Hen Harrier Mitigation Measures	Merlin Mitigation Measures
<p><b>Timing of protection measures</b></p>	<ul style="list-style-type: none"> <li>• <b>Maintain the current period of protection measures (from 1<sup>st</sup> March to 15<sup>th</sup> August).</b> This timing may be further refined based on the review of the timing of breeding of Merlin in Ireland (see Section 6.3) including assessing whether the timing of protection measures should be extended in late summer to provide protection to juvenile Hen Harrier in the pre-dispersal or early dispersal period and based on recent research (McCarthy, 2022) (Section 6.3).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Maintain the current period of protection measures (1<sup>st</sup> March to 31<sup>st</sup> August).</b> This timing may be further refined based on the review of the timing of breeding of Merlin in Ireland (see Section 6.3).</li> </ul>

## 6.2 Recommended approach for the protection of Hen Harrier and Merlin during forest operations

A new approach is proposed in Figure 6.1 and Text Box 1, reflecting the recommendations presented above. This recommended approach integrates a robust and reliable method for assessing the presence/absence of breeding Merlin and until such time as this method is in place, the current habitat-based approach to applying the Merlin mitigations should be maintained.

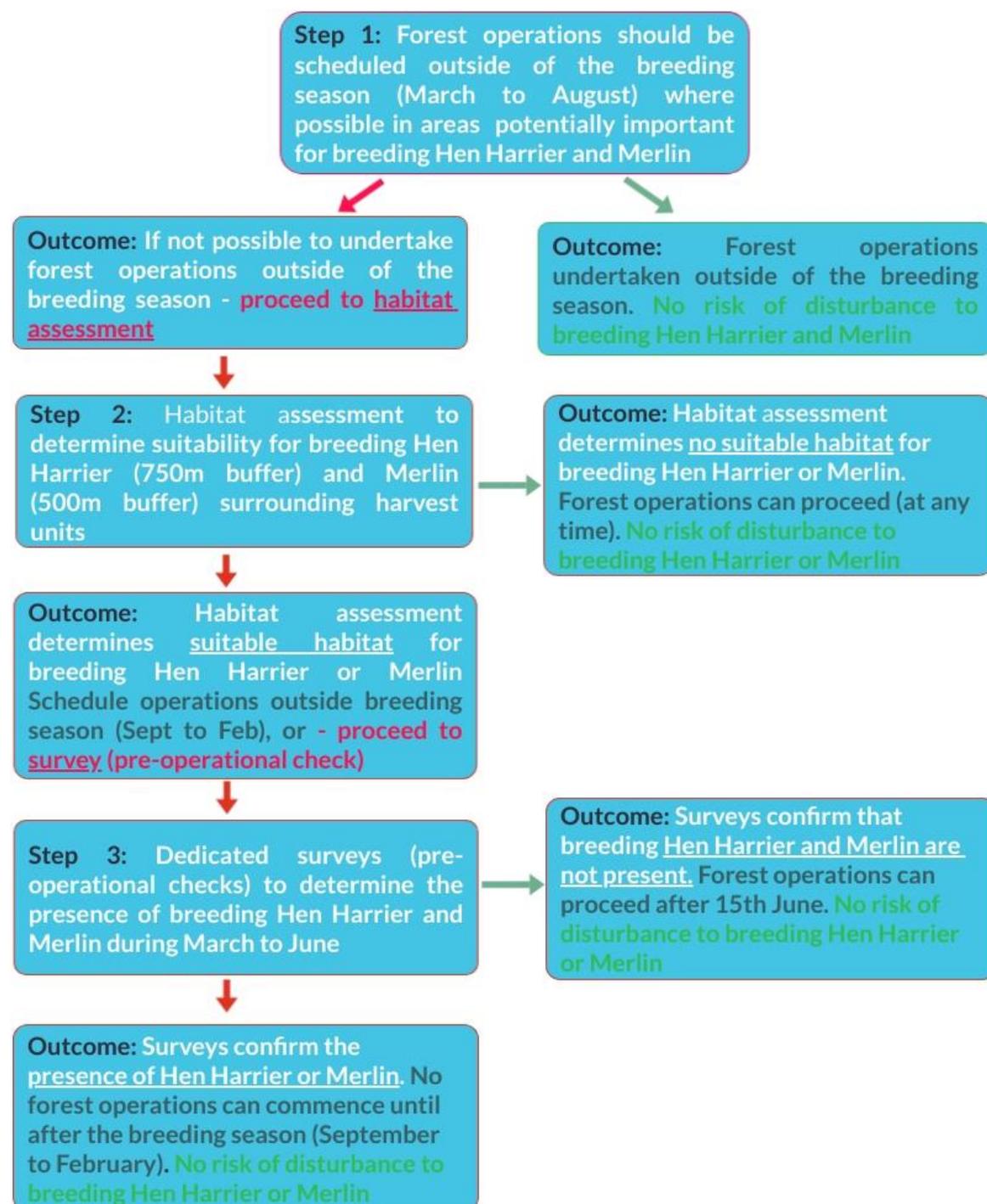


Figure 6.1 Recommended approach for the protection of Hen Harrier and Merlin from forestry activities

TEXT BOX 1. Description of the proposed approach for the protection of Hen Harrier and Merlin from forest management related disturbances	
<p><b>Step 1: Forest planning to avoid disturbance</b></p>	<ul style="list-style-type: none"> <li>Forestry project areas, will include the sites of planned operations, with the relevant disturbance-free zone for the specific forestry activity applied (e.g., high impact activities will require 750m buffer for Hen Harrier and 500m buffer for Merlin). These areas shall be assessed to determine suitability for breeding Hen Harrier/Merlin. A suitably qualified ecologist must undertake the habitat assessments according to the defined method and reporting protocol. Habitat assessments must be undertaken within a six-month period prior to the planned forest management operations.</li> <li><b>Forestry project areas which contain potentially suitable habitat for breeding Hen Harrier/Merlin should be scheduled for forest management operations during the relevant non-breeding season (Hen Harrier: 16<sup>th</sup> Aug-28<sup>th</sup> Feb; Merlin: 1<sup>st</sup> Sept-28<sup>th</sup> Feb incl.),</b> in order to minimise the potential effects to breeding Hen Harrier/Merlin, provided there are no other environmental considerations or sensitivities (for example, the presence of other sensitive species), and operations are within the legislative requirements.</li> <li>Forestry project areas which do not contain potentially suitable habitat for breeding Hen Harrier/Merlin may proceed with forest management operations, <b>provided there are no other environmental considerations or sensitivities, and operations are within the legislative requirements.</b></li> </ul>
<p><b>Step 2: Surveys to inform mitigation to minimise risk of disturbance</b></p>	<ul style="list-style-type: none"> <li>Forest operations scheduled in project areas, containing potentially suitable Hen Harrier/Merlin habitat (i.e. areas where Hen Harrier and Merlin have the potential to nest), during the breeding season (e.g. in situations where it may not be possible to operate during the non-breeding season due to ground conditions or other environmental considerations), <b>may proceed only when it is determined that Hen Harrier/Merlin are not present in the survey area</b> (the harvest unit/area of operation including the surrounding buffer of 750m for Hen Harrier and 500m for Merlin) and there is no potential for disturbance.</li> <li>To determine the presence of breeding Hen Harrier/Merlin, the use of robust, contemporary data (from the same breeding season) and/or pre-operational surveys are required. Pre-operational surveys shall be undertaken by a suitably qualified ecologist during the period late March to mid-June to a defined methodology and reporting protocol.</li> <li>If the presence of breeding Hen Harrier/Merlin is confirmed in a forestry project area, then forest management operations shall not be carried out within the breeding season (i.e., Hen Harrier: 1<sup>st</sup> Mar-15<sup>th</sup> Aug; Merlin: 1<sup>st</sup> Mar-31<sup>st</sup> Aug incl.).</li> <li>If on the basis of robust and contemporary data and/or pre-operational surveys, breeding Hen Harrier/Merlin are confirmed to not be present (within the relevant disturbance-free zone), then forest management operations can proceed after the 15<sup>th</sup> June, provided there are no other environmental considerations(e.g. sensitive species present), and the operations are within the legislative requirements.</li> </ul>

### **Additional recommendations to support the recommendations**

- All data generated through surveys (pre-operational surveys) must be stored and managed in a manner that protects the confidentiality of nest locations.
- All data gathered must be shared with relevant stakeholders (including but not limited to NPWS and DAFM) in a transparent and timely fashion, to add to our understanding of Hen Harrier and Merlin, to improve our understanding of the potential effects of forest management operations on the species (see Section 6.3) and to facilitate review of this approach.
- All data on potential disturbance events must be shared with relevant stakeholders (including but not limited to NPWS and DAFM) to improve our understanding of the potential effects of forest management operations on the species (see Section 6.3).
- A system to validate the effectiveness of this approach should be designed and implemented (through the Working Group, see Section 6.3). This should include monitoring a selection of forest management operations sites where works are undertaken during the breeding season, to assess any disturbance events at the time of operations.
- We recommend that this approach is initiated on a phased basis, in selected areas (e.g., SPAs or other important defined areas for Hen Harrier and/or Merlin), to ensure it is practical and robust, to instil confidence in stakeholders, to learn and to review its effectiveness on a small scale before expansion.
- We recommend a structured and open system of independent review (through the Working Group, see Section 6.3) of this approach on an on-going basis and to an agreed timescale, with the ability to refine accordingly, on the basis of new information.
- The recommended procedures must adhere to the provisions of the Birds Directive and Article 6.3 of the Habitats Directive relative to forestry felling licenses.

### **Benefits of the recommended approach**

The recommended procedures would result in the following improvements:

- The recommended approach provides greater confidence in ensuring that risk of disturbance to Hen Harrier and Merlin are minimised (forestry activities are not permitted in areas important for breeding Hen Harrier and Merlin until it is confirmed that these species are not present and therefore will not be impacted).
- This approach ensures that protection measures are targeted to the areas where they are required. For example, the recommended approach implements protection measures where breeding Hen Harrier are known to be present in the same season, as opposed to areas where Hen Harrier was previously present or predicted to be present, as is the case with the current measures (i.e., red areas) (DAFM 2012, 2015). In simple terms, forest management operations are only permitted to proceed during the breeding season where it is proven beyond reasonable doubt that Hen Harrier and Merlin are not present and therefore will not be impacted by forestry activities.

- The effective implementation of this approach allows for Hen Harrier population expansion, colonisation of new areas and protection in those areas more so than the current mitigation measures (*i.e.* red area procedures)
- The effective implementation of this approach will facilitate identification of Merlin nest areas (information which is currently limited) and can inform forest management to ensure nesting habitat is maintained (e.g., retention of forest areas which Merlin nest in).
- The recommended protocol represents a significant improvement and increased protection to Hen Harrier and Merlin in non-designated regionally important breeding areas, through creating an evidence-based procedure in these areas (including areas adjacent to the SPAs for breeding Hen Harrier and Merlin) for the first time.
- This approach facilitates gathering data on Hen Harrier and Merlin, to inform and refine these procedures and to improve our understanding of the impacts of forest management on these species.
- This approach should maximise the collection and use of existing survey data on the distribution and nest locations of Hen Harrier/Merlin thus reducing the necessity and resources required for pre-operational surveys.
- This protocol allows for flexibility in site-specific circumstances to ensure the safeguarding of Hen Harrier/Merlin pairs (*e.g. the required disturbance-free zone may be revised, informed by the specific sensitivities of a breeding pair, accuracy of nest/territory location, topography, landscape conditions, timing of breeding etc*) and that any decisions made in this regard are transparent, accountable and open to review.
- This approach is designed from the outset to be reviewed and refined where required and to be fully transparent to all stakeholders.
- The recommended mitigations provides consistency of approach in the mitigation strategies for Hen Harrier and Merlin.

### **Challenges presented by the recommended approach**

The following issues need to be addressed if the recommended procedures are to be successfully implemented:

- It is recognised that while the recommendations as set out in this report will provide for greater protections for Hen Harrier and Merlin from forest management related disturbances, these recommendations require significant changes from the existing measures in place (particularly with regards the red area procedures for Hen Harrier) and will have to be progressed on a step-by-step basis to build trust among stakeholders and ensure confidence in the approach.
- This procedure would apply to extensive areas (both within and outside of the SPA network). The resources required to effectively deliver this procedure will need to be scoped and quantified and will be somewhat dependent on the ability to access and utilise robust and contemporary data on the distribution and nest locations of the relevant species.

- The proposed new approach requires changes to processing of felling licences and roads permits by the Forest Service of the Department of Agriculture, Food and the Marine (DAFM). Currently, licences are approved either on the basis of data from the previous season or before (Hen Harrier red areas) OR on the basis of potentially suitable habitat adjacent to sites where forest management operations are planned (Merlin). While the current DAFM procedure for the protection of Hen Harrier (DAFM 2012, 2015) describes a bird survey procedure, in practice the scope to respond to current, real-time survey information is somewhat limited. Legal opinion may be required to explore if and how licensed operations can proceed in a way that is responsive to real-time bird survey information that arises during the current bird breeding season.
- This procedure should capitalise on existing survey data on the distribution and nest locations of Hen Harrier/Merlin or data which is being collected through other projects and unless it does so, then there is potential for duplication of effort. Consideration should be given to whether efficiencies can be realised by sharing information arising from surveys already planned or in progress, to aid mitigation strategies and forest management planning to minimise the risk of disturbance to sensitive species.

## 6.3 General recommendations

This section recommends wider support measures that will enhance the effectiveness of the recommended approach described in Section 6.2.

Objectives	Overview	Stakeholders
<b>Communication and stakeholder engagement</b>		
<b>1. Establish a formal Working Group with representation from all relevant stakeholders</b>		
<p>To improve communication, data sharing, and as the vehicle to improve and review forest management mitigation strategies;</p> <p>To improve consistency of approach and decision-making in forest management and operations;</p> <p>To improve the effectiveness of procedures aimed at minimising disturbance to Hen Harrier and Merlin in the SPA network and wider countryside.</p>	<ul style="list-style-type: none"> <li>An effective mitigation strategy should be transparent, inclusive, clearly communicated and based on the best and most contemporary data. At present, there are significant improvements required on all fronts and the most appropriate means of addressing these constraints in an open forum is through a Working Group with representation from all relevant stakeholders.</li> <li>This Working Group would also be tasked with overseeing and ensuring the delivery of the agreed recommendations (Section 6.1).</li> </ul>	<p>Forest Service (DAFM), NPWS, Coillte, Golden Eagle Trust, Irish Raptor Study Group, BirdWatch Ireland</p>
<b>Data-sharing</b>		
<b>2. Improve the application of data to inform forest planning for the protection of priority species</b>		
<p>To ensure that mitigation strategies are based on the best available data on Hen Harrier and Merlin;</p> <p>To appropriately target mitigations that protect Hen Harrier and Merlin during forest management operations.</p>	<ul style="list-style-type: none"> <li>Sensitive planning and management of commercial forests is the most effective way of reducing/minimising negative impacts on species conservation (e.g., Kortland <i>et al.</i>, 2011). At present, there are issues with data accessibility and availability and the transparency of the protection measures, specifically in relation to Hen Harrier, which limits the ability and effectiveness of forest planning to avoid disturbance.</li> <li>We recommend that improved systems for data sharing are established with robust data sharing agreements in place to provide confidence to data collectors in relation to the sensitivities, ownership and use of the data, while allowing the data to be specifically used to: (i) inform forest planning at the earliest stages to avoid areas where priority bird species are present or are likely to be present, and (ii) ensure that protection measures are</li> </ul>	<p>NPWS, Forest Service (DAFM), Coillte,</p>

	appropriately targeted and that Hen Harrier breeding attempts are protected.	
<b>Knowledge gaps</b>		
<b>3. Design and implement a system for collating data on disturbance events and effects on Hen Harrier and Merlin</b>		
<p>To build the evidence base and improve our understanding of the direct and indirect effects of forest management operations on Hen Harrier and Merlin;</p> <p>To inform forest management and to inform and refine mitigation strategies;</p> <p>To benefit forest planning by focussing mitigation measures more effectively.</p>	<ul style="list-style-type: none"> <li>Information on the specific effects and potential for disturbance from forest management operations on Hen Harrier and Merlin is limited in the Irish context and internationally and is mostly inferred based on information on the ecology of the species and estimates and expert opinion on distances at which these species are likely to be disturbed (Ruddock and Whitfield, 2007).</li> <li>Gathering data on the direct or indirect effects of forest management activities on bird species is challenging. However, this should not prevent efforts to gather such information in the Irish context to inform the potential effects of forest management operations on breeding birds and to refine future mitigation strategies based on this information and Article 12 Reporting (<i>for example, there are several incidents of potential disturbance events each year and documenting the details and outcome of these in a structured way would add to the knowledge base</i>).</li> </ul>	<p>Led by the Working Group (Recommendation 1) with input from NPWS, Forest Service (DAFM), Coillte, Golden Eagle Trust, Irish Raptor Study Group, BirdWatch Ireland</p>
<b>4. Conduct a review to provide information on the timing of breeding of Hen Harrier and Merlin in the Irish context</b>		
<p>To improve our understanding and the evidence base on the timing of breeding of Hen Harrier and Merlin in Ireland to inform and refine mitigation strategies based on robust scientific data.</p>	<ul style="list-style-type: none"> <li>Hen Harrier breeding ecology has been extensively studied in Ireland, and there is information available on the breeding ecology of Merlin also, however a systematic review of the timing of breeding to inform mitigation strategies and disturbance risks has not been carried out and would be valuable, particularly in the context of informing the timing of mitigation strategies to protect Hen Harrier and Merlin during the breeding season.</li> <li>Using available data (national and SPA surveys, monitoring studies and ringing records), it would be possible to conduct a structured review to provide information on the timing of various breeding behaviours (e.g., the earliest, average and peak timings of display and fledging) in</li> </ul>	<p>NPWS, Forest Service, Coillte</p>

	<p>comparison to survey effort, as well as information on laying dates from nest visits and ringing data unpublished and detection times based on survey effort.</p> <ul style="list-style-type: none"> <li>This review would improve the evidence base on the timing of breeding of Hen Harrier and Merlin in Ireland and facilitate more robust decision making on the timing of protection measures to ensure protection from forest management related disturbances.</li> </ul>	
<p><b>5. Assess the merits of aerial thermal imaging surveys to detect Merlin</b></p>		
<p>To increase efficiency and effectiveness of Merlin surveys; To detect breeding Merlin and inform forest planning and management.</p>	<ul style="list-style-type: none"> <li>Due to their low population density, widespread distribution in remote upland areas and discrete breeding behaviour, Merlin are a challenging species to monitor (Ewing <i>et al.</i>, 2011; Lusby <i>et al.</i>, 2011). This is reflected in the limited information on Merlin populations in Ireland.</li> <li>Landscapes with high forest cover and particularly a high occurrence of forest edge, are the most difficult in which to survey Merlin, despite the propensity for Merlin to nest in forest edges (Lusby <i>et al.</i>, 2017). For this reason, it is recommended that alternative methods for detecting breeding Merlin are assessed. In particular, the use of drones combined with thermal imaging may prove effective and we recommend that structured trials are undertaken to assess the potential application of drones with thermal imaging to improve detection, efficiency, and confidence in Merlin surveys.</li> </ul>	<p>NPWS, Forest Service, BirdWatch Ireland</p>
<p><b>Conservation Tools</b></p>		
<p><b>6. Integrate the conservation of Hen Harrier and Merlin in forest planning and management</b></p>		
<p>To improve the conservation status of Hen Harrier and Merlin through habitat enhancement and maintaining and enhancing important nesting and foraging areas.</p>	<ul style="list-style-type: none"> <li>Assess the requirement for structured forest removal, enhancing connectivity of open habitats, ensuring a well-balanced age structure of forest and maintaining disturbance-free zones in wider areas identified as important for Hen Harrier and Merlin, and assess the merits of Continuous Cover Forest in areas identified as important for breeding</li> </ul>	<p>Led by the Working Group (Recommendation 1) with input from the Forest Service, Coillte, NPWS</p>

	Merlin and/or maintain selected forest stands which are used by breeding Merlin for nesting.	
<b>7. Develop standard protocol for assessing the habitat suitability for breeding Merlin</b>		
To ensure high standard and consistency of approach in assessing habitat suitability for Merlin to inform mitigation and forest management.	<ul style="list-style-type: none"> <li>We recommend that a standard methodology for conducting and reporting on habitat suitability for Merlin is adopted to standardise and ensure a high standard and consistency of approach in the planning, preparing, conducting, and reporting of Merlin habitat assessments and facilitate identification of the habitat suitability for breeding Merlin in areas where forest management operations are planned to inform mitigation requirements</li> <li>The habitat assessments should be undertaken by a suitably qualified ecologist according to the defined method and reporting protocol and results should be available for review (Working Group, Recommendation 1).</li> </ul>	Led by the Working Group (Recommendation 1) with input from the Forest Service
<b>8. Establish a formal procedure for reviewing information on potential disturbance events to Hen Harrier and Merlin outside the SPA network</b>		
To improve protection, consistency of approach and decision making in relation to potential disturbance incidents (Hen Harrier and Merlin) outside the SPA network as they arise.	<ul style="list-style-type: none"> <li>Until there is a formal system established for the protection of Hen Harrier and Merlin from forest management related disturbances outside the SPA network (see Section 6.1), there should be a coordinated system to collate and respond to information on potential, suspected or confirmed disturbance incidents to ensure the appropriate advice and action is taken in line with the legislative requirements and the specific circumstances of the incident</li> </ul>	NPWS
<b>9. Provide detail on the specific forestry activities and associated conditions which are permitted or restricted</b>		

<p>To provide clarity on the specifics and practical implementation of the mitigation measures that should apply to forest management operations.</p>	<ul style="list-style-type: none"> <li>All forestry activities should be defined in relation to the potential risks and the requirements for protection to provide clarity to all stakeholders and practitioners on the specific activities which are permitted and those that are not, and any conditions attached to those activities (i.e., define the activities that are currently listed as ‘other operation(s) the Forest Service may deem as creating disturbance’.)</li> </ul>	<p>Forest Service (and Working Group, Recommendation 1)</p>
<p><b>10. Provide clear and comprehensive guidance on minimising the disturbance to breeding birds through forest management operations and the legislative requirements for same</b></p>		
<p>To improve protection, consistency of approach and awareness of best practice and the legislative requirements in minimising disturbance to breeding birds from forestry activities.</p>	<ul style="list-style-type: none"> <li>Forest Service Guidance ‘Standards for Felling and Reforestation’ should be reviewed and revised to include specific guidance on how to minimise the negative effects of forest management operations to breeding birds, including specific guidance for priority and sensitive species.</li> </ul>	<p>Forest Service, NPWS (and Working Group, Recommendation 1)</p>

## 7. References

- Anon. 1979. Irish Forestry Policy. National Economic and Social Council. Government Publication Office
- Balmer, D., Gillings, S., Caffrey, B., Swan, B., Downie, I. & Fuller, R. (2013). Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland. British Trust for Ornithology, Thetford, UK.
- 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. *Irish Birds* 8: 1–20.
- Bibby, C.J. & Nattrass, M. (1986). Breeding status of the Merlin in Britain. *British Birds* 79, 170–185.
- Bleasdale, A. (1998). Overgrazing in the West of Ireland – assessing solutions. In G. O’Leary & F. Gormley (eds). *Towards a Conservation Strategy for the Bogs of Ireland*. Irish Peatland Conservation Council, Dublin.
- Caravaggi, A., S. Irwin, J. Lusby, M. Ruddock, A. Mee, T. Nagle, L. O’Toole, S. O’Neill, and J. O’Halloran (2020). Anthropogenic pressures within the breeding range of the Hen Harrier *Circus cyaneus* in Ireland. *Bird Study* 66:461–470.
- Currie, F., and Elliot, G. (1997). *Forests and birds - A guide for managing forests for rare birds*. Forestry Authority, Cambridge and Royal Society for the Protection of Birds, Sandy, UK.
- DAFM (2014). *Forests, products and people. Ireland’s forest policy- a renewed vision*. Dublin. The Department of Agriculture, Food and the Marine.
- DAFM (2015). *Forestry Standards Manual*. November 2015. The Department of Agriculture, Food and the Marine. <https://assets.gov.ie/72450/2b76f13760574c1fb559d6518e03aebd.pdf>
- DAFM (2018). *Ireland’s National Forest Inventory 2017 – Main Findings*. The Department of Agriculture, Food and the Marine, The Government of Ireland, 2018.
- DAFM (2020). *Annual Review and Outlook for Agriculture, Food and the Marine 2020*. The Department of Agriculture, Food and the Marine.
- DAFM (2022). *Forest statistic Ireland 2022*. The Department of Agriculture, Food and the Marine.
- Ellis, P.M. & Okill, J.D. (1990). Breeding ecology of the Merlin *Falco columbarius* in Shetland. *Bird Study* 37, 101–110.
- Esmail, A.B. and Geneletti, G. (2018). Multi-criteria decision analysis for nature conservation: A review of 20 years of applications. *Methods in Ecology and Evolution*. Volume 9, Issue1.
- Ewing, S.R., Rebecca, G.W., Heavisides, A., Court, I.R., Lindley, P., Ruddock, M., Cohen, S. and Eaton, M.A. (2010) Breeding status of Merlins *Falco columbarius* in the UK in 2008. *Bird Study* 58, 379–389.
- Fernández-Bellon, D. & Lusby, J. (2011). The feeding ecology of Merlin *Falco columbarius* during the breeding season in Ireland, and an assessment of current diet analysis methods. *Irish Birds* 9, 159–164.
- Fernández-Juricic, E., Venier, M. P., Renison, D., and Blumstein, D. T. (2005). Sensitivity of wildlife to spatial patterns of recreationist behavior: a critical assessment of minimum approaching distances and buffer areas for grassland birds. *Biological Conservation* 125, 225–235.
- Forestry Commission Scotland (2006). *FCS Guidance Note 32: Forest operations and birds in Scottish forests - the law and good practice*.

- Forest Service. (2000). Forest harvesting and the environment guidelines. Forest Service, Department of the Marine and Natural Resources.
- Fuller, R.J. & Gough, S.J. (1999). Changes in sheep numbers in Britain: implications for bird populations. *Biological Conservation* 91, 73-89.
- Gilbert, G., Stanbury, A. & Lewis, L. (2021) Birds of Conservation Concern in Ireland 4: 2020 – 2026. *Irish Birds* 43, 1–22.
- Goodship, N.M. and Furness, R.W. (MacArthur Green) (2022) Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. *Nature Scot Research Report* 1283.
- Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. (2009) *Raptors: a field guide for surveys and monitoring*. Stationery Office, Edinburgh.
- Hen Harrier Programme (2020). *Hen Harrier Monitoring 2020*. November 2020.
- Irwin, S., Wilson, W., O'Donoghue, B., O'Mahony, B., Kelly, T., O'Halloran, J. (2012). Optimum scenarios for Hen Harrier Conservation in Ireland; Final Report 2012. Prepared for the Department of Agriculture, Food and the Marine by the School of Biological, Earth and Environmental Sciences, University College Cork.
- Kortland, K., Evans, R., Douse, A., and Patterson, G. (2011). *Managing forests for white-tailed eagles - Practice note*. Forestry Commission Scotland.
- Livezey, K. B., Fernández-Juricic, E., and Blumstein, D. T. (2016). Database and metadata of bird flight initiation distances worldwide to assist in estimating human disturbance effects and delineating buffer areas. *Journal of Fish and Wildlife Management*.
- Lusby, J., Fernández-Bellon, D., Norriss, D., & Lauder, A. (2011) Assessing the effectiveness of monitoring methods for Merlin *Falco columbarius* in Ireland: the Pilot Merlin Survey 2010. *Irish Birds* 9, 143 – 154.
- Lusby, J., Corkery, I., McGuinness, S., Fernández-Bellon, D., Toal, L., Norriss, D., Breen, D., O'Donail, A., Clarke, D., Irwin, S., Quinn, J.L., O'Halloran, J. (2017) Breeding ecology and habitat selection of Merlin *Falco columbarius* in forested landscapes, *Bird Study* 64, 445-454.
- Lusby, J., O'Brien, I., Lauder, A., Wilson-Parr, R., Breen, D., Cummins, S. & Tierney, D. (2022) Survey of breeding Merlin in the Special Protection Area network 2018. *Irish Wildlife Manuals*, No. 139. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.
- McCarthy, A. (2022). *Seasonal Ecology and the Conservation of Hen Harriers (Circus cyaneus) in Ireland*. Unpublished PhD Thesis, University College Cork.
- McElheron, A. (2005) *Merlins of the Wicklow Mountains*. Currach Press, Dublin.
- Meek, E.R. (1988). The breeding ecology and decline of the Merlin *Falco columbarius* in Orkney, *Bird Study* 35, 209-218.
- Mitchell, J. G. 1995. The Dynamics of Irish Post-Glacial Forests. In: *Wood, trees and forests*. Royal Irish Academy. Proceedings of a Seminar Held on 22 and 23 February 1994. Dublin
- 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.
- Naylor, B.J. (2009). Forest management and stick-nesting birds: New direction for mitigation in Ontario. *The Forestry Chronicle*, 2009. Vol. 85, No. 2.

- NEPCon (2017). Timber Legality Risk Assessment, Belgium. Version 1.3 November, 2017.
- Newton, I., Meek, E.R. and Little, B. (1978). Breeding ecology of the Merlin in Northumberland, British Birds 71, 376-398.
- Newton, I., Meek, E.R. & Little, B. (1986). Population and breeding of Northumbrian Merlins. British Birds 79, 155–170.
- 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.
- Norriss, D.W., Haran, B., Hennigan, J., McElheron, A., McLaughlin, D.J., Swan, V. & Walsh, A. (2010) Breeding biology of Merlins *Falco columbarius* in Ireland, 1986-1992. Irish Birds 9, 23-30.
- NPWS (2015). Hen Harrier Conservation and the Forestry Sector in Ireland. The National Parks and Wildlife Service. Date 31/03/2015, Version 3.2.
- NPWS (2024). Threat Response Plan for the Hen Harrier 2024-2028. Draft for Public Consultation. The National Parks and Wildlife Service.
- O'Carroll, N. (2004) Forestry in Ireland – A Concise History, COFORD, 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. & King, F. (2011). The Hen Harrier in Ireland: conservation issues for the 21st century. Biology and Environment: Proceedings of the Royal Irish Academy 111B.
- O'Flynn, W. J. (1983). Population changes of the hen harrier in Ireland. Irish Birds 2:337–343.
- Rebecca, G.W., Cosnette, B.L., Hardy, J.J.C. & Payne, A.G. (1992). Status, distribution and breeding biology of the Merlin in Northeast Scotland, 1980–1989. Scottish Birds 16, 165–183.
- Redpath, S.M., Arroyo, B.E., Etheridge, B., Leckie, F., Bouwman, K. & Thirgood, S.J. (2002). Temperature and hen harrier productivity: From local mechanisms to geographical patterns. Ecography 25: 533–540.
- Richardson, C. T., and Miller, C. K. (2007). Protecting from human disturbance: a review. 25, 634–638.
- Roberts, J.L. & Green, D. (1983). Breeding failure and decline of Merlins on a north Wales moor. Bird Study 30, 193–200.
- Ruddock, M., and Whitfield, D. (2007). A review of disturbance distances in selected bird species. Natural Research (Projects) Ltd.
- 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, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.
- Ruddock, M., Mee, A., Lusby, J., Nagle, T., O'Neill, S. & O'Toole, L. (2016). The 2015 National Survey of Breeding Hen Harrier in Ireland. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, 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. Irish Wildlife Manuals, No. 147. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.
- Ruffino, L. (2016). A review of disturbance effects caused by forestry operations and recreational activities to birds nesting in Scottish woodlands. A report from Natural Research (Projects) Ltd to Forest Enterprise Scotland.

Sale, R. (2015). The Merlin. Snowfinch Publishing, UK.

Sharrock, J.T.R. (1976). The Atlas of Breeding Birds in Britain and Ireland. British Trust for Ornithology, Hertfordshire.

Staneva, A. & Burfield, I. (2017). European Birds of Conservation Concern: populations, trends and national responsibilities. BirdLife International and Central Asian Partnership, Cambridge, UK.

Watson, D. (1977). The Hen Harrier. T. & A.D. Poyser, London.

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 Harriers *Circus cyaneus* breeding in forested landscapes. *Ibis* 154, 578–589.

Wilson, M. W., Fernández-Bellon, D., Irwin, I. & O'Halloran, J. (2015). The interactions between Hen Harriers and wind turbines. WINDHARRIER. Final Project Report, January 2015.

Wright, P.M. (1997). Distribution, site occupancy and breeding success of the Merlin *Falco columbarius* on Barden Moor and Fell, North Yorkshire. *Bird Study* 44, 182-193.

## Appendices

### Appendix A

#### MITIGATION MEASURE FOR MERLIN, for relevant AA Report & Determination ref. Coillte felling in Slieve Aughties SPA

Wording to be included in all AA Reports & Determinations and included as a condition in all licences issued in this SPA.

(18Dec19)

#### Merlin *Falco columbarius*

The potential for the project to result in displacement of breeding Merlin was identified on a precautionary basis.

Heathlands are vital hunting habitats for the species (Fernandez-Bellon & Lusby, 2011). Merlin traditionally nest on-the-ground on heath, mountain and blanket bog, but now predominantly nest in trees with a strong preference for conifer plantations (favouring older trees and often nesting within 10 m of forest edge). Breeding success is positively related to the proportion of suitable foraging habitat (heath, extensive grassland, bog, other open and semi-open habitats) within the breeding territory (Lusby *et al.*, 2017).

In light of the bird's ecology regarding nesting and the requirement to avoid disruption that might interfere with breeding, the following mitigation, presented in the form of a licence condition, is identified to avoid impact. Furthermore, given the area of forest cover within the SPA (insert area of forest cover in ha), the emergence of new edge trees elsewhere within the forest estate within the Natura site, and Merlin's lack of faithfulness regarding nest sites, any edge tree felling associated with this project and undertaken outside of the breeding season will not impact future nesting opportunities within the SPA.

#### Wording for condition:

Where the project area:

- contains mature conifer forest of at least 10 years of age; and
  - is within or adjacent to a Special Protection Area for which the Merlin is a special conservation interest; and
  - adjoins or is immediately adjacent to the following habitats: moors, heathland, peat bogs or natural grassland; then
1. No felling, thinning or other forestry operations associated with this licence shall take place during the period 1<sup>st</sup> March to 31<sup>st</sup> August inclusive, within 100 metres of the forest edge, where such forest edge is immediately adjacent to moors, heathland, peat bogs or natural grassland; or within 100 metres of a clearing in the forest of larger than one hectare.
  2. Such operations can commence in sections of the project area furthest away from the 100 metre exclusion zone. Such operations can progress towards this exclusion zone but can only enter it during the period 1<sup>st</sup> September to 29<sup>th</sup> February inclusive.

## Appendix B

**Table B.1.** Results of red area effectiveness analysis (for details on parameters see GIS analysis section).

Lag	Year 1	Year 1b	Year 1c	Year 1d	Year 2	Region	Nests 1	Nests 2	Trend	Min. polygon	Density	Protected	Part protected	Not protected	% protected	% part protected	% not protected	Red area area	Nests year 2 area	Red area intersect	Red area effective
15	2000	-	-	-	2015	Ctl Mullaghareirks	10	16	0.6	247	0.04	3	0	13	18.8	0.0	81.3	42.6	67.0	15.0	15.0
10	2005	-	-	-	2015	S Aughties	24	14	-0.4	494	0.05	3	7	4	21.4	50.0	28.6	103.3	60.7	29.2	29.2
10	2005	-	-	-	2015	Ballyhouras	17	12	-0.3	183	0.09	4	3	5	33.3	25.0	41.7	67.9	42.3	26.5	26.5
10	2005	-	-	-	2015	Comeragh Mts	1	3	2.0	65	0.02	0	0	3	0.0	0.0	100.0	4.5	13.6	1.6	1.6
10	2005	-	-	-	2015	Ctl Mullaghareirks	20	13	-0.4	337	0.06	4	2	7	30.8	15.4	53.9	83.9	58.7	23.9	23.9
10	2005	-	-	-	2015	Derrynasaggart	5	3	-0.4	316	0.02	1	1	1	33.3	33.3	33.3	22.6	13.6	3.5	3.5
10	2005	-	-	-	2015	Galtees	3	3	0.0	170	0.02	0	0	3	0.0	0.0	100.0	13.6	13.6	0.1	0.1
10	2005	-	-	-	2015	Knockmealdowns	2	6	2.0	179	0.01	0	1	5	0.0	16.7	83.3	9.1	26.2	3.0	3.0
10	2005	-	-	-	2015	Leitrim	1	7	6.0	155	0.01	0	0	7	0.0	0.0	100.0	4.5	31.7	0.0	0.0
10	2005	-	-	-	2015	Nth Mullaghareirks	9	14	0.6	179	0.05	2	6	6	14.3	42.9	42.9	40.6	56.2	20.9	20.9
10	2005	-	-	-	2015	Nagles	9	5	-0.4	119	0.08	3	0	2	60.0	0.0	40.0	38.3	21.7	14.3	14.3
10	2005	-	-	-	2015	S Beagh	4	3	-0.3	34	0.12	2	0	1	66.7	0.0	33.3	15.2	12.8	5.7	5.7
10	2005	-	-	-	2015	S Bearnagh	1	7	6.0	117	0.01	0	1	6	0.0	14.3	85.7	4.5	28.3	2.4	2.4
10	2005	-	-	-	2015	S Blooms	5	12	1.4	156	0.03	1	1	10	8.3	8.3	83.3	22.6	50.1	8.9	8.9
10	2005	-	-	-	2015	Sth Donegal	3	14	3.7	546	0.01	1	0	13	7.1	0.0	92.9	13.6	63.3	4.3	4.3
10	2005	-	-	-	2015	S Felims	7	12	0.7	321	0.02	2	2	8	16.7	16.7	66.7	31.7	54.0	11.5	11.5
10	2005	-	-	-	2015	S Rushen	1	2	1.0	17	0.06	0	0	2	0.0	0.0	100.0	4.5	8.7	0.0	0.0
10	2005	-	-	-	2015	Stacks	11	4	-0.6	113	0.10	1	2	1	25.0	50.0	25.0	48.0	18.1	8.7	8.7
5	2010	-	-	-	2015	S Aughties	25	14	-0.4	513	0.05	7	2	5	50.0	14.3	35.7	107.4	60.7	34.1	34.1
5	2010	-	-	-	2015	Ballyhouras	15	12	-0.2	165	0.09	3	2	7	25.0	16.7	58.3	56.5	42.3	17.9	17.9
5	2010	-	-	-	2015	Comeragh Mts	1	3	2.0	57	0.02	1	0	2	33.3	0.0	66.7	4.5	13.6	3.5	3.5
5	2010	-	-	-	2015	Ctl Mullaghareirks	12	16	0.3	300	0.04	5	0	11	31.3	0.0	68.8	47.5	67.0	18.1	18.1
5	2010	-	-	-	2015	Derrynasaggart	8	3	-0.6	336	0.02	1	0	2	33.3	0.0	66.7	31.8	13.6	4.2	4.2
5	2010	-	-	-	2015	Galtees	6	3	-0.5	170	0.04	1	0	2	33.3	0.0	66.7	26.0	13.6	2.9	2.9
5	2010	-	-	-	2015	Knockmealdowns	2	6	2.0	175	0.01	1	2	3	16.7	33.3	50.0	9.1	26.2	7.3	7.3
5	2010	-	-	-	2015	Leitrim	5	7	0.4	154	0.03	1	0	6	14.3	0.0	85.7	21.6	31.7	3.3	3.3
5	2010	-	-	-	2015	Nth Mullaghareirks	15	16	0.1	220	0.07	7	0	9	43.8	0.0	56.3	62.7	64.2	26.8	26.8
5	2010	-	-	-	2015	Nagles	11	5	-0.5	85	0.13	5	0	0	100.0	0.0	0.0	33.7	21.7	18.3	18.3
5	2010	-	-	-	2015	S Beagh	6	3	-0.5	41	0.15	2	0	1	66.7	0.0	33.3	22.0	12.8	8.4	8.4

Lusby, J., Fernández-Bellón, D. & Kavanagh, L. (2024). Review of mitigation measures for the protection of Hen Harrier and Merlin from forest management disturbances and recommendations for improvements to protection procedures.

---

5	2010	-	-	-	2015	S Bearnagh	2	7	2.5	128	0.02	0	1	6	0.0	14.3	85.7	9.1	28.3	2.0	2.0
---	------	---	---	---	------	------------	---	---	-----	-----	------	---	---	---	-----	------	------	-----	------	-----	-----

**Table A.1. (continued).** Results of red area effectiveness analysis (for details on parameters see GIS analysis section).

Lag	Year 1	Year 1b	Year 1c	Year 1d	Year 2	Region	Nests 1	Nests 2	Trend	Min. polygon	Density	Protected	Part protected	Not protected	% protected	% part protected	% not protected	Red area area	Nests year 2 area	Red area intersect	Red area effective
5	2010	-	-	-	2015	S Blooms	9	12	0.3	179	0.05	3	0	9	25.0	0.0	75.0	40.6	50.1	15.5	15.5
5	2010	-	-	-	2015	Sth Donegal	5	14	1.8	509	0.01	2	0	12	14.3	0.0	85.7	22.6	63.3	7.8	7.8
5	2010	-	-	-	2015	S Felims	14	12	-0.1	392	0.04	5	1	6	41.7	8.3	50.0	61.9	54.0	22.6	22.6
5	2010	-	-	-	2015	Sth Mullaghareirks	3	1	-0.7	109	0.03	0	0	1	0.0	0.0	100.0	13.6	4.5	0.0	0.0
5	2010	-	-	-	2015	S Rushen	7	2	-0.7	29	0.24	2	0	0	100.0	0.0	0.0	22.7	8.7	8.1	8.1
5	2010	-	-	-	2015	Stacks	8	6	-0.3	108	0.07	0	2	4	0.0	33.3	66.7	33.2	27.1	6.8	6.8
5	2010	-	-	-	2015	W Clare	17	8	-0.5	167	0.10	4	2	2	50.0	25.0	25.0	58.0	33.8	20.1	20.1
5	2005	-	-	-	2010	S Aughties	24	25	0.0	538	0.04	10	4	11	40.0	16.0	44.0	103.3	107.4	54.3	54.3
5	2005	-	-	-	2010	Ballyhouras	17	15	-0.1	182	0.09	6	2	7	40.0	13.3	46.7	67.9	56.5	26.4	26.4
5	2005	-	-	-	2010	Comeragh Mts	1	1	0.0	8	0.13	0	0	1	0.0	0.0	100.0	4.5	4.5	1.5	1.5
5	2005	-	-	-	2010	Ctl Mullaghareirks	20	12	-0.4	332	0.06	6	0	6	50.0	0.0	50.0	83.9	47.5	22.3	22.3
5	2005	-	-	-	2010	Derrynasaggart	5	8	0.6	284	0.02	2	1	5	25.0	12.5	62.5	22.6	31.8	10.0	10.0
5	2005	-	-	-	2010	Galtees	3	6	1.0	159	0.02	1	0	5	16.7	0.0	83.3	13.6	26.0	4.2	4.2
5	2005	-	-	-	2010	Knockmealdowns	2	2	0.0	127	0.02	1	0	1	50.0	0.0	50.0	9.1	9.1	3.1	3.1
5	2005	-	-	-	2010	Leitrim	1	5	4.0	58	0.02	0	0	5	0.0	0.0	100.0	4.5	21.6	0.0	0.0
5	2005	-	-	-	2010	Nth Mullaghareirks	9	15	0.7	217	0.04	2	1	12	13.3	6.7	80.0	40.6	62.7	12.0	12.0
5	2005	-	-	-	2010	Nagles	9	11	0.2	124	0.07	5	3	3	45.5	27.3	27.3	38.3	33.7	18.9	18.9
5	2005	-	-	-	2010	S Beagh	4	6	0.5	40	0.10	2	1	3	33.3	16.7	50.0	15.2	22.0	9.6	9.6
5	2005	-	-	-	2010	S Bearnagh	1	2	1.0	48	0.02	0	0	2	0.0	0.0	100.0	4.5	9.1	0.4	0.4
5	2005	-	-	-	2010	S Blooms	5	9	0.8	137	0.04	2	0	7	22.2	0.0	77.8	22.6	40.6	9.3	9.3
5	2005	-	-	-	2010	Sth Donegal	3	5	0.7	339	0.01	0	0	5	0.0	0.0	100.0	13.6	22.6	0.0	0.0
5	2005	-	-	-	2010	S Felims	7	14	1.0	397	0.02	3	1	10	21.4	7.1	71.4	31.7	61.9	12.7	12.7
5	2005	-	-	-	2010	S Rushen	1	7	6.0	30	0.03	1	0	6	14.3	0.0	85.7	4.5	22.7	3.4	3.4
5	2005	-	-	-	2010	Stacks	11	8	-0.3	120	0.09	4	1	3	50.0	12.5	37.5	48.0	33.2	13.0	13.0
5	2005	2010	-	-	2015	S Aughties	25	14	-0.4	547	0.05	7	5	2	50.0	35.7	14.3	156.4	60.7	42.0	42.0
5	2005	2010	-	-	2015	Ballyhouras	15	12	-0.2	187	0.08	6	3	3	50.0	25.0	25.0	98.0	42.3	32.7	32.7
5	2005	2010	-	-	2015	Comeragh Mts	1	3	2.0	66	0.02	1	0	2	33.3	0.0	66.7	7.6	13.6	3.7	3.7
5	2005	2010	-	-	2015	Ctl Mullaghareirks	12	16	0.3	343	0.04	7	2	7	43.8	12.5	43.8	109.1	67.0	34.0	34.0
5	2005	2010	-	-	2015	Derrynasaggart	8	3	-0.6	376	0.02	1	0	2	33.3	0.0	66.7	44.4	13.6	4.3	4.3
5	2005	2010	-	-	2015	Galtees	6	3	-0.5	200	0.03	1	0	2	33.3	0.0	66.7	35.4	13.6	2.9	2.9

**Table A.1. (continued).** Results of red area effectiveness analysis (for details on parameters see GIS analysis section).

Lag	Year 1	Year 1b	Year 1c	Year 1d	Year 2	Region	Nests 1	Nests 2	Trend	Min. polygon	Density	Protected	Part protected	Not protected	% protected	% part protected	% not protected	Red area area	Nests year 2 area	Red area intersect	Red area effective
5	2010	-	-	-	2015	S Blooms	9	12	0.3	179	0.05	3	0	9	25.0	0.0	75.0	40.6	50.1	15.5	15.5
5	2010	-	-	-	2015	Sth Donegal	5	14	1.8	509	0.01	2	0	12	14.3	0.0	85.7	22.6	63.3	7.8	7.8
5	2010	-	-	-	2015	S Felims	14	12	-0.1	392	0.04	5	1	6	41.7	8.3	50.0	61.9	54.0	22.6	22.6
5	2010	-	-	-	2015	Sth Mullaghareirks	3	1	-0.7	109	0.03	0	0	1	0.0	0.0	100.0	13.6	4.5	0.0	0.0
5	2010	-	-	-	2015	S Rushen	7	2	-0.7	29	0.24	2	0	0	100.0	0.0	0.0	22.7	8.7	8.1	8.1
5	2010	-	-	-	2015	Stacks	8	6	-0.3	108	0.07	0	2	4	0.0	33.3	66.7	33.2	27.1	6.8	6.8
5	2010	-	-	-	2015	W Clare	17	8	-0.5	167	0.10	4	2	2	50.0	25.0	25.0	58.0	33.8	20.1	20.1
5	2005	-	-	-	2010	S Aughties	24	25	0.0	538	0.04	10	4	11	40.0	16.0	44.0	103.3	107.4	54.3	54.3
5	2005	-	-	-	2010	Ballyhouras	17	15	-0.1	182	0.09	6	2	7	40.0	13.3	46.7	67.9	56.5	26.4	26.4
5	2005	-	-	-	2010	Comeragh Mts	1	1	0.0	8	0.13	0	0	1	0.0	0.0	100.0	4.5	4.5	1.5	1.5
5	2005	-	-	-	2010	Ctl Mullaghareirks	20	12	-0.4	332	0.06	6	0	6	50.0	0.0	50.0	83.9	47.5	22.3	22.3
5	2005	-	-	-	2010	Derrynasaggart	5	8	0.6	284	0.02	2	1	5	25.0	12.5	62.5	22.6	31.8	10.0	10.0
5	2005	-	-	-	2010	Galtees	3	6	1.0	159	0.02	1	0	5	16.7	0.0	83.3	13.6	26.0	4.2	4.2
5	2005	-	-	-	2010	Knockmealdowns	2	2	0.0	127	0.02	1	0	1	50.0	0.0	50.0	9.1	9.1	3.1	3.1
5	2005	-	-	-	2010	Leitrim	1	5	4.0	58	0.02	0	0	5	0.0	0.0	100.0	4.5	21.6	0.0	0.0
5	2005	-	-	-	2010	Nth Mullaghareirks	9	15	0.7	217	0.04	2	1	12	13.3	6.7	80.0	40.6	62.7	12.0	12.0
5	2005	-	-	-	2010	Nagles	9	11	0.2	124	0.07	5	3	3	45.5	27.3	27.3	38.3	33.7	18.9	18.9
5	2005	-	-	-	2010	S Beagh	4	6	0.5	40	0.10	2	1	3	33.3	16.7	50.0	15.2	22.0	9.6	9.6
5	2005	-	-	-	2010	S Bearnagh	1	2	1.0	48	0.02	0	0	2	0.0	0.0	100.0	4.5	9.1	0.4	0.4
5	2005	-	-	-	2010	S Blooms	5	9	0.8	137	0.04	2	0	7	22.2	0.0	77.8	22.6	40.6	9.3	9.3
5	2005	-	-	-	2010	Sth Donegal	3	5	0.7	339	0.01	0	0	5	0.0	0.0	100.0	13.6	22.6	0.0	0.0
5	2005	-	-	-	2010	S Felims	7	14	1.0	397	0.02	3	1	10	21.4	7.1	71.4	31.7	61.9	12.7	12.7
5	2005	-	-	-	2010	S Rushen	1	7	6.0	30	0.03	1	0	6	14.3	0.0	85.7	4.5	22.7	3.4	3.4
5	2005	-	-	-	2010	Stacks	11	8	-0.3	120	0.09	4	1	3	50.0	12.5	37.5	48.0	33.2	13.0	13.0
5	2005	2010	-	-	2015	S Aughties	25	14	-0.4	547	0.05	7	5	2	50.0	35.7	14.3	156.4	60.7	42.0	42.0
5	2005	2010	-	-	2015	Ballyhouras	15	12	-0.2	187	0.08	6	3	3	50.0	25.0	25.0	98.0	42.3	32.7	32.7
5	2005	2010	-	-	2015	Comeragh Mts	1	3	2.0	66	0.02	1	0	2	33.3	0.0	66.7	7.6	13.6	3.7	3.7
5	2005	2010	-	-	2015	Ctl Mullaghareirks	12	16	0.3	343	0.04	7	2	7	43.8	12.5	43.8	109.1	67.0	34.0	34.0
5	2005	2010	-	-	2015	Derrynasaggart	8	3	-0.6	376	0.02	1	0	2	33.3	0.0	66.7	44.4	13.6	4.3	4.3
5	2005	2010	-	-	2015	Galtees	6	3	-0.5	200	0.03	1	0	2	33.3	0.0	66.7	35.4	13.6	2.9	2.9

**Table A.1. (continued).** Results of red area effectiveness analysis (for details on parameters see GIS analysis section).

Lag	Year 1	Year 1b	Year 1c	Year 1d	Year 2	Region	Nests 1	Nests 2	Trend	Min. polygon	Density	Protected	Part protected	Not protected	% protected	% part protected	% not protected	Red area area	Nests year 2 area	Red area intersect	Red area effective
5	2005	2010	-	-	2015	Knockmealdowns	2	6	2.0	179	0.01	1	2	3	16.7	33.3	50.0	15.0	26.2	7.9	7.9
5	2005	2010	-	-	2015	Nth Mullaghareirks	15	16	0.1	224	0.07	9	3	4	56.3	18.8	25.0	91.2	64.2	41.3	41.3
5	2005	2010	-	-	2015	Nagles	11	5	-0.5	126	0.09	5	0	0	100.0	0.0	0.0	53.0	21.7	19.6	19.6
5	2005	2010	-	-	2015	S Beagh	6	3	-0.5	42	0.14	2	1	0	66.7	33.3	0.0	27.6	12.8	11.0	11.0
5	2005	2010	-	-	2015	S Bearnagh	2	7	2.5	132	0.02	0	2	5	0.0	28.6	71.4	13.2	28.3	4.4	4.4
5	2005	2010	-	-	2015	S Blooms	9	12	0.3	180	0.05	4	0	8	33.3	0.0	66.7	53.9	50.1	21.0	21.0
5	2005	2010	-	-	2015	Sth Donegal	5	14	1.8	546	0.01	2	1	11	14.3	7.1	78.6	36.2	63.3	12.0	12.0
5	2005	2010	-	-	2015	S Felims	14	12	-0.1	405	0.03	5	2	5	41.7	16.7	41.7	80.8	54.0	25.5	25.5
5	2005	2010	-	-	2015	S Rushen	7	2	-0.7	30	0.23	2	0	0	100.0	0.0	0.0	23.8	8.7	8.1	8.1
5	2005	2010	-	-	2015	Stacks	8	6	-0.3	127	0.06	2	2	2	33.3	33.3	33.3	68.2	27.1	15.5	15.5
2	2007	-	-	-	2009	S Aughties	9	12	0.3	407	0.02	4	2	6	33.3	16.7	50.0	35.7	53.6	19.2	19.2
2	2007	-	-	-	2009	Ballyhouras	11	10	-0.1	152	0.07	6	0	4	60.0	0.0	40.0	41.2	36.1	18.2	18.2
2	2007	-	-	-	2009	W Clare	10	12	0.2	153	0.07	7	1	4	58.3	8.3	33.3	41.7	45.9	24.8	24.8
2	2009	-	-	-	2011	S Aughties	12	7	-0.4	377	0.03	5	0	2	71.4	0.0	28.6	53.6	31.7	20.1	20.1
2	2009	-	-	-	2011	Ballyhouras	10	6	-0.4	80	0.13	2	1	3	33.3	16.7	50.0	36.1	24.9	12.0	12.0
2	2009	-	-	-	2011	W Clare	12	6	-0.5	148	0.08	4	0	2	66.7	0.0	33.3	45.9	24.2	14.9	14.9
1	2007	-	-	-	2008	S Aughties	9	12	0.3	334	0.03	6	0	6	50.0	0.0	50.0	35.7	53.3	20.3	20.3
1	2007	-	-	-	2008	Ballyhouras	11	14	0.3	161	0.07	7	4	3	50.0	28.6	21.4	41.2	53.7	32.4	32.4
1	2007	-	-	-	2008	W Clare	10	12	0.2	141	0.07	6	2	4	50.0	16.7	33.3	41.7	54.2	31.5	31.5
1	2008	-	-	-	2009	S Aughties	12	12	0.0	476	0.03	5	1	6	41.7	8.3	50.0	53.3	53.6	21.2	21.2
1	2008	-	-	-	2009	Ballyhouras	14	10	-0.3	153	0.09	7	1	2	70.0	10.0	20.0	53.7	36.1	25.6	25.6
1	2008	-	-	-	2009	W Clare	12	12	0.0	145	0.08	6	4	2	50.0	33.3	16.7	54.2	45.9	31.9	31.9
1	2009	-	-	-	2010	S Aughties	12	8	-0.3	384	0.03	3	2	3	37.5	25.0	37.5	53.6	36.2	17.1	17.1
1	2009	-	-	-	2010	Ballyhouras	10	7	-0.3	71	0.14	5	0	2	71.4	0.0	28.6	36.1	25.1	15.5	15.5
1	2009	-	-	-	2010	W Clare	12	10	-0.2	147	0.08	6	2	2	60.0	20.0	20.0	45.9	36.5	21.8	21.8
1	2010	-	-	-	2011	S Aughties	8	7	-0.1	366	0.02	2	2	3	28.6	28.6	42.9	36.2	31.7	11.8	11.8
1	2010	-	-	-	2011	Ballyhouras	7	6	-0.1	85	0.08	1	0	5	16.7	0.0	83.3	25.1	24.9	6.6	6.6
1	2010	-	-	-	2011	W Clare	10	6	-0.4	141	0.07	4	0	2	66.7	0.0	33.3	36.5	24.2	13.8	13.8
1	2007	2008	-	-	2009	S Aughties	12	12	0.0	480	0.03	7	2	3	58.3	16.7	25.0	68.6	53.6	29.9	29.9
1	2007	2008	-	-	2009	Ballyhouras	14	10	-0.3	161	0.09	8	0	2	80.0	0.0	20.0	62.4	36.1	26.9	26.9

**Table A.1. (continued).** Results of red area effectiveness analysis (for details on parameters see GIS analysis section).

Lag	Year 1	Year 1b	Year 1c	Year 1d	Year 2	Region	Nests 1	Nests 2	Trend	Min. polygon	Density	Protected	Part protected	Not protected	% protected	% part protected	% not protected	Red area area	Nests year 2 area	Red area intersect	Red area effective
1	2007	2008	-	-	2009	W Clare	12	12	0.0	153	0.08	8	2	2	66.7	16.7	16.7	64.4	45.9	35.6	35.6
1	2007	2008	2009	-	2010	S Aughties	12	8	-0.3	493	0.02	3	4	1	37.5	50.0	12.5	92.2	36.2	22.7	22.7
1	2007	2008	2009	-	2010	Ballyhouras	10	7	-0.3	166	0.06	5	0	2	71.4	0.0	28.6	71.7	25.1	17.6	17.6
1	2007	2008	2009	-	2010	W Clare	12	10	-0.2	161	0.07	7	2	1	70.0	20.0	10.0	74.7	36.5	27.2	27.2
1	2007	2010	2009	2010	2011	S Aughties	8	7	-0.1	496	0.02	6	1	0	85.7	14.3	0.0	105.7	31.7	25.4	25.4
1	2007	2010	2009	2010	2011	Ballyhouras	7	6	-0.1	168	0.04	4	1	1	66.7	16.7	16.7	79.1	24.9	20.1	20.1
1	2007	2010	2009	2010	2011	W Clare	10	6	-0.4	172	0.06	5	0	1	83.3	0.0	16.7	84.0	24.2	17.4	17.4
5	2010	-	-	-	2015	S Aughties	25	14	-0.4	513	0.05	7	2	5	50.0	14.3	35.7	107.4	60.7	34.1	34.1
5	2010	-	-	-	2015	Ballyhouras	15	12	-0.2	165	0.09	3	2	7	25.0	16.7	58.3	56.5	42.3	17.9	17.9
5	2010	-	-	-	2015	Comeragh Mts	1	3	2.0	57	0.02	1	0	2	33.3	0.0	66.7	4.5	13.6	3.5	3.5
5	2010	-	-	-	2015	Ctl Mullaghareirks	12	16	0.3	300	0.04	5	0	11	31.3	0.0	68.8	47.5	67.0	18.1	18.1
5	2010	-	-	-	2015	Derrynasaggart	8	3	-0.6	336	0.02	1	0	2	33.3	0.0	66.7	31.8	13.6	4.2	4.2
5	2010	-	-	-	2015	Galtees	6	3	-0.5	170	0.04	1	0	2	33.3	0.0	66.7	26.0	13.6	2.9	2.9
5	2010	-	-	-	2015	Knockmealdowns	2	6	2.0	175	0.01	1	2	3	16.7	33.3	50.0	9.1	26.2	7.3	7.3
5	2010	-	-	-	2015	Nth Mullaghareirks	15	16	0.1	220	0.07	7	0	9	43.8	0.0	56.3	62.7	64.2	26.8	26.8
5	2010	-	-	-	2015	Nagles	11	5	-0.5	85	0.13	5	0	0	100.0	0.0	0.0	33.7	21.7	18.3	18.3
5	2010	-	-	-	2015	S Beagh	6	3	-0.5	41	0.15	2	0	1	66.7	0.0	33.3	22.0	12.8	8.4	8.4
5	2010	-	-	-	2015	S Bearnagh	2	7	2.5	128	0.02	0	1	6	0.0	14.3	85.7	9.1	28.3	2.0	2.0
5	2010	-	-	-	2015	S Blooms	9	12	0.3	179	0.05	3	0	9	25.0	0.0	75.0	40.6	50.1	15.5	15.5
5	2010	-	-	-	2015	Sth Donegal	5	14	1.8	509	0.01	2	0	12	14.3	0.0	85.7	22.6	63.3	7.8	7.8
5	2010	-	-	-	2015	S Felims	14	12	-0.1	392	0.04	5	1	6	41.7	8.3	50.0	61.9	54.0	22.6	22.6
5	2010	-	-	-	2015	S Rushen	7	2	-0.7	29	0.24	2	0	0	100.0	0.0	0.0	22.7	8.7	8.1	8.1
5	2010	-	-	-	2015	Stacks	8	6	-0.3	108	0.07	0	2	4	0.0	33.3	66.7	33.2	27.1	6.8	6.8
1	2007	-	-	-	2008	S Aughties	9	12	0.3	334	0.03	6	0	6	50.0	0.0	50.0	35.7	53.3	20.3	20.3
1	2007	-	-	-	2008	Ballyhouras	11	14	0.3	161	0.07	7	4	3	50.0	28.6	21.4	41.2	53.7	32.4	32.4
1	2007	-	-	-	2008	W Clare	10	12	0.2	141	0.07	6	2	4	50.0	16.7	33.3	41.7	54.2	31.5	31.5

## Appendix C

# Hen Harrier Survey 2021

## Survey Methods & Recording Guidelines

### Background

The red area procedures are designed to protect breeding Hen Harrier from disturbance from forest management activities during the nesting season within the SPA network. The effectiveness of the red area procedures can be compromised when data on Hen Harrier distribution and occupancy is out of date. A review of the effectiveness of the red areas for the protection of breeding Hen Harrier has shown that improvements are required and specifically that up to date information on Hen Harrier territories, available to all stakeholders would ensure increased protection of nest sites and allow better planning of forest management activities to avoid important areas for Hen Harrier during the breeding season. Through this project we are trialling a new method to determine the presence of Hen Harrier in relation to forest areas, to provide real-time data to inform forest management. This is a trial, and the survey findings will not dictate or inform forest management in this season (2021) but rather inform a new approach for the protection of Hen Harrier in the SPA network. Sample Harvest Units (which form the survey areas) have been selected (which include survey areas within existing red areas and outside of red areas but in suitable breeding habitat for Hen Harrier) and the objective of the survey is to establish occupancy of breeding Hen Harrier in these survey areas in 2021, in the Slieve Aughty Mountains SPA and the Slieve Bloom Mountains SPA.

### Hen Harrier Survey Methodology

The survey areas are defined by a 750m buffer surrounding sample harvest units. Each surveyor will be allocated survey areas and will be provided with 1) an OSI map of the survey area, 2) an aerial image of the survey area, and 3) an overview map of the SPA showing the location of all survey areas to aid navigation.

The first step is to define the search area within your allocated survey area. To define the search area, it is important to distinguish habitat which is unsuitable for breeding Hen Harrier and habitat which is suitable breeding habitat for Hen Harrier, as defined below.

**Unsuitable** habitat is classified as ground above 600m; built-up/urban areas or within 100m of occupied farms and dwellings; improved pasture and arable farmland; the interior of unbroken, closed-canopy forest blocks; sheep-walk; extensive areas of bracken; degraded or overgrazed upland areas without any heather cover and areas within close proximity to sea-cliffs, inland crags, rocky outcrops, boulder fields and scree slopes (see Hardey *et al.*, 2009 and Ruddock *et al.*, 2016).

**Suitable** Hen Harrier breeding habitat is defined as heather dominated and/or grass moorland, other open habitats with extensive scrub or bramble cover and developing pre-thicket forest (first and second rotation) (see Hardey *et al.*, 2009 and Ruddock *et al.*, 2016).

Particular attention should be paid to heather moorland which contains stands of deep (usually >0.4m tall), well-drained heather with greater than 50% cover and areas with good all-round visibility such as slopes and river valleys and deep heather areas within forest clearings, forest rides and heather at the edges of forest plantations. The latter is usually found where livestock are excluded by fencing associated with afforestation and/or unplanted areas within the forest ownership boundary.

Grass-dominated and degraded moorland should also be included in the search area where these contain patches of deep heather or other shrub cover. Other shrub-dominated areas such as river valleys, abandoned fields and scrubby bogs should be included in the survey.

Pre-thicket coniferous forests are surveyed, and particular attention is paid to areas where forest compartments are characterised by prolific shrub layers.

In addition, areas of scrub (e.g. willow and bramble), often on the edges of moorland or bog, are surveyed for occupancy by Hen Harriers.

## **1. Defining the search area**

A combination of aerial images and map (provided) of the entire survey area should be used to identify all areas of suitable and unsuitable habitat for breeding Hen Harrier.

The suitability of these areas can be confirmed during the first visit by walking through the survey area to “ground-truth” likely breeding habitats, ensuring the whole area is covered and passing within 250m of every location with restricted viewing. Areas of unsuitable habitat for breeding Hen Harrier should be marked accordingly on OSI survey maps and excluded from further survey effort.

Depending on the quantity of suitable breeding habitat and the views over this habitat, some survey areas may require multiple vantage point locations to effectively cover. Regular communication with the Survey Coordinator (details below) should be maintained, particularly at the early stages of the survey to ensure coverage is achieved.

## **2. Survey Technique**

### **2.1 Vantage Point Watches**

Vantage point watches should be carried out to cover all areas of suitable breeding habitat within the survey area, in order to record Hen Harrier activity and to determine occupancy. The location and number of vantage points should be selected by the surveyor to ensure that all areas of potentially suitable breeding habitat within each survey square can be effectively watched. Vantage point locations can be outside the survey area (i.e. on an opposite hillside etc.) and should be

selected to maximise views and coverage of potentially suitable breeding habitat while ensuring that all Hen Harrier activity (observations and/or vocalisations) is recorded.

- Vantage point watches of three hours uninterrupted should be undertaken with a good view over the area of suitable breeding habitat being watched. Preferably watches should be undertaken in the morning or evening where possible (starting before 10:00h or after 16:00h). Two watches can be carried out per survey day. Watches which extend longer than three hours should include adequate rest time after each 3-hour period to avoid fatigue.
- Vantage point watches should only be carried out in suitable weather conditions, defined as visibility of > 1km, no precipitation or just sporadic showers and wind speed of less than Force 5 (fresh to strong breeze). Try to time vantage point watches so that the sun is behind you (or at least you are not facing directly into the sun)
- The vantage point location should preferably allow a 180o arc of view, however there may be situations where this is not possible.
- All details of the vantage point watch should be filled in on the recording form (details below) to include a 10-figure Irish Grid reference of the vantage point (using a hand-held GPS unit), the start and finish times and details of all encounters with Hen Harrier other key species according to the specific behaviour and habitat codes listed below in Tables 1 & 2, and all other bird species encountered.
- On the OSI survey map the following details should be recorded at the bottom of the page; the survey area ID (each survey area is assigned a unique ID reference which will be provided), survey area name, SPA name, date, visit no., start and finish times and page no. On each OSI map, the location and number of each vantage point should be clearly marked, alongside the viewshed from each vantage point, which is important so that the area covered, and potential gaps in coverage can be identified. Typically, the same VP locations will be used on subsequent visits, but if necessary or beneficial to change the VP locations then please do so.
- The approximate or known location of Hen Harrier nest sites should be marked with an 'X' on the survey map.
- The location of other key species encountered should be marked on the map according to the instructions listed below in Table 3.
- Record all other species encountered using the BTO species codes
- The activities/threats or pressures observed, if any, within the survey area, should also be recorded on the recording form, codes listed below in Tables 4.
- Nests should not be approached, and if birds are accidentally disturbed or flushed, record the location details and vacate the area immediately.
- Please use a different map and recording form for each visit to an area of suitable habitat to record the surveyed areas and the locations of Hen Harrier sightings and/or nests.

**Table F.1.** Behaviour codes and descriptions of behaviours utilised during the survey to record Hen Harrier activity.

<b>Behaviour (Code)</b>	<b>Description of behaviour</b>
<i>Display (D)</i>	Including “sky-dancing” or aerial display involving rapid stooping and climbing, and occasionally mutual or individual high circling may be observed
<i>Food pass (FP)</i>	Male passing food to the female or adult to juvenile, usually in mid-air
<i>Hunting (H)</i>	Low level “quartering” flights <5m above ground level
<i>Flying (F)</i>	Flying or commuting where no other behaviours are recorded
<i>With Prey (WP)</i>	Carrying prey in its talons
<i>Soaring (S)</i>	Circling very high (above tree-tops) on thermals
<i>Circling (C)</i>	Circling below tree-top height
<i>Perched (P)</i>	Perched on a tree or fence post with no other behaviour recorded
<i>on Ground (G)</i>	Perched on the ground
<i>Alarm (A)</i>	Adults calling or appearing agitated, usually occurs close to the nest during territorial defence
<i>Mobbing (M)</i>	Territorial behaviour and chasing or attacking other harriers or other bird species. May occasionally be observed to attack mammal predators
<i>Other (O)</i>	Describe behaviour(s) where not indicated by any other category above

**Table F.2.** Habitat codes and descriptions utilised during the survey.

<b>Habitat (Code)</b>	<b>Description of habitat</b>
<i>First rotation (or new) forest (1F)</i>	First-rotation forest plantations before canopy closure. Characterised by prolific herb layer with varying shrub layer development. Trees generally >1m tall with large open spaces between lines of planting.
<i>Second rotation forest (2F)</i>	Second-rotation forest plantations before canopy closure. Characterised by varying shrub layer development and brash and tree root-plates from the previous crop and large open spaces between lines of planting. Newly established second-rotation trees are not always obvious.
<i>Thicket (pole) or mature stage forest (T)</i>	Closed-canopy forest plantations including both 1F & 2F crops. Usually >10 years old. Characterised by absence of shrub layer, except in rides between stands of trees and in small patches of unplanted ground or failed crop.

<b>Clearfell (CF)</b>	Harvested plantation not yet restocked with trees. Characterised by limited development of herb and shrub layer, and brash and tree root-plates evident from the previous crop.
<b>Heather moorland/bog (H)</b>	Unenclosed heather-dominated moorland characterised by species such as heather, bilberry and purple-moor grass plus blanket bog characterised by <i>Calluna</i> and bell heather, bog cotton, deer grass and moss. Typically grazed by red deer and low densities of sheep.
<b>Grass moorland (G)</b>	Unenclosed grass-dominated moorland usually grazed by sheep. Characterised by species such as wavy hair grass, mat grass and heath rush. Stands of <i>Juncus</i> spp. and bracken occasionally occur.
<b>Rough grassland (RG)</b>	Unenclosed or enclosed, neglected pastures occasionally stocked with sheep or cattle that have not recently been improved, re-seeded or fertilised. Usually contains long grass, waterlogged areas and stands of rushes ( <i>Juncus</i> spp).
<b>Improved grassland (IG)</b>	Enclosed pastures that have been drained, fertilised or re-seeded characterised by lush green grass vegetation and containing higher densities of sheep or cattle. Also includes hay meadows.
<b>Scrub (S)</b>	Areas outside or away from plantation forests consisting of willow, bramble, furze etc which have not been tended by humans. Includes bushy vegetation such as Willow ( <i>Salix</i> spp), Gorse ( <i>Ulex</i> spp), Bramble ( <i>Rubus</i> spp), Alder ( <i>Alnus</i> spp), Birch ( <i>Betula</i> spp) and Bracken ( <i>Pteridium</i> spp).
<b>Linear feature associated with rough grassland (LR)</b>	Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to rough grassland.
<b>Linear feature associated with improved grassland (LI)</b>	Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to improved grassland.
<b>Other trees or woodland (O)</b>	Other trees or woodland other than coniferous plantation which include native forest, open woodland, shelter belts, copses, tree lines, wooded islands on inland lakes and isolated trees.

**Table F.3.** Details and recording methods for other key species

Species (Code)	Method of recording
Curlew (Cu)	
Golden Plover (GP)	Mark location, encounter no. and nest location (if known) on map. Record all details of location, behaviour and habitat on recording form.
Dunlin (DN)	
Red Grouse (RG)	
Short-eared Owl (SE)	



Code	Description of activity, threat or pressure
F2	illegal killing (e.g. shooting, trapping, poisoning)
G1	human intrusions and disturbances
G2	outdoor sports and leisure activities, recreational activities
G3	walking, horse-riding and non-motorised vehicles
G4	motorised vehicles
G5	off-road motorised driving
G6	other outdoor sports and leisure activities
G7	military manoeuvres
H1	pollution (e.g. water pollution, fly-tipping)
J1	natural fires
J2	controlled burning (e.g. strip burning for grouse management)
J3	uncontrolled burning (e.g. widespread unmanaged or malicious burning)
J4	modification of water levels or waterbodies
J5	reduction or loss of specific habitat features (e.g. removal of hedgerows, deep heather, scrub, walls, drains)
J6	reduction of prey availability
J7	anthropogenic reduction of habitat connectivity (i.e. fragmentation such as by removal of large areas of habitat or creation of barriers between habitats)
K1	interspecific faunal relations - predation (by other birds e.g. crows)
K2	interspecific faunal relations - predation (by mammals e.g. foxes)
X	no threats or pressures
O	other threats or pressures not listed above

### 3. Survey Schedule

The duration of each visit may vary depending on the size of the search area to be covered, the quantity of potentially suitable breeding habitat within the area, and the number of vantage point watches required to confidentially cover all potentially suitable breeding habitat. For example, to effectively cover a survey area may require a single vantage point (3 hrs watch per visit), or it may require up to six vantage points (18 hrs watches per visit). Becoming familiar with your survey area will inform the requirements to achieve effective coverage at the start of the survey. If any difficulties are experienced achieving effective coverage of a survey area or part of during any of the visits, please notify a Survey Coordinator as soon as you become aware of this so that appropriate assistance can be organised.

Suitable habitat within all survey squares are to be visited on two occasions between April and the 20<sup>th</sup> of May, with a possible third visit required between late May and late June.

The two visits are required to establish territorial occupancy with the first visit between April and late-April (25<sup>th</sup> April) and the second between late-April (26<sup>th</sup> April) and the 20<sup>th</sup> of May.

A third survey visit will be required for a sub sample of survey squares where evidence of occupancy has not been established during the first two visits and will take place during late May (20<sup>th</sup> May) to mid-June (14<sup>th</sup> June).

Note: As the objective of the surveys is to establish occupancy in the survey area, if breeding evidence for Hen Harrier is confirmed on the first or second visit, then subsequent visits may not be necessary. For this reason, it is important to try and enter data from visits as soon as possible after a survey visit, and the data entry is made straightforward for this reason (see below).

**Table 5.** Schedule of survey visits

Visit No.	Type of visit	Timings
1	Required	1 <sup>st</sup> April – 25 <sup>th</sup> April
2	Required	26 <sup>th</sup> April – 20 <sup>th</sup> May
3	TBD	20 <sup>th</sup> May – 14 <sup>th</sup> June

#### 4. Data recording

Each surveyor will be provided with an aerial image and an OSI map of their survey area (showing the boundary of the survey area), recording form and link to Google Forms to enter the survey data (optional).

Please use a separate map and recording form for each survey date. Use multiple maps and recording forms for each date if necessary.

#### 4.1 Survey Maps

Using a combination of aerial images and ground-truthing as required, on the map mark all areas of unsuitable habitat to be excluded from survey effort. On completion of the survey, please provide a single map which clearly shows all unsuitable areas for the survey square you are covering.

For each survey date use a separate map. Record the survey area ID, survey area name, SPA name, date, visit no., start and finish times and page no. on each map.

The location and number of each vantage point should be clearly marked on the map, alongside the view from each vantage point.

The approximate or known location of Hen Harrier nest sites should be marked with an 'X' on the survey map.

The locations of other key species should be marked on the map and details noted on the recording form (as per Table 3.).

Complete the map during each survey visit and finalise at the end of the survey day.

Note that it is just as important to submit nil return sheets if there are no sightings.

#### 4.2 Recording Forms

Using a separate recording form for each survey date, please record as much information as possible for each survey date. There are two Google Forms for entering data, one for the Hen Harrier Occupancy Survey 2021: <https://forms.gle/UFyuhCovVgMs6Mxx6>

And the other for Casual Observations: [https://docs.google.com/forms/d/e/1FAIpQLSdSkI\\_c7443qYtt-89gjat7fvMADriv9S5KDaV3mXfnYWSS2w/viewform](https://docs.google.com/forms/d/e/1FAIpQLSdSkI_c7443qYtt-89gjat7fvMADriv9S5KDaV3mXfnYWSS2w/viewform), you can fill these in directly in the field using a mobile phone with mobile data or fill in the recording form and transcribe to Google Forms later on computer or mobile. Once you submit the data via Google Forms we receive it directly.

## 6. Equipment

The following equipment should be kept by the surveyor and taken in the field on all survey visits:

- Survey map and recording form
- OSI map of the area
- Binoculars & scope
- Handheld GPS unit
- Compass or similar app
- Fully charged mobile phone with emergency contact details
- First aid kit
- Tic remover
- Sun screen, sun hat and clothes to protect from the sun
- Water and food

## 7. Contact details

Contact details for Survey Coordinators, if you should have any queries in relation to any aspects of the survey please contact either:

John Lusby, Mob: 0857201892, Email: [jlusby@birdwatchireland.ie](mailto:jlusby@birdwatchireland.ie)

Laura Kavanagh, Mob: 087 9035844, Email: [lauramaykavanagh@gmail.com](mailto:lauramaykavanagh@gmail.com)

## 8. Health & Safety

Please message John Lusby (by WhatsApp or text message) before you set out on field surveys with the survey area and times, and again when you complete the survey for that day.

## Appendix D

### Survey maps and recording forms for the Hen Harrier Survey 2021



Survey square ID \_\_\_\_\_

Date \_\_\_\_\_

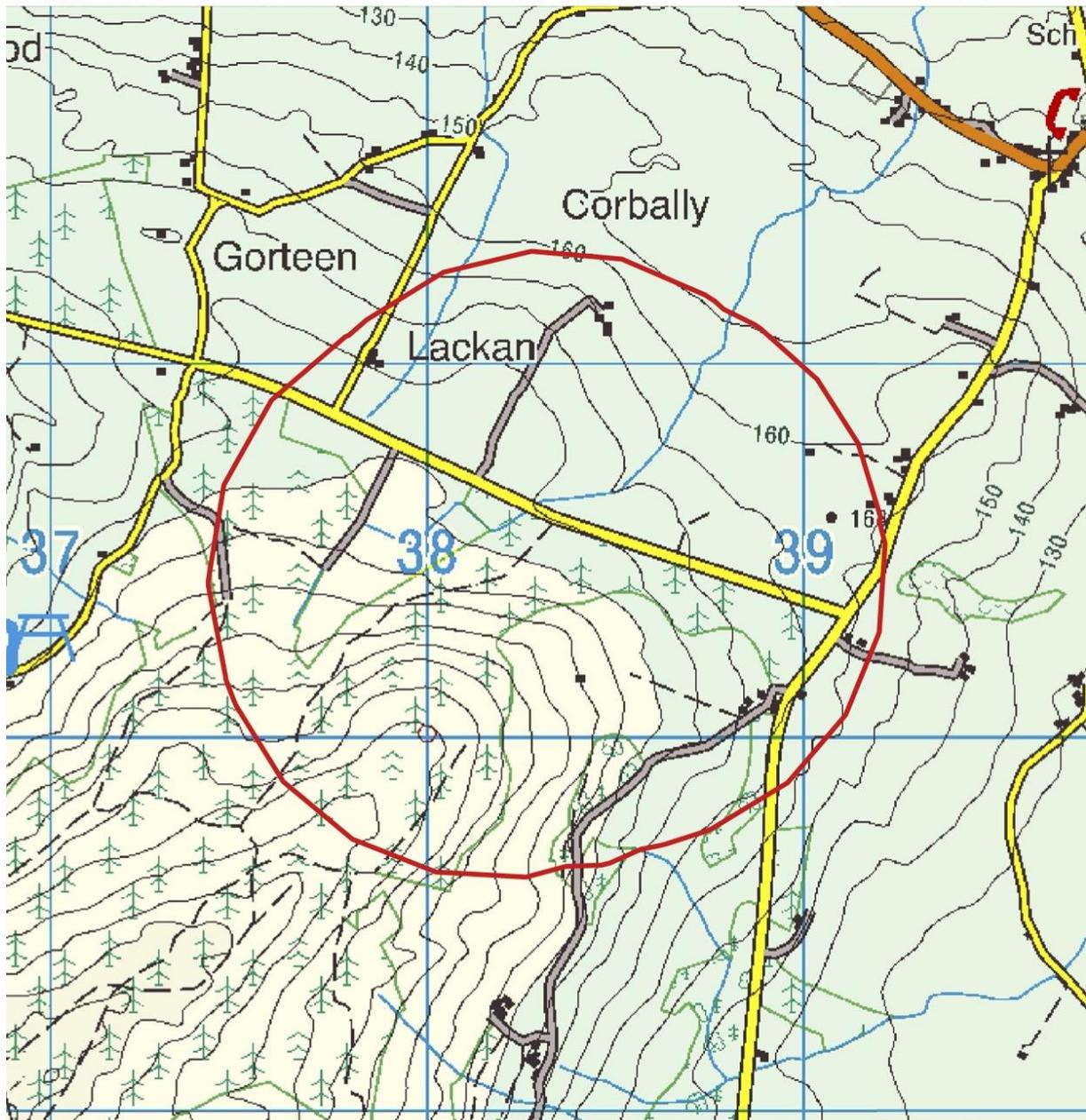
SPA name \_\_\_\_\_

Visit number \_\_\_\_\_

Surveyor's name \_\_\_\_\_

Survey start time \_\_\_\_\_

Survey finish time \_\_\_\_\_



Survey square ID \_\_\_\_\_

Date \_\_\_\_\_

SPA name \_\_\_\_\_

Visit number \_\_\_\_\_

Surveyor's name \_\_\_\_\_

Survey start time \_\_\_\_\_

Survey finish time \_\_\_\_\_



# Hen Harrier Occupancy Survey 2021

lauramaykavanagh@gmail.com [Switch account](#)



\* Required

Email \*

Your email

SurveySquare\_ID \*

This is the unique ID reference for each site, which you will find on the maps for each site etc. (e.g. GY10-H0008)

Your answer

SPA\_Name

The name of the SPA in which the survey square is contained

Choose



County

The county in which the square is contained, for squares which fall in two counties use the county which the majority of that square is in

Choose



Date

## Appendix E

**Table E.1.** Habitat codes and descriptions for use on recording forms.

Habitat (Code)	Description of habitat
First rotation (or new) forest (1F)	First-rotation forest plantations before canopy closure. Characterised by prolific herb layer with varying shrub layer development. Trees generally >1m tall with large open spaces between lines of planting.
Second rotation forest (2F)	Second-rotation forest plantations before canopy closure. Characterised by varying shrub layer development and brash and tree root-plates from the previous crop and large open spaces between lines of planting. Newly established second-rotation trees are not always obvious.
Thicket (pole) or mature stage forest (T)	Closed-canopy forest plantations including both 1F & 2F crops. Usually >10 years old. Characterised by absence of shrub layer, except in rides between stands of trees and in small patches of unplanted ground or failed crop.
Clearfell (CF)	Harvested plantation not yet restocked with trees. Characterised by limited development of herb and shrub layer, and brash and tree root-plates evident from the previous crop.
Heather moorland/bog (H)	Unenclosed heather-dominated moorland characterised by species such as heather, bilberry and purple-moor grass plus blanket bog characterised by <i>Calluna</i> and bell heather, bog cotton, deer grass and moss. Typically grazed by red deer and low densities of sheep.
Grass moorland (G)	Unenclosed grass-dominated moorland usually grazed by sheep. Characterised by species such as wavy hair grass, mat grass and heath rush. Stands of <i>Juncus</i> spp. and bracken occasionally occur.
Rough grassland (RG)	Unenclosed or enclosed, neglected pastures occasionally stocked with sheep or cattle that have not recently been improved, re-seeded or fertilised. Usually contains long grass, waterlogged areas and stands of rushes ( <i>Juncus</i> spp).

Improved grassland (IG)	Enclosed pastures that have been drained, fertilised or re-seeded characterised by lush green grass vegetation and containing higher densities of sheep or cattle. Also includes hay meadows.
Scrub (S)	Areas outside or away from plantation forests consisting of willow, bramble, furze etc which have not been tended by humans. Includes bushy vegetation such as Willow ( <i>Salix</i> spp), Gorse ( <i>Ulex</i> spp), Bramble ( <i>Rubus</i> spp), Alder ( <i>Alnus</i> spp), Birch ( <i>Betula</i> spp) and Bracken ( <i>Pteridium</i> spp).
Linear feature associated with rough grassland (LR)	Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to rough grassland.
Linear feature associated with improved grassland (LI)	Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to improved grassland.
Other trees or woodland (O)	Other trees or woodland other than coniferous plantation which include native forest, open woodland, shelter belts, copses, tree lines, wooded islands on inland lakes and isolated trees.

---

Note. From “The 2015 National Survey of Breeding Hen Harrier in Ireland”, by Ruddock *et al.*, 2016, *Irish Wildlife Manuals*, No.93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

**Table E.2.** Activities, management, threats or pressures codes and descriptions for use on recording forms.

Code	Description of activity, threat or pressure
A1	modification of cultivation practices
A2	agricultural intensification
A3	mowing / cutting of grassland
A4	abandonment / lack of mowing
A5	intensive grazing
A6	non intensive grazing
A7	abandonment of pastoral systems, lack of grazing

- A8 fertilisation (agricultural)
- A9 removal of hedges and copses or scrub
- B1 forest planting on open ground (increase in forest area, planting e.g. on grassland , heathland)
- B2 forest and plantation management & use
- B3 forest replanting (i.e. replanting on forest ground after clear-cutting)
- B4 forest clearance (clear-cutting, removal of all trees)
- B5 thinning of tree layer
- B6 fertilisation (forestry)
- B7 other forest activities (e.g. erosion due to forest clearing, fragmentation)
- C1 hand cutting of peat
- C2 mechanical removal of peat
- C3 wind energy production
- D1 paths, tracks, cycling tracks (includes non-paved forest roads)
- D2 roads, motorways (all paved/ tarred roads)
- D3 utility and service lines (e.g. power-lines, pipelines)
- D4 aircrafts or flightpaths
- D5 improved access to site
- E1 urbanisation, residential and commercial development
- E2 dispersed habitation (i.e. little or no human disturbance)
- F1 nest destruction
- F2 illegal killing (e.g. shooting, trapping, poisoning)
- G1 human intrusions and disturbances
- G2 outdoor sports and leisure activities, recreational activities
- G3 walking, horse-riding and non-motorised vehicles
- G4 motorised vehicles
- G5 off-road motorised driving
- G6 other outdoor sports and leisure activities
- G7 military manoeuvres
- H1 pollution (e.g. water pollution, fly-tipping)
- J1 natural fires
- J2 controlled burning (e.g. strip burning for grouse management)
- J3 uncontrolled burning (e.g. widespread unmanaged or malicious burning)
- J4 modification of water levels or waterbodies
- J5 reduction or loss of specific habitat features (e.g. removal of hedgerows, deep

	heather, scrub, walls, drains)
<b>J6</b>	reduction of prey availability
<b>J7</b>	anthropogenic reduction of habitat connectivity (i.e. fragmentation such as by removal of large areas of habitat or creation of barriers between habitats)
<b>K1</b>	interspecific faunal relations - predation (by other birds e.g. crows)
<b>K2</b>	interspecific faunal relations - predation (by mammals e.g. foxes)
<b>X</b>	no threats or pressures
<b>O</b>	other threats or pressures not listed above

Note. From “The 2015 National Survey of Breeding Hen Harrier in Ireland”, by Ruddock *et al.*, 2016, *Irish Wildlife Manuals*, No.93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

**Table E.3.** Behaviour codes and descriptions of behaviours utilised during the survey to record Hen Harrier activity.

<b>Behaviour (Code)</b>	<b>Description of behaviour</b>
<i>Display (D)</i>	Including “sky-dancing” or aerial display involving rapid stooping and climbing and occasionally mutual or individual high circling may be observed
<i>Food pass (FP)</i>	Male passing food to the female or adult to juvenile, usually in mid-air
<i>Hunting (H)</i>	Low level “quartering” flights <5m above ground level
<i>Flying (F)</i>	Flying or commuting where no other behaviours are recorded
<i>With Prey (WP)</i>	Carrying prey in its talons
<i>Soaring (S)</i>	Circling very high (above tree-tops) on thermals
<i>Circling (C)</i>	Circling below tree-top height
<i>Perched (P)</i>	Perched on a tree or fence post with no other behaviour recorded
<i>on Ground (G)</i>	Perched on the ground

<i>Alarm (A)</i>	Adults calling or appearing agitated, usually occurs close to the nest during territorial defence
<i>Mobbing (M)</i>	Territorial behaviour and chasing or attacking other harriers or other bird species. May occasionally be observed to attack mammal predators
<i>Other (O)</i>	Describe behaviour(s) where not indicated by any other category above

**Table E.4.** Details and recording methods for other priority species.

<b>Species (Code)</b>	<b>Method of recording</b>
Curlew ( <b>Cu</b> )	
Golden Plover ( <b>GP</b> )	
Dunlin ( <b>DN</b> )	
Red Grouse ( <b>RG</b> )	
Short-eared Owl ( <b>SE</b> )	Mark location, encounter no. and nest location (if known) on map. Record all details of location, behaviour and habitat on recording form.
Hen Harrier ( <b>HH</b> )	
Peregrine Falcon ( <b>PE</b> )	
Kestrel ( <b>K.</b> )	
Sparrowhawk ( <b>SH</b> )	
Buzzard ( <b>BZ</b> )	
Whinchat ( <b>WC</b> )	
Other (list species name)	
Raven ( <b>RN</b> )	Mark location, encounter no. and nest location (if known) on map, where bird/nest is. Record all details of location, behaviour and habitat on recording form.
Hooded Crow ( <b>HC</b> )	

**Table E.5.** Behaviour codes and descriptions of behaviours utilised during the survey to record Merlin activity.

<b>Behaviour (Code)</b>	<b>Description of behaviour</b>
<i>Display (D)</i>	Display flights, pair or single bird circling high over the potential nest site, may also be observed shivering their wings in flight

<i>Hunting (H)</i>	Actively hunting, typically low fast flights in pursuit of prey in suitable habitat
<i>Flying (F)</i>	Flying or commuting where no other behaviours are recorded
<i>With Prey (WP)</i>	Carrying prey
<i>Perched (P)</i>	Perched on a tree or fence post with no other behaviour recorded
<i>on Ground (G)</i>	Perched on the ground
<i>Plucking (PL)</i>	Plucking prey at perch
<i>Prey delivery (PD)</i>	Adult delivering prey to a nest, or male delivering prey to female
<i>Alarm (A)</i>	Adults calling or appearing agitated, usually occurs close to the nest during territorial defence
<i>Mobbing (M)</i>	Mobbing other species, defensive behaviour usually close to a nest
<i>Other (O)</i>	Describe behaviour(s) where not indicated by any other category above

---

## Appendix F

# Merlin Occupancy Survey 2021

## Merlin Survey Methods & Recording Guidelines

### Background

Merlin nest at the edge of mature forest plantation, which puts them at risk from disturbance from forest management activities (Lusby et al. 2017). The Forest Service introduced mitigation measures in 2020 to protect breeding Merlin, whereby forest management activities are restricted within a 100m buffer at the edge of mature forest plantation adjacent to open unenclosed upland. The effectiveness of these measures for protecting breeding Merlin have not yet been assessed. Through this project we are trialling a new method to determine the presence of breeding Merlin in relation to forest areas, to provide real-time data to inform forest management. This is a trial and the survey findings will not dictate or inform forest management in this season (2021) but rather inform a new approach for the protection of Merlin in and surrounding the SPA network. Sample Harvest Units (which form the survey areas) have been selected and the objective of the survey is to establish occupancy of breeding Merlin in these survey areas in 2021, in the Slieve Aughty Mountains SPA and the Connemara Bog Complex SPA.

### Merlin Survey Methodology

The survey areas are defined by a 500m buffer surrounding sample harvest units. Each surveyor will be allocated survey areas and will be provided with 1) an OSI map of the survey area, 2) an aerial image of the survey area, and 3) an overview map of the SPA showing the location of all survey areas to aid navigation.

The first step is to define the search area within your allocated survey area. To define the search area, it is important to distinguish habitat which is unsuitable for breeding Merlin and habitat which is suitable breeding habitat for Merlin, as defined below. To determine the presence of breeding Merlin, the search area and vantage points should focus on potentially suitable breeding habitat (i.e. watches should not be carried out over areas of suitable foraging habitat, but where there are no nesting opportunities for Merlin).

**Unsuitable habitat:** All areas of open water, urban and built-up areas, lowland farmland including semi-improved, improved and enclosed pastures and areas above 700m in altitude (Hardey *et al.* 2009, Lusby *et al.* 2017) should be considered unsuitable breeding habitat for Merlin.

**Suitable foraging habitat:** Unenclosed upland areas which include grass and heather moorland and bog which do not include suitable nesting opportunities for Merlin (as defined below) should be considered as suitable foraging habitat. All areas of suitable foraging habitat within 300m of potentially suitable breeding habitat should be included in the search area, as sign searching in suitable foraging

habitat in proximity (within 300m) to potential breeding habitat can be an important survey tool to establish occupancy via evidence of plucking perches and signs of Merlin.

**Potentially suitable breeding habitat:** In Ireland Merlin predominantly nest in old corvid stick nests in trees adjacent to, or in close proximity to unenclosed lands. A study which assessed Merlin nest site selection showed that the majority of Merlin nest sites (n = 183) were in trees (99.5%), with a positive selection for conifer plantations. Moors and heathland were strongly selected as an adjacent land use to nest sites (Lusby *et al.* 2017). The majority of nests in plantation forest were located within 10m of the forest edge (Lusby *et al.* 2017), although nests may be located up to 60m from the edge of the plantation, or within the forest interior close to the edge of breaks or clearings in the tree canopy caused by roads or forest fires (Norriss *et al.* 2010). Most nests in forests were in plantations aged between 31 to 40 years, with nests in forest as young as 11 years and over 50 years in age (Lusby *et al.* 2017). In addition to forest plantations, Merlin will also nest in trees in open woodland, shelter belts, copses, tree lines, wooded islands on inland lakes and isolated trees in open upland areas provided there is a suitable stick nest available (Lusby *et al.* 2017). If it is possible to ascertain that there are no suitable stick nests present, then individual or groups of trees can be ruled out as unsuitable, however caution should be applied with this approach as some stick nests can be difficult to observe from the ground. Merlin may also nest on the ground in moorland where heather is 30 – 70cm high (Hardey *et al.* 2009, McElheron 2005) typically on sloping ground, and any areas which provide such opportunities should be considered as potentially suitable breeding habitat. Rocky crags and rock faces are likely to be rarely used by nesting Merlin but should not be ruled out (D. Norriss *pers. Comm.*).

## 1. Defining the search area

- A combination of aerial images, map and ground-truthing of the entire survey area should be used to identify all areas of unsuitable habitat for breeding Merlin. These areas can be excluded from further survey effort and marked as such (cross hatch) on the survey map showing the search area (see Image 1.).

All areas within the survey area considered to be potentially suitable for breeding Merlin and all areas of suitable foraging habitat within 300m should be assessed in the field to confirm suitability or otherwise and marked accordingly on the survey map showing the search area (see Image 1.).

The defined search area will be the focus for the Merlin survey, and the initial assessment (either carried out before or during the first survey visit in April) should inform the most suitable approach to effectively surveying this area for Merlin according to the survey methods outlined below. The entire survey area should be surveyed.

Depending on the quantity and characteristics of potentially suitable breeding habitat, even small areas may be time consuming to effectively survey for Merlin (e.g. extensive areas of forest which require multiple vantage point locations to effectively cover). Regular communication with a Survey Coordinator (details below) should be maintained, particularly at the early stages of the survey to ensure coverage is achieved and so that additional support can be allocated as necessary.

## 2. Survey Techniques

The main survey technique employed to confirm occupancy and locate breeding Merlin is **vantage point watches** over potentially suitable breeding habitat, which can be supplemented by **sign searching** to record evidence of the presence of Merlin in an area and to assist with locating breeding activity.

### 2.1 Vantage Point Watches

Vantage point watches should be carried out over all areas of potentially suitable breeding habitat within the defined search area, in order to record Merlin activity and to determine occupancy. The locations of vantage points should be selected to maximise views and coverage of potentially suitable breeding habitat while ensuring that all Merlin activity (observations and/or vocalisations) is recorded.

- Vantage points should be located at a maximum distance of 800m from the area of potentially suitable breeding habitat which is being watched, to increase confidence of recording Merlin which may be associated with that habitat. In certain situations, vantage points may need to be located much closer to the habitat which is being watched, and the surveyor should select the vantage point location to ensure that they can most effectively record Merlin in the area covered.
- The number of vantage points should be selected to ensure that all areas of potentially suitable breeding habitat are covered. The preference is to cover less survey areas and cover them well, rather than covering many survey areas but potentially missing areas or breeding pairs.
- Vantage point watches should only be carried out in suitable weather conditions, defined as visibility of > 1km, no precipitation or just sporadic showers and wind speed of less than Force 5 (fresh to strong breeze).
- Preferably watches should be undertaken in the morning or evening where possible (starting before 10:00h or after 16:00h). Two watches can be carried out per survey day. Watches should last for a minimum of three hours uninterrupted. Watches which extend longer than this should include adequate rest time after each 3-hour period to avoid fatigue.
- The vantage point location should preferably allow a 180° arc of view, however there may be situations where this is not possible.
- All details of the vantage point watch should be filled in on the recording form to include a 10-figure Irish Grid reference of the vantage point (using a hand-held GPS unit), the start and finish times and details of all encounters with Merlin and other key species according to the specific behaviour and habitat codes listed below in Tables 1 & 2.
- On the survey map the following details should be recorded at the bottom of the page; survey square ID, survey square name, SPA name, date, visit no., start and finish times and page no. On each map, the location and number of each vantage point should be clearly marked, alongside the view from each vantage point, which is important so that the area covered, and potential gaps in coverage can be identified. The location of sign searching transects should also be noted if sign searching was carried out.

- All Merlin encounters should be mapped, according to the encounter no., and the full extent of flight lines and direction of movements marked on maps. The approximate or known location of Merlin nest sites should be marked accordingly on the survey map. See Image 2 which shows a sample map completed.
- The location of other key species encountered should be marked on the map according to the instructions listed below in Table 3.
- The activities/threats or pressures observed, if any, within the survey area should also be recorded, codes listed below in Tables 4.
- During the watch, particular attention should be paid to corvids, raptors, herons, gulls and other species passing over or interacting with potentially suitable breeding habitat which may elicit a response from breeding Merlin.
- Merlin nests should not be approached, if birds are disturbed or flushed accidentally from a nest, the location details should be recorded, and the area should be immediately vacated to allow the bird to return.

**Table F.1.** Behaviour codes and descriptions of behaviours utilised during the survey to record Merlin activity.

<b>Behaviour (Code)</b>	<b>Description of behaviour</b>
<i>Display (D)</i>	Display flights, pair or single bird circling high over the potential nest site, may also be observed shivering their wings in flight
<i>Hunting (H)</i>	Actively hunting, typically low fast flights in pursuit of prey in suitable habitat
<i>Flying (F)</i>	Flying or commuting where no other behaviours are recorded
<i>With Prey (WP)</i>	Carrying prey
<i>Perched (P)</i>	Perched on a tree or fence post with no other behaviour recorded
<i>on Ground (G)</i>	Perched on the ground
<i>Plucking (PL)</i>	Plucking prey at perch
<i>Prey delivery (PD)</i>	Adult delivering prey to a nest, or male delivering prey to female
<i>Alarm (A)</i>	Adults calling or appearing agitated, usually occurs close to the nest during territorial defence
<i>Mobbing (M)</i>	lobbing other species, defensive behaviour usually close to a nest

<b>Behaviour (Code)</b>	<b>Description of behaviour</b>
<i>Other (O)</i>	Describe behaviour(s) where not indicated by any other category above

**Table F.2.** Habitat codes and descriptions utilised during the survey.

<b>Habitat (Code)</b>	<b>Description of habitat</b>
<i>First rotation (or new) forest (1F)</i>	First-rotation forest plantations before canopy closure. Characterised by prolific herb layer with varying shrub layer development. Trees generally >1m tall with large open spaces between lines of planting.
<i>Second rotation forest (2F)</i>	Second-rotation forest plantations before canopy closure. Characterised by varying shrub layer development and brash and tree root-plates from the previous crop and large open spaces between lines of planting. Newly established second-rotation trees are not always obvious.
<i>Thicket (pole) or mature stage forest (T)</i>	Closed-canopy forest plantations including both 1F & 2F crops. Usually >10 years old. Characterised by absence of shrub layer, except in rides between stands of trees and in small patches of unplanted ground or failed crop.
<i>Clearfell (CF)</i>	Harvested plantation not yet restocked with trees. Characterised by limited development of herb and shrub layer, and brash and tree root-plates evident from the previous crop.
<i>Heather moorland/bog (H)</i>	Unenclosed heather-dominated moorland characterised by species such as heather, bilberry and purple-moor grass plus blanket bog characterised by <i>Calluna</i> and bell heather, bog cotton, deer grass and moss. Typically grazed by red deer and low densities of sheep.
<i>Grass moorland (G)</i>	Unenclosed grass-dominated moorland usually grazed by sheep. Characterised by species such as wavy hair grass, mat grass and heath rush. Stands of <i>Juncus</i> spp. and bracken occasionally occur.
<i>Rough grassland (RG)</i>	Unenclosed or enclosed, neglected pastures occasionally stocked with sheep or cattle that have not recently been improved, re-seeded or fertilised. Usually contains long grass, waterlogged areas and stands of rushes ( <i>Juncus</i> spp).
<i>Improved grassland (IG)</i>	Enclosed pastures that have been drained, fertilised or re-seeded characterised by lush green grass vegetation and containing higher densities of sheep or cattle. Also includes hay meadows.
<i>Scrub (S)</i>	Areas outside or away from plantation forests consisting of willow, bramble, furze etc which have not been tended by humans. Includes bushy vegetation such as Willow ( <i>Salix</i> spp), Gorse ( <i>Ulex</i> spp), Bramble ( <i>Rubus</i> spp), Alder ( <i>Alnus</i> spp), Birch ( <i>Betula</i> spp) and Bracken ( <i>Pteridium</i> spp).

*Linear feature associated with rough grassland (LR)* Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to rough grassland.

*Linear feature associated with improved grassland (LI)* Linear feature (e.g. hedgerows, ditches, drainage channels etc) that are contained or in close proximity to improved grassland.

*Other trees or woodland (O)* Other trees or woodland other than coniferous plantation which include native forest, open woodland, shelter belts, copses, tree lines, wooded islands on inland lakes and isolated trees.

**Table F.3.** Details and recording methods for other key species

Species (Code)	Method of recording
Curlew (Cu)	
Golden Plover (GP)	
Dunlin (DN)	
Red Grouse (RG)	
Short-eared Owl (SE)	
Hen Harrier (HH)	Mark location, encounter no. and nest location (if known) on map. Record all details of location, behaviour and habitat on recording form.
Peregrine Falcon (PE)	
Kestrel (K.)	
Sparrowhawk (SH)	
Buzzard (BZ)	
Whinchat (WC)	
Other (list species name using BTO codes)	
Raven (RN)	Mark location, encounter no. and nest location (if known) on map, where bird/nest is within 50m of potentially suitable breeding habitat for Merlin. Record all details of location, behaviour and habitat on recording form.
Hooded Crow (HC)	

**Table F.4.** Activities, management, threats or pressures codes and descriptions for use on recording forms

Code	Description of activity, threat or pressure
A1	modification of cultivation practices
A2	agricultural intensification
A3	mowing / cutting of grassland
A4	abandonment / lack of mowing
A5	intensive grazing
A6	non intensive grazing
A7	abandonment of pastoral systems, lack of grazing
A8	fertilisation (agricultural)

<b>Code</b>	<b>Description of activity, threat or pressure</b>
<b>A9</b>	removal of hedges and copses or scrub
<b>B1</b>	forest planting on open ground (increase in forest area, planting e.g. on grassland , heathland)
<b>B2</b>	forest and plantation management & use
<b>B3</b>	forest replanting (i.e. replanting on forest ground after clear-cutting)
<b>B4</b>	forest clearance (clear-cutting, removal of all trees)
<b>B5</b>	thinning of tree layer
<b>B6</b>	fertilisation (forestry)
<b>B7</b>	other forest activities (e.g. erosion due to forest clearing, fragmentation)
<b>C1</b>	hand cutting of peat
<b>C2</b>	mechanical removal of peat
<b>C3</b>	wind energy production
<b>D1</b>	paths, tracks, cycling tracks (includes non-paved forest roads)
<b>D2</b>	roads, motorways (all paved/ tarred roads)
<b>D3</b>	utility and service lines (e.g. power-lines, pipelines)
<b>D4</b>	aircrafts or flightpaths
<b>D5</b>	improved access to site
<b>E1</b>	urbanisation, residential and commercial development
<b>E2</b>	dispersed habitation (i.e. little or no human disturbance)
<b>F1</b>	nest destruction
<b>F2</b>	illegal killing (e.g. shooting, trapping, poisoning)
<b>G1</b>	human intrusions and disturbances
<b>G2</b>	outdoor sports and leisure activities, recreational activities
<b>G3</b>	walking, horse-riding and non-motorised vehicles
<b>G4</b>	motorised vehicles
<b>G5</b>	off-road motorised driving
<b>G6</b>	other outdoor sports and leisure activities
<b>G7</b>	military manoeuvres
<b>H1</b>	pollution (e.g. water pollution, fly-tipping)
<b>J1</b>	natural fires
<b>J2</b>	controlled burning (e.g. strip burning for grouse management)
<b>J3</b>	uncontrolled burning (e.g. widespread unmanaged or malicious burning)
<b>J4</b>	modification of water levels or waterbodies
<b>J5</b>	reduction or loss of specific habitat features (e.g. removal of hedgerows, deep heather, scrub, walls, drains)
<b>J6</b>	reduction of prey availability
<b>J7</b>	anthropogenic reduction of habitat connectivity (i.e. fragmentation such as by removal of large areas of habitat or creation of barriers between habitats)
<b>K1</b>	interspecific faunal relations - predation (by other birds e.g. crows)
<b>K2</b>	interspecific faunal relations - predation (by mammals e.g. foxes)
<b>X</b>	no threats or pressures

Code	Description of activity, threat or pressure
O	other threats or pressures not listed above

## 2.2 Sign Searching

Merlin select prominent features in suitable foraging habitat within breeding territories to pluck their prey. These plucking perches are typically in open habitat with good views of the surrounding landscape and include boulders, hummocks, fence posts, turf stacks, tree stumps and isolated trees. Checking potential plucking perches can reveal evidence of Merlin occupancy in the form of signs which include the remains of prey taken by Merlin such as plucked feathers and body parts of avian prey, moth wings and Merlin pellets, white-wash, and moulted feathers. As the breeding season progresses, signs may accumulate in proximity to the area of breeding activity, which can help to narrow down the search area, and inform the best positioning of vantage point watches.

The effectiveness of sign searching can vary depending on habitat conditions and the availability of suitable plucking perches within a search area. Extensive sign searching previously conducted in suitable foraging habitat revealed limited signs to indicate occupancy of Merlin, despite the fact that there was an active nest site in close proximity (Lusby *et al.* 2010). In such a situation, it is likely that Merlin may use trees, including those at the edge or within forest plantation for plucking prey. The resources allocated to sign searching should therefore be informed by the likely profitability of this method in establishing occupancy and helping to identify areas of activity of breeding Merlin, based on habitat and landscape characteristics and particularly the presence and availability of suitable plucking perches. Sign searching is more profitable from the second visit (May) onwards when breeding Merlin have been longer established in an area and signs may be more abundant. In situations where there is a limited quantity of potentially suitable breeding habitat, and these areas can be relatively easily covered using vantage point watches, then this is often a better use of resources to determine occupancy. Therefore, in situations where sign searching is not deemed to be a suitable survey technique to determine Merlin occupancy in an area the emphasis should be placed solely on vantage point watches over suitable breeding habitat, which is the more important technique. If there are any difficulties establishing the best survey approach, then please contact a Survey Coordinator for advice.

- Sign searching involves walking transects of defined spacing in suitable open foraging habitat within 300m of potential breeding habitat to inspect prominent features which may provide suitable plucking perches for Merlin.
- The spacing of transects can vary from 20 – 150m depending on the landscape and availability of suitable plucking perches. For example, in an area with a small number of prominent features, the spacing should be selected to inspect most or all potential plucking perches.
- Transect routes should be marked (lines with arrows) on the survey map (See Image 2.). The start and finish time of sign searching should be recorded on the recording form.

- Where signs suspected to be of Merlin are found, the relevant details should be noted on the recording form to include: sign no., perch grid reference (10-figure grid reference using a hand held GPS), perch type (e.g. boulder, hummock, fence post etc.), whether the perch was re-used (Y/N), the species responsible for the signs (e.g. Merlin, Sparrowhawk etc.) sign type (plucking, moth wings etc.), and no. of prey species (based on identification of different prey species or by collating various body parts to assign a minimum number for each prey species).
- All signs should be collected, placed in an individual sealable bag (single bag per plucking perch), and labelled with the date, site name, surveyor name, perch type and grid reference. Collecting signs can aid in confirming identification of the species of origin should this be necessary. A range of species can use plucking perches and discerning signs of Merlin with those of other raptors (e.g. Kestrel, Sparrowhawk) can be difficult in certain situations. Collecting signs will also make it possible to assess recent activity at the same plucking perch on subsequent visits, as Merlin may reuse the same plucking perches on repeated occasions.
- While conducting sign searching, all encounters with Merlin should be noted on the recording form and mapped accordingly.

### **3. Survey Schedule**

All areas of potentially suitable breeding habitat and suitable foraging habitat within 300m of the potentially suitable breeding habitat in the defined search area should receive two visits, with a possible third visit to be decided based on the information returned from the first two visits during the nesting season (timing of visit outlined below). The first two visits are essential to record any Merlin activity including breeding pairs which may subsequently fail and may not be possible to detect later in the season. Particularly on the first visit (April – early May) breeding Merlin may be recorded displaying which will provide evidence of breeding and the potential nesting area. Due to the difficulties in detecting breeding Merlin during laying and incubation periods, it may be possible to miss evidence of occupancy on initial visits and for this reason lack of evidence on the first two visits should not be taken as evidence of absence of Merlin in that area. Therefore, it should be attempted to survey all areas of potentially suitable breeding habitat preferably over the first two visits as activity may be more obvious (e.g. increased prey deliveries, vocalisations of young, recently fledged young etc.) on later visits.

The timing of visits should be spaced by two weeks. The duration of each visit may vary from a single day to several days depending on the size of the defined search area to be covered, the quantity of potentially suitable breeding habitat within the area, and the number of vantage point watches required to confidently cover all potentially suitable breeding habitat. For example, to effectively cover the survey area may require a single vantage point (3 hrs watch per visit), or it may require up to six vantage points (18 hrs watches per visit). Becoming familiar with your survey area will inform the requirements to achieve effective coverage at the start of the survey. If any difficulties are experienced achieving effective coverage of a survey square or part of a square during any of the visits, please notify a Survey Coordinator as soon as you become aware of this so that appropriate assistance can be organised.

The first visit (April 1<sup>st</sup> – April 25<sup>th</sup>) will likely be the most time consuming as it requires becoming familiar with the search area. The first visit will also inform the best approach to undertaking the survey and inform resource requirements to effectively survey the area for breeding Merlin. Any further unsuitable habitat which is recorded on this visit can be excluded from the search area and marked on the survey map accordingly. This visit should aim to establish occupancy of Merlin and identify potential nesting areas if possible. The locations of vantage point watches to overlook all areas of potentially suitable breeding habitat should be selected and vantage point watches conducted.

The second visit (April 26<sup>th</sup> – May 20<sup>th</sup>) aims to establish occupancy of Merlin within the defined search area and to identify areas of potential breeding activity based on evidence of Merlin encounters and associated behaviour and/or signs. Vantage point watches should be carried out as informed by the first visit, and sign searching should be conducted if deemed appropriate.

The third visit (May 21<sup>st</sup> – June 15<sup>th</sup>) aims to locate active nests, where these are not already located. Where areas of nesting activity are known or suspected the emphasis should be placed on vantage point watches, where this information is not available sign searching can be carried out in addition if deemed relevant, informed by the earlier visits and to include revisiting plucking perches where signs were previously recorded.

A schedule of the survey visits is outlined below, each visit should be spaced by a minimum of one week.

**Table F.5.** Schedule of survey visits

Visit No.	Type of visit	Timings
1	Required	April 1 <sup>st</sup> – April 25 <sup>th</sup>
2	Required	April 26 <sup>th</sup> – May 20 <sup>th</sup>
3	TBD	May 21 <sup>st</sup> – June 15 <sup>th</sup>

## 4. Data recording

### 4.1 Survey Maps

- Each surveyor will be provided with aerial images and a map of their survey square area, recording form and link to Google Forms to enter the data, as below. All data for vantage point surveys should be entered via the ‘Merlin Occupancy Survey’ form, if you conduct sign searching, enter the data via the ‘Merlin sign searching’ form, and if you have any casual observations, enter the data via the ‘casual observations’ form.
- Please use a separate map and recording form for each survey date. Use multiple maps and recording forms for each date if necessary.

- Using a combination of aerial images and ground-truthing as required, on the map mark all areas of unsuitable habitat to be excluded from survey effort. This can be refined and added to as you become more familiar with the survey area on subsequent visits. On completion of the survey, please provide a single map which clearly shows all unsuitable areas and the defined search area (see Image 1) for the survey area you are covering.
- For each survey date use a separate map. Record the survey square ID, survey square name, SPA name, date, visit no., start and finish times and page no. on each map. On the map the location and number of each vantage point should be clearly marked, alongside the view from each vantage point and the location of sign searching transects (if sign searching was carried out).
- All Merlin encounters should be mapped and the full extent of flight lines and direction of movement marked on maps. The approximate or known location of Merlin nests should be marked with the following



- The locations of other key species should be marked on the map and details noted on the recording form (as per Table 3.).
- Complete the map during each survey visit and finalise at the end of the survey day.
- Note that it is just as important to submit nil return sheets if there are no sightings.

## 4.2 Recording Forms

- Using a separate recording form for each survey date, please record as much information as possible for each survey date. You have also been provided with links to three Google forms (1) Merlin Occupancy Survey 2021, 2) Merlin Sign Searching and 3) Casual Observations), you can fill these in directly in the field using a mobile phone with mobile data or fill in recording form and transcribe to Google Forms later on computer or mobile. All data for vantage point surveys should be entered via the 'Merlin Occupancy Survey' form, if you conduct sign searching, enter the data via the 'Merlin sign searching' form, and if you have any casual observations, enter the data via the 'casual observations' form.

Merlin Occupancy Survey: [https://docs.google.com/forms/d/e/1FAIpQLSdfUIvtrVxEHdc1tVnX1IMcJAqOmUArrxF5a9uZqFpte\\_aDvQ/viewform](https://docs.google.com/forms/d/e/1FAIpQLSdfUIvtrVxEHdc1tVnX1IMcJAqOmUArrxF5a9uZqFpte_aDvQ/viewform)

Merlin sign searching: <https://docs.google.com/forms/d/e/1FAIpQLSec2ew7qmv32onqNOhPhI6oPAJLndtGCHnAs1I3GM4icBQ10g/viewform>

Casual observations:

[https://docs.google.com/forms/d/e/1FAIpQLSdSkI\\_c7443qYtt89gjat7fvMADriv9S5KDaV3mXfnYWSS2w/viewform](https://docs.google.com/forms/d/e/1FAIpQLSdSkI_c7443qYtt89gjat7fvMADriv9S5KDaV3mXfnYWSS2w/viewform)

- All other bird species recorded on vantage point watches should be recorded on the form (Merlin Occupancy Form) using BTO species codes (see here:

[https://www.bto.org/sites/default/files/u16/downloads/forms\\_instructions/bto\\_bird\\_species\\_codes.pdf](https://www.bto.org/sites/default/files/u16/downloads/forms_instructions/bto_bird_species_codes.pdf)) and listing the highest level of evidence recorded for that species using the BTO breeding codes (see here: <https://www.bto.org/sites/default/files/u36/downloads/breedingcodes.pdf>).

Also, include an '(F)' for species where breeding evidence was associated with mature (closed canopy) forest in the survey area. This will allow a determination of the species which may be affected by forest management.

For example, if Red Grouse is heard calling in suitable habitat, then this should be recorded as 'RG, S.

If Coal Tit (CT) were recorded which were likely visiting a nest (N) in mature forest plantation in the survey area, then this should be recorded as: CT, N (F)

If Kestrel is recorded carrying prey into a forest, then this should be recorded as: K., FF (F).

## 6. Equipment

The following equipment should be kept by the surveyor and taken in the field on all survey visits:

- Survey map and recording form
- OS map of the area
- Binoculars & scope
- Handheld GPS unit
- Compass or similar app
- Fully charged mobile phone with emergency contact details
- First aid kit
- Tic remover
- Sun screen, sun hat and clothes to protect from the sun
- Water and food

## 7. Contact details

Contact details for Survey Coordinators, if you should have any queries in relation to any aspects of the survey please contact either

John Lusby, Mob: 0857201892, Email: [jlusby@birdwatchireland.ie](mailto:jlusby@birdwatchireland.ie)

Laura Kavanagh, Mob: 087 9035844, Email: [lauramaykavanagh@gmail.com](mailto:lauramaykavanagh@gmail.com)

## 8. Health & Safety

Please message John Lusby (by WhatsApp or text message) before you set out on field surveys with the survey area and times, and again when you complete the survey for that day.

## Appendix G

### Survey maps and recording forms for the Merlin Surveys 2021



Survey square ID \_\_\_\_\_

Date \_\_\_\_\_

SPA name \_\_\_\_\_

Visit number \_\_\_\_\_

Surveyor's name \_\_\_\_\_

Survey start time \_\_\_\_\_

Survey finish time \_\_\_\_\_



Survey square ID \_\_\_\_\_

Date \_\_\_\_\_

SPA name \_\_\_\_\_

Visit number \_\_\_\_\_

Surveyor's name \_\_\_\_\_

Survey start time \_\_\_\_\_

Survey finish time \_\_\_\_\_



# Merlin Occupancy Survey 2021

lauramaykavanagh@gmail.com [Switch account](#)



\* Required

Email \*

Your email

SurveySquare\_ID \*

This is the unique ID reference for each site, which you will find on the maps for each site etc. (e.g. GY10-H0008)

Your answer

SPA\_Name

The name of the SPA in which the survey square is contained

Choose



County

The county in which the square is contained, for squares which fall in two counties use the county which the majority of that square is in

Choose



Date