

# THE HEN HARRIER IN IRELAND: CONSERVATION ISSUES FOR THE 21ST CENTURY

**Barry O'Donoghue, Timothy A. O'Donoghue and Frank King**

## ABSTRACT

The hen harrier in Ireland has suffered a loss in numbers and distribution, primarily through habitat loss, and persecution. Further declines are possible if current issues (involving public opinion, forestry, wind farming and loss of traditional farming practices) are not addressed. Without public support or goodwill towards this, one of Ireland's rarest and most vulnerable birds of prey, it will be difficult to conserve both the population and its habitats. Education and awareness programmes regarding the hen harrier and upland wildlife in general should continue to be supported. Within Special Protection Areas, Appropriate Assessments of the potential impacts of further afforestation and wind-farming on hen harriers (and other species) appears necessary. Proactive steps can be taken with regard to forest biodiversity and structure with hen harriers in mind. Support should continue for those managing the upland landscape in ways that benefit the hen harrier and other wildlife.

Barry O'Donoghue  
(corresponding  
author; email:  
barryodonoghue@  
yahoo.ie) and  
Timothy A.  
O'Donoghue,  
Ballynabrennagh,  
Tralee, Co. Kerry;  
Frank King,  
Blennerville, Tralee,  
Co. Kerry.

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## INTRODUCTION

The hen harrier (*Circus cyaneus*) is one of only six relatively widespread day-active breeding birds of prey in Ireland (Dempsey and O'Clery 2002). With less than 200 confirmed breeding pairs on the island, which lies at the most westerly extreme of its global range, the hen harrier is a species of conservation concern in Ireland (Lynas *et al.* 2007), and it appears to have become more and more so, as time has passed. This article reviews what is known of the hen harrier's history in Ireland, assesses the current status, threats and concerns, and looks towards the future, suggesting practicable measures by which the current situation may be improved.

## METHODS

In this article, data is drawn from the longest standing study of hen harriers in Ireland—a survey of territories in County Kerry over each breeding season between 1955 and 2010. The main study area covers the Stacks and Glanaruddery Mountains, through to Mount Eagle and Knockanefune in East Kerry. This is

one of the most important regions in Western Europe for hen harriers and has recently (2007) been designated as a proposed Special Protection Area (SPA) for the species. Surveying entailed early season (March/April) searches for the bird's spectacular courtship displays ('sky dances'), which advertise the location of a territory, remote location of nests and determination of the final outcome of the breeding attempt (i.e. number of young fledged, if any). Surveying was typically finished by mid-August. In addition, data from observations in West Clare in 2008 and 2009 are included to add to the dataset. Before and after construction, studies at a windfarm in a hen harrier territory were conducted for a total of 22 breeding seasons. Before construction, vantage point observations at the Kerry wind farm area (totalling 104 hours) were carried out for eleven breeding seasons, when hen harriers nested on what is now the edge of the existing wind farm. The number of foraging bouts at the time was not recorded, but it is known with certainty that harriers hunted the area each year in which they nested there. Since construction of the wind farm, vantage point observations have continued for an equivalent eleven breeding seasons (totalling 108 hours), detailing the number of foraging

bouts (if any) within the wind farm. The section on the history of hen harriers in Ireland is drawn from an extensive literature review.

### HISTORY OF THE HEN HARRIER IN IRELAND

The earliest evidence of hen harriers in Ireland, bone finds dating back to the tenth century, was found in archaeological excavations at Fishamble Street, Dublin (D'Arcy 1999). The earliest mention of harriers in Irish literature appears to be that in Plunkett's Latin–Irish dictionary (1662), where 'Circus' is translated to 'Fos gné sheibhce', meaning a 'type of hawk'. In the first direct account of the 'Common Harrier' from Jardine (1838), it was said to be 'of general distribution in Ireland'. Thompson (1849) concurred and noted that harriers were 'pretty generally distributed over the island', and were 'often met with' and had breeding strongholds in Kerry, Wicklow and the Tipperary/Waterford border in the south, and Derry and Antrim in the north. Shawe-Taylor (Watson 1977) said that it was 'common on all the hills in Connemara' in 1851, even though Thompson (1849) stated that its breeding status there was rare. In addition to the widespread distribution recounted by Thompson (1849), Watters (1853) said the hen harrier existed 'in considerable numbers both north and south', though was very rare in the east. However, both authors ominously referred to the decline of the species as they wrote their accounts.

By the turn of the twentieth Century, Ussher and Warren (1900) confirmed this decline. While the hen harrier was present in the counties of Kerry, Cork, Limerick, Tipperary, Waterford, Wicklow, Dublin, Offaly, Laois, Galway, Mayo, Fermanagh, Donegal, Derry, Antrim and Down, and could be seen in 'other counties' outside of the breeding season, the hen harrier was 'decreasing in numbers, in many mountainous districts', and had 'ceased to breed in other localities where it used formerly to do so'. This decline has been attributed to widespread persecution of birds of prey in general at this time (O'Flynn 1983), to the point where the hen harrier was listed under the Wild Birds Protection Act, 1894 (Chomley-Farran 1907). It is likely also that the decline was exacerbated by land reclamation by the Commissioners of Public Works throughout the nineteenth century. Humphreys (1937) believed the hen harrier was still probably resident in the 1930s in a 'few of its original haunts, the wilder mountain districts', but numbers had decreased

considerably. Meinertzhagen (1947), for example, mentioned the hen harrier had become extinct as a breeding species in south Kerry by 1945. By the 1950s it was considered by some to have become extinct as a breeding species altogether (Kennedy *et al.* 1954; Bannerman and Lodge 1956) but it had, in fact, continued to survive in a few areas such as the Slieve Bloom Mountains in Laois, the Tipperary/Waterford border and the Cork/Kerry border (Watson 1977; authors' unpublished data).

The population then began to recover in the 1950s, with increased planting of young coniferous forests. It was not the trees *per se* that prompted recovery, but the fact that the land was fenced off. Persecution declined as an issue as these tracts of land began to hold less interest for game and agriculture. Forests were less likely to have been burned than open ground (a traditional practice in upland areas of Ireland to increase the amount of grass available to livestock), and when ground was fenced off for forestry, it allowed vegetation between the sapling trees to grow unhindered, thereby creating increased harrier nesting habitat, as well as habitat for passerines (O'Flynn 1983; Hamerstrom 1986; Madders 2003). New forests must have also facilitated an expansion of the (at the time) recently introduced bank vole (*Myodes glareolus*), as they did with the short-tailed vole (*Microtus agrestis*) in Scotland (Picozzi 1978; Harris 1983).

By 1964 at least 35 pairs were known to be breeding in six southern counties: Cork, Waterford, Kilkenny, Laois, Wicklow and Wexford (Ruttledge 1966; O'Flynn 1983). Sharrock (1976) actually thought this was an underestimate and believed that 75 breeding pairs existed at that time. The increase continued in line with the increase in planting, with an estimated 250–300 pairs breeding on the island of Ireland in the 1970s (David Scott in Watson (1977)) when harriers were found 'with ease' (O'Flynn 1983).

In the late 1970s, however, with forest maturation, came a marked decline in breeding numbers, and by the early 1980s, breeding attempts had apparently ceased in the Slieve Aughty Mountains (Clare and Galway), the hills of North Tipperary, the Ballyhoura Mountains in North Cork, the hills of South Kilkenny and the Comeragh Mountains in Waterford (O'Flynn 1983), all areas where harrier breeding was recorded not long before (Sharrock 1976). A similar pattern was noted in Northern Ireland (Scott 2008). The Wicklow Mountains on the east coast of Ireland are a prime example—once a stronghold of breeding hen harriers (Ruttledge 1966; O'Flynn 1983), this area was the first to

be afforested on a large scale, and subsequently its hen harrier population was lost. The only areas reputed to have been 'holding their own' at that stage were those where no significant change in habitat had occurred (O'Flynn 1983). O'Flynn (1983) suggested the counties of the west and north-west were not recolonised to the extent that other areas were during the new forest 'boom' because the new forest had matured in these areas before the hen harrier expanded its range expansion from the south Leinster/east Munster (where harriers apparently never disappeared at the turn of the twentieth century). This period also coincided with intensified farming, land reclamation, hedgerow removal and scrub clearance under the Common Agricultural Policy (CAP). Given almost a quarter of a million hectares of land were drained by arterial drainage and almost 1.2 million hectares by field drainage between 1950 to 1979 (Temple-Lang 1988), it is likely that a contraction in breeding distribution occurred on two fronts, with particular loss of hen harriers that may have been breeding in low-land locations.

The cause of decline and main threats had then shifted from persecution to habitat loss, which is arguably more serious and long-lasting. The Irish breeding population of hen harriers was estimated at just 70 pairs in 1982 (Watson 1983). Habitat loss, primarily due to afforestation and overgrazing of mountains and bogs, continued through the 1980s (Temple-Lang 1988). Whilde (1993) considered there may have been no more than 50–70 pairs still breeding in Ireland in the early 1990s and accordingly included the hen harrier as a Red Data Book species. However, Gibbons *et al.* (1993) estimated the population for the whole island of Ireland in 1988–1991 to be 180 pairs, assuming an average density of two pairs per 10km<sup>2</sup> where breeding was probable or confirmed. Murphy (1995) continued documenting damaging effects of afforestation and overgrazing on the hen harrier.

Reform of the Common Agricultural Policy since 1992 increasingly emphasised the importance of care for nature and the environment. Council Regulation No. 2078/92 saw farmers, for the first time, as managers and custodians of the rural environment, as well as producers of food. In Ireland, the regulation was implemented through the Rural Environmental Protection Scheme (REPS), which encouraged farmers to protect natural and cultural heritage. Uptake of REPS was particularly high in uplands where hen harriers existed.

The first Republic of Ireland census of breeding hen harriers (Norris *et al.* 2002) confirmed

102 breeding pairs, while Sim *et al.* (2001) reported up to 38 breeding pairs in Northern Ireland, to give an all-Ireland breeding population of just 140 pairs. Surveys were repeated for Northern Ireland and the Republic of Ireland in 2004 (Sim *et al.* 2007) and 2005 (Barton *et al.* 2006) respectively, and up to 50 extra territorial pairs were found, probably due to an increased availability of restock over mature forest, as well as better quality surveying (Barton *et al.* 2006).

The population distribution and range has experienced much change since the earliest accounts. The species is no longer as widespread or as commonly met with as Thompson (1849) had experienced, and hen harriers have been lost from a number of the regions where Ussher and Warren (1900) reported them as common. Unfortunately, threats to remaining hen harriers in Ireland have not subsided, and are as evident now as ever before.

## ISSUES FOR HEN HARRIER CONSERVATION IN THE 21ST CENTURY

### PERSECUTION AND PUBLIC OPINION

The hen harrier and all birds of prey are protected by law in Ireland, but unfortunately persecution does not appear to be an issue confined to history. Today, the impetus for persecution appears to come from ignorance and misinformation, in particular with regard to the implementation of conservation policies involving the bird. This was evident when SPAs (designated under the EU Bird's Directive (79/409/EEC) for birds of priority conservation importance, in order to protect the bird's habitat) were originally flagged in 2002. Major resistance to this process was received from farming organisations, private forestry groups and politicians who assumed controls within the SPAs would be severely restrictive (Feehily 2003; Houses of the Oireachtas 2003; Lavery 2003; O'Connor 2003a; 2003b; O'Toole 2003; MacConnell 2007). The anti-SPA campaign culminated in the shooting dead of a number of hen harriers, most notably a male bird which was posted to a regional newspaper in May 2003, carrying a threat referring to the planned SPA designations. In 2007, a suite of six proposed SPAs was officially notified, by which time the National Parks and Wildlife Service (NPWS) had made significant strides towards assuring the stakeholders that activities that had been falsely rumoured would be vetoed (e.g. house building) would not be prohibited. In addition, it was clarified that traditional farm practices would not be

curtailed, but would in fact be financially supported through a NPWS Farm Plan Scheme, aimed at maintaining, increasing and improving habitats on the farm for hen harriers.

However, given five years of largely negative connotation, the respect for the hen harrier, which was revered in old Irish mythology (Anderson 2008), had been tainted. In a 2009 Heritage Council sponsored programme of hen harrier awareness talks aimed at school children in the hen harrier SPA in Kerry, over 50% of children had negative perceptions of the hen harrier (A. O'Donoghue, pers. comm.) at the outset of the talks. However, by the end of the education talks on the natural history of the hen harrier, including its spectacular sky dances and aerial food passes, all children were excited by the prospect of seeing such activity within their own localities.

In 2009, a survey of 100 households was conducted to establish the attitudes of people who manage the land of the hen harrier in the Kerry SPA. A number of questionnaires ( $n = 27$ ) were not returned. Of those that were returned ( $n = 73$ ), 70% ( $n = 51$ ) were happy to have such a rare bird of prey in their area. 22% of households held no particular opinion on hen harriers ( $n = 16$ ) and 8% of households would prefer if the hen harrier was not in their locality ( $n = 6$ ). Given that 8% of householders expressed negative opinions (or a maximum of 35% did so if all those who did not return forms held negative attitudes), there is a discrepancy between adult householders (8–35% negative) and the children (> 50% negative). It seems that while adults have quietly realised that the SPA is not overly restrictive, children have been influenced by the vociferous campaign against hen harriers at the outset of the SPA designations.

Thus, it is vital that nature awareness campaigns for schools in SPAs continue and are expanded to highlight the heritage and ecological value of hen harriers. The landowners and decision-makers of future generations within the hen harrier's range need not grow up with negative perceptions of the bird and can work towards its continued conservation. Further awareness work and cooperation with those currently farming the land in hen harrier areas will instil not only an acceptance of the hen harrier as part of the same landscape, but also a welcome for this rare bird of prey, given associated agri-environmental schemes and the possibility of ecotourism, using the blueprint of Mull with white-tailed sea eagles (*Haliaeetus albicilla*), Wales with red kites (*Milvus milvus*), and indeed the Forest of Bowland (in Lancashire) with hen harriers. Eco-tourism is on

the rise, and traditional tourism hotbeds such as Kerry and Clare have hen harriers within minutes of attractions like the Lakes of Killarney, Bunratty and the Cliffs of Moher.

While the issues surrounding SPAs and their implications for landowners were largely resolved by time of notification, a further issue has begun to emerge with the advent of wind energy. In short, there is an apparent perception among various people wishing to develop land into wind farms that conservation objectives regarding the hen harrier may not marry with their planned developments. In a study of 71 breeding attempts in 2008, 2009 and 2010, there was a breeding success rate of 79.2% in territories where no wind farms were planned ( $n = 53$ ), but a meagre success rate of 16.7% in territories where wind farms were planned ( $n = 18$ ), meaning harriers nesting on ground associated with wind farm proposals have a significantly higher failure rate than harriers nesting elsewhere ( $\chi^2 = 12.65$ , d.f. = 1,  $P = 0.000$ ).

Strategic Environmental Assessment (SEA Directive 2001/42/EC), applied to county development plans in consultation with competent authorities, can outline areas where wind farming is not desirable on the grounds of nature conservation and is advised by the European Commission (European Commission 2010). This eliminates the direct conflict that may crop up at the site specific level with resident harriers. Such zoning also helps wind energy companies concentrate on areas where they will have more chance of a successful application. A holistic approach that considers Irish uplands as unique and special entities, with an important assemblage of flora and fauna, natural and built heritage, tourism potential, and a sense of identity should be encouraged, rather than using the hen harrier as a sole vehicle for restrictions.

#### FORESTRY AND HEN HARRIERS

As discussed in 'the history of hen harriers in Ireland' section above, the relationship between hen harriers and forestry here has been mixed. While the initial phase of first rotation forests proved beneficial to hen harriers in its early (pre-thicket) stage, on reaching thicket stage, it excluded harriers from many areas, particularly where forest maturation happened on a mass-scale, with little age diversity. After 55 years of surveying hen harriers in Kerry, a 10km × 10km area that was originally heather moorland but is now predominantly forest, now holds no hen harriers, where previously there were eleven pairs. Such loss is echoed by O'Flynn (1983) across Ireland,

Barton *et al.* (2006) for the Slieve Blooms and Clarke and Watson (1997) for an area of south-west Scotland and is underpinned by the research of Madders (2000; 2003) and O'Donoghue (2004), who both showed that forestry ultimately reduces foraging habitat for hen harriers. Bibby and Etheridge (1993) and Cormier *et al.* (2008) also pointed to the disadvantages for hen harriers associated with commercial forestry. Madders (2000) predicted a loss of breeding hen harriers in Western Scotland with the maturation of forests. Site synopses for the six hen harrier proposed SPAs state that 'the main threat to the long-term survival of hen harriers within the site is further afforestation, which would reduce and fragment the area of foraging habitat, resulting in possible reductions in breeding density and productivity' (National Parks and Wildlife Service 2007). In addition to excluding hunting harriers, commercial forest plantations can be prey species poor (Lack and Lack 1951; Bryant 1994) and present an increased risk of nest predation (Thompson *et al.* 1988; Chadwick *et al.* 1997), and it is possible that this is why nests in conifer forests have been shown to have reduced survival rates compared to (unkept) moors in Scotland (Etheridge *et al.* 1997).

Undoubtedly, the effects of expansion of exotic forest plantations has proven ultimately negative, not just for hen harriers, but also for iconic species such as red grouse (*Lagopus lagopus hibernicus*), curlew (*Numenius arquata*), marsh fritillary (*Euphydryas aurinia*) and Atlantic salmon (*Salmo salar*). Commercial forestry has been noted to impact negatively on a large number of bird species and bird assemblages (Lack and Lack 1951; Marquiss *et al.* 1978; 1985; Moss *et al.* 1979; Newton *et al.* 1982; Harris 1983; Mearns 1983; Ratcliffe and Petty 1985; Watson *et al.* 1987; Thompson *et al.* 1988; Petty and Avery 1990; Ratcliffe 1990).

However, there may be some respite for harriers in terms of the commercial plantation cycle, when mature trees are harvested and the ground is 'unlocked' and made available once again. The trees are invariably replanted, in what is known as 'restock'. O'Donoghue (2004) was first to research the use of restock forests by hen harriers and found them to be attractive to harriers for foraging, but that the window of usefulness was even less than the first rotation. On clearfelling, the bare ground or scant vegetation that exists for the first early stages is of limited use, and because the newly planted trees derive adequate nutrients from the breakdown of the litter layer and brash (Taylor 1990), particularly in the first five years of growth (Smith and MacKay 2002), the

thicket stage is reached earlier than the first rotation. Restock has recently been shown to be a well utilised nesting habitat for hen harriers in Ireland (Barton *et al.* 2006). However, whether this is a good thing and whether restocked forest plantations can continue to support breeding hen harriers are questions that remain to be answered (Wilson *et al.* 2006). Wilson *et al.* (2005) predict that there may be a decrease of up to 30% of the carrying capacity of hen harrier areas in Ireland by 2015, as a result of the maturation of forests.

Given government policy aims to expand national forest cover (Department of Agriculture, Food and Forestry 1996), it is imperative that due consideration is taken of biodiversity, particularly of raptors, which are biodiversity indicators (Sergio *et al.* 2005). The EU Council Directive on the conservation of natural habitats and of wild fauna and flora (92/43/EEC) establishes the requirement for an Appropriate Assessment to determine whether a proposed plan likely to have significant effects on a NATURA 2000 site does or does not affect the integrity of the protection area. Given the documented effects of forestry on hen harriers, it appears necessary to subject further afforestation plans within hen harrier SPAs to Appropriate Assessment.

For existing forest plantations, felling and restocking represent an opportunity to improve the situation for hen harriers (and other wildlife) by considerate planning. Within hen harrier SPAs, there is a mandatory minimum Area of Biodiversity Enhancement (ABE) of 20% of new forest plantations. However, there are no guidelines as to how this ABE may be best utilised, and often roads or turning areas, of limited use to nature, are proffered as ABE. While each forest plan will come with its own, often unique, considerations, notional plans as to how the ABE may be optimised for harriers are presented in Fig. 1. The hen harrier's world is one of habitat structure as much as habitat composition. The dearth of surface area in closed canopy plantation can be addressed through 'breaking up' the forest structure through strategic ABE design as in Fig. 1 (b), (c) and (d) rather than utilising all the ABE in one section as in Fig. 1 (a). The suggested designs are aimed to facilitate both foraging and nesting. Scrub is one of the most preferred and productive foraging habitats for hen harriers in Ireland (O'Donoghue 2004; in prep.). Edge habitats (which would be created through a combination of scrub and conifers) are also preferred features for foraging (Redpath 1992) and would likely prove even more useful if serrated, as this would further increase surface area as well as offer

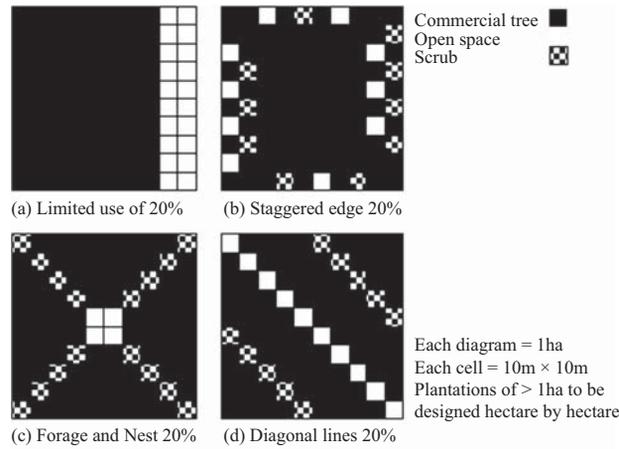


Fig. 1—Suggested use of 20% area of biodiversity enhancement to optimise habitat for hen harriers.

hunting harriers a greater element of surprise over prey.

Petty and Anderson (1986) suggested that access to large areas of open ground are critical for hen harriers nesting in forest plantations, but such areas have become rarer as more forests are planted. Working within such a landscape, diversification of age profile is possibly the best way forward, ensuring that there is never more closed canopy forest at the one time than is sustainable. Implementing such a plan in terms of providing ample foraging habitat near to the nest will not be as easy, however, given operational and commercial logistics. Nevertheless, it is possible. A suggested approach over a 33-year plan, whereby forestry surrounding a hen harrier nest is felled over a series of years to achieve a diverse age structure, is given in Fig. 2. Mid-term to long-term

fallow areas within forest stands could present nesting opportunity for harriers while allowing foresters and conservationists alike to plan ahead with reasonable certainty of nest site locations.

WIND FARMING

The need to address climate change and reduce harmful emissions of greenhouse gases is now widely accepted. The contribution of wind farms towards this is recognised and supported by the Irish Government (O’Leary *et al.* 2007), and local authorities have zoned areas as preferable or open to consideration for wind development (including hen harrier SPAs). There is much debate about the impact of wind farms on hen harriers. Studies have been produced that claim that wind farms may have minimal, if any, impact on hen harriers (Whitfield and Madders 2006; Madden and Porter 2007), while studies such as Johnson *et al.* (2000) and Pearce-Higgins *et al.* (2009) outline negative impacts.

At least three hen harrier fatalities have been recorded at European wind farms (Lekuona and Ursúa 2006; Scott and Mchaffie 2008; K. Bevanger, pers. comm) and a further four northern harrier (*Circus hudsonius*) fatalities have been recorded by American researchers (Johnson *et al.* 2001; Smallwood and Thelander 2008). In the only Irish programme of searches for bird collisions at a wind farm, Scott and McHaffie (2008) found a hen harrier (among other birds) to have been apparently struck by turbine blades. The risk of collision with ancillaries including power lines, fences, guy wires, etc., should not be disregarded (Morris 1984; McNicholl 2007). Land-take (i.e. the wind farm’s direct footprint) is classed as of limited concern for hen harriers (Whitfield



Fig. 2—Suggested staggering of felling program (by year) in hen harrier territories.

and Madders 2006), although modern 3.0MW turbine infrastructure may merit reappraisal.

Emphasis is placed on the disturbance or displacement effects of wind farms on hen harriers (Johnson *et al.* 2000; Whitfield and Madders 2006; Madden and Porter 2007; Pearce-Higgins *et al.* 2009). Personal observations have shown that hen harriers fly through wind farms (six times in 108.3 hours of wind farm observation, with up to six breeding pairs within 5km): Madden and Porter (2007) recorded at least six inter-turbine flights in over 96 hours of observation. Whether or not a harrier flies through a wind farm is, in fact, not the main issue. The potential impacts of greatest importance are those on foraging success and breeding productivity.

A 22-year study of a Kerry hen harrier territory in which a wind farm was built in 2000 has monitored nest location and breeding productivity, and concurrent observations of sky dancing, foraging and food passes were made. Results of these observations, before and after construction of the wind farm, are outlined in Table 1. The distance that hen harriers nest from what is now the edge of the wind farm site has increased significantly from a pre-construction median of 140m to a post-construction median of 537.5m (Wilcoxon two-sample test:  $W = 77.5$ ,  $P = 0.025$ ). An apparent decrease in nesting distance

in recent years (2004–2010) is not attributed to habituation to the wind farm but to an extension of the wind farm further towards the traditional nest site. Whitfield and Madders (2006) and Scott and McHaffie (2008) also referred to nest displacement. The harriers abandoned the site in 2000, the year of construction of the original wind farm. However, in 2004, when the wind farm was extended, the harriers successfully nested in the territory.

While hunting rates cannot be directly compared between pre- and post-construction stages, foraging was regularly noted on-site before construction of the wind farm, but there have been a number of years since the construction of the wind farm when foraging was not recorded at all (Table 1). Since construction of the wind farm, sky dancing and food passes have not been recorded within the site. The breeding productivity of the territory within which the wind farm has been built has significantly dropped since the introduction of the wind farm (Wilcoxon two-sample test  $W = 158$ ,  $P = 0.007$ ). While 30 chicks were fledged in eleven years of pre-construction monitoring (mean productivity of 2.63), just 14 were fledged in eleven years of post-construction monitoring (mean productivity of 1.27). There have been no other significant habitat changes in the territory in question.

**Table 1—Hen harrier activity at Kerry Wind Farm 1985–2010.**

<i>Year</i>	<i>Nesting distance (m)</i>	<i>Young fledged</i>	<i>Sky dancing on site</i>	<i>Foraging bouts on site</i>	<i>Food passes on site</i>	<i>Notes</i>
1985	390	0	N/A	Yes	No	4 eggs chilled. Nest abandoned
1989	140	3	Yes	Yes	Yes	Foraging time not recorded
1990	150	3	Yes	Yes	Yes	Foraging time not recorded
1991	200	4	Yes	Yes	Yes	Foraging time not recorded
1992	145	2	Yes	Yes	Yes	Foraging time not recorded
1993	120	3	Yes	Yes	Yes	Foraging time not recorded
1994	90	3	Yes	Yes	Yes	Foraging time not recorded
1995	100	2	Yes	Yes	Yes	Foraging time not recorded
1996	130	3	Yes	Yes	Yes	Foraging time not recorded
1998	125	4	Yes	Yes	Yes	Foraging time not recorded
1999	730	2	Yes	Yes	No	Foraging time not recorded
2000	Deserted territory	0	No	0.00hr <sup>-1</sup>	No	23 turbines erected
2001	750	0	No	0.00hr <sup>-1</sup>	No	
2002	765	1	No	0.03hr <sup>-1</sup>	No	
2003	1280	2	No	0.02hr <sup>-1</sup>	No	
2004	550	1	No	0.00hr <sup>-1</sup>	No	8 extra turbines erected
2005	525	2	No	0.00hr <sup>-1</sup>	No	
2006	700	0	No	0.00hr <sup>-1</sup>	No	
2007	490	2	No	0.18hr <sup>-1</sup>	No	
2008	140	2	No	0.04hr <sup>-1</sup>	No	
2009	495	2	No	0.00hr <sup>-1</sup>	No	
2010	470	2	No	0.00hr <sup>-1</sup>	No	

Madden and Porter (2007) previously provided evidence of reduced usage of an area developed as a wind farm in Ireland. Table 2 of that study shows a foraging rate of 18.4sec hr<sup>-1</sup> on site prior to construction. When the wind farm was built, even with five times the amount of open foraging habitat available (when a large area of mature forestry within the site was felled), a decreased foraging rate of 8.1sec hr<sup>-1</sup> was observed. Just one strike at prey was observed during almost 97 hours of post-construction observations. Hen harriers hunt aurally as much as visually (Rice 1982). It is possible that noise generated from rotating turbines may deter hen harriers from hunting in a wind farm as much as would otherwise be expected, or it may reduce the birds' foraging success rate.

Further wind farm/bird studies, during both breeding and non-breeding seasons, will improve our understanding of the effects of wind farms on all upland birds in Ireland. These studies must be independent of anti-wind or pro-wind development interests, follow a suitably designed protocol and utilise sound experimental design and statistics. Given data presented by a number of studies to date (Johnson *et al.* 2000; 2001; Madden and Porter 2007; Scott and McHaffie 2008; Smallwood and Thelander 2008; Pearce-Higgins *et al.* 2009; present study); the potential and likely cumulative impacts of multiple or large-scale wind farms; and the fact that hen harrier habitat has already been diminished, an Appropriate Assessment for wind farms in hen harrier SPAs appears necessary. Such an assessment (or studies independent of any Appropriate Assessment) should focus not just on flight paths but also focus critically on foraging success rates and breeding productivity. Observations should be correlated to on-site noise, and results should be compared to use of ground outside the wind farms. The use of accurate GPS tags on adult males with wind farms in their territories would give more complete coverage and datasets.

#### LOSS OF TRADITIONAL FARMING

The hen harrier in Ireland is closely associated with an upland farmed landscape, typified by rushy fields, bushy hedgerows and parts of farms that were never 'improved' agriculturally and have essentially been left to nature. However, looking across the farmed landscape of the twenty-first century, it is evident that many changes have taken place, with field boundaries and hedgerows removed to increase field size, scrub cleared and boggy ground drained. Old

hay meadows, which were species rich, have been replaced by monoculture perennial rye-grass (Feehan 2003). Nevertheless, what is left remains precious, and agri-environmental schemes have helped retain and improve from an environmental point of view the habitats for wildlife on the farm. Alternative enterprises (predominantly planting the land with commercial forests or developing wind farms) have become commonplace, as diminishing farm returns and an ageing farmer population signal a loss of a long-standing farming population and traditional stewardship of the uplands.

Changes in agricultural practice have been noted to negatively impact hen harriers internationally (e.g. Arroyo 1996; Garcia and Arroyo 2001; Amar *et al.* 2003; 2008; Amar and Redpath 2005). Given the close association of hen harriers with farmland in Ireland, it will be important to retain and encourage continuation of traditional farming practices. Measures already put in place by the Irish government to protect the farmed landscape for harriers (and other wildlife and habitats) include legal obligations to acquire consent to remove hedgerows or to reclaim heather/bog on protected lands, as well as proactive measures through voluntary agri-environmental schemes such as the National Parks and Wildlife Service Hen Harrier Farm Plan Scheme. The successor to the Rural Environmental Protection Scheme (REPS), the Agri-Environment Options Scheme (AEOS) may yet provide more targeted benefit to hen harriers than was the case in REPS, with measures including creation of wild bird cover, hedgerows, extensive grassland and riparian and grassland 'buffer' margins.

#### CONCLUSION

Ireland has lost a higher percentage of its native breeding raptor species than any other European country (Golden Eagle Trust 2010). While much progress is being made towards reintroducing golden eagles (*Aquila chrysaetos*), white-tailed eagles and red kites, the hen harrier is arguably our most precious of all, for if it is lost, it will be due to habitat loss, and there are no grounds for reintroducing a species where habitat no longer exists (International Union for the Conservation of Nature and Natural Resources 1998).

If measures to conserve hen harriers are to be successful, it is essential to bridge gaps between science, policy and practice, as mutual understanding can often be lacking (Clark 2002).

Improving the chances of forests, farmsteads and moorland in Ireland to sustain a hen harrier population will not just benefit this rare and threatened bird and meet pressing obligations under the various directives and conventions, but will also provide the opportunity for Irish residents and other visitors of today and future generations to continue to see this magnificent bird of prey, where it should be forever—sky-dancing on the uplands of Ireland.

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