Assessing the effectiveness of monitoring methods for Merlin *Falco columbarius* in Ireland: the Pilot Merlin Survey 2010

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Previous research and monitoring of Merlin *Falco columbarius* in Ireland has been limited. This has resulted in a lack of understanding of the status, trends and ecology of the population. A Pilot Survey was initiated in 2010 to assess the effectiveness of standard survey methods applied to the Irish population, and to inform an appropriate protocol for future monitoring. Similar to a trial of methods conducted for the 1993-94 Merlin Survey in Britain, two survey elements were undertaken simultaneously. Ten 3 x 3km squares were independently surveyed between April and July 2010. One group of surveyors (BWI) had no prior knowledge of Merlin within the squares, whereas another group (NPWS) possessed previous information on Merlin occupancy. Results for both surveys were similar for six squares. BWI recorded a higher level of breeding in two squares, while NPWS obtained more accurate detail on breeding status in two squares. Combined results confirmed all squares to be occupied. Successful breeding was confirmed in two squares. The findings emphasise considerable difficulties with monitoring Merlin in Ireland. A high degree of variation in detection rates, plucking behaviour and mobbing response was recorded, which affected the success of the methods employed. The average number of Merlin signs located per square was 20.2, but ranged from 0-79. From 40 potential mobbing events, only 12.5% resulted in responses from resident Merlin. A series of recommendations for future research and monitoring are outlined.

Introduction

Previous research and monitoring of Merlin *Falco columbarius* in Ireland has been limited, resulting in an absence of comprehensive data on distribution, abundance and ecological requirements of the species. Evidence from the Breeding Bird Atlases suggested a moderate decline in the breeding range of the Irish population (Sharrock 1976, Gibbons *et al.* 1993), while preliminary results from the latest Breeding Bird Atlas (2007-2011) highlights a continuation of this downward trend (B. Caffrey, pers. comm.). The population fluctuations detected by the Breeding Birds Atlases (Sharrock 1976, Gibbons *et al.* 1993) have been the primary sources used to determine the categorisation of Merlin on the Amber list of Birds of Conservation Concern in Ireland (Lynas *et al.* 2007). However, due to difficulties associated with detecting breeding Merlin, the survey methods employed by

Plate 61. Merlin (Shay Connolly).

Breeding Bird Atlases may not have provided a true indication of the abundance, densities or distribution of the population. In the absence of more comprehensive species specific monitoring, sufficient data on the status and ecology of Merlin necessary for the design and implementation of an effective conservation strategy is lacking. The Action Plan for Upland Birds in Ireland 2011-2020 (BirdWatch Ireland 2011) identified significant gaps in knowledge of the Irish Merlin population, as well as the necessity to establish baseline data and conservation priorities for the species. Merlin are an Annex 1 species on the European Birds Directive 2009/147/EC (OJEU 2010), and there is a requirement to address these issues to afford the species the appropriate protection.

Breeding Merlin populations are typically associated with upland habitat types, where they occur in low densities (Hardey *et al.* 2009, Ayers and Anderson 1999). In Ireland they have a widespread but sporadic breeding distribution (Gibbons *et al.* 1993). Due to numerous factors associated with their nesting ecology and their discrete breeding behaviour, it is generally accepted that the Merlin is a difficult species to survey (Ayers and Anderson 1999). Three national surveys have been previously conducted in Britain. Due to concerns over population declines, a partial survey was initiated in 1983-84, followed by more comprehensive surveys in 1993-94 (Bibby and Nattrass 1986) and in 2008, which also included coverage in Northern Ireland (Ewing *et al.* in press).

As part of the 1993-94 survey, trials were also conducted to validate the methods employed. Six 3 x 3km squares were surveyed by contract fieldworkers with no previous knowledge of Merlin within the survey squares. These squares were also simultaneously surveyed by local raptor fieldworkers who had monitored breeding Merlin within these survey areas in previous years, and whose results were assumed to accurately reflect Merlin occupancy and breeding status in each square. Results from both groups of surveyors were similar for all six squares, concluding that the methods developed were likely to provide accurate estimates of Merlin in areas not previously surveyed (Rebecca and Bainbridge 1998).

Research findings in Ireland suggest a variation in the breeding ecology of the species in comparison to Britain. Although tree nesting has been recorded in Britain, predominantly in areas where suitable ground nesting opportunities are limited (Bibby and Nattrass 1986), the majority of the British population is ground-nesting (Hardey *et al.* 2009). In contrast, trees are the dominant nest site choice in Ireland (McElheron 2005, Haworth 1985, Norriss *et al.* 2010, Fernández-Bellon *et al.* 2010), which is likely to be influenced by the limitation of heather cover of sufficient quality to provide optimal ground nesting opportunities. There has been a major decrease in heather cover over the past century in Ireland (Bleasdale 1998), with such changes being partially driven by increases in sheep numbers on marginal upland habitats as a result of EU grants to farmers in the 1980s and 1990s (Fuller and Gough 1999). The pattern of widespread, small-scale afforestation in Ireland, in contrast to more extensive plantations in upland habitats in Britain, is also likely to be a factor which influences nest site choice. Norriss *et al.* (2010) assessed Merlin breeding and nesting habitat at five traditional and geographically isolated sites in the late 1980's. Of 28 confirmed nests, all were located in old Hooded Crow *Corvus cornix* nests, the majority (n = 26) of which were in conifer plantations. McElheron (2005) conducted one of the most comprehensive studies on Merlin in Ireland by monitoring populations on a long-term basis in the Wicklow Mountains. Of 24 pairs recorded, only one pair nested on the ground, with another pair nesting on a large boulder. All other nest sites recorded as part of this study were located in trees, the majority of which were associated with forest plantations. A survey in Connemara (Galway) located 12 breeding pairs, of which only two pairs were ground nesting, both of which bred on densely vegetated islands on fresh water lakes (Haworth 1985).

Established survey methods for Merlin have been successfully used in Britain and elsewhere to census predominantly ground nesting populations (Hardey *et al.* 2009). However, the variation in the breeding ecology of the Irish population has the potential to impact on the accuracy of results when using these methods. A pilot survey in Ireland to test the effectiveness of established methods, as practised in Britain, was deemed appropriate in order to inform a practical and realistic protocol for future monitoring of the population. Research on sign distribution, activity patterns and mobbing behaviour was also carried out by BirdWatch Ireland (BWI) to facilitate further insights into Merlin breeding behaviour and the effectiveness of standard survey methods in detecting the species.

Methods and study areas

As in the trial of methods conducted as part of the 1993-94 survey in Britain, two survey elements were undertaken simultaneously. The BirdWatch Ireland (BWI) survey team comprised experienced fieldworkers, which included experience of surveying raptors. However, this team had not previously worked on Merlin and had no previous information on breeding Merlin in the selected survey squares. The National Parks and Wildlife Service (NPWS) survey team (which included input from the Irish Raptor Study Group) covered the same squares. In contrast, these surveyors possessed knowledge of Merlin within the survey squares, including the locations of previous nest sites. Both survey elements were carried out over the same time frame but were otherwise independent. The findings of both surveys were

then compared in order to highlight the success, shortcomings and requirements of the survey techniques for future work.

Ten 3 x 3km squares were selected for the pilot survey. Survey squares were chosen by NPWS, based on previous knowledge of nest sites and distribution of NPWS surveyors. All squares were suitable for breeding Merlin, were occupied in previous years and were expected to hold at least one breeding pair. Squares were located in three counties, with two squares in Wicklow, three in Galway and five in Donegal. The locations and names of the selected survey squares are shown in Figure 1. A practical workshop of survey techniques was held over two days at known Merlin sites in the Slieve Bloom and Wicklow Mountains on the 19 and 20 March 2010. This ensured a sufficient level of expertise among all fieldworkers involved. Survey work was carried out over four months from 1 April to 31 July 2010.

Figure 1. Location of the ten 3 x 3km Pilot Merlin Survey squares.

BWI survey methods

The BWI survey methods were primarily based on Hardey *et al.* (2009). Two fieldworkers made four visits to each square between April and July 2010. Survey forms were used to record the date, visit number, surveyors present, distance walked and start and finish times of each visit. Weather variables were recorded by assessing visibility, rain, wind and cloud cover (assigning each a value of 1-3). The habitat composition of each square was assessed via aerial photographs with further assessments made on foot or by vehicle on the initial visit. Areas not considered suitable for breeding Merlin were identified on 1: 50,000 Ordnance Survey maps and excluded from further survey effort. These areas included open water, urban areas, farmland, enclosed pastures and areas above 700m (Hardey *et al.* 2009). The remaining areas representing suitable Merlin habitat, including heather and grass moorland, forestry and bracken (Hardey *et al.* 2009) were intensively and systematically searched for signs of Merlin activity on the first visit.

Sign searching

All prominent features (boulders, hummocks, posts, etc.) which could be used as perches by Merlin were checked for signs of activity (plucking remains, moth wings, white wash, pellets, moulted feathers, etc.). Hardey *et al.* (2009) and Gilbert *et al.* (1998) recommend walking within 500m of all points of suitable habitat when searching for evidence. For the pilot survey this distance was reduced to 200m to increase the likelihood of locating signs left by tree-nesting Merlin, which can be more difficult to detect than the signs of ground nesting pairs (Little and Davison 1992, Newton *et al.* 1984). Norriss *et al.* (2010) noted the tendency of some tree nesting pairs in Ireland to avoid plucking on the ground in favour of branch perches, meaning open ground searches are less likely to be successful in locating signs.

All signs located were assigned an individual reference number and a ten-figure grid reference. The type of sign (plucking, moth wings, etc.), perch type, number of prey and age of sign estimated by assessing condition, deterioration and weather exposure (previous season, more than three weeks old, or less than three weeks old) was recorded. All signs left by other raptor and corvid species were also recorded. To determine variation in abundance and distribution of signs between sites, and to assess the reliability of sign searching as a method for confirming Merlin occupancy, all recorded signs were mapped using ArcView and Mapsource software for each square. Research in Britain has shown that as the breeding season progresses, Merlin pluckings and signs tend to concentrate in the vicinity of the nest site, and can therefore aid nest finding (Newton *et al.* 1994, A. Heavisides, pers. comm.). The quantity of seasonal signs located within a 200 and 500m radius of all confirmed breeding attempts was determined.

Any encounters with Merlins during sign searching were logged as a casual encounter. These were assigned an individual reference number and ten-figure grid reference of the bird's position. The type of encounter (visual observation or calls), bird involved (male, female, juvenile or unknown) and time and behaviour (flying in transition, perched, hunting, preening, mobbing other species, delivering prey to the nest, calling, etc.) was recorded. Sightings of other species (e.g. corvids, herons, raptors, etc.) which might stimulate mobbing behaviour by Merlin were noted.

Vantage point watches

Once areas of Merlin activity were located from sign searching, vantage points were selected overlooking suitable nesting habitat as defined by Hardey *et al.* (2009), as well as nesting habitats detailed in accounts of breeding Merlin in Ireland (McElheron 2005, Haworth 1985, Norriss *et al.* 2010). These included forest edges, moorland with heather 30-70cm high (Hardey *et al.* 2009, McElheron 2005, Norriss *et al.* 2010), islands with dense vegetation or potential corvid nests (Haworth 1985) and crags and rock faces (D. Norriss, pers. comm.). Particular attention was paid to passing corvids, herons, raptors and other species likely to elicit a mobbing response from Merlin (Hardey *et al.* 2009).

Previous studies recommended vantage point watches of two hours (Rebecca and Bainbridge 1998, Gilbert *et al.* 1998) or four to six hours duration (Hardey *et al.* 2009). For the BWI element of the pilot survey, watches were carried out for a minimum of three hours. Hardey *et al.* (2009) also recommended carrying out watches in the morning or evening to coincide with peak periods of activity. For the BWI survey watches were initiated before 10:00 or after 16:00. In squares where no signs were found, or where there were no obvious areas of Merlin activity, vantage points were selected to cover all potential nesting habitat within the square. All vantage points were assigned a unique reference number and a ten-figure grid reference and start and finish times were also logged. Any observations of Merlin or other species were recorded in a similar manner to casual encounters. If vantage point watches revealed new information which might be enhanced by further watches, these were also carried out on the same visit.

Repeat visits

On subsequent visits (May, June and July) all perches holding signs on the first visit were checked for renewed activity, and areas of known activity were searched for new signs. Vantage points were modified based on any new and relevant information (new signs, encounters, etc.). Squares where information was considered incomplete after four visits were visited a fifth time to increase the level of knowledge of the square (confirm fledging, failed breeding attempts, etc).

Activity patterns and mobbing behaviour

To assess Merlin activity patterns and the efficiency of detection rates from vantage point watches in relation to their timing and duration, three full day (dawn to dusk) watches were also carried out at two known nest sites. Two watches were carried out at a confirmed nest site in a small block of forest in Glenveagh (Donegal) on 3 June and 5 July 2010. These dates corresponded to the incubation and fledging period of the breeding cycle respectively. A third full day watch was undertaken on 18 June 2010 at a nest on an island in the Kinvarra (Galway) survey square. Based on the behaviour of this pair, it is likely that this watch coincided with the pre-laying period. However, this cannot be confirmed as this attempt failed later in the season. Weather variables were recorded every hour to evaluate the relationship between Merlin activity and weather patterns. All Merlin sightings, calls and behavioural observations were noted.

To assess the benefits of utilising Merlin mobbing behaviour as a survey tool, all potential mobbing events during the full day watches were noted. A potential mobbing event was defined as an observation of corvids, gulls, herons or raptors, either in flight or perched, within a radius of 50m of a Merlin or an active Merlin nest site. Merlin responses to the presence of any species in these groups were recorded to assess the benefits of this method in locating occupied nesting areas for future work.

Classification criteria

The criteria used to classify the status of each survey square was based on Hardey *et al.* (2009), incorporating modifications to adjust for the ecology of the Irish Merlin population (McElheron 2005, Haworth 1985, Norriss *et al.* 2010). Non-breeding was excluded due to the difficulty in differentiating it from failed breeding. Therefore the following four categories were used for the pilot survey:

Unoccupied: Fresh signs recorded on a single visit or no sightings or calls recorded throughout the season.

Occupied: At least one Merlin seen or heard, or fresh signs of occupation (pluckings, pellets, droppings or moulted Merlin feathers) found on at least two occasions separated by at least one week.

Breeding attempt: Courtship display, alarm calling, copulation, eggs or eggshells found, young seen or heard.

Successful breeding attempt: At least one young fledged or capable of flight recorded.

NPWS survey methods

NPWS surveyors were not required to adhere to a defined survey protocol. Alternatively, they relied on previous monitoring experience within the selected squares to determine the best means of assessing Merlin activity. All visits were carried out over the same time period as the BWI survey (April-July) by a team of eight surveyors. The number of visits

required in order to obtain accurate information on occupancy and breeding status was left to the discretion of individual surveyors. In general, initial searches for signs were undertaken in the vicinity of historical sites, followed by watches covering areas of potential or expected activity. Timing of vantage point watches were not standardised and were carried out for as long as was deemed necessary (ranging from one to six hours). Surveys were less exhaustive and systematic when searching for field signs and more effort was invested in vantage point watches. Surveyors were asked to categorise Merlin status in each square according to the same criteria as above.

Results

BWI survey

Two surveyors required 845 hours, over 137 field days (1 April-20 July 2010) to complete four visits to each of the ten survey squares. Surveyors walked a combined total of 1,049km within the survey squares over the course of the field season.

Parameters recorded indicate that weather conditions were in general favourable for Merlin survey work. Of 112 field days, 77% had little or no rain, there were showers on 22% of days with heavy rain recorded on less than 1% of days. Similarly, only 22% of days were completely overcast, while the rest were intermittently cloudy (44%) or clear (34%). Strong winds were recorded on 5% of days, 54% were breezy, and the remaining 41% were calm. Visibility was mostly good (61% of the days), with only some days of intermediate (35%) or low (4%) visibility.

Sign searching

A total of 412 Merlin signs were recorded at 366 individual perches by BWI across all sites during the survey period. Of these, 223 were classed as fresh or seasonal, while the remaining 143 were assigned to the previous season or older. Plucked avian prey items (n = 292) were the most abundant sign recorded, followed by moths wings (n = 68 individuals), pellets (n = 26), probable Merlin white wash (n = 22), moulted Merlin feathers (n = 3) and dragonfly wings (n = 1). Boulders were the most abundant perch type recorded (n = 170), followed by hummocks (n = 120) and posts (n = 65), with other features such as upturned roots, earth banks and turf stacks also used (n = 11). Perches where more than one prey item was found, accounted for 31% of all signs (n = 103). Of these, 45 corresponded to signs where more than one pair of moth wings was found, or where moth wings were found alongside plucked feathers. The majority of perches holding more than one item (n = 43) were recorded in the squares which held breeding attempts (n = 5) and were predominantly located close (less than 500m) to breeding sites.

The average number of fresh signs recorded in the ten survey squares was 20.2, but varied significantly between sites, ranging from 0-79 signs per square. Two squares which held breeding attempts (one successful and one failed) showed a concentration of signs in proximity to the nest site, with more than 15 fresh signs recorded within a radius of 500m of the nest. None of the remaining four sites which held breeding attempts (one successful, three failed) showed a similar sign distribution pattern, with less than five signs located per site within 500m of the nest, despite comprehensive and standardized searches.

Merlin encounters during sign searching were recorded on 30 occasions. For two of the survey squares these encounters represented the only sightings throughout the season (as birds were not detected at these sites during vantage point watches).

Vantage point watches

A total of 97 vantage point watches were undertaken by BWI (an average of 9.3 per square), each lasting a minimum of three hours, with the longest extending to 5.5 hours. Merlins were recorded on 75 occasions, but these encounters were unevenly distributed across watches. A total of 21 watches yielded sightings, with no Merlin encounters recorded on the remaining 76 watches.

The initial full day watch at Glenveagh on 3 June (incubation period) recorded 14 Merlin encounters over a 17 hour period (04:45-22:15), 13 of which were observations and one vocalisation. The female was recorded ten times, the male four times, and an unidentified adult on one occasion (with both birds sighted together on one occasion). No Merlin activity was recorded during two three-hour periods (11:00-14:00 and 18:00-21:00) despite the fact that this nest was active and subsequently successful.

The 5 July watch (fledging period) at Glenveagh, conducted over a 17 hour period (04:45-22:15) yielded a total of 52 encounters, of which 29 were sightings and 23 were calls. The male was observed on 13 occasions, the female on four, and the fledglings on 47 (on 12 occasions an adult was observed with the fledglings). Despite showers and strong wind throughout the day, Merlin activity appeared to be constant and independent of weather conditions.

A total of 22 Merlin encounters were recorded on 18 June (pre-laying period) at Kinvarra, all of which were observations. Three of these were of an unknown adult, four were of the male, and 15 were of the female. The distribution and timing of Merlin encounters recorded during each of the full day watches at both sites are shown in Figure 2.

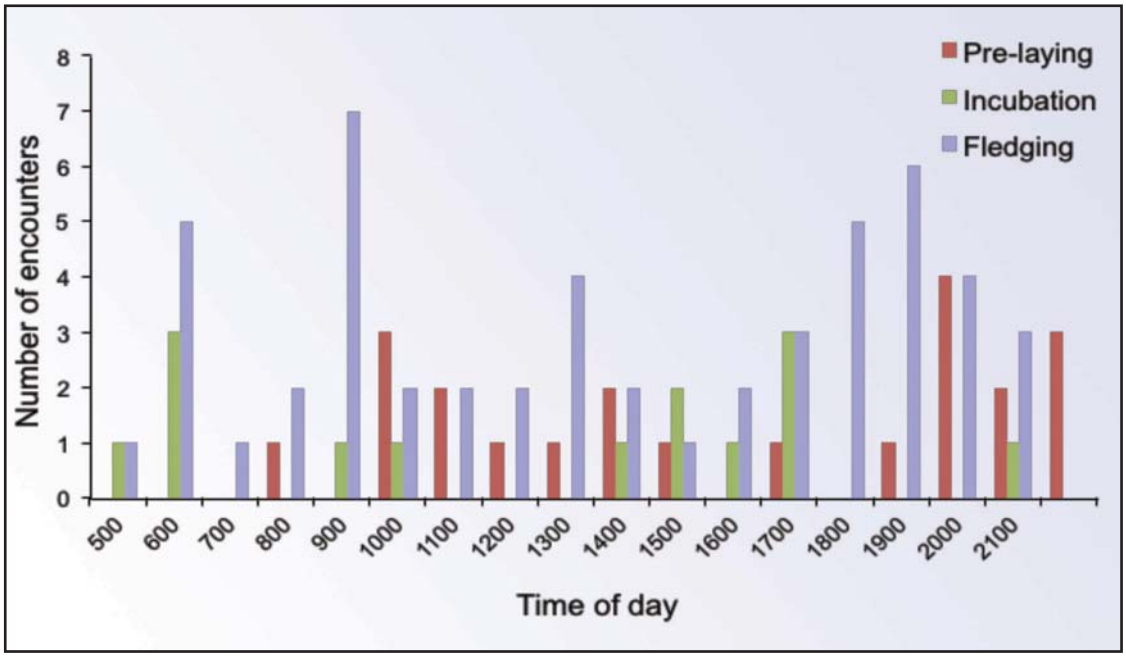

Figure 2. The distribution and timing of Merlin encounters during three full day watches.

Mobbing behaviour

A total of 40 potential mobbing events were recorded during the three full day watches. These events involved seven species; Grey Heron *Ardea cinerea,* Sparrowhawk *Accipiter nisus,* Merlin, Great Black-backed Gull *Larus marinus,* Lesser Black-backed Gull *Larus fuscus,* Hooded Crow and Raven *Corvus corax.* Of these, five resulted in a mobbing response from resident Merlin. Table 1 shows Merlin responses to each of the potential mobbing events in relation to the species involved.

Occupancy and breeding success

The ten squares surveyed by BWI were classified as follows; one was unoccupied, four were occupied and breeding attempts were confirmed in five (one of which is likely to have held two breeding attempts). Four of these were considered to be unsuccessful, with only a single square confirmed as holding a successful breeding pair (Table 2).

Table 1. The response of Merlin to potential mobbing events.

Species	Number of potential mobbing events	Number eliciting a response by Merlin	Birds involved		
			Male	Female	Both
Grey Heron	10	2	-	1	1
Sparrowhawk	4	1	1	-	-
Merlin	1	1	1	-	-
Great Black-backed Gull	1	-	-	-	-
Lesser Black-backed Gull	11	1	-	1	-
Hooded Crow	11	-	-	-	-
Raven	2	-	-	-	-
Total	**40**	**5**	**2**	**2**	**1**

Table 2. Comparison of BWI and NPWS survey results.

Square	BWI			NPWS		
	Fresh signs	Sightings	Result	Fresh signs	Sightings	Result
Duff Hill	Yes	No	Occupied	Yes	No	Occupied
Carriglaur	Yes	Yes (many)	Two failed breeding attempts	No	Yes (many)	Two failed breeding attempts
Letterfir	Yes	Yes (1)	Occupied	Yes	Yes (1)	Occupied
Glenamaddy	Yes	Yes (1)	Breeding attempt, possibly failed	Yes	No	Unoccupied
Kinvarra	Yes	Yes (many)	Breeding attempt, failed	Yes	Yes (many)	Breeding attempt, failed
Ardara	Yes	Yes (many)	Breeding attempt, failed	Yes	Yes	Occupied
Glenties	Yes	Yes (1)	Occupied	Yes	Yes	Successful breeding
Glenveagh	Yes	Yes (many)	Successful breeding	-	Yes	Successful breeding
Buncrana	No	No	Unoccupied	Yes	Yes (1)	Occupied
Burnfoot	Yes	Yes (2)	Occupied	Yes	Yes (1)	Occupied

NPWS survey

NPWS surveyors spent an average of five and a half days in each square and carried out an average of 8.3 watches (lasting between one and six hours) per square to determine occupancy or breeding status. The ten squares surveyed by NPWS were classified as follows; one was unoccupied, five were occupied and breeding attempts were confirmed in four. Two of the squares with a confirmed breeding attempt were considered to have failed (one with two failed attempts), and two were considered to have held successful breeding pairs (Table 2).

Comparing results from the two surveys

The BWI and NPWS survey results were similar for six squares (Duff Hill, Carriglaur, Letterfir, Kinvarra, Glenveagh and Burnfoot) with contrasting findings recorded for the remaining four. Buncrana was recorded as unoccupied by the BWI survey, but was found to be occupied by NPWS. Conclusions on breeding status varied between the surveys in relation to the three remaining squares. At Glenamaddy and Ardara, BWI confirmed breeding attempts while NPWS surveyors considered Glenamaddy to be unoccupied and Ardara to be occupied but did not record a breeding attempt. At Glenties, BWI surveyors recorded occupation while NPWS surveyors were able to confirm a successful breeding attempt. Table 2 shows a comparison of the results for both surveys.

Discussion

Survey comparisons

One of the most significant results of the pilot survey was the contrast in findings between the BWI and NPWS survey elements. This emphasises the difficulties associated with monitoring Merlin in Ireland, and also highlights specific aspects that need to be addressed prior to establishing an effective monitoring protocol. Results for both elements were similar for only six of the ten survey squares. BWI recorded a higher level of breeding information in two squares, with NPWS also obtaining more accurate detail on breeding status in two squares. These findings indicate that even intensive and systematic survey work (BWI survey), or previous experience of monitoring Merlin at traditional sites (NPWS survey) cannot guarantee accurate determination of breeding status using the pilot survey methods. In contrast to the results of the current survey, similar trials undertaken as part of the 1993-94 Merlin survey in Britain revealed identical classifications for all six squares between the two teams of surveyors. This comparison highlights the potential variation in effectiveness of established Merlin survey techniques

between Britain and Ireland, and the necessity for further research on Merlin monitoring methods in the Irish context.

There are numerous potential factors responsible for the disparity in results between the BWI and NPWS survey elements compared with the trials conducted as part of the 1993-94 Merlin survey in Britain. Firstly, the level of Merlin monitoring in Britain is more comprehensive than in Ireland. The raptor workers involved in the British trials had an intimate knowledge of the Merlin in their survey areas. NPWS surveyors possessed a similar level of knowledge for certain squares, but other squares had only received sporadic monitoring in recent years.

The year 2010 was considered a poor one for breeding Merlin, and this may potentially explain some of the variation in results between the survey elements. Lower breeding success rates were recorded in 2010 in comparison to the findings of Norriss *et al.* (2010) who assessed breeding parameters of the species between 1986 and 1992. Non-breeding birds are less likely to restrict their movements or plucking activity to specific areas or to engage to the same extent in behaviour (mobbing, courtship display, calling etc.) which may facilitate locating a breeding pair (Newton *et al*. 1984, A. Heavisides pers. comm.). Therefore, it is to be expected that survey methods are less efficient at detecting non-breeders. It is likely that a reduction in passerine prey in typical upland Merlin sites was responsible for low breeding success in 2010, with only two successful nesting attempts recorded at ten 3 x 3km pilot survey squares. Studies have indicated that breeding Merlin densities are likely to be related to prey density and abundance (Wiklund 1996, Wiklund and Larsson 1994).

The 2009/10 winter was one of the most severe in 50 years (Met Éireann 2010), and this is likely to have resulted in a reduction in certain passerine populations. Preliminary results from the Countryside Bird Survey (CBS) (Coombes 2010) and Breeding Bird Atlas 2007-2011 (B. Caffrey, pers. comm.) indicate severe declines in some upland species, such as Meadow Pipit *Anthus pratensis* and Stonechat *Saxicola torquata.* These species are known to be important prey of the Merlin (Rae 2010, McElheron 2005, Rebecca 2004, Clarke and Scott 1994, Bibby 1987, Newton *et al.* 1984, Watson 1979). The pilot survey methods would, therefore, be expected to be more effective in a typical Merlin breeding season with higher numbers of successful breeding pairs.

However, the most likely factors impacting the effectiveness of the pilot survey methods relate to the nesting ecology and breeding behaviour of Merlin in Ireland. The findings of the pilot survey indicate a high degree of variation between sites in relation to breeding ecology, sign distribution, plucking and mobbing behaviour, which is probably driven by habitat and nest site characteristics. This resulted in a significant difference in the efficiency of survey methods for determining occupancy and breeding status between sites. Sign searching and vantage point watches are the standard methods used for surveying Merlin throughout their range, and were the primary methods employed by the BWI survey. Both methods proved to be valuable survey tools, but the merits of each in detecting Merlin varied greatly between squares.

Sign searching

Sign searching provided confirmation of occupancy in seven squares in the BWI survey. Evidence of fresh signs on visits separated by a week or more, in addition to casual encounters provided the final survey results for six squares. However the pilot survey also identified the unreliability of sign searching for determining occupancy and for locating nests in certain situations. The dominance of tree nesting in Ireland is likely to impact on the effectiveness of this method compared with Britain, where the majority of pairs nest on the ground (Hardey *et al.* 2009). In a study in Northumberland, Little and Davison (1992) found that tree-nesting birds tend to pluck on branches, which makes the location of both signs and nests more difficult. Newton *et al.* (1984) noted that prey remains are more evident around Merlin nests surrounded by heather moorland compared with nests which are surrounded by grassland or forestry, which are generally the dominant habitat types associated with Merlin breeding sites in Ireland. Norriss *et al.* (2010) also commented on the difficulties in locating nests 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, survey efficiency was reported to drop from 87% to 60% in this study.

The BWI sign searching methodology was more intensive and systematic than the methods used or recommended in previous studies (Hardey *et al.* 2009). Despite the fact that all ten survey squares were confirmed to be occupied, there was a very low number of signs located within certain squares. Less than 20 seasonal signs were recorded in six individual squares. One square (Burnfoot) only held a single fresh sign and one seasonal sign, with another square (Buncrana) yielding no signs at all. Based on sign searching alone and the criteria used, both squares would have been classed as unoccupied. Therefore negative results from comprehensive sign searching in suitable habitat cannot definitively rule out Merlin occupancy. Further research is required to assess the specific aspects which influence Merlin plucking behaviour in the Irish context, which would allow greater confidence in this method based on the characteristics of individual sites.

The distribution of signs with respect to nest sites was also highly variable between sites. Of the four sites where failed breeding attempts were recorded, only one (Ardara) produced more than 15 signs within 500m of the nest.

Plate 62. Merlin (Shay Connolly)

However, McElheron (2005) suggested that sign patterns only become evident once clutches are complete. As the stage at which these four attempts failed remained unknown, it is not possible to fully analyse the merits of nest finding based on sign distribution at these sites. Of the two successful sites, only one (Glenveagh) followed a pattern of sign distribution which allowed relative ease of confirmation of occupancy and which aided the subsequent locating of the nest. At Glenties, the other successful site, a similar sign distribution pattern was not evident. This further indicates sign searching to be a beneficial survey tool for locating certain pairs, but for other pairs this method is significantly less effective.

Vantage point watches

Vantage point watches provided specific information regarding the breeding outcome in five squares. Merlins nesting in forests tend to select concealed nests (Sieg and Becker 1990) which are seldom directly visible (Hardey *et al.* 2009) therefore, observations around nest sites may be restricted. This is accentuated when birds' nest within fire breaks in plantations or away from the forest edge. Norriss *et al.* (2010) recorded 72% of nests (n = 61) within 60m of the forest edge, and also recorded four nests which were over 250m from the forest edge. Results from the vantage point watches conducted during this survey suggest that watches at nests in more 'open' habitats, such as open woodland, islands, small blocks of forest or shelter belts, yield more encounters than nesting sites in more 'concealed' habitats, such as large and dense forest plantations. However it is not possible to comprehensively analyse this aspect with the current dataset due to the small sample sizes and high degree of variation between the habitat characteristics of each site.

The BWI survey carried out six watches on three active nests without any observations. This stresses the discrete nature of the species and reinforces the fact that absence of breeding Merlin cannot be determined from negative results. In relation to the required timing and duration of vantage

point watches, it must be noted that no Merlin encounters were recorded over two three-hour periods (11:00-14:00 and 18:00-21:00) on a full day watch on 3 June at Glenveagh, despite the fact that watches focused on the active nest area. These watches were within the time frame recommended by Hardey *et al.* (2009), indicating that the duration of vantage point watches should be extended beyond three hours to afford greater confidence in the results. In common with sign searching, further research is needed on how the success of vantage point watches vary between Merlin sites, and the determining factors which influence this is recommended. Vantage point watches are labour intensive and produce poor detection rates in certain situations. Therefore, we recommend that the broadcasting of Merlin calls, which has been used with some degree of success in other parts of the species range (Ayers and Anderson 1999, Doolittle and Balding 1995), should be considered in Ireland.

Mobbing

Merlin territorial behaviour, including aggressive defence of the nesting area from a range of species including corvids, herons and other raptors can be useful in locating occupied territories and nest sites. Hardey *et al.* (2009) recommend close observation of such species in the proximity of potential or known Merlin sites during the breeding season to aid identification of occupied territories and nesting locations. However, the findings from the three full day watches carried out in 2010 show that although Merlin mobbing behaviour can assist in locating breeding sites, the rates of response were low. Only 12.5% of all potential mobbing events resulted in a response by breeding Merlin. Similar to other methods used for locating breeding Merlin (sign searching and vantage point watches), negative results from potential mobbing events therefore do not guarantee absence of breeding Merlin.

Fieldworker requirements

In addition to the difficulties outlined above, the time consuming nature and specific fieldworker requirements to achieve accurate survey results must also be taken into account when planning a future monitoring scheme. Substantial survey efforts were necessary over the course of the field season for a comparatively low return. The characteristics of the terrain and the methods employed required a high level of physical fitness and motivation. The BWI survey was primarily undertaken by two fieldworkers, which required four months to survey ten 3 x 3km squares. Weather conditions were favourable for survey work for the majority of the season (over 95% of days were classified as suitable). Despite this there was insufficient time to accurately ascertain breeding status in a minimum of two squares. It must be noted however, that given the low breeding success recorded, the 2010 season was regarded as an exceptionally poor breeding year for Merlin, and that time constraints may be a less significant issue in a more productive year. Regardless, the time, fitness, experience and motivation required of surveyors in order to achieve accurate results must be taken into account when devising a future realistic survey or monitoring protocol for Merlin in Ireland, particularly in light of the limited raptor fieldworker resources.

Recommendations for future work

The Merlin is an Annex I species on the European Birds Directive 2009/147/EC (OJEU 2010), and is Amber-listed on the Birds of Conservation Concern in Ireland (Lynas *et al.* 2007). Due to the lack of information on Merlin population parameters in Ireland, it is recommended that the priority focus for future work should be to determine population status and trends. The urgency for obtaining such data is accentuated by the results of this study in conjunction with evidence from the latest Breeding Bird Atlas (B. Caffrey, pers. comm.), which indicate that Irish Merlin populations may be undergoing at least short-term declines. Monitoring of breeding parameters at key sites was continued in 2011(Fernández-Bellon and Lusby 2011). Merlin breeding success values combined for 2010 and 2011 were 0.7-1.3 fledglings per breeding attempt (n = 14), which is significantly lower than those reported by previous studies of stable or increasing populations. These results are similar to the findings of Meek (1988) and Roberts and Green (1983). These authors reported marked population declines in Orkney and Wales, respectively, and the productivity figures are lower than required for a population to remain stable (2.2-2.6 fledglings per breeding attempt) (Bibby and Nattrass 1986, Rebecca *et al.* 1992). All of this is indicative of short-term declines in the Irish population. In the Irish context, breeding success and productivity are markedly lower than recorded by previous work carried out in 1986-92, when populations were considered to be stable (Norriss *et al.* 2010).

It is clear that strategic monitoring of Merlin in Ireland is required in order to obtain sufficient data to inform and implement an adequate conservation plan for the species. The pilot survey highlights significant difficulties associated with surveying Merlin in Ireland, and suggests that implementation of a national census of the Merlin population is likely to be overly ambitious at this stage. It is therefore recommended that efforts could be more effectively focused on comprehensive monitoring of key populations (particularly within SPA networks) to assess densities, breeding success and trends over successive years. In addition, given the findings in relation to the unreliability of standard survey methods at detecting Merlin at specific sites, it is also recommended to

assess the potential benefits of alternative survey methods. Playback methods for detecting breeding have been used with some success (Ayers and Anderson 1999, Doolittle and Balding 1995), as have decoys (Warkentin *et al.* 1990, Doolittle and Balding 1995, Wiklund 1996), and both should be considered for future monitoring work.

As well as a lack of information on Merlin distribution and abundance in Ireland there is also a limited understanding of the ecological requirements of the species, factors which impact on the population and conservation measures which would benefit the population. Data on nesting ecology, including nest site availability, selection and the implications of forestry management at key sites, as well as information on habitat requirements is essential. The provision of artificial nesting sites, in the form of nest baskets, is a measure that has been implemented with success in other countries (Rebecca 1998, Ivanovski 2000). It is recommended that a strategic nest basket scheme be initiated at suitable sites which would provide additional nesting options for the species where natural sites may be limited, and also serve to facilitate more detailed monitoring in future years.

In conclusion, the following recommendations are listed in order of priority:

- Strategic monitoring of key sites (particularly SPA's) to determine Merlin densities, breeding success, productivity and movements over successive years to assess population status and trends.
- Implement and evaluate the conservation benefits of a nest basket scheme at key sites.
- Test the effectiveness of playback as a method for detecting breeding Merlin.
- Assess the effectiveness of decoys for detecting breeding Merlin and for trapping Merlin for telemetry studies.
- Initiate a telemetry study to determine breeding home range sizes and habitat use in order to inform SPA management and conservation plans.
- Expand on previous dietary studies to facilitate an understanding of diet and prey requirements in relation to habitat use.

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