



Scottish Raptor Monitoring Scheme Annual Report 2016

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Scottish Raptor Monitoring Scheme

Annual Report 2016

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Front cover image: Female Sparrowhawk in Fife (Harry Bell)

Back cover image: Adult female Goshawk in Ayrshire (Angus Hogg)

Contents

1 ROUND-UP OF RAPTOR MONITORING SEASON IN 2016

An overview of the 2016 breeding season for Scottish raptors, with hyperlinks to more detailed data reporting on the SRMS website.

Pg. 1

2 TRENDS IN BREEDING NUMBERS & PRODUCTIVITY

A summary of all the latest trend information available for Scottish raptors, as a one-stop shop for stakeholders with hyperlinks to more detailed data reporting on the SRMS website.

Pg. 9

3 NATIONAL SURVEY - THE YEAR OF THE HEN HARRIER

Find out how Hen Harrier fared in the year of the fifth national survey from Simon Wotton (RSPB).

Pg. 10

4 HOW HAVE SRMS DATA BEEN USED OVER THE LAST YEAR?

Find out how SRMS partner organisations have been using SRMS data to benefit raptor conservation over the last year from Chris Wernham & Mark Wilson (BTO Scotland).

Pg. 15

Foreword

Welcome to the 2016 report which follows the same style as last year's revamp. Again publication has unfortunately been later than planned, but we are taking steps to enable us to catch up in the future. Meantime I hope you enjoy reading the report.

As seems to be becoming a regular feature, the weather was quite patchy with poor weather at key times of the year in different parts of the country. This not only affects the birds but also the ability to monitor them, so it is encouraging to see that over 6,600 sites were checked in 2016.

2016 saw the latest national Hen Harrier survey and the species saw increased survey effort as a result. Sadly the results indicate a further decline and Simon Wotton's article in this report covers the survey and its results in more detail. A scientific paper on the results is at an advanced stage and will be published in due course. The Hen Harrier survey brings to an end a run of three raptor surveys in a row with Peregrine in 2014 and Golden Eagle in 2015. The Golden Eagle paper came out earlier this year while as I write the Peregrine paper is imminent. Given many of the same surveyors were involved in all three surveys their fantastic efforts should be recognised.

The article on Raven population modelling in this report highlights the need for good quality information on our widespread species even though Raven is still recovering in parts of the east of the country. Whilst some will disagree about the need for it, it is included in the Wildlife & Countryside Act and licensing is a statutory function of Scottish Natural Heritage, so any licencing decisions should be made on the best available objective information. The article shows the importance of the SRMS data, in this case combined with other data, to help inform an often controversial topic.

Thanks are due once again to partner representatives on the SRMG and their organisations for continuing support of the SRMS and in particular to Amy as the SRMS Coordinator who is working extremely hard to further the aims of the Scheme.

Andrew Stevenson (Chair of the Scottish Raptor Monitoring Scheme)
on behalf of the Scottish Raptor Monitoring Group.

Regular readers of the SRMS annual report will note that in this new format, which we initiated for the 2015 Annual Report, we present fewer data tables than in previous editions. Species-specific and regional breakdowns showing the results of monitored breeding attempts can be found on the species-specific pages of the SRMS website: <http://raptormonitoring.org/>

1 ROUND-UP OF RAPTOR MONITORING SEASON IN 2016

The Scottish Raptor Monitoring Scheme received more than 6600 records of checked raptor home ranges in 2016. This represents a tremendous effort from SRMS contributors to whom we are extremely grateful. This section provides an overview of the 2016 season, setting the scene for the weather conditions and prey situation that Scottish raptors experienced. Here we also provide a summary of the records received from each region of Scotland in 2016, along with some species highlights, and provide links to more detailed breakdowns on the SRMS website.

WEATHER

The winter preceding the 2016 breeding season was the third warmest since recording began in 1910. In Scotland the winter was the equal wettest on record. Wet winters can affect vole abundance in the spring, and this is likely to have had a knock-on effect on the breeding success of raptor species for which voles form a significant part of the diet. Eastern Scotland experienced an exceptionally wet January. The relatively mild and wet winter was followed by a fairly average spring, both in terms of temperature and rainfall. The first half of February was very unsettled with frequent westerly and south-westerly winds, and it was particularly wet in the south-west with strong winds and significant snowfalls across the Scottish mountains. March was fairly dry across Scotland except in Aberdeenshire where there was 64% of average rainfall based on the 1981-2010 mean. April was mostly unsettled with widespread low-lying snow during the last week which is likely to have delayed breeding for the ground-nesting species such as Hen Harrier and Merlin in some areas. May was generally warm, dry and sunny, particularly in Western Scotland. July was a particularly wet month with 140% of average rainfall based on the 1981-2010 mean and parts of the east coast, the Western Isles and Northern Isles were especially so.

VOLE ABUNDANCE

Cyclic changes in the annual and seasonal abundance of voles can have a profound effect on the number of pairs and breeding success of a number of raptor and owl species (e.g. Petty *et al.* 2000; Lambin *et al.* 2000), particularly

affecting Kestrel, Barn Owl and Short-eared Owl (Figure 1; Village 1990; Korpimäki & Norrdahl 1991, Taylor 1994). If vole populations reach a peak during the spring, these predators can respond with an increase in the number of pairs settling to breed and a corresponding increase in brood size, nesting success and productivity. Conversely, when vole numbers are low, the reverse can occur. Vole numbers in many areas of Scotland were low, still recovering from the crash in numbers in the spring of 2015. This was reflected by low occupancy and breeding productivity for all owl species in 2016.



Figure 1: Short-eared Owl breeding success is heavily influenced by vole abundance. (Photo: Angus Hogg, South Strathclyde RSG).

MONITORING

In general, raptor workers try to visit known home ranges and other suitable habitat several times before and during the breeding season, with the aim of establishing whether ranges are occupied or not. In 2016, a total of 6,640 raptor home ranges in Scotland received at least one visit to check for occupancy (Table 1). Figure 2 shows a summary of raptor monitoring coverage in 2016, depicting 10 km squares that

received at least one visit to check for occupancy. Not all of these home ranges held pairs: some had only single birds and others were apparently vacant. The regional breakdown of home ranges checked in 2016 can be seen in Table 1.

Equally important to checking occupancy are follow-up visits to confirm the findings of the first visit and to monitor the nesting success of birds present. The nesting success, normally expressed as the percentage of monitored breeding pairs producing fledged young, together with the mean brood size, provides one measure of the health of the population. In 2016, 2,928 potential breeding pairs received further visits, enabling their nest success to be determined.

Species-specific and regional breakdowns showing the results of monitored breeding attempts can be found on the SRMS website, <http://raptormonitoring.org/>.

It is important to recognise that, for the majority of species, not all breeding pairs were monitored, thus the numbers presented do not represent entire populations or provide a complete picture of breeding productivity, at either regional or national scales. Table 1 provides the most recent population estimates available for each species to help contextualise the SRMS data.

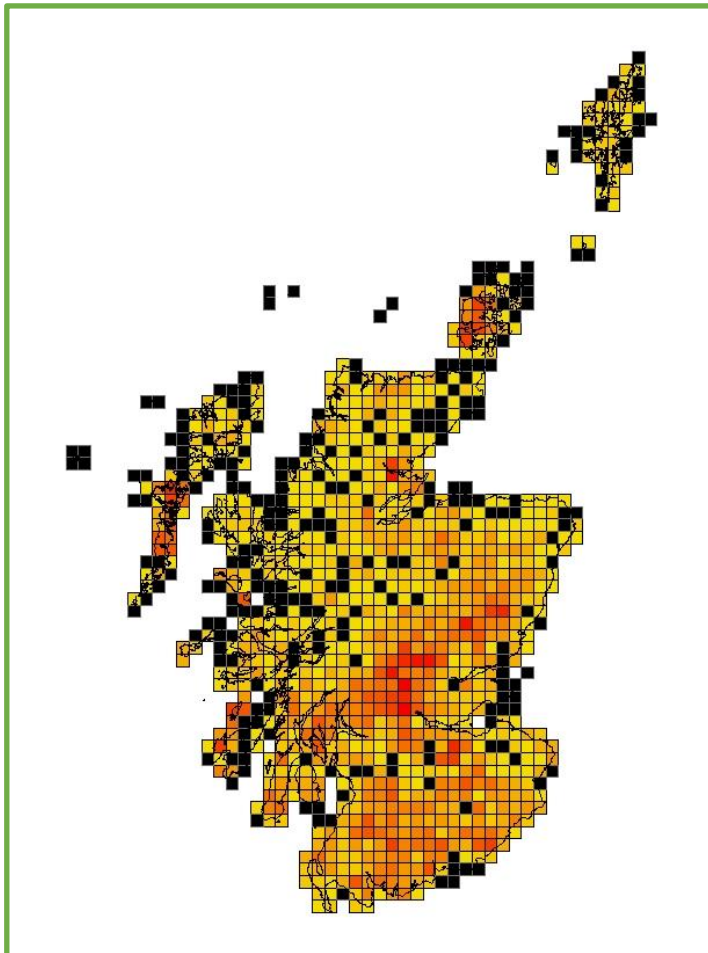


Figure 2: Raptor, owl and Raven monitoring coverage in Scotland in 2016. For each 10 km square, this map illustrates the number of SRMS species for which occupancy (or absence) was recorded. The redder the square, the more species were covered. The maximum number of species checked for occupancy in a single square in 2016 was 11. Black squares indicate no monitoring records for 2016. N.B. This figure masks variation in coverage at finer geographic scales and work is ongoing to improve our knowledge of coverage (See Chapter 2).

All SRMS fieldworkers are asked to follow best practice guidance for raptor monitoring set out in Hardey *et al.* (2013). For more information about what raptor monitoring entails please visit:

<http://raptormonitoring.org/raptor-monitoring>

Table 1. The number of home ranges of raptors, owls and Raven checked in 2016 that were submitted to the Scottish Raptor Monitoring Scheme. For a given region and species combination a “-” indicates that the SRMS does not hold any previous records and “0” indicates that no records were provided for 2016 (but that SRMS does hold records from previous years). The most recent population estimates available for each species are also presented for context, where possible for Scotland, otherwise for a broader geographic region.

Species	Argyll	Central Scotland	Dumfries & Galloway	Highland	Lewis & Harris	Lothian & Borders	North-east Scotland	Orkney	Shetland	South Strathclyde	Tayside	Uist	TOTAL	Estimated population size (pairs)	Region estimate relates to	Year estimate relates to
Honey-buzzard	-	-	0	0	-	-	-	-	-	-	2	-	2	< 10	Scotland	2003-2015 ¹
Red Kite	-	55	120	11	-	0	28	-	-	0	88	-	302	≥ 273	Scotland	2015 ¹
White-tailed Eagle	29	-	-	46	16	-	-	1	-	-	4	10	106	≥ 91	Scotland	2015 ¹
Marsh Harrier	0	-	-	0	-	0	0	2	-	-	8	-	10	< 10	Scotland	2003-2015 ¹
Hen Harrier	149	45	33	138	4	16	40	239	-	113	110	56	943	460	Scotland	2016 ²
Goshawk	-	4	34	12	-	50	5	-	-	19	15	-	139	144-173	Scotland	2015 ³
Sparrowhawk	10	47	12	2	0	12	3	29	-	10	23	5	153	35,000	UK	2009 ⁴
Buzzard	168	127	55	128	3	72	33	14	-	14	241	20	875	57,000–77,000	UK	2009 ⁴
Golden Eagle	71	11	2	202	31	1	26	-	-	2	46	26	418	508	Scotland	2015 ⁵
Osprey	33	49	15	81	-	15	32	-	-	3	82	-	310	216	Scotland	2015 ¹
Barn Owl	98	156	303	24	-	72	24	-	-	63	16	-	756	500–1000	Scotland	post 2004 ⁶
Little Owl	-	-	-	-	-	2	-	-	-	-	-	-	2			
Tawny Owl	60	113	58	43	-	20	2	-	-	4	14	-	314	50,000	UK	2015 ⁴
Long-eared Owl	5	3	0	6	-	7	3	4	-	3	11	9	51	1,800–6,000	UK	2007-2011 ⁴
Short-eared Owl	7	6	1	1	-	0	0	125	-	0	30	12	182	620–2,180	UK	2007-2011 ⁴
Kestrel	23	38	22	13	0	27	0	48	-	28	38	13	250	2,750–5,500	Scotland	2013 ⁷
Merlin	7	0	16	94	2	31	112	68	74	17	62	9	492	733	Scotland	2008 ⁸
Hobby	-	-	-	1	-	0	-	-	-	-	8	-	9	1-6	Scotland	2015 ³
Peregrine	40	37	116	23	3	138	101	35	11	79	106	4	693	523 (479-592)	Scotland	2014 ⁹
Raven	92	77	94	23	7	63	1	34	38	60	106	38	633	7,400	UK & IOM	2009 ⁴
TOTAL:	792	768	881	848	66	526	410	599	123	415	1010	202	6640			

Sources of estimated population sizes: ¹Challis *et al.* 2016; ²Wotten *et al.* Submitted; ³Holling *et al.* 2017; ⁴Musgrove *et al.* 2013; ⁵Hayhow *et al.* 2017; ⁶Shaw 2007; ⁷Wilson *et al.* 2015; ⁸Ewing *et al.* 2011; ⁹Wilson *et al.* Submitted.

SPECIES SUMMARIES

Throughout this report the names of birds follow the SOC list of English vernacular names (<http://www.the-soc.org.uk/bird-recording/the-scottish-list/>).

Honey-buzzard

Honey-buzzard continues to be a very under-monitored species in Scotland with only two records submitted to the Scheme in 2016, both of these in Angus in Tayside. RBBP has information on further breeding pairs in Dumfries & Galloway and Perth & Kinross which highlights that not all breeding raptor data are independently reaching the SRMS and there is still a job to do in raising awareness of the existence of the SRMS among existing and potential recorders.

Red Kite

In 2016, 230 of 302 home ranges checked were occupied by pairs. Of 215 pairs that were monitored, 209 were confirmed to lay eggs. A total of 155 pairs went on to fledge a minimum of 261 young. In 2016 SNH funding of the RSPB to monitor the north Scotland Red Kite population ended, so for the first time since this population was reintroduced monitoring coverage within this region was poor, with only 11 ranges checked for occupation, from a maximum of 100 known home ranges in 2015. It would be useful to have increased monitoring because a recent study showed that the north Scotland population is still subjected to high level of illegal killing (Sansom *et al.* 2016a). In Dumfries & Galloway there was some notable westward range expansion as a pair was confirmed breeding near Stranraer, 42 km away from the nearest known breeding pair (George Christie, pers. comm.).



Figure 3: A brood of three Red Kite chicks in Perthshire (Photo: Chris Baker, Tayside RSG).

White tailed-Eagle

In 2016, 104 of 106 home ranges checked were occupied by pairs. A total of 52 pairs fledged a minimum of 67 young. Two pairs established in Badenoch & Strathspey, one of which was known to lay eggs and went on to successfully fledge a single chick. A recent study showed that the species is likely to expand its breeding range and population size across particularly the west and northwest of Scotland, but also in parts of eastern Scotland (Sansom *et al.* 2016b).

Marsh Harrier

Marsh Harrier is a scarce breeder and passage migrant in Scotland. In 2016, eight pairs were located, all in Tayside. Of six pairs that were monitored, all were successful and together these pairs produced a minimum of 15 young.

Hen Harrier

In this national survey year, the SRMS received its first records of breeding Hen Harrier on Lewis – of four monitored pairs two pairs successfully fledged one chick each and a further two nests failed at the egg stage. On Orkney a male Northern Harrier paired with a female Hen Harrier (per RBBP). To see more detailed results and to learn more about the national Hen Harrier survey, see Chapter 3: *National Survey - The Year of the Hen Harrier*.

Goshawk

In 2016, 99 of 139 home ranges checked were occupied by pairs, with a further 18 home ranges in use (either single birds or fresh signs were reported). Of 80 pairs that were monitored, 70 were confirmed to lay eggs. A total of 60 pairs went on to fledge a minimum of 115 young. Goshawks in Dumfries & Galloway had a poor breeding season with the lowest mean brood size ever recorded (Chris Rollie, pers. comm.).

Sparrowhawk

In 2016, 83 of the 153 home ranges checked were occupied by pairs. Of 74 pairs that were

monitored, 67 were confirmed to lay eggs. A total of 65 pairs went on to fledge a minimum of 166 young. This species is still under-monitored across Scotland, with only one long-term study running – an urban study within Edinburgh. Territory occupancy and breeding success of Sparrowhawks in the Edinburgh study have recently been compared with a former long-term study in rural Ayrshire and this has shown that urban Sparrowhawks have better breeding success than rural ones (Thornton *et al.* 2017).

Buzzard

In 2016, 611 of 875 home ranges checked were occupied by pairs, with a further 28 ranges occupied by single birds. Of 463 pairs that were monitored, 436 were confirmed to lay eggs. A total of 406 pairs went on to fledge a minimum of 642 young.

Golden Eagle

In 2016, 340 of 418 home ranges checked were occupied by pairs, with a further 38 home ranges in use (either single birds or fresh signs were reported). Of 247 pairs that were monitored, 179 were confirmed to lay eggs. A total of 121 pairs went on to fledge a minimum of 137 young. In Highland there was one new territory newly occupied since the national survey the previous year (Stuart Benn, pers. comm.).

Osprey

In 2016, 198 of 310 home ranges checked were occupied by pairs. A further 17 home ranges were occupied by single birds. Of 176 pairs that were monitored, 167 were confirmed to lay eggs. A total of 145 pairs went on to fledge a minimum of 287 young. In Highland and Moray there was an interesting west-east contrast in the fate of nests, with West Moray and Inverness-shire pairs having a good season. Ospreys in East



Figure 4: Female Osprey in Perthshire. (Photo: Keith Brockie, Tayside RSG).

Moray had a poor season, with a period of continuous rain over five days in June considered responsible for the death on many chicks (Roy Dennis, pers. comm.). Ospreys in Dumfries & Galloway in contrast had their best every year, eight pairs successfully fledging 18 chicks.

Barn Owl

In 2016, only 273 of 756 home ranges checked were occupied by pairs, with a further 60 sites occupied by single birds. Of 216 pairs that were monitored, 204 were confirmed to lay eggs. A total of 185 pairs went on to fledge a minimum of 457 young. Productivity was 2.3 young per laying pair, so had improved on the poor season of 2015. Overall, this was a year of low occupancy and relatively low breeding productivity caused by the low vole numbers.

Little Owl

This species continues to be a very scarce breeder in Scotland, with two known sites in the Scottish Borders occupied by pairs in 2016.

Tawny Owl

In 2016, only 89 of 314 home ranges checked were occupied by pairs. A total of 64 pairs went on to fledge a minimum of 102 young. The low vole abundance caused this low occupancy rate and breeding productivity.

Long-eared Owl

This species is severely under-recorded in Scotland, with only 26 pairs located in 2016. Of 22 pairs that were monitored, 21 were confirmed to lay eggs. A total of 17 pairs went on to fledge a minimum of 31 young.

Short-eared Owl

A very poor year caused by low vole abundance, with only 57 of 182 home ranges checked occupied by pairs and a further 42 home ranges occupied by single birds. Of 44 home ranges that were monitored, 41 of which were on Orkney, only two pairs were known to lay eggs. A single chick was known to fledge from one of these pairs.

Kestrel

In 2016, 114 of 250 home ranges checked were occupied by pairs. Of 87 pairs that were monitored, 75 were confirmed to lay eggs. A total of 67 pairs went on to fledge a minimum of 204 young. Kestrels in a long-term study in Ayrshire (<http://raptormonitoring.org/srms-species/falconiformes/common-kestrel/ayrshire-study>) had a poor year with low occupation and productivity continuing a pattern reported for this study since 2010 (Gordon Riddle, pers comm). In a study in the Pentland Hills, pairs using nest boxes (Figure 5) had a more successful season, compared to pairs using natural sites - the majority of pairs using old crows nests failed (Graham Anderson, pers. comm.).

Kestrel is a species that the Breeding Bird Survey has shown is struggling in Scotland (i.e. a 69% population decline 1995-2015) and more widely across the UK (Harris *et al.* 2017).



Figure 5: Kestrel next box in the Pentland Hills. (Photo: Graham Anderson, Lothian & Borders RSG)

The SRMS has a role in providing objective information to show how Kestrels are doing so that other bodies including SRMS partners can respond accordingly. However, the SRMS can only report on the data we actually hold, which still remains limited – only 87 pairs of Kestrel were monitored in 2016 which is less than 5% of the 2,750–5,500 pairs that have been estimated to breed in Scotland (Wilson *et al.*, 2015). In our previous report we introduced *Raptor Patch* as one of the ways that the SRMS is hoping that we can collect more systematic data on this species.

Merlin

In 2016, 243 of 492 home ranges checked were occupied by pairs. Of 147 pairs that were monitored, 134 were confirmed to lay eggs. A total of 101 pairs went on to fledge a minimum of 301 young. Sadly, a long-term study of Merlin in the Lammermuir Hills (Heavisides *et al.*, 2017) had drawn to completion the previous year, so there were

Could you help contribute to regional trends for Kestrel? Why not consider adopting the *Raptor Patch* approach: identify an area representative of the wider landscape, define a boundary and then monitor all suitable habitat equally to locate every breeding pair each year to achieve complete coverage.

<http://raptormonitoring.org/getting-involved/raptor-patch>

fewer records from Lothian & Borders than in recent years.



Figure 6: Tree nesting Merlin in the Pentland Hills. (Photo: Graham Anderson, Lothian & Borders RSG).

Hobby

In 2016, two of the nine home ranges (known to have been used in recent years) checked were occupied by pairs. A monitored pair in Angus successfully fledged a minimum of one young.

Peregrine

In 2016, 298 of 693 home ranges checked were occupied by pairs, with a further 51 home ranges in use (either single birds or fresh signs were reported). Of 259 pairs that were monitored, 218 were confirmed to lay eggs. A total of 183 pairs went on to fledge a minimum of 414 young.



Figure 7: Adult female Peregrine in South-west Scotland. (Photo: Angus Hogg, South Strathclyde RSG).

Raven

In 2016, 489 of 633 home ranges checked were occupied by pairs. Of 377 monitored pairs, 327 were confirmed to lay eggs. A total of 296 pairs went on to fledge a minimum of 832 young. SRMS data from this species have been made available to BTO Scotland to undertake a piece of modelling work on behalf of SNH to help inform decision making with respect to issuing licences for Raven control. Read more about this work in Chapter 4: *How has SRMS data been used over the last year?*

Scarcer species

When the SRMS receives data on breeding attempts by irregular breeders such as Snowy Owl, Pallid Harrier and Montagu's Harrier we will include them in the annual report. Apart from Northern Harrier (see Hen Harrier, above), no such records were supplied to the SRMS for the 2016 breeding season.

It is always sad to hear when a long-term study has drawn to a close, particularly one that has been running as long as the Merlin study in the Lammermuir Hills. Arguably the most useful data that reaches the SRMS comes from such long-term studies, where complete coverage has been achieved for at least one species.

If you have a long-term study, have you considered its legacy for when the time comes that you are no longer able to monitor it as you do now? Will someone be there to take up the reins with the monitoring? Have you considered ensuring that the data you have collected over the decades can be available for conservation in the future?

2 TRENDS IN BREEDING NUMBERS & PRODUCTIVITY

A key role for the Scottish Raptor Monitoring Scheme is to provide robust information on Scottish raptor populations, in order to report on trends in numbers, range, survival and productivity and also to understand the causes of population changes and constraints on raptor populations. Such trends are important in allowing us to monitor the health of our raptor populations, understand the causes of population change and identify problems that conservation NGOs, statutory agencies and ultimately Scottish Government can act on to protect these raptors. This section of the report is being developed to provide a concise summary of all trend information available for Scottish raptors, as a one-stop shop for stakeholders.

The SRMS is currently undertaking a programme of work to produce study area, regional and national trends from its data holdings for all species for which suitable data are available. Finalised trends from SRMS information can be viewed on the SRMS website. These are currently available for White-tailed Eagle (<http://raptormonitoring.org/srms-species/accipitriformes/white-tailed-eagle>) and Kestrel (<http://raptormonitoring.org/srms-species/falconiformes/common-kestrel>). Provisional trends, demonstrating the potential of SRMS information, are available for many other SRMS species (see Roos *et al.* 2015, http://www.snh.org.uk/pdfs/publications/commissioned_reports/542.pdf).

Between publication of the 2015 report in November 2016 and writing the present report, the SRMC has started to progress a programme of meetings with Scottish Raptor Study Group members who contribute data to the SRMS. These meetings are aimed at documenting changes in coverage and effort in their long-term study areas over time, so that rigorous temporal trends in breeding numbers and productivity can be produced whenever possible.

The SRMG have set a priority order and indicative timescales for trends development,

based on the mutual needs of SRMS partners (Table 2), and recent work has focused on Peregrine & Raven. Some SRMS species do not feature in Table 2 as monitoring coverage is either considered poor and/or there are too few pairs for formal trends analysis to be undertaken currently. Trends will be published on the SRMS website once completed.

Table 2. SRMG priorities for trends production with indicative timetable for reporting (forward funding permitting).

Financial year	Priority species for trends production
Available currently on the SRMS web site	White-tailed Eagle Kestrel
2018-2019	Raven Peregrine Hen Harrier Merlin
2019-2020	Golden Eagle Red Kite Buzzard
2020-2021	Marsh Harrier Goshawk Sparrowhawk Osprey Barn Owl Tawny Owl

3 NATIONAL SURVEY - THE YEAR OF THE HEN HARRIER

The Statutory Conservation Agencies/RSPB Annual Breeding Bird Scheme (SCARABBS) provides a programme of regular national surveys of species that are not effectively covered by other national monitoring schemes. SCARABBS is UK wide, involving Statutory Conservation Agencies from across the UK including Scottish Natural Heritage, Natural Resources Wales, Natural England and Northern Ireland Environment Agency. The surveys happen over a 6–12 year cycle and SRMS data are essential in planning and coordinating these surveys successfully. Surveys under the programme allow national population estimates to be derived. The SRMS data also complement the periodic SCARABBS surveys by giving us a picture of how the species are faring in the intervening years between the national surveys. In 2016, Hen Harriers were surveyed across the UK and Isle of Man, a survey funded by SNH, NRW and RSPB and coordinated by RSPB. Read on to learn more about what this survey involved from the survey organiser Dr Simon Wotton (Senior Conservation Scientist, RSPB).

SUMMARY

The Hen Harrier population in the UK and Isle of Man was surveyed in 2016, the fifth survey since 1988/89. The aims of the survey were to provide updated estimates of population size, distribution and breeding success, to identify trends and to provide data for further analyses of drivers of population change. In Scotland, the survey was carried out by members of the Scottish Raptor Study Group, six research assistants employed by the RSPB Centre for Conservation Science, and other volunteers and staff of conservation organisations. In 2016, there were an estimated 575 (95% confidence limits 477–694), territorial pairs in the UK and Isle of Man, a non-significant decline of 13% since 2010. Scotland held the majority of the population with 460 (359–573) territorial pairs, a statistically non-significant decline of 9% since 2010.

PLANNING

Planning for the survey in Scotland began in September 2015 and involved RSPB, the SRSG and SNH. An updated breeding range, defined by 10 km square, was collated from the 2010 national survey results, the 2007–11 Bird Atlas (Balmer *et al.* 2013), annual data from SRMS (from 2010 onwards) and records from other sources. Each 10 km square was classified as belonging to one of two strata:

Upper – all 10 km squares containing Special Protection Areas (SPAs) designated for Hen Harrier plus all 10 km squares with >50% Hen Harrier habitat cover (from Hen Harrier Framework; Fielding *et al.* 2011) and with breeding records between 2010 and 2015 (216 squares).

Lower – all other 10 km squares in the defined breeding range (434 squares).

In early 2016, the Hen Harrier survey coordinators for each SRSG branch identified which of the 10 km squares in the breeding range could be covered by SRSG members. A stratified random selection of the remaining 10 km squares, by region, was undertaken to select squares for coverage by RSPB field staff to ensure sufficient 10 km squares would be surveyed within each region and within each stratum.

SURVEY METHODOLOGY

The survey methods followed the standard methods from previous national surveys. Surveys were carried out in suitable weather conditions from the beginning of April to the end of July. A minimum of two visits were made to each 10 km square. If breeding was not confirmed during the two visits, a third visit was recommended between late June and the end of July. It should be noted that many areas

covered by SRSF members received more than three visits.

All potentially suitable breeding habitat within each 10 km square was surveyed. Surveys were conducted through a combination of searches and scanning suitable habitat from appropriate vantage points. Where Hen Harriers were observed, information was collected on the location: six-figure grid reference; the number and sex of birds; the behaviour of the bird(s); the dominant habitat within 100 m of each sighting; and any evidence of nesting. As Hen Harriers can be polygynous, observers were advised to continue searching in the vicinity of confirmed pairs for additional nests. On subsequent visits, all suitable habitat was searched again and attempts were made to confirm breeding at all locations where birds were recorded on the previous visit.

RESULTS

Across Scotland, 334 10 km squares were surveyed compared to 213 squares in 2010

(+55%). In the UK and Isle of Man, the number of territorial pairs was estimated at 575 (95% Confidence Limits, 477–694), a non-significant 13% decline since 2010. The UK total (excluding the Isle of Man) was estimated at 545 territorial pairs (95% CI, 447–664), but was not significantly different from the 2010 estimate of 633 territorial pairs (95% CI, 547–741). The Scottish population estimate was 460 territorial pairs (95% CI, 359–573) in 2010, 9% lower than the estimate of 505 territorial pairs (95% CI, 417–612) in 2010, although this population change was not statistically significant.

Scotland held 80% of the total UK and Isle of Man Hen Harrier population (compared to 76% in 2010).

As in previous surveys, the West Highlands held the largest proportion of the Scottish population (40%). Considering only the subset of 10 km squares surveyed in both 2010 and 2016 (Figure 9), there was evidence of decreases in territorial pairs in the East Highlands (-51%), North Highlands (-47%),



Figure 8. Hen Harrier brood in Perthshire. (Photo: Keith Brockie, Tayside RSG).

Southern Uplands (-61%) and West Highlands (-25%), which needs further investigation. The highest density of territorial pairs was on Orkney, with 19.8 territorial 'pairs' per 100 km² of suitable habitat; across Scotland, including Orkney, the average density was 2.0 territorial pairs per 100 km² of suitable habitat. The

results from the UK and Isle of Man survey are analysed and discussed fully in a scientific paper which has been submitted (Wotton *et al.* submitted).

Table 3 presents the summary of the breeding success of Hen Harrier in Scotland in 2016 based on data submitted to the SRMS.

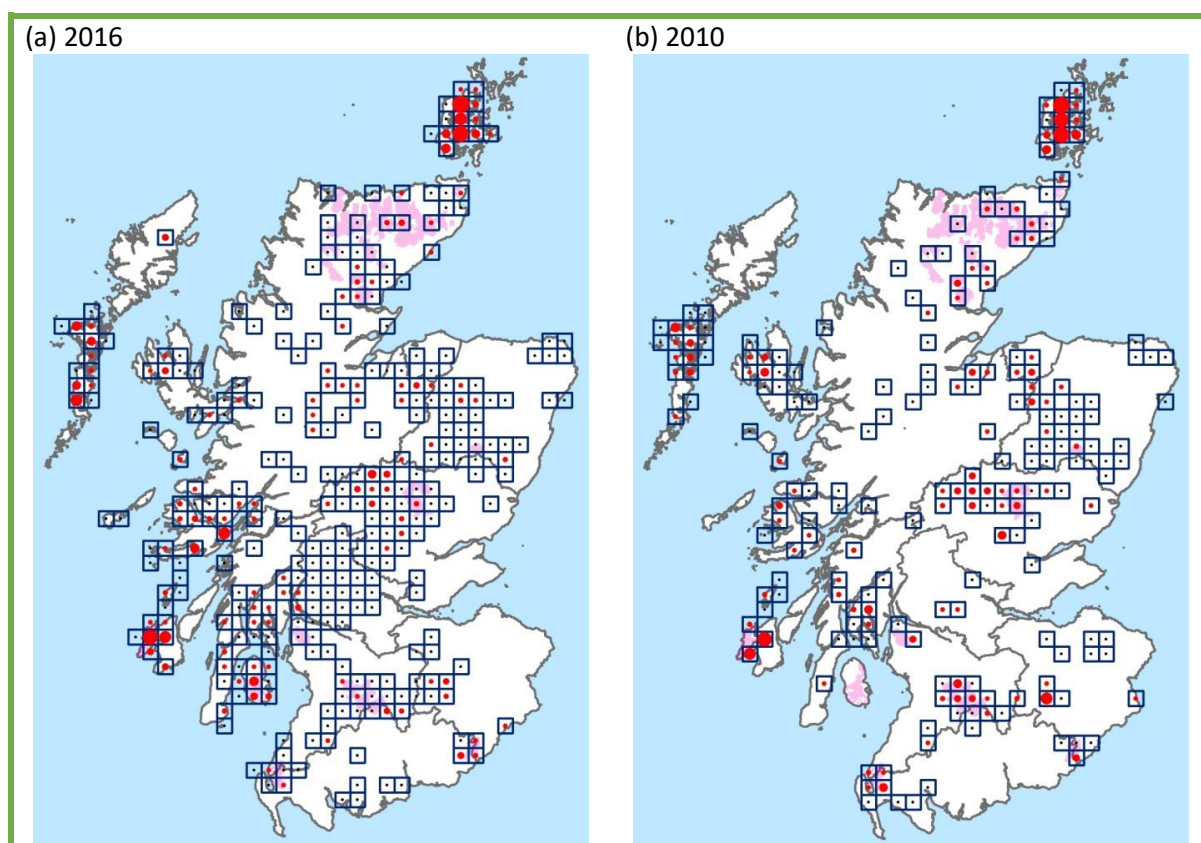


Figure 9. Survey coverage in Scotland in (a) 2016 and (b) 2010, with black dots within each square signifying zero counts and graduated red circles showing the number of territorial pairs (scale 1-29). Areas shaded pink are SPAs for Hen Harriers.

Table 3. Breeding success of Hen Harrier in Scotland in 2016. N.B. The presented total of 431 observed home ranges occupied by pairs differs from the estimated total number of 460 territorial pairs from the national survey.

Region	Home ranges checked	Home ranges occupied by pairs	Home ranges occupied by single birds	Pairs monitored	Pairs failing early or non-breeding	Pairs known to lay eggs	Pairs known to hatch eggs	Pairs known to fledge young	Minimum number of young fledged	Productivity (Young fledged per successful pair)	Productivity (Young fledged per pair laying eggs)	Productivity (Young fledged per pair occupied home range monitored)
Argyll	149	107	12	76	0	68	53	47	122	2.7 (n=45)	1.8	1.6
- Argyll Islands	101	82	8	58	0	53	39	38	98	2.6 (n=37)	1.8	1.7
- Argyll Mainland	46	24	4	17	0	14	13	9	24	2.6 (n=8)	1.6	1.4
- Bute	2	1	0	1	0	1	1	0	0	-	-	-
Central	45	5	2	4	0	4	2	2	5	2.5 (n=2)	1.2	1.2
- Arrochar & Helensburgh	14	5	0	4	0	4	2	2	5	2.5 (n=2)	1.2	1.2
- Clackmannanshire	1	0	0	0	0	0	0	0	0	-	-	-
- Dunbartonshire	5	0	1	0	0	0	0	0	0	-	-	-
- North Lanarkshire	2	0	0	0	0	0	0	0	0	-	-	-
- Stirling	23	0	1	0	0	0	0	0	0	-	-	-
Dumfries & Galloway	33	9	2	9	2	7	7	7	28	4 (n=7)	4	3.1
Highland	138	63	13	37	2	29	18	13	28	2.2 (n=13)	1	0.8
- Badenoch & Strathspey	12	6	2	3	0	3	3	2	4	2 (n=2)	1.3	1.3
- Caithness	11	7	2	0	0	0	0	0	0	-	-	-
- Inverness-shire	19	10	1	8	0	6	3	2	4	2 (n=2)	0.7	0.5
- Isle of Skye	13	5	3	5	0	4	2	0	0	-	-	-
- Lochaber	12	5	0	3	0	1	0	0	0	-	-	-
- Nairn	2	0	0	0	0	0	0	0	0	-	-	-
- Ross-shire	16	3	1	2	0	2	2	1	5	5 (n=1)	2.5	2.5
- Small Isles	5	4	0	4	0	3	3	3	6	2 (n=3)	2	1.5
- Sutherland	26	13	3	3	0	3	2	2	4	2 (n=2)	1.3	1.3
- Unknown	5	3	1	2	2	0	0	0	0	-	-	-
- West Moray	17	7	0	7	0	7	3	3	5	1.7 (n=3)	0.7	0.7
Lewis & Harris	4	4	0	4	0	4	2	2	2	1 (n=2)	0.5	0.5

Region	Home ranges checked	Home ranges occupied by pairs	Home ranges occupied by single birds	Pairs monitored	Pairs failing early or non-breeding	Pairs known to lay eggs	Pairs known to hatch eggs	Pairs known to fledge young	Minimum number of young fledged	Productivity (Young fledged per successful pair)	Productivity (Young fledged per pair laying eggs)	Productivity (Young fledged per pair occupied home range monitored)
- Lewis	4	4	0	4	0	4	2	2	2	1 (n=2)	0.5	0.5
Lothian & Borders	16	9	5	9	0	8	7	4	12	3 (n=4)	1.5	1.3
- Lothian	1	0	1	0	0	0	0	0	0	-	-	-
- Scottish Borders	15	9	4	9	0	8	7	4	12	3 (n=4)	1.5	1.3
Northeast Scotland	40	9	5	2	0	2	2	2	6	3 (n=2)	3	3
- Aberdeenshire	34	4	4	1	0	1	1	1	4	4 (n=1)	4	4
- East Moray	6	5	1	1	0	1	1	1	2	2 (n=1)	2	2
Orkney	239	124	11	124	76	48	33	14	32	2.3 (n=14)	0.7	0.3
South Strathclyde	113	30	5	30	4	15	13	11	23	2.1 (n=11)	1.5	0.8
- Arran & Cumbrae	34	18	2	18	0	11	10	10	20	2 (n=10)	1.8	1.1
- Ayrshire	45	7	2	7	4	1	1	1	3	3 (n=1)	3	0.4
- Inverclyde	12	0	1	0	0	0	0	0	0	-	-	-
- Renfrewshire	8	0	0	0	0	0	0	0	0	-	-	-
- South Lanarkshire	13	5	0	5	0	3	2	0	0	-	-	-
- Unknown	1	0	0	0	0	0	0	0	0	-	-	-
Tayside	110	32	20	24	2	20	17	12	23	1.9 (n=12)	1.1	1
- Angus	8	0	1	0	0	0	0	0	0	-	-	-
- Fife	1	0	0	0	0	0	0	0	0	-	-	-
- Perth & Kinross	101	32	19	24	2	20	17	12	23	1.9 (n=12)	1.1	1
Uist	56	39	11	20	0	19	18	17	45	2.8 (n=16)	2.5	2.3
- Benbecula	3	2	1	2	0	2	2	2	6	3 (n=2)	3	3
- North Uist	26	16	7	5	0	5	4	3	9	3 (n=3)	1.8	1.8
- South Uist	27	21	3	13	0	12	12	12	30	2.4 (n=11)	2.4	2.2
TOTAL:	943	431	86	339	86	224	172	131	326	2.5 (n=128)	1.5	1

4 HOW HAVE SRMS DATA BEEN USED OVER THE LAST YEAR?

The Scottish Raptor Monitoring Scheme aims to help get the raptor data that we hold to those conservation bodies that can best use it to benefit raptor conservation, whether they are a statutory agency or non-governmental organisation. In 2016, with SRMS data contributors' permission, SRMS data were provided for a number of purposes. BTO Scotland has been using SRMS data to undertake a piece of work on modelling Raven populations to provide background information to SNH with regard to ongoing decisions with respect to issuing licenses for Raven control. Please read on to find out more about this important piece of work.

Population modelling for the Scottish Raven population

by Dr Chris Wernham (BTO) and Dr Mark Wilson (BTO)

RAVEN ECOLOGY AND STATUS

Ravens (*Corvus corax*) are highly intelligent members of the crow family that have adapted to a wide range of ecological circumstances. They rely on eating carrion in many situations but they are not obligate scavengers, and also take a wide range of live prey, eggs and plants. Ravens were once widespread across the UK, occupying almost all terrestrial habitats. Numbers declined steadily from the mid-17th Century, with a low point in population at the start of the 20th Century, by which time the distribution had contracted into the uplands of western Britain.



Figure 10: Raven on the South Ayrshire coast. (Photo: Angus Hogg, South Strathclyde RSG).

The decline of Ravens was caused by a range of factors, including changes in livestock farming practices, reduction in human waste associated

with settlements and killing (both deliberate and accidental) associated with farming and game management. Since the low point, the UK population of Ravens has increased in size and expanded its range once more, now occupying most of its previous range, with the exception of some eastern areas (e.g. north-east Scotland). The recovery in both range and numbers has led to concerns about renewed damage to livestock and, in some cases, also to game bird and other wild bird populations.

GRANTING OF LICENCES TO CAPTURE OR KILL RAVENS

Ravens are protected by law, so it is illegal to capture or kill wild Ravens unless under the terms of a licence. The numbers of applications for such licences submitted to SNH, the number of licences granted in response to these applications, and maximum number allowed to be shot, have all increased in recent years. SNH has a duty to ensure that such licensed control does not impact adversely on the conservation status of the Raven in Scotland. The objective data collated by the SRMS has an important role to play in such decision making, and members of the SRSRG who monitor Ravens granted BTO Scotland permission to access the SRMS dataset for a study to assess the evidence base on behalf of SNH.

STUDY AIMS

The aim of this study is to assess the current level of knowledge of Scottish Raven populations and the likely effects of different levels of licensed control, using the best

available demographic information from a range of sources. It will also assess the levels of certainty that can currently be attached to the predicted outcomes of licensed control, and give guidance on any gaps in knowledge that would be most beneficial to fill in order to increase confidence in the study's findings (and, therefore, licensing decisions).

HOW SRMS DATA HAVE BEEN USED

Information from the SRMS has been used to derive breeding Raven densities in areas where intensive surveys have been undertaken. These were compared with spatial variation in relative abundance estimates from the BTO/BirdWatch Ireland/SOC Bird Atlas 2007-11 project, in order to derive population estimates for Scotland (Figure 11).

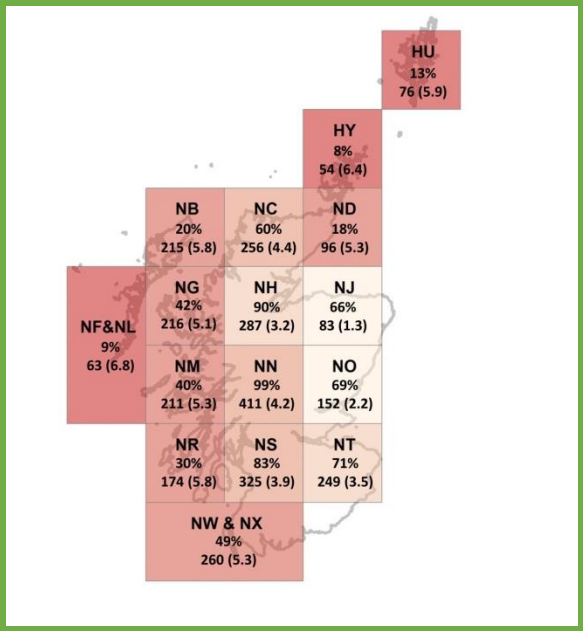


Figure 11. Variation in the estimated number and density of breeding Raven pairs in 100 km grid squares across Scotland, shaded according to estimated population density. The percentage of the square occupied by land is given, followed by the number of breeding pairs estimated for the square, and the density (pairs per hectad) in brackets.

Breeding productivity information from the SRMS was also used to provide national and regional estimates of productivity (Figure 12), including assessment of the extent to which this information is representative of Scottish and regional Raven populations.

In addition to SRMS data, the study has used ringing recovery information to derive survival estimates for different age classes of Raven (Figure 13), and to produce information on the movements (natal and breeding dispersal as well as seasonal movements) of Scottish ravens (Figure 14). A breakdown of dispersal distance by age class suggests that movements of more than 50 km away from

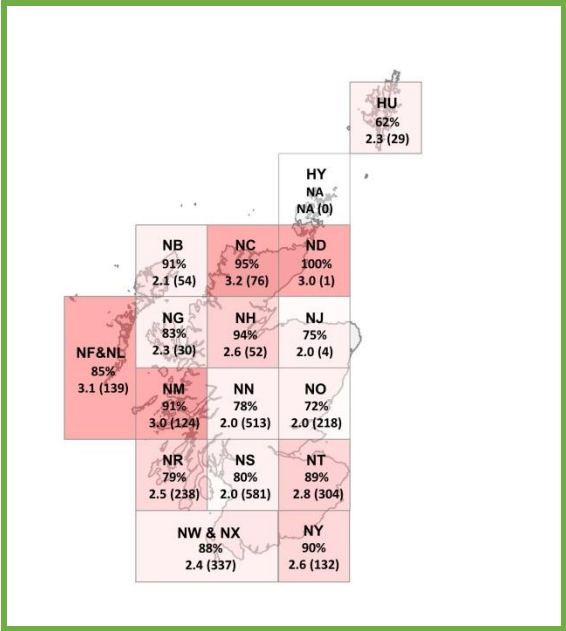


Figure 12. Variation in breeding success and productivity of Ravens from Scottish Raptor Monitoring Scheme (SRMS) data for different parts of Scotland. For each 100 km square for which breeding outcomes of nesting attempts are recorded in the SRMS, the percentage of attempts successfully fledging at least 1 young, the number of breeding attempts with known outcome and the average minimum fledged brood size recorded for breeding attempts with known outcome (in brackets) are given.

the natal site are commonest among birds aged four years old or less (Figure 15), suggesting that birds typically establish territories within 50 km of their natal site.

Current knowledge of non-breeding Raven populations in Scotland, any information on the dispersal and seasonal movement of non-breeding birds, and observed distributions of flock size, have also been collated. All of this information on demography and movements is now being used to model Raven population changes under different scenarios of licensed control, at national and sub-national scale. At the latter scale, it is important to contrast the established Raven populations in the west with recovering populations in the east of Scotland.

WHAT NEXT?

The findings are expected to be published in an SNH Commissioned Report in early 2018.

THANKS

We are very grateful to SRMS contributors of Raven data for allowing their information to be used for this work, and for the extra guidance and support that individual observers have provided during the course of the study. We also thanks BTO colleagues Aonghais Cook, Cat Horswill, Rob Robinson, Nick Moran and Simon Gillings for their supportive contributions.

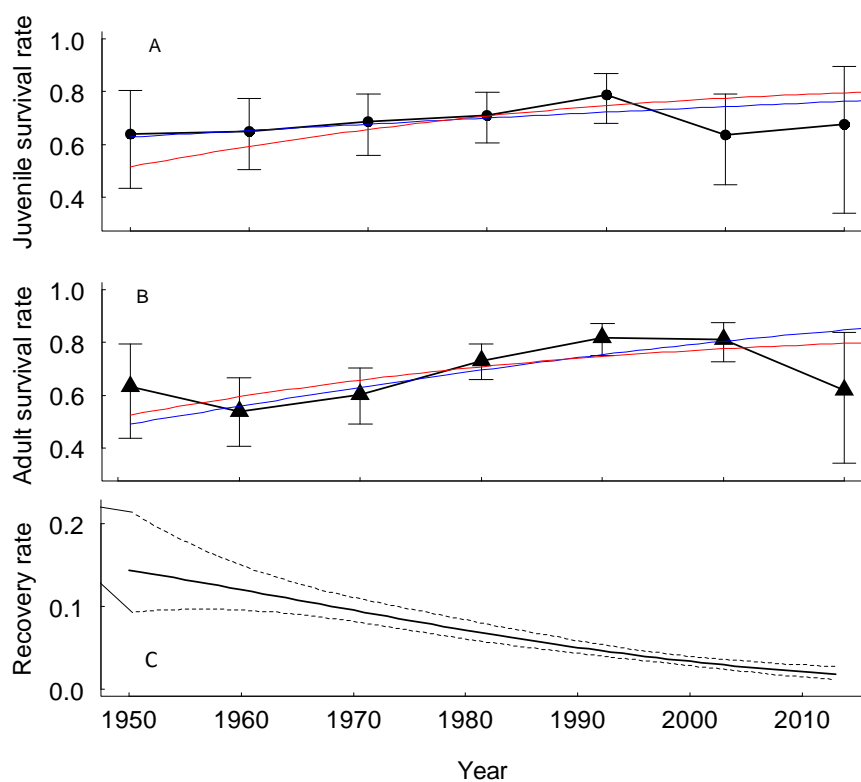


Figure 13. (A) The survival rates of juvenile British Ravens 1950-2013; modelled in 10 year blocks with an interaction between the age classes (black line and 95% confidence interval), modelled as a linear function with an interaction between the age classes (red line), and modelled as a quadratic function with an interaction between the age classes (blue line). (B) The survival rates of British Ravens older than age one, model structures as detailed for plot A. (C) The recovery rate of rings from British Ravens 1950-2013 modelled as a quadratic function of time. Data from the BTO Ringing Scheme.

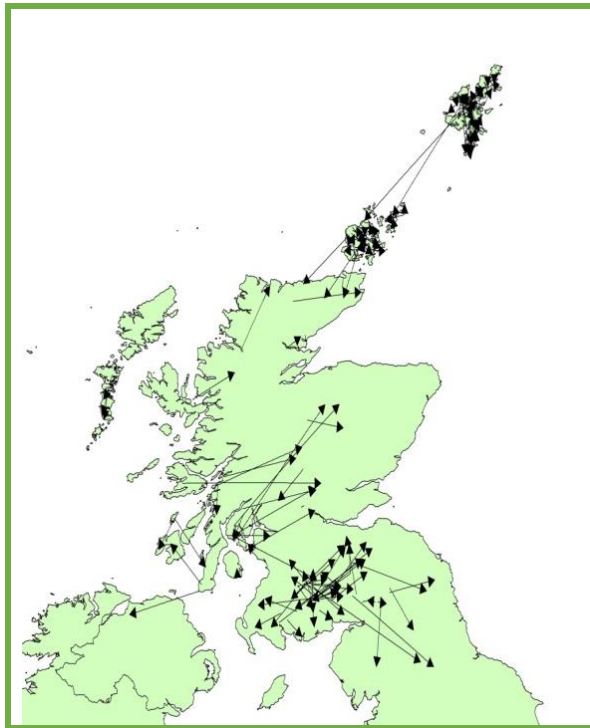


Figure 14. Dispersal of Ravens ringed as chicks in nests in Scotland since 1950 from BTO Ringing Scheme data. Arrows show direction of movement between ringing and recovery. The mean distance travelled for birds ringed in Scotland was 33.36 km.

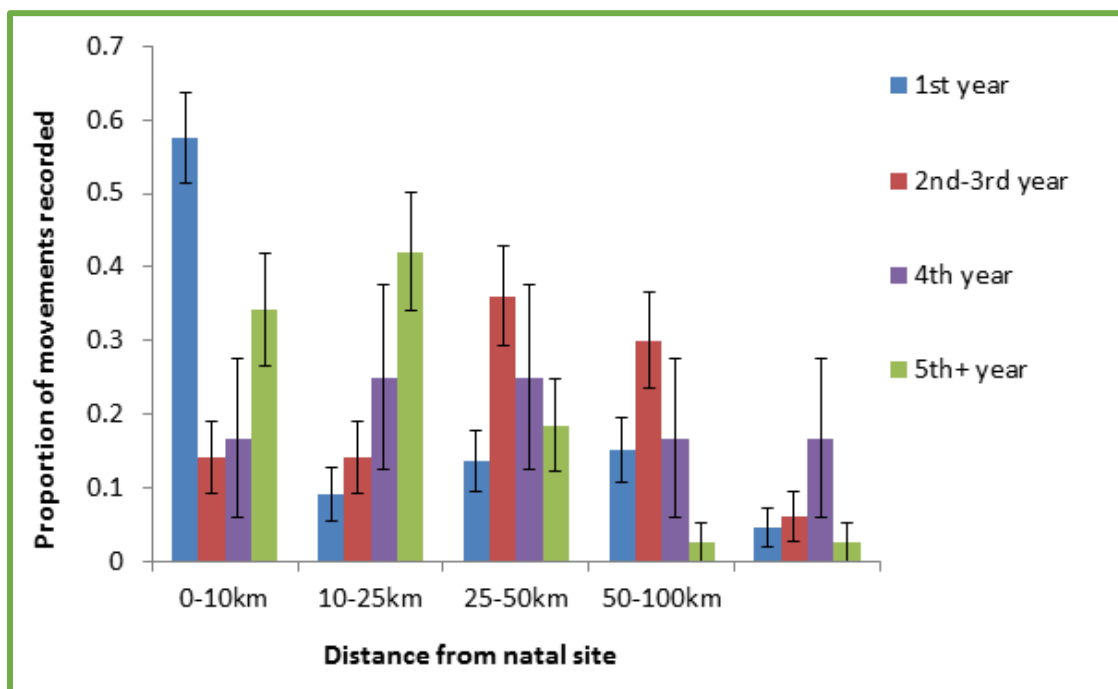


Figure 15. Dispersal distances according to age class for all recoveries, up to 2015, of Ravens ringed as nestlings in Scotland (n=178). Error bars represent standard errors.

Work is ongoing in 2017–18 to finalise a SRMS Data Sharing & Use Policy to ensure that the data we hold can be more readily accessible to conservation professionals within our partner organisations working to benefit raptors

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