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Scottish Raptor Monitoring Scheme Annual Report 2023

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Front cover image: Long-eared Owl *Asio otus* (Gaby Peniche, Lothian & Borders RSG).
Back cover image: Peregrine Falcon *Falco peregrinus* (Philip Croft, BTO).

Foreword

Welcome to the slightly belated 2023 report of the Scottish Raptor Monitoring Scheme. Firstly, I'd like to welcome Gaby Peniche to the Scheme coordinator role having replaced Amy Challis who has moved on to another role within BTO though still with some input into the Scheme. Amy has carried the baton with distinction for more than a decade, and we wish her well. Gaby will be known to some of our readers through her PhD on raptor health and is well placed to take on the role.

2023 saw the latest national Hen Harrier survey and it is pleasing to see that it achieved even higher coverage than previous surveys and recorded an increase in the Scottish population to approximately 529 pairs, from 460 in the 2016 survey. SRMS data played an important role in planning the survey in Scotland and SRMS contributors carried out a large proportion of the fieldwork. More details of the survey can be found in the article by Leah Kelly of the RSPB.

The Scheme continues to receive a large volume of records. The species accounts highlight where coverage is good and where even more effort, including new volunteers, would be welcomed to help improve coverage further. Leading from that is the article looking at how we are assessing and planning to improve coverage generally, working with an advisory science group and the volunteer base. This has added impetus following the passing of the Wildlife Management and Muirburn (Scotland) Act in 2024 which will require the Scottish Government to report on the status of Golden Eagle, Hen Harrier, Peregrine and Merlin every five years.

SRMS partners continue to make regular use of the Scheme's data for a range of important purposes including statutory requirements, and it is good to see another year of data added to the data portal. Highly Pathogenic Avian Influenza (HPAI) is still with us and still showing signs of affecting raptors in Scotland though some of the impacts appear not to be as great as they are elsewhere in the world. For instance, there is significant concern about impacts on Peregrine, and Bald Eagle in the USA, whereas in Scotland there is limited impact detected so far in Peregrine and with the sympatric White-tailed Eagle the main impact appears to be depressed breeding success rather than mortality overall. NatureScot commissioned BTO to carry out an analysis of the 2023 SRMS data for impacts of HPAI to follow up on the report on the 2022 data which had detected evidence of HPAI impacts particularly on the productivity of Golden and White-tailed Eagles, with evidence of some smaller impacts on other species. The analysis of 2023 SRMS data for impacts of HPAI has been completed and is in the process of publication. SRMS contributors and data also produced several research articles on the effects of HPAI just published in a special issue of the journal Bird Study.

As ever, particular thanks to all those who have contributed records; to the partner organisations which provide funding and in-kind contributions; and the partner representatives who help oversee the Scheme. Special thanks once again to Gaby, Amy and colleagues at BTO Scotland for their hard work collating and analysing the data.

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

Contents

1 SYNOPSIS OF THE RAPTOR MONITORING SEASON IN 2023

Thanks to the expertise and volunteered time of over 400 data contributors, the Scottish Raptor Monitoring Scheme received 6,154 records from raptor home ranges checked in 2023. Of these, a total of 5,982 records (97%) were available to be used for SRMS reporting, thanks to most data contributors giving explicit permission for their data to be used in this way. This is an increase of c.11% on the previous year and represents another tremendous effort from SRMS contributors, giving up thousands of days of their time to comb the Scottish landscape to monitor raptor populations.

This section provides an overview of the 2023 breeding season, setting the scene with a look at the weather conditions and prey situation that Scottish raptors experienced in 2023. Here, we also provide a summary of the records received from each region of Scotland in 2023, along with some species highlights, and provide links to more detailed information on the SRMS website.

WEATHER

Overall, 2023 was a rather wet and warm year, aligning with UK Climate Projections (UKCP), with winters becoming warmer and wetter and summers hotter and drier. However, these warm conditions were punctuated by cold snaps in mid-January and mid-March. There were record-breaking temperatures in June, a heatwave in September, and multiple storms through autumn and winter. The year included the UK's sixth wettest March and July, and eastern Scotland had the wettest October on record since 1836 (by a large margin). Western Scotland aside, the UK experienced a wetter than average year, with 111% of the annual average rainfall.

VOLE ABUNDANCE

Cyclic changes in the annual and seasonal abundance of voles, which can see some UK vole populations fluctuate with a tenfold difference between peaks and troughs (Korpimäki 2003; Lambin *et al.* 2006), can have a profound effect on the number of pairs and breeding success of many raptor and owl species (e.g. Petty *et al.* 2000; Lambin *et al.* 2000). These vole fluctuations have particularly strong impacts on specialist small mammal predators, such as Kestrel, Barn Owl and Short-eared Owl (Village 1990; Korpimäki & Norrdahl 1991, Taylor 1994). An example of these fluctuations can be seen in the Scottish Borders where detailed counts of voles are made at 19 sites twice per year by Andrew Village (Figure 1). If vole populations reach a peak during the spring, predator populations can respond with increases in the number of pairs settling to breed. Similarly, brood sizes, levels of breeding success and overall productivity tend to increase. Conversely, during vole cycle 'troughs', the numbers and output of breeding pairs can be very low.

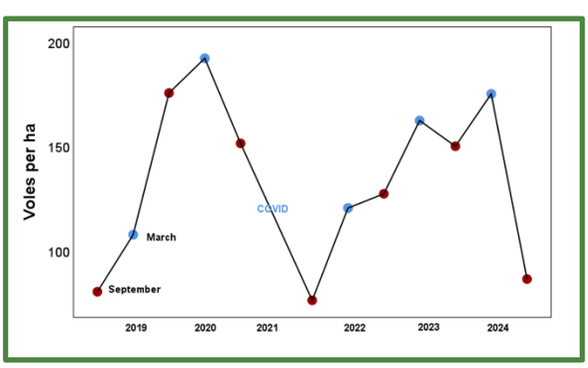

Figure 1: Estimated average numbers of voles per hectare at 19 sites in the Scottish Borders (Source: Andrew Village, Lothian and Borders RSG).

The results suggest that vole numbers in southern Scotland were fairly high in March 2023 and remained so through the year, with a slight decline by September 2023. More data on small mammal abundance across other parts of Scotland would be a useful contribution to our understanding of demographic drivers in Scottish raptors.

HIGHLY PATHOGENIC AVIAN INFLUENZA

Since October 2021 the UK has been experiencing outbreaks of highly pathogenic

avian influenza (HPAI) of the subtypes H5N1 and H5N5 in wild birds (Cunningham *et al* 2022; Günther 2024), mostly reverting to H5N1 subtype. Initial effects were apparent in wintering waterbirds and, subsequently, breeding seabirds, but testing of dead birds showed that the virus was affecting a wide range of other species, including several raptors. An analysis of SRMS data compared the breeding performance of 12 raptor species in 2022 to that in previous years (Wilson *et al*., 2023). As reported in the previous SRMS Annual Report, the results showed declines in breeding success of Golden Eagle and White-tailed Eagle consistent with impacts of avian influenza. For other raptor species, breeding success in most areas was similar to that in previous years.

The BTO journal Bird Study has just published two special issues with research on HPAI, including a summary of the above-mentioned report on SRMS data, two articles from SRMS contributors on bird flu in Buzzards and Peregrines in Scotland, and an article on the use of ring recovery data to assess the impacts of HPAI on birds including Red Kites: https://www.tandfonline.com/journals/tbis20/collections/Highly_Pathogenic_Avian_Influenza. All articles are free to view for three months from June 2025. After that, where not openly accessible, articles are available from authors.

MONITORING

Broadly, raptor monitoring in Scotland involves visiting known home ranges and other areas of suitable habitat. These visits are timed to detect signs of home range occupancy and, in occupied home ranges, to determine the outcome of any breeding attempts (Hardey *et al.* 2013, https://raptormonitoring.org/need-advice-on-monitoring). In 2023, a total of 5,982 raptor home ranges in Scotland were checked for occupancy (Table 1).

Figure 2 shows a summary of raptor monitoring coverage in 2023, depicting 10-km squares where suitable habitat or known home ranges of one or more species were checked. Not all these 10-km squares were found to hold pairs. Some checked home ranges held single birds and others were recorded as vacant. Tables 1 and 2 provide regional breakdowns of home ranges checked in 2023.

Species-specific and regional breakdowns showing the results of monitored breeding attempts will appear on the SRMS website: https://raptormonitoring.org/.

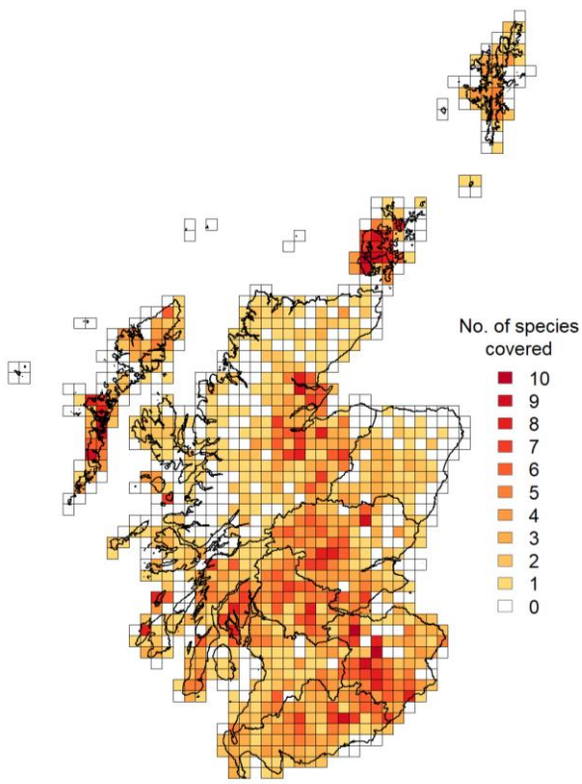

Figure 2: Raptor, owl and Raven monitoring coverage in Scotland in 2023. This map illustrates the number of SRMS species for which occupancy was checked in each 10-km square. The redder (darker) the square, the more species were covered. The maximum number of species checked for occupancy in a single square in 2023 was 10, from a total of 20 species. White squares received no monitoring records for 2023. Note that this figure masks variation in coverage at finer geographic scales, and work is ongoing to improve our knowledge of coverage.

DATA SUBMISSION & SRMS ONLINE

We are very pleased to report that submissions of records via SRMS Online continue to increase. It is rewarding to see that a proportion of records for all 20 SRMS species is now reaching the scheme via SRMS Online. Since 2020 there has been a steady rise in online reporting: 3% of SRMS records in 2020, 27% in 2021, 38% in 2022 and 39% in 2023.

We are very grateful to all recorders who are using the system and are providing feedback and ideas to improve it further.

Many users provided feedback through an SRMS questionnaire in early 2024, and we are working with an 'SRMS Online ideas sharing group', formed of data contributors and scheme partner representatives, to discuss, suggest and test system features to continue to improve SRMS Online.

The SRMS Coordinator will continue to offer training and support for new and existing users of SRMS Online and is always available to help (srms@bto.org).

SRMS Online is the preferred data entry system for several reasons. When recorders use the online system, they are essentially entering data directly into the central database. This significantly reduces the need for additional processing and potential for errors (e.g. entering multiple sources of information from email, phone or spreadsheet submissions, checking for duplicate records or typos in grid references) and thus increases the accuracy of results drawn from the data.

Another important advantage of SRMS Online is that it supports visit-by-visit recording. Knowing when visits took place and what was observed on each occasion allows us, for example, to calculate daily nest survival rates throughout the nesting season ("Mayfield analysis"). This is a more comprehensive measure of breeding success than the proportion of monitored nests that successfully fledge young.

Visit-by-visit data also allow calculating laying dates, which have been shifting earlier in the year for several species (Wilson *et al.* 2021, Figure 3), requiring nest protection measures to be adjusted, such as an earlier end to the muirburn season (31st March) implemented in the new Wildlife Management & Muirburn Act from 2026.

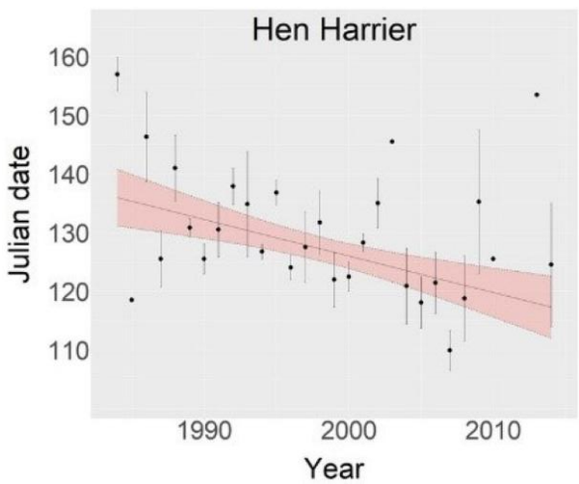

Figure 3: Change in average Hen Harrier laying dates in Britain (from Wilson *et al.* 2021). The analysis suggests that mean laying dates have advanced by about two weeks between 1985 and 2014 from around the middle of May to around the end of April (with large variations). The analysis was based on BTO Nest Record Scheme data. Analyses of this kind can now include visit-by-visit data from SRMS Online, adding a large number of available records and improving the evidence base for conservation measures, such as an earlier end to the muirburn season implemented in the Wildlife Management & Muirburn Act.

We are also very pleased to report that most contributors have now given express permission for their records to be used via the SRMS Registration Form (which became necessary following changes in privacy laws). Of the records received in 2023, less than 3% came from contributors who had not given explicit permission for their records to be used for standard SRMS purposes. These records have not been used to inform the species accounts reported here, nor for any other reporting or analysis. Unless and until this permission is granted, these records cannot be shared with SRMS partners, in line with our SRMS Data Sharing & Use Policy.

Table 1: The number of home ranges of raptors, owls and Raven checked in 2023 that were submitted to the SRMS. For a given region and species combination "-" indicates that the SRMS does not hold any previous records and "0" indicates that no records were provided for 2023 (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 the UK.

Species	Argyll	Central Scotland	Dumfries & Galloway	Highland	Lewis & Harris	Lothian & Borders	North-east Scotland	Orkney	Shetland	South Strathclyde	Tayside & Fife	Uist	**TOTAL**	Estimated population size (pairs)	Region estimate relates to	Year estimate relates to
Osprey	25	50	21	68	-	18	18	-	-	12	45	-	**257**	229	Scotland	2021[2]
Honey-buzzard	-	0	2	16	-	-	1	-	-	-	0	-	**19**	58	Scotland	2021[2]
Golden Eagle	54	12	3	124	30	4	0	2	-	1	32	22	**284**	508	Scotland	2015[4]
Sparrowhawk	16	26	2	15	2	3	1	40	26	6	14	7	**158**	30,500	UK	2016[9]
Goshawk	0	16	29	13	-	46	0	-	-	8	20	-	**132**	315	Scotland	2022[11]
Marsh Harrier	0	4	-	0	-	2	0	5	-	-	17	-	**28**	19	Scotland	2022[2]
Hen Harrier	107	10	22	69	24	16	42	277	-	44	36	63	**710**	529	Scotland	2023[10]
Red Kite	-	44	88	53	-	4	30	-	-	7	65	-	**291**	≥ 254	Scotland	2022[1]
White-tailed Eagle	41	3	-	65	29	-	0	1	-	-	6	18	**163**	148	Scotland	2022[11]
Buzzard	103	7	58	147	5	111	0	30	-	1	48	35	**545**	63,000–87,500	UK	2016[9]
Barn Owl	98	120	140	72	-	71	0	-	-	27	27	-	**555**	500–1000	Scotland	post 2004[5]
Tawny Owl	52	148	58	40	-	55	0	-	-	4	13	-	**370**	50,000	UK	2015[9]
Little Owl	-	-	-	-	-	1	-	-	-	-	-	-	**1**	<10	Scotland	2022[1]
Long-eared Owl	10	0	0	7	-	7	0	8	13	8	2	1	**56**	1,800–6,000	UK	2007-2011[9]
Short-eared Owl	12	0	0	6	2	8	0	185	5	3	19	23	**263**	620–2,200	UK	2007-2011[9]
Kestrel	12	51	18	33	4	50	0	60	-	8	67	25	**328**	2,750–5,500	Scotland	2013[6]
Merlin	1	2	8	26	19	33	60	86	50	3	23	14	**325**	733	Scotland	2008[3]
Hobby	-	-	0	0	-	0	-	-	-	-	6	-	**6**	2,050	UK	2016[9]
Peregrine	10	31	97	41	1	139	26	26	12	77	69	6	**535**	523 (479-592)	Scotland	2014[7]
Raven	96	75	40	32	9	52	0	72	59	43	70	39	**587**	3241 (1035–5447)	Scotland	2007-2011[8]
TOTAL	**637**	**599**	**586**	**827**	**125**	**620**	**178**	**792**	**165**	**252**	**579**	**253**	**5613**			

Sources of estimated population sizes: [1]Challis *et al*. 2023; [2]Eaton *et al*. 2023; [3]Ewing *et al*. 2011; [4]Hayhow *et al*. 2017; [5]Shaw 2007; [6]Wilson *et al*. 2015; [7]Wilson *et al*. 2018; [8]Wilson *et al*. 2019; [9]Woodward *et al*. 2020; [10]Kelly *et al*. 2025; [11]Eaton *et al.* 2024.

Table 2: Number of raptor, owl and Raven breeding attempts monitored (i.e. with known outcome) under the Scottish Raptor Monitoring Scheme in 2023.

Species	Argyll	Central Scotland	Dumfries & Galloway	Highland	Lewis & Harris	Lothian & Borders	North-east Scotland	Orkney	Shetland	South Strathclyde	Tayside & Fife	Uist	TOTAL
Osprey	15	29	12	57	-	16	16	-	-	11	35	-	**191**
Honey-buzzard	-	0	1	6	-	-	0	-	-	-	0	-	**7**
Golden Eagle	44	9	3	91	24	1	0	1	-	1	22	13	**209**
Sparrowhawk	8	14	2	9	1	2	1	18	19	5	9	1	**89**
Goshawk	0	11	18	9	-	34	0	-	-	3	12	-	**87**
Marsh Harrier	0	3	-	0	-	0	0	0	-	-	13	-	**16**
Hen Harrier	22	3	5	37	15	8	16	111	-	8	10	33	**268**
Red Kite	-	18	62	39	-	3	17	-	-	6	29	-	**174**
White-tailed Eagle	32	1	-	52	23	-	0	1	-	-	6	13	**128**
Buzzard	35	6	31	98	1	89	0	15	-	1	31	23	**330**
Barn Owl	63	71	85	56	-	58	0	-	-	22	23	-	**378**
Tawny Owl	25	67	28	37	-	50	0	-	-	3	12	-	**222**
Little Owl	-	-	-	-	-	0	-	-	-	-	-	-	**0**
Long-eared Owl	6	0	0	6	-	7	0	6	1	7	2	1	**36**
Short-eared Owl	3	0	0	2	0	0	0	31	2	2	9	4	**53**
Kestrel	10	36	6	19	3	25	0	16	-	7	40	7	**169**
Merlin	1	0	4	7	10	12	26	19	31	0	9	4	**123**
Hobby	-	-	0	0	-	0	-	-	-	-	1	-	**1**
Peregrine	6	15	35	14	0	48	12	9	1	28	29	4	**201**
Raven	52	45	22	19	4	33	0	51	30	25	44	30	**355**
TOTAL:	**322**	**328**	**314**	**558**	**81**	**386**	**88**	**278**	**84**	**129**	**336**	**133**	**3037**

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/).

The following species accounts draw principally on the information presented in the SRMS summary tables which can be accessed on the SRMS website:

https://raptormonitoring.org/annual-report.

If you have a genuine need for a printed copy of the tables and do not have access to a printer, then you can request a copy from the Scheme coordinator – srms@bto.org

The tables presented in this report summarise the records which the SRMS has received and passed through quality assurance processes as set out in the SRMS Data Sharing & Use Policy (https://raptormonitoring.org/srms-data/data-sharing-use-policy).

It is important to recognise that, for nearly all species, **monitoring was not carried out for all breeding pairs. This means that the numbers presented do not represent absolute population sizes 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.

Osprey

Thanks to the efforts of SRMS contributors, a large proportion of the estimated total breeding population of Ospreys in Scotland is monitored annually (Table 1). This is allowing the Scheme to calculate several national and regional trends for the species (see Chapter 3). There is room for further improvement and our ability to report on trends for Osprey would benefit from additional study areas across its range as the species continues to expand successfully.

2023 207 of 257 checked home ranges were occupied by pairs. A further 5 home ranges were occupied by single birds. Of 191 pairs that were monitored, 177 were confirmed as having laid eggs and 153 of these went on to fledge a minimum total of 298 young.

Figure 4: Osprey nestlings (Photo: Keith Brockie, Tayside & Fife RSG).

Honey-buzzard

Honey-buzzard continues to be a very under-recorded species in Scotland. However, since the 2020 national survey, organised by Honey-buzzard experts on behalf of the RBBP, we have a better understanding of the species' presence around the country. While a couple of studies for this species have been established in Tayside & Fife and in Central Scotland since 2017 (McInerny *et al*. 2017; Shaw *et al*. 2017 and McInerny *et al*. 2018) the data from these are not fully shared with the SRMS (and so do not appear in our summary tables).

2023 From records reported to the SRMS from Dumfries and Galloway, Highlands, and North-east Scotland we know that 8 of 19 home ranges checked were occupied in 2023. A further 7 ranges were occupied by single birds. Of the 7 pairs that were monitored, 6 were known to lay eggs, fledging a minimum of 7 young between them.

Figure 5: Golden Eagle fledglings, Uist (Photo: Jon Brain, Highlands RSG).

Golden Eagle

Golden Eagles are monitored very widely across Scotland, and home ranges of a substantial proportion of the estimated total breeding population are checked annually by SRMS contributors (Table 1). This monitoring enables the Scheme to calculate national and regional trends in Golden Eagle productivity as well as trends in numbers of breeding pairs for several regions (Chapter 3). There are some knowledge gaps that remain across the country. These gaps exist in part due to some remote areas having limited coverage, and in a few areas due to some monitoring data not currently being shared with the SRMS.

The South of Scotland Golden Eagle Project (SSGEP) continues to bolster the population in Southern Scotland, with over 50 birds now once again flying around the skies of Southern Scotland. Many released birds are still too young to breed, but some are beginning to pair up and settling down on territories. In 2014, during the SSGEP feasibility assessment, Fielding & Haworth (2014) suggested that the South of Scotland could support a population of 11-16 pairs. The current movements and behaviour of these birds seems to support the feasibility assessment original calculations so far. From current observations, individuals appear to be settling in areas that resemble the expected distribution of the original feasibility assessment.

2023 243 of 284 checked home ranges were occupied by pairs, with single birds or fresh signs reported from a further 24 home ranges.

Of 205 pairs that were monitored, 56 failed early or did not breed but 138 pairs were confirmed to lay eggs, of which 91 went on to fledge a minimum total of 106 young.

Sparrowhawk

Sparrowhawks are common and widespread but secretive. As such, the species is challenging to monitor. In relation to its estimated total population size, the species receives limited attention, constraining our ability to report on regional and national trends in breeding numbers and productivity. Wider monitoring of the species across the country would increase our ability to produce comprehensive regional and national trends. This is one of the key species

for which the SRMS is trying to improve coverage through the *Raptor Patch* initiative.

2023 101 of 158 checked home ranges were occupied by pairs. Of these, 89 pairs were monitored, 84 of which were confirmed to lay eggs. A total of 73 pairs went on to fledge a minimum total of 208 young. The species has been breeding successfully in Shetland since 2018 and the number of pairs monitored continues to increase each year. In 2023, 19 monitored pairs fledged 30 young.

Goshawk

The coverage of Goshawk by SRMS contributors, relative to the total estimated population, is much greater than that of its smaller cousin the Sparrowhawk (Tables 1 and 2). With their famously elusive nature and a gradually expanding population, Goshawks are very challenging to monitor comprehensively. Goshawks favour woodland with sufficient space between trees for their nest sites, and breeding sites include mature plantations as well as windblow, meaning that nest sites may be felled and therefore move from year to year, adding to the difficulty of monitoring. Additional study areas in the Goshawk's range are always welcome and would further increase the SRMS' ability to produce regional and national trends for breeding numbers and productivity.

Figure 6: Goshawk chicks in Lothian and Borders (Photo: Malcolm Henderson Lothian & Borders RSG).

2023 103 of 132 checked home ranges were occupied by pairs, with single birds or fresh signs reported from a further 13 home ranges. Of 87 pairs that were monitored, 83 were confirmed to lay eggs. 67 of these went on to fledge a minimum total of 121 young.

Marsh Harrier

Marsh Harrier continues to be a scarce breeder and passage migrant in Scotland. However, monitoring by data submitters has shown that occupation of known home ranges has been maintained for the past three years, and the number of breeding pairs continues to increase.

2023 18 of 28 checked home ranges were occupied by pairs. Of 16 pairs monitored across Scotland, 14 pairs were known to lay eggs, 12 of which went on to successfully fledge a minimum total of 33 fledglings.

Hen Harrier

Hen Harrier is monitored very widely across Scotland thanks to the efforts of SRMS contributors. Coverage in 2023 was even better than normal, due to extra monitoring effort carried out for the national survey (see pages 14-15). Important geographical gaps in annual monitoring are still present in Caithness, East Sutherland and north-east Scotland, where additional study areas would improve the Scheme's ability to produce regional and national trends in breeding numbers and productivity.

The 2023 national survey for Hen Harrier was coordinated by RSPB as part of the Statutory Conservation Agency and RSPB Annual Breeding Bird Scheme (SCARABBS) programme. Planning of the survey in Scotland was underpinned by SRMS data, and a large proportion of the fieldwork was carried out by SRMS contributors. The UK and Isle of Man Hen Harrier population was estimated at 691 territorial pairs (95% confidence limits, 593-802), a near-significant 20% increase since the last national survey in 2016. In the 2023 survey, Scotland held 77% of the population with 529 (431-640) pairs. For further details, see Leah Kelly's account of the survey in Chapter 3, and the full survey research publication, which is available from the authors: https://doi.org/10.1080/00063657.2024.2446373.

2023 419 of 710 checked home ranges were occupied by pairs with a further 73 ranges occupied by single birds. Of 268 pairs that were monitored, 221 were confirmed to lay eggs, 181 of which went on to fledge a minimum total of 485 young.

Figure 7: Hen Harrier clutch in Uist, 2024 (Photo: Jon Brain, Highlands RSG).

Red Kite

Red Kites were reintroduced to Scotland in 1989. The species is widely and effectively monitored by SRMS contributors in much of its current core Scottish range. A growing challenge is to ensure that all breeding pairs are monitored within these core areas, where population densities continue to increase, as well as in newly occupied areas in the Red Kite's steadily expanding Scottish range.

2023 222 of 291 checked home ranges were occupied by pairs. Home ranges were checked in a total of 100 separate 10x10 km squares. Eight of these squares were checked for the first time in 2023, reflecting both the continuing range expansion of the species and the ongoing monitoring efforts to keep up with this expansion. Of 174 pairs that were monitored across Scotland, 168 were confirmed to lay eggs and 143 pairs went on to fledge a minimum total of 253 young.

The species is well known to form loose colonies or clusters of breeding pairs (Hardey *et al.* 2013). In some areas pairs have been known to successfully fledge clutches when their nests have been as close as 30m from each other (Dumfries and Galloway).

White-tailed Eagle

White-tailed Eagles were reintroduced to Scotland in 1975. SRMS contributors currently achieve very good coverage of much of the population, allowing the calculation of national and several regional trends in both breeding numbers and productivity (Chapter 3). As for Red Kites, a growing challenge is to ensure that monitoring keeps up with the continued increase in this species' breeding range.

2023 148 of 163 checked home ranges were occupied by pairs. Home ranges were checked in a total of 124 separate 10x10 km squares. Nine of these squares were checked for the first time in 2023, reflecting the continuing successful range expansion of the species and the monitoring efforts of recorders to track this expansion.

Figure 8: Ringing and DNA sampling of White-tailed Eagle chick by Justin Grant and Lewis Pate, Highlands RSG (Photo: Gaby Peniche, Lothian & Borders RSG).

Of 128 pairs that were monitored, 117 were confirmed to lay eggs, 68 of which fledged a minimum total of 88 young.

Buzzard

Buzzard has not always been the commonest raptor in Scotland, but this is now very much the case. Its abundance and ubiquity make effective monitoring of this species challenging. Despite having some of the highest numbers of records submitted annually, the number reported reflects a small fraction of the national population (Tables 1 and 2). As for other common and widespread species, our ability to report on regional and national trends in breeding numbers and productivity would be

improved by a greater emphasis on area-based monitoring, with the focus on monitoring all pairs breeding within discrete study areas. Areas where abundance of Buzzards is high, but representation could be improved, are south of the Central Belt, Angus, the North-East and large parts of the Highlands and Islands. Buzzard is one of the key species for which the SRMS will be trying to improve coverage through the *Raptor Patch* initiative.

2023 377 of 545 checked home ranges were occupied by pairs, with a further 34 ranges occupied by single birds. Of 330 monitored pairs, 317 were confirmed to lay eggs. 276 of these went on to fledge a minimum total of 495 young.

Barn Owl

SRMS contributors are monitoring a significant proportion of the estimated breeding population of Barn Owls in Scotland, mostly through nest box schemes in several regions (Tables 1 and 2). Our ability to report on regional and national trends in breeding numbers and productivity of Barn Owl could improve further with additional study areas across many parts of its Scottish range, as well as better understanding of the number of pairs breeding outwith nestbox schemes.

2023 414 of 555 checked home ranges were occupied by pairs, with a further 20 sites occupied by single birds. Of 378 pairs that were monitored, 369 were confirmed to lay eggs, 332 of which went on to fledge a minimum total of 1098 young.

Tawny Owl

Tawny Owl is well monitored in several study areas, including through active nest box schemes. As a widespread and common species, our ability to report on regional and national trends in breeding numbers and productivity is limited and could be improved further with additional study areas for this species. Monitoring of pairs breeding in natural sites is challenging. Acoustic monitoring may be a promising method to help with this and increase monitoring coverage in the future (e.g. https://doi.org/10.1080/00063657.2018.1522527).

2023 238 of 370 checked home ranges were occupied by pairs. Of 222 pairs that were monitored, 220 were confirmed to lay eggs. 179 of these went on to fledge a minimum total of 373 young.

Little Owl

Little Owl reaches the northern edge of its UK range in southern Scotland and combined with an ongoing decline across its predominantly English and Welsh range, is a very scarce breeding bird here.

2023 A single record was received for a nest site occupied by a single bird checked in the Scottish Borders.

Long-eared Owl

Long-eared Owl is a widespread but scarce and challengingly secretive species to monitor and is therefore thought to be severely under-recorded throughout Scotland. However, the number of pairs monitored in 2023 was almost double that of 2021, representing a very good year for the species and a great effort from contributors.

2023 39 of 56 checked home ranges were occupied by pairs. Of 36 pairs that were monitored, 30 laid eggs and all of them were successful, fledging a minimum total of 60 young.

Figure 9: Pentlands Long-eared Owl clutch monitored by Graham Anderson and Keith Brockie (Photo: Gaby Peniche, Lothian & Borders RSG).

Following the successful breeding attempt in Shetland in 2021, no further successful attempts have been recorded there to date, but Long-eared Owls had a good year in Orkney. The number of breeding attempts has been increasing in the last few years. In 2023, 6 of 8

home ranges checked were occupied by pairs and three pairs laid eggs, each of which successfully fledged at least one young.

Short-eared Owl

Short-eared Owl is a challenging species to survey systematically. Yearly variation in the distribution and local abundance of this nomadic owl species is closely tied to patterns in the abundance of its small mammal prey. Breeding Short-eared Owls are quick to move away from areas where voles are scarce to colonise areas where voles are more abundant. Overall, it is likely that the species is under-recorded. However, a steady increase in breeding attempts has been detected in Orkney for the last three years. Together with this, the activity signs of Orkney Vole *Microtus arvalis* have been increasing (Perkins 2024), providing, hopefully, more food for Short-eared Owls. This may be related to non-native stoat eradication under the Orkney Native Wildlife Project beginning to bear fruit (Barker 2025; Perkins 2024).

2023 85 of 263 checked home ranges were occupied by pairs, with a further 77 home ranges occupied by single birds. Of 53 pairs that were monitored, 31 were confirmed to lay eggs. 30 of these went on to fledge a minimum total of 64 young.

Kestrel

Like several other widespread and common raptor species, Kestrel is challenging to monitor at national or regional scales. Thanks to the efforts of SRMS contributors, the species is monitored comprehensively in a few local study areas, but these represent a small proportion of the estimated total breeding population (Tables 1 and 2). Our ability to report on regional and national trends in breeding numbers and productivity of Kestrel would benefit from more study areas for this species. There is a particular need for more study areas in much of the Highlands, north-east Scotland and much of central and southern Scotland. Kestrel is one of the key species for which the SRMS will be trying to improve coverage through the *Raptor Patch* initiative.

2023 207 of 328 checked home ranges were occupied by pairs. Of 169 pairs that were monitored, 154 were confirmed to lay eggs. 149 of these went on to fledge a minimum total of 500 young.

Merlin

Merlin is monitored very widely across Scotland thanks to the efforts of SRMS contributors. Nevertheless, additional geographic coverage, particularly of some northern and western areas would further improve the regional and national trends in breeding numbers and productivity that the Scheme can produce.

2023 149 of 325 checked home ranges were occupied by pairs. Of 123 pairs that were monitored, 109 were confirmed to lay eggs. 92 of these went on to fledge a minimum of 268 young.

Hobby

Hobby is a scarce summer visitor to Scotland, with small numbers of records reaching the SRMS each year. This migrant breeder has significantly increased its range in the UK in recent decades and may become a more widespread breeder in Scotland.

2023 We received records of 6 checked home ranges, all in Angus. One pair was monitored and known to have laid and successfully fledged 1 young.

Peregrine

Peregrine is one of the most comprehensively monitored raptor species in Scotland thanks to the efforts of SRMS contributors. Nevertheless, additional geographic coverage of the Highland region and other regions, including urban areas, would further improve the regional and national trends in breeding numbers and productivity that the Scheme can produce.

Figure 10: Jon Brain ringing Peregrine chicks in Uist (Photo: Gaby Peniche, Lothian & Borders RSG).

2023 238 of 535 checked home ranges were occupied by pairs, with single birds or fresh signs reported from a further 35 home ranges. Of 196 pairs monitored, 158 were confirmed to lay eggs and 141 went on to fledge a minimum total of 324 young.

Raven

Raven is the Scheme's honorary raptor - it is actually a songbird(!). However, as a top predator and scavenger, it is ecologically similar to some raptors and monitoring Raven populations can tell us about some aspects of ecosystem health. SRMS contributors check many territories annually, but these represent only a small proportion of the overall estimated population which is continuing to expand (Tables 1 and 2).

Our ability to report on regional and national trends in breeding numbers and productivity would benefit from better coverage in many areas, particularly in the northern half of Scotland and in eastern areas where the species is recolonising. Along with Buzzard, Kestrel and Sparrowhawk, Raven is one of the species for which the SRMS will be trying to improve coverage through the *Raptor Patch* initiative.

2023 445 of 587 checked home ranges were occupied by pairs. Of 355 monitored pairs, 311 were confirmed to lay eggs. 286 of these went on to fledge a minimum total of 777 young.

Figure 11: Raven fledglings in the Scottish Borders (Photo: Malcolm Henderson, Lothian & Borders RSG).

Scarcer species

A single immature male Snowy Owl *Bubo scandiacus* was observed on Mainland Shetland throughout the summer of 2023. No records of other irregular breeders such as Pallid Harrier and Montagu's Harrier were reported to the SRMS for the 2023 breeding season.

2 THE SIXTH NATIONAL HEN HARRIER SURVEY

LEAH KELLY (RSPB)

The Scarce Breeding Bird Survey (SBBS; formerly the Statutory Conservation Agency and RSPB Annual Breeding Bird Scheme (SCARABBS)) provides a programme of regular UK-wide surveys of scarce bird species which are not effectively monitored by other national monitoring schemes, such as the BTO/JNCC/RSPB Breeding Bird Survey. Each SBBS survey takes place over a 6- to 12-year cycle and enables national population estimates to be derived. For surveys of scarce raptor species, SRMS data are essential in planning and coordinating the surveys successfully and complement the periodic SBBS surveys by providing a picture of how the species are faring in the intervening years between the national surveys.

As part of the sixth national Hen Harrier Survey, surveys were undertaken on the Isle of Man in 2022 and across the UK in 2023. The UK survey was funded by Natural England, Natural Resources Wales, NatureScot, Northern Ireland Environment Agency, and RSPB, and the Isle of Man survey was supported by the Gough Ritchie Charitable Trust. Here, one of RSPB's survey organisers and Conservation Scientists, Dr Leah Kelly, explains what the sixth national survey involved.

SUMMARY

Hen Harriers were surveyed across the UK and the Isle of Man in 2022/23, the sixth national survey since 1988/89. The main aim of the survey was to provide updated breeding Hen Harrier population estimates in 2023 for the UK and Isle of Man, constituent countries, Scottish regions, and UK Special Protection Area (SPA) network for breeding Hen Harrier. In Scotland, the survey was carried out by members of the Scottish Raptor Study Group (SRSG), seven contract field workers employed by the RSPB Centre for Conservation Science, and other volunteers and staff of conservation organisations, following the same approach to survey design and field methods as in previous surveys. The UK and Isle of Man population was estimated at 691 territorial pairs (95% confidence limits, 593–802), a near significant 20% increase since 2016. Scotland held 77% of the population with 529 (431–640) pairs, alongside tens of pairs in other areas.

PLANNING

Planning for the survey in Scotland began in autumn 2022 and involved RSPB, SRSG, and NatureScot. An updated breeding range, defined by 10-km square, was collated using the 2016 national survey results and post-2016 Hen Harrier sightings from other data sources including SRMS, BirdTrack, Rare Breeding Birds Panel, and RSPB.

Each 10-km square was classified as belonging to one of two sampling strata:

- High – all 10-km squares containing Hen Harrier SPAs, plus all 10-km squares with >50% suitable habitat cover for breeding Hen Harrier and with breeding records between 2016 and 2022 (355 squares).
- Low – all other 10-km squares in the defined breeding range (354 squares).

In early 2023, a stratified random selection of 'sample' squares from the defined breeding range was undertaken to ensure sufficient 10-km squares would be surveyed within each of the survey regions and within each stratum. The Hen Harrier Survey coordinators from each SRSG branch then identified which of the 10-km squares, both within the random selection and the remaining 10-km squares, could be covered by SRSG members as 'census' squares. On Orkney, a complete census was planned of all 10-km squares with recent records of occupancy.

Coverage of all suitable habitat within the identified known breeding range, defined by squares, was planned for England, Northern Ireland, Wales, and the Isle of Man.

SURVEY METHODOLOGY

The survey methods followed the standard methods adopted in previous national surveys. Surveys were carried out in suitable weather conditions from late March to early August. A minimum of two visits were made (separated by a minimum of two to three weeks if only two visits) to each 10-km square. If breeding was not confirmed during the two visits, a third visit was recommended from late June onwards. Many

areas covered by SRSG members received more than three visits.

All suitable breeding habitat within each 10-km square was surveyed. Surveys were conducted through a combination of scanning suitable habitat from appropriate vantage points, and searches whilst walking through suitable habitat. 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. Fieldworkers worked under disturbance licences from the appropriate statutory agencies.

Hen Harrier records were classified, according to the criteria followed for the previous national surveys, into proven, probable, or possible breeding categories. As with previous national surveys, the number of territorial pairs (proven and probable breeding territories) was used to estimate the breeding Hen Harrier population.

RESULTS

In the UK and Isle of Man, the number of territorial pairs was estimated at 691 (95% confidence limits (CL), 593–802). The UK total (excluding the Isle of Man) was estimated at 653 territorial pairs (95% CL, 555–764). Both represent a marginally non-significant increase of approximately 20% since 2016.

Figure 12 shows the coverage of the Hen Harrier survey in 2023 compared to that of 2016. In 2023 Scotland held 77% of the UK and Isle of Man Hen Harrier population (compared to 80% in 2016). The Scottish population estimate was 529 territorial pairs (95% CL, 431–640) in 2023, a non-significant 15% increase compared to the estimate of 460 territorial pairs (95% CL, 359–573) in 2016. As in previous surveys, the West Highlands held the largest proportion of the Scottish population (32%). The region holding the second largest proportion was the Hebrides (21%), showing a significant 125% increase between 2016 and 2023. A significant 69% increase between 2016 and 2023 was also observed in the East Highlands. No other Scottish region showed a significant change.

The results of the sixth national Hen Harrier survey are analysed and discussed in greater detail in a scientific paper which has just been published and which is available from the authors (https://doi.org/10.1080/00063657.2024.2446373, Kelly *et al.* 2025).

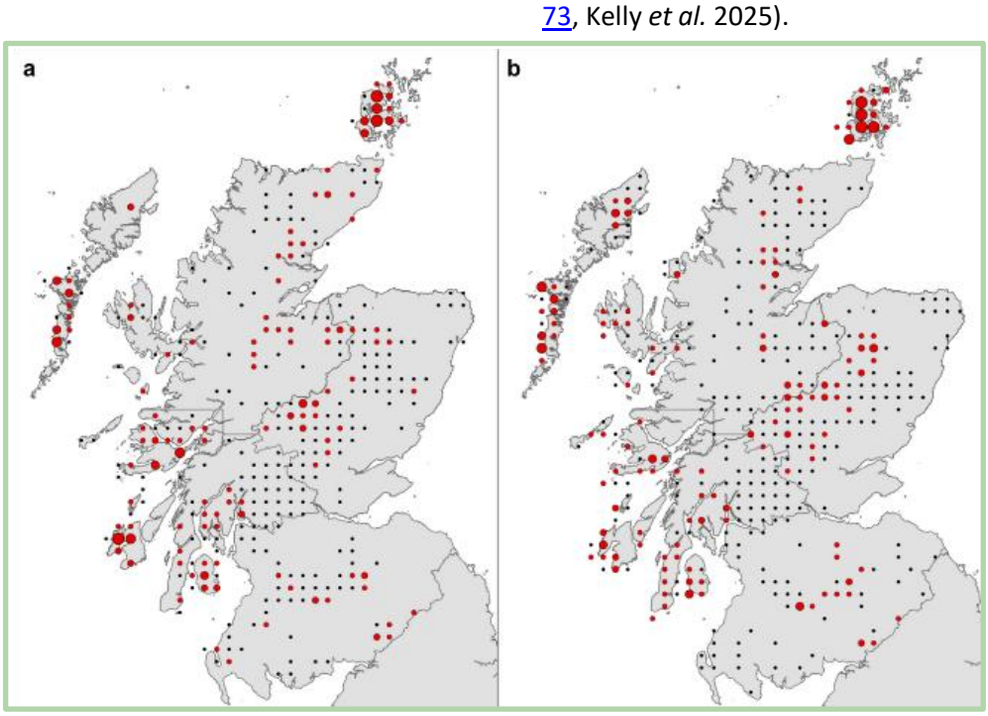

Figure 12: Survey coverage in Scotland in (a) 2016 and (b) 2023, with black dots signifying zero counts and graduated red circles showing the number of territorial pairs (scale: 1-2, 3-5, 6-8, 9-13, 14+).

3 ASSESSING SRMS MONITORING COVERAGE TO IMPROVE TRENDS IN BREEDING NUMBERS & PRODUCTIVITY

A key objective of the Scottish Raptor Monitoring Scheme is to provide robust information on Scottish raptor populations. Robust, representative data allow calculation of population trends in numbers, range and productivity. Such trends are important, as they help to monitor the health of raptor populations, understand the causes of population change, and identify problems constraining these populations. This information can advise conservation NGOs, statutory agencies and ultimately, Scottish Government to protect raptors. This section of the report provides a summary of current trend information available on Scottish raptors and current work to evaluate and enhance monitoring coverage. The ability of the Scheme to produce robust trends has gained added importance given the requirement on the Scottish Government to report on the status of Golden Eagle, Hen Harrier, Peregrine and Merlin under the Wildlife Management and Muirburn (Scotland) Act 2024.

BACKGROUND

The SRMS aims *"to provide robust information on Scottish raptor populations to determine trends in numbers, range, survival and productivity, and to understand potential causes of population change"*. Of these factors, survival is the hardest to monitor, and for this reason, the SRMS has initially concentrated on developing trends in breeding numbers and productivity using the annual monitoring data provided by Scheme contributors from across Scotland. In 2022, the SRMS published a first set of national (Scottish) and regional (SRMS Regions and Natural Heritage Zones) trends in breeding numbers and productivity (Figure 13). These were created by using breeding records submitted to the SRMS since its inception. The trends cover the period 2009-2018 and are summarised in a report (Challis *et al*. 2022).

a) b)

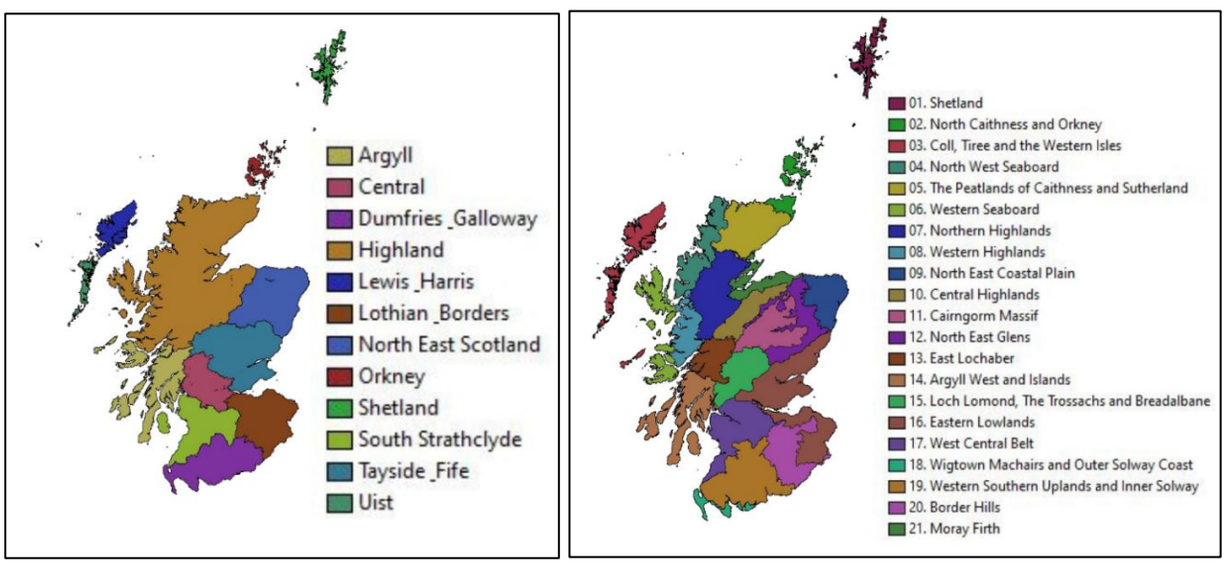

Figure 13: a) SRMS Regions for which summary trends have been produced. **b)** Natural Heritage Zones for which summary trends have been produced. A summary of SRMS regional trends for **numbers** of breeding pairs and breeding success can be found in Challis *et al*., 2022. A summary of NHZ regional trends can be viewed on the SRMS website.

Detailed trend information is published on the SRMS website (https://raptormonitoring.org/trends) where you can access trends summarised by species, by region or by parameter. You can explore and compare trends using an interactive tool (https://raptormonitoring.org/trends/explore-trends-interactively).

Following the production of national and regional trends for 2009-2018, we are currently preparing updated trends, including data from 2019 onwards. To improve robustness of these trends further for a range of important purposes, Scheme partners decided to carry out an assessment of monitoring coverage and identify ways to enhance it where required.

Assessing and enhancing SRMS monitoring coverage

Every year, contributors to the Scottish Raptor Monitoring Scheme (SRMS) generate thousands of raptor breeding records, through a colossal and largely voluntary monitoring effort spread across 20 species and 12 regions (Chapter 1). While for most species and regions, it is not possible to find and monitor all breeding attempts annually, robust trends can be produced from a representative sample of the wider population.

Many species and regions already receive large numbers and a good spread of monitoring visits across habitats and sites (Chapter 1, Wilson *et al.* 2022). Others require additional records and more representative coverage. National trends require representative coverage of most regions where a species occurs.

Population numbers and breeding productivity are best assessed from multiple areas of high survey intensity (Study Areas), where most breeding attempts are likely to be found and monitored.

The Wildlife Management and Muirburn Act requires reporting every five years on the effect of grouse moor licences including "an assessment of the conservation status, population size and range" of Golden Eagle, Hen Harrier, Peregrine and Merlin. The SRMS steering group, SRMG, has agreed that, in designing coverage for the future, SRMS will consider the information required for this monitoring.

Monitoring of raptors on grouse moors (and for other purposes) can be interpreted most robustly in the context of comparable, representative data nationally and regionally across habitats and populations, so that other drivers of population change and future changes in the areas covered by licencing can be accounted for.

Aims

The SRMS coverage assessment and enhancement work aims to:

1. Illustrate and evaluate current monitoring coverage, by species and SRMS region.
2. Determine additional coverage needs for robust regional and national trends, taking into account monitoring requirements for the Wildlife Management & Muirburn Act and where possible for protected areas.
3. Recommend ways to maintain, prioritise and enhance coverage to meet these needs, making best use of existing monitoring and the interests of volunteers.

The work is a collaboration of the SRMS partners. Feedback and input from all contributors is very important and welcome at all times. Representatives from BTO, NatureScot, RBBP, RSPB and SRSG formed a "science sub-group" to oversee and develop this work in collaboration with the scheme's steering group SRMG. Many individual SRMS contributors provided direct input through a data contributor survey in early 2024 as well as through an ideas-sharing workshop in January 2025, and we will continue to seek input and feedback from all Scheme contributors.

Evaluating current monitoring coverage

To illustrate and evaluate current SRMS coverage, we have produced maps for each species showing:

- background information about distribution and abundance of the species, using National Survey or Bird Atlas data
- annual numbers of SRMS records per 10km square, including checks of both occupied and vacant sites
- areas of high survey intensity (Study Areas), where records are closely spaced given typical territory sizes for the species, i.e. where most breeding attempts are likely to be found and monitored.

For relevant species, we have produced a second map, showing:

- areas of managed grouse moor (based on high Red Grouse abundance (Calladine *et al.* 2022) and controlled burning (Shewring *et al.* 2024)
- designated sites (Special Protection Areas)
- annual numbers of SRMS records and areas of high survey intensity as in the first maps.

The information contained in these maps is summarised in a table for each species, illustrating availability of breeding records by SRMS region / SRSG branch, and how well these records represent populations in each region, on managed grouse moors, and in protected areas.

Together, the maps and tables help to distinguish areas where species are effectively monitored from those where species are known to occur or suitable habitat exists, but current monitoring coverage is not comprehensive. These maps can also be used for understanding the potential for monitoring to detect range expansion of species such as Red Kites and White-tailed Eagles.

Understanding the availability of raptor monitoring data for designated sites can inform statutory reporting on the status of protected areas. Similarly, raptor monitoring coverage on grouse moors is relevant to statutory reporting on the conservation status of Golden Eagle, Hen Harrier, Peregrine and Merlin under the Wildlife Management and Muirburn (Scotland) Act. Understanding how trends for these species compare between managed moorland landscapes and other areas will be important.

IDENTIFYING ADDITIONAL COVERAGE NEEDS

Based on the coverage maps and tables, we are assessing where current coverage is representative, and where additional coverage is required. If funding becomes available, it will be desirable to refine these assessments using habitat suitability modelling and estimate the magnitude of detectable changes using power analysis.

Many species coordinators within SRSG branches already effectively plan and coordinate monitoring coverage. It is hoped that the maps and tables produced here will further support this process. Branch-level maps and tables can be produced if desired.

We are particularly keen to identify ways of improving monitoring coverage without placing an extra burden on existing raptor surveyors, as many are already working at full capacity to monitor the raptors in their Study Areas.

For common and widespread species, such as Buzzard, Sparrowhawk, Kestrel and Raven, the most effective way to improve coverage in many areas is likely to be through *RaptorPatch*. This remains a pilot initiative, but we are hoping to formally launch *RaptorPatch* for the 2027 breeding season, provided we can find sufficient resources to do so.

SRMS ONLINE

Supporting the increasing number of data contributors supplying their data via SRMS Online, our online data entry system is another way in which SRMS can improve the production of trends. Monitoring data are particularly valuable when they are associated with pre-defined Study Areas where surveyors aim to find and monitor all breeding pairs of one or more species.

Please delineate your Study Areas in SRMS Online and record your monitoring effort against them.

If you are comprehensively surveying an area, which has a low density of territories within it, it may not have been included in previous analyses. Setting up a Study Area in SRMS Online allows information from monitored areas with few or no birds to contribute to trends analysis.

SRMS Online allows users to define the areas they operate in on the system and to record their survey effort within these areas. This enables better understanding about the areas being monitored and any changes in coverage between years. Over time, this information will allow population trends to draw on SRMS data from a wider range of areas, making them more representative of regional and national populations and to more robustly reflect changes in abundance or productivity.

Another feature of SRMS Online that can enhance trend production is visit-by-visit data recording. Trend robustness can be affected by variation in the number, duration, and timing of visits as well as the effort spent searching for new nest sites. Knowing visit dates and what was observed on each occasion allows us to take account of this variation during trends production and can improve estimates of breeding success and other relevant parameters. For example, this information can be used to calculate daily nest survival rates ("Mayfield analysis"), a comprehensive measure of nest success which can help to take into consideration early nest failures that are difficult to observe.

The SRMS Coordinator will continue to offer training and support for new and existing users of SRMS Online and is always available to help (srms@bto.org).

Figure 14: Jon Brain monitoring and ringing White-tailed Eagles in Uist (Photo: Gaby Peniche, Lothian & Borders RSG)

4 How have SRMS data been used over the last year?

One of the main functions of the Scottish Raptor Monitoring Scheme is to curate raptor monitoring data to make them available for the benefit of raptor conservation, whether by non-governmental organisations, statutory agencies or ultimately the Scottish Government.
SRMS partner organisations make regular use of the Scheme's data for a range of important purposes including statutory requirements.
SRMS data are also made available to others on a case-by-case basis. SRMS partners have granted access to SRMS data to researchers at the BTO to investigate the drivers of the ongoing concerning declines in Kestrel numbers.
SRMS volunteers regularly author or contribute to raptor research publications. The scheme newsletter "Scottish Raptor" available on the scheme website www.raptormonitoring.org lists recent publications which SRMS has been made aware of.

Use of SRMS data by the Scheme's partner organisations

SRMS partner organisations make frequent use of the Scheme's data for a range of important purposes including statutory requirements.

For NatureScot, use of SRMS data includes ongoing statutory requirements such as reporting on protected area status, providing context information for assessments of development proposals, and informing the current review of bird monitoring priorities including planning of future national surveys.

For Scottish Forestry and Forestry & Land Scotland, SRMS data provide important background and context information, for example for assessing planting schemes and for planning harvesting operations.

For RSPB, SRMS data provide context for monitoring raptors on reserves, inform research, and provide context for wildlife crime investigations. SRMS data played an important role in planning the 2023 National Hen Harrier Survey in Scotland, and SRMS contributors carried out a large proportion of the fieldwork.

For the Rare Breeding Birds Panel, SRMS data are an important source of information, including for the RBBP's latest report "Rare Breeding Birds in the UK in 2022" published in November 2024 in the journal British Birds (Eaton *et al.* 2024). This, in turn, is an important source of information for conservation decisions (see RBBP website).

SRSG members provide the large majority of SRMS data and also regularly author or contribute to raptor research publications, including three on the effects of HPAI on raptors in Scotland (see below). The scheme newsletter "Scottish Raptor", available on the scheme website www.raptormonitoring.org, lists further recent publications which SRMS has been made aware of.

For BTO, SRMS data frequently provide important contributions to research projects – recent examples are described in the following sections.

Research into the effects of Highly Pathogenic Avian Influenza on raptors

In 2022 NatureScot contracted BTO to undertake an analysis of SRMS data to improve understanding of the impact of the Highly Pathogenic Avian Influenza (HPAI) outbreak on raptor populations in Scotland. As reported in the 2021/2022 SRMS annual report, the analysis found evidence for impacts particularly on the breeding success of Golden and White-tailed Eagles, along with some smaller impacts on other species (Wilson *et al.* 2023).

Figure 15: Dead large White-tailed Eagle chick found in the Western Isles during the HPAI outbreak in 2022. (Photo: Justin Grant, Highland RSG).

In 2023 NatureScot commissioned BTO to carry out a repeat analysis of SRMS data for impacts of HPAI, which has been completed and is in the process of publication. We will report on the findings in due course.

The BTO journal Bird Study has just published two special issues with research on HPAI, including a summary of the analysis of 2022 SRMS data, two articles from SRMS contributors on bird flu in Buzzards and Peregrines in Scotland, and an article on the use of ring recovery data to assess the impacts of HPAI on birds including Red Kites:

https://www.tandfonline.com/journals/tbis20/collections/Highly_Pathogenic_Avian_Influenza.

All articles are free to view for three months from June 2025. After that, where not openly accessible, articles are available from authors.

Further research is required to improve understanding of how populations of raptors and other species of wild birds are affected by HPAI. Some species of birds which serve as prey for raptors are recovering, developing resistance and seem to be adapting to different viral strains (Ross *et al.* 2024).

Research on drivers of Kestrel declines

Annual monitoring data have highlighted alarming declines in Kestrel numbers in recent decades: According to Breeding Bird Survey (BBS) data, Kestrel numbers have declined by 40% since 1995 for the UK as a whole, with numbers in Scotland declining much more steeply (67%) than in England (26%) (Heywood *et al.* 2024).

In some areas, predation by Goshawks has been linked to the loss of local breeding Kestrels. Increasing exposure to rodenticides is also suspected as a factor contributing to Kestrel declines. However, the overall importance of these and other factors remains largely unclear.

To understand the drivers of declines in Kestrel numbers, researchers at BTO are conducting a study to investigate habitat use and behavioural differences in adult and juvenile Kestrels using monitoring and remote tracking data. They have been constructing integrated population models using BTO monitoring data (BBS, Ringing, Nest Record Scheme) with an initial focus on the UK and England due to available data sample sizes.

SRMS partners have now granted access to SRMS data for this research project. If the sample sizes for Scotland can be increased by integrating SRMS data with Nest Record Scheme data, the project will be able to consider Scotland separately as part of the population models and explore why Kestrels have declined more strongly in Scotland than in England. We await the results of the study with interest and hope they will help to understand the reasons for Kestrel declines and inform effective measures to reverse them.

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