Scottish Raptor Monitoring Scheme
Annual Report 2015

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Front cover image: Golden Eagle chick at an eyrie in Perthshire (Keith Brockie)
Back cover image: Sparrowhawk nest in Ayrshire (Ian Todd)

Contents

Foreword

Welcome to our new-look annual report. Whilst it still contains the annual breeding summary we've added some wider content which showcases what the SRMS does and how the data we hold can be used to further raptor conservation. We hope you enjoy the new format and would welcome any feedback. Unfortunately the report has appeared later than we'd hoped for a number of reasons and we apologise for this.

In terms of the 2015 breeding season, it is good to see that monitoring levels were maintained despite it turning out to be a poor season for many species - primarily due to a combination of poor weather (spring and summer barely arrived in some areas) and a dip in the vole populations in many areas. The poor season made the national Golden Eagle survey a challenge for many raptor workers across Scotland although readers will see there has been a significant improvement in the fortunes of this iconic species in Scotland since the last national survey in 2003.

The articles in this report cover a range of topics and show how the various elements of the SRMS can link together. This is illustrated well with the example of the Kestrel. Although annual SRMS monitoring of Kestrels has improved in recent years, monitoring coverage across Scotland still remains poor. Trends drawn from SRMS data and also the BTO/JNCC/RSPB Breeding Bird Survey are less certain because of this. Gordon Riddle's long term study, the only one in Scotland, and which started before the declines, helps validate the trends drawn from broader datasets. The piloting of the *Raptor Patch* initiative aimed at increasing coverage of Kestrel along with several other widespread species, and is complementary to the current annual SRMS survey effort, will also help improve our understanding of what is happening with a species that has been 'common', and which people assumed would always be so.

I'd also highlight the causes of breeding failure work that is ongoing. Standardising how breeding failures are recorded is important as it makes the SRMS dataset more robust and objective.

Thanks are once again due to the 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 we present fewer data tables than previous editions. Species-specific and regional breakdowns showing the results of monitored breeding attempts can be found on the species-specific pages on the SRMS website: http://raptormonitoring.org/

1 ROUND-UP OF RAPTOR MONITORING SEASON IN 2015

The Scottish Raptor Monitoring Scheme currently receives more than 6000 records of checked raptor home ranges each year. This represents a tremendous amount of effort from SRMS contributors to whom we are extremely grateful. This section provides an overview of the 2015 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 2015 along with some species highlights and provide links to more detailed breakdowns on the SRMS website.

WEATHER

The winter preceding the 2015 breeding season was Scotland's sixth-wettest winter since recording began in 1910 and it was especially wet across the Northern Isles. The Scottish mountains received large accumulations of snow in January and February, especially in the west. The spring of 2015 was the second wettest spring on record for Scotland, with spring rainfall totals of 130% in Western Scotland compared to the 1981–2010 average. March was particularly wintery across Scotland's mountains and in late April there were late-season snowfalls. The snow is probably responsible for early breeding failures in some species. The summer continued to be a wet affair with western and northern Scotland, and Orkney in particular, being wetter than average.

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. see Petty *et al.* 2000; Lambin *et al.* 2000), particularly Kestrel (Figure 1), Barn Owl and Short-eared Owl (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.

Following a peak year in vole abundance in 2014, 2015 was considered to be a poor vole year in many areas, with numbers crashing in the spring. This "crash" in vole numbers in 2015 combined with poor weather at key times during the breeding season is likely to be a major factor in productivity declines.

Figure 1: Kestrel breeding success is heavily influenced by vole abundance. Here is a Kestrel brood of seven, which only occurs in years with high vole abundance. (Photo credit: Jon Brain, Highland 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 they are occupied or not. In 2015, a total of 6,608 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 2015, 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 2015 can be seen in Table 1.

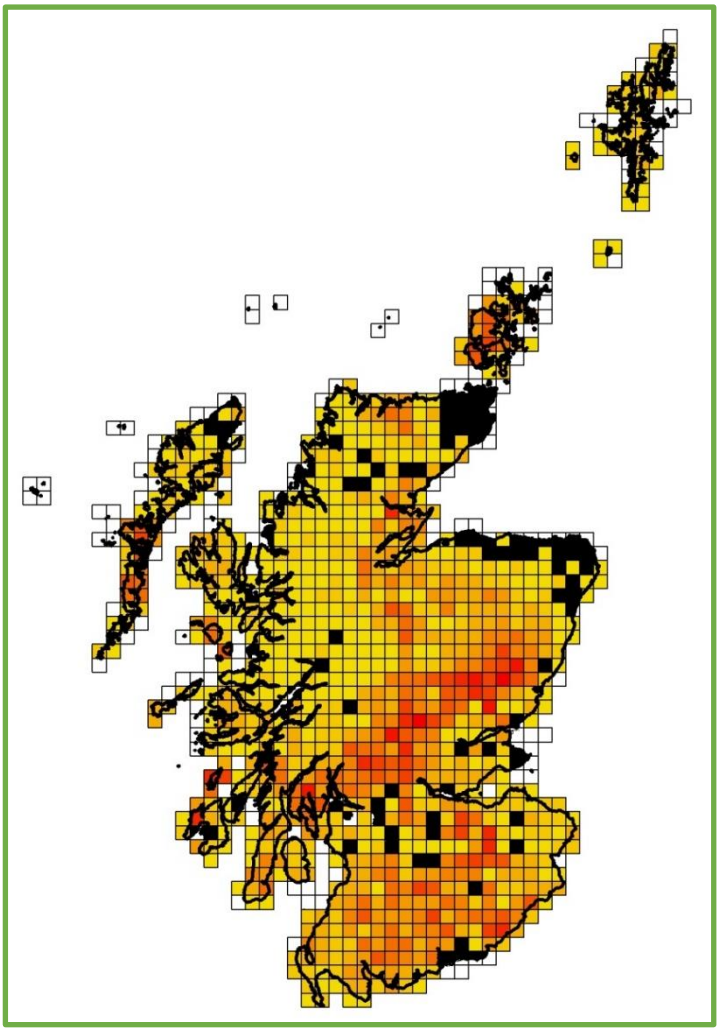

Figure 2: Raptor, owl and Raven monitoring coverage in Scotland in 2015. For each 10 km square, this map illustrates the number of SRMS species for which occupancy (or absence!) was recorded. The redder the square the more species were covered. The maximum number of species checked for occupancy in a single square in 2015 was 12. Black squares indicate no monitoring records for 2015.

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

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, can also provide an indication of the health of the population. In 2015, 3,542 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. The number of home ranges of raptors, owls and Raven checked in 2015 that were submitted to the Scottish Raptor Monitoring Scheme.

Species	Argyll	Central Scotland	Dumfries & Galloway	Highland	Lewis & Harris	Lothian & Borders	North-east Scotland	Orkney	Shetland	South Strathclyde	Tayside	Uist	TOTAL
Honey-buzzard			4								2		**6**
Red Kite		53	105	100			36				96		**390**
White-tailed Eagle	31			45	19			1			3	11	**110**
Marsh Harrier				1							7		**8**
Hen Harrier	75	13	18	46		14	10	236		40	76	33	**561**
Goshawk			40	6		51	104			12	21		**234**
Sparrowhawk	7	40	5	5		41	2	26		10	15	4	**155**
Buzzard	167	72	63	140	4	81	3	11		12	182	22	**757**
Golden Eagle	106	12	6	326	73	3	37			7	49	28	**647**
Osprey	29	42	15	103		15	41			2	75		**322**
Barn Owl	82	160	285	27		49	24			59	19		**705**
Little Owl						2							**2**
Tawny Owl	61	111	56	45		26				1	18		**318**
Long-eared Owl	6	1		11		15	8	3			16	7	**67**
Short-eared Owl	7	13	10	9		21	6	98		6	48	4	**222**
Kestrel	23	47	30	26		32		46		39	99	13	**355**
Merlin	2	3	10	69	4	40	113	72	76	19	61	7	**476**
Hobby				2							6		**8**
Peregrine	35	43	111	18		140	85	28	14	77	118	4	**673**
Raven	73	76	84	39	3	51	26		37	59	105	39	**592**
TOTAL:	**704**	**686**	**842**	**1018**	**103**	**581**	**495**	**521**	**127**	**343**	**1016**	**172**	**6608**

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

In 2015 only six records were submitted to the Scheme, four from Dumfries & Galloway and two from Tayside.

Red Kite

In 2015, 273 of 390 home ranges checked were occupied by pairs. Of 245 pairs that were monitored, 240 were confirmed to lay eggs. A total of 190 pairs went on to fledge a minimum of 347 young. In Central Scotland and Tayside, Red Kites had their worst productivity since the reintroductions began, only 1.1 young fledged per pair laying eggs.

Quite a number of dead chicks were found during nest visits in June, and these failures are likely attributable to the late snow-fall. Unusually not a single brood of three chicks was produced (Duncan Orr-Ewing pers. comm.). A recently SNH commissioned report suggests that the north Scotland Red Kite population is still constrained by illegal killing (Sansom *et al.* 2016a).

White tailed-Eagle

In 2015, White-tailed Eagles continued to expand their range over Scotland with more pairs appearing to settle and breed successfully in the North-West and Sutherland. A total of 96 of 110 home ranges checked were occupied by pairs. Of these, 91 were established breeding pairs (i.e. at least building/lining a new or existing nest), of which 75 pairs were confirmed to have laid at least one egg. A total of 49 pairs went on to

fledge a minimum of 66 young. A recently published modelling study commissioned by SNH suggests that we are likely to see this population to continue to expand in range and numbers for the foreseeable future (Sansom *et al*. 2016b).

Marsh Harrier

Marsh Harrier is a scarce breeder and passage migrant in Scotland. In 2015, eight pairs were located, one in Highland and seven in Tayside. Of six pairs that were monitored in Tayside, all were successful and together these pairs produced a minimum of 18 young.

Hen Harrier

In 2015, 303 of 561 home ranges checked were occupied by pairs with a further 58 ranges occupied by single birds. Of 276 pairs that were monitored, 181 were confirmed to lay eggs. A total of 120 pairs went on to fledge a minimum of 309 young. Average productivity was the lowest that that the SRMS has reported to date, with only 1.1 fledged young per occupied home range monitored. In North-east Scotland, three of the seven pairs that were known to lay eggs went on to fledge ten young. While these numbers do not sound very impressive when considered in context of the whole Scottish population, this is an increase on reported figures of recent years for this region, where persecution is considered to be a significant limiting factor on the Hen Harrier population (Rebecca *et al*. 2016). At the time of writing, this species is undergoing a national survey as part of the SCARABBS programme.

Goshawk

In 2015, 161 of 234 home ranges checked were occupied by pairs, with a further 16 home ranges in use (either single birds or fresh signs were reported). Of 146 pairs that were monitored, 139 were confirmed to lay eggs. A total of 108 pairs went on to fledge a minimum of 264 young. A long-term study area in North-east Scotland saw an increase in the number of breeding pairs which may in part be attributable to high levels of productivity in 2014 - about a fifth of the aged breeding females in 2015 were yearlings (Mick Marquiss pers. comm.).

Sparrowhawk

In 2015, 85 of the 155 home ranges checked were occupied by pairs. Of 69 pairs that were monitored, 62 were confirmed to lay eggs. A total of 52 pairs went on to fledge a minimum of 134 young. For such a widespread species, this species still receives limited attention from existing SRMS contributors. It is one of a number of species (including Buzzard, Kestrel and Raven) for which SRMG are working to enhance monitoring coverage (See Chapter 5: *Keeping it Local*).

Buzzard

In 2015, 565 of 757 home ranges checked were occupied by pairs, with a further 16 ranges occupied by single birds. Of 440 pairs that were monitored 414 were confirmed to lay eggs. A total of 375 pairs went on to fledge a minimum of 592 young.

Figure 3: Sparrowhawk – one of a number of SRMS species which could benefit from enhanced monitoring. (Photo credit: Harry Bell, Tayside RSG.

Golden Eagle

In this national survey year, there was a west-east split in Golden Eagle breeding success in the Highlands, with a large proportion of monitored pairs in the west failing on eggs or young (Liz Macdonald pers. comm.). Productivity was higher in the east, with one pair successfully rearing triplets, which is quite a rare event (Stuart Benn pers. comm.). In Dumfries & Galloway two pairs of Golden Eagle bred successfully, each fledging a single chick. This is the first time that two chicks have fledged in mainland southwest Scotland since 1995 (Chris Rollie pers. comm.) To see more detailed results and to learn more about the national Golden Eagle survey, see Chapter 6: *National Survey - The Year of the Golden Eagle*.

Osprey

In 2015, 216 of 322 home ranges checked were occupied by pairs. A further 21 home ranges were occupied by single birds. Of 212 pairs that were monitored, 191 were confirmed to lay eggs. A total of 154 pairs went on to fledge a minimum of 294 young. The music festival "T in the Park" held at Strathallan Castle in Perthshire drew media attention in July, not just for the music acts that performed there, but also for concerns over a pair of Ospreys that were breeding nearby (Figure 4). Despite all the human hustle and bustle in the lead up to and during the event, the pair went on to successfully fledge three young.

Figure 4: Osprey nesting tree at the music festival "T in the Park". (Photo credit: Keith Brockie, Tayside RSG).

Barn Owl

In 2015, 370 of 705 home ranges checked were occupied by pairs, with a further 53 sites occupied by single birds. Of 334 pairs that were monitored, 316 were confirmed to lay eggs. A total of 247 pairs went on to fledge a minimum of 548 young. Fieldworkers across Scotland reported a poor year for productivity, the average being 1.7 young fledged per laying pair. This contrasts starkly with the situation in 2014 when vole numbers were high and an average of 4.0 young were fledged from first attempts, with 18 pairs reported to lay a second clutch.

Little Owl

This species continues to be a very scarce breeder in Scotland, with just a single site monitored in 2015. BTO have been exploring methods for monitoring Little Owl more effectively using playback, such that a UK survey might be a possibility in the near future (Clewley *et al*. 2016).

Tawny Owl

In 2015, 178 of 318 home ranges checked were occupied by pairs. A total of 131 pairs went on to fledge a minimum of 227 young.

Long-eared Owl

This species is severely under-recorded in Scotland, with only 49 pairs located in 2015. Of 44 pairs that were monitored, 42 were confirmed to lay eggs. A total of 40 pairs went on to fledge a minimum of 65 young.

Short-eared Owl

In 2015, 100 of 222 home ranges checked were occupied by pairs with a further 42 home ranges occupied by single birds. Of 78 pairs that were monitored 42 were confirmed to lay eggs. A total of 36 pairs went on to fledge a minimum of 62 young. Compared to 2014, productivity was poor in 2015, with only 1.7 young fledged per successful pair compared to 2.1 in 2014.

Kestrel

In 2015, 222 of 355 home ranges checked were occupied by pairs. Of 145 pairs that were monitored, 130 were confirmed to lay eggs. A total of 118 pairs went on to fledge a minimum of 379 young. For the first time in Europe, satellite tags were fitted to six young Kestrels as part of a long-term study in Ayrshire. Read more about this study in Chapter 3: *Kestrel in Ayrshire and beyond: trends in breeding numbers and productivity*.

Merlin

In 2015, 225 of 476 home ranges checked were occupied by pairs. Of 171 pairs that were monitored, 151 were confirmed to lay eggs. A total of 123 pairs went on to fledge a minimum of 279 young. Productivity was poor with an average of 1.6 fledged young per occupied home range.

Hobby

In 2015, two of eight home ranges (known to have been used in recent years) checked were occupied by pairs.

Peregrine

In 2015, 301 of 673 home ranges checked were occupied by pairs, with a further 48 home ranges in use (either single birds or fresh signs were reported). Of 264 pairs that were monitored, 210 were confirmed to lay

eggs. A total of 165 pairs went on to fledge a minimum of 351 young. In Lothian & Borders, Peregrines have been monitored as part of a long-term study since the 1960's and reported one of their worst seasons since the ban of organochlorine pesticides (George Smith pers. comm.). The productivity was 2.1 young fledged per successful pair, which is the lowest reported in the lifetime of the SRMS.

Figure 5: Juvenile Peregrine on a nesting ledge, Ayrshire. (Photo credit: Angus Hogg, South Strathclyde RSG)

Raven

In 2015, 477 of 592 home ranges checked were occupied by pairs. Of 366 monitored pairs, 316 were confirmed to lay eggs. A total of 284 pairs went on to fledge a minimum of 807 young.

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 aims to provide a concise summary of all trend information available for Scottish raptors as a one-stop shop for stakeholders.

In 2016, the SRMS has been able to finalise national Scottish trends as well as regional trends for White-tailed Eagle, covering the period from reintroduction to 2015, and these are discussed in the article below. The SRMS is currently working with its contributors to finalise trends for other species which will appear in future annual reports. Below we also provide a glimpse of what this future reporting may look like and explain the work that needs to happen to ensure these trends can be realised. We also provide links to more detailed data reporting on the SRMS website.

In March 2015, provisional trends in breeding numbers and productivity were published for many raptor species in Scotland largely using SRMS data (Roos *et al*. 2015). A priority for the SRMS is to build on the recommendations of this report and update these trends, publishing them on the SRMS website as they are finalised.

In addition to reporting on trends in **breeding numbers** the SRMS aims to report on trends in a range of productivity parameters including **clutch size** of pairs that laid, **hatching success** (proportion of pairs known to lay that hatched at least one young), **brood size** at hatching of pairs that hatched young, **fledging success** (proportion of pairs known to hatch young that fledged at least one young) and **number of fledglings produced** per successful pair.

The SRMS aims to produce trends at three different geographic scales – (i) local study area, (ii) regional and ultimately (iii) national (i.e. Scottish). Deriving robust national trends is dependent on having robust regional trends which in turn are dependent on having representative raptor monitoring coverage at a more local level.

The provisional trends report (Roos *et al*. 2015) concluded that formal trends production is likely to remain unfeasible for the following species: Honey-buzzard, Marsh Harrier & Hobby (due to the small sample sizes) and Long-eared Owl & Short-eared Owl (due to the monitoring being too variable). This section of the report therefore focuses on bringing you a summary of the latest trends available for the 15 species for which national population trends may ultimately be feasible.

Full information regarding the production of trends (i.e. analytical methods and consideration of sample sizes) can be found on our website: http://raptormonitoring.org/trend-production

NATIONAL POPULATION TRENDS

In 2016, the SRMS has been able to finalise national trends for White-tailed Eagle, covering the period from the first breeding attempts in the early 1980s to 2015. In order to produce robust trends it is important to have an understanding of both survey coverage and survey effort so that any significant changes through time can be taken into account. The trends for White-tailed Eagle have been relatively straightforward to update – up until relatively recently the whole population received complete monitoring coverage and survey effort has been consistent between years. As this population continues to grow it will become unrealistic to expect to achieve complete coverage every year and this will need to be taken into account in updating these trends in the future.

White-tailed Eagle

Table 2 shows the national trend in breeding numbers and various productivity parameters between 1983 and 2015.

White-tailed Eagle have shown a linear increase in breeding numbers since the species was reintroduced to Scotland more than 30 years ago (Table 2 and Figure 6). Over the period 1985–2015 there has been a linear increase in the fledging success of White-tailed Eagle pairs in Scotland, with an average probability of fledging being 0.61 ± 0.02 (Table 2 and Figure 7).

Other species

National trends may become possible for other species once we have built up an understanding of underpinning regional trends, which in turn depends on understanding local study-area based trends. For these species we will be working in close collaboration with raptor fieldworkers to see whether trends production is feasible for their study areas for which we will need to get a handle on survey effort and coverage and the extent to which this may have changed over the course of the study to date. In addition to working with those who have operated studies for many years, the SRMG is hoping to optimise the collection of data on more widespread species through a new survey which will ultimately be essential in helping to derive robust trends and indices for these species. Read more about this new survey in Chapter 5: *Keeping it Local*.

Table 2: White-tailed Eagle Scottish population trends during between 1983 and 2015. The regional trends are available at http://raptormonitoring.org/srms-species/accipitriformes/white-tailed-eagle.

Parameter	Period	Years	Mean annual sample + SE	Type of trend	Mean + SE
Breeding pairs	1983–2015	33	NA*	Linear increase	27.4 ± 4.4
Laying pairs	1995–2015	21	38.3 ± 5.2	Linear increase	0.9 ± 0.0
Clutch size	1983–2015	33	20. 5 ± 2.9	Stable	1.5 ± 0.0
Hatching success	1995–2015	21	36.7 ± 4.6	Linear increase	0.7 ± 0.0
Brood size	1995–2015	21	24.0 ± 3.3	Stable	1.5 ± 0.0
Fledging success	1985–2015	31	24.6 ± 3.9	Linear increase	0.6 ± 0.0
Number of fledglings	1995–2015	21	20.8 ± 3.3	Stable	1.4 ± 0.0

* As there was comprehensive monitoring coverage throughout the period 1983–2015 the mean annual sample is effectively 100% (i.e. not a sample at all) as the whole population was monitored.

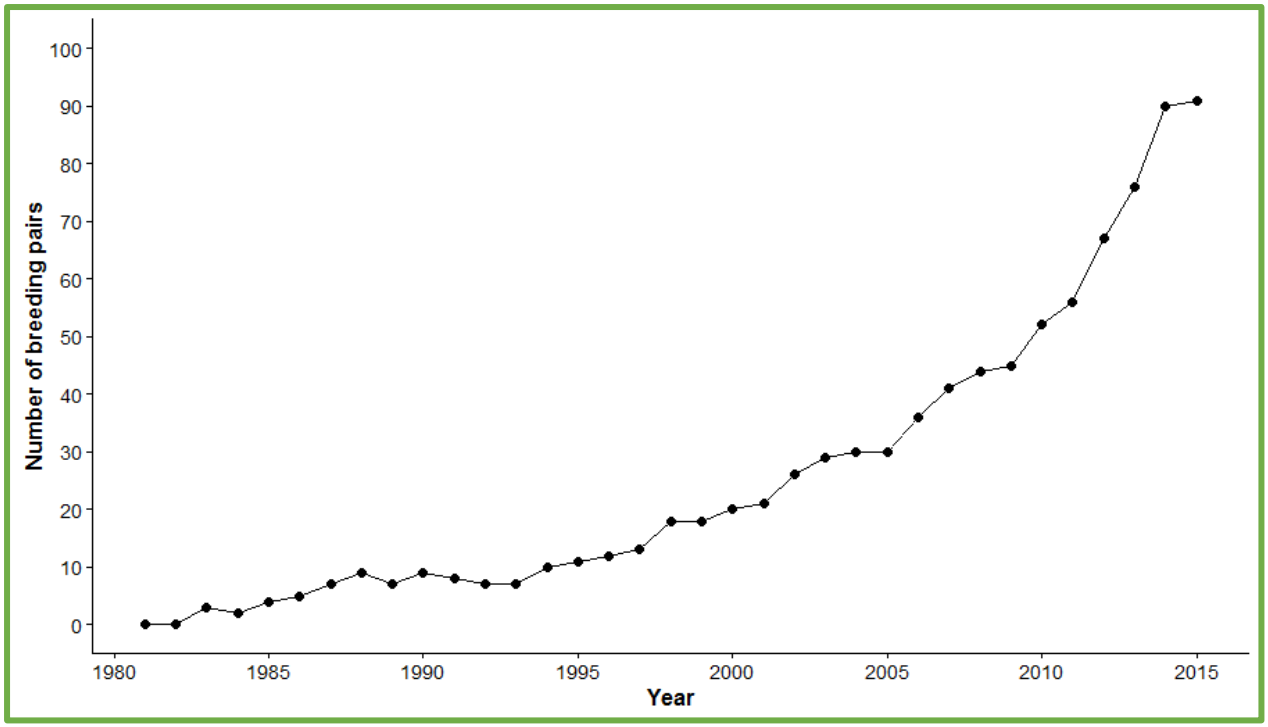

Figure 6: Trend in breeding numbers of White-tailed Eagle in Scotland between 1981 and 2015.

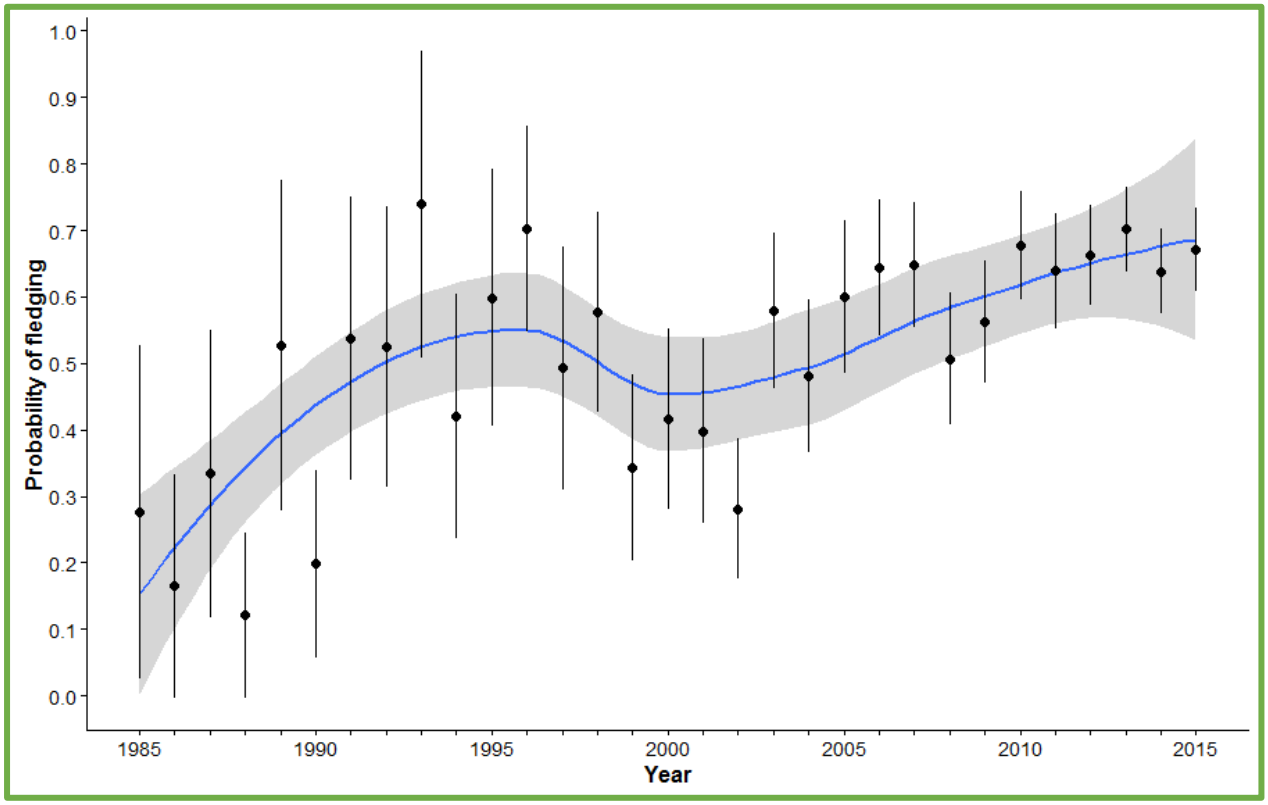

Figure 7: Trend in fledging success of White-tailed Eagle in Scotland between 1985 and 2015. The annual means are shown as black circles, with bars representing 1 standard error (SE). The blue line shows the smoothed trend and associated SE (grey area). The smooth trend should be used as a visual aid only.

REGIONAL POPULATION TRENDS

In 2016 the SRMS has been able to finalise regional trends for White-tailed Eagle, covering the period from reintroduction to 2015. We have summarised these trends for two different regional breakdowns to hopefully suit different stakeholders: SRMS regions (which are akin to the areas covered by the 12 SRSG branches operational in Scotland, and can be viewed on the SRMS website: http://raptormonitoring.org/srms-regions) and Natural Heritage Zones (which are an established biogeographical regional classification used by SNH, and can be viewed on the SRMS website: http://raptormonitoring.org/natural-heritage-zones).

White-tailed Eagle

Table 3 and Table 4 summarises the White-tailed Eagle regional population trends that have been updated to 2015. Detailed trends can be viewed on the SRMS website (http://raptormonitoring.org/srms-species/accipitriformes/white-tailed-eagle).

The regional trends provide some interesting examples of contrasting trends in fledging success. For example, the fledging success has increased significantly in Argyll between 1998 and 2015, with a particular strong increase up to 2006. Here, on average 68 ± 3% of the pairs are successful (i.e. producing at least one fledgling; Figure 8). However, in the Highlands there has been no significant change in fledging success between 1994 and 2015, with an average of 56 ± 3% of the pairs being successful (Figure 9).

Table 3: Summary of White-tailed Eagle regional population trends based on SRMS regions updated to 2015. For a map of SRMS regions please visit: http://raptormonitoring.org/srms-regions.

SRMS region	Parameter	Period	Years	Mean annual sample size	Type of trend	Mean + SE
Argyll	Breeding pairs	1998–2015	18	NA*	Linear increase	13.3 ± 1.9
	Clutch size	1998–2014	17	9.7 ± 1.1	Stable	1.6 ± 0.0
	Hatching success	2007–2015	9	17.6 ± 1.8	Stable	0.8 ± 0.0
	Brood size	2000–2015	16	9.9 ± 1.2	Stable	1.4 ± 0.4
	Fledging success	1998–2015	18	11.8 ± 1.7	Linear increase	0.7 ± 0.0
	No. fledglings	2005–2015	11	11.5 ± 1.4	Stable	1.3 ± 0.0
Highland	Breeding pairs	1987–2015	29	NA*	Linear increase	14.3 ± 1.8
	Clutch size	1990–2015	26	11.8 ± 1.3	Stable	1.4 ± 0.0
	Hatching success	1996–2015	20	17.1 ± 1.5	Stable	0.7 ± 0.0
	Brood size	1995–2015	21	10.2 ± 1.2	Stable	1.5 ± 0.0
	Fledging success	1994–2015	22	14.6 ± 1.5	Stable	0.6 ± 0.0
	No. fledglings	1998–2015	18	9.3 ± 1.0	Stable	1.4 ± 0.0
Lewis & Harris	Breeding pairs	2004–2015	12	NA*	Linear increase	9.4 ± 1.2
	Clutch size	2005–2015	11	8.6 ± 1.2	Stable	1.5 ± 0.1
	Hatching success	2006–2015	10	10.2 ± 1.4	Stable	0.6 ± 0.1
	Brood size	2005–2015	11	6.1 ± 0.9	Stable	1.6 ± 0.1
	Fledging success	2008–2015	8	9.3 ± 1.3	Linear increase	0.6 ± 0.1
	No. fledglings	2007–2015	9	5.6 ± 1.0	Stable	1.6 ± 0.1

*No annual sample was calculated, because we were not dealing with a sample of breeding pairs, as we had full knowledge of every pair. Therefore, we give the mean annual number of pairs in the column "Mean ± SE".
**Sample size too small for meaningful trend production.

Table 4: Summary of White-tailed Eagle regional population trends based on Natural Heritage Zones updated to 2015. For a map of NHZ's please visit: http://raptormonitoring.org/natural-heritage-zones.

NHZ	Parameter	Period	Years	Mean annual sample size	Type of trend	Mean + SE
3. Coll, Tiree & the Western Isles	Breeding pairs	2000–2015	16	NA*	Linear increase	11.4 + 1.7
	Clutch size	2002–2015	14	9.9 ± 1.2	Stable	1.5 ± 0.0
	Hatching success	2006–2015	10	14.4 ± 1.6	Linear increase	0.7 ± 0.0
	Brood size	2004–2015	12	8.7 ± 1.0	Stable	1.6 ± 0.1
	Fledging success	2008–2015	8	14.1 ± 1.6	Linear increase	0.7 ± 0.0
	No. fledglings	2006–2015	10	8.7±1.2	Stable	1.5 ± 0.1
4. North West Seaboard	Breeding pairs	2008–2015	8	NA*	Stable	5.4 ± 0.4
	Clutch size	2005–2015	11	3.6 ± 0.3	Stable	1.6 ± 0.1
	Hatching success	–	–	–	NA**	–
	Brood size	–	–	–	NA**	–
	Fledging success	2012–2015	4	4.8 ± 0.5	Stable	0.7 ± 0.1
	No. fledglings	–	–	–	NA**	–
6. Western Seaboard	Breeding pairs	1986–2015	30	NA*	Linear increase	17.2 ± 2.0
	Clutch size	1986–2015	30	12.9 ± 1.3	Stable	1.5 ± 0.0
	Hatching success	1995–2015	21	20.8 ± 1.6	Stable	0.7 ± 0.0
	Brood size	1991–2015	25	11.9 ± 1.3	Stable	1.5 ± 0.0
	Fledging success	1987–2015	29	15.3 ± 1.7	Stable	0.6 ± 0.0
	No. fledglings	1985–2015	21	11.4 ± 1.4	Stable	1.4 ± 0.0
8. Western Highlands	Breeding pairs	2010–2015	6	NA*	Stable	4.3 ± 0.3
	Clutch size	–	–	–	NA**	–
	Hatching success	–	–	–	NA**	–
	Brood size	–	–	–	NA**	–
	Fledging success	–	–	–	NA**	–
	No. fledglings	–	–	–	NA**	–
14. Argyll West & Islands	Breeding pairs	2010–2015	6	NA*	Linear increase	5.5 ± 1.1
	Clutch size	–	–	–	NA**	–
	Hatching success	–	–	–	NA**	–
	Brood size	–	–	–	NA**	–
	Fledging success	–	–	–	NA**	–
	No. fledglings	–	–	–	NA**	–

*No annual sample was calculated, because we were not dealing with a sample of breeding pairs, as we had full knowledge of every pair. Therefore, we give the mean annual number of pairs in the column "Mean ± SE".
**Sample size too small for meaningful trend production.

LOCAL STUDY AREA POPULATION TRENDS

To date, the SRMS has also been able to finalise a local study area trend for a single Kestrel study. Find out more about this local study in Chapter 3: *Kestrel in Ayrshire and beyond: trends in breeding numbers and productivity*. The SRMS is currently working with its contributors to finalise trends for other species which will appear in future annual reports.

To find out more about what trends production at the study area level entails and how you can assist the SRMS in producing rigorous trends for your study please visit: http://raptormonitoring.org/producing-rigorous-population-trends

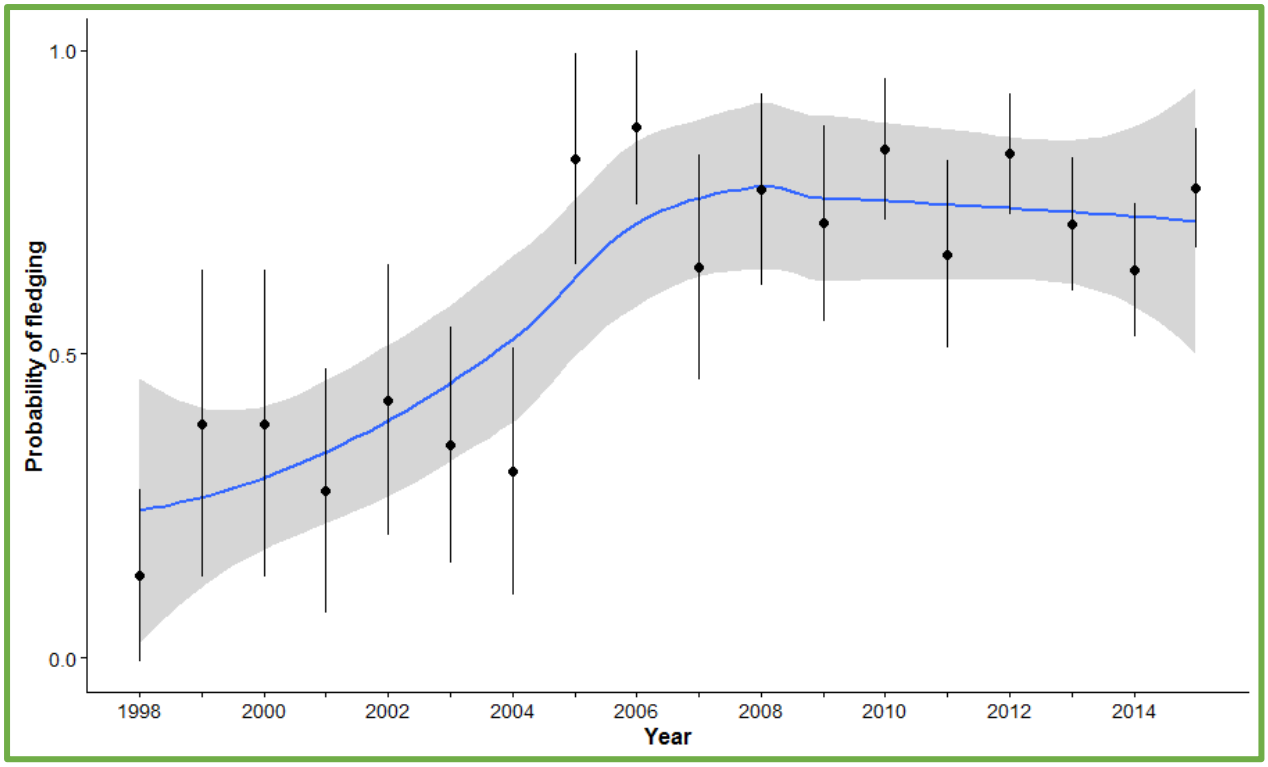

Figure 8: The proportion of White-tailed Eagle pairs in Argyll SRMS regions breeding successfully (i.e. producing at least one fledging) between 1998 and 2015.

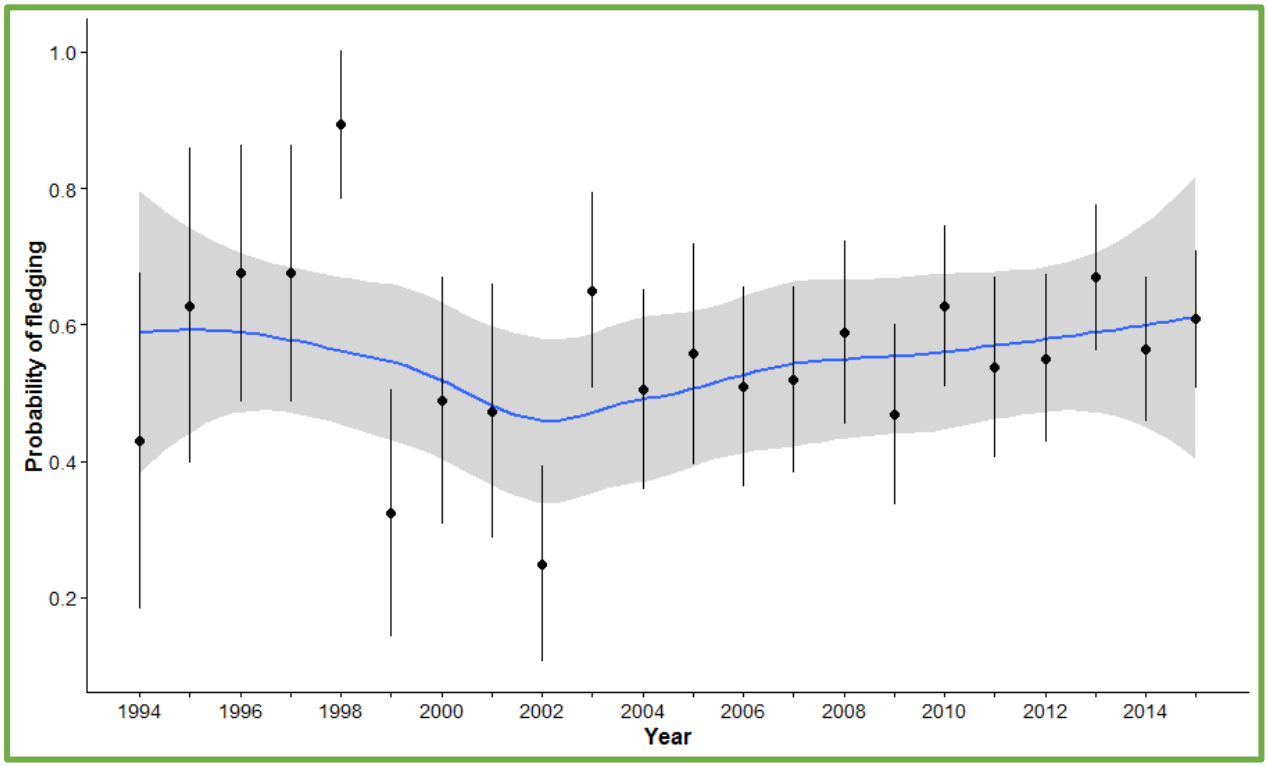

Figure 9: The proportion of White-tailed Eagle pairs in Highland SRMS regions breeding successfully (i.e. producing at least one fledging) between 1994 and 2015.

3 KESTREL IN AYRSHIRE AND BEYOND: TRENDS IN BREEDING NUMBERS AND PRODUCTIVITY

In this report we take a closer look at Kestrel, one of four species of falcon native to Scotland, and explore what we can learn from the data held by the SRMS. In particular we focus on a fairly discreet geographical area of Scotland, where a local study of Kestrel has been ongoing since 1972 and discuss the latest trends in breeding numbers and productivity that we have been able to produce in collaboration with Gordon Riddle, Chair of South Strathclyde Raptor Study Group. We hope that this article will inspire others running long-term studies for Kestrel and other species across Scotland to collaborate with the Scheme to produce trends for their own studies which will ultimately help us generate regional and even potentially national trends for Scotland as discussed in Chapter 2: *Trends in breeding numbers and productivity*.

KESTREL IN SCOTLAND

Distribution & abundance

Kestrels are birds of open habitats and are widespread across most of Scotland, with the exception of upland areas of the north and most of Lewis and Shetland. They are most abundant in the lowlands of south, central and eastern Scotland. The Breeding Bird Atlas shows that Kestrels were thought to breed in 789 10-km squares in Scotland during the period 2007–11 (Balmer *et al*. 2013) (Figure 10).

Population trends

Since the late 1960s the Scottish range has contracted by 11% and breeding abundance has decreased in most areas since the 1980s (Balmer *et al.* 2013).

Data from the BTO/JNCC/RSPB Breeding Bird Survey (BBS) has shown a sustained and statistically significant decrease between 1994 and 2014. The overall change in abundance between 1995 and 2014 was -62%, the largest decrease shown by any Scottish species for which the BBS produces trends (Harris *et al.* 2016). The BBS trend may not be fully representative of changes over the whole of Scotland's breeding population, however, as the sample of squares covered is heavily biased towards lowland areas (Roos *et al.* 2015).

Prior to the late 1990s, Kestrels were known to be widespread as a breeding bird across Scotland but there was little quantitative data on population numbers (Village 1990; Forrester *et al.* 2007). Kestrels are known to favour unimproved grassland and similar

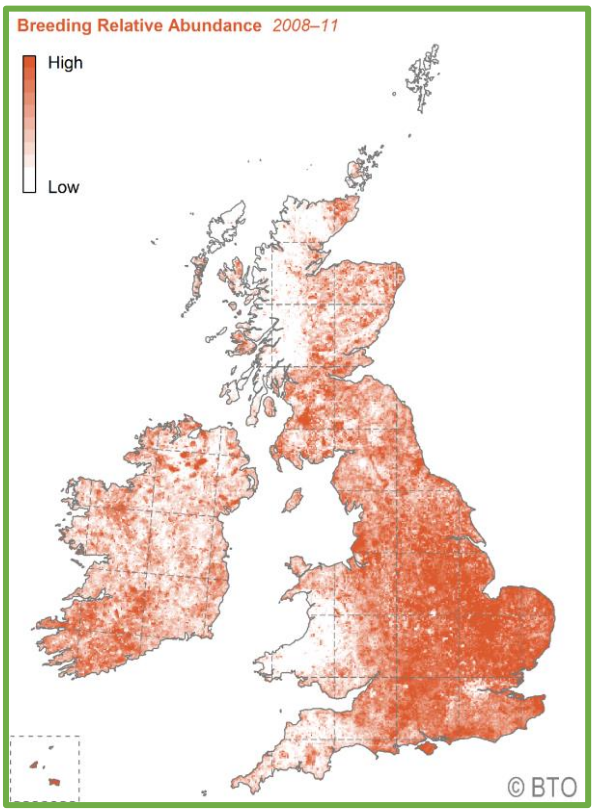

Figure 10: Kestrel breeding relative abundance 2008–2011 from the Bird Atlas 2007–2011.

habitats for hunting (Figure 11), and populations in Scotland are thought to have benefitted from the widespread afforestation that took place during the 1960s and 1970s, which involved an initial phase of reduced grazing and increased vole and songbird densities (Forrester *et al.* 2007). However, when the canopy closed, the planted areas became less suitable, and the Kestrels could no longer use them for hunting. Subsequently the scale of afforestation reduced and second rotation plantings were considered less favourable for the species; the Scottish population was considered to be fairly stable during the 1980s (Thom 1986) before the 1988-91 Bird Atlas demonstrated range contractions.

A number of factors have been suggested as contributing to the declines since the late 1980s: agricultural intensification (e.g. loss of unimproved habitats) and reduction in small mammal populations (e.g. Shrubb 2003); impacts of second-generation rodenticides (e.g. Cornulier *et al.* 2013); and competition or direct predation by recovering populations of other predatory birds, notably Goshawk (Petty *et al.* 2003; Forrester *et al.* 2007).

Figure 11: Hunting Kestrel. (Photo credit: John Anderson).

Kestrel monitoring by the SRMS

Kestrel is a species that is currently under-recorded by existing SRMS contributors. This species is too sparsely distributed to be covered well by general bird surveys such as the BTO/JNCC/RSPB Breeding Bird Survey but at the same time is too widespread and abundant for complete coverage to be

achievable as is attempted for some of the rarer species such as Golden Eagle.

Along with Buzzard, Sparrowhawk and Raven, Kestrel is among the species that the SRMS is aiming to collect more information on through our new *Raptor Patch* survey which was piloted in 2016.

Gordon Riddle (Figure 12) is currently operating the only long-term study for this species in Scotland. Below we describe Gordon's study and how Gordon and the SRMS is hoping to use these data (and hopefully those from other studies being set up now and in the future) to further the conservation of this species.

Ayrshire Kestrel study

Gordon has been monitoring Kestrels in a discrete area bordering Ayrshire and Dumfries & Galloway since 1972. Gordon monitors a range of natural sites, including tree cavities, old crow nests, cliffs and quarries in addition to a series of nest boxes. Each year, he visits 30-35 territories. The study area comprises a broad range of habitats, the upland areas comprising a mixture of rough pasture grazed by sheep, interspersed with small shelter belts, and commercial forestry plantations, while the lowland area is a mixture of coastal estate and mixed farmland.

Figure 12: Gordon Riddle with a Kestrel chick which has just been fitted with a satellite tag.

As Gordon has maintained a similar level of coverage and survey effort since the study began, we have been able to produce up-to-date trends for his study area which we are pleased to report here.

Table 5: Summary of Kestrel study area trends that we have updated to 2015.

Study area	Parameter	Period	Years	Mean annual sample size	Type of trend	Mean + SE
Ayrshire	Breeding pairs	1988–2015	28	39.6 ± 1.0*	Decreasing	25.5 ± 1.2
	Clutch size	1988–2015	28	17.6 ± 1.3	Stable	5.1 ± 0.0
	Brood size	1988–2015	28	15.0 ± 1.1	Stable	4.7 ± 0.1
	Fledging success	1988–2015	28	21.3 ± 1.2	Linear increase	0.9 ± 0.0
	No. fledglings	1988–2015	28	17.9 ± 1.0	Stable	4.1 ± 0.0

*This is the mean number of territories for which information contributes to each parameter in the table.

Trends in breeding numbers

Figure 13 shows the trend in breeding numbers in Gordon's study area between 1988 and 2015. Despite approximately similar survey effort during the whole period, the number of Kestrel pairs breeding in Gordon's study area has declined significantly between 1988 and 2015, from 40 in 1988 to 21 in 2015 (Figure 13 and Table 5). The variation in number of pairs is mainly due to the changes in vole abundance; in years with many voles, such as 2004, 2008 and 2011, the number of Kestrels is higher than in years with low vole abundance (e.g. in 2002, 2005 and 2009). Overall, an average of around 40 territories was checked each year, with a mean of 25.5 being occupied by pairs.

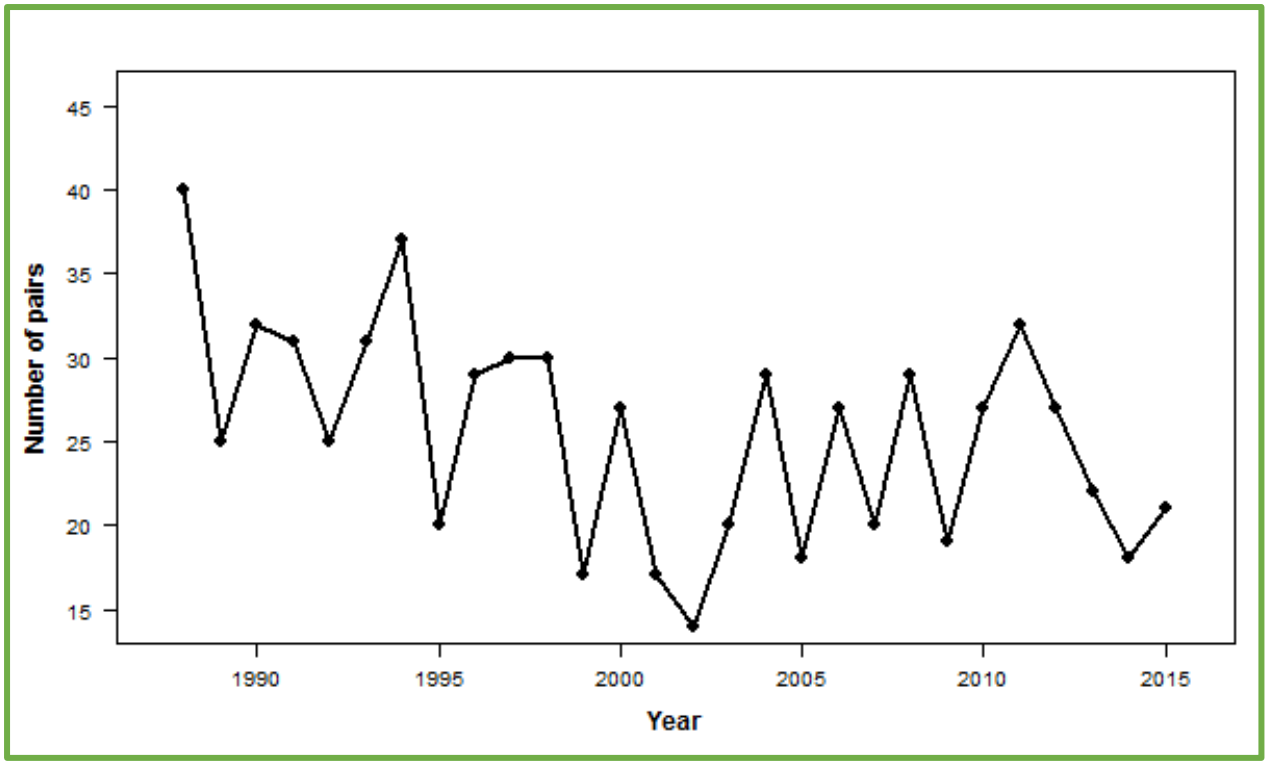

Figure 13: Trend in breeding numbers of Kestrels in Gordon's study area between 1988 and 2015. N.B. Linear regression between "number of pairs" and "year"; F=6.2438, df = 1, p=0.0191. This equates to an annual decline of about 0.3 pairs, but the variable "year" only explains 16.3% of the variation of the decline. Other factors, such as voles and weather, explain a lot of the ups and downs of the generally negative population trend.

Trends in productivity

Trends in a range of productivity parameters have been possible for Gordon's study area. Detailed trends can be viewed on the SRMS website (http://raptormonitoring.org/srms-species/falconiformes/common-Kestrel/ayrshire-study).

There were no significant trends over time in clutch size (overall mean ± 1 SE: 5.13 ± 0.04 eggs; Figure 14), brood size (mean: 4.66 ± 0.05 chicks) and the number of fledglings produced by successful Kestrel pairs (mean: 4.12 ± 0.06 fledglings) in Gordon' study area. The annual variation in these parameters is mainly due to food abundance, with higher breeding productivity in years with high vole abundance (e.g. 2004, 2008 and 2011). Interestingly, the data suggest a slightly higher clutch size and brood size in two periods; the first period occurred in the late 1990s and the second period in the last few years, with 2013 being a clear exception of this increased trend. However, not in every year did the higher clutch and brood sizes result in a higher number of fledglings produced. This was particularly evident in 2011, when the clutch size (mean ± standard error: 5.45 ± 0.70) was above the long-term average, but the number of fledglings produced by successful pairs (mean ± SE: 3.37 ± 0.42) was much lower than the long-term average.

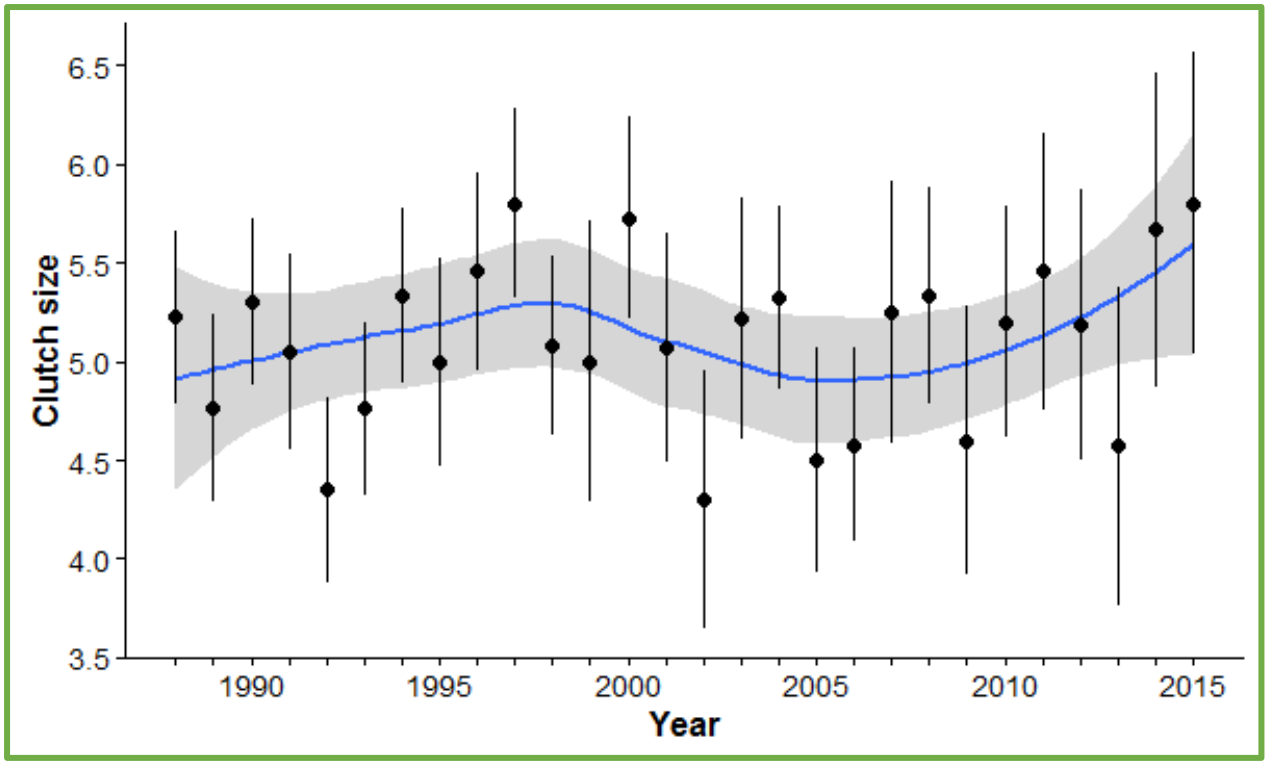

Figure 14: Trend in the clutch size of Kestrel pairs that were confirmed to have laid at least one egg in Gordon's study area between 1988 and 2015. The annual means are shown as a black circle, with bars representing 1 standard error (SE). The blue line shows the smoothed trend and associated SE (grey area). The smooth trend should be used as a visual aid only, and does not represent a significant change over time.

Gordon attributed this reduction in numbers from the egg stage to the fledgling stage to an extreme weather spell around the 23rd of May, with gale force winds and prolonged heavy rain. This resulted in many pairs of Kestrels abandoning their nesting attempts, and, for the pairs that continued their breeding attempt, many eggs not hatching.

There was a linear increase in fledging success between 1988 and 2015 (mean: 0.86 ± 0.01; Figure 15), probably due to the very low breeding success in 1993 and some extraordinarily high breeding success in later years (e.g. in 2007 and 2014 all pairs were successful).

Overall, Gordon Riddle's long-term Kestrel study in Ayrshire give us both interesting facts about the breeding biology of Kestrels and robust baseline data to tackle emerging conservation issues (e.g. the effect of changing land-use, climate and pesticide levels) on raptor populations. However, Gordon's study alone can only give us one piece in the jigsaw to begin to understand Kestrel population trends at different geographic scales. This study only covers a relatively discrete geographical area of Scotland so the extent to which these reported local trends for could be considered relevant at a regional or even Scottish scale depend on how representative this study population is considered to be. Having more dedicated Kestrel studies (both nest-box and non-nest-box based) from more areas across Scotland will add to our understanding.

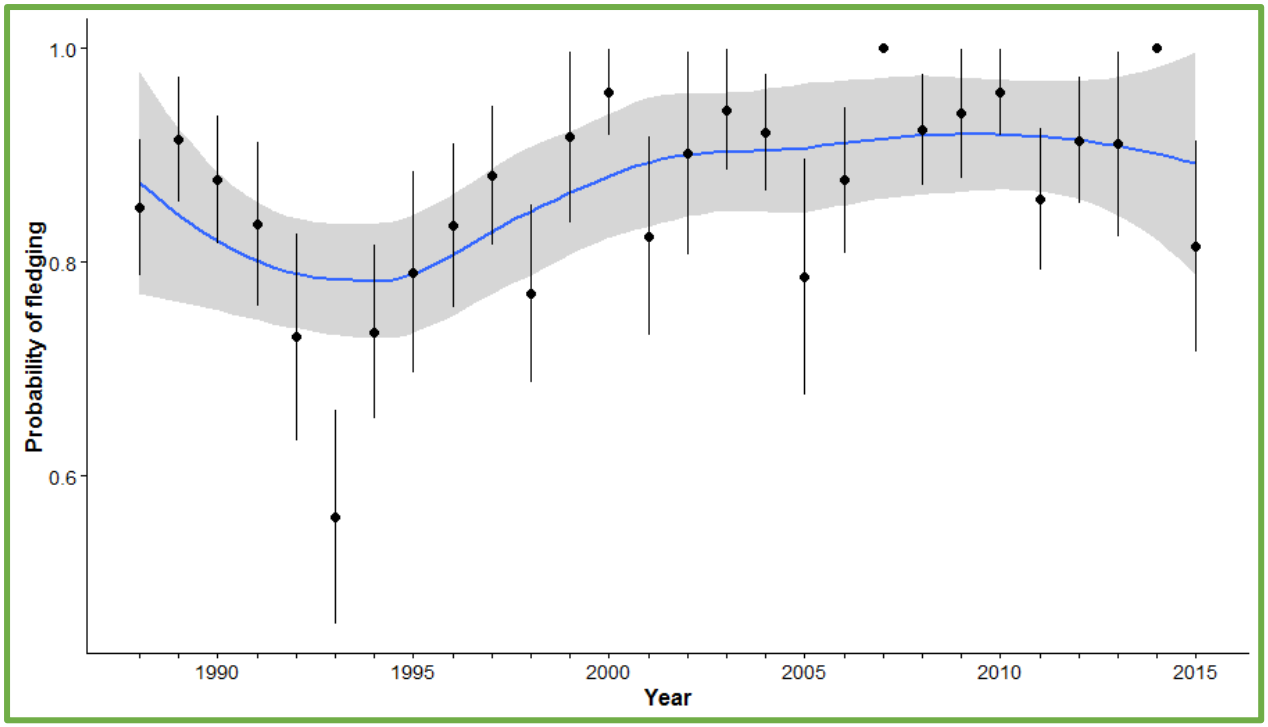

Figure 15: The proportion of Kestrels breeding successfully (i.e. producing at least one fledging) in Gordon Riddle's study area between 1988 and 2015. The annual means are shown as a black circle, with bars representing 1 standard error (SE). The blue line shows the smoothed trend and associated SE (grey area). The smooth trend should be used as a visual aid only, and does not represent a significant change over time.

TRENDS PRODUCTION FOR OTHER STUDY AREAS

We have already noted that Gordon is currently operating the only long-term Kestrel study in Scotland for which trends production is currently feasible. However, we are pleased to note that more studies have been initiated in recent years and trends production should also become possible for these studies.

Gordon's study provides a good exemplar of what can be achievable provided we have good information about survey effort and coverage about a particular study.

Over the next year the SRMS will be working closely with its existing volunteers who operate studies to produce trends with the aim to update these on the SRMS website annually. The SRMS will also be developing an overall strategy for better targeting of raptor monitoring across Scotland so that we can encourage volunteer monitoring efforts in ways that will be of most overall use to the SRMS's aims.

4 PATTERNS OF BREEDING AND CAUSES OF FAILURE IN 2015

Every year a proportion of raptor breeding attempts will fail, i.e. young will not successfully fledge from nests where eggs have been laid. By monitoring a nesting attempt using standard visits it is possible to determine the stage when nest failure occurs, although, in the absence of very intensive field effort, it can be difficult to distinguish birds that fail soon after laying from non-breeders that have not laid at all. Here, as examples, we report on the spatial patterns of Hen Harrier failures (proportion of failed breeding attempts and the stage of failure) and the types of causes and supporting evidence for failures for all SRMS species in 2015. We also explain ongoing SRMS work to improve the analysis and reporting of causes of failure in the future.

PATTERNS OF BREEDING SUCCESS

The SRMS database can be analysed to explore patterns in breeding success both temporarily and spatially. Below are a few examples of the spatial patterns that we are able to explore using Hen Harrier as an example for 2015.

Spatial patterns in breeding success

Figure 16 shows the breeding success of Hen Harrier in Scotland in 2015. Each column in the chart represents a different SRMS region, and for each region it is possible to see the proportion of breeding pairs that were successful (i.e. where at least one chick was known to have fledged successfully), failed (i.e. where no chicks fledged) or where the outcome was unknown (i.e. where it was not known whether chicks successfully fledged). Uist had the highest proportion of successful breeding attempts (70.4%) and Orkney had the highest proportion of failed breeding attempts (79.0%). It was not known whether fledging was successful for approximately 11.4% of the records, a useful reminder perhaps to SRMS contributors of the importance of monitoring breeding attempts to a conclusion wherever possible.

Spatial patterns in stage of failure

Figure 17 shows the stage of failure of Hen Harrier breeding attempts in Scotland in 2015. For each region it is possible to see what proportion of failures happened at each stage in the breeding cycle, from pre-egg, egg, small chick to large young. Overall 50.3% of breeding failures in 2015 occurred at the pre-egg stage. In Central Scotland, Orkney & South Strathclyde at least 50% of breeding attempts failed at this stage. Overall 28.8% of breeding failures in 2015 occurred at the egg stage. Argyll, Highland and Lothian & Borders in particular had their highest proportions of failure at the egg stage, 50%, 45.5% and 50%, respectively. Overall 20.9% of failures happened at the chick stage, 14.1% on small chicks and 6.7% on large chicks. Dumfries & Galloway, North-east Scotland and Uist all had the highest failures at chick stage, 60% and 42.9% and 100%, respectively. It is perhaps important to note that differences between regions could be influenced by differences in the stage at which nests are found, for example, there will be few opportunities for records of failures at pre-egg stage if most nests are found after laying has happened. This is why we ask SRMS observers to make visits at standard times during the nesting cycle, and to record nest contents at each visit (so that we can correct for different stages of first checking).

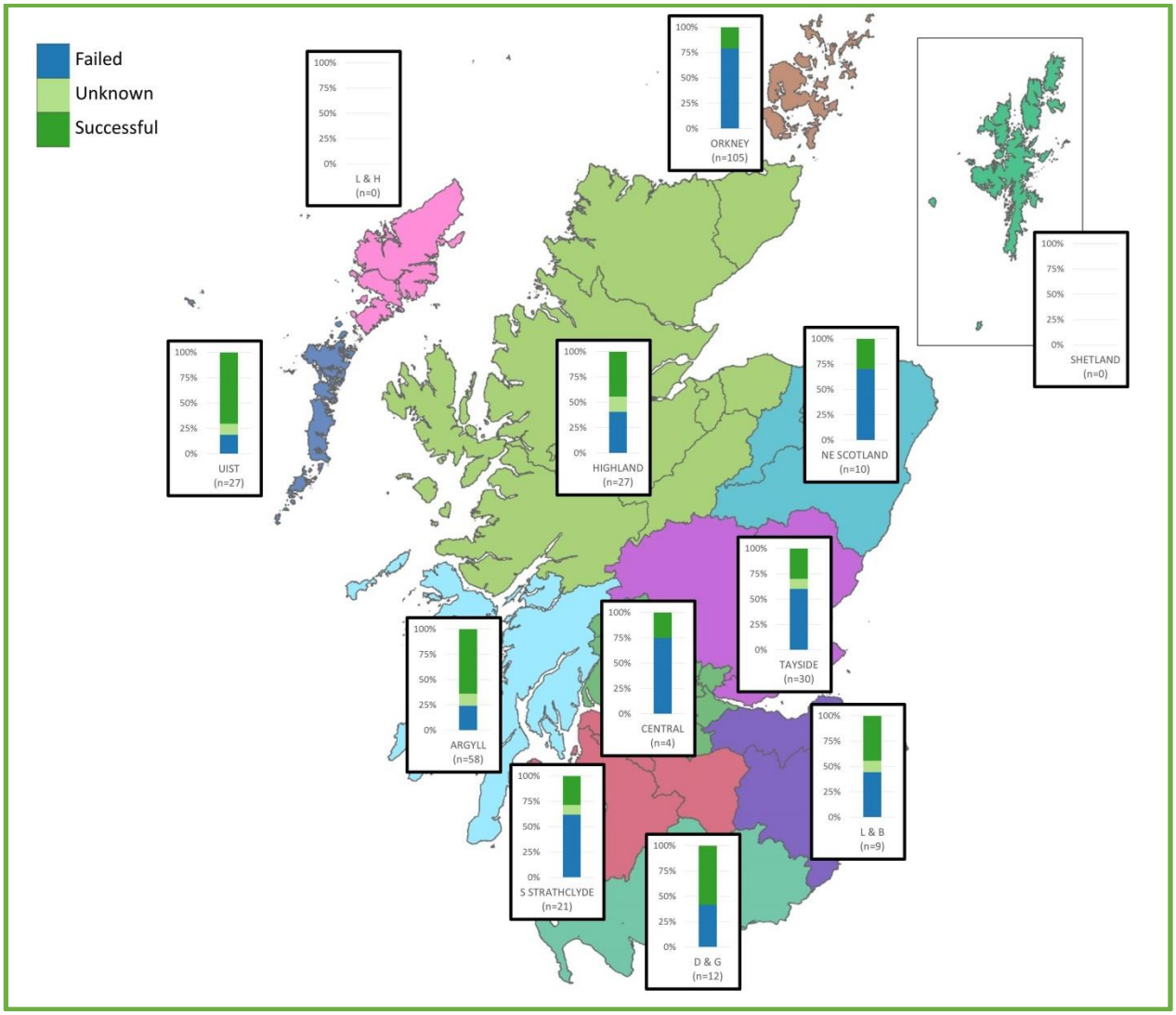

Figure 16: Proportion of breeding pairs of Hen Harrier that were successful, failed or the outcome was unknown in in each SRMS region of Scotland in 2015.

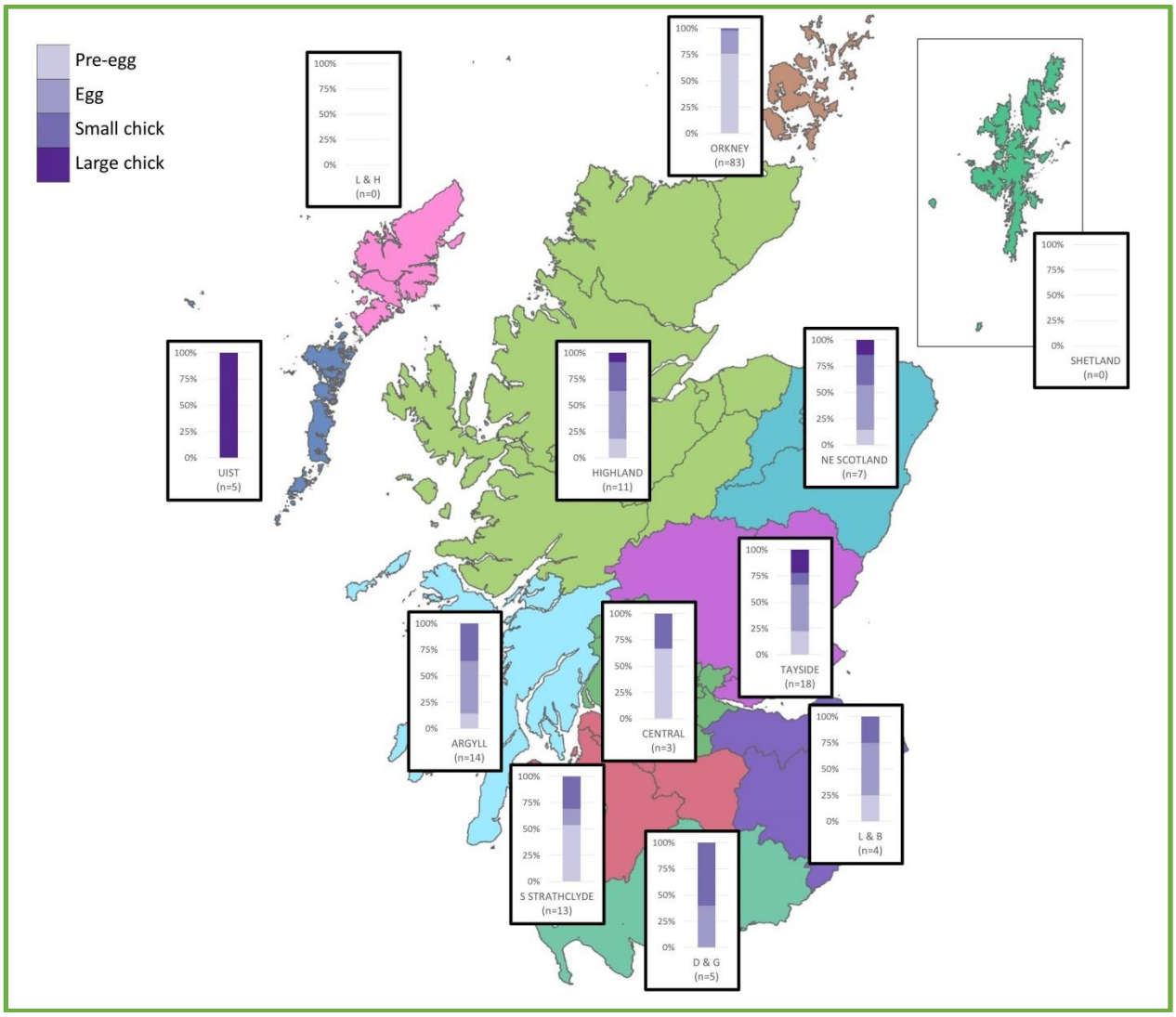

Figure 17: Stage of breeding failure confirmation for Hen Harrier in each SRMS region of Scotland in 2015.

Spatial patterns in cause of failure

The SRMS database contains important objective information on causes of breeding failure, including changes in these through time and variation across Scotland. Up to now this information has remained a relatively untapped resource, and not an area that we have reported on previously.

Following advice from Charlie Everitt at the National Wildlife Crime Unit (NWCU), we revisited the 2015 data. Based on the information that observers have provided in the "Reason for Failure", "Supporting Evidence for Failure" and "Other notes" fields in the SRMS spreadsheet we objectively assigned every record with a cause of failure and also captured any evidence for the cause of failure from two pre-defined lists (Tables 6 and 7). The "Cause of Failure" is the raptor fieldworkers' own interpretation of why the breeding failure occurred, while the "Evidence of failure" relates to any evidence they recorded that could be used in an independent assessment of cause of failure. For the purposes of this report we have grouped the causes of failure into several broad types – Disease, Food supply, Human, Intrinsic, Other animal, Weather and Unknown. For the vast majority of cases in 2015, 1,053 observers reported the cause of

failure to be unknown (Table 8). Across all species, weather was the main cause of failure reported by observers, responsible for 106 failures. Other animal (35 failures), intrinsic (27 failures), human (31 failures) and food supply (10 failures) were reported to be responsible for the remaining failures (Table 8).

Table 6: List of causes to which SRMS records can be objectively assigned.

Type of cause	Cause
Disease	Disease
Food supply	Extrinsic (outside factor)
	Intrinsic (due to parents)
	Unknown
Human	Burning
	Poisoning
	Shooting
	Disturbance induced abandonment:
	Deliberate
	Fieldwork
	Forestry
	Other works (house building, road repair etc.)
	Quarry or mining operations
	Walkers, climbers, other recreation
	Other disturbance
Intrinsic	Breeder old, infertile or in poor condition
	Cannibalism or self-destruct
	Infertile eggs
	Young breeder
	Avian predation
Other animal	Conspecific competitor
	Fulmar
	Mammalian predation
	Nest competitor
	Nest trampling
	Other intra-guild
	Unknown/other predator
	Cold (including snow)
Weather	Heat
	Nest flooded
	Rain (non-flood)
	Unknown
	Weather (other)
	Wind/falling object
	Unknown
Unknown	

Table 7: List of causes to which SRMS records can be objectively assigned.

Supporting Evidence provided by observer
Observed cause of failure directly as it happened
Trampled nest or surrounding vegetation
Human signs in or around nest
Predator signs in or around nest
Remains of predated eggs/young
Failure captured by camera
Burnt out nest
Burning near nest
Nest fallen from ledge or tree
Nest destroyed in rock or snow fall
Nest flooded
Recent adverse weather
Evidence of inadequate food supply
Confirmed poisoned adult or young
Confirmed poison bait observed near nest
Other evidence of poison bait near nest
Confirmed shot adult or young
Observed or heard shooting near nest
Dead adult
Injured adult
Death or injury of parent(s) confirmed
Human activity observed near nest
Negative response to fieldwork observed or suspected
Low provisioning rate observed before failure
Poor chick development observed
Lab or vet diagnosis
Other
None

Please remember if wildlife crime is suspected, accurate records of any observations or evidence should be made and reported directly to the Police as soon as possible.

It appears likely, from studying the way the "Reason for Failure", "Supporting Evidence for Failure" and "Other notes" columns in the SRMS spreadsheet have been completed in the past that many of the definitive assessments of causes of failure have been somewhat subjective. In many cases, circumstantial evidence will be sufficiently compelling that observers will record an unequivocal cause of failure, however, it remains important for the SRMS to be able to distinguish situations where cause is *known* from those where it has been *assumed*.

Table 8 shows that out of a total of 1,262 failed breeding attempts in 2015, evidence for the cause of failure was only provided in 63 cases.

Table 8: Summary of causes of breeding failure in 2015. Numbers are the total number of records for a given species attributed to a particular type of cause of failure. Numbers in parentheses represent the total number of records for which supporting evidence was provided by observer.

Species	Type of cause of failure						Total
	Food supply	Human	Intrinsic	Other animal	Weather	Unknown	
Honey-buzzard						1	1 (0)
Red Kite		1 (1)	1	2 (1)	9 (3)	42 (5)	55 (10)
White-tailed Eagle		1	5	2	3 (2)	38 (1)	49 (3)
Marsh Harrier						1	1 (0)
Hen Harrier	1 (0)	1	1	10 (3)	9 (1)	141 (3)	163 (7)
Goshawk		2 (2)		1		13	16 (2)
Sparrowhawk				1	1	17	19 (0)
Buzzard				3	5	80	88 (0)
Golden Eagle	1 (0)	13 (5)	16 (1)	1	51 (5)	276 (2)	358 (13)
Osprey		1	2	1	7 (2)	48 (3)	59 (5)
Barn Owl	8 (1)	1		3 (1)		78 (1)	90 (3)
Tawny Owl				1 (1)	2	31	34 (1)
Long-eared Owl						4	4 (0)
Short-eared Owl				1	3	41	45 (0)
Kestrel					3 (1)	27 (2)	30 (3)
Merlin		6 (2)		2 (1)	2	47 (3)	57 (6)
Peregrine		4 (1)	1	5 (1)	7 (1)	90 (3)	107 (6)
Raven		1	1	2 (1)	4	78 (3)	86 (4)
Grand Total	**10 (1)**	**31 (11)**	**27 (1)**	**35 (9)**	**106 (15)**	**1053 (26)**	**1262 (63)**

ENHANCING FUTURE REPORTING

For this report we have illustrated spatial patterns for just one SRMS species as an example of future potential. Spatial patterns for the other SRMS species in 2015 will be published on our website. In addition to looking at spatial patterns, we will also publish temporal patterns in breeding success, to reveal how breeding success within different SRMS regions changes through time. In order to maximise the value of the information on causes of breeding failure already held in the SRMS database, we will be undertaking the same manual exercise of objective code assignment for the 2003–2014 SRMS data as we have undertaken for 2015.

From 2017 the SRMS will be implementing an online data entry system, which will allow us to report more robustly on causes of failure in the future. The online data entry system is designed to more readily distinguish failures where the cause is actually *known* from where it has been *assumed*. Raptor fieldworkers will be able to select from a pre-defined list of causes of failure and evidence types (the same as those used to manually classify the 2003–2015 records; Tables 6 & 7) thereby ensuring that these data are captured directly in a standard format. There will also be the scope to provide additional detailed evidence where it is available.

The new online data entry system will also be encouraging visit-based data collection. There are a number of scientific advantages to recording nesting progress at each visit (rather than summary information across the season). Of particular relevance to monitoring patterns of breeding success, visit-based recording enables calculation of failure rates in a standard manner using Mayfield estimates (Mayfield 1961, 1975). While many SRMS participants currently record the outcome of attempts, the probability of observing a failure is dependent on the length of the period over which the nest is observed. This means that failure is more likely to be recorded for nesting attempts monitored from an early stage than for those found near to fledging. The accuracy of information about stage of failure is also dependent on visit dates, with long periods between visits

leading to greater uncertainty about failure stage. Only by recording the stage at which nests are found, and when they are subsequently visited, can these sources of bias and uncertainty be taken into account. This, in turn, will enable greater confidence in comparisons involving failure rates, guarding against the possibility that comparisons could be confounded by differences in methods.

The SRMS and its partner organisations are committed to supporting activities directed at combatting wildlife crime, which in the context of raptors may involve poisoning, shooting, the destruction or taking of nests, eggs or young or the illegal use of traps. Such information contained in the SRMS records has the potential be very useful to organisations like NWCU and RSPB Investigations Unit to inform their operations and target effort appropriately. Over the next year the SRMG will be considering the best ways of making this important information more readily accessible to assist the work of these and other organisations.

If you are a regular SRMS data contributor please embrace the new data entry system when it arrives and help the SRMS maximise the value of your data to understand causes of failure in Scottish raptors. Please provide the SRMS with as complete information that you can for every raptor monitoring visit that you make and ensure that you document causes of failure and the evidence that has led you to making that conclusion objectively using the lists available.

Figure 18: Breeding attempts can fail for a variety of reasons. In 2014 this tree held an Osprey eyrie in its upper branches, making for a challenging climb for Keith Brockie, the raptor fieldworker who regularly monitors this pair. In January 2015 the tree blew down in the gales and upon their return the Osprey pair rebuilt a new eyrie on the remaining tree stump. This nesting attempt failed with small young, with evidence suggesting natural causes. (Photo credit: Keith Brockie, Tayside RSG).

5 KEEPING IT LOCAL

The Scottish Raptor Monitoring Scheme (SRMS) relies on the breadth of knowledge and skills of its existing contributors (many of whom are Scottish Raptor Study Group members) to produce high quality information on raptors in Scotland. The Scottish Raptor Monitoring Group (SRMG), which oversees the work of the SRMS, recognises the importance of fostering these skills and also motivating a new generation to take up raptor monitoring.

In this issue, we are profiling Dave Taylor, one of our newest volunteers based in Central Scotland. Dave has been taking part in *Raptor Patch*, a new survey that the Scheme was piloted in 2016. Read on to find out more about *Raptor Patch* and Dave's raptor monitoring journey so far.

MOTIVATING A NEW GENERATION

A recent review of SRMS data (Roos *et al*., 2015) demonstrated the potential to produce rigorous trends in breeding numbers and productivity for a range of Scottish raptor species and identified those areas and species for which enhanced monitoring coverage would be beneficial. In general, scarcer (Annex 1) species are surveyed more widely by Scottish Raptor Study Group (SRSG) members because of the way the SRMS has evolved from the personal interests of these volunteers, whilst a number of more widespread species such as Kestrel, Sparrowhawk and a number of the owl species would benefit from enhanced monitoring. Scarcer raptor species have, understandably, attracted more attention for a number of reasons, including conservation concern, enthusiasm for finding and watching unusual birds, and the challenge of getting to grips with rare and elusive species. However, there is increasing recognition that we need to know more about our commoner raptor species, some of which have undergone worrying declines in recent years (see Chapter 3: *Kestrel in Ayrshire and beyond: trends in breeding numbers and productivity*).

There is also a need to encourage more volunteers to get involved in surveying raptors in Scotland to ensure that the valuable long-term studies carried out by existing SRSG members are maintained into the future.

One of the ways that the SRMS is trying to motivate a new generation to take up raptor monitoring is through a new raptor recording project. The aims of this project are to: (i) complement the training/mentoring already being carried out by the SRSG; (ii) provide additional information for the more widespread raptor species in Scotland that can be used to generate trends; (iii) provide a source of additional volunteers giving them the skills and confidence to start their way up the 'volunteering ladder of progression' and (iv) provide a source of competent and committed volunteers to feed through to SRSG for further mentoring and encouragement to take up long-term studies.

INTRODUCING *RAPTOR PATCH*

In 2016 we began piloting a new survey called *Raptor Patch* where we are particularly encouraging monitoring of four species – Buzzard, Kestrel, Sparrowhawk & Raven. While there are a small handful of long-term studies of these species operating across Scotland (for example Gordon Riddle's Kestrel study in Ayrshire, see Chapter 3: *Kestrel in Ayrshire and beyond: trends in breeding numbers and productivity*.), in general these species are currently under-recorded by the existing SRMS contributors.

Through *Raptor Patch*, individuals are encouraged to take on the monitoring of a defined geographic area (or "patch") of their choosing where they will ultimately get to grips with all the breeding raptors within it. The emphasis of *Raptor Patch* is on selecting a patch that it representative of the wider landscape and ensuring that monitoring achieves complete coverage of this area.

Figure 19: Raptor Patch training day. (Photo credit: Amy Challis, SRMC).

In March 2016 we held a training day for our new recruits to equip them which the knowledge and skills to be able to set up their own *Raptor Patch* (Figure 19). One of those attending the training day, and quick to set up his own *Raptor Patch*, was Dave Taylor (Figure 20).

An interview with Dave Taylor

Dave lives with his wife Ida and dog Ted in Clackmannanshire. Dave had a successful career as a Photography Instructor with the Royal Air Force for 22 years. Following four further years working as an Education Field Teacher for the RSPB at their Vane Farm reserve in East Scotland, Dave moved on to set up his own company delivering wildlife photography courses across Scotland. Through this current venture Dave is able to combine his passion and knowledge of both photography and wildlife.

Dave's *Raptor Patch* is around 300 ha and straddles the B9140 road between Coalsnaughton and Dollarbeg in Clakmannanshire. The patch has an irregular boundary (as do most other *Raptor Patches*) delineated by the River Devon to the north and a combination of field and woodland boundaries to the south, west and east. Around two thirds of the area is unimproved grassland with the remaining third consisting of woodland of varying types.

At the end of June Amy Challis, the Scottish Raptor Monitoring Coordinator, went along to meet Dave in his *Raptor Patch* to find out about his experience of taking part in *Raptor Patch* over the last three months. Below, Amy reports on her visit.

I visited Dave on an overcast day at the end of June. The sky was threatening showers all afternoon but it remained dry and the Skylarks were singing as Dave led me across the fields from his house to show me around his *Raptor Patch*.

Dave was keen to show me the Raven nest which had been active earlier in the season (Figure 21).

Figure 20: Dave Taylor in his *Raptor Patch.* (Photo credit: Amy Challis, SRMC).

The Raven breeding season starts much earlier than that of the other *Raptor Patch* species so the five Raven chicks from this nest had already successfully fledged.

Figure 21: Raven nest in Dave Taylor's Raptor Patch. (Photo credit: Dave Taylor, Central Scotland RSG).

This particular Raven nest was in a tree in an area of mixed woodland. We could see a second nest structure below the main nest and Dave explained how he had learned from Mark Rafferty (a member of the Central Scotland Raptor Study Group) that often Ravens will take old nests apart and rebuild them again nearby.

Within the same woodland, Dave also took me to the first of two active Buzzard nests that he located within his patch this breeding season. We could hear the calls of the adult Buzzards overhead as we approached the nest site. Dave described how it had been the Buzzards displaying over the woodland which led him to believe that he must have an active nest. Having located the nest, it was several visits later before it became apparent it was active, when he saw an adult fly off the nest. The location of this nest was somewhat frustrating to a ground-based observer in that it was so high up the tree that it was impossible to see the chick that was yet to fledge. However, the splash at the bottom of the tree indicated that all was still well. Dave explained that he had learned from Mark that the area of splash around the tree provides a good indication of the age of the chicks, with the radius of splash

increasing as the chicks get older and are able to project further.

Dave also took me to an area of the woodland where he had located a cluster of old nests of varying sizes. He had seen Sparrowhawk displaying over this particular area of woodland earlier in the season but on our visit we did not find any evidence of an active nest, such as an accumulation of plucks nearby or splash below any of the nests. We visited a second area of woodland within the patch where Dave had located a second active Buzzard nest, again with a single chick and this time we were able to view the chick more readily from a vantage point 100 m from the nest tree.

Over the course of the afternoon I asked Dave a number of questions about his experience of taking part in *Raptor Patch* to date:

Q1: How did you get interested in raptors?

I first got interested in wildlife and natural history as I was growing up through my mother and brother. I'm now a keen wildlife photographer with a particular fascination for birds.

Q2: What motivated you to get involved in raptor monitoring?

I was concerned by reading what was happening to raptors throughout the UK and wanted to get involved to help to protect them. I met some existing members of the Central Scotland Raptor Study Group through both my voluntary countryside ranger work and also my wildlife photography and they encouraged my interest and invited me to join the local raptor study group.

Q3: How did you hear about *Raptor Patch*?

I first heard about *Raptor Patch* at the first Central Scotland Raptor Study Group meeting that I attended as a new member in March 2016. Amy was attending from the SRMS and I learned of the *Raptor Patch* training event that was happening literally the following weekend.

Q4: Did you find the *Raptor Patch* training day useful? Was there anything about it that particularly liked, or anything that you think should be changed?

I found the training day both enjoyable and interesting. The extra snippets that the experts were able to pass on were particularly useful, such as the different flight patterns of different birds and the different types of display such as soaring and circling.

Q5: Had you been involved in other wildlife monitoring or surveys before taking part in *Raptor Patch*? If so what?

I volunteer as a Countryside Ranger with Clackmannanshire Council and I am a member of the local mammalian group so have been involved with Badger and Red Squirrel surveys in the past. As a keen wildlife photographer I am doing informal surveying all the time, in the sense that I will always try to pass on any interesting sightings of wildlife to the relevant people or organisations that might be interested.

Q6: What species do you most enjoy monitoring?

Perhaps they are not as shiny as some of the other species but I really enjoy monitoring and photographing Buzzards. I'm really pleased to see that they have made a comeback. You hear some people saying that there are too many Buzzards but I'd argue that the food needs to be there to support the birds in the first place.

Q7: What has been your highlight of the raptor monitoring year so far?

Figure 22: Dave Taylor learning how to weigh a Buzzard chick in his *Raptor Patch*. (Photo credit: Mark Rafferty, Central Scotland RSG).

I've been lucky in that Mark Rafferty from the Central Scotland Raptor Study Group has come along to ring all of the chicks in the nests I have found – five Raven chicks from one nest and a single Buzzard chick from each of two nests. Witnessing the ringing of the chicks and seeing the birds close up for the first time has been a definite highlight. At one of the Buzzard nests in particular, at no point did I have a view into the nest to be able to see directly what was happening. I knew that chicks must have hatched from the increasing amount of splash below the tree, but it wasn't until Mark climbed the tree and brought the chick down from the nest for ringing that I saw it for the first time.

Q8: How familiar were you with your patch area before you started *Raptor Patch*? Have you found out anything about this area during your monitoring that you found especially surprising or interesting?

I've lived here since 2001 and walk the dog twice a day so was fairly familiar with some parts of it. However, *Raptor Patch* has definitely got me exploring off the beaten track and got me into woodlands that I wouldn't have normally explored regularly. It was through *Raptor Patch* and learning about display behaviour that I was able to identify the breeding woods and then locate the nests of Buzzard that I hadn't previously known were there.

Q9: What aspects of raptor monitoring do you find particularly satisfying or challenging? Is there any particular skill or area of knowledge that you would like to improve in?

Raptor monitoring is all about playing detective and putting all the pieces together which I find exciting.

Figure 23: Buzzard chick in Dave Taylor's *Raptor Patch*. (Photo credit: Mark Rafferty, Central Scotland RSG).

I'm really interested in food competition and how that affects the distribution of Buzzards and the number of chicks produced. I was interested to see for example that both my Buzzard nests this year only produced a single chick, which is below the average of 2-4.

Dave's *Raptor Patch* Stats…

Location – Near Dollar in Clackmannanshire. **Size** – approximately 300 ha.

Distance from home – 0 miles, I live in the middle of my *Raptor Patch*.

Summary of findings so far – I've recorded one occupied Raven territory. I located the active nest and five chicks were ringed by the local raptor study group, all of which fledged successfully. I also have two occupied Buzzard territories. I located an active nest in each territory and each nest produced one large and one smaller chick each which has been ringed. Fledging has yet to take place. I also saw Sparrowhawk displaying in my *Raptor Patch* earlier in the season but have so far not located an active nest. I have not seen any Kestrels.

There were also differing prey remains in both nests that Mark saw when he climbed to retrieve the chicks for ringing – both seemed to be mostly passerines (there was a Blue Tit and Great Tit). Some small mammal bones were found in pellets at the base of one tree.

Q10: Can you sum up raptor monitoring in three words?
Observing and learning.

Q11: Do you hope to continue your *Raptor Patch* next year?

Yes, definitely. There are still areas of my *Raptor Patch* that I have not explored properly this year which I am looking forward to getting into next year. For example, I think I may well have another Buzzard territory within my *Raptor Patch* – at one point I did see an adult carrying food towards a different area of my patch so something I hope to get a better handle on next year. I am also looking forward to seeing the changes from one year to the next, for example, to see whether the Raven come back to the nest they used this year or whether it might be taken over by a pair of Buzzards that seemed to be eyeing it up earlier in the season and had raised a single chick in it last year.

Q12: What would you say to other people thinking of starting up their own *Raptor Patch*?

You need to get off the beaten track to explore your *Raptor Patch* properly. It is in the areas which other people rarely visit that you are more likely to stumble across the rarer wildlife and you might be surprised at what you find. I've been lucky enough to discover a wide variety of species living in my Raptor Patch – not just raptors but other birds and also Pine Marten, Badgers, Red Squirrels and Otters.

If you have been inspired to think about taking up raptor monitoring and would like to find out how you can get involved in *Raptor Patch* please visit: http://raptormonitoring.org/getting-involved/raptor-patch

6 National Survey - the year of the Golden eagle

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 2015 it was the turn of the Golden Eagle, a survey funded by SNH and JNCC and coordinated by RSPB. Read on to learn more about what this survey involved from the survey organiser Dr Daniel Hayhow (Conservation Scientist, RSPB).

Summary

The Golden Eagle population in Britain was surveyed in 2015, the fourth complete national survey. The survey aimed to investigate population size, distribution and breeding success and to compare results with similar surveys since the early 1980s. The last survey in 2003 found that the population had remained stable overall but declines in eastern Highlands of Scotland raised concerns regarding the threat posed by illegal persecution. This survey was carried out by six full time research assistants and two contract fieldworkers employed by the RSPB Centre for Conservation Science, alongside c.150 members of the Scottish Raptor Study Groups. In 2015, a total of 508 territorial pairs was located, which is a substantial increase in numbers since the last survey which found 442 pairs.

Planning

Planning for the survey began in September 2014 and involved RSPB, SRSG and the SRMS. In the run up to fieldwork commencing in January 2015, plans for complete coverage were made between RSPB and SRSG. A comprehensive database of Golden Eagle territories, historical and current, was collated using the 2003 national survey results and subsequent annual SRMS data. SRSG species coordinators and species experts were then consulted on these territories.

Survey Methodology

The 2015 survey followed the well-established three-visit methodology used in the three previous national surveys. Each home range was visited on a minimum of three occasions; firstly to look for eagles or signs of their presence, then to look for evidence of breeding or further checks for occupation, and finally to record productivity of nesting pairs. It was stressed that early visits (January - March) were very important for the national survey to minimise the chances of missing breeding attempts that failed early on. Details of each survey visit were recorded on bespoke survey forms; including location of sightings and area of search, details of eyries located, and habitat features surrounding any nest sites.

Figure 24: A Golden Eagle eyrie in Perthshire, monitored as part of the national Golden Eagle survey in 2015. This eyrie has a pair of Roe Deer fawns which have been brought to the eyrie to feed the growing Golden Eagle chick. (Photo credit: Keith Brockie, Tayside RSG).

RESULTS

Of the 729 potential home ranges, a total of 64 of these were considered to be amalgamated in some way with neighbouring ranges (some of these amalgamations were long standing, others recorded for the first time in 2015). Taking this into account and to avoid double counting of two ranges occupied by the same pair, only one of the two (or sometimes three) ranges considered to be amalgamated were retained in summarising the total number of occupied ranges in 2015.

Data were received for a total of 663 home ranges that were visited in 2015 (this includes 37 ranges which were listed in the 2003 inventory but which are largely considered to be long term vacant, in some cases this is where the habitat is no longer suitable).

Of 663 ranges surveyed, results indicate that 508 were considered to be occupied by a pair of birds. Birds were observed on a further 59 ranges, but with insufficient evidence to determine whether an active pair was present. This figure of 508 breeding pairs represents a 14.9% increase in the population from 442 in 2003. This increase stems from a recovery in numbers from a known earlier (but subsequently depleted) population level. The results from the national survey will be analysed and discussed fully in a scientific paper which is currently in preparation.

Due to differing criteria used by the SRMS and the national survey the figures for ranges considered occupied by pairs and productivity differ slightly (Table 9).

Table 9: Breeding success of Golden Eagle in Scotland in 2015, based on SRMS data.

Region	Home ranges checked	Home ranges occupied by pairs	Of which immature pairs[1]	Further home ranges in use (single birds or fresh signs)	Pairs monitored	Failed 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	**106**	**87**	**3**	**8**	**81**	**21**	**54**	**29**	**19**	**19**	**1.0**	**0.4**	**0.2**
- Argyll Islands	56	50	2	3	44	14	27	13	6	6	1.0	0.2	0.1
- Argyll Mainland	50	37	1	5	37	7	27	16	13	13	1.0	0.5	0.4
Central	**12**	**10**	**0**	**1**	**10**	**4**	**6**	**5**	**4**	**5**	**1.3**	**0.8**	**0.5**
- Arrochar & Helensburgh	1	1	0	0	1	1	0	0	0	0	–	–	0.0
- Stirling	11	9	0	1	9	3	6	5	4	5	1.3	0.8	0.6
Dumfries & Galloway	**6**	**2**	**0**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1.0**	**1.0**	**0.5**
Highland	**326**	**260**	**17**	**32**	**249**	**81**	**137**	**81**	**69**	**86**	**1.2**	**0.6**	**0.3**
- Badenoch & Strathspey	19	14	2	3	13	4	9	8	7	12	1.7	1.3	0.9
- Caithness	4	4	1	0	4	1	2	0	0	0	–	0.0	0.0
- Inverness-shire	30	19	3	3	18	5	7	6	6	9	1.5	1.3	0.5
- Isle of Skye	37	30	0	1	30	4	25	12	9	12	1.3	0.5	0.4
- Lochaber	81	71	3	3	69	29	35	18	11	11	1.0	0.3	0.2
- Nairn	1	0	0	1	0	0	0	0	0	0	–	–	–
- Ross-shire	95	73	6	16	69	20	36	18	17	20	1.2	0.6	0.3
- Small Isles	8	7	0	0	7	2	5	4	4	5	1.3	1.0	0.7
- Sutherland	51	42	2	5	39	16	18	15	15	17	1.1	0.9	0.4
Lewis & Harris	**73**	**69**	**3**	**1**	**68**	**13**	**48**	**21**	**16**	**18**	**1.1**	**0.4**	**0.3**
- Harris	22	21	0	0	21	1	18	6	4	4	1.0	0.2	0.2
- Lewis	51	48	3	1	47	12	30	15	12	14	1.2	0.5	0.3
Lothian & Borders	**3**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	–	**0.0**	**0.0**
- Scottish Borders	3	1	0	0	1	0	1	0	0	0	–	0.0	0.0
North-east	**37**	**12**	**2**	**4**	**12**	**5**	**7**	**5**	**5**	**6**	**1.2**	**0.9**	**0.5**

Region	Home ranges checked	Home ranges occupied by pairs	Of which immature pairs[1]	Further home ranges in use (single birds or fresh signs)	Pairs monitored	Failed 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)
- Aberdeenshire	29	10	1	3	10	4	6	4	4	5	1.3	0.8	0.5
- East Moray	8	2	1	1	2	1	1	1	1	1	1.0	1.0	0.5
South Strathclyde	**7**	**7**	**0**	**0**	**7**	**5**	**2**	**2**	**2**	**2**	**1.0**	**1.0**	**0.3**
- Arran & Cumbrae	6	6	0	0	6	5	1	1	1	1	1.0	1.0	0.2
- Ayrshire	1	1	0	0	1	0	1	1	1	1	1.0	1.0	1.0
Tayside	**49**	**29**	**3**	**12**	**28**	**8**	**20**	**13**	**12**	**15**	**1.3**	**0.8**	**0.5**
- Angus	17	7	2	5	7	2	5	3	3	4	1.3	0.8	0.6
- Perth & Kinross	32	22	1	7	21	6	15	10	9	11	1.2	0.7	0.5
Uist	**28**	**26**	**0**	**2**	**24**	**5**	**15**	**9**	**7**	**8**	**1.1**	**0.5**	**0.3**
- Barra	5	4	0	1	4	1	2	1	1	1	1.0	0.5	0.3
- Benbecula	2	2	0	0	2	0	2	2	2	3	1.5	1.5	1.5
- North Uist	11	10	0	1	10	3	7	5	4	4	1.0	0.6	0.4
- South Uist	10	10	0	0	8	1	4	1	0	0	–	0.0	0.0
TOTAL:	**647**	**503**	**28**	**62**	**482**	**143**	**291**	**166**	**135**	**160**	**1.2**	**0.5**	**0.3**

[1]These immature pairs are included in the column 'Home ranges occupied by pairs'. Pairs consisting of either one or two birds with immature plumage are treated as immature pairs.

N.B. [1]The total number of ranges assessed by the national survey includes ranges considered to have been vacant over a long period, but these ranges are not included in SRMS annual summaries monitoring. [2]The national survey and SRMS annual monitoring use slightly differing criteria for determining occupation of a range by a pair. Following the approach taken for the last national survey, a territory is considered occupied if a pair of birds is recorded OR if only a single bird is seen but a newly built up nest is recorded. As a consequence, the national survey figure for ranges considered occupied by a pair is slightly higher than the SRMS figures.

7 How has SRMS data been used over the last year?

One of the main functions of the Scottish Raptor Monitoring Scheme is 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 2015, with SRMS data contributors' permission SRMS data were provided for a number of purposes. SNH and JNCC have been using SRMS data to support a review of Special Protection Areas in the UK and RSPB have used SRMS data to inform their Environmentally Sustainable Grouse Moor Management Project. Please read on to find out more about both of these important pieces of work.

Assessment of the UK SPA network for raptors

by Nigel Buxton (SNH) and David Stroud (JNCC)

The protection and management of important breeding areas is crucially important to the conservation of birds of prey. These areas are legally notified as Sites of Special Scientific Interest in Britain with some additionally classified as Special Protection Areas (SPAs) under the 1979 EU Birds Directive. Although implementation of this EU legislation is the responsibility of UK government, day-to-day responsibility in Scotland is devolved to the Scottish Government with advice from SNH (and from JNCC on UK contexts).

SPAs are classified for species listed on Annex I of the Directive and for regularly occurring migratory birds. Selection of key sites for each species gives a 'suite' which together, across all species, forms the national SPA network. Identifying, monitoring and, especially, classifying SPAs is data-hungry and the need for extensive, high quality, robust data is essential. As high profile and often controversial species, Scotland's raptors are at the forefront of this need.

Dedicated regular surveys under the Statutory Conservation Agencies & RSPB Annual Breeding Birds Scheme (SCARABBS) programme produce national population estimates but, alongside these in Scotland, a high proportion of most breeding raptor populations are monitored annually via SRMS.

Figure 25: In 2016 Hen Harrier have received a full national survey as part of the SCARABBS programme. (Photo credit: Keith Brockie, Tayside RSG).

The SPA network in Scotland comprises 153 sites covering 12,053.68 km^2 (as at October 2016). The efforts of SRSG to survey breeding raptors across Scotland are central to the identification and classification of SPAs and to our ability to report on raptor status nationally and internationally.

Table 10 shows details of the raptor species which are qualifying interests on Scottish SPAs.

Following reviews of the SPA network in the 1980s and 1990s (Stroud *et al.* 1990, 2001), JNCC has coordinated a third decadal review of the status of species within the network covering the 2000s and which was published by JNCC in October (Stroud *et al.* 2016). For

Scottish raptors, much of the data and information from their extensive and often remote breeding areas derive from SRMS data-holdings.

For the latest Review, a number of data issues relating to raptors and other rare breeding birds were encountered:-

- Lack of locational information such as six or four figure grid references for a significant number of records, greatly restricting their value.
- In some years, missing data in runs of counts from sites with no information as to whether this reflected zero presence or just lack of survey (null counts). Assumptions made as to whether birds were present in those years lacking data introduced (sometimes significant) uncertainty to some of the conclusions about specific sites and species.
- Lack of data for whole sites – typically for some large sites classified for widely-dispersed upland species.

Resolution of such issues would further enhance the value, and ease of use, of these data.

Table 11 shows how SRMS data have been used to better the conservation of eight important Scottish species. Goshawk, Buzzard, Kestrel and Sparrowhawk, although not Annex 1 species, are partial migrants and sensitive species with a variety of conservation issues for which high quality data, as produced by the SRMS, are required to facilitate management.

In summary the use and benefits of SRMS data are:-

- essential to national population estimates for all raptors;
- of known high quality, collected to consistent high standards, and readily available;
- at Scotland-wide scale with broad geographical sampling;
- critical to identification of important areas for Annex 1 raptors, so as to support classification of new SPAs as required;
- essential to monitor status within existing SPAs to assessment site and network conservation status;
- critical to casework related to SPAs and other species protection/management requirements; and
- effective in the use of extensive volunteer networks, and giving data that would otherwise be unaffordable.

See the third SPA Review at http://jncc.defra.gov.uk/page-7307 to see what it means for Scotland's raptors.

Table 10: Raptor species which are qualifying interests on Scottish SPAs.

Site	Marsh Harrier	Hen Harrier (breeding)	Hen Harrier (non-breeding)	Golden Eagle	Osprey (feeding)	Merlin	Peregrine
Total number of UK SPAs for species	10	17	20	12	9	15	11
Total number of Scottish SPAs for species	1	11	4	12	9	7	5
Total numbers in Scottish SPAs (prs)	**4**	**129**	**47**	**125**	**76**	**64**	**25**
Proportion of UK SPA total in Scottish SPAs	**2%**	**63%**	**19%**	**100%**	**100%**	**26%**	**35%**
Proportion of UK population in Scottish SPAs	**1%**	**23%**	**3%**	**28%**	**34%**	**6%**	**2%**
Abernethy Forest					■		
Arran Moors		■					
Caenlochan				■			
Cairngorms					■	■	■
Cairngorms Massif				■			
Caithness & Sutherland Peatlands		■		■		■	
Cnuic agus Cladach Mhuile (Mull Coast and Hills)				■			
Cromarty Firth					■		
Cuillins				■			
Dornoch Firth and Loch Fleet					■		
Drumochter Hills						■	
East Caithness Cliffs							■
Firth of Tay and Eden Estuary	■						
Foinaven				■			
Forest of Clunie		■			■	■	■
Glen Affric to Strathconon				■			
Glen App-Galloway Moors		■					
Glen Etive and Glen Fyne				■			
Glen Tanar		■			■		
Hoy							■
Inner Moray Firth					■		
Jura, Scarba and the Garvellachs				■			
Langholm - Newcastleton Hills		■					
Lewis Peatlands				■		■	
Loch of Inch and Torrs Warren			■				
Foinaven				■			
Moray and Nairn Coast					■		
Muirkirk and North Lowther Uplands		■	■			■	■
North Caithness Cliffs							■
North Harris Mountains				■			
Orkney Mainland Moors		■	■				
Moidart and Ardgour				■			
Renfrewshire Heights		■					
Rinns of Islay		■					
River Spey - Insh Marshes			■		■		
Ronas Hill - North Roe and Tingon						■	
Rum				■			
Strath Carnaig and Strath Fleet Moors		■					

Table 11: Summary of how SRMS data have been used to better the conservation of eight important species.

Species	Comments
Red Kite	With Red Kites now extending throughout the UK, Scottish data are currently being assessed.
White-tailed Eagle	Assessment of past and present data is currently being undertaken.
Marsh Harrier	Firth of Tay and Eden Estuary is the only Scottish site.
Hen Harrier	SPA and other monitoring is a very high current priority in Scotland.
Golden Eagle	Six new SPAs were classified in 2010: Cairngorms Massif; Foinaven; Glen Affric to Strathconon; Glen Etive and Glen Fyne; Jura, Scarba and the Garvellachs; and Moidart and Ardgour. All were identified using SRMS data.
Osprey	Ospreys are still increasing, with the range expanding both south and westwards in Scotland and also locally in England and Wales. SRMS data are fundamental to assessing this exciting, ongoing spread in Scotland.
Merlin	SRMS data are currently being assessed to see if further Scottish concentrations exist outwith the SPA network.
Peregrine	SRMS data are currently being assessed to see if further Scottish concentrations exist outwith the SPA network.

Environmentally Sensitive Grouse Moor Management Project

by Pat Thompson (RSPB Senior Policy Officer – Land Use)

Background

Across the Scottish and English uplands, large areas of bog and heath are managed for grouse shooting. Many of the areas in question are protected as Sites of Special Scientific Interest and afforded special protection measures under the EC Birds (Special Protection Areas) and/or EC Habitats Directive (Special Areas of Conservation) with some inside National Parks. The impact of management practices deployed to increase grouse numbers on the natural environment are increasingly well understood. Predators of grouse are killed (legally and illegally), vegetation burnt, grouse treated with veterinary medicines to prevent disease, mountain hares killed and, in places, sheep used as so-called 'tick mops' to reduce tick numbers (Thompson *et al*. 2016).

Figure 26: Extensively managed area of blanket bog on Keighley Moor, Yorkshire. (Photo credit: Pat Thompson, RSPB).

These management practices are deployed at varying intensities, largely in line with the aspirations of the shooting rights holder, with those wanting to shoot large numbers of grouse employing more keepers and managing the land more intensively. The most 'productive' moors typically have more lines of butts and more access tracks.

Figure 27: On many driven grouse moors, large areas of upland vegetation are burnt in support of grouse production. In the Peak District, intensive burning regimes have resulted in heather becoming dominant, even on deep peat soils. (Photo credit: Pat Thompson, RSPB).

Figure 28: At the RSPB's Geltsdale Reserve, vegetation cutting is used instead of burning to try to restore degraded blanket bog. The removal of heather is enabling the bog vegetation to recover from years of excessive burning and sheep grazing. (Photo credit: Pat Thompson, RSPB).

Whilst it is undoubtedly true that some grouse moors, even driven grouse moors, may support important numbers of some birds of conservation concern, it is increasingly evident that these same moors may lack key species and have priority habitats like blanket bog and wet heath in poor condition. Arguments persist about the merits of driven grouse shooting, with proponents increasingly talking about the local economic benefits and wider nature conservation benefits, despite repeated reminders of the impact of the illegal killing on some of our most cherished wildlife.

The RSPB is concerned with the increasingly intensive and sometimes illegal management practices associated with grouse shooting, particularly driven grouse shooting. In recent years, the RSPB has broadened our understanding of the impacts of grouse moor management, arguing that the grouse shooting community needs to reform and cease all illegal activities and focus on environmentally sustainable management practices. In doing so, we have tended to argue that moor owners need to shift from big bag driven shooting to other models (e.g. walked-up shooting). This of course assumes that areas managed for walked-up shooting differ in their environmental performance from those managed for driven shooting. However, this fundamental information has been largely unknown, so in 2015, the RSPB commissioned a piece of research to assess the environmental performance of different styles of grouse shooting. Here, we report some of the preliminary findings.

Data

As the study progressed, it quickly became evident that we lacked some key data regarding the shooting estates. In particular, we lacked data on gamekeeper numbers (a proxy for management intensity), data on the provision of medicated grit (e.g. dose strength), grouse bags (a proxy for management intensity) and even data on estate boundaries (England). Whilst this presented a significant challenge to the study, the research scientist (Davide Scridel) collated a series of data sets on burning intensity, confirmed incidents of illegal killing of birds of prey and shooting style (driven or walked-up). Information on shooting style was gathered from hunting web sites and RSPB colleagues who knew the different areas well. Estate boundaries for Scotland (57 estates) were obtained from SNH (a deer management estate map) and a map of English estates (29

estates) produced from information provided by RSPB colleagues in the North Pennines, Bowland and parts of the Peak District. Additional data layers on designated sites, peat depth and Hen Harrier occupancy and breeding success were included. The Hen Harrier data comprised data for England (compiled annually by RSPB, Natural England and the Northern England Raptor Forum) and data generously provided by the Scottish Raptor Monitoring Scheme. In addition to the data compiled across our sample of driven (53 estates) and walked-up (34 estates) moors, a further set of data was added for 24 control sites (sites where Red Grouse were present but not shot).

RESULTS

As expected, burning was more evident on driven moors. On driven moors, 53% of all 'moorland' 1-km squares were burnt compared with 22% and 2% of walked-up and control moors respectively. Though not significant, a greater number of 1-km squares were burnt on driven moors in England (78%) compared with driven moors in Scotland (51%). Where burning was recorded, squares on driven moors were burnt significantly more intensively than on walked-up moors.

On driven moors, burning was significantly more frequently recorded on squares with deep peat (53%) when compared with walked-up (15%) and control (3%) moors. Burning intensity was significantly greater on deep peat squares managed for driven shooting when compared with walked-up moors. The proportion of 1-km squares burnt on deep peat was significantly greater on English driven moors (82%) compared with Scottish driven moors (46%) with the overall burning intensity (proportion of square burnt) significantly greater on driven moors in England. Likewise, burning was significantly more prevalent on driven moors in protected areas (55% of 1-km squares burnt) when compared with walked-up moors (18%) with a significantly greater proportion of each 1-km square burnt on driven moors compared with walked-up moors. Across driven moors as a whole, significantly more 1-km squares were burnt on protected areas in England (79%) compared with Scotland (50%). An earlier study found that burning was frequent on deep peat across England and Scotland with 44% of 1-km squares in England and 28% of 1-km squares where burning occurred classified as deep peat. This same study, which used aerial images, also found that burning was widespread across protected areas (Douglas *et al*. 2015).

Over the areas for which we had data, 93 confirmed incidents of illegal activity (e.g. poisoning, illegal use of traps) were recorded between 2003–2013, with incidents significantly more common on driven estates (87 incidents) than on walked-up (5 cases) and control sites (1 case). Where Hen Harriers occurred, breeding success was significantly greater on walked-up moors (83/118 pairs of Hen Harrier (70%) bred successfully) than on driven moors (30/70 pairs of Hen Harrier (43%) bred successfully).

Despite data limitations, the study found consistent differences between the different styles of shooting with management for driven shooting found to have greater impact on the environment than walked-up shooting, which was similar in impact to control sites.

A hierarchical cluster analysis was performed using estate-based data on burning and incidents of wildlife crime, to try to group sites of similar environmental impact. The analysis identified three groups of named estates – the first group comprised 29 driven moors, two walked-up moors and a control site; the second group was more mixed with 18 driven, 13 walked-up and four control sites; the third group was made up of one driven moor, 19 walked-up moors and 19 control sites. These findings confirm that driven moors are typically characterised by high levels of burning and wildlife crime whilst walked-up moors are typically (but not

always) managed less intensively. Clearly, the findings may have been even more marked if we had included more English estates and included a measure of gamekeeper intensity, treatment of grouse and grouse bags though it is plausible that measures of burning and wildlife crime are associated to the number of gamekeepers employed per estate.

The results of the cluster analysis may be used to identify and target estates thought to be managing land in a legal and more environmentally manner and to highlight the effects of intensive land-management on the uplands.

We are grateful to the Scottish Raptor Monitoring Scheme for the provision of Hen Harrier data and to colleagues in Scotland and England for supporting this study.

Work is ongoing in 2016–17 to progress data sharing agreements between SRMS and its partners to ensure that the data we hold can be more readily accessible to those that are able to maximise the use of it to conserve raptors.

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