



Predatory Bird
Monitoring Scheme
<http://pbms.ceh.ac.uk/>

PBMS Archive holdings: a Predatory Bird Monitoring Scheme (PBMS) report

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This report should be cited as:

Walker, L.A., J.S. Chaplow, Potter, E.D., & Shore, R.F. (2014). PBMS archive holdings.: a Predatory Bird Monitoring Scheme (PBMS) report. Centre for Ecology & Hydrology, Lancaster, UK. 36 pp.

Centre for Ecology and Hydrology Project Number: NEC05191

Suggested keywords: Annual report; Birds of Prey; Archive, Monitoring; United Kingdom (UK)

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Executive Summary

The Predatory Bird Monitoring Scheme (PBMS; <http://pbms.ceh.ac.uk/>) is the umbrella project that encompasses the Centre for Ecology & Hydrology's National Capability contaminant monitoring and surveillance work on avian predators. By monitoring sentinel vertebrate species, the PBMS aims to detect and quantify current and emerging chemical threats to the environment and in particular to vertebrate wildlife.

As part of its chemical monitoring studies the PBMS receives and carries out post-mortem examinations on approximately 300 birds or prey each year. A range of tissues are taken from the carcasses. Around 100 addled and deserted eggs from various species are also submitted to the PBMS. The eggs are cracked open and the contents collected. The shells are retained for two years prior to being donated to the National Museums Scotland for cataloguing and archiving.

The main purpose for collecting tissues and egg contents is for use in annual monitoring of pollutant concentrations by the PBMS. However, not all samples are used each year for chemical analyses and, even when samples are used, typically only a sub-sample is analysed. Samples that are not analysed or for which only a sub-sample is analysed are retained in the PBMS archive. Overall, the number of samples in the PBMS archive is approaching 50,000 tissue and egg content samples.

The material in the archive is used for research studies investigating chemical fate and behaviour, to trial new monitoring, and for a wide range of other studies, some of which are unrelated to pollutants.

The purpose of this short report is to summarise the main holdings in the PBMS archive. This is done for the seven species for which we currently or used to obtain relatively large numbers of carcasses. We also draw attention to holdings of a small number of other species which may be of priority conservation concern. The information is broken down by type of sample that is held, the decade in which it was collected, and provenance as to whether samples were from England and Wales, or Scotland. In addition to information on numbers of samples from carcasses, we provide a description on the holdings for the number of egg contents for various species, again broken down by decade and provenance.

1. Introduction

1.1. Background to the PBMS

The Predatory Bird Monitoring Scheme (PBMS; <http://pbms.ceh.ac.uk/>) is the umbrella project that encompasses the Centre for Ecology & Hydrology's long-term contaminant monitoring and surveillance work on avian predators. The PBMS is a component of CEH's National Capability activities.

By monitoring sentinel vertebrate species, the PBMS aims to detect and quantify current and emerging chemical threats to the environment and, in particular, to vertebrate wildlife. Our monitoring provides the scientific evidence needed to determine how chemical risk varies over time and space. This may occur due to market-led or regulatory changes in chemical use and may also be associated with larger-scale phenomena, such as global environmental change. Our monitoring also allows us to assess whether detected contaminants are likely to be associated with adverse effects on individuals and their populations.

Overall, the PBMS provides a scientific evidence base to inform regulatory decisions about sustainable use of chemicals (for example, the [*EU Directive on the Sustainable Use of Pesticides*](#), *Biocides Directive 98/8EC*, *UNEP Convention on migratory species: Minimizing the risk of poisoning to migratory birds*; *UNEP/CMS 10.26*). In addition, the outcomes from the monitoring are used to assess whether mitigation of exposure is needed and what measures might be effective. Monitoring also provides information by which the success of mitigation measures can be evaluated.

Currently, the PBMS has two key objectives:

- (i) to detect temporal and spatial variation in exposure, assimilation and risk for selected pesticides and pollutants of current concern in sentinel UK predatory bird species and in species of high conservation value
- (ii) in conjunction with allied studies, to elucidate the fundamental processes and factors that govern food-chain transfer and assimilation of contaminants by top predators.

Further details about the PBMS, copies of previous reports, and copies of (or links to) published scientific papers based on the work of the PBMS can be found on the [PBMS website](#).

1.2. Archiving of samples by the PBMS

As part of its chemical monitoring studies the PBMS receives and carries out post-mortem examinations on approximately 300 birds of prey each year. Over 100 observations are recorded during these examinations and a putative cause of death is attributed to the bird. A range of tissues are taken from the carcasses.



Around 100 addled and deserted eggs from various species are also submitted to the PBMS. These are typically collected by fieldworkers undertaking ringing or other nest-monitoring studies and collections made by them are done under licence from the statutory national bodies for nature conservation. The PBMS is likewise licensed to hold such samples.

Biometric data relating to egg size, shell thickness and embryonic development are recorded for the eggs. The eggs are then cracked open and the contents collected. The shells are retained for two years prior to being donated to the National Museums Scotland for cataloguing and archiving.



The main purpose for collecting tissues and egg contents is for use in annual monitoring of pollutant concentrations by the PBMS. However, not all samples are used each year for chemical analyses and, even when samples are used, typically only a sub-sample is analysed. Samples that are not analysed or for which only a sub-sample is analysed are retained in the PBMS archive.

The material in the archive is used for research studies investigating chemical fate and behaviour, to trial new monitoring, and for a wide range of other studies, some of which are unrelated to pollutants. Many of these studies are conducted in collaboration with other research groups. Examples of such studies include completion of a PhD, in collaboration with Lancaster University, on a study to investigate change in environmental concentrations of polbrominated flame retardants in marine and freshwater systems (Crosse *et al.* 2012a; Crosse *et al.* 2012b; Crosse *et al.* 2013), studies on the transfer of trace elements, including ¹³⁷Caesium, into wildlife (Barnett *et al.* 2012), and the genetic structure of golden eagle populations in Scotland (Bourke *et al.* 2010).

Overall, the number of samples in the PBMS archive is approaching 50,000 tissue and egg content samples.

1.3. Aim and contents of the report

The purpose of this short report is to summarise the holdings in the PBMS archive.

This is done for the seven species for which we currently or used to obtain relatively large numbers of carcasses (barn owl *Tyto alba*, tawny owl *Strix aluco*, sparrowhawk *Accipiter nisus*, kestrel *Falco tinnunculus*, common buzzard *Buteo buteo*, red kite *Milvus milvus* and heron *Ardea cinerea*). We also draw attention to holdings of a small number of other species that are of priority conservation concern, such as golden eagle *Aquila chrysaetos*, merlin *Falco columbarius*, and peregrine falcon *Falco peregrinus*.

The information is broken down by type of sample that is held, the decade in which it was collected, and provenance as to whether samples were from England and Wales, or from Scotland. Scottish samples are identified separately in response to the specific needs of the Scottish stakeholders who provide funding support to the PBMS. We also present maps, by decade, that illustrate the provenance of the birds from which carcasses have been collected (10 km²) resolution, thereby providing an indication of the spatial coverage obtained by the PBMS sampling.

In addition to information on numbers of samples from carcasses, we provide a description on the holdings for the number of egg contents for various species, again broken down by decade and provenance. The locations from which these eggs came are not mapped, partly because the spatial resolution for provenance is often at the regional level.

2. Description of samples retained in the PBMS archive

All samples are held at -20 °C in glass jars, unless otherwise stated. The tops to the jars have varied over the years in which samples have been archived. They were originally Bakelite, then metal and we now use jars with high density polypropylene tops.

The types of sample collected are:

Liver – whole liver samples are retained. If a liver is larger than 30 g then the liver is split between two jars. Liver is the organ most frequently analysed for organic and inorganic pollutants.

Kidney – both kidneys are retained as a single sample. Consequently, archived left and right kidneys cannot be distinguished from each other. Kidneys can likewise be used to measure bioaccumulation of a range of contaminants, but have been used less frequently to date.

Brain – whole brain samples are retained. Brains can be analysed to determine concentrations of pollutants that have passed across the blood-brain barrier, and to examine changes in biochemical structure through techniques such as infra-red microscopy.

Muscle – a segment of pectoral muscle is retained. For smaller species, both pectoral muscles are retained. Measurement of muscle provides information on the body condition of the bird. Muscle can also be used to measure a range of pollutants and particularly those that have affinity for protein.

Fat – available fatty deposits from the breast and abdominal cavity are retained. Fat can be analysed for a range of lipophilic contaminants.

Gizzard – the contents of the gizzard were retained up until the mid 1990s. Retention of these samples was stopped in 2001 because of limited resources and a need to consider collection of other material. Gizzard contents provide information on diet.

Bone – the left femur, stripped of flesh using *Dermestes maculatus* beetles, of each bird is retained. Samples are stored in plastic bags at -20 °C. Collection of femurs began in 2005. Bone can be analysed to determine structural bone strength and analysed for certain accumulated pollutants such as lead and strontium.

Feathers – where available 10th and 9th primary, 1st secondary and a sample of breast feathers are retained. Samples are stored in paper envelopes at -20 °C. Collection of feathers began in 2004. Feathers can be analysed for a range of contaminants and for hormones.

Egg contents – Biometric data (weight, length, breadth etc.) and developmental stage of the embryo, if present, is recorded for each egg. The contents of each egg is homogenised prior to storage and the shells are cleaned, dried and stored at room temperature. Egg contents can be used to measure bioaccumulation of a range of pollutants, and those that have embryotoxic effects are of particular interest.

3. Archive holdings of tissues from predatory birds collected from the 1960s to present

Data for seven species are presented as a series of tables that summarise the holdings together with accompanying maps. It should be noted that the maps only show the location of birds for which we have a 10km grid square (100km²) reference and so the number of birds presented in the maps may be lower than the total number presented in the tables. This is particularly the case for samples received before the 2000s for which we hold specific location data on paper records that have been archived as electronic images. These location data have not yet been translated into 10km-square grid references nor been digitised and are not represented on the map outputs.

Other holdings for species of high conservation value include golden eagle (*Aquila chrysaetos*), merlin (*Falco columbarius*), and peregrine falcon (*Falco peregrinus*). The PBMS archive contains samples from 15 golden eagles, all found dead in Scotland, and the majority (10) were found dead in the 1990s. Samples from a total of 128 merlin (67 from England & Wales and 61 from Scotland) and 112 peregrine falcon (90 from England & Wales and 22 from Scotland) carcasses are also held in the archive. The 1990s was the decade from which the highest numbers of birds were collected (71 merlins and 50 peregrine falcons). The archive contains samples from the majority of other raptor species received by the PBMS (approximately 350 individual birds).

In addition, the archive contains samples from 150 great crested grebes (*Podiceps cristatus*), and 230 kingfishers (*Alcedo atthis*). These other species have not been the focus of monitoring studies for many years and most samples are from before 2000. Provenance data for these samples are on paper records that have been archived as electronic images but have not been translated into 10km grid square references.

3.1. Barn owl (*Tyto alba*).

The archive holdings for barn owls are summarised in Table 1 and Figure 1.

Table 1. Tissue archive holdings for barn owls (*Tyto alba*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	0	0	8	0	0	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	0	0	8	0	0	0	0	0
1970s	Eng & Wales	66	19	31	19	5	0	0	0
1970s	Scotland	1	0	0	0	0	0	0	0
1970s	<i>Total</i>	67	19	31	19	5	0	0	0
1980s	Eng & Wales	106	131	32	137	37	50	0	0
1980s	Scotland	7	12	1	12	6	6	0	0
1980s	<i>Total</i>	113	143	33	149	43	56	0	0
1990s	Eng & Wales	517	457	138	468	103	166	0	0
1990s	Scotland	67	61	18	63	16	25	0	0
1990s	<i>Total</i>	584	518	156	531	119	191	0	0
2000s	Eng & Wales	761	737	702	764	518	0	616	374
2000s	Scotland	38	38	39	39	32	0	25	23
2000s	<i>Total</i>	799	775	741	803	550	0	641	397
2010s	Eng & Wales	270	270	263	284	79	0	288	269
2010s	Scotland	21	21	21	21	4	0	12	10
2010s	<i>Total</i>	291	291	284	305	83	0	300	279
ALL YEARS	Eng & Wales	1720	1614	1174	1672	742	216	904	643
	Scot	134	132	79	135	58	31	37	33
	Total	1854	1746	1253	1807	800	247	941	676

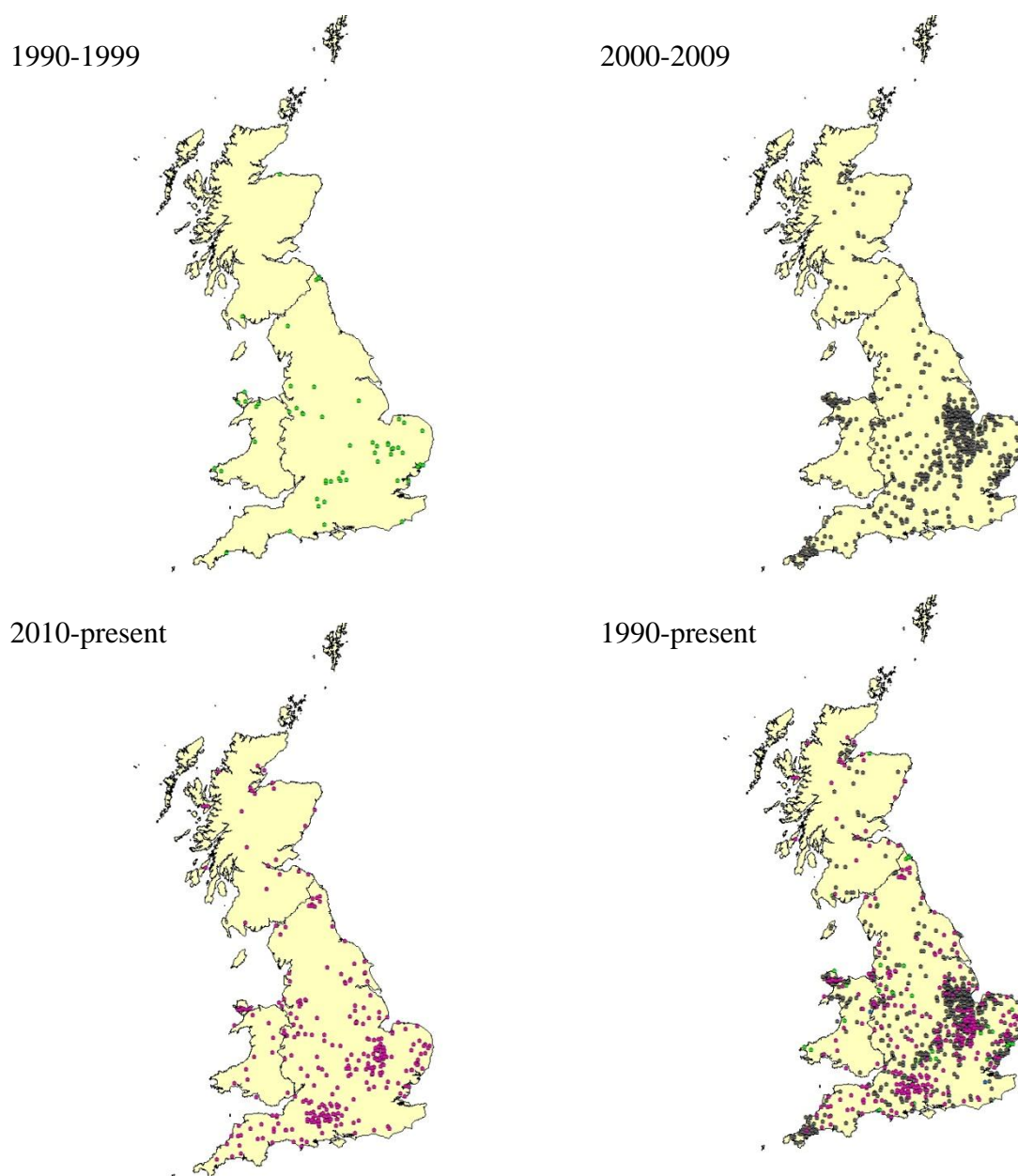


Figure 1. Location of barn owls for which tissue samples are held in the PBMS archive
Location data for most birds that died in the 1990s and for all birds that died earlier have not been translated into 10km grid square references and are not represented on the map outputs.

3.2. Sparrowhawk (*Accipiter nisus*)

The archive holdings for sparrowhawks are summarised in Table 2 and Figures 2 and 3.

Table 2. Tissue archive holdings for Eurasian sparrowhawk (*Accipiter nisus*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	0	1	5	1	0	0	0	0
1960s	Scotland	0	1	3	1	0	0	0	0
1960s	<i>Total</i>	0	2	8	2	0	0	0	0
1970s	Eng & Wales	89	129	121	132	20	1	0	0
1970s	Scotland	53	57	54	57	3	1	0	0
1970s	<i>Total</i>	142	186	175	189	23	2	0	0
1980s	Eng & Wales	287	327	169	333	61	28	0	0
1980s	Scotland	81	86	48	89	15	6	0	0
1980s	<i>Total</i>	368	413	217	422	76	34	0	0
1990s	Eng & Wales	684	598	165	619	88	55	0	0
1990s	Scotland	152	136	39	143	22	15	0	0
1990s	<i>Total</i>	836	734	204	762	110	70	0	0
2000s	Eng & Wales	373	365	360	372	278	0	259	212
2000s	Scotland	37	37	37	37	23	0	32	27
2000s	<i>Total</i>	410	402	397	409	301	0	291	239
2010s	Eng & Wales	144	142	134	144	35	0	153	153
2010s	Scotland	33	33	32	33	9	0	23	23
2010s	<i>Total</i>	177	175	166	177	44	0	176	176
ALL YEARS	Eng & Wales	1577	1562	954	1601	482	84	412	365
	Scot	356	350	213	360	72	22	55	50
	Total	1933	1912	1167	1961	554	106	467	415

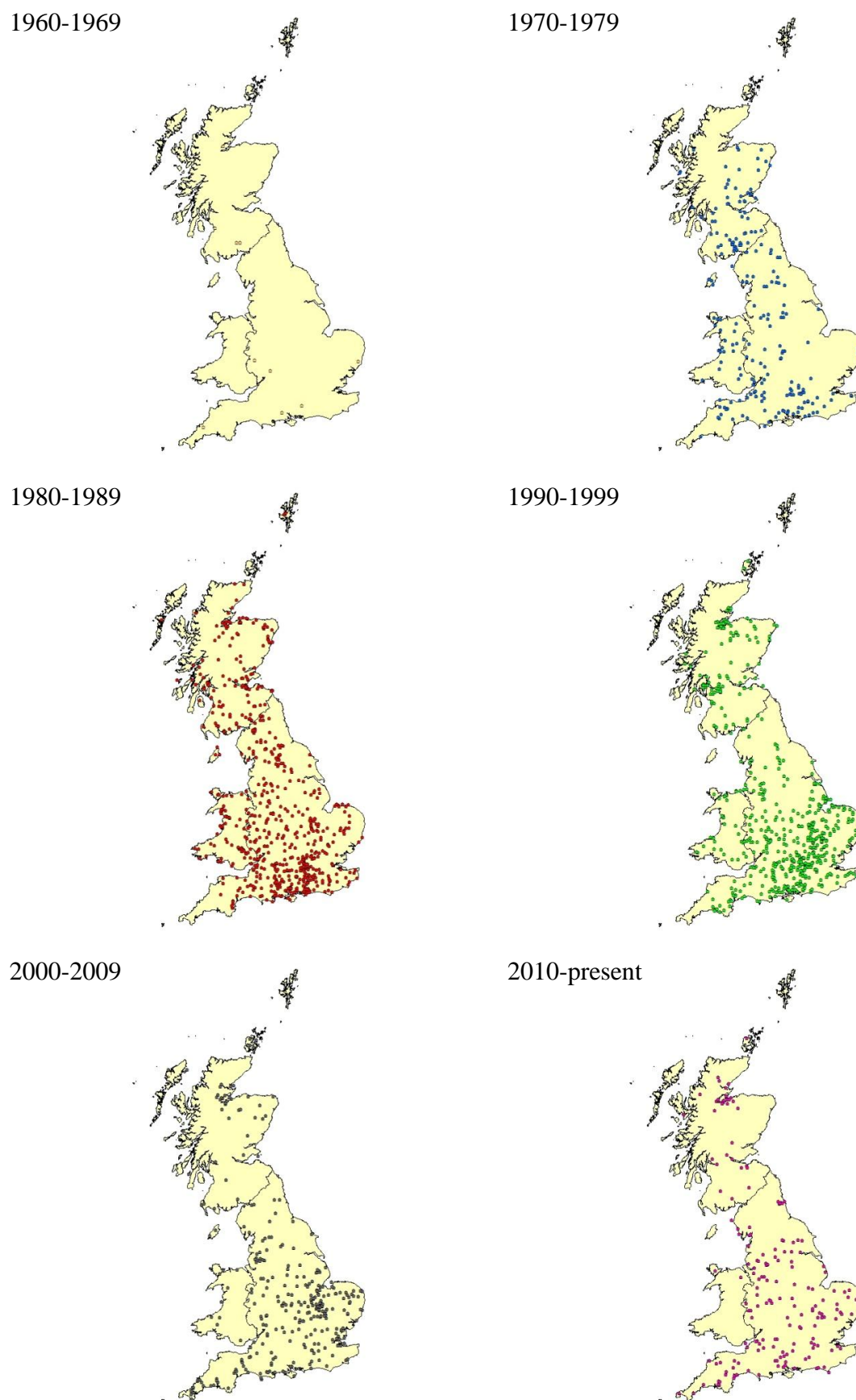


Figure 2. Location of Eurasian sparrowhawks for which tissue samples are held in the PBMS archive

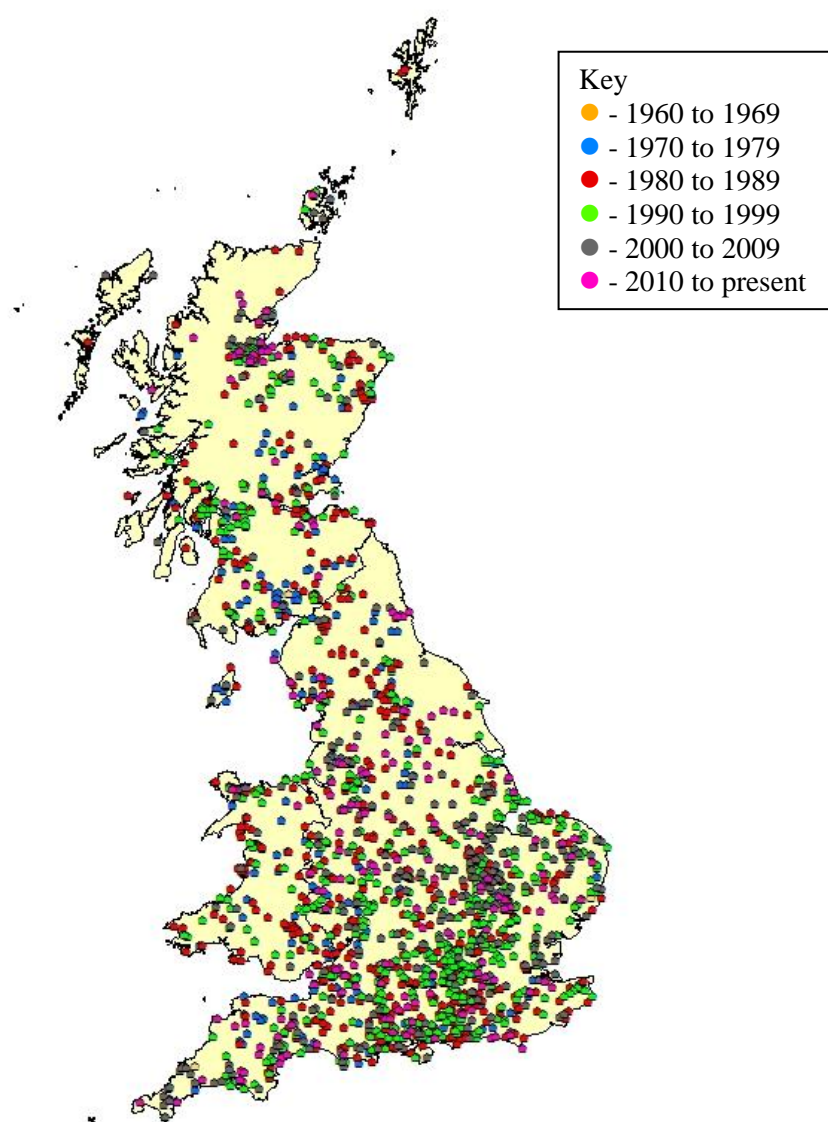


Figure 3. Summary map showing the location of Eurasian sparrowhawks for which tissue samples are held in the PBMS archive for all years from 1960 to present

3.3. Common kestrel (*Falco tinnunculus*)

The archive holdings for kestrels are summarised in Table 3 and Figures 4 and 5.

Table 3. Tissue archive holdings for common kestrel (*Falco tinnunculus*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	1	1	6	1	0	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	1	1	6	1	0	0	0	0
1970s	Eng & Wales	112	230	225	238	26	0	0	0
1970s	Scotland	14	20	20	22	2	0	0	0
1970s	<i>Total</i>	126	250	245	260	28	0	0	0
1980s	Eng & Wales	224	271	195	279	26	19	0	0
1980s	Scotland	35	40	20	39	3	7	0	0
1980s	<i>Total</i>	259	311	215	318	29	26	0	0
1990s	Eng & Wales	282	243	86	245	24	75	0	0
1990s	Scotland	80	66	30	68	2	14	0	0
1990s	<i>Total</i>	362	309	116	313	26	89	0	0
2000s	Eng & Wales	169	167	165	172	121	0	111	84
2000s	Scotland	6	6	6	6	3	0	4	4
2000s	<i>Total</i>	175	173	171	178	124	0	115	88
2010s	Eng & Wales	78	75	73	78	10	0	77	65
2010s	Scotland	2	2	2	3	1	0	3	3
2010s	<i>Total</i>	80	77	75	81	11	0	80	68
ALL YEARS	Eng & Wales	866	987	750	1013	207	94	188	149
	Scot	137	134	78	138	11	21	7	7
	Total	1003	1121	828	1151	218	115	195	156

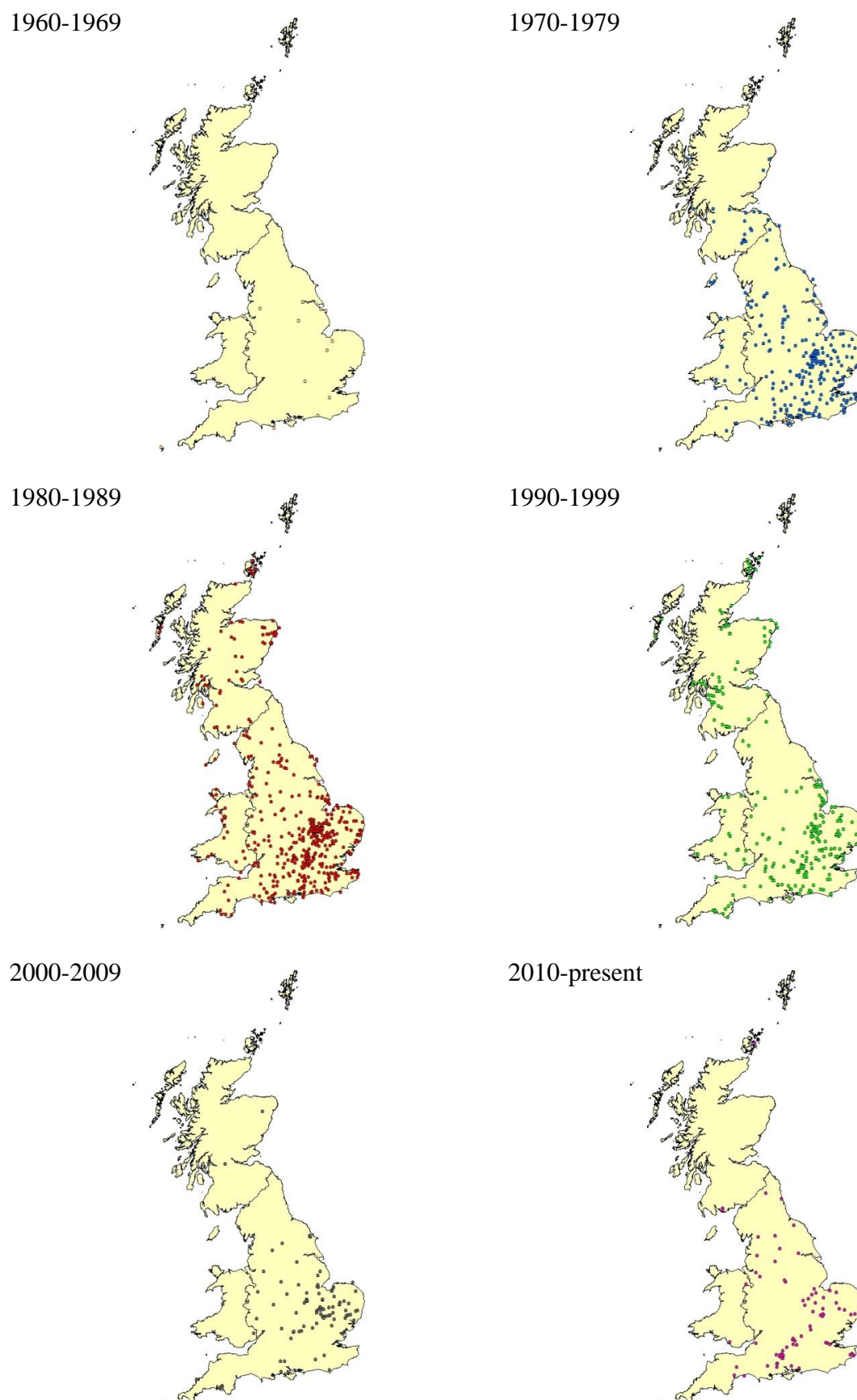


Figure 4. Location of common kestrels for which tissue samples are held in the PBMS archive

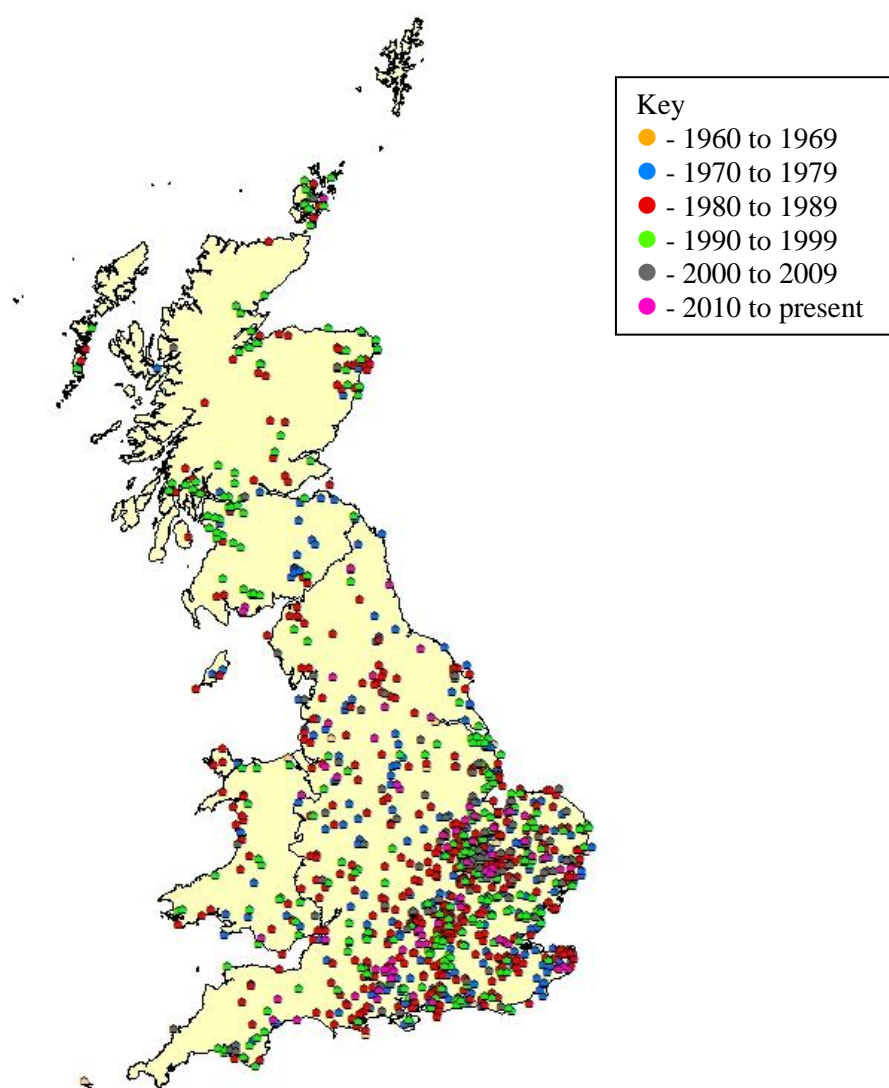


Figure 5. Summary map showing the location of common kestrels or which tissue samples are held in the PBMS archive for all years from 1960 to present

3.4. Common buzzard (*Buteo buteo*)

The archive holdings for buzzards are summarised in Table 4 and Figure 6. Location data for buzzards only started to be recorded digitally as 10km grid square references in 2005 and locations of birds that died earlier are not represented on the mapped outputs.

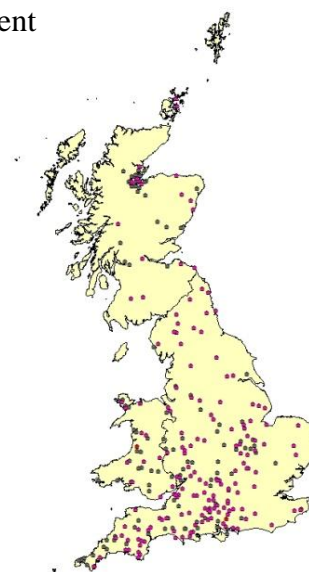
Table 4. Tissue archive holdings for common buzzards (*Buteo buteo*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	0	0	0	0	0	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	0	0	0	0	0	0	0	0
1970s	Eng & Wales	4	0	0	0	0	0	0	0
1970s	Scotland	0	0	0	0	0	0	0	0
1970s	<i>Total</i>	4	0	0	0	0	0	0	0
1980s	Eng & Wales	16	15	7	15	8	5	0	0
1980s	Scotland	4	5	3	5	0	2	0	0
1980s	<i>Total</i>	20	20	10	20	8	7	0	0
1990s	Eng & Wales	104	85	38	93	32	21	0	0
1990s	Scotland	15	12	1	12	4	2	0	0
1990s	<i>Total</i>	119	97	39	105	36	23	0	0
2000s	Eng & Wales	133	119	113	126	109	0	49	44
2000s	Scotland	27	27	27	28	14	0	26	14
2000s	<i>Total</i>	160	146	140	154	123	0	75	58
2010s	Eng & Wales	156	155	146	162	49	0	146	156
2010s	Scotland	16	16	14	16	0	0	20	14
2010s	<i>Total</i>	172	171	160	178	49	0	166	170
ALL YEARS	Eng & Wales	413	374	304	396	198	26	195	200
	Scot	62	60	45	61	18	4	46	28
	<i>Total</i>	475	434	349	457	216	30	241	228

2000-2009



2010-present



2000-present

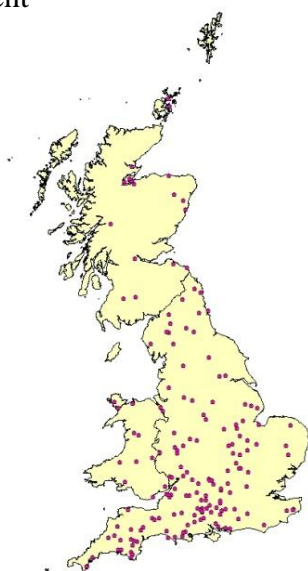


Figure 6. Location of common buzzards for which tissue samples are held in the PBMS archive

3.5. Grey heron (*Ardea cinerea*)

The archive holdings for herons are summarised in Table 5 and Figure 7. Efforts to collect herons were reduced during the 2000s when the PBMS began to link with the Cardiff University otter project, one of its WILDCOMS (www.wildcoms.org.uk) partners and use Eurasian otter (*Lutra lutra*) for studying contaminants in freshwaters.

Table 5. Tissue archive holdings for grey heron (*Ardea cinerea*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	2	0	11	1	1	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	2	0	11	1	1	0	0	0
1970s	Eng & Wales	71	96	92	96	34	0	0	0
1970s	Scotland	6	10	9	11	3	0	0	0
1970s	<i>Total</i>	77	106	101	107	37	0	0	0
1980s	Eng & Wales	90	72	54	70	20	5	0	0
1980s	Scotland	10	10	6	9	2	0	0	0
1980s	<i>Total</i>	100	82	60	79	22	5	0	0
1990s	Eng & Wales	93	88	27	89	28	2	0	0
1990s	Scotland	32	30	10	30	8	2	0	0
1990s	<i>Total</i>	125	118	37	119	36	4	0	0
2000s	Eng & Wales	40	40	39	40	34	0	15	12
2000s	Scotland	4	4	4	4	3	0	1	1
2000s	<i>Total</i>	44	44	43	44	37	0	16	13
2010s	Eng & Wales	3	3	3	4	1	0	2	2
2010s	Scotland	1	1	1	1	0	0	1	1
2010s	<i>Total</i>	4	4	4	5	1	0	3	3
ALL YEARS	Eng & Wales	299	299	226	300	118	7	17	14
	Scot	53	55	30	55	16	2	2	2
	<i>Total</i>	352	354	256	355	134	9	19	16

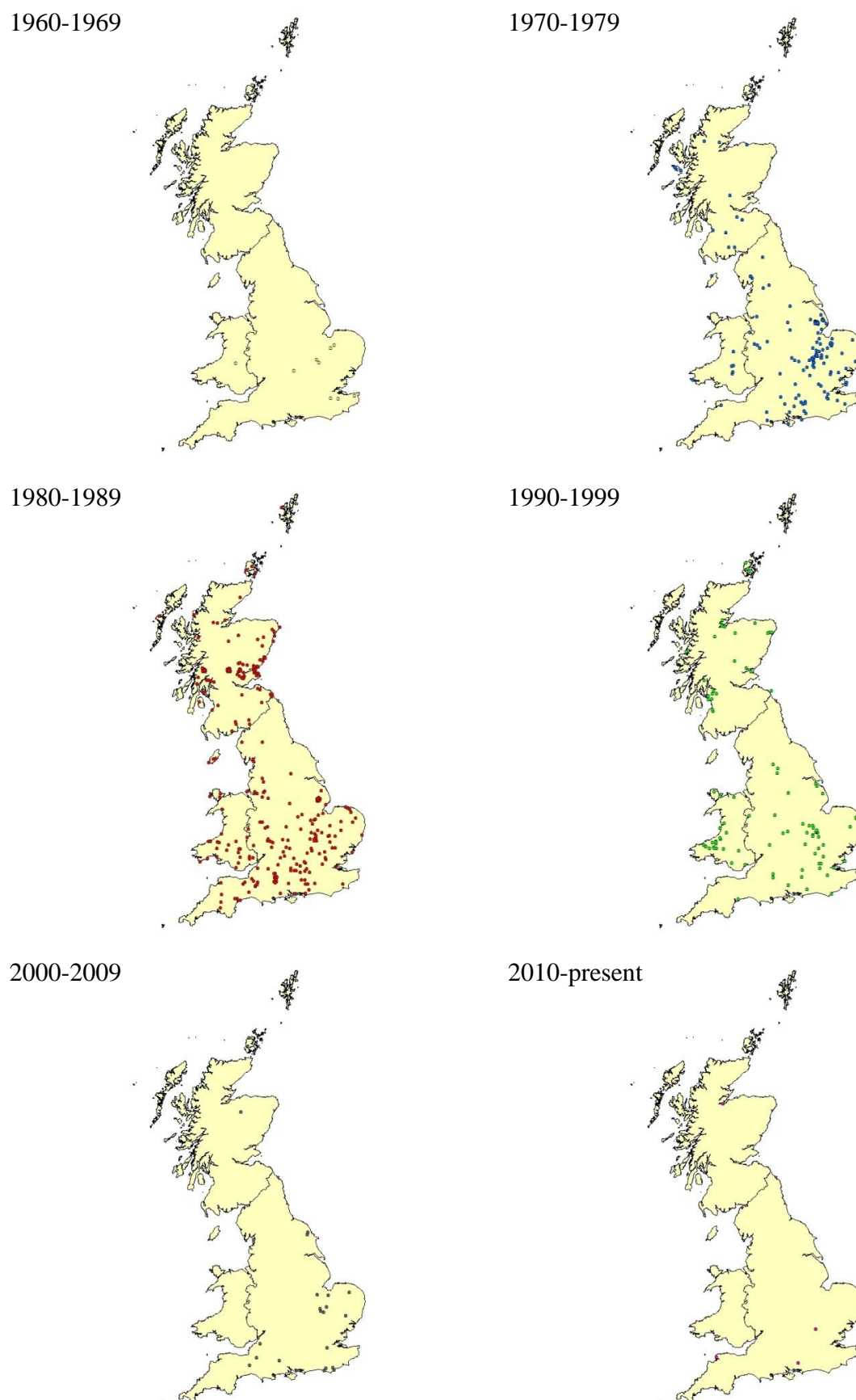


Figure 7. Location of grey heron for which tissue samples are held in the PBMS archive

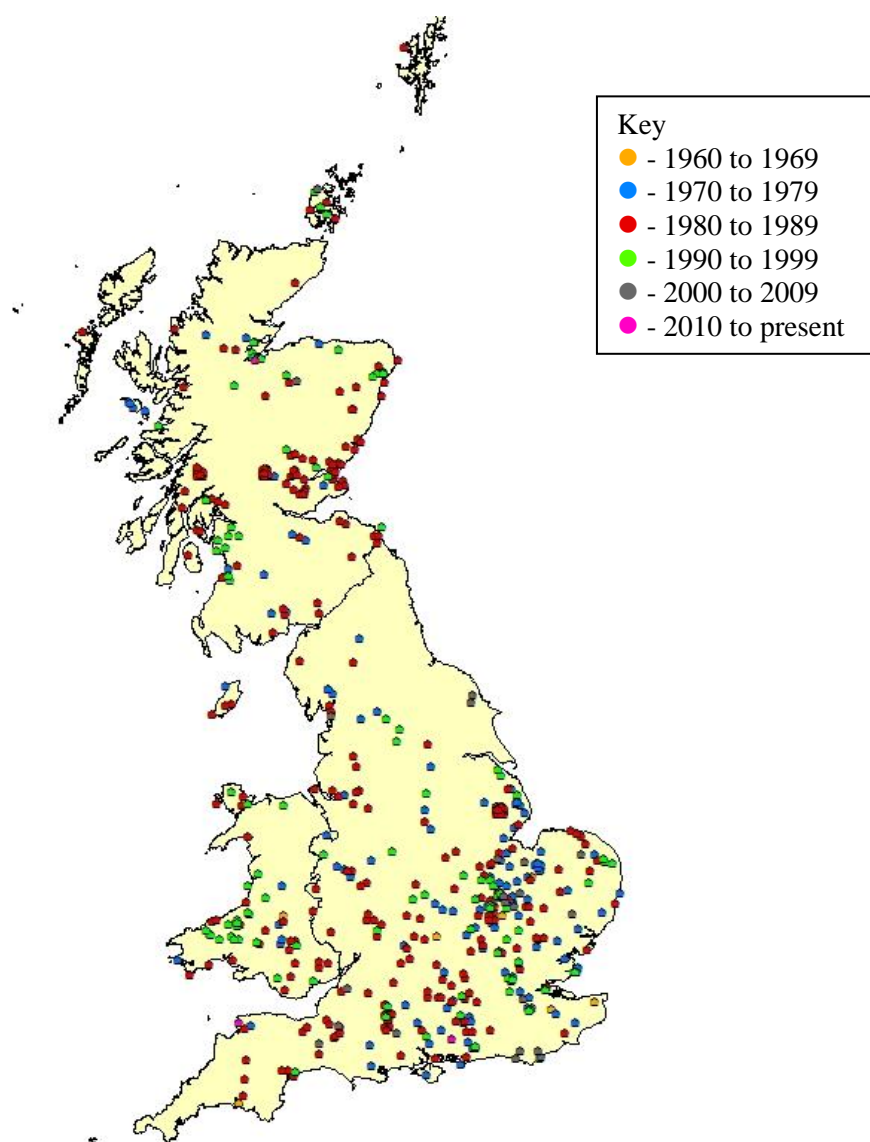


Figure 8. Summary map showing the location of grey herons for which tissue samples are held in the PBMS archive 1960 to present

3.6. Tawny owl (*Strix aluco*)

The archive holdings for tawny owls are summarised in Table 6 and Figures 9 and 10. Location data for tawny owls only started to be recorded digitally as 10km square grid references in 1990 and locations of birds that died earlier are not represented on the mapped outputs.

Table 6. Tissue archive holdings for tawny owl (*Strix aluco*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	0	0	0	0	0	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	0	0	0	0	0	0	0	0
1970s	Eng & Wales	6	2	3	3	1	0	0	0
1970s	Scotland	1	0	0	0	0	0	0	0
1970s	<i>Total</i>	7	2	3	3	1	0	0	0
1980s	Eng & Wales	0	0	0	0	0	0	0	0
1980s	Scotland	2	0	0	0	0	0	0	0
1980s	<i>Total</i>	2	0	0	0	0	0	0	0
1990s	Eng & Wales	146	6	2	7	0	4	0	0
1990s	Scotland	19	0	1	0	0	1	0	0
1990s	<i>Total</i>	165	6	3	7	0	5	0	0
2000s	Eng & Wales	303	284	279	295	211	0	125	61
2000s	Scotland	14	13	13	15	11	0	5	4
2000s	<i>Total</i>	317	297	292	310	222	0	130	65
2010s	Eng & Wales	127	124	123	133	36	0	135	133
2010s	Scotland	11	9	8	10	2	0	6	6
2010s	<i>Total</i>	138	133	131	143	38	0	141	139
ALL YEARS	Eng & Wales	582	416	407	438	248	4	260	194
	Scot	47	22	22	25	13	1	11	10
	<i>Total</i>	629	438	429	463	261	5	271	204

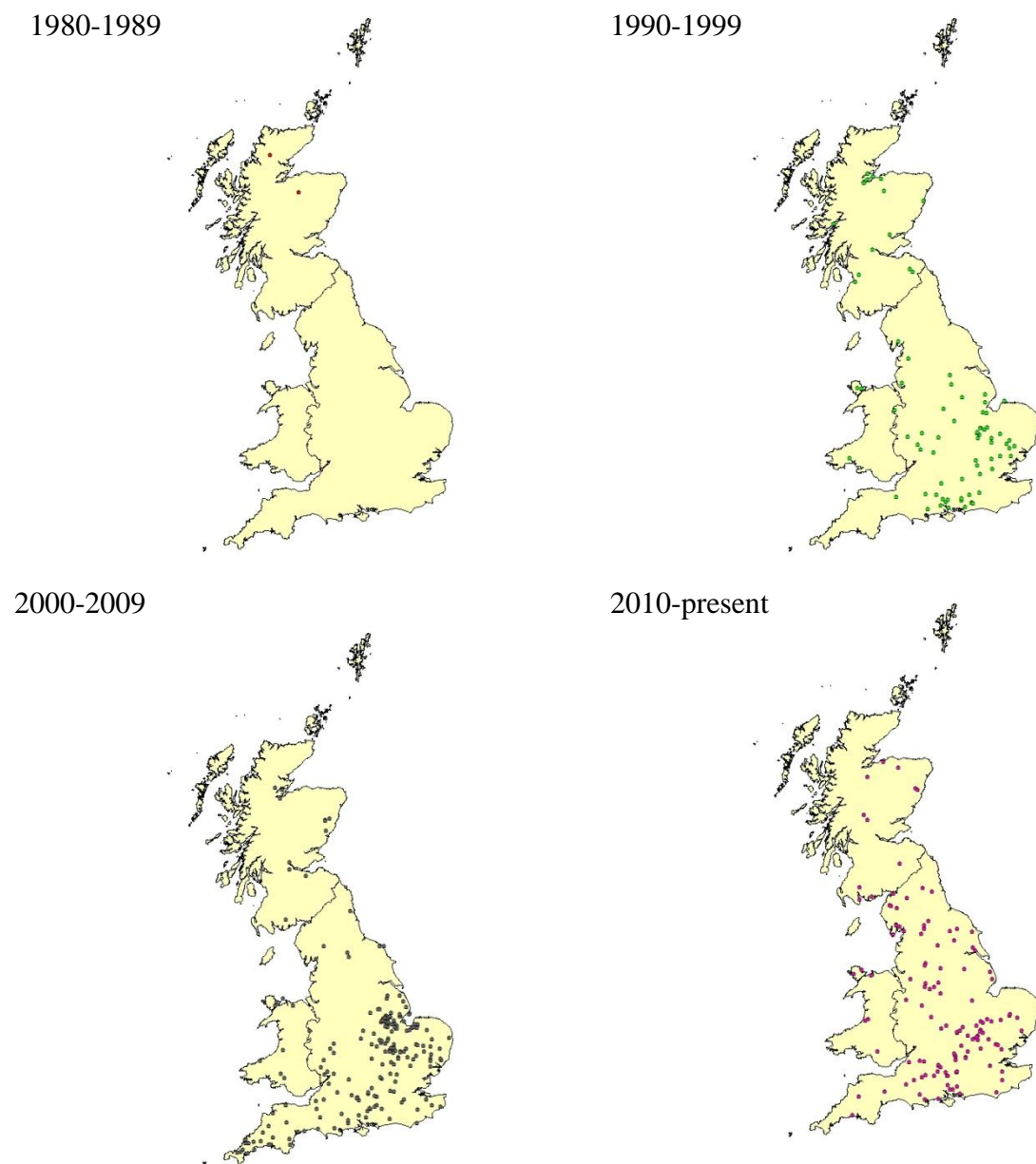


Figure 9. Location of tawny owl for which tissue samples are held in the PBMS archive

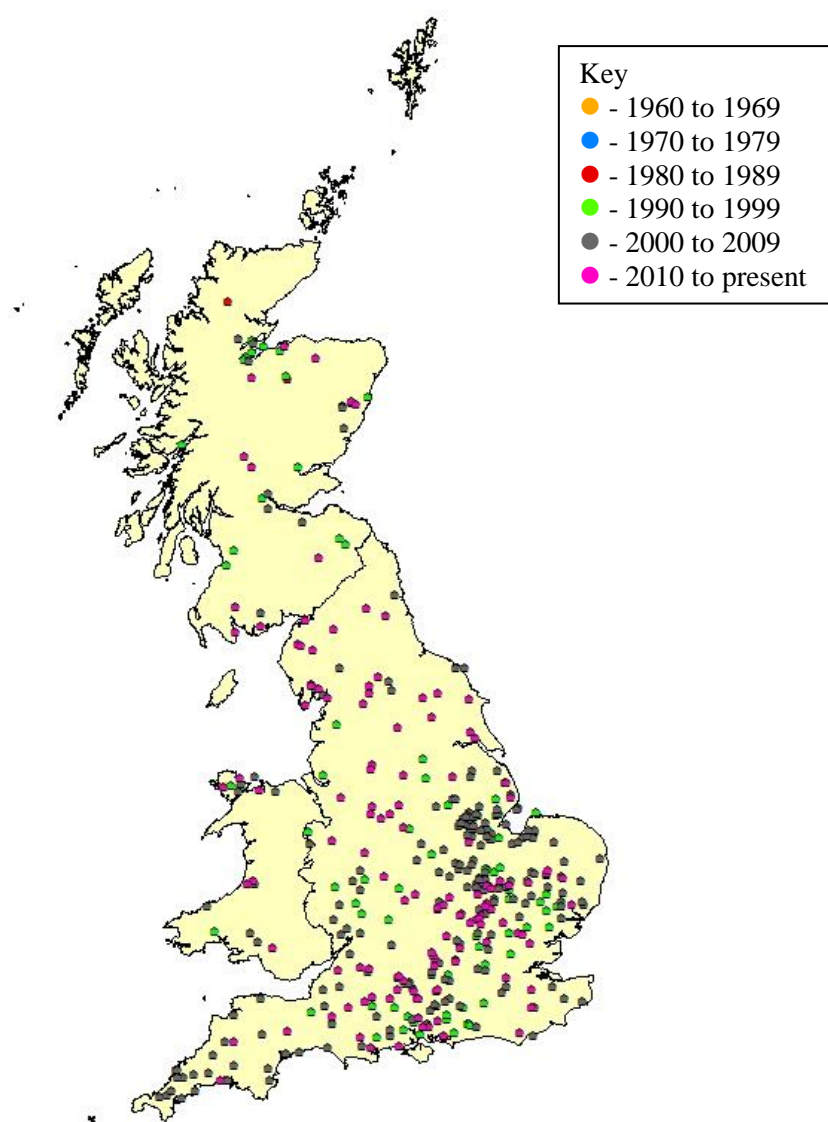


Figure 10. Summary map showing the location of tawny owls for which tissue samples are held in the PBMS archive 1960 to present

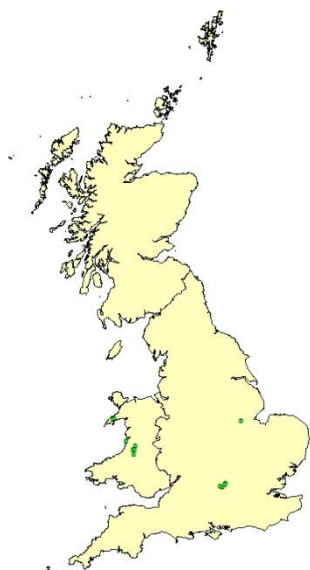
3.7. Red kite (*Milvus milvus*)

The archive holdings for red kites are summarised in Table 7 and Figure 11. The clustered locations for red kites in England reflect the location of reintroduction sites for this species.

Table 7. Tissue archive holdings for red kites (*Milvus milvus*)

Decade	Provenance	Tissue type							
		Liver	Kidney	Brain	Muscle	Fat	Gizzard	Bone	Feather
1960s	Eng & Wales	0	0	0	0	0	0	0	0
1960s	Scotland	0	0	0	0	0	0	0	0
1960s	<i>Total</i>	0	0	0	0	0	0	0	0
1970s	Eng & Wales	4	1	1	1	1	0	0	0
1970s	Scotland	0	0	0	0	0	0	0	0
1970s	<i>Total</i>	4	1	1	1	1	0	0	0
1980s	Eng & Wales	4	3	1	3	1	2	0	0
1980s	Scotland	0	0	0	0	0	0	0	0
1980s	<i>Total</i>	4	3	1	3	1	2	0	0
1990s	Eng & Wales	11	7	6	6	1	0	0	0
1990s	Scotland	0	0	0	0	0	0	0	0
1990s	<i>Total</i>	11	7	6	6	1	0	0	0
2000s	Eng & Wales	53	50	51	48	33	0	47	51
2000s	Scotland	0	0	0	0	0	0	0	0
2000s	<i>Total</i>	53	50	51	48	33	0	47	51
2010s	Eng & Wales	48	49	45	51	39	0	54	53
2010s	Scotland	0	0	0	0	0	0	0	0
2010s	<i>Total</i>	48	49	45	51	39	0	54	53
ALL YEARS	Eng & Wales	120	110	104	109	75	2	101	104
	Scot	0	0	0	0	0	0	0	0
	<i>Total</i>	120	110	104	109	75	2	101	104

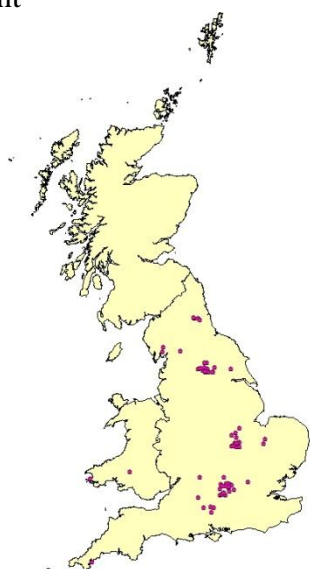
1990-1999



2000-2009



2010-present



1990-present

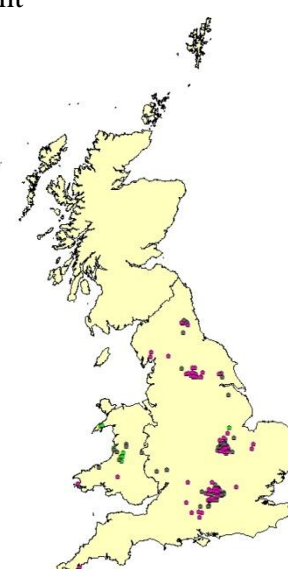


Figure 11. Location of red kites for which tissue samples are held in the PBMS archive 1990-present

4. Archive holdings of egg contents from predatory birds collected from the 1970s to present

4.1. Golden eagle (*Aquila chrysaetos*)

The archive holdings for golden eagle eggs are summarised in Table 8. All eggs are from Scotland. The nest locations from which failed eggs have been collected are summarised by regions in Scotland as shown in Figure 12.

Table 8. Egg contents archive holdings for golden eagle (*Aquila chrysaetos*) by region

Region	Years					Total
	1970s	1980s	1990s	2000s	2010s	
Eastern Highlands	0	12	15	32	5	64
Northern Moors	0	0	2	0	0	2
North Central Highlands	3	2	2	0	0	7
North West Highlands	1	1	4	9	3	18
South Central Highlands	3	2	1	2	3	11
Western Highlands	3	1	4	16		24
South Western Highlands	2	29	36	30	3	100
Hebrides	1	4	13	45	5	68
Total	13	51	77	134	19	294

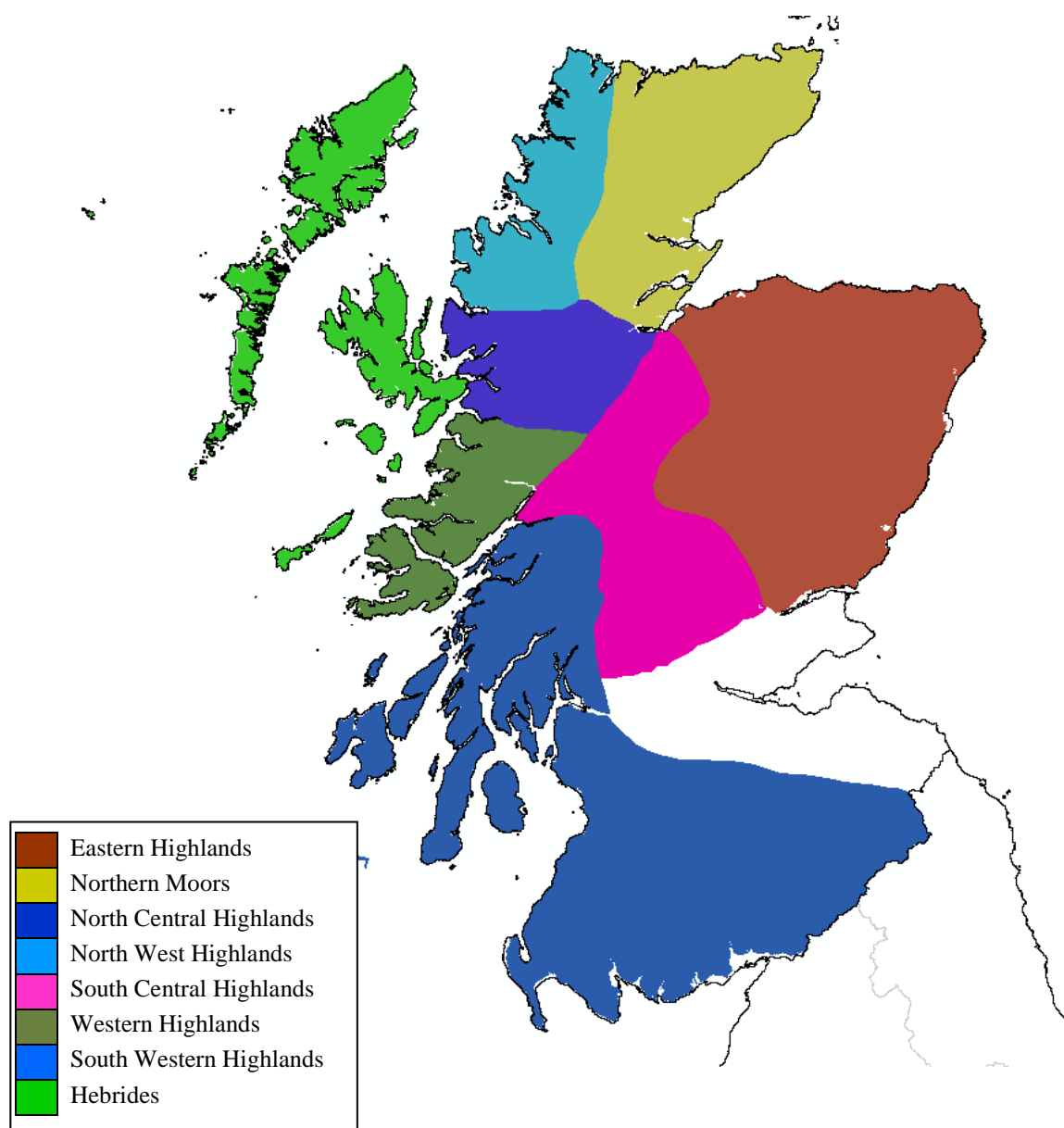


Figure 12. Regions from which failed/deserted golden eagle eggs have been collected

4.2. Merlin (*Falco columbarius*)

The archive holdings for merlin eggs are summarised in Table 9. The nest locations from which failed or deserted eggs have been collected are summarised by regions as shown in Figure 13.

Table 9. Egg contents archive holdings for merlin (*Falco columbarius*) by region

	Years						Total
	1970s	1980s	1990s	2000s	2010s	Unknown	
Southern England	1	2	4	1	0	0	9
North East England	41	79	195	68	7	0	390
North West England	3	23	4	7	0	0	37
Southern Scotland	6	59	99	29	8	0	201
Central Scotland	0	0	0	0	0	0	0
Northern Scotland	7	131	88	25	0	0	251
Shetland Isles	6	52	55	10	0	0	123
Orkney	6	12	10	17	1	0	46
Western Isles	0	2	0	10	4	0	16
Wales	6	33	14	0	0	0	53
Unknown	1	24	0	0	0	4	29
Total	77	417	469	167	20	4	1154

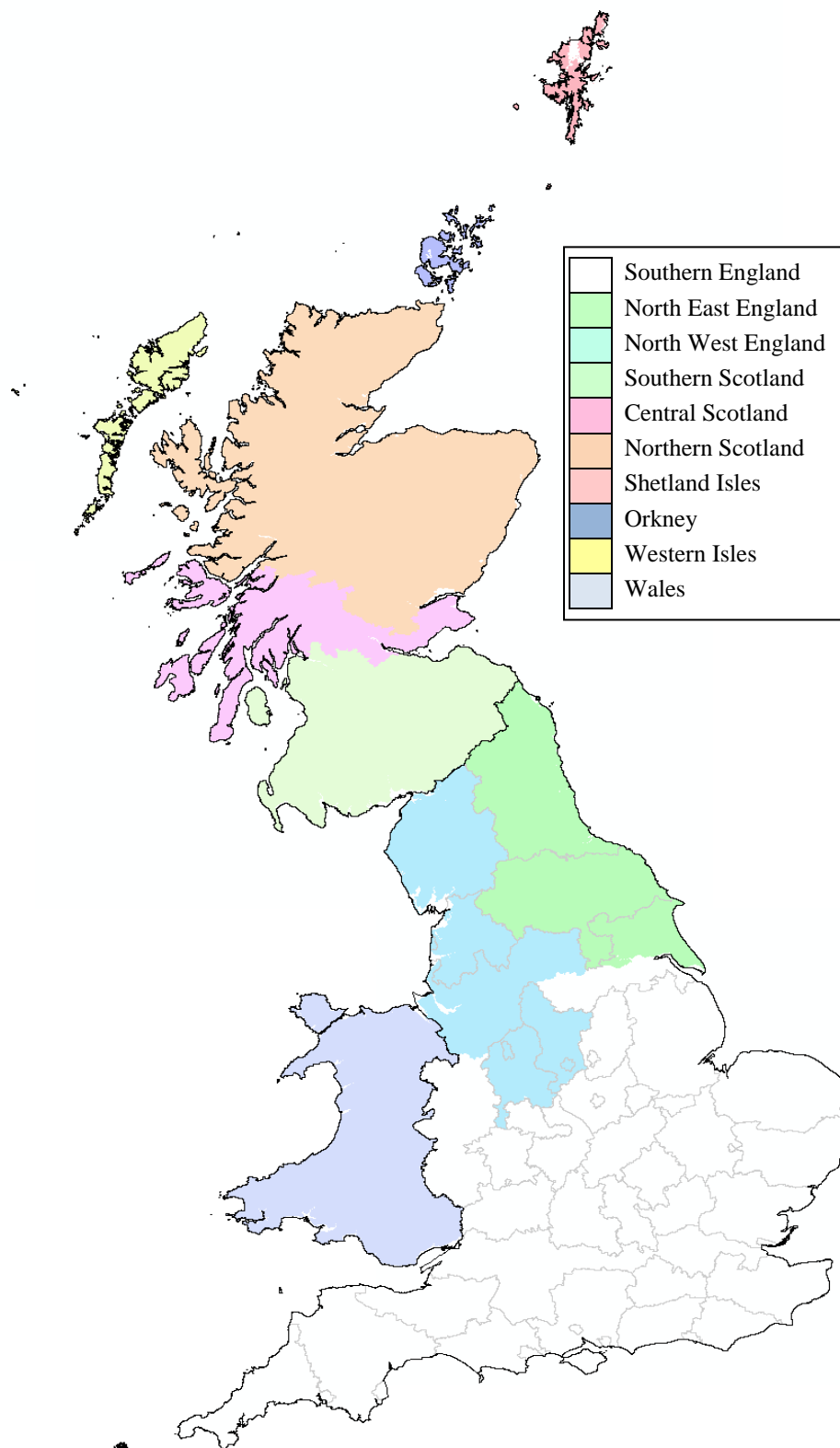


Figure 13. Regions from which merlin eggs have been collected

4.3. Northern gannet (*Morus bassanus*)

The archive holdings for gannet eggs are summarised by the colonies from which they have been collected (Table 10). Collections have been made primarily from the colonies of Ailsa Craig (west coast of Scotland) and Bass Rock (east coast of Scotland). Sampling from other colonies was conducted in the 1980s and, to a lesser extent, in the 1990s.

Table 10. Egg contents archive holdings for northern gannet (*Morus bassanus*) by colony

	Years					Total
	1970s	1980s	1990s	2000s	2010s	
Ailsa Craig	20	50	48	40	20	178
Bass Rock	43	42	50	20	10	165
St Kilda		14	42			56
Grassholm		20				20
Scar Rocks		20				20
Hermness		31	40			71
Little Skellig		6				6
Great Saltee		28				28
Total	63	211	180	60	30	544

4.4. White-tailed Sea Eagle (*Haliaeetus albicilla*)

The PBMS tissue archive holds the contents of 26 failed or deserted white-tailed sea eagle (*Haliaeetus albicilla*) eggs collected between 1986 and 2013. The majority of the eggs, 16 in total, come from nests located on the Island of Mull , and the remaining eggs were collected from Islay, Isle of Rum, Isle of Skye, Argyll and the Western Isles. Sample holdings for this species, up to 2006, along with residues of persistent organic pollutants and mercury are reported in Walker *et al.* (2008).

5. Acknowledgements

We thank all the members of the public who have submitted birds to the Predatory Bird Monitoring Scheme. Their efforts are key to the success of the scheme. We thank Kim Parmar for proof-reading the final version of this report.

Fieke Molenaar, Rebecca Vaughan and Gabriela Peniche, all from the Institute of Zoology, carried out post mortem examinations on the red kites.

We also thank Andy Bright (www.digiscoped.com) and Gerry Whitlow (www.hyelms.com) for providing photographs of predatory birds.

The Predatory Bird Monitoring Scheme is co-funded by the Natural Environment Research Council (NERC) through its national capability funding to CEH, and by Natural England, the Department for Environment, Food & Rural Affairs (Defra), the Campaign for Responsible Rodenticide Use, the Royal Society for the Protection of Birds (RSPB), the Scottish Environment Protection Agency and Scottish Natural Heritage.

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