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1. Preface and summary

1.1 Introduction

The Wildlife and Pollution contract covers a long-term monitoring programme that examines the levels of certain pollutants in selected wildlife species in Britain. The programme was started more than 35 years ago, when there were serious concerns over the effects of organochlorine insecticides and organomercury fungicides on various species of birds and mammals. This early work demonstrated the effects of the organochlorines, and eventually contributed to the ban on their use in the UK and abroad. The programme has measured levels of these compounds in predatory and fish-eating birds since then. Investigations have also been made into the levels of industrial polychlorinated biphenyls (PCBs), following their identification as pollutants in 1966. Mercury levels, derived from both agricultural and industrial sources, have also been tracked. In addition, the contract supports a wildlife incident investigation service, which can examine the causes of unexpected mortality incidents that are not obviously related to oil pollution or to agricultural pesticides. In recent years, investigations have been made into the effects of the newest generation of rodenticides on barn owls *Tyto alba*. Gannet *Morus bassanus* eggs are regularly collected biennially from two colonies and, when available, from other sites; eggs were collected from three sites in 1998.

This programme is now the longest running of its kind anywhere in the world and the findings stimulate considerable interest internationally, as well as in Britain. Annual reports (like the present one) give an interim summary of results. This current report presents the results of analyses carried out on material collected in 1999. Every three years these annual results are gathered together into a more substantial report in which they are integrated with previous findings. The last report of this type covered the period up to and including 1997 (Newton *et al*. 1998) and the next, due in 2002, will cover material sent to Monks Wood during the period up to and including 2000. Results are published periodically in the scientific literature, and recent key papers are listed in the present report.

The Wildlife and Pollution contract was the subject of scientific assessment within JNCC's rolling programme of peer review in autumn 1993 and was further assessed in 1997. As a result of the last assessment, some monitoring was curtailed. Specifically kestrels *Falco tinnunculus* were no longer monitored for organochlorines, although CEH still collects specimens for studying other contaminants as part of its core research programme. Similarly, other species (peregrine falcon *Falco peregrinus*, common buzzard *Buteo buteo*, long-eared owl *Asio otus*, little owl *Athene noctua*, kingfisher *Alcedo atthis*, great-crested grebe *Podiceps cristatus*, and bittern *Botaurus stellaris*) that were received in small numbers in occasional years were also not analysed. Hence, the present report is the first not to report organochlorine and total mercury concentrations in kestrel livers and in the livers of some individuals of other miscellaneous species that were received.

Each section within the Wildlife and Pollution contract is summarised below. Each is dependent on the provision of material from amateur naturalists and other interested parties, and it is not always possible to obtain desired material for analysis, especially from remote areas. No major incidents were investigated in 1999.

1.2 Organochlorines and mercury in the livers of predatory birds

The main objective of this work is to analyse the bodies of certain predatory and fish-eating bird-species, supplied by members of the public, in order to continue the monitoring of organochlorine and mercury residues in livers. This enables us to keep a watch on the effects of previous hard-won withdrawals of permitted uses of some of these chemicals, and to examine geographical variation in residues. For 1999, the livers from 59 sparrowhawks *Accipiter nisus* and five herons *Ardea cinerea* were analysed. These birds came from various localities in Scotland, England and Wales.

Over the whole monitoring period (1963-99), the data for these species, and others that have previously been monitored, have revealed significant long-term downward trends in residues (except for PCBs in kestrels and mercury in kingfishers). Declines may be levelling-off for DDE (the main metabolite of DDT) and HEOD (derived from aldrin and dieldrin) in sparrowhawks and herons. There was only one significant change in geometric mean levels between 1998 and 1999, which was an increase in HEOD concentrations in sparrowhawks. It is impossible to say whether this difference reflects a real year-to-year change in exposure.

1.3 Organochlorines and mercury in peregrine *Falco peregrinus* eggs

Single eggs from five peregrine clutches from various parts of England were analysed in 1999. The levels of organochlorine pesticides in British peregrine eggs continue to decline and, at least in inland areas, are unlikely now to cause breeding failures and mortality.

1.4 Organochlorines and mercury in merlin *Falco columbarius* eggs

Single eggs collected in 1999 from 15 merlin clutches from various parts of Scotland and England were analysed. The results confirm that the merlin remains the most contaminated of the British raptors.

1.5 Organochlorines and mercury in golden eagle *Aquila chrysaetos* eggs

Single eggs from four clutches from Scotland and England were analysed in 1999. These confirm the low levels of contamination in eggs found in recent years.

1.6 Organochlorines and mercury in gannet *Morus bassanus* eggs

No gannet eggs were analysed in 1999. Gannet eggs are usually only analysed every two years.

1.7 Organochlorines and mercury in sea eagle *Haliaeetus albicilla* eggs

No sea eagle eggs were received for analysis.

1.8 Organochlorines and mercury in the eggs of various other species

Eggs from a number of other (mostly predatory) bird species were examined for organochlorine and mercury residues through the course of the year. This was done as part of CEH's own core research programme and not as part of the JNCC Wildlife and Pollution contract. However, the data are included in the present report for information. All the eggs contained background levels of organochlorine insecticides, confirming the widespread nature of low-level contamination at the present time. All the eggs analysed were also contaminated with PCBs and most contained mercury.

1.9 Rodenticide residues in barn owls *Tyto alba*

The second-generation anticoagulant rodenticides (currently difenacoum, bromadiolone, brodifacoum and flocoumafen) were considered a potential threat to barn owls. These rodenticides are rapidly replacing warfarin and are both more toxic to vertebrates and more persistent. The study has included annual analysis of rodenticides in barn owls since 1983. Fifty-four barn owls were examined in 1999. The residues of one or more rodenticides were found in the livers of 20 (37%) birds; six (11%) of these had levels in the potentially lethal range (>0.1-0.2 ppm; see section 9.3 for details). The results for the 1999 sample were consistent with the trend reported for earlier years which suggested that the increase in the proportion of birds containing residues since 1983 (when monitoring began) was beginning to level-off at about 40%.

2. Organochlorines and mercury in the livers of predatory birds

2.1 Introduction

The main objective of this work was to analyse the carcasses of predatory birds, supplied by members of the public, in order to continue the monitoring of organochlorine and metal residues in livers. The chemicals of interest included DDE (from the insecticide DDT), HEOD (from the insecticides aldrin and dieldrin), PCBs (polychlorinated biphenyls from industrial products) and Hg (mercury from agricultural and industrial sources). Throughout this section, the levels of organochlorines are given as ppm in wet weight and of mercury as ppm in dry weight.

The species analysed were the sparrowhawk, representing the terrestrial environment, and the fish-eating heron, which represented the aquatic environment. A small number of other species (kestrel, peregrine falcon, buzzard, long-eared owl, little owl, kingfisher, great-crested grebe, and bittern) were also received during 1999. These were not analysed for organochlorine and mercury residues because of the reduction in the scope of the monitoring scheme agreed in 1998. However, post-mortem examinations were carried out on each of these birds, relevant information being recorded and the cause of death determined (and reported back to the volunteer who submitted the carcass). Body organs and tissues from all birds received at Monks Wood in 1999 were archived at -20°C and can be analysed for organochlorines and other contaminants at some future time, if appropriate. Some of the livers taken from kestrels received in 1999 are to be analysed for second-generation rodenticides in an additional study to be carried out in 2001.

Findings from previous years are given in earlier reports in this series and by Newton *et al.* (1993).

2.2 Results

The livers from 59 sparrowhawks and five herons were analysed. These included some birds that had died in earlier years but which were only sent to Monks Wood in 1999. The results from all these birds are listed in Table 2.1 and the geometric means for each chemical (data for birds found dead in 1999 only) are given in Table 2.2. Data from the birds collected in earlier years will be included in the three-yearly combined analysis that will be reported in 2002.

Some birds from 1999 had unexpectedly high levels of organochlorine insecticides and PCBs. Two sparrowhawks (one from Glamorgan, the other from north Hampshire) had liver HEOD concentrations greater than 10 ppm and one female from east Kent had a pp'-DDE residue greater than 150 ppm. These concentrations are exceptionally high and likely to be a contributory cause of death. Liver PCB residues were relatively high (20-55 ppm) in five sparrowhawks, but these birds had no visible fat deposits in their bodies, and residues of <100 ppm are not exceptional in starved individuals. One other bird, from Bedfordshire, had a residue of >100 ppm and also contained trace amounts of fat in the body. The bird was sent to Monks Wood in 1999 but the sender did not provide the date on which it was found and so the year of death is uncertain. The PCB residue level in this sparrowhawk was exceptionally high and may have been a contributory cause of death. However, the biological significance of liver total PCB residues in birds is uncertain because there is considerable overlap in levels between birds dying from PCB poisoning and those surviving. The toxicological significance of residues is better-defined for individual PCB congeners.

Relatively high mercury concentrations (>10 ppm) were found in two sparrowhawks (one from Staffordshire, one from south Somerset), but they were less than half the concentration associated with toxic effects in birds of prey (30 ppm) (Thompson 1996). As found in previous years, mercury levels were generally higher in the heron than the sparrowhawk; the geometric mean concentration in herons was similar in magnitude to the highest concentrations found in individual sparrowhawks. Two herons had concentrations of approximately 30 ppm. Although this residue level is associated with toxic effects in non-marine birds, concentrations of up to an order of magnitude higher are found in piscivorous seabirds and have apparently little, if any, effect (Thompson 1996). There do not appear to be published toxicological studies that relate tissue mercury concentrations to effects in herons, and the toxicological significance of the mercury levels in herons is uncertain.

Out of eight comparisons, the only significant differences in geometric mean values found between the 1998 and 1999 results was an increase for HEOD (from 0.080 ppm to 0.166 ppm) in sparrowhawk (Table 2.3). It is impossible to say whether this difference reflected a real change in exposure, especially as levels were generally low, but it is notable that there has been no significant change in HEOD concentrations in sparrowhawks if the last five years are considered (Table 2.4). Overall, there was no significant decline over the last five years for any of the compounds determined in sparrowhawk and heron livers (Table 2.4).

Table 2.1 Levels of organochlorines (ppm wet weight) and mercury (ppm dry weight) in the livers of juvenile (in first year) and adult (older than first year) predatory birds received during 1999.
* indicates missing data that were either not provided by the sender of the carcass or that could not be obtained from the sample received.

Specimen number	Year found	County	Age	Sex	pp'-DDE	HEOD	PCB	Hg
Sparrowhawk								
12861	1998	East Norfolk	A	F	8.845	0.854	13.263	2.306
12865	1999	Mid-West Yorkshire	A	M	4.460	0.572	29.109	2.068
12871	1999	Surrey	A	F	0.769	0.195	5.051	1.917
12874	1999	Westmorland with north Lancashire	A	F	0.382	0.125	1.128	2.227
12885	1999	Shropshire	J	M	0.377	0.159	0.477	4.463
12894	1999	Northamptonshire	A	F	7.503	0.585	11.332	2.395
12900	1999	Bedfordshire	J	F	0.218	0.154	0.183	0.774
12904	1999	Staffordshire	J	M	5.846	0.538	15.751	12.030
12905	1999	Glamorgan	A	F	16.862	10.973	12.061	7.904
12906	1999	Northamptonshire	A	M	0.442	0.189	0.871	3.646
12909	1999	West Suffolk	J	F	1.827	0.118	0.657	3.448
12912	1999	North Hampshire	J	F	12.682	10.380	20.166	6.985
12917	1999	Surrey	A	F	8.071	0.668	29.112	6.574
12918	1999	East Kent	A	M	1.474	0.178	2.355	3.289
12943	1999	Mid-West Yorkshire	J	M	1.023	0.705	1.411	6.074
12946	1999	Oxfordshire	A	M	0.553	0.059	1.317	4.102
12947	1999	North Devon	A	F	3.168	0.167	3.103	3.647
12962	1999	Bedfordshire	J	F	1.766	0.143	0.825	1.631
13024	1999	South Devon	J	M	0.130	0.085	0.260	3.429
13028	1999	South Essex	J	F	0.446	0.041	0.339	0.999
13033	1999	Derbyshire	J	M	0.06	0.039	0.801	0.406
13043	1999	North Somerset	J	F	0.379	0.266	2.384	1.472
13048	1999	South Lancashire	J	M	0.279	0.138	1.306	0.762
13057	1999	East Cornwall	J	F	0.651	0.074	1.655	3.089
13074	1999	Hertfordshire	J	M	0.365	0.038	0.547	0.748
13082	1999	South Somerset	A	M	5.346	0.497	8.416	11.427
13097	1999	North Somerset	J	F	0.057	0.019	0.084	0.628
13116	1999	West Sussex	J	F	0.150	0.045	0.295	0.949
13121	1996	West Suffolk	A	M	5.373	0.344	3.310	2.306
12969	1999	Cambridgeshire	A	M	6.570	0.131	2.813	2.771
12972	1999	Dunbartonshire	J	M	0.792	0.073	4.016	1.752
12981	1999	Dorset	A	F	0.767	0.049	2.567	3.422
13002	1999	Surrey	A	F	12.532	4.194	29.689	5.977
13018	1999	North Aberdeenshire	A	F	1.459	0.109	1.371	5.617
13037	1999	West Norfolk	J	M	17.629	0.202	4.617	5.212
13052	1999	East Norfolk	J	F	0.457	0.037	0.464	1.180
13058	1999	Stirlingshire	J	F	0.096	0.050	0.460	2.954
13063	1999	Leicestershire	J	F	0.316	0.140	2.479	0.813
13096	1999	Oxfordshire	J	M	0.818	0.159	3.893	1.404
13099	1999	Berkshire	A	F	0.545	0.217	1.855	0.273
13105	1999	Huntingdonshire	J	F	0.945	0.086	0.598	0.970
13108	1999	South Lincolnshire	A	M	15.721	0.352	15.407	1.269
13117	1996	Cambridgeshire	J	M	3.880	0.132	1.619	3.184
13125	1996	Cambridgeshire	A	F	0.644	0.092	0.571	0.021
12956	1999	East Kent	A	F	221.59	5.891	54.250	9.694

Specimen number	Year found	County	Age	Sex	pp'-DDE	HEOD	PCB	Hg
12999	*	Bedfordshire	A	F	8.765	0.746	123.376	2.788
13000	1999	Surrey	J	F	0.123	0.086	1.371	0.365
13035	1999	South-east Yorkshire	J	F	1.049	0.087	0.674	0.654
13036	1999	Derbyshire	J	F	0.054	0.033	0.459	0.630
13046	1999	Cambridgeshire	J	F	0.889	0.187	0.348	0.842
13049	1999	Buckinghamshire	J	M	0.204	0.029	0.875	0.505
13051	1999	Cumberland	J	F	0.072	0.052	0.190	0.389
13066	1999	Surrey	J	F	0.173	0.047	1.058	1.307
13068	1999	South Hampshire	J	F	0.507	0.070	2.460	1.415
13072	1999	South-west Yorkshire	J	F	0.988	0.113	4.815	3.246
13092	1999	West Lancashire	J	M	0.308	0.120	1.785	1.117
13095	1999	West Kent	A	F	36.111	0.318	19.195	0.678
13106	1999	Clyde Isles	J	F	0.379	0.080	0.234	1.724
13112	1999	East Suffolk	A	F	10.875	0.672	15.712	2.514
Heron								
12887	1999	East Cornwall	*	*	0.649	0.046	4.842	16.213
12942	1999	Argyll Main	J	M	0.474	0.070	4.411	5.273
12965	1999	Glamorgan	*	*	0.463	0.478	21.126	2.522
12996	1999	East Lothian	*	*	12.128	1.517	49.110	29.508
13101	1999	South Somerset	*	*	0.022	0.017	0.166	30.852

Table 2.2 Geometric mean levels of pollutants in the sparrowhawk and heron in Table 2.1 (data are only for birds found dead in 1999). GSE=geometric standard error.

	pp'-DDE	HEOD	PCB	Hg
Sparrowhawk				
Geometric mean	1.003	0.166	1.920	1.891
N	54	54	54	54
Range within 1 GSE	0.782 – 1.286	0.137 – 0.200	1.556 – 2.368	1.662 – 2.153
Heron				
Geometric mean	0.52	0.132	5.166	11.444
N	5	5	5	5
Range within 1 GSE	0.191 – 1.413	0.058 – 0.298	1.954 – 13.656	6.980 – 18.763

Table 2.3 Comparison of geometric mean residue levels (log values) from birds collected in 1998 and 1999; values for the two years and the statistical t-values are shown. Minus values indicate a decrease and plus values indicate an increase from 1998.

		pp'-DDE	HEOD	PCB	Hg
Sparrowhawk					
	1998	0.786	0.080	1.964	1.638
	1999	1.003	0.166	1.920	1.891
		t_{111} = +0.84	t_{111} = +2.54*	t_{111} = -0.07	t_{111} = +0.82
Heron					
	1998	0.761	0.315	1.383	7.787
	1999	0.520	0.132	5.166	11.444
		t_6 = -0.16	t_6 = -0.42	t_6 = +1.01	t_6 = +0.62

Significance of difference: *P<0.05; **P<0.01; ***P<0.001.

Table 2.4 Trends in pollutant levels in livers of predatory birds during 1963-1999 and 1994-1999. Figures show sample sizes (N) and linear regression coefficients (b) based on log values regressed against year. (Analyses for PCBs and Hg were started in 1967 and 1970 respectively in sparrowhawk and heron)

		1963-1999			1994-1999		
		N	**b**		**N**	**b**	
Sparrowhawk							
	pp'-DDE	1852	-0.0336	***	403	0.0157	ns
	HEOD	1853	-0.0327	***	403	0.0362	ns
	PCB	1808	-0.0114	***	403	0.0465	ns
	Hg	1602	-0.0215	***	398	0.0155	ns
Heron							
	pp'-DDE	807	-2.0429	***	41	0.0686	ns
	HEOD	797	-0.0495	***	41	0.1080	ns
	PCB	673	-0.0227	***	41	0.0690	ns
	Hg	510	-0.0204	***	41	0.0921	ns

Significance of difference: *P=<0.05; **P=<0.01;***P<0.001; ns=not significant

3. Organochlorines and mercury in peregrine *Falco peregrinus* eggs

3.1 Introduction

The findings from all peregrine eggs analysed between 1961 and 1986 were summarised in Newton *et al.* (1989), which was updated in the 1997-98 report in this series (Newton *et al.* 1998). The results from five eggs (one per clutch received) analysed in 1999 are given in Table 3.1. Unfortunately, none of the eggs received were from coastal nests.

3.2 Results

The findings confirm continuing contamination of British peregrine eggs with organochlorines and mercury. However, all the residues in the eggs collected in 1999 were present at relatively low levels. (<1 ppm wet weight) (Table 3.1). The monitoring data indicate that organochlorine levels in British peregrines are continuing to decrease. Over most of the country, the population recovered some years ago from its pesticide-induced decline. At least in inland areas, breeding failure and mortality from organochlorine pollution now seem unlikely.

Table 3.1 Residue levels and shell indices (SI) for peregrine eggs received in 1999. Organochlorine insecticide and PCB concentrations are expressed as ppm wet weight (ppm lipid weight in parentheses) and mercury is expressed as ppm dry weight.
* indicates where shell indices could not be measured because of the poor condition of the eggshell.

Specimen number	Year found	County	SI	pp'-DDE		HEOD		PCB		Hg
Northern England										
E7558	1999	West Yorkshire	*	0.318	(6.32)	0.199	(3.97)	0.939	(18.66)	ND
E7561	1999	Lancashire	2.02	0.054	(0.88)	0.009	(0.15)	0.393	(6.41)	0.208
E7562	1999	Lancashire	*	0.046	(0.53)	0.017	(0.20)	0.233	(2.71)	0.208
E7571	1999	Lancashire	1.89	0.092	(1.11)	0.014	(0.17)	0.734	(8.85)	0.192
E7519	1999	Cheshire	1.73	0.226	(3.58)	0.028	(0.45)	0.828	(13.13)	0.405

ND = none detected

4. Organochlorines and mercury in merlin *Falco columbarius* eggs

4.1 Introduction

The findings from previous analyses of merlin eggs were given in Newton & Haas (1988), Newton, Dale & Little (1999) and also in previous reports in this series. Those from 15 eggs (one per clutch) analysed in 1999 are summarised in Table 4.1.

4.2 Results

The results from the eggs collected in 1999 confirm the continuing widespread contamination of British merlins with organochlorines and mercury. Levels of all contaminants were generally higher than those detected in peregrine eggs collected in 1999.

High levels of contamination were found in one egg from Grampian. This had a DDE concentration of 46 ppm that was likely to have caused failure of the egg. As in merlin eggs in previous years, the high level of DDE in the Grampian egg was associated with high concentrations of HEOD (0.9 ppm) and PCBs (21 ppm). Shell-indices were available for 13 eggs in 1999 and the mean was 1.19, some 4% less than the pre-DDT value

Together with previous findings, these data indicate a continuing downward trend in DDE and HEOD residues in merlin eggs, but occasional high levels still occur. Declines in organochlorine insecticide residues during the last 10-15 years have coincided with a substantial recovery in merlin numbers over much of the country. The long-term pattern for PCBs and mercury residues in merlin eggs is less clear and appears to vary regionally. In previous years, eggs from the Northern Isles have contained relatively high levels of mercury (none of the eggs collected in 1999 were from this area) and long-term declines in PCBs have only been detected in merlin eggs from Wales and north-west England (Newton, Dale & Little 1999).

Table 4.1 Residue levels and shell indices (SI) for merlin eggs received in 1999. Organochlorine insecticide and PCB concentrations are expressed as ppm wet weight (ppm lipid weight in parentheses) and mercury is expressed as ppm dry weight.
* indicates where shell indices could not be measured because of the poor condition of the eggshell.

Specimen number	Year found	County	SI	pp'-DDE		HEOD		PCB		Hg
Central and eastern Highlands										
E7608	1999	Grampian	1.08	46.55	(118.62)	0.905	(2.31)	20.549	(52.37)	3.377
E7609	1999	Grampian	1.47	3.042	(45.95)	0.245	(3.70)	1.313	(19.84)	1.401
E7610	1999	Grampian	1.07	3.153	(45.20)	0.308	(4.42)	1.154	(16.54)	1.361
E7611	1999	Grampian	1.16	9.897	(164.46)	0.269	(4.47)	1.666	(27.69)	1.802
Southern Scotland										
E7576	1999	Borders	1.28	1.411	(27.69)	0.042	(0.82)	1.138	(22.34)	4.891
Northern England										
E7575	1999	North Yorkshire	*	4.19	(83.08)	0.579	(11.49)	1.714	(33.98)	2.295
E7652	1999	Northumberland	1.00	12.95	(383.24)	0.246	(7.28)	1.274	(37.69)	5.968
E7653	1999	Northumberland	*	2.866	(73.27)	0.395	(10.11)	2.926	(74.81)	5.36
E7654	1998	Northumberland	1.63	4.183	(51.09)	0.245	(2.99)	1.769	(21.60)	1.326
E7655	1998	Northumberland	1.24	3.717	(43.44)	1.077	(12.59)	3.357	(39.24)	2.395
E7668	1998	County Durham	0.96	7.287	(144.26)	0.33	(6.53)	2.57	(50.88)	2.596
E7669	1998	County Durham	1.18	2.519	(44.85)	0.106	(1.89)	1.37	(24.39)	1.639
E7671	1998	County Durham	1.08	14.24	(169.20)	0.79	(9.38)	5.687	(67.57)	1.8
E7672	1998	County Durham	1.22	1.718	(25.07)	0.127	(1.86)	1.263	(18.43)	1.486
E7578	1999	Derbyshire	1.14	10.59	(135.62)	1.118	(14.32)	9.208	(11.98)	2.739

5. Organochlorines and mercury in golden eagle *Aquila chrysaetos* eggs

5.1 Introduction

The findings from analyses of golden eagle eggs obtained during 1963-86 were given in Newton & Galbraith (1991), and from 1987-98 in previous reports in this series. Eggs from four clutches were received in 1999, and the results are given in Table 5.1. There were possibly three eggs from coastal areas (Western Isles, Dumfries & Galloway and Argyll).

5.2 Results

All residue levels were low and well within the range of previously recorded values. These results are consistent with the low levels of contamination found in the recent years in the eggs of golden eagles from inland areas.

Table 5.1 Residue levels (organochlorine ppm wet weight (lipid weight), mercury ppm dry weight) and shell indices (SI) for golden eagle eggs received in 1999

Specimen number	Year found	County	SI	pp'-DDE		HEOD		PCB		Hg
Western Isles										
E7518	1999	Western Isles	3.05	0.067	(1.60)	0.023	(0.54)	0.648	(15.49)	0.255
E7609	1999	Grampian	1.47	3.042	(45.95)	0.245	(3.70)	1.313	(19.84)	1.401
E7610	1999	Grampian	1.07	3.153	(45.20)	0.308	(4.42)	1.154	(16.54)	1.361
E7611	1999	Grampian	1.16	9.897	(164.46)	0.269	(4.47)	1.666	(27.69)	1.802
Southern Scotland										
E7573	1999	D&G†	2.91	0.072	(1.31)	0.04	(0.73)	0.265	(4.85)	0.139
E7625A	1997	Argyll	3.18	0.019	(0.28)	0.017	(0.25)	0.184	(2.65)	0.079
Northern England										
E7651	1999		2.87	0.036	(1.20)	0.088	(2.96)	0.125	(4.20)	0.105

†Dumfries and Galloway

6. Organochlorines and mercury in gannet *Morus bassanus* eggs

6.1 Introduction

The findings from all gannet eggs examined up to 1988 were published in Newton *et al.* (1990) and up to 1998 in the report for 1998/99 (Newton *et al.* 2000). Gannet eggs are usually included in this study every one-two years. No gannet eggs were analysed in 1999 because none were received.

7. Organochlorines and mercury in sea eagle *Haliaeetus albicilla* eggs

7.1 Introduction

So far, the sea eagles introduced to western Scotland in the period 1976-85 have bred with poor success. Most breeding attempts have failed completely. One of the possible problems might be contamination with organochlorine and mercury residues, which the birds could acquire particularly from the marine component of their diet, various fish and seabirds. Some of the nests have been on inaccessible sea-cliffs.

No sea eagle eggs were analysed in 1999. So far, a total of six eggs has been obtained and analysed during the course of this scheme, no more than one egg per year having been analysed.

8. Organochlorines and mercury in eggs of various other species

8.1 Introduction

Eggs from a number of other predatory bird species have been examined for organochlorine and mercury residues through the course of the year. These were done as part of the core research work of CEH and were not funded by the JNCC Wildlife and Pollution Contract. However, they provide useful information on the current state of contamination of other species and are, therefore, included in the present report for completeness.

8.2 Results

In total, three osprey *Pandion haliaetus*, six red kite *Milvus milvus*, two hen harrier *Circus cyaneus*, twelve sparrowhawk, one kestrel, one gyr falcon *Falco rusticolus* and one little auk *Alle alle* eggs were analysed. Results are given in Table 8.1. All the eggs contained background levels of organochlorine insecticides, confirming the widespread nature of low-level contamination at the present time. All the eggs analysed were contaminated with PCBs. Most contained mercury, although none was detected in any of the (six) red kite eggs that were analysed; all these eggs came from nests in Buckinghamshire.

Table 8.1 Residue levels (organochlorine ppm wet weight (lipid weight), mercury ppm dry weight) and shell indices (SI) for eggs (various species) received in 1999

Specimen number	Year found	County	SI	pp'-DDE		HEOD		PCB		Hg
Osprey										
E7417	1998	Strathclyde	2.34	0.596	(9.63)	0.053	(0.86)	6.13	(99.11)	0.776
E7418	1998	Central	2.19	0.951	(20.33)	0.129	(2.75)	4.747	(101.45)	0.455
E7419	1998	Central	2.30	0.319	(11.10)	0.047	(1.62)	1.489	(51.75)	0.338
Red kite										
E7523	1998	Buckinghamshire	2.28	0.022	(0.46)	0.035	(0.72)	0.503	(10.38)	ND
E7525	1998	Buckinghamshire	1.82	0.015	(0.33)	0.109	(2.32)	0.263	(5.60)	ND
E7526	1998	Buckinghamshire	1.86	0.014	(0.43)	0.032	(1.00)	0.504	(15.59)	ND
E7527	1998	Buckinghamshire	1.94	0.254	(3.56)	0.09	(1.27)	0.843	(11.80)	ND
E7528	1998	Buckinghamshire	1.92	0.032	(0.60)	0.02	(0.36)	0.239	(4.41)	ND
E7529	1998	Buckinghamshire	1.90	0.026	(0.33)	0.017	(0.21)	0.233	(2.95)	ND
Sparrowhawk										
E7428	1998	Hampshire	1.23	4.177	(23.17)	0.354	(1.97)	7.598	(42.14)	0.752
E7429	1998	Hampshire		0.689	(11.07)	0.077	(1.24)	1.654	(26.58)	0.651
E7431	1998	Hampshire	1.40	1.167	(12.43)	0.201	(2.14)	2.168	(23.09)	0.754
E7432	1998	Hampshire	1.51	0.815	(21.86)	0.102	(2.74)	2.796	(75.00)	0.698
E7433	1998	Hampshire	1.29	2.316	(66.74)	0.189	(5.45)	3.797	(109.42)	1.661
E7436	1998	Hampshire		0.524	(17.09)	0.072	(2.36)	2.137	(69.74)	1.295
E7437	1998	Hampshire	1.48	2.484	(37.39)	0.260	(3.91)	4.003	(60.25)	1.526
E7439	1998	Hampshire	1.53	1.504	(25.34)	0.154	(2.59)	3.693	(62.23)	0.510
E7441	1998	Hampshire		0.578	(11.99)	0.100	(2.08)	1.844	(38.24)	0.867
E7532	1998	Northants.		7.508	(26.97)	0.668	(2.40)	16.809	(60.38)	0.455
E7533	1998	Northants.	1.43	4.543	(48.45)	0.292	(3.12)	2.041	(21.77)	ND
E7534	1998	Northants.	1.35	4.253	(46.89)	0.300	(3.31)	2.381	(26.25)	0.235
Hen harrier										
E7363	1998	Lancashire	1.64	0.058	(0.53)	0.055	(0.51)	0.474	(4.38)	ND
E7365	1998	Lancashire	1.71	0.132	(2.12)	0.042	(0.70)	0.455	(7.65)	0.309
Kestrel										
E7408	1998	Cambridgeshire	1.11	0.684	(10.91)	0.518	(8.26)	0.378	(6.02)	1.07
Gyr falcon										
E7604	1999	Greenland		0.654	(14.25)	0.11	(2.39)	3.109	(67.74)	1.941
Little auk										
E7606	1999	Greenland	1.46	0.119	(0.53)	0.107	(0.48)	0.482	(2.16)	0.187

ND = none detected

9. Rodenticide residues in barn owls *Tyto alba*

9.1 Introduction

The aim of this work was to screen barn owl carcasses for residues of 'second-generation' rodenticides. The carcasses, supplied by members of the public, included birds that had died from various causes, mainly accidents. The chemicals of interest included difenacoum, bromadiolone, brodifacoum and flocoumafen. The findings from all barn owls analysed in previous years were given in Newton *et al.* (1997b, 1999), and in previous reports in this series, while those from 57 birds (54 barn owls, two kestrels and one little owl) sent to Monks Wood in 1999 are given in Tables 9.1 and 9.2.

9.2 Methods

Analysis of rodenticides in liver tissue was carried out by the same methods as in previous reports and described by Newton *et al.* (1997a), but using new HPLC and detection equipment (Hewlett Packard LC-MS Series 1100) first employed to analyse birds collected in 1998 (Newton *et al.* 2000). Quantification was carried out on the basis of peak height, although quantification using peak area gave comparable results.

9.3 Results

Of the 54 barn owls analysed, 20 (37%) contained detectable levels of rodenticides. This proportion was lower than that for 1998 birds, which had been the highest proportion in an annual sample recorded during rodenticide analysis at Monks Wood (28/54 = 52%). Eight of the owls received at Monks Wood in 1999 had actually been found dead either in 1998 (4) or 1997 (4) and none of these contained detectable rodenticide residues. Thus, of the owls found dead in 1999, 20 out of 46 (43.5%) contained rodenticides, although this value may subsequently change marginally as some birds received at Monks Wood in 2000 and future years may include individuals that died in 1999. Overall, the data for the 1999 birds was consistent with the trend reported for earlier years that suggested the increase in the proportion of birds exposed since 1983 (when monitoring began) was levelling-off at about 40% (Newton *et al.* 1999); the peak reported for the 1998 birds therefore appears to have been exceptional.

Difenacoum, bromadiolone, brodifacoum and flocoumafen occurred in 14 (26% of the samples), 4 (7.4%), 6 (11%) and 0 (0%) barn owls, respectively. The predominance of difenacoum and absence of flocoumafen is consistent with findings in previous years (Newton *et al.* 2000) and in other predators (Shore *et al.*, in press), although the proportion of birds that contained bromadiolone was relatively low compared to most previous years (Newton *et al.* 2000). Brodifacoum is restricted to use indoors but has been detected in barn owls in previous years. The proportion of 1999 birds containing brodifacoum was less than half that in 1998 but was similar to or greater than the proportions recorded in other years in the 1990s.

A number of the barn owls had residue levels considered to be in the potentially lethal range. This range has variously been described as >0.1 ppm (Newton *et al.* 2000) and >0.2 ppm (Newton *et al.* 1999) and is so classed on the basis of two sets of observations. These are that owls diagnosed at post-mortem of having died from rodenticide poisoning (because they had characteristic signs of haemorrhaging) almost all had liver residues >0.1 ppm, and, secondly, that owls that had been experimentally poisoned had residues of the range 0.2-1.72 ppm (see Newton *et al.* 1999 for review). Of the barn owls in the 1999 sample, five (9.2% of the sample) had liver residues between 0.1 and 0.2 ppm and one (1.8%) had a liver residue >0.2 ppm; this is broadly consistent with findings for previous years. None of these birds showed signs of haemorrhage consistent with clinical sign of poisoning by anticoagulants; on post-mortem examination, starvation (four birds), collision (one bird) and road traffic accident (one bird) were diagnosed as the causes of death. Two barn owls (birds 12954 and 12978) did show signs of haemorrhage and were considered at post-mortem to be possible rodenticide victims. However, they contained very low (0.002 ppm difenacoum) or non-detectable amounts of rodenticides.

Two kestrels and one little owl also showed signs of haemorrhage at post-mortem examination and so their livers were analysed for rodenticides. However, residues were either very low or non-detectable (Table 9.2).

Table 9.1 Levels of rodenticides (ppm wet weight) in the livers of adult (A) and juvenile (J) male (M) and female (F) barn owls received in 1999. Juveniles are bird in first year, adults are birds older than first year; brod=brodifacoum, difen=difenacoum, brom=bromadialone, floc=flocoumafen

					Rodenticide residue			
Specimen number	**Date found**	**County**	**Age**	**Sex**	**brod**	**difen**	**brom**	**floc**
12859	December-98	West Suffolk	J	M	ND	ND	ND	ND
12863	January-99	South Wiltshire	J	F	ND	0.012	ND	ND
12866	January-99	West Norfolk	J	F	ND	ND	ND	ND
12869	January-99	Oxfordshire	J	M	0.103	ND	ND	ND
12870	January-99	Cambridgeshire	A	M	ND	0.073	ND	ND
12872	January-99	Anglesey	A	F	ND	0.008	ND	ND
12873	January-99	Oxfordshire	J	M	ND	ND	ND	ND
12880	February-99	West Norfolk	J	M	ND	ND	ND	ND
12889	February-99	South Wiltshire	J	M	ND	ND	ND	ND
12898	February-99	N. Northumberland	J	M	0.203	0.017	ND	ND
12901	February-99	Berkshire	J	F	ND	ND	ND	ND
12902	February-99	East Sussex	A	M	ND	0.195	ND	ND
12903	March-99	N. Northumberland	A	F	0.062	ND	ND	ND
12908	February-99	Cheshire	J	F	ND	ND	ND	ND
12910	October-98	South Essex	J	F	ND	ND	ND	ND
12911	March-99	Pembrokeshire	J	M	ND	ND	ND	ND
12939	March-99	South Lancashire	J	F	ND	ND	ND	ND
12940	March-99	Oxfordshire	J	M	0.102	ND	ND	ND
12944	March-99	Oxfordshire	J	M	0.188	0.006	ND	ND
12945	March-99	Oxfordshire	A	F	ND	0.01	ND	ND
12950	April-99	Berkshire	J	F	ND	ND	ND	ND
12953	April-99	Cumberland	A	M	ND	ND	0.016	ND
12954	April-99	East Cornwall	A	F	ND	ND	ND	ND
12959	April-99	Hertfordshire	J	M	0.112	0.015	ND	ND
12966	May-99	Northamptonshire	J	M	ND	ND	ND	ND
12973	May-99	East Suffolk	A	M	ND	ND	ND	ND
12978	March-99	South Lancashire	A	F	ND	0.002	ND	ND
12988	June-99	Cheshire	J	M	ND	ND	ND	ND
12989	June-99	Cheshire	J	F	ND	ND	ND	ND
12994	May-99	South Hampshire			ND	ND	ND	ND
13004	July-99	Northamptonshire	J	M	ND	ND	ND	ND
13013	June-99	Anglesey	J	F	ND	ND	ND	ND
13017	July-99	North Aberdeenshire	J	M	ND	ND	ND	ND
13021	July-99	Morayshire	A	F	ND	0.003	0.019	ND
13030	August-99	South Essex	J	F	ND	0.008	ND	ND
13044	August-99	Cheshire	A	F	ND	0.031	0.091	ND
13045	August-99	East Norfolk	J	M	ND	0.031	ND	ND
13047	August-99	North Wiltshire	J	M	ND	ND	ND	ND
13050	August-99	West Suffolk	J	F	ND	ND	0.021	ND
13076	September-99	South Essex	J	M	ND	0.019	ND	ND
13079	January-99	Wigtownshire	J	M	ND	ND	ND	ND
13080	October-99	Warwickshire	J	M	ND	ND	ND	ND
13086	October-99	Huntingdonshire	J	M	ND	ND	ND	ND
13093	October-99	N. Northumberland	J	F	ND	ND	ND	ND
13094	October-99	West Norfolk	J	M	ND	ND	ND	ND
13100	November-99	East Suffolk	J	F	ND	ND	ND	ND
13102	November-99	Staffordshire	J	M	ND	ND	ND	ND
13111	December-99	South Lincolnshire	A	M	ND	0.010	ND	ND
13119	December-97	Caernarvonshire	A	F	ND	ND	ND	ND
13120	December-97	Huntingdonshire	J	F	ND	ND	ND	ND
13122	December-97	West Suffolk		M	ND	ND	ND	ND
13123	March-98	East Suffolk			ND	ND	ND	ND
13124	May-98	West Suffolk		M	ND	ND	ND	ND
13126	July-97	Huntingdonshire	J	M	ND	ND	ND	ND

ND = none detected

Table 9.2 Levels of rodenticides (ppm wet weight) in the livers of adult (A) or juvenile (J), male (M) or female (F) kestrels and little owls received in 1999. Juveniles are birds in first year, adults are birds older than first year; brod=brodifacoum, difen=difenacoum, brom=bromadialone, floc=flocoumafen

					Rodenticide residue			
Specimen number	**Date found**	**County**	**Age**	**Sex**	**brod**	**difen**	**brom**	**floc**
Kestrel								
13107	November-99	Durham	J	F	ND	0.014	ND	ND
13190	March-00	Dorset	J	M	ND	ND	ND	ND
Little owl								
13109	December-99	West Suffolk	A	M	ND	ND	ND	ND

ND = none detected

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