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2005/06 Annual report

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1 Preface and Summary

1.1 Introduction

The Wildlife and Pollution contract covers a long-term monitoring programme, the Predatory Bird Monitoring Scheme (PBMS), which examines the levels of certain pollutants in selected wildlife species in Britain. The programme was started in the early 1960s, 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 subsequently assessed the success of these bans by measuring whether there has been a decline in the concentrations of organochlorine pesticides in the livers and eggs of predatory and freshwater fish-eating birds. 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, although mercury concentrations were not measured in birds collected in 2001. In recent years, investigations have been made into the effects of the newest generation of rodenticides on barn owls *Tyto alba*. Northern gannet *Morus bassanus* eggs are also collected approximately biennially from two colonies and, when available, from other sites; eggs were last collected in 2004.

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 give an interim summary of results and every three years these annual results are gathered together into a more substantial report in which they are integrated with previous findings. These 'long-term trends' reports for the organochlorine contaminants and mercury, and those for second generation anticoagulant rodenticides (SGARs) are desynchronized. The latest report of this type for organochlorine contamiants and mercury covers the period up to and including 2003 (Shore *et al.*, 2006b), while the long-term trends in SGARS were last described in 2004 (Walker *et al.*, *in press*). Results are published periodically in the scientific literature. This current report presents the results of analyses carried out on material collected in 2005.

The Wildlife and Pollution contract has been subject to regular scientific assessments within JNCC's rolling programme of peer review. As a result of these, some monitoring activities have been modified, so as to allow the initiation of new studies and reorientation of the PBMS so that remains focused on current chemical risks. Most notably, common kestrels *Falco tinnunculus* are no longer monitored for organochlorines and the intensity of monitoring for organochlorines in sparrowhawks has been reduced. However, kestrels have been monitored for second-generation anticoagulant rodenticides since 2001. This is because an individual study, carried out as part of the PBMS activities, demonstrated that this species may be particularly vulnerable to exposure to these compounds (Shore *et al.*, 2001). Furthermore, new studies have been initiated to investigate potential risks from other chemicals, such as polycyclic aromatic hydrocarbons (Shore *et al.*, 2006a), and to test the principles and approaches of contaminant monitoring in general. These studies draw on the whole range of material submitted by volunteers to the PBMS.

The core PBMS samples used for chemical monitoring are body tissues from the carcasses of sparrowhawk *Accipiter nisus*, grey heron *Ardea cinerea*, barn owl *Tyto alba*, kestrel *Falco tinnunclulus*, red kite *Milvus milvus*, and the eggs of merlin *Falco columbarius*, golden eagle *Aquila chrysaetos*, sea eagle *Haliaeetus albicilla* and gannet *Morus bassanus*. Carcasses and eggs of other predatory bird species (such as peregrine falcon *Falco peregrinus*, common buzzard *Buteo buteo*, long-eared owl *Asio otus*, little owl *Athene noctua*, common kingfisher *Alcedo atthis*, great crested grebe *Podiceps cristatus*, and great bittern *Botaurus stellaris*) which do not form the core part of the PBMS but are sent to the Centre for Ecology & Hydrology (CEH) by volunteers, are not analysed chemically. However, post-mortem examinations are carried out the carcasses, relevant information is recorded and the cause of death is determined (and reported back to the volunteer who submitted the carcass). Samples of the egg contents and body organs for these species, and those that do form part of the core monitoring, are archived at -20°C as part of the unique PBMS tissue and egg sample archive. This is an invaluable resource and is often used in specific targeted research studies. A summary of the numbers of birds and eggs received in 2005 can be found in Tables 1.1 and 1.2, respectively.

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. The results from the core monitoring of organochlorine and mercury concentrations in the livers and eggs of various species and of second-generation anticoagulant rodenticides in barn owl and kestrel livers are summarised in sections 1.2-1.6 and in section 1.7, respectively. In addition, as part of the 2005/2006 Wildlife and Pollution contract, a review of the role and focus of the PBMS was produced as a separate report (Shore *et al.*, *in press*).

Table 1.1. Summary of birds receive by the predatory bird monitoring scheme in 2005. It is not always possible to take a liver sample from a bird and so the number of samples analysed may differ from the values in this table.

Group	Common Name	Latin Name	Number received	Notes
Owls	Barn Owl	*Tyto alba*	149	Core Species
	Eagle Owl	*Bubo bubo*	2	
	Tawny Owl	*Strix aluco*	53	
	Little Owl	*Athene noctua*	10	
	Long-eared Owl	*Asio otus*	11	
	Short-eared Owl	*Asio flammeus*	1	
Falcons	Kestrel	*Falco tinnunculus*	24	Core Species
	Merlin	*Falco columbarius*	3	
	Peregrine	*Falco peregrinus*	2	
	Hobby	*Falco subbuteo*	2	
Hawks & Vultures	Sparrowhawk	*Accipiter nisus*	62	Core Species
	Buzzard	*Buteo buteo*	29	
	Hen Harrier	*Circus cyaneus*	1	
	Montague's Harrier	*Circus pygargus*	1	
	Marsh Harrier	*Circus aeruginosus*	3	
	Red Kite	*Milvus milvus*	3	
Others	Heron	*Ardea cinerea*	5	Core Species
	Kingfisher	*Alcedo atthis*	3	
	Bittern	*Botaurus stellaris*	2	
	Little Egret	*Egretta garzetta*	1	
	Water Rail	*Rallus aquaticus*	1	
		Total	368	

Table 1.2. Summary of eggs received by the predatory bird monitoring scheme in 2005. Note that these figures may include more than one egg from a single clutch.

Group	Common Name	Latin Name	Eggs Received	Notes
Falcons	Merlin	*Falco columbarius*	24	Core Species
	Peregrine falcon	*Falco peregrinus*	20	
	Hobby	*Falco subbuteo*	4	
	Kestrel	*Falco tinnunculus*	7	
Eagles	Golden Eagle	*Aquila chrysaetos*	25	Core Species
	White-tailed Sea Eagle	*Haliaeetus albicilla*	1	Core Species
Hawks & Vultures	Sparrowhawk	*Accipiter nisus*	26	
	Goshawk	*Accipiter gentilis*	9	
	Hen Harrier	*Circus cyaneus*	25	
	Monatague's Harrier	*Circus pygargus*	4	
	Buzzard	*Buteo buteo*	6	
	Red Kite	*Milvus milvus*	8	
Others	Barn Owl	*Tyto alba*	44	
	Gannet	*Morus bassanus*	0	Core Species
	Osprey	*Pandion haliaetus*	1	
	Tawny Owl	*Strix aluco*	5	
		Total	209	

1.2 Organochlorines and mercury (Hg) 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 (Hg) residues in livers. This enables surveillance of the effects of previous withdrawals of permitted uses of some of these chemicals, and to examine geographical variation in residues. For 2005, the livers from 32 Eurasian sparrowhawks and four grey herons from various localities in Scotland, England and Wales, were analysed for dichlorodiphenyldichloroethylene (DDE), hexachloro-epoxy-octahydro-dimethanonaphthalene (HEOD), polychlorinated biphenyls (PCBs), and mercury (Hg). None of the sparrowhawks or herons collected during 2002 had liver concentrations of organochlorine insecticides, PCBs or mercury which were indicative of lethal exposure. Average liver concentrations of PCBs in sparrowhawks were significantly lower in birds that died in 2005 compared to those that died in 2004. However, there has not been any consistent nor significant decline in PCB residues in sparrowhawk livers over the last five-years up to 2005. There were no significant differences in contaminant concentrations between herons that had died in 2005 and 2004. PCB toxic equivalents (TEQ) concentrations were at least an order of magnitude, and on average three orders of magnitude, below the lowest observed effect concentration (LOEC) reported for some species.

1.3 Organochlorines in merlin (*Falco columbarius*) eggs

Twenty eggs collected in 2005 from merlin clutches from various parts of Scotland and England were analysed. The results confirm that the eggs of merlins in Britain are still generally contaminated with organochlorine pesticides, PCBs and Hg but concentrations were generally low and below concentrations thought to be toxicologically significant. Mercury was detected in all of the merlin eggs received in 2005 but were below concentrations associated with adverse effects on reproduction except for one egg, from the Isle of Rum, in which signs of development were not apparent.

1.4 Organochlorines in golden eagle (*Aquila chrysaetos*) eggs

Single eggs from 16 clutches from Scotland were analysed in 2005; nine were from coastal areas (Western Isles and Hebrides). DDE, HEOD, total PCB and Hg concentrations in the eggs were generally low and below concentrations thought to impair reproduction, although one egg from Sandray in the Hebrides had a DDE concentration well above the average for golden eagles from coastal areas of western Scotland; unfortunately the shell index could not be estimated as the shell was damaged on receipt. In addition, the total PCB concentration and the associated TEQ concentration were within the ranges associated with adverse reproductive effects in birds.

1.5 Organochlorines in gannet (*Morus bassanus*) eggs

No gannet eggs were received by the PBMS in 2005. The findings from all gannet eggs examined up to 1988 were published by Newton (1990a) and long-term trends in contaminant levels were summarised as part of the series of reports for the PBMS by Shore *et al*., (2005b). Gannet eggs are typically collected during visits to colonies made during laying or the early incubation period, and approximately ten eggs are taken from each colony. Collections are made approximately every two years.

1.6 Organochlorines in sea eagle (*Haliaeetus albicilla*) eggs

One failed egg, from Mull, was collected and analysed in 2005. The PCB and TEQ concentrations in this egg were sufficiently high to have potentially caused adverse effects and may have been a contributory cause to the failure of this egg. In addition, DDE (the persistent metabolite of the organochlorine insecticide DDT) concentrations exceeded those thought to potentially cause egg shell thinning and reduce productivity in this species.

1.7 Second generation anticoagulant rodenticides (SGARs) in barn owls (*Tyto alba*), kestrels (*Falco tinnunculus*), and red kites (*Milvus milvus*)

A total of 67 barn owls, and 21 kestrels were received at Monks Wood in 2005 and analysed for four SGARs, difenacoum, bromadiolone, brodifacoum and flocoumafen. The year of death of all birds was known to be 2005. Twenty barn owls (29.9%) and ten (47.6%) kestrels contained detectable levels of one or more SGAR. Difenacoum and bromadiolone were the compounds that were most frequently detected. The proportion of barn owls that contained residues, and (in comparison) the higher proportion of kestrels that were contaminated, was lower than in previous years. Six barn owls and five kestrels had liver residues that were in the potentially lethal range of > 0.1-0.2 µg/g wet weight, but none of these birds were diagnosed, on the basis of post-mortem and examination, to have unequivocally died from rodenticide poisoning. It was concluded that for one barn owl and two kestrels, SGARs may have contributed to the death of these birds.

2 Organochlorines in the livers of predatory birds

2.1 Introduction

The main objective of this work is to analyse the livers of predatory birds in order to continue the monitoring of contamination by organochlorines and toxic metals. The livers were from carcasses of birds found dead by members of the public. The chemicals of interest included DDE (from the insecticide dichlorodiphenyltrichloroethane (DDT)), HEOD (from the insecticides aldrin and dieldrin), PCBs (polychlorinated biphenyls from industrial products) and Hg (mercury from agricultural and industrial sources). Concentrations of gamma-hexachlorocyclohexane (g-HCH) are also reported. Liver organochlorine concentrations are reported in this section as µg/g wet weight (wet wt), and mercury concentrations are expressed as µg/g dry weight (dry wt). PCB TEQ values were expressed as pg/g wet wt.

The species analysed were the Eurasian sparrowhawk *Accipiter nisus*, representing the terrestrial environment, and the fish-eating grey heron *Ardea cinerea*, which represented the aquatic environment. A number of other species that do not form part of the core monitoring programme were also sent in to CEH during 2005 (see table 1.1). 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 2005 are archived at -20°C and can be analysed for other contaminants in specific future studies.

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

2.2 Results

A total of 75 sparrowhawks were received at CEH in 2005. A post-mortem examination was conducted on all the birds and selected tissues from each were retained in the PBMS -20ºC tissue archive. The livers of a stratified (by month of death) random sample of about half of the carcasses were analysed chemically, as suggested by Shore *et al.*, (2005c). In all, livers from 32 sparrowhawks and four herons were analysed. 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 2005 only) are given in Table 2.2.

None of the sparrowhawks collected during 2005 had liver concentrations of organochlorine insecticides which were indicative of lethal exposure. The majority of liver pp'-DDE and HEOD residues were below 20 µg/g wet wt and 2 µg/g wet wt respectively, concentrations that are typically found in sparrowhawks in Britain currently (Newton *et al.*, 1992, 1993). Three sparrowhawks had DDE residues that exceeded these background concentrations. However, all three birds were in a starved state which typically elevates liver residues and so does not necessarily indicate increased exposure in these birds (Shore *et al.*, 2006b). Gamma-HCH was not detected in any of the sparrowhawk livers.

Liver total PCB concentrations in sparrowhawks were typically lower than 20 µg/g wet wt. One sparrowhawk, bird 14842, had a concentration of 30 µg/g wet wt. However, post mortem examination indicated that this bird was in a starved state and so this may account to some degree for its elevated PCB concentrations. Furthermore, analysis of the PCB liver concentration data since monitoring began for all sparrowhawks diagnosed as having died from starvation indicates that the upper quartile (75^{th} percentile), the 95^{th} percentile and the 99^{th} percentile total PCB liver concentrations are approximately 20, 50 and 100 µg/g wet wt respectively. Thus, liver residues of < 100 µg/g wet wt are not exceptional in starved individuals.

Liver TEQ concentrations varied markedly between individual sparrowhawks. Five of the sparrowhawks that died in 2005 had non-detected TEQ concentrations associated with their PCB contamination and the geometric mean (±95% CI) concentration for the remainder was 2.57 (1.08-6.10) pg/g wet wt. This is within the ranges reported in the livers of various predatory bird species from Europe, the USA and Japan (Coady *et al.*, 2001; Kannan *et al.*, 2003; Senthilkumar *et al.*, 2002). The toxicological significance of liver TEQ concentrations is less well established for livers than for eggs (Hoffman *et al.*, 1996), but 25 ng/g on a lipid weight (lipid wt) basis has been reported as the lowest observed effect concentration (LOEC) for induction of cytochrome P450 enzymes and for a 50% reduction in plasma thyroxine levels in common tern (*Sterna hirundo*) chicks (Bosveld *et al.*, 2000). The geometric mean TEQ concentration for sparrowhawks that died in 2005 and that had detectable TEQ concentrations was 78.1 pg/g, when expressed on a lipid weight basis. This was approximately three orders of magnitude lower than the LOEC reported for tern chicks. The highest TEQ concentration measured in the sparrowhawk livers (bird 14842) was approximately an order of magnitude below the LOEC for terns.

The concentrations of organochlorine insecticides and PCBs in the four herons analysed were low and not considered to be toxicologically significant, although one heron (14682) had marginally above background levels of DDE in it liver. This may have been because it was in a starved state. Gamma-HCH was not detected in any of the birds. The TEQ concentrations were low, ranging between 1.40 and 18.7 pg/g ww, and below those previously reported as having toxicological significance (Bosveld *et al.*, 2000).

Mercury concentrations in sparrowhawks and herons were well below the concentration (30 µg/g wet wt, equivalent to approximately 105 µg/g dw) associated with toxic effects in birds of prey (Thompson, 1996).

The only statistically significant differences between liver residues in birds that died in 2005 and those that died in the previous year for the compounds analysed was a decrease in liver PCB concentrations in sparrowhawks (Table 2.3). Linear regression analysis of the whole of the monitoring period (1967 to present) suggests that there has been a close to statistically significant decline in the liver PCB residues ($F_{1,2043}$=3.72; P=0.054) in sparrowhawks (Table 2.4). However, these declines are not consistent (Shore *et al.*, 2006b) and it is notable that there has been no significant decline over the last five years for

PCBs in sparrowhawks ($F_{1,219}$=0.49; P=0.484). Thus, it is not possible to say whether these differences reflect a real change in exposure between the two years for these compounds.

Table 2.1: Concentrations of organochlorines insecticides, total PCBs (µg/g wet wt), TEQs (pg/g wet wt) and mercury (µg/g dw) in the livers of juvenile (in first year) and adult (older than first year) sparrowhawks and herons received during 2002. Lipid wt concentrations for organochlorines and PCBs can be calculated by multiplying the wet wt concentrations by the conversion factor (CF). * indicates missing data that were either not provided by the sender of the carcass or that could not be obtained from the sample received. Congener specific data for PCBs are given in Tables 9.1 and 9.2 in the appendix

Bird No/	Year Found	Vice-County	Age	Sex	CF	pp' DDE	HEOD	Total PCB	PCB (TEQ)	Hg
Eurasian sparrowhawk *Accipiter nisus*										
14613	2005	Dorset	J	M	31.1	25.76	0.039	2.721	3.364	1.07
14615	2005	West Gloucestershire	A	F	15.9	2.221	0.164	8.070	13.62	1.34
14618	2005	Berkshire	J	F	15.9	1.561	0.075	2.097	2.649	0.57
14623	2005	North Lincolnshire	J	M	29.4	3.810	0.220	5.282	10.80	3.02
14625	2005	North Somerset	J	F	32.2	5.370	0.065	9.080	10.97	2.14
14628	2005	North Lincolnshire	A	M	30.0	20.07	0.624	12.17	20.11	5.68
14666	2005	South-west Yorkshire	A	F	22.3	4.643	0.670	10.70	26.84	2.44
14679	2005	South Devon	J	F	38.5	1.138	0.084	3.236	3.698	3.78
14686	2005	Huntingdonshire	J	M	27.6	1.100	0.061	0.726	0.870	3.58
14693	2005	Herefordshire	A	F	22.6	6.744	0.177	1.073	1.024	2.11
14704	2005	Worcestershire	A	F	25.6	3.868	0.238	2.189	2.771	3.56
14762	2005	West Cornwall	A	F	34.5	60.02	0.333	16.98	22.21	7.37
14842	2005	Mid-west Yorkshire	A	M	32.6	4.066	0.248	30.79	54.34	4.66
14846	2005	South Devon	*	M	10.4	2.866	0.044	8.430	14.41	1.50
14848	2005	Leicestershire (& Rutland)	A	M	35.4	5.132	0.121	16.65	46.34	8.44
14850	2005	South Somerset	J	F	19.3	0.043	0.034	0.110	ND	0.47
14868	2005	Northamptonshire	J	F	29.7	0.104	0.448	0.411	0.047	0.47
14872	2005	Cumberland	J	M	27.5	0.059	0.028	0.324	0.060	1.49
14876	2005	Wigtownshire	J	F	34.9	0.027	0.036	0.384	0.068	4.63
14879	2005	Huntingdonshire	A	M	22.8	1.868	0.154	1.606	2.979	1.00
14903	2005	East Kent	J	F	47.1	5.329	0.352	2.335	6.901	1.76
14905	2005	Buckinghamshire	J	F	31.8	1.706	0.143	3.215	3.597	0.94
14919	2005	East Kent	J	M	32.2	7.608	0.081	7.926	35.19	1.50
14926	2005	North Essex	J	F	39.1	0.351	0.031	0.142	ND	0.16
14947	2005	East Ross	J	F	38.1	0.009	0.014	0.078	ND	2.17
14953	2005	Mid-west Yorkshire	J	M	32.1	0.096	0.040	0.479	0.088	1.71
14955	2005	South Lincolnshire	J	F	31.3	3.311	0.246	0.752	0.895	0.63
14961	2005	South Wiltshire	J	F	43.4	0.926	0.027	1.443	0.208	0.68
14970	2005	East Ross	J	M	31.0	0.045	0.009	0.339	0.117	2.58
14991	2005	South Aberdeenshire	J	F	26.6	1.830	0.072	0.722	2.141	1.12
14995	2005	East Norfolk	J	F	34.1	0.054	0.031	0.218	ND	0.41
15321	2005	West Cornwall	J	F	40.5	0.055	0.015	0.119	ND	0.66

ND is not detected

Table 2.1 Continued:

Bird No/	Year Found	Vice-County	Age	Sex	CF	pp' DDE	HEOD	Total PCB	PCB (TEQ)	Hg
Grey heron *Ardea cinerea*										
14682	2005	East Sussex	J	F	39.5	0.246	2.103	1.265	1.396	6.12
14697	2005	Cambridgeshire	A	M	22.6	0.200	0.057	0.879	1.432	4.75
14830	2005	North-east Yorkshire	J	F	10.0	0.479	0.022	3.039	6.820	11.20
14893	2005	East Sussex	J	M	26.2	0.837	0.043	6.284	18.65	12.58

ND is not detected

Table 2.2: Geometric mean concentrations of pollutants in the sparrowhawk and heron in Table 1 (data are only for birds found dead in 2005). GSE=geometric standard error.

	pp'- DDE µg/g wet wt	HEOD µg/g wet wt	Total PCB µg/g wet wt	PCB (TEQ) pg/g wet wt	Hg µg/g dw
Sparrowhawk					
Geometric mean	1.045	0.086	1.581	0.753	1.584
N	32	32	32	32	32
Range of 1 GSE	0.703 - 1.554	0.070 - 0.105	1.176 - 2.124	0.404 - 1.404	1.346 - 1.865
Heron					
Geometric mean	0.375	0.103	2.147	3.993	8.001
N	4	4	4	4	4
Range of 1 GSE	0.270 - 0.519	0.037 - 0.287	1.379 - 3.342	2.119 - 7.525	6.326 - 10.12

ND values were assigned a value of 0.001 µg/g (organochlorines, PCBs and Hg) and 0.001 pg/g (PCB(TEQ)) to calculate the geometric mean

Table 2.3: Results from student t-test comparison (log_{10} transformed data) of residue levels from birds collected in 2005 and 2004; values for the two years and the statistical t-values are shown. Minus values indicate a decrease and plus values indicate an increase from 2005.

	pp'- DDE	HEOD	Total PCB	PCB (TEQ)	Hg
Sparrowhawk					
2005	1.045	0.086	1.581	0.753	1.584
2004	0.964	0.101	7.354	0.253	1.429
	t_{55} = 0.13	t_{55} = -0.41	t_{55} = -3.41**	t_{55} = 1.12	t_{54} = 0.19
Heron					
2005	0.375	0.103	2.147	3.993	8.001
2004	0.078	0.072	1.307	0.390	9.668
	t_9 = 1.68	t_9 = 0.38	t_9 = 0.59	t_9 = 1.25	t_9 = -0.34

Significance of difference: *P<0.05; **P<0.01; ***P<0.001
Non-detected values taken as 0.001 µg/g

Table 2.4: Trends in pollutant levels in livers of predatory birds during 1963-2005 and 2000-2005. 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). Data for TEQs not shown as data for previous years have not been reported.

		1963-2002 N	b		1997-2002 N	b	
Sparrowhawk							
	pp'-DDE	2089	-0.030	***	221	-0.021	ns
	HEOD	2090	-0.031	***	221	-0.022	ns
	Total PCB	2045	-0.004	ns	221	-0.020	ns
	Hg	1790	-0.012	***	172	-0.068	ns
Heron							
	pp'-DDE	842	-0.043	***	31	-0.073	ns
	HEOD	832	-0.046	***	31	-0.054	ns
	Total PCB	708	-0.020	***	31	-0.011	ns
	Hg	541	-0.016	***	31	-0.047	ns

*P=<0.05; **P=<0.01;***P<0.001; ns=not significant
Non-detected values taken as 0.001 µg/g

3 Organochlorines in merlin (*Falco columbarius*) eggs

3.1 Introduction

The eggs of merlins have been monitored since the late 1960s for organochlorine compounds as part of the core PBMS monitoring. The findings from previous analyses of merlin eggs are reported elsewhere (Newton *et al.*, 1982; Newton *et al.*, 1999a; Newton & Haas, 1988) and in previous recent reports in this series (Shore *et al.*, 2005b, a; Shore *et al.*, 2006b). Those from 20 eggs (one per clutch) collected during 2005 are summarised in Table 3.1.

3.2 Results

The analyses of the eggs collected in 2005 confirm that the eggs of merlins in Britain are still generally contaminated with organochlorine pesticides and PCBs. Total PCB, DDE and HEOD residues were detected in all 20 eggs and TEQ residues in all but one (E8629). The concentrations of all four contaminants were generally low and are below concentrations that are thought to be toxicologically significant (AMAP, 1998; Blus, 1996; Hoffman *et al.*, 1996; Peakall, 1996). The gamma isomer of hexachlorohexane (gamma-HCH) was not detected in any of the merlin eggs analysed.

No Observable Effect Concentrations (NOECs) for eggs of various experimental and wild bird species range between 1.5 and 200 pg TEQs/ g wet wt; LOECs range between 10 and 2200 pg/g wet wt and the LD_{50} for embryo mortality in white leghorn chickens, one of the more sensitive species, is 115-147 pg/g wet wt (AMAP, 1998). Thus, there is considerable overlap between NOEC, LOEC and LD_{50} TEQ values which, in part, reflects species variation in sensitivity. The geometric mean and the maximum calculated TEQ concentration associated with PCB contamination in the merlin eggs received in 2005 was 4.09 pg/g wet wt and 14.3 pg/g wet wt, respectively. Therefore it is likely that the TEQ concentrations measured in the merlin eggs received in 2005 were not toxicologically significant. However, NOEC and LOEC concentrations have not been derived for merlins and it is possible that they are more sensitive to the effects of PCBs than some other species. Accumulation of further TEQ data for this and other species through the PBMS will assist in interpreting the long-term trends and toxicological significance of TEQ concentrations in merlins eggs in Britain.

Mercury was detected in all of the eggs received in 2005. The geometric mean and the maximum concentration was 1.86 µg/g dry wt and 11.02 µg/g dry wt and was typical of concentrations recorded in previous years (Shore *et al.*, 2005b). Total mercury concentrations greater than approximately 2 µg/g wet wt have been associated with impaired hatching in laboratory studies on some species, although the extent to which this effect level can be extrapolated to other species is uncertain as there appears to be considerable variation in sensitivity between species (Thompson, 1996). When expressed on a wet wt basis, the maximum mercury concentration in the merlin eggs received in 2005 was 2.61 µg/g wet wt (E8666), which exceeds the concentration associated with adverse effects on reproduction. Egg E8666 was from a nest on the Isle of Rum and no development was apparent in the egg.

Table 3.1: Concentrations of organochlorines insecticides and total PCBs (all in µg/g wet wt), TEQs (pg/g wet wt), mercury (µg/g dw) and the shell indices (SI) for merlin eggs received in 2005. Lipid wt concentrations for organochlorines and PCBs can be calculated by multiplying the wet wt concentrations by the conversion factor (CF). * indicates where shell indices could not be measured because of the poor condition of the eggshell. Congener specific data for PCBs and TEQs are given in Tables 9.3 and 9.4, respectively of the Appendix.

Egg No/	Year	Vice-County	SI	CF	pp'-DDE	HEOD	Total PCB	PCB TEQ	Hg
South Scotland									
E8714	2005	Lothian	*	23.13	1.971	0.218	1.647	3.855	2.70
E8716	2005	Borders	*	22.07	4.145	0.099	1.071	2.358	2.79
North Scotland									
E8783	2005	Inverness-shire	1.27	14.47	1.423	0.078	1.424	3.583	1.91
Western Isles									
E8629	2005	Benbecula	*	18.30	0.172	0.058	1.237	ND	0.71
E8666	2005	Rum	*	12.23	7.507	0.101	4.039	7.120	11.02
North East England									
E8611	2005	North Yorks.	*	10.80	1.742	0.028	2.230	4.978	1.58
E8669	2005	North Yorks.	1.25	21.19	0.913	0.057	1.131	2.291	3.28
E8670	2005	North Yorks.	1.12	19.62	2.954	0.341	1.791	3.877	1.97
E8681	2005	North Yorks.	1.19	16.06	9.442	0.122	1.739	3.639	2.32
E8717	2005	Durham	1.02	16.10	11.130	0.792	1.864	3.465	1.94
E8718	2005	Durham	1.18	18.77	2.537	0.210	2.048	5.268	1.78
E8719	2005	Durham	0.83	16.33	3.008	0.102	2.045	4.075	1.59
E8720	2005	Durham	1.34	15.79	1.343	0.055	1.856	3.135	1.38
E8722	2005	Durham	1.40	20.75	0.285	0.051	0.694	1.003	1.71
E8723	2005	Durham	1.06	15.28	8.202	0.107	2.099	4.874	1.49
E8726	2005	Durham	1.36	13.86	1.701	0.077	2.522	4.235	1.72
E8790	2004	North'land	1.35	14.54	2.714	0.339	6.645	7.450	1.35
North West England									
E8705	2005	West Yorks.	1.22	16.59	0.992	0.114	1.968	4.354	2.34
E8727	2005	Derbyshire	*	5.72	9.689	0.204	5.791	14.27	0.49
Others									
E8704	2005	South Yorks.	1.19	15.72	4.540	0.207	2.314	5.045	1.70

ND is not detected

4 Organochlorines and mercury in golden eagle (*Aquila chrysaetos*) eggs

4.1 Introduction

The findings from the long-term monitoring of contaminants in golden eagle eggs carried out as part of the PBMS have been reported in previous reports by Newton & Galbraith (1991) and were recently summarised as part of the series of reports for the PBMS (Shore *et al.*, 2005b). Eggs from 16 clutches were received in 2005, and nine were from coastal areas (Western Isles and Hebrides). The results of the chemical analyses are given in Table 4.1.

4.2 Results

The DDE, HEOD, total PCB and Hg concentrations in the eggs received in 2005 were generally low and below concentrations thought to impair reproduction (AMAP, 1998; Blus, 1996; Hoffman *et al.*, 1996; Peakall, 1996; Thompson, 1996). However one egg (E8762) from Sandray, in the Hebrides, had a DDE concentration (6.58 ug/g wet wt) that was well above the average for golden eagles from coastal areas of western Scotland (Shore *et al.*, 2005b). Unfortunately, the shell was damaged upon receipt and so we were unable to calculate the shell index. Both the total PCB concentration and the associated TEQ concentration (8185 pg/g wet wt) were within the ranges associated with adverse reproductive effects in birds (AMAP, 1998; Hoffman *et al.*, 1996). There was no apparent development in this egg.

The elevated TEQ concentration in egg E8762 is largely due to the presence of the congener 3,3',4,4',5-Pentachlorobiphenyl (PCB 126), which is rarely detected in both bird tissue and eggs, and may have contributed to the failure of this egg to hatch. Wet weight concentrations of contaminants may be elevated if the contents of an egg have partially dried. However if this was the case, it would be expected that the wet weight to lipid weight conversion factor (CF) would be low, whereas the CF for this egg was within the 95% confidence interval for the golden eagle eggs collected in 2005. Consequently, the concentrations of DDE, total PCBs, PCB congener sum (Table 9.3), and TEQ are elevated in this egg whether they are measured on a wet weight or lipid weight basis.

Overall five, of the 16 eggs analysed had non-detected TEQ concentrations (Tables 4.5 and 4.6). Gamma-HCH, the main hexachlorohexane isomer in the insecticide lindane, was detected in three of the golden eagle eggs analysed this year; namely E8626, E8747 and E8751. However, none of the residues were more than 0.008 µg/g ww, and so would be considered to be within background levels.

Table 4.1: Concentrations of organochlorines insecticides and total PCBs (all in µg/g wet wt), TEQs (pg/g wet wt), mercury (µg/g dw) and the shell indices (SI) for golden eagle eggs received in 2005. Lipid wt concentrations for organochlorines and PCBs can be calculated by multiplying the wet wt concentrations by the conversion factor (CF). * indicates where shell indices could not be measured because of the poor condition of the eggshell. Congener specific data for PCBs and TEQs are given in Tables 9.5 and 9.6 respectively in the Appendix.

Egg Number	Year	Vice-County	SI	CF	pp'-DDE	HEOD	Total PCB	PCB TEQ	Hg
Western Highlands									
E8747	2005	Mull	2.73	24.23	0.014	0.046	0.620	ND	0.37
South Central Highlands									
E8622	2005	Abernethy Forest	3.25	20.49	ND	0.031	0.106	ND	ND
E8626	2005	Perthshire	2.76	17.66	0.006	0.015	1.000	ND	0.16
Hebrides									
E8628	2005	North Uist	*	37.86	0.149	0.019	1.231	2.074	0.85
E8630	2005	North Uist	3.31	29.68	0.059	0.018	0.912	0.905	1.58
E8632	2005	South Uist	3.71	19.57	0.056	0.004	0.329	0.088	0.67
E8645	2004	Skye	2.77	32.05	0.032	0.024	1.776	2.594	0.10
E8647	2005	Skye	2.42	17.46	0.022	0.040	0.598	0.091	0.37
E8649	2005	Skye	2.99	17.49	0.041	0.048	1.322	0.112	0.47
E8761	2005	South Uist	3.00	22.68	0.149	0.039	2.092	2.090	1.39
E8762	2005	Sandray	*	26.27	6.579	0.177	36.69	8185	3.17
E8764	2005	Lewis	3.07	26.08	0.044	0.010	0.751	0.075	0.27
South Western Highlands									
E8749	2005	Argyll	2.72	23.65	0.022	0.033	0.503	0.055	0.13
E8750	2005	Argyll	2.99	23.79	0.016	0.021	0.282	ND	ND
E8751	2005	Argyll	4.44	23.66	0.029	0.010	2.417	0.076	0.49
E8752	2005	Argyll	*	28.59	0.023	0.014	0.223	ND	ND

5 Organochlorines and mercury in gannet (*Morus bassanus*) eggs

5.1 Introduction

The findings from all gannet eggs examined up to 1988 were published by Newton *et al*., (1990a) and long-term trends in contaminant levels were summarised as part of the series of reports for the PBMS by Shore *et al*., (2005b). Gannet eggs are typically collected during visits to colonies made during laying or the early incubation period, and approximately ten eggs are taken from each colony. Collections are made approximately every two years. No gannet eggs were received in 2005.

6 Organochlorines and mercury in sea eagle (*Haliaeetus albicilla*) eggs

6.1 Introduction

Sea eagles were reintroduced to western Scotland between 1976 and 1985. They have had lower breeding success than individuals in some populations in continental Europe, although productivity has been similar to that of birds in Iceland. The relatively poor breeding success of the Scottish population is due to the number of total nest failures, and a few pairs persistently fail to rear young. One potential cause of breeding failure may be exposure to contaminants which the birds could acquire particularly from the marine component (various fish and seabirds) of their diet.

Some of the Scottish white-tailed eagles nest on inaccessible sea cliffs. This makes collection of samples difficult. One failed egg was collected in 2005 and a total of 12 eggs have been obtained and analysed during the course of this monitoring scheme.

6.2 Results

The wet weight contaminant concentrations in the egg collected in 2005 are given in table 6.1. The lipid wt equivalent concentrations of the DDE and total PCB wet wt concentrations in this egg were 62.6 µg/g and 418 µg/g, respectively. Lipid DDE concentrations in sea eagle eggs of 30-50 µg/g and 100-120 µg/g have been suggested as the LOECs for eggshell thickness and productivity, respectively. Complete reproductive failure has been associated with a DDE concentration of 900 µg/g lipid wt (Helander *et al.*, 2002). Adverse effects on productivity due to PCBs appear to occur at lipid concentrations of about 300 µg/g in sea eagle eggs, although, because there is a strong association between PCB and DDE residues, there is some uncertainty about whether such effects are due to PCBs or DDE (Helander *et al.*, 2002). The lipid DDE concentration in the egg collected from Mull exceeded the LOEC for eggshell thickness. The total PCB concentration in the sea eagle egg collected from Mull in 2005 was above the LOEC associated with adverse effects in sea eagles and within the range of 3.25 - 25 µg/g wet weight associated with decreased hatching success in various avian species (AMAP, 1998; Hoffman *et al.*, 1996). The PCB TEQ concentration was within the range of NOECs and LOECs for reproduction that have been reported for various avian species (see section 3.2 and (AMAP, 1998). It is not certain that PCBs were a contributory cause of reproductive failure of this egg. However, the DDE concentration in this egg exceeds those previously suggested as LOECs for egg shell thickness. The egg had an egg shell index of 2.63, while there was not any embryo development apparent.

The mercury concentration in the egg collected in 2005 is below that thought to be associated with impaired hatching in laboratory studies on some species, although the extent to which this effect level can be extrapolated to other species is uncertain as there appears to be considerable variation in sensitivity between species (Thompson, 1996).

Table 6.1: Concentrations of organochlorines insecticides and total PCBs (all in µg/g wet wt), TEQs (pg/g wet wt), mercury (µg/g dw) and the shell indices (SI) for the white-tailed sea eagle egg received in 2005. Lipid wt concentrations for organochlorines and PCBs can be calculated by multiplying the wet wt concentrations by the conversion factor (CF). Congener specific data for PCBs and TEQs are given in Tables 9.7 in the Appendix

Egg Number	Year	County	SI	CF	pp'-DDE	HEOD	Total PCB	PCB TEQ	Hg
Western Highlands									
E8746	2005	Mull	2.63	25.17	2.485	0.067	16.61	11.03	0.84

7 Second generation anticoagulant rodenticides (SGARs) in barn owls (*Tyto alba*), kestrels (*Falco tinnunculus*)

7.1 Introduction

The aim of this work is to monitor the exposure of certain predatory bird species to second-generation anticoagulant rodenticides (SGARs). The compounds of interest are difenacoum, bromadiolone, brodifacoum and flocoumafen and the species monitored are the barn owl, kestrel, and red kite. The carcasses were supplied by members of the public and included birds that had died from various causes, mainly accidents. The PBMS has monitored SGAR residues in barn owls since 1983 and the findings from barn owls analysed in previous years have been reported by Newton *et al*., (1999b, 1990b) and long-term trends were last reviewed in this report series by Shore *et al*., (2005a). This is the fifth year in which the PBMS has routinely monitored kestrels for SGARs. Kestrels have been incorporated into the scheme because a study of birds that died between 1997 and 2000 indicated that a very high proportion (24/36 individuals) of the sample) had detectable concentrations of one or more SGAR in the liver (Shore *et al.*, 2001).

The results of the analysis of the livers of 67 barn owls, 21 kestrels and one red kite that were sent in to CEH in 2005 are reported in Table 7.1 and 7.2, respectively.

7.2 Methods

Analysis of rodenticides in liver tissue was carried out using the general technique outlined by Hunter (1985), and described in previous reports and by Newton *et al*., (1990b), 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. A detailed description of the methods is given in Shore *et al*., (2003). Livers from barn owls, kestrels and kites were analysed together and in random order.

7.3 Results of analyses of birds received in 2005

All of the 67 barn owls received in 2005 had died during that year and 20 (29.9%) contained detectable levels of one or more SGAR. This proportion was similar to that (19/55 = 34.5%) for owls that were received at Monks wood in 2004. However, the proportions of birds that had detectable SGAR residues in these last two years were the two lowest since 1997. It remains unclear whether this represents a deviation from the trend reported for earlier years that suggested the increase since 1983 (when monitoring began) in the proportion of birds exposed was leveling off at about 40% (Newton *et al.*, 1999b) or whether these results are within the inter-year variation. Some of this apparent decline may also be due, in part, to the higher limits of detection for bromadiolone and brodifacoum during the analysis of the livers from 2004 and 2005 compared with previous years.

Difenacoum, bromadiolone, brodifacoum and flocoumafen occurred in 9 (13.4% of the sample), 11 (16.4%), 2 (3.0%) and none of the barn owls, respectively. The predominance of difenacoum and bromadiolone and low levels of brodifacoum and flocoumafen (both indoor use only) is consistent with findings in barn owls in previous years.

Six barn owls had residue levels considered to be in the potentially lethal range. This range has variously been described as > 0.1 µg/g wet wt (Newton *et al.*, 1998) and > 0.2 µg/g wet wt (Newton *et al.*, 1999b) 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 from such organs as the heart, lungs, liver, brain and/or subcutaneous areas) almost all had liver residues >0.1 µg/g wet wt, and, secondly, that owls that had been experimentally poisoned had residues of the range 0.2-1.72 µg/g wet wt (Newton *et al.*, 1999b). Of the barn owls that died or were assumed to have died in 2005, 6 (9.0% of the sample) had liver residues (summed values for all four SGARS that were monitored) greater than 0.1 µg/g wet wt, one of which had a liver residue >0.2 µg/g wet wt. The proportion of owls that died in 2005 that had "high" residues was somewhat lower than in recent previous years but it is possible that this may simply due to random inter-year variation. Of these, one bird, bird number 14943, showed signs of haemorrhaging at one or more sites within the body and a liver bromadiolone residue of 0.146 µg/g ww. It was equivocal whether the haemorrhaging was caused by trauma or other non-rodenticide cause and it was concluded that rodenticides may have contributed to the death. In the other five birds, either the post mortem examination did not show signs of hemorrhaging or the examination or circumstances in which the bird was found suggested a physical trauma had caused the observed haemorrhaging.

Of the 21 kestrels received in 2005, ten birds (47.6% of the sample) contained detectable concentrations of one or more SGAR; this was lower than the proportion (66.7%) in the sample of 12 kestrels that were known to have died in 2004 (Walker *et al.*, *in press*). The difference between the proportions of barn owls and kestrels received in 2005 that contained detectable liver residues of one or more SGAR (29.9% vs 47.6 %) was not statistically significant (Fisher's Exact test, $P > 0.05$) but the trend of higher frequency of detection in kestrels than barn owls was also found in birds that died in 2004 and in earlier years (Walker *et al.*, *in press*). Difenacoum and bromadiolone were detected most frequently in kestrels and both occurred in 5 birds (23.8% of the sample). Brodifacoum and flocoumafen were detected in two (9.5 %) and no birds, respectively. Two kestrels contained detectable concentrations of more than one SGAR; one had both difenacoum and bromadiolone residues while the other bird had both bromadiolone and brodifacoum residues.

Five kestrels (23.8% of the sample) had a liver SGAR residue >0.1 µg/g wet wt; three of which had residues >0.2 µg/g wet wt. Post-mortem examinations did not reveal evidence of hemorrhaging that may have been due to rodenticide poisoning three birds. Of the other two, bird 14917 showed signs of subcutaneous haemorrhaging but this bleeding may have been due to the bird having been euthanased. Bird 14631 showed signs of haemorrhaging in the skull and lungs with bruising to the musculature without any apparent physical trauma to the skeleton. In both cases it was observed that haemorrhaging was present at one or more sites within the body but it was equivocal whether these were caused by trauma or other non-rodenticide cause. Consequently it was concluded that in both cases rodenticides may have contributed to the death of this bird.

Table 7.1: Difenacoum (difen), bromadiolone (brom), flocoumafen (floc) and brodifacoum (brodif) concentrations (µg/g wet wt) in the livers of 67 male (M) and female (F) barn owls received in 2005. Juveniles are birds in first year; adults are birds older than first year.

bird no/	date	Vice-county	age	sex	difen	brom	floc	brodif
14622	Jan 2005	East Suffolk	J	F	ND	ND	ND	ND
14632	Jan 2005	East Kent	J	*	0.041	ND	ND	ND
14634	Feb 2005	East Suffolk	*	F	ND	ND	ND	ND
14636	Feb 2005	Huntingdonshire	J	M	ND	ND	ND	ND
14638	Dec 2005	Isle of Man	J	M	ND	ND	ND	ND
14646	Feb 2005	Cambridgeshire	A	F	ND	ND	ND	ND
14663	Feb 2005	North Aberdeenshire	J	M	ND	ND	ND	ND
14670	Mar 2005	West Norfolk	J	F	ND	ND	ND	ND
14685	Mar 2005	East Inverness-shire	A	F	ND	ND	ND	ND
14691	Mar 2005	North Essex	J	F	ND	ND	ND	ND
14706	Mar 2005	Cambridgeshire	J	M	ND	ND	ND	ND
14707	Mar 2005	Buckinghamshire	A	F	ND	ND	ND	0.153
14722	Jan 2005	North Devon	A	M	ND	ND	ND	ND
14760	Feb 2005	East Suffolk	J	F	ND	ND	ND	ND
14764	Jan 2005	*	J	F	ND	ND	ND	ND
14776	Jun 2005	Moray (Elgin)	J	F	ND	ND	ND	ND
14789	Jun 2005	Berkshire	J	F	ND	ND	ND	ND
14793	Jul 2005	Middlesex	J	M	ND	ND	ND	ND
14798	Jul 2005	Oxfordshire	J	M	ND	ND	ND	ND
14800	Mar 2005	South Lincolnshire	A	M	ND	0.048	ND	ND
14837	Jun 2005	Shropshire (Salop)	J	M	ND	ND	ND	ND
14858	Jul 2005	Merionethshire	J	F	ND	ND	ND	ND
14860	Aug 2005	Shropshire (Salop)	J	*	ND	ND	ND	ND
14885	Aug 2005	Buckinghamshire	A	M	ND	ND	ND	ND
14889	Sep 2005	Oxfordshire	J	F	ND	0.030	ND	ND
14891	Jul 2005	Cambridgeshire	J	*	ND	ND	ND	ND
14900	Jul 2005	Cambridgeshire	J	M	ND	ND	ND	ND
14907	Sep 2005	Anglesey	J	M	ND	ND	ND	ND
14911	Sep 2005	Anglesey	J	M	0.015	ND	ND	ND
14923	Sep 2005	North Wiltshire	J	F	ND	ND	ND	ND
14933	Oct 2005	Huntingdonshire	J	F	0.017	0.098	ND	ND
14935	Sep 2005	South Lincolnshire	*	F	ND	ND	ND	ND
14941	Mar 2005	Nottinghamshire	A	M	ND	ND	ND	ND
14943	Mar 2005	South Lincolnshire	J	M	ND	0.146	ND	ND
14948	Mar 2005	South Lincolnshire	J	M	ND	ND	ND	ND
14950	Mar 2005	South Lincolnshire	J	M	ND	ND	ND	ND

ND is not detected

Table 7.1 Continued:

bird no/	date	Vice-county	age	sex	difen	brom	floc	brodif
14957	* 2005	Merionethshire	J	F	ND	ND	ND	ND
14960	Oct 2005	West Norfolk	J	F	ND	ND	ND	ND
14962	Oct 2005	South Lincolnshire	J	M	ND	ND	ND	ND
14965	Oct 2005	South Lincolnshire	J	F	ND	0.114	ND	ND
14969	Oct 2005	South Lincolnshire	J	F	0.056	ND	ND	ND
14974	Mar 2005	South Lincolnshire	J	F	ND	0.074	ND	ND
14976	Feb 2005	North Lincolnshire	J	F	0.037	ND	ND	ND
14981	Feb 2005	West Norfolk	A	F	ND	ND	ND	ND
14985	Oct 2005	South Northumberland	J	F	ND	ND	ND	ND
14989	Sep 2005	Anglesey	J	F	ND	ND	ND	ND
14993	Nov 2005	Radnorshire	J	*	0.022	ND	ND	ND
15000	Nov 2005	Buckinghamshire	A	F	ND	ND	ND	ND
15012	Dec 2005	East Suffolk	J	M	ND	ND	ND	ND
15014	Dec 2005	South Wiltshire	J	M	ND	ND	ND	ND
15021	Dec 2005	Huntingdonshire	J	*	ND	ND	ND	0.065
15024	Dec 2005	North Hampshire	A	M	ND	ND	ND	0.060
15045	Dec 2005	Bedfordshire	A	F	ND	ND	ND	ND
15048	Dec 2005	Anglesey	J	M	0.014	ND	ND	ND
15074	Jul 2005	Dorset	J	M	ND	0.074	ND	ND
15111	Feb 2005	South Lincolnshire	J	M	ND	ND	ND	ND
15113	Nov 2005	Northamptonshire	A	F	ND	ND	ND	ND
15119	Nov 2005	South Lincolnshire	J	M	ND	0.024	ND	ND
15121	Dec 2005	*	*	F	ND	0.117	ND	ND
15123	Nov 2005	South Lincolnshire	J	M	ND	0.210	ND	ND
15196	Oct 2005	Hertfordshire	J	M	ND	ND	ND	ND
15304	May 2005	Merionethshire	A	F	ND	ND	ND	ND
15305	Jul 2005	East Cornwall	J	M	ND	ND	ND	ND
15306	Aug 2005	South Devon	A	F	0.017	ND	ND	ND
15307	Sep 2005	East Cornwall	A	F	ND	ND	ND	ND
15308	Oct 2005	West Cornwall (with Scilly)	A	F	ND	ND	ND	ND
15309	Nov 2005	West Cornwall (with Scilly)	A	M	0.013	0.035	ND	ND

ND is not detected

Table 7.2: Difenacoum (difen), bromadiolone (brom), flocoumafen (floc) and brodifacoum (brodif) concentrations (µg/g wet wt) in the livers of 21 male (M) and female (F) kestrels and one red kite received in 2005. Juveniles are bird in first year, adults are birds older than first year.

bird no/	date	Vice-county	age	sex	difen	brom	floc	brodif
Common Kestrel (*Falco tinnunculus*)								
14620	Jan 2005	Nottinghamshire	J	F	ND	ND	ND	ND
14631	Feb 2005	Oxfordshire	A	M	ND	0.106	ND	ND
14640	Feb 2005	North Lincolnshire	A	M	0.030	0.246	ND	ND
14661	Feb 2005	North Lincolnshire	J	F	ND	ND	ND	ND
14745	Jan 2005	East Kent	A	F	ND	ND	ND	ND
14782	Jun 2005	West Norfolk	A	M	ND	0.031	ND	0.060
14803	Jul 2005	East Norfolk	J	M	0.024	ND	ND	ND
14828	Jul 2005	Northamptonshire	J	*	ND	ND	ND	ND
14829	Jul 2005	Cambridgeshire	J	M	ND	ND	ND	ND
14831	Jul 2005	East Suffolk	J	*	0.469	ND	ND	ND
14835	Jul 2005	East Norfolk	J	F	ND	ND	ND	ND
14838	Jun 2005	Shropshire (Salop)	A	F	ND	ND	ND	0.093
14855	Aug 2005	West Norfolk	J	*	ND	ND	ND	ND
14913	Jul 2005	Hertfordshire	J	F	ND	ND	ND	ND
14914	Jul 2005	Cambridgeshire	J	F	ND	ND	ND	ND
14915	Jul 2005	Huntingdonshire	J	F	0.022	ND	ND	ND
14916	Jul 2005	Cambridgeshire	J	F	0.031	ND	ND	ND
14917	Aug 2005	North Essex	J	M	ND	0.192	ND	ND
14931	Sep 2005	East Suffolk	J	F	ND	ND	ND	ND
14932	Oct 2005	East Suffolk	J	F	ND	ND	ND	ND
14986	Oct 2005	South Hampshire	J	F	ND	0.366	ND	ND
Red Kite (*Milvus milvus*)								
14929	Oct 2005	Berkshire	A	*	ND	0.197	ND	ND

ND is not detected

8 References

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9 Appendix

In the following tables, PCB congeners are identified using the nomenclature of Ballschmiter & Zell, (1980) and the Toxic Equivalency Factors (TEFs) are from Ahlborg *et al*., (1994) and Van de Berg *et al*., (1998). Toxic Equivalent (TEQ) concentrations for individual congeners are calculated as the product of the congener concentration and the congener-specific TEF value. Non-detected values for specific congeners are assigned a concentration value of zero when calculating the TEQ; sum TEQ concentrations are the sum of the congener specific concentrations. Lipid wt concentrations for PCB congeners and TEQs can be calculated by multiplying the wet wt concentrations by the conversion factor (CF).

Table 9.1: Congener specific TEFs and PCB congener concentrations (µg/g wet wt) in the livers of sparrowhawks and herons received in 2005

	TEF	Liver PCB congener concentration in birds											
		14613	**14615**	**14618**	**14623**	**14625**	**14628**	**14666**	**14679**	**14682**	**14686**	**14693**	**14697**
CF		31.07	15.92	15.93	29.42	32.19	30.04	22.27	38.50	39.53	27.59	22.60	22.56
8		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52		0.009	ND	ND	ND	0.014	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
101		0.030	0.067	0.073	0.030	0.708	0.082	0.627	0.033	0.009	ND	0.011	0.006
105	0.0001	ND	0.020	ND	0.018	0.018	0.026	0.017	ND	ND	ND	ND	0.006
114	0.0001	ND	ND	ND	ND	ND	ND	0.129	ND	ND	ND	ND	ND
118	0.00001	0.044	0.107	0.035	0.087	0.104	0.147	0.112	0.040	0.028	0.009	0.010	0.023
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
128		0.020	0.051	0.023	0.030	0.049	0.071	0.060	0.021	0.009	ND	0.007	0.008
138		0.086	0.224	0.110	0.135	0.183	0.350	0.278	0.089	0.049	0.021	0.027	0.035
141		ND	0.016	ND	ND	0.009	0.012	0.021	0.006	ND	ND	ND	ND
149		ND	0.016	ND	ND	0.012	0.022	0.024	0.017	ND	ND	ND	ND
153		0.208	0.558	0.174	0.436	0.516	0.914	0.651	0.252	0.100	0.057	0.063	0.052
156	0.0001	0.029	0.100	0.023	0.078	0.078	0.153	0.109	0.032	0.011	0.008	0.009	0.006
157	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
163		0.047	0.162	0.046	0.095	0.121	0.211	0.183	0.089	ND	0.015	0.023	0.023
167	0.00001	ND	0.030	ND	0.023	0.016	0.045	0.019	0.008	ND	ND	ND	ND
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
170		0.052	0.156	0.030	0.117	0.127	0.229	0.174	0.053	0.019	0.014	0.012	0.009
171		ND	0.032	ND	0.020	0.024	0.040	0.029	0.009	ND	ND	ND	ND
180		0.157	0.614	0.086	0.395	0.461	0.840	0.608	0.154	0.068	0.040	0.037	0.026
183		0.030	0.092	0.020	0.064	0.083	0.132	0.099	0.031	0.015	0.010	0.012	0.008
187		0.136	0.606	0.082	0.284	0.528	0.645	0.656	0.244	0.097	0.064	0.073	0.048
189	0.00001	ND	0.018	ND	0.014	0.014	0.028	ND	ND	ND	ND	ND	ND
194		0.035	0.132	0.013	0.079	0.111	0.171	0.109	0.036	0.013	ND	0.016	ND
199		0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.012	ND
201		0.043	0.204	0.021	0.082	0.179	0.213	0.191	0.065	0.024	0.014	0.019	0.010
205		ND	ND	ND	ND	ND	ND	0.007	ND	ND	ND	ND	ND
206		ND	0.039	ND	0.017	0.050	0.055	0.045	0.013	ND	ND	ND	ND
209		ND	0.024	ND	0.014	0.021	0.050	0.040	0.009	ND	ND	ND	ND
Sum		0.937	3.268	0.737	2.018	3.426	4.436	4.186	1.201	0.444	0.251	0.332	0.261

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.1 cont:

	TEF	Liver PCB congener concentration in birds											
		14704	**14762**	**14830**	**14842**	**14846**	**14848**	**14850**	**14868**	**14872**	**14876**	**14879**	**14893**
CF		25.62	34.54	9.96	32.56	10.45	35.44	19.31	29.73	27.46	34.86	22.83	26.24
8		ND	ND	0.004	ND	ND	ND	ND	ND	ND	ND	ND	ND
18		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
101		0.025	0.160	ND	1.351	0.020	0.055	ND	ND	ND	ND	0.007	0.058
105	0.0001	ND	0.011	0.020	0.119	0.015	0.031	ND	ND	ND	ND	ND	0.089
114	0.0001	ND	ND	ND	ND	ND	0.186	ND	ND	ND	ND	ND	ND
118	0.00001	0.035	0.113	0.102	0.447	0.081	0.163	ND	0.005	0.006	0.007	0.021	0.296
123	0.00001	ND	ND	ND	ND	ND	0.009	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
128		0.017	0.096	0.025	0.171	0.036	0.085	ND	ND	ND	ND	0.011	0.069
138		0.073	0.625	0.180	0.778	0.178	0.377	ND	0.010	0.011	0.014	0.038	0.350
141		ND	ND	ND	0.076	ND	0.011	ND	ND	ND	ND	ND	ND
149		0.011	0.017	ND	0.071	0.009	0.025	ND	ND	ND	ND	ND	ND
153		0.151	1.559	0.357	1.515	0.446	0.955	0.007	0.025	0.026	0.036	0.099	0.521
156	0.0001	0.024	0.194	0.036	0.349	0.109	0.220	ND	ND	ND	ND	0.028	0.058
157	0.0001	ND	ND	ND	0.018	0.007	ND	ND	ND	ND	ND	ND	0.008
163		0.063	0.303	0.052	0.398	ND	0.302	ND	0.010	ND	0.007	0.031	0.115
167	0.00001	ND	0.022	0.015	0.083	0.029	0.058	ND	ND	ND	ND	ND	0.021
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
170		0.031	0.338	0.070	0.495	0.155	0.302	ND	ND	ND	ND	0.032	0.075
171		ND	0.061	0.019	0.076	0.023	0.053	ND	ND	ND	ND	ND	0.024
180		0.110	1.276	0.186	2.165	0.569	1.306	ND	0.018	0.019	0.020	0.078	0.231
183		0.020	0.199	0.046	0.290	0.073	0.166	ND	ND	ND	ND	0.017	0.065
187		0.167	1.070	0.090	1.627	0.531	1.244	ND	0.033	0.017	0.020	0.115	0.163
189	0.00001	ND	0.040	ND	0.045	0.017	0.037	ND	ND	ND	ND	ND	ND
194		0.019	0.227	0.022	0.556	0.268	0.299	ND	ND	ND	ND	0.024	0.035
199		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
201		0.040	0.313	0.023	0.659	0.209	0.404	ND	0.009	ND	ND	0.040	0.051
205		ND	0.011	ND	0.022	0.007	0.014	ND	ND	ND	ND	ND	ND
206		ND	0.071	ND	0.147	0.040	0.079	ND	ND	ND	ND	0.008	0.014
209		ND	0.067	ND	0.048	0.015	0.036	ND	ND	ND	ND	ND	ND
Sum		0.786	6.772	1.256	11.51	2.837	6.416	0.007	0.111	0.079	0.104	0.549	2.244

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.1 cont:

	TEF	Liver PCB congener concentration in birds											
		14903	14905	14919	14926	14947	14953	14955	14961	14970	14991	14995	15321
CF		47.10	31.80	32.18	39.14	38.14	32.12	31.33	43.37	30.98	26.59	34.13	40.49
8		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
101		0.048	0.047	0.104	ND	ND	ND	0.018	0.022	ND	0.009	0.013	ND
105	0.0001	ND	ND	0.137	ND	ND	ND	ND	ND	ND	ND	ND	ND
114	0.0001	0.034	ND	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND
118	0.00001	0.038	0.039	0.402	ND	ND	0.009	0.014	0.021	0.012	0.017	ND	ND
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
128		0.017	0.021	0.149	ND	ND	ND	0.007	0.009	ND	0.007	ND	ND
138		0.071	0.086	0.547	ND	ND	0.015	0.024	0.038	ND	0.032	ND	ND
141		ND	ND	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND
149		ND	ND	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND
153		0.198	0.200	0.605	0.011	0.007	0.034	0.044	0.100	0.024	0.059	0.014	0.010
156	0.0001	0.031	0.032	0.145	ND	ND	ND	0.008	ND	ND	0.009	ND	ND
157	0.0001	ND	ND	0.023	ND	ND	ND	ND	ND	ND	ND	ND	ND
163		0.044	0.065	0.153	ND	ND	ND	0.012	0.023	ND	0.011	ND	ND
167	0.00001	0.008	ND	0.047	ND	ND	ND	ND	ND	ND	ND	ND	ND
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
170		0.042	0.048	0.134	ND	ND	0.009	0.012	0.021	ND	0.014	ND	ND
171		ND	ND	0.029	ND	ND	ND	ND	ND	ND	ND	ND	ND
180		0.152	0.163	0.299	ND	ND	0.030	0.029	0.079	0.014	0.044	0.010	0.007
183		0.025	0.033	0.068	ND	ND	ND	ND	ND	ND	0.010	ND	ND
187		0.132	0.189	0.212	0.010	ND	0.027	0.053	0.094	0.011	0.028	0.009	0.007
189	0.00001	ND	ND	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND
194		0.031	0.037	0.056	ND	ND	ND	0.007	0.022	ND	0.008	ND	ND
199		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
201		0.047	0.056	0.071	ND	ND	0.010	0.017	0.035	ND	0.009	ND	ND
205		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
206		0.009	0.013	0.022	ND	ND	ND	ND	ND	ND	ND	ND	ND
209		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum		0.927	1.027	3.253	0.021	0.007	0.133	0.243	0.464	0.061	0.268	0.046	0.024

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.2: Congener specific and sum TEQ concentrations (pg/g wet wt) in the livers of sparrowhawks and herons received in 2005

	TEQ concentration in livers of birds											
	14613	**14615**	**14618**	**14623**	**14625**	**14628**	**14666**	**14679**	**14682**	**14686**	**14693**	**14697**
CF	31.07	15.92	15.93	29.42	32.19	30.04	22.27	38.50	39.53	27.59	22.60	22.56
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
105	ND	2.043	ND	1.751	1.825	2.639	1.712	ND	ND	ND	ND	0.584
114	ND	ND	ND	ND	ND	ND	12.88	ND	ND	ND	ND	ND
118	0.436	1.070	0.351	0.874	1.038	1.474	1.120	0.399	0.280	0.094	0.101	0.230
123	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
156	2.928	10.03	2.298	7.801	7.810	15.27	10.94	3.222	1.116	0.777	0.924	0.617
157	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
167	ND	0.299	ND	0.226	0.156	0.451	0.187	0.077	ND	ND	ND	ND
169	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	0.178	ND	0.144	0.142	0.279	ND	ND	ND	ND	ND	ND
Sum	3.364	13.62	2.649	10.80	10.97	20.11	26.84	3.698	1.396	0.870	1.024	1.432

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.2: continued

	TEQ concentration in livers of birds											
	14704	**14762**	**14830**	**14842**	**14846**	**14848**	**14850**	**14868**	**14872**	**14876**	**14879**	**14893**
CF	25.62	34.54	9.96	32.56	10.45	35.44	19.31	29.73	27.46	34.86	22.83	26.24
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
105	ND	1.097	2.017	11.92	1.454	3.075	ND	ND	ND	ND	ND	8.886
114	ND	ND	ND	ND	ND	18.58	ND	ND	ND	ND	ND	ND
118	0.346	1.125	1.016	4.467	0.806	1.635	ND	0.047	0.060	0.068	0.206	2.961
123	ND	ND	ND	ND	ND	0.088	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
156	2.426	19.36	3.642	34.92	10.95	22.01	ND	ND	ND	ND	2.773	5.833
157	ND	ND	ND	1.754	0.735	ND	ND	ND	ND	ND	ND	0.755
167	ND	0.222	0.145	0.828	0.294	0.583	ND	ND	ND	ND	ND	0.213
169	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	0.402	ND	0.453	0.167	0.371	ND	ND	ND	ND	ND	ND
Sum	2.771	22.21	6.820	54.34	14.41	46.34	ND	0.047	0.060	0.068	2.979	18.65

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.2: continued

	TEQ concentration in livers of birds											
	14903	**14905**	**14919**	**14926**	**14947**	**14953**	**14955**	**14961**	**14970**	**14991**	**14995**	**15321**
CF	47.10	31.80	32.18	39.14	38.14	32.12	31.33	43.37	30.98	26.59	34.13	40.49
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
105	ND	ND	13.75	ND	ND	ND	ND	ND	ND	ND	ND	ND
114	3.351	ND	ND	ND	ND	ND	ND	ND	ND	1.075	ND	ND
118	0.383	0.394	4.015	ND	ND	0.088	0.141	0.208	0.117	0.169	ND	ND
123	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
156	3.087	3.203	14.54	ND	ND	ND	0.754	ND	ND	0.897	ND	ND
157	ND	ND	2.310	ND	ND	ND	ND	ND	ND	ND	ND	ND
167	0.080	ND	0.471	ND	ND	ND	ND	ND	ND	ND	ND	ND
169	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	ND	0.105	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum	6.901	3.597	35.19	ND	ND	0.088	0.895	0.208	0.117	2.141	ND	ND

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.3: Congener specific TEFs and PCB congener concentrations (µg/g wet wt) for merlin eggs received in 2005

	TEF	Liver PCB congener concentrations in merlin eggs									
		E8611	**E8629**	**E8666**	**E8669**	**E8670**	**E8681**	**E8704**	**E8705**	**E8714**	**E8716**
CF		10.80	18.30	12.23	21.19	19.62	16.06	15.72	16.59	23.13	22.07
8		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
101		ND	ND	ND	ND	ND	0.006	ND	0.013	ND	ND
105	0.0001	0.011	ND	0.014	0.006	0.009	0.010	0.010	0.013	0.009	0.006
114	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
118	0.00001	0.052	ND	0.071	0.027	0.039	0.043	0.053	0.052	0.045	0.025
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
128		0.015	ND	0.017	0.006	0.009	0.010	0.010	0.012	0.009	0.005
138		0.066	ND	0.099	0.033	0.052	0.050	0.056	0.067	0.057	0.030
141		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
149		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
153		0.220	0.109	0.344	0.097	0.155	0.160	0.179	0.198	0.178	0.086
156	0.0001	0.032	ND	0.048	0.014	0.025	0.021	0.034	0.025	0.024	0.015
157	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
163		0.037	ND	0.059	0.015	0.026	0.031	0.072	ND	0.023	0.017
167	0.00001	0.014	ND	0.021	ND	0.010	0.009	0.011	0.011	0.011	0.006
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
170		0.047	ND	0.075	0.021	0.037	0.030	0.041	0.033	0.034	0.022
171		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
180		0.150	0.050	0.227	0.070	0.102	0.090	0.083	0.096	0.103	0.060
183		0.023	ND	0.039	0.011	0.018	0.017	0.024	0.020	0.018	0.012
187		0.075	ND	0.155	0.038	0.062	0.071	0.168	0.057	0.049	0.038
189	0.00001	0.007	ND	ND	ND	ND	ND	ND	ND	ND	ND
194		0.044	ND	0.093	0.024	0.033	0.027	0.034	0.023	0.031	0.028
199		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
201		0.034	ND	0.072	0.019	0.027	0.025	0.045	0.019	0.023	0.017
205		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
206		0.014	ND	0.036	0.008	0.009	0.009	0.010	ND	0.008	0.007
209		0.012	ND	0.025	0.008	ND	0.009	ND	ND	ND	0.007
Sum		0.852	0.159	1.396	0.397	0.615	0.621	0.831	0.638	0.624	0.381

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.3: continued

	TEF	Liver PCB congener concentrations in merlin eggs									
		E8717	**E8718**	**E8719**	**E8720**	**E8722**	**E8723**	**E8726**	**E8727**	**E8783**	**E8790**
CF		16.10	18.77	16.33	15.79	20.75	15.28	13.86	5.72	14.47	14.54
8		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.016
18		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.018
29		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.163
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
101		ND	0.007	ND	ND	ND	ND	ND	0.014	0.012	0.008
105	0.0001	0.008	0.016	0.007	0.007	ND	0.012	0.010	0.038	0.008	0.017
114	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
118	0.00001	0.039	0.064	0.044	0.036	0.018	0.057	0.047	0.148	0.041	0.072
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
128		0.010	0.015	0.014	0.010	ND	0.015	0.013	0.033	0.008	0.017
138		0.049	0.073	0.090	0.054	0.025	ND	0.064	0.192	0.043	0.089
141		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
149		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
153		0.141	0.184	0.237	0.154	0.067	0.000	0.202	0.582	0.148	0.271
156	0.0001	0.022	0.029	0.028	0.020	0.008	0.029	0.027	0.084	0.023	0.047
157	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
163		0.046	0.039	0.026	0.034	0.010	0.036	0.043	0.079	0.019	0.052
167	0.00001	0.008	0.012	0.012	ND	ND	0.012	0.008	0.035	0.010	0.019
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
170		0.028	0.034	0.051	0.030	0.012	0.041	0.041	0.118	0.030	0.070
171		ND	ND	0.009	ND	ND	ND	0.008	0.018	ND	0.011
180		0.089	0.103	0.138	0.105	0.035	0.115	0.146	0.378	0.071	0.204
183		0.018	0.020	0.027	0.021	0.007	0.022	0.029	0.064	0.014	0.036
187		0.110	0.079	0.056	0.119	0.026	0.072	0.161	0.185	0.035	0.146
189	0.00001	ND	ND	ND	ND	ND	ND	ND	0.017	ND	0.009
194		0.028	0.028	0.029	0.026	0.008	0.035	0.040	0.108	0.022	0.058
199		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
201		0.033	0.028	0.021	0.038	0.009	0.030	0.055	0.089	0.016	0.057
205		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
206		0.010	0.009	0.008	0.009	ND	0.012	0.013	0.028	ND	0.015
209		ND	0.008	ND	ND	ND	0.012	0.012	0.012	ND	ND
Sum		0.639	0.748	0.797	0.665	0.225	0.501	0.920	2.222	0.500	1.395

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.4: Congener specific and sum TEQ concentrations (pg/g wet wt) for merlin eggs received in 2005

	TEQ concentrations in merlin eggs									
	E8611	**E8629**	**E8666**	**E8669**	**E8670**	**E8681**	**E8704**	**E8705**	**E8714**	**E8716**
CF	10.80	18.30	12.23	21.19	19.62	16.06	15.72	16.59	23.13	22.07
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
105	1.064	ND	1.412	0.642	0.890	1.017	1.014	1.264	0.923	0.574
114	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
118	0.521	ND	0.711	0.266	0.389	0.430	0.534	0.519	0.453	0.254
123	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
156	3.181	ND	4.790	1.383	2.496	2.099	3.383	2.464	2.368	1.472
157	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
167	0.138	ND	0.207	ND	0.103	0.092	0.114	0.108	0.111	0.058
169	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
189	0.074	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum	4.978	ND	7.120	2.291	3.877	3.639	5.045	4.354	3.855	2.358

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.4: continued

	TEQ concentrations in merlin eggs									
	E8717	**E8718**	**E8719**	**E8720**	**E8722**	**E8723**	**E8726**	**E8727**	**E8783**	**E8790**
CF	16.10	18.77	16.33	15.79	20.75	15.28	13.86	5.72	14.47	14.54
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
105	0.824	1.639	0.696	0.743	ND	1.240	0.972	3.844	0.792	1.707
114	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
118	0.394	0.641	0.436	0.365	0.180	0.567	0.471	1.478	0.408	0.721
123	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
156	2.170	2.868	2.822	2.027	0.823	2.945	2.710	8.429	2.279	4.742
157	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
167	0.077	0.120	0.120	ND	ND	0.123	0.082	0.349	0.104	0.189
169	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	ND	ND	ND	ND	ND	ND	0.175	ND	0.090
Sum	3.465	5.268	4.075	3.135	1.003	4.874	4.235	14.274	3.583	7.450

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.5: Congener specific TEFs and PCB congener concentrations (µg/g wet wt) for golden eagle eggs received in 2005

	TEF	Liver PCB congener concentration in golden eagle eggs							
		E8622	**E8626**	**E8628**	**E8630**	**E8632**	**E8645**	**E8647**	**E8649**
CF		20.49	17.66	37.86	29.68	19.57	32.05	17.46	17.49
8		ND	ND	ND	ND	ND	ND	ND	0.004
18		ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND
101		ND	ND	0.008	0.012	ND	0.006	ND	0.011
105	0.0001	ND	ND	0.005	ND	ND	ND	ND	ND
114	0.0001	ND	ND	ND	ND	ND	ND	ND	ND
118	0.00001	ND	ND	0.030	0.016	0.009	0.024	0.009	0.011
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND
128		ND	ND	0.009	0.006	ND	0.006	ND	ND
138		ND	ND	0.046	0.037	0.017	0.029	0.013	0.030
141		ND	ND	ND	ND	ND	ND	ND	ND
149		ND	ND	ND	ND	ND	ND	ND	ND
153		0.003	ND	0.144	0.096	0.042	0.154	0.045	0.117
156	0.0001	ND	ND	0.012	0.007	ND	0.021	ND	ND
157	0.0001	ND	ND	ND	ND	ND	ND	ND	ND
163		ND	ND	0.007	0.011	ND	ND	ND	0.010
167	0.00001	ND	ND	0.007	ND	ND	0.021	ND	ND
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND
170		ND	ND	0.029	0.016	0.006	0.040	0.010	0.024
171		ND	ND	ND	ND	ND	ND	ND	ND
180		ND	0.008	0.111	0.054	0.019	0.282	0.053	0.075
183		ND	ND	0.018	0.010	ND	0.024	ND	0.011
187		ND	ND	0.025	0.022	0.008	0.019	0.014	0.013
189	0.00001	ND	ND	ND	ND	ND	0.006	ND	ND
194		ND	ND	0.018	0.010	ND	0.061	0.013	0.016
199		ND	ND	ND	ND	ND	ND	ND	ND
201		ND	ND	ND	ND	ND	0.008	ND	ND
205		ND	ND	ND	ND	ND	ND	ND	ND
206		ND	ND	ND	ND	ND	ND	ND	ND
209		ND	ND	ND	ND	ND	ND	ND	ND
Sum		0.003	0.008	0.469	0.298	0.101	0.700	0.157	0.322

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.5: continued

	TEF	Liver PCB congener concentration in golden eagle eggs							
		E8622	**E8626**	**E8628**	**E8630**	**E8632**	**E8645**	**E8647**	**E8649**
CF		20.49	17.66	37.86	29.68	19.57	32.05	17.46	17.49
8		ND	ND	ND	ND	ND	ND	ND	0.004
18		ND	ND	ND	ND	ND	ND	ND	ND
28		ND	ND	ND	ND	ND	ND	ND	ND
29		ND	ND	ND	ND	ND	ND	ND	ND
31		ND	ND	ND	ND	ND	ND	ND	ND
52		ND	ND	ND	ND	ND	ND	ND	ND
77	0.05	ND	ND	ND	ND	ND	ND	ND	ND
101		ND	ND	0.008	0.012	ND	0.006	ND	0.011
105	0.0001	ND	ND	0.005	ND	ND	ND	ND	ND
114	0.0001	ND	ND	ND	ND	ND	ND	ND	ND
118	0.00001	ND	ND	0.030	0.016	0.009	0.024	0.009	0.011
123	0.00001	ND	ND	ND	ND	ND	ND	ND	ND
126	0.1	ND	ND	ND	ND	ND	ND	ND	ND
128		ND	ND	0.009	0.006	ND	0.006	ND	ND
138		ND	ND	0.046	0.037	0.017	0.029	0.013	0.030
141		ND	ND	ND	ND	ND	ND	ND	ND
149		ND	ND	ND	ND	ND	ND	ND	ND
153		0.003	ND	0.144	0.096	0.042	0.154	0.045	0.117
156	0.0001	ND	ND	0.012	0.007	ND	0.021	ND	ND
157	0.0001	ND	ND	ND	ND	ND	ND	ND	ND
163		ND	ND	0.007	0.011	ND	ND	ND	0.010
167	0.00001	ND	ND	0.007	ND	ND	0.021	ND	ND
169	0.001	ND	ND	ND	ND	ND	ND	ND	ND
170		ND	ND	0.029	0.016	0.006	0.040	0.010	0.024
171		ND	ND	ND	ND	ND	ND	ND	ND
180		ND	0.008	0.111	0.054	0.019	0.282	0.053	0.075
183		ND	ND	0.018	0.010	ND	0.024	ND	0.011
187		ND	ND	0.025	0.022	0.008	0.019	0.014	0.013
189	0.00001	ND	ND	ND	ND	ND	0.006	ND	ND
194		ND	ND	0.018	0.010	ND	0.061	0.013	0.016
199		ND	ND	ND	ND	ND	ND	ND	ND
201		ND	ND	ND	ND	ND	0.008	ND	ND
205		ND	ND	ND	ND	ND	ND	ND	ND
206		ND	ND	ND	ND	ND	ND	ND	ND
209		ND	ND	ND	ND	ND	ND	ND	ND
Sum		0.003	0.008	0.469	0.298	0.101	0.700	0.157	0.322

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.6: Congener specific and sum TEQ concentrations (pg/g wet wt) for golden eagle eggs received in 2005

	TEQ concentration in golden eagle eggs							
	E8622	**E8626**	**E8628**	**E8630**	**E8632**	**E8645**	**E8647**	**E8649**
CF	20.49	17.66	37.86	29.68	19.57	32.05	17.46	17.49
77	ND	ND	ND	ND	ND	ND	ND	ND
105	ND	ND	0.543	ND	ND	ND	ND	ND
114	ND	ND	ND	ND	ND	ND	ND	ND
118	ND	ND	0.302	0.163	0.088	0.238	0.091	0.112
123	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	ND	ND
156	ND	ND	1.160	0.742	ND	2.085	ND	ND
157	ND	ND	ND	ND	ND	ND	ND	ND
167	ND	ND	0.068	ND	ND	0.206	ND	ND
169	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	ND	ND	ND	ND	0.064	ND	ND
Sum	ND	ND	2.074	0.905	0.088	2.594	0.091	0.112

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.6: continued

	TEQ concentration in golden eagle eggs							
	E8747	**E8749**	**E8750**	**E8751**	**E8752**	**E8761**	**E8762**	**E8764**
CF	24.23	23.65	23.79	23.66	28.59	22.68	26.27	26.08
77	ND	ND	ND	ND	ND	ND	ND	ND
105	ND	ND	ND	ND	ND	ND	16.16	ND
114	ND	ND	ND	ND	ND	ND	ND	ND
118	ND	0.055	ND	0.076	ND	0.267	7.970	0.075
123	ND	ND	ND	ND	ND	ND	ND	ND
126	ND	ND	ND	ND	ND	ND	8121	ND
156	ND	ND	ND	ND	ND	1.740	33.94	ND
157	ND	ND	ND	ND	ND	ND	2.795	ND
167	ND	ND	ND	ND	ND	0.082	1.890	ND
169	ND	ND	ND	ND	ND	ND	ND	ND
189	ND	ND	ND	ND	ND	ND	0.685	ND
Sum	ND	0.055	ND	0.076	ND	2.090	8185	0.075

ND is not detected. CF is conversion factor needed to convert from wet wt to lipid wt concentrations

Table 9.7: Congener specific and sum PCB and TEQ wet wt concentrations for the sea eagle egg received in 2005

	TEF	PCB concentration (µg/g wet wt)	TEQ concentration (pg/g wet wt)
CF		25.17	25.17
8		ND	
18		ND	
28		ND	
29		ND	
31		ND	
52		ND	
77	0.05	ND	ND
101		0.071	
105	0.0001	0.067	6.652
114	0.0001	ND	ND
118	0.00001	0.320	3.201
123	0.00001	ND	ND
126	0.1	ND	ND
128		0.117	
138		0.652	
141		ND	
149		0.009	
153		1.924	
156	0.0001	ND	ND
157	0.0001	ND	ND
163		0.068	
167	0.00001	0.083	0.831
169	0.001	ND	ND
170		0.480	
171		0.054	
180		1.852	
183		ND	
187		0.232	
189	0.00001	0.034	0.344
194		0.310	
199		ND	
201		0.050	
205		0.010	
206		0.056	
209		0.015	
Congener Sum		6.402	11.029