Institute of Terrestrial Ecology

1992/93

WILDLIFE ~~BIRDS~~ AND POLLUTION

Natural Environment Research Council

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- improving productivity in forestry
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INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT T07061f5

Annual report to the Joint Nature Conservation Committee

BIRDS AND POLLUTION

Part 1 Organochlorines and mercury in predatory birds, 1992

2 Organochlorines and mercury in peregrine eggs, 1992

3 Organochlorines and mercury in merlin eggs, 1992

4 Organochlorines and mercury in golden eagle eggs, 1992

5 Organochlorines and mercury in gannet eggs, 1992

6 Rodenticides in barn owls

7 Incidents investigated during 1992-93

I Newton, A Asher, P Freestone, M C French,
H Malcolm, D Osborn, J Wright, C Wyatt & I Wyllie

Monks Wood
Abbots Ripton
Huntingdon
Cambs PE17 2LS

July 1993

C O N T E N T S

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1 ORGANOCHLORINES AND MERCURY IN PREDATORY BIRDS, 1992

1.1 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 main species involved included the sparrowhawk and kestrel, representing the terrestrial environment, and the fish-eating heron, kingfisher and great-crested grebe, representing the aquatic environment. The findings from various other species received during the year are also included. Earlier results from the programme were summarised by Newton *et al* (1993), and in previous reports in this series.

1.2 Results

During the past year, the livers from 221 birds were analysed, including those from 50 kestrels, 113 sparrowhawks, 12 herons, 7 kingfishers, 3 great-crested grebes and 28 others. These totals included some birds which had died in earlier years, but which were analysed in 1992. The results for each chemical from the main species (1992 specimens only) are given in Table 1, and the geometric mean levels in Table 2.

The birds received in 1992 contained many with surprisingly high levels of contaminants, well above the usual levels for their species. Such birds included a kestrel from Orkney with 67 ppm PCB and another from South Uist with 16 ppm mercury; six sparrowhawks with more than 15 ppm DDE; 14 sparrowhawks with more than 20 ppm PCB (including values of 75 and 88 from Greater London); four sparrowhawks with more than 10 ppm mercury (including a record 21 ppm in a Norfolk bird); a merlin from Cleveland with 21 ppm PCB and another from Stirling with 10 ppm mercury; a long-eared owl from Shetland (presumably a migrant) with 13 ppm DDE and 32 ppm PCB; and a Kingfisher from Strathclyde with 18 ppm DDE. Four herons and two bitterns also contained more than 10 ppm mercury, but high mercury levels are not unusual in these species.

Two significant differences in geometric mean values were found between the 1992 and 1991 results, out of 20 comparisons (Table 3). These involved increases in the levels of HEOD and PCBs in sparrowhawks. It is impossible to say whether these differences reflected real changes in exposure.

1.3 Reference

NEWTON, I., WYLLIE, I. & ASHER, A. 1993. Long-term trends in organochlorine and mercury residues in some predatory birds in Britain. Environ. Pollut. 79: 143-51.

Table 1. Levels of organochlorines (ppm in wet weight) and mercury (ppm in dry weight) in the livers of predatory birds analysed between April 1992 and March 1993.

ND=none detected.

Spec. no.	Date found	County	Age	Sex	DDE	HEOD	PCB	Hg
Kestrel (<u>Falco tinnunculus</u>)								
10934	Apr 91	Highland	A	M	0.09	0.19	0.68	1.21
10713	Sep 91	Grampian	J	F	0.23	0.25	1.62	0.94
10714	Sep 91	Grampian	J	F	0.21	0.41	0.80	0.54
10646	Jan 92	Argyll	J	M	0.41	0.07	2.75	1.39
10648	Jan 92	E. Sussex	J	F	0.03	0.02	0.44	1.34
10649	Jan 92	Central	J	F	0.10	0.10	1.27	1.85
10659	Jan 92	Glos	J	F	0.12	0.39	2.28	0.74
10664	Jan 92	Powys	J	F	0.03	0.14	1.10	1.14
10681	Jan 92	S. Devon	J	F	0.23	0.35	2.37	0.71
10706	Feb 92	Norfolk	J	F	0.51	0.36	6.92	0.73
10711	Feb 92	Cornwall	J	M	0.08	0.13	0.78	0.50
10719	Feb 92	Central	A	M	0.08	0.13	1.30	1.20
10745	Mar 92	Warks	A	M	0.03	0.42	0.87	0.22
10756	Mar 92	Herts	A	F	0.25	0.13	2.29	0.95
10784	Apr 92	S'Clyde	J	M	0.03	0.07	0.37	0.24
10800	May 92	London	A	M	0.12	0.12	5.44	0.30
10810	Jun 92	Humberside	A	M	1.70	1.10	3.30	1.63
10820	Jul 92	Lincs	J	M	2.37	0.68	0.50	2.22
10829	Jul 92	Gwynedd	J	F	0.06	0.29	0.15	0.91
10916	Jul 92	Orkney	J	F	0.07	0.25	1.68	5.78
10917	Jul 92	Orkney	J	F	0.19	0.06	7.26	2.19
10841	Aug 92	Gwent	.	.	0.04	0.07	0.30	0.58
10843	Aug 92	Northants	J	M	0.01	0.15	0.13	0.34
10846	Aug 92	Suffolk	J	F	0.19	0.47	0.45	1.37
10851	Aug 92	Clwyd	J	F	0.07	0.14	0.74	3.94
10870	Aug 92	Worcs	.	.	0.03	0.31	0.88	0.61
10871	Aug 92	Worcs	.	.	0.13	ND	0.58	0.25
10880	Aug 92	Wilts	A	F	0.07	0.13	1.34	0.23
10881	Aug 92	Wilts	J	F	0.10	0.31	1.24	0.35
10891	Sep 92	Lincs	J	F	0.40	0.13	3.93	1.14
10913	Sep 92	Berks	J	M	0.05	0.26	0.32	0.51
10914	Sep 92	Essex	J	F	0.08	0.25	0.44	0.46
10923	Sep 92	Grampian	J	M	0.06	0.16	0.19	1.40
10924	Sep 92	Worcs	A	F	0.06	0.12	0.06	ND
10935	Sep 92	Sutherland	A	F	0.03	0.06	0.28	1.60
10941	Oct 92	Leics	J	M	0.08	0.25	0.60	0.94
10943	Oct 92	S'Clyde	J	F	0.02	0.09	0.45	0.72
10944	Oct 92	Orkney	J	F	0.05	0.21	1.18	7.10
10953	Oct 92	Cornwall	J	F	0.29	0.08	2.07	0.93
10973	Nov 92	S'Clyde	J	M	0.01	0.11	0.75	0.92
10981	Nov 92	Somerset	J	F	0.002	0.05	0.10	0.20

10982	Nov 92	S'Clyde	A	F	0.01	0.14	0.24	1.42
10994	Dec 92	N. Yorks	J	M	0.10	0.11	3.51	2.02
10995	Dec 92	Camarthen	J	F	0.32	0.20	2.54	ND
10996	Dec 92	Devon	A	F	0.01	0.05	0.13	0.25
11000	Dec 92	S'Clyde	J	F	0.06	0.05	0.64	0.81
11002	Dec 92	Cambs	J	M	0.12	0.20	0.75	1.01
11006	Dec 92	S. Uist	J	F	0.17	0.10	3.57	15.82
11008	Dec 92	Wilts	J	M	0.01	0.08	0.79	1.12
11065	Dec 92	Orkney	A	F	2.41	0.22	3.84	9.73

Sparrowhawk (Accipiter nisus)

10926	Jun 91	Cumbria	A	F	0.20	0.05	0.82	2.36
10725	Oct 91	Dorset	J	M	4.18	0.36	6.53	3.89
10900	Oct 91	Highland	A	M	1.16	0.23	0.75	ND
10645	Jan 92	Humberside	A	M	1.84	0.24	2.35	0.72
10655	Jan 92	W. Glam.	A	M	0.52	0.09	2.74	3.97
10657	Jan 92	Cambs	J	M	0.39	0.08	0.63	0.68
10660	Jan 92	S. Humber.	A	M	6.45	0.56	15.93	0.78
10661	Jan 92	S. Devon	J	M	0.13	0.05	0.56	5.41
10662	Jan 92	Northants	A	F	6.51	0.53	8.17	ND
10663	Jan 92	Notts	J	F	0.40	0.17	0.84	1.18
10668	Jan 92	W. Midlands	J	F	4.06	0.47	0.79	1.33
10669	Jan 92	Devon	A	F	0.96	0.25	1.56	1.51
10692	Feb 92	Hereford	A	M	0.32	0.16	2.81	1.73
10693	Feb 92	Glos	A	F	0.15	0.08	0.51	0.74
10698	Feb 92	Inverness	J	F	0.72	0.18	0.83	2.10
10700	Feb 92	Bedfordshire	J	F	0.95	0.22	1.25	3.05
10702	Feb 92	Renfrew	A	M	6.55	0.75	31.02	13.34
10705	Feb 92	Kilmarnock	J	F	13.67	0.71	16.09	9.06
10708	Feb 92	Central	J	F	1.25	0.17	0.81	4.16
10710	Feb 92	S. Clyde	A	F	0.31	0.10	1.40	9.50
10717	Feb 92	G. London	A	M	7.73	0.76	88.60	2.42
10718	Feb 92	Staffs	J	M	6.48	0.82	17.75	6.26
10720	Feb 92	Surrey	A	F	11.76	1.50	67.87	2.74
10728	Feb 92	Bucks	A	F	6.08	0.61	21.46	2.30
10743	Feb 92	Norfolk	J	F	14.65	1.08	29.00	21.31
10899	Feb 92	Inverness	J	F	4.87	0.42	9.44	NA
10724	Mar 92	Norfolk	J	F	10.91	0.70	12.99	4.60
10730	Mar 92	Northants	J	F	1.46	0.33	2.86	1.72
10731	Mar 92	G. London	J	F	8.49	0.39	75.19	1.36
10733	Mar 92	D & G	A	M	7.39	0.29	31.35	15.03
10735	Mar 92	Worcs	A	M	9.62	0.38	3.91	1.55
10747	Mar 92	Dorset	A	F	13.25	2.22	69.76	16.61
10753	Mar 92	Northants	J	F	0.48	0.02	0.20	1.00
10754	Mar 92	Beds	J	M	2.24	0.14	0.93	1.63
10757	Mar 92	Cambs	J	F	3.38	0.18	2.18	NA
10759	Mar 92	Essex	J	M	7.70	2.94	26.01	ND
10760	Mar 92	Kent	J	F	20.68	1.21	10.74	NA
10761	Mar 92	Beds	A	M	0.80	0.04	0.77	2.04
10762	Mar 92	Hants	J	M	1.93	0.10	0.97	2.96
10763	Mar 92	Norfolk	A	M	17.84	0.35	10.92	6.37
10764	Mar 92	Derbyshire	A	M	1.42	0.07	4.84	1.43
10765	Mar 92	Derbyshire	J	F	15.43	2.72	28.77	NA
10766	Apr 92	Berks	J	M	0.45	0.04	3.28	NA
10767	Apr 92	Bucks	J	M	0.64	0.09	2.17	1.91
10773	Apr 92	Salop	J	F	10.12	4.86	11.73	NA
10777	Apr 92	Worcs	A	F	16.64	7.57	13.96	0.85
10780	Apr 92	Cambs	J	F	18.34	2.21	9.00	NA
10782	Apr 92	Mid Glam.	A	F	1.72	0.17	4.77	2.92
10783	Apr 92	Dorset	A	F	1.72	0.15	14.46	NA

10786	Apr 92	Cheshire	J	F	0.69	0.14	2.91	NA
10792	Apr 92	H & W	J	F	8.58	1.12	7.97	NA
10798	Apr 92	IOW	A	M	0.83	0.05	1.95	NA
10808	Apr 92	Gwent	A	M	8.55	0.18	9.98	NA
10901	Apr 92	Inverness	J	F	8.20	0.54	18.97	5.22
10960	Apr 92	Suffolk	J	M	14.42	0.22	17.10	3.77
10794	May 92	H & W	.	.	7.02	0.48	16.18	3.79
10807	May 92	Warks	A	F	1.00	0.17	2.37	NA
10834	May 92	Leics	A	F	0.95	0.13	0.91	4.64
10987	May 92	Bucks	A	F	12.17	1.82	38.29	3.59
10951	Jun 92	Northants	A	F	0.11	0.10	0.08	NA
10827	Jul 92	Leics	A	M	0.43	0.25	2.19	0.54
10874	Jul 92	H & W	.	.	16.83	0.76	22.88	NA
10836	Aug 92	Northants	J	M	0.20	0.05	0.15	NA
10837	Aug 92	Worcs	J	M	0.19	0.11	0.27	NA
10839	Aug 92	E. Ireland	A	F	5.46	0.15	17.57	NA
10840	Aug 92	Notts	J	M	0.65	0.24	3.95	NA
10844	Aug 92	Argyll	J	F	0.30	0.07	2.58	9.95
10845	Aug 92	Cambs	J	F	0.19	0.03	0.08	0.64
10848	Aug 92	Essex	J	F	0.39	0.05	0.48	0.29
10850	Aug 92	Rhondda	J	F	0.09	0.04	0.20	0.50
10853	Aug 92	Angus	J	F	0.05	0.04	0.11	NA
10855	Aug 92	Worcs	.	.	0.10	0.03	0.12	0.32
10856	Aug 92	Gwynnedd	J	F	2.86	0.16	4.21	5.57
10859	Aug 92	Derbyshire	J	F	0.11	0.11	0.73	0.44
10860	Aug 92	W. Sussex	J	M	0.34	0.09	ND	ND
10861	Aug 92	Worcs	J	M	0.12	0.04	0.42	0.67
10862	Aug 92	S'Clyde	J	F	0.14	0.03	0.59	NA
10864	Aug 92	Norfolk	J	F	0.05	0.04	0.23	1.60
10867	Aug 92	Durham	A	F	0.08	0.04	0.68	ND
10872	Aug 92	H & W	.	.	1.67	0.05	0.28	ND
10873	Aug 92	Worcs	.	.	0.14	0.08	0.50	0.34
10875	Aug 92	Worcs	.	.	2.10	0.23	5.52	0.61
10876	Aug 92	Wilts	J	F	0.25	0.05	0.57	0.88
10879	Aug 92	Essex	J	F	0.29	0.03	0.24	0.46
10898	Aug 92	Inverness	J	F	0.04	0.02	0.13	1.71
10903	Aug 92	Highland	J	F	0.17	0.02	0.36	2.26
10877	Sep 92	Cheshire	J	F	0.19	0.04	0.20	1.24
10883	Sep 92	Herts	J	F	13.24	0.52	40.68	0.57
10884	Sep 92	Salop	J	F	0.10	0.10	0.85	0.67
10888	Sep 92	Devon	J	F	0.13	0.09	0.28	1.11
10890	Sep 92	Glos	J	F	0.14	0.05	0.21	0.58
10892	Sep 92	Cumbria	J	F	0.06	0.02	0.15	0.80
10902	Sep 92	Highland	A	F	4.12	0.90	1.93	4.20
10928	Sep 92	Ayrshire	A	M	0.67	0.05	1.84	3.23
10933	Sep 92	Ross-shire	J	F	0.19	0.02	0.08	1.49
10937	Oct 92	Grampian	J	F	0.22	0.02	0.01	0.53
10940	Oct 92	Merseyside	J	F	0.05	0.03	0.16	0.37
10952	Oct 92	Salop	J	M	3.28	0.14	2.80	4.19
10954	Oct 92	Beds	J	F	0.39	0.06	0.06	0.73
10959	Oct 92	Devon	J	M	0.44	0.45	ND	ND
10961	Oct 92	Worcs	J	F	5.26	0.34	9.91	0.37
10963	Oct 92	Cheshire	J	M	0.09	0.06	0.33	0.66
10967	Oct 92	Hants	J	M	0.38	0.04	0.33	0.90
10969	Nov 92	W. Midlands	J	F	0.05	0.07	0.13	0.55
10974	Nov 92	Herts	J	M	0.83	0.07	0.92	0.69
10976	Nov 92	G. Manchester	J	F	0.09	0.08	0.97	0.62
10977	Nov 92	Derbyshire	J	M	0.16	0.06	1.15	0.74
10978	Nov 92	Cornwall	J	F	0.40	0.05	0.83	0.90
10984	Nov 92	Notts	J	M	0.21	0.05	0.53	0.75
10999	Dec 92		J	F	0.30	0.06	1.79	0.36

11004	Dec 92	Norfolk	J	F	4.45	1.25	3.66	1.64
11005	Dec 92	W. Yorks	J	M	0.11	0.07	0.62	1.50
11007	Dec 92	Oxon	A	F	5.02	0.62	4.52	0.74

Peregrine Falcon (Falco peregrinus)

10768	Mar 92	S'Clyde	A	M	1.51	0.03	2.39	0.77
10799	Apr 92		A	F	1.25	0.58	5.76	1.29
10866	Aug 92	D & G	J	M	0.79	0.07	2.69	1.86
10972	Nov 92	Orkney	J	F	0.41	0.08	3.38	4.97

Goshawk (Accipiter gentilis)

10858	Aug 92	Gwent	.	.	0.03	0.11	0.75	0.56

Merlin (Falco columbarius)

10744	Mar 92	Yorks	A	M	1.70	0.11	6.72	1.85
10752	Mar 92	Lancs	A	F	1.28	0.34	4.05	7.25
10811	May 92	Durham	A	F	13.69	4.08	10.36	3.00
10812	Jun 92	Yorks	J	.	0.04	0.08	0.15	ND
10816	Jul 92	Borders	J	F	0.10	0.07	0.34	ND
10817	Jul 92	Borders	J	F	0.13	0.08	1.05	0.56
10818	Jul 92	Borders	J	F	0.16	0.07	0.30	0.35
10897	Aug 92	Sutherland	J	M	0.79	0.11	2.41	8.68
10970	Sep 92	Ayr	J	F	0.33	0.09	2.39	8.01
10949	Oct 92	Stirling	J	M	1.66	0.47	2.00	10.47

Hobby (Falco subbuteo)

10886	Sep 92	Cambs	A	F	5.61	0.78	11.70	2.25

Osprey (Pandion haliaetus)

10936	Aug 92	Ross-shire	J	F	0.24	0.05	0.96	3.78

Buzzard (Buteo buteo)

10696	Feb 92	Gwent	A	M	0.01	0.04	0.11	0.40
11022	Sep 92	Beds	J	F	0.05	0.10	0.15	0.20
10968	92	Notts	A	F	0.01	0.03	ND	0.22
10986	Nov 92	Highland	A	F	0.04	0.05	0.98	0.54

Marsh Harrier (Circus aeruginosus)

10912	Sep 92	Cambs	A	F	0.13	0.05	0.03	0.17

Long-eared Owl (Asio otus)

10703	Feb 92	Cambs	A	F	0.12	0.05	0.21	0.24
10774	Apr 92	London	J	F	0.06	0.05	0.15	0.12
10787	Apr 92	Shetland	A	F	13.84	0.65	32.29	3.03
10796	May 92	S'clyde	J	M	0.04	0.05	0.16	0.16
10904	May 92	Highland	A	F	0.05	0.03	0.04	0.30
10802	Jun 92	Cheshire	J	F	0.08	0.08	0.59	0.10

Little Owl (Athene noctua)

10729	Mar 92	Dyfed	A	M	0.01	0.04	1.13	0.27
10789	Apr 92	Hants	A	M	0.19	0.12	0.59	0.55
10809	Jun 92	Wilts	A	F	0.08	0.05	0.12	1.32
10813	Jun 92	Wilts	A	M	1.46	0.05	1.40	2.81
10849	Aug 92	Herts	J	M	0.02	0.07	0.01	0.28
10983	Nov 92	Suffolk	J	M	0.14	0.05	0.51	0.45
10991	Nov 92	Suffolk	A	F	0.11	0.04	0.04	0.33

Short-eared Owl (Asio flammeus)

10667	Jan 92	Hampshire	J	F	0.19	0.14	0.53	0.52
10905	Jul 92	Sutherland	J	F	0.18	0.02	0.12	2.39

Heron (Ardea cinerea)

10643	Jan 92	Norfolk	A	F	2.51	0.06	6.83	5.82
10694	Jan 92	Tyne & Wear	A	F	0.09	0.08	2.03	6.05
10712	Jan 92	Grampian	J	F	4.65	0.16	4.25	15.47
10704	Feb 92	Cambs	A	F	0.04	0.04	0.20	1.99
10758	Mar 92	Highland	J	M	0.22	0.04	2.71	32.66
10942	Apr 92	Powys	.	.	0.54	0.04	0.75	3.82
10885	Sep 92	N'umberland	J	M	0.16	0.06	1.72	5.72
10918	Sep 92	Essex	J	F	0.01	0.03	0.15	2.92
10919	Sep 92	Essex	J	F	0.04	0.03	1.17	6.35
10971	Nov 92	S'Clyde	A	F	0.05	0.04	0.41	2.53
11080	Nov 92	Highland	J	F	0.69	0.14	2.86	16.28
11003	Dec 92	Caithness	J	F	0.02	0.04	0.53	15.68

Bittern (Botaurus stellaris)

11043	Oct 92	Norfolk	J	M	0.13	0.01	0.12	10.92

Kingfisher (Alcedo atthis)

10771	Apr 92	Essex	A	M	5.91	1.44	19.34	2.24
10815	Jul 92	Beds	A	M	0.09	0.23	0.18	1.57
10828	Jul 92	Mid Glam	J	M	0.08	0.40	0.11	0.50
10832	Aug 92	IOW	J	M	0.48	0.42	1.11	1.46
10927	Oct 92	London	J	M	1.01	0.25	5.18	1.30
10955	Oct 92	S'clyde	J	F	18.38	0.56	3.45	3.91
10956	Oct 92	Kent	A	M	10.50	1.48	4.55	8.66

Great-crested Grebe (Podiceps cristatus)

10769	Apr 92	S. Yorks	A	M	3.18	1.34	18.37	6.51
10776	Apr 92	Wilts	A	F	0.13	0.06	1.56	6.04
10915	Aug 92	Staffs	A	M	2.22	0.01	4.34	9.85

Table 2. Geometric mean levels of pollutants in the various species in Table 1, but for 1992 specimens only.

	HEOD	p,p'-DDE	PCBs	Hg
Kestrel				
Mean	0.13	0.08	0.86	0.80
N	47	47	47	47
Range within 1 SE	0.12 - 0.16	0.06 - 0.10	0.73 - 1.02	0.66 - 0.98
Sparrowhawk				
Mean	0.16	0.99	0.65	1.12
N	110	110	110	89
Range within 1 SE	0.14 - 0.18	0.83 - 1.18	1.34 - 2.02	0.94 - 1.33
Merlin				
Mean	0.17	0.50	1.49	0.95
N	10	10	10	10
Range within 1 SE	0.11 - 0.26	0.29 - 0.87	0.95 - 2.31	0.41 - 2.20
Heron				
Mean	0.06	0.16	1.13	6.77
N	12	12	12	12
Range within 1 SE	0.05 - 0.06	0.09 - 0.27	0.80 - 1.60	5.27 - 8.69
Kingfisher				
Mean	1.21	0.53	1.66	1.96
N	7	7	7	7
Range within 1 SE	0.52 - 2.81	0.40 - 0.70	0.81 - 3.38	1.40 - 2.76
Great-crested Grebe				
Mean	0.09	0.97	4.99	7.29
N	3	3	3	3
Range within 1 SE	0.02 - 0.39	0.35 - 2.67	2.44 - 10.21	6.26 - 8.49

Note: Zero values (ND) were taken as 0.001 for all residues

Table 3. Comparison of geometric mean residue levels (log values) from birds collected in 1991 and 1992; t-values are shown. Minus values indicate a decrease and plus values indicate and increase from 1991.

	HEOD	p,p'-DDE	PCBs	Hg
Kestrel	t_{114}=-0.18	t_{114}=-0.44	t_{114}=+1.74	t_{114}=-1.26
Sparrowhawk	t_{220}=+3.47***	t_{220}=+1.86	t_{220}=+3.78***	t_{199}=-1.28
Merlin	t_{15}=+0.09	t_{15}=-1.03	t_{15}=+0.89	t_{15}=-0.81
Kingfisher	t_{16}=+0.45	t_{16}=+0.92	t_{16}=+0.26	t_{16}=-0.41
Heron	t_{38}=-1.52	t_{38}=-0.95	t_{38}=+0.29	t_{38}=-0.74

Notes: Zero values were taken as 0.001 for all residues.

* significance of difference P<0.05; ** P<0.01; *** P<0.001

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BIRDS AND POLLUTION

Part 2 Organochlorines and mercury in peregrine eggs, 1992

I Newton, A Asher, P Freestone, M C French,
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Monks Wood
Abbots Ripton
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July 1993

2 ORGANOCHLORINES AND MERCURY IN PEREGRINE EGGS, 1992

2.1 Introduction

The findings from all peregrine eggs analysed between 1961 and 1986 were summarised in Newton *et al* (1989); those from eggs analysed in 1987-91 are given in previous reports in this series, and those from eggs analysed in 1992 are given in Table 4.

2.2 Results

Among the eggs from 14 clutches received in 1992, none of the contaminants were at high level, compared to previous years. This continues the trend of declining contamination in this species. The only figure of note was a level of 11 ppm PCB in an egg from Inverness-shire.

2.3 Reference

NEWTON, I., BOGAN, J.A. & HAAS, M.B. 1989. Organochlorines and mercury in British Peregrine eggs. Ibis 131; 355-376.

Table 4. Residue levels (organochlorine ppm wet weight; mercury ppm dry weight) and shell-indices for Peregrine eggs analysed in 1992. ND=none detected.

Egg No.	Year	County	Shell Index	pp'-DDE	HEOD	PCBs	Hg
SOUTHERN ENGLAND							
E5206	92	Cornwall	1.79	1.26	0.11	2.87	0.40
E5232	92	Cornwall	1.89	0.29	0.05	1.93	0.23
WALES							
E5215	92		1.90	0.52	0.11	1.18	0.83
E5216	92		1.72	1.36	0.10	2.31	0.82
E5333	92	W. Glam.	2.00	1.08	0.11	0.98	0.16
NORTHERN ENGLAND							
E5359	92	Cumbria	1.69	2.41	0.13	5.89	0.56
E5360	92	Cumbria	1.72	1.41	0.05	3.89	1.24
E5361	92	Cumbria	1.71	0.18	0.05	1.92	0.22
E5362	92	Cumbria	1.43	1.46	0.06	2.07	0.68
E5363	92	Cumbria	2.05	0.87	0.04	5.49	0.53
SOUTHERN SCOTLAND							
E5210	92	Borders	1.79	0.20	0.03	0.45	0.37
E5261	92	Edinburgh	-	1.23	0.05	0.43	0.27
CENTRAL AND EASTERN HIGHLANDS							
E5492	84	Highland	-	0.70	0.32	3.93	1.73
E5493	84	Inverness	1.96	1.74	0.08	10.65	1.60
E5515	92	L. Deeside	1.93	0.61	0.02	0.34	ND
E5517	92	L. Deeside	1.75	0.64	0.04	0.55	0.38

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BIRDS AND POLLUTION

Part 3 Organochlorines and mercury in merlin eggs, 1992

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3 ORGANOCHLORINES AND MERCURY IN MERLIN EGGS, 1992

3.1 Introduction

The findings from most previous analyses of merlin eggs were given in Newton & Haas (1988), those from 1987-1991 in previous reports in this series, while those from 1992 are summarised in Table 5.

3.2 Results

The results from these additional 24 merlin clutches serve to confirm that the merlin continues to be the most contaminated of the British raptors. As in previous years, mercury was present at high level (3.8-12.1 ppm in dry weight) in eggs from the Northern Isles.

3.3 Reference

NEWTON, I. & HAAS, M.B. 1988. Pollutants in Merlin eggs and their effects on breeding. Brit. Birds 81: 258-269.

Table 5. Residue levels (organochlorine ppm wet weight; mercury ppm dry weight) and shell-indices for Merlin eggs analysed in 1992. ND=None detected

County	Shell Index	DDE	HEOD	PCBs	Hg
SOUTHERN ENGLAND					
E5204	-	1.23(18.99)	0.08(1.28)	2.15(33.27)	4.26
WALES					
E5334	1.10	3.63(60.94)	0.28(4.77)	3.89(65.25)	1.25
NORTHERN ENGLAND					
E5200	0.99	7.62(95.67)	3.00(37.66)	3.04(38.16)	0.53
E5364	1.22	3.90(98.11)	0.23(5.78)	1.88(47.25)	2.75
E5365	1.30	4.71(94.09)	0.39(7.84)	2.32(46.46)	2.36
E5366	1.21	4.49(101.53)	0.31(7.11)	2.08(47.08)	2.98
E5367	1.09	5.30(102.28)	0.44(8.53)	2.39(46.14)	3.41
E5368	1.15	3.26(58.79)	0.21(3.79)	6.72(121.03)	4.35
E5371	1.15	5.60(78.36)	0.31(4.29)	4.20(53.74)	2.97
E5372	1.21	5.14(72.26)	0.28(3.93)	3.93(54.96)	3.31
E5373	1.17	3.64(70.13)	0.10(1.87)	2.50(48.08)	2.45
E5374	1.31	2.19(38.45)	0.08(1.40)	2.75(48.31)	2.99
E5375	1.12	6.15(105.01)	0.09(1.58)	5.44(92.79)	2.44
E5376	1.11	3.66(60.09)	0.46(7.61)	2.99(49.02)	1.50
E5377	1.03	4.84(88.40)	0.30(5.39)	3.33(60.83)	2.48
E5378	1.19	1.60(33.01)	0.14(2.85)	1.81(37.32)	2.98
HIGHLANDS					
E5190	1.26	3.37(52.91)	0.23(3.59)	3.02(47.36)	2.32
NORTHERN ISLES					
E5462	-	5.96(40.650	0.15(1.00)	3.77(25.75)	3.83
E5498	1.16	0.37(18.13)	0.05(2.47)	0.97(47.00)	10.16
E5500	-	4.43(94.98)	0.07(1.45)	3.10(66.48)	4.54
E5502	1.15	2.40(69.94)	0.06(1.61)	3.19(92.73)	7.86
E5504	-	0.90(21.48)	0.05(1.08)	1.99(47.48)	8.31
E5505	1.14	1.65(29.03)	0.05(0.93)	1.68(29.45)	9.97
E5506	-	0.79(23.88)	0.03(0.96)	1.85(55.96)	12.08

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BIRDS AND POLLUTION

Part 4 Organochlorines and mercury in golden eagle eggs, 1992

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4 ORGANOCHLORINES AND MERCURY IN GOLDEN EAGLE EGGS, 1992

4.1 Introduction

The findings from earlier analyses of golden eagle eggs to 1986 were given in Newton & Galbraith (1991), and those from 1987-91 in the previous reports in this series. The results for eggs analysed in 1992 are summarised in Table 6.

4.2 Results

Recent analyses serve to confirm the low levels of contamination found in recent years in eagle eggs from inland districts (Table 6). All results were well within the range of previous values. Some coastal eggs were also obtained in 1992, and one contained a relatively high level of PCB, at 19 ppm.

4.3 Reference

NEWTON, I. & GALBRAITH, A.E. 1991. Organochlorines and mercury in the eggs of Golden Eagles *Aquila chrysaetos* from Scotland. Ibis 133: 115-120.

Table 6. Residue levels (organochlorine ppm wet weight; Mercury ppm dry weight) and shell-indices for Golden Eagle eggs received in 1992.

Number	SI	DDE	HEOD	PCB	Hg
WESTERN SCOTLAND - COASTAL					
E5209	2.70	0.16	0.06	2.55	0.33
E5246	2.29	2.44	0.05	19.27	0.48
E5344	2.54	0.11	0.04	1.07	1.03
E5439	2.73	0.07	0.03	0.77	ND
E5440	2.84	0.16	0.04	2.02	ND
WESTERN SCOTLAND - INLAND					
E5249	3.17	0.12	0.02	0.82	1.69
E5345	3.93	0.11	0.02	0.75	ND
E5441	3.34	0.02	0.01	1.58	0.15
E5442	3.25	0.02	0.01	0.58	0.18
EASTERN SCOTLAND - INLAND					
E5158	-	0.01	0.03	0.40	0.49
E5198	-	ND	0.28	0.13	ND
E5343	3.37	0.01	0.03	0.01	ND

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BIRDS AND POLLUTION

Part 5 Organochlorines and mercury in gannet eggs, 1992

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5 ORGANOCHLORINES AND MERCURY IN GANNET EGGS, 1992

5.1 Introduction

The findings from all gannet eggs collected during the period 1971-87 were summarised in Newton et al (1989), while those from 1988-92 were given in previous reports in this series. The findings for eggs from three colonies sampled in 1992 are summarised in Table 7.

5.2 Results

At all three colonies the levels of all contaminants were generally low, but a PCB level of 32 ppm was found in an egg from Ailsa Craig.

Comparing the eggs from different colonies, the mean shell index was significantly lower at Ailsa Craig than at both Bass Rock and Hermaness, and the goemetric mean mercury level was significantly lower at Bass Rock than Hermaness (Table 8a). These results were in line with previous findings. Compared with the previous samples of eggs from the same colonies, significant declines were evident in the levels of HEOD at Ailsa Craig and Bass Rock, significant declines in DDE at Hermaness and Bass Rock, and a significant increase in PCBs at Hermaness (Table 8b). It is hard to judge the biological significance of these temporal variations except in a longer term context.

5.3 Reference

NEWTON, I., HAAS, M.B. & FREESTONE, P. 1990. Trends in organochlorine and mercury levels in gannet eggs. Environ. Pollut. 63: 1-12.

Table 7. Residues of organochlorines (ppm wet weight) and mercury (ppm dry weight) in the eggs of Gannets (Sula bassana), 1992.

Colony	Shell Index*	DDE	HEOD	PCBs	Hg
BASS ROCK	3.24	0.09	0.07	1.72	1.65
	2.90	0.13	0.12	3.47	2.00
	3.15	0.05	0.08	1.29	1.32
	3.26	0.14	0.14	4.31	1.47
	3.19	0.06	0.10	1.22	1.88
	2.79	0.24	0.09	4.23	2.14
	3.16	0.08	0.06	2.05	1.35
	3.18	0.11	0.08	1.73	1.90
	2.87	0.06	0.11	2.93	1.50
	3.28	0.06	0.09	1.99	1.47
Mean	3.10	0.09	0.09	2.26	1.65
SD	0.18	0.21	0.11	0.20	0.07
Range within 1 SE	3.04-3.16	0.08-0.11	0.08-0.10	1.96-2.62	1.56-1.74
HERMANESS	2.79	0.06	0.07	0.96	2.95
	3.17	0.09	0.05	1.28	3.07
	3.20	0.14	0.17	2.33	3.62
	2.96	0.11	0.08	2.25	5.18
	3.01	0.07	0.08	1.13	3.02
	3.29	0.07	0.11	1.73	2.89
	3.16	0.11	0.12	1.67	2.24
	3.32	0.10	0.12	2.15	2.27
	3.36	0.13	0.13	2.45	2.83
	3.13	0.08	0.10	1.23	2.82
Mean	3.14	0.09	0.10	1.63	3.01
SD	0.18	0.12	0.15	0.15	0.10
Range within 1SE	3.08-3.20	0.08-0.10	0.09-0.11	1.47-1.82	2.79-3.24
AILSA CRAIG	2.75	0.08	0.07	2.71	2.04
	2.92	0.23	0.17	3.79	5.14
	2.85	0.05	0.07	1.02	2.18
	2.93	0.03	0.09	0.87	1.00
	2.83	0.06	0.06	1.31	2.04
	2.84	0.20	0.14	6.48	0.73
	2.61	2.52	0.21	31.99	1.43
	3.02	0.05	0.04	1.14	2.50
	2.88	0.11	0.07	2.80	2.10
	2.89	0.34	0.05	5.64	3.80
Mean	2.85	0.13	0.08	2.92	1.99
SD	0.11	0.56	0.23	0.48	0.25
Range within 1SE	2.82-2.89	0.09-0.20	0.07-0.10	2.06-4.14	1.66-2.39

Zero values (ND) were taken as 0.01 for all residues

*Means: arithmetic for Shell index; geometric otherwise

Table 8a. Changes in geometric mean residue levels (log values) and shell index (arithmetic mean) in Gannet eggs from different sites, collected in 1992.

*P<0.05 **P<0.01 ***P<0.001

Shell Index	pp'-DDE	HEOD	PCBs	Hg
Ailsa Craig v. Bass Rock, 1992				
t_{18}=+3.76**	t_{18}=-0.85	t_{18}=+0.41	t_{18}=-0.67	t_{18}=+1.00
Ailsa Craig v. Hermaness, 1992				
t_{18}=+4.36***	t_{18}=-0.84	t_{18}=+0.71	t_{18}=-1.59	t_{18}=+2.10
Bass Rock v. Hermaness, 1992				
t_{18}=+0.47	t_{18}=+0.12	t_{18}=+0.48	t_{18}=-1.80	t_{18}=+6.50***

Table 8b. Changes in geometric mean residue levels (log values) and shell index (arithmetic mean) in 1992 Gannet eggs compared with previous eggs from the same site. (No eggs were received from St. Kilda in 1992)

*P<0.05 **P<0.01 ***P<0.001

Shell Index	pp'-DDE	HEOD	PCBs	Hg
<u>Ailsa Craig</u> (1990 v. 1992)				
t_{17}=-1.80	t_{18}=+0.74	t_{18}=-3.64**	t_{18}=+0.74	t_{18}=-0.18
<u>Bass Rock</u> (1990 v. 1992)				
t_{18}=+0.40	t_{18}=-2.25*	t_{18}=-8.45***	t_{18}=-1.90	t_{18}=+1.59
<u>Hermaness</u> (1991 v. 1992)				
t_{18}=0.02	t_{18}=-2.89**	t_{18}=+0.24	t_{18}=+7.07***	t_{18}=-0.70

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BIRDS AND POLLUTION

Part 6 Rodenticides in barn owls

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6 RODENTICIDES IN BARN OWLS

6.1 Introduction

The aim of this work was to screen barn owl carcasses for residues of 'second generation' rodenticides. The carcasses were supplied by members of the public, and included birds which 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* (1990) and in previous reports in this series, while those from 60 birds examined in 1992 are given in Table 9.

6.2 Results

Residues were detected in 15 (25%) of the 60 birds examined, about the same overall percentage as in the last three years. Brodifacoum was detected in three birds, difenacoum in 12, bromadiolone in four and flocoumafen in one. The two birds in which more than one chemical was detected included one from Hants in which all four chemicals were found. Most of the residues were well below the level associated with death, but three birds contained bromadiolone at levels (0.26-0.33 ppm) which were probably approaching lethal. However, no symptoms of rodenticide poisoning were seen in these birds, which were classed on post-mortem as victims of starvation (two birds) and road accident (one). The appearance of flocoumafen in only one individual is in keeping with the more recent introduction of this chemical.

6.3 Reference

NEWTON, I., WYLLIE, I. & FREESTONE, P. 1990. Rodenticides in British Barn Owls. Environ. Pollut. 68: 101-117.

Table 9. Levels of rodenticides (ppm in wet weight) in the livers of Barn Owls (<u>Tyto alba</u>) analysed in 1992.

ND=None detected; J=juvenile in first year; A=adult other than first year; M=male; F=female; brod=brodifacoum; difen=difenacoum; brom=bromadialone; floc=flocoumafen.

No.	Date	County	Age	Sex	brod	difen	brom	floc
10823	Sep 90	Norfolk	J	M	ND	ND	ND	ND
10824	Aug 91	Norfolk	A	F	ND	ND	ND	ND
10825	Dec 91	Norfolk	J	F	ND	ND	ND	ND
10647	Jan 92	Lincs	J	F	ND	0.135	ND	ND
10656	Jan 92	IOW	J	M	ND	ND	ND	ND
10666	Jan 92	Leics	J	M	ND	ND	ND	ND
10670	Jan 92	Lincs	J	M	ND	ND	ND	ND
10671	Jan 92	Herefords	J	F	ND	ND	ND	ND
10676	Jan 92	Wilts	J	M	ND	0.023	ND	ND
10683	Jan 92	Berks	J	F	ND	ND	ND	ND
10684	Jan 92	Sussex	J	M	ND	ND	ND	ND
10686	Feb 92	Shropshire	J	M	ND	ND	ND	ND
10687	Feb 92	Herefords	J	M	ND	ND	ND	ND
10689	Feb 92	Gwynedd	J	F	ND	0.017	ND	ND
10690	Feb 92	Essex	J	M	ND	ND	ND	ND
10691	Feb 92	Kent	J	F	ND	0.028	ND	ND
10695	Feb 92	Cumbria	J	M	ND	ND	ND	ND
10701	Feb 92	Lanarks	J	M	ND	ND	ND	ND
10709	Feb 92	Cambs	J	M	ND	ND	ND	ND
10721	Feb 92	Avon	J	M	ND	ND	ND	ND
10732	Mar 92	Yorks	A	F	ND	ND	ND	ND
10737	Mar 92	Lincs	J	M	ND	ND	ND	ND
10741	Mar 92	Wilts	J	M	ND	ND	ND	ND
10746	Mar 92	Oxon	A	M	ND	ND	ND	ND
10750	Mar 92	Dyfed	J	F	ND	ND	ND	ND
10755	Mar 92	Dorset	J	M	ND	ND	ND	ND
10781	Mar 92	Glamorgan	A	M	ND	ND	ND	ND
10772	Apr 92	Hants	J	F	0.009	ND	0.325	ND
10779	Apr 92	Lincs	J	M	ND	0.014	ND	ND
10790	Apr 92	D & G	J	M	ND	ND	0.257	ND
10793	Apr 92	Ayrshire	J	M	ND	ND	ND	ND
10868	Apr 92	Northants	J	F	ND	ND	ND	ND
10931	Apr 92	D & G	J	F	ND	ND	ND	ND
10805	Jun 92	Hants	J	F	0.007	0.004	0.015	0.007
10835	Jun 92	Herts	J	M	ND	ND	ND	ND
10814	Jul 92	Humberside	J	M	ND	ND	ND	ND
10831	Jul 92	Somerset	A	F	ND	ND	0.256	ND
10847	Aug 92	Gwynedd	J	M	ND	0.013	ND	ND
10863	Aug 92	Shropshire	J	M	ND	ND	ND	ND
10878	Sep 92	Hants	J	M	ND	ND	ND	ND
10889	Sep 92	Cheshire	A	M	ND	ND	ND	ND

10894	Sep 92	D & G	J	F	ND	ND	ND	ND
10895	Sep 92	N. Yorks	J	M	ND	ND	ND	ND
10945	Sep 92	Cornwall	J	F	ND	0.011	ND	ND
10929	Oct 92	Norfolk	J	F	ND	ND	ND	ND
10938	Oct 92	Cumbria	J	M	ND	ND	ND	ND
10948	Oct 92	Oxon	J	F	ND	ND	ND	ND
10950	Oct 92	Dyfed	J	F	ND	ND	ND	ND
10958	Oct 92	D & G	J	F	ND	ND	ND	ND
10962	Oct 92	Cambs	J	M	ND	ND	ND	ND
10966	Oct 92	Berks	J	F	ND	ND	ND	ND
10975	Nov 92	Cumbria	J	M	ND	0.046	ND	ND
10980	Nov 92	Cambs	J	M	ND	ND	ND	ND
10985	Nov 92	Oxon	J	F	ND	0.009	ND	ND
10989	Nov 92	Essex	J	F	ND	0.012	ND	ND
10990	Nov 92	Devon	J	F	0.161	0.007	ND	ND
11017	Nov 92	Shropshire	J	F	ND	ND	ND	ND
10992	Dec 92	Cambs	J	M	ND	ND	ND	ND
10993	Dec 92	Cambs	J	M	ND	ND	ND	ND
11001	Dec 92	Cambs	A	M	ND	ND	ND	ND
11018	Dec 92	Shropshire	J	F	ND	ND	ND	ND

INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT T07061f5

Annual report to the Joint Nature Conservation Committee

BIRDS AND POLLUTION

Part 7 Incidents investigated during 1992-93

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Monks Wood
Abbots Ripton
Huntingdon
Cambs PE17 2LS

July 1993

7 INCIDENTS INVESTIGATED DURING 1992-93

Four wildlife mortality and morbidity incidents were investigated during 1992-93. Two involved seabirds, one waders, and one wildfowl. Throughout this section of the report HCH refers to gamma-HCH (lindane).

7.1 Birds killed in the Braer oiling incident

Introduction

Livers of about 40 birds found dead near the Braer incident were analysed for a selected range of organchlorine compounds (HCH, HCB, DDE, HEOD, and DDT), total PCBs, PCB congeners, and metals. This work was done to determine the current levels of these persistent compounds in seabirds, to obtain information on inter-species differences, and to compare levels found in these birds with those found in earlier sampling programmes (eg NERC, 1983). No equivalent survey has been done since the North Sea wreck of seabirds in 1983 (Osborn et al, 1984). There is no reason to believe that these comparisons would be biased by the oiling.

Organochlorine compounds

Mean residues of non-PCB organochlorine compounds, were low (Table 10), and almost certainly of no toxicological significance.

Apart from the 2 razorbills (*Alca torda*), the highest mean residues of HCB, HCH, and the DDT group of compounds (DDE, TDE, and DDT) were found in the kittiwakes (*Rissa tridactyla*). The highest HEOD residues occurred in puffins (*Fratercula arctica*). In general, the levels were similar to those found in earlier studies of contamination in seabirds (NERC 1983; Osborn et al, 1984; Osborn et al, 1987).

PCBs and PCB congeners

Mean total PCB residues (Table 10) were highest in the kittiwakes. These levels were about 4 times higher than that found in the puffin and an order of magnitude above that in the shag (*Phalacrocorax aristotelis*) and guillemot (*Uria aalge*). Residues in all these birds were similar to levels reported earlier for these species from various locations around the British Isles (NERC, 1983; Osborn et al 1984; Osborn et al 1987). The toxicological significance of these concentrations of PCBs in seabirds is currently under review. There is no reason to believe they were high enough to affect either breeding success or survival (Harris and Osborn, 1981).

The pattern of PCB congeners in these seabirds (Table 11a and 11b) was dominated by the more heavily chlorinated ones (eg 153, 180). In the kittiwake, mean residues of congeners could be ranked in declining order of mean residue: 153 > 170 > 180 > 118 > 138 .... A slightly different congener pattern was found in the puffin: 153 > 138 > 180 > 118 > 170 ....; in the guillemot: 138 > 153 > 118 > 170 > 180 ....; and in the shag: 153 > 138 > 180 = 118 > 170 ....

These 5 congeners occur frequently in marine life, partly because of the environmental persistence that results from their high degree of chlorination. They are often the congeners that are found in the highest concentrations. Other congeners detected in the birds were present at only lower levels (Table 11a and 11b).

With so few birds examined, it is impossible to say whether these patterns of occurrence represent consistent differences between species. Such differences could arise for a number of reasons. For example, because different species have different diets and foraging areas their exposure to congeners or mixtures of congeners may vary. Alternatively, there may be differences between species in their ability to metabolise or retain PCBs. The differences in congener pattern could also indicate the type of PCB that was the original source for these residues, but more work is needed before sources can be identified in this way.

Metals

A range of essential (magnesium, copper, and zinc), non-essential (rubidium and strontium) and toxic metals (silver, cadmium, mercury and lead) were measured by quantitative ICP-MS (Table 12), following preliminary analysis with the ICP-MS in scanning mode to determine which metals of interest might be present in these samples.

The kittiwake contained the highest concentrations of cadmium, mercury and lead. Studies on other species (eg Osborn et al 1979) suggest that levels of cadmium in seabird kidneys are about 6 times those in liver and that tissue damage occurs in birds with cadmium levels in kidney in excess of c. 100 mg/kg dry wt (Nicholson et al 1983). Thus, these kittiwakes may have suffered some kidney damage as a result of contamination with cadmium. The levels of mercury and lead were not high enough to be of toxicological significance. No silver was detected in any of these birds (see section on mute swans).

Levels of other essential and non-essential metals were within normal ranges, except for the values of zinc in the livers of kittiwakes which appeared to be elevated, probably as a result of the presence of sufficient cadmium to have induced metallothionein (which binds cadmium, mercury, and zinc). Metallothionein is a protein specially produced in vertebrates and many other forms of life in response to exposure to certain metals, particularly cadmium (but not lead). The presence of PCB in these samples may also have contributed to enhanced zinc levels (Osborn & Harris, unpublished observations).

Results from qualitative ICP-MS scanning analysis revealed the presence of boron in the kittiwake livers. This was not found in the other species. It is possible that this element originated from the glassware used in sample preparation. This is being investigated, but seems an unlikely explanation, as other samples analysed in this batch contained none of this material.

7.2 Swans from Orkney

The livers of four mute swans (*Cygnus olor*) from Orkney were analysed for both metal and organic chemicals to try to determine whether these birds were killed by pollutants (Table 10, 11a, 11b and 12). Whilst none of the levels of organic compounds were of significance, the level of silver is of interest, because (i) this element is not normally found in birds (eg see Braer samples), and (ii) other samples of swan liver from recent years have also contained this metal occasionally.

Although silver is generally regarded as being less toxic to higher animals than lead, antimony and arsenic, it is usually present in humans not occupationally exposed to silver at ug/kg concentrations rather than the mg/kg values measured here. Thus, it seems that these birds had been exposed to unusual quantities of silver. The source is unknown, as is the toxicological significance. Any effects would depend on whether the metal was present as a salt or in a metallic form. If the swans had been acutely exposed to silver, then the concentrations in the liver will be the higher than in other tissues. If they were chronically exposed, other tissues may have contained significant quantities (eg spleen or skin). Toxic effects of silver in vertebrates include pulmonary or immunological reactions. Low concentrations of silver are toxic to many forms of aquatic life. There is evidence from earlier studies that some marine species can accumulate up to 16 mg/kg in their tissues (most values being well below this). There appear to be no data on the levels of silver found in wild terrestrial animals.

Copper levels were much higher than those usually found in other groups of birds, but wildfowl generally contain relatively high levels of this essential element (eg Simpson et al 1979). Thus, these levels of copper are not considered too unusual.

The level of rubidium in these birds was higher than the levels of strontium (Table 12), whereas in the seabirds from Shetland rubidium was at the higher concentration. This finding is not unusual. A relationship between rubidium and strontium concentrations in environmental samples is emerging which requires further study before it can be discussed more fully.

7.3 Wader mortalities on the Wash

Some waders were analysed for organochlorine compounds and metals to help eliminate pollutants from the list of possible causes of the unusual migratory patterns and mortalities of wading birds on the Wash during the overwintering period of 1992-93. These unusual events were thought to be primarily the result of food shortage.

None of the levels of chemicals detected (Table 10, 11a, 11b, and 12) were high enough to have contributed to the mortality. Cadmium levels are probably high enough to have induced metallothionein production and thus to have caused some elevation of zinc levels in these birds.

7.4 Further mortalities of seabirds near Bacton

Reports of deaths of auks and other species of birds near Bacton, Norfolk, have been received intermittently since the late-1980s. Past incidents have attracted Parliamentary interest. No cause for these repeated incidents has been determined. Six guillemots that died in the care of a Norfolk animal welfare group during the past year have been analysed for metals and organic substances to see if the levels of any these substances were high enough to have contributed to death (Table 10, 11a, 11b and 12). None of the levels were.

Birds that die in this area are often said to be unable to maintain their normal waterproofing, and this has been attributed by some to exposure to glycols originating from the gas terminal at Bacton. This possibility is being investigated further. The feathers of some of the birds in this group repelled topically applied water, whereas the feathers from others did not.

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Table 10: Mean levels of organochlorine compounds (mg/kk wet weight) in livers of birds from incident investigations. Figures are arithmetic means ± 1 SE. Figures in parenthesis are the range. nd = none detected. PCB-MAT = PCB level quantified using only peaks corresponding to those found in Arochlor 1254. PCB-TOT = PCB level quantified using all peaks found on GC trace in the region in which PCB congeners occur.

Area	Species	Sample size	HCB	HCH	DDE	HEOD	TDE	DDT	PCB-MAT	PCB-TOT
Shetland	shag	15	0.02 ± 0.00 (0.01 - 0.06)	nd	0.09 ± 0.03 (0.01 - 0.33)	0.13 ± 0.06 (0.03 - 0.95)	0.00 ± 0.00 (nd - 0.01)	nd	0.72 ± 0.24 (0.01 - 3.25)	1.03 ± 0.87 (0.03 - 4.08)
Shetland	guillemot	9	0.05 ± 0.01 (nd - 0.10)	0.00 ± 0.00 (nd - 0.00)	0.28 ± 0.13 (nd - 1.09)	0.03 ± 0.01 (0.00 - 0.09)	nd	nd	1.09 ± 0.44 (nd - 3.86)	1.56 ± 0.66 (nd - 5.84)
Shetland	puffin	5	0.07 ± 0.02 (0.01 - 0.16)	nd	0.47 ± 0.23 (0.04 - 1.34)	0.12 ± 0.03 (0.04 - 0.25)	nd	nd	3.20 ± 1.15 (0.16 - 7.09)	4.84 ± 1.61 (0.23 - 9.38)
Shetland	razorbill	2	0.13 (0.10, 0.16)	0.00 (nd, 0.01)	1.30 (0.35, 2.25)	0.26 (0.15 - 0.37)	0.08 (nd, 0.17)	nd	6.39 (2.84, 9.94)	11.7 (5.89, 17.45)
Shetland	kittiwake	10	0.24 ± 0.04 (0.04 - 0.40)	0.01 ± 0.00 (nd -0.02)	0.92 ±0.28 (0.03 - 0.76)	0.09 ± 0.01 (0.03 - 0.16)	0.01 ± 0.01 (nd - 0.09)	0.02 ± 0.01 (nd - 0.04)	16.79 ± 3.49 (2.74 - 34.65)	20.4 ± 4.0 (3.0 - 41.0)
The Wash	oyster-catcher	10	0.01 ± 0.00 (nd - 0.01)	0.00 ± 0.00 (nd - 0.01)	0.27 ± 0.08 (0.03 - 0.76)	0.14 ± 0.02 (0.05 - 0.23)	0.01 ± 0.01 (nd - 0.08)	0.01 ± 0.00 (nd - 0.02)	2.00 ± 0.50 (0.57 - 4.93)	3.49 ± 1.16 (0.69 - 12.5)
Bacton	guillemot	6	0.07 ± 0.02 (0.01 - 0.12)	0.00 ± 0.00 (nd - 0.00)	0.78 ± 0.14 (0.31 - 1.27)	0.06 ± 0.02 (0.02 - 0.12)	0.01 ± 0.01 (nd - 0.03)	0.02 ± 0.02 (nd - 0.12)	7.10 ± 2.91 (0.67 - 18.7)	8.26 ± 3.49 (0.74 - 23.05)
Orkney	mute swan	4	nd	nd	0.01 ± 0.00 (0.00 - 0.02)	0.06 ± 0.01 (0.04 - 0.07)	0.01 ± 0.01 (nd - 0.03)	0.21 ± 0.20 9nd - 0.82)	0.18 ± 0.05 (0.03 - 0.29)	0.22 ± 0.05 (0.07 - 0.33)

Table 11a: Mean PCB congener levels (mg/kg wet weight) in livers of birds from incident investigations. Figures are arithmetic means ± 1 SE. Figures in parenthesis show the range. nd = none detected.

Area	Species	Sample size	8	18	28	31	52	77	101	118
Shetland	shag	15	nd	nd	nd	nd	nd	nd	nd	0.03 ± 0.01 (0.00 - 0.14)
Shetland	guillemot	9	nd	nd	nd	0.00 ± 0.00 (nd - 0.02)	nd	nd	nd	0.03 ± 0.01 (nd - 0.23)
Shetland	puffin	5	nd	nd	nd	0.05 ± 0.02 (nd - 0.13)	0.01 ± 0.01 (nd - 0.04)	0.09 ± 0.09 (nd - 0.25)	0.02 ± 0.01 (nd - 0.04)	0.09 ± 0.04 (nd - 0.23)
Shetland	razorbill	2	nd	nd	nd	0.02 (0.02, 0.02)	0.04 (nd, 0.07)	nd	0.03 (0.01 , 0.04)	0.27 (0.08 , 0.47)
Shetland	kittiwake	10	nd	nd	nd	0.04 ± 0.01 (nd - 0.08)	0.03 ± 0.04 (nd - 0.08)	0.02 ± 0.02 (nd - 0.14)	0.01 ± 0.00 (nd - 0.03)	0.39 ± 0.08 ((0.05 - 0.86)
The Wash	oyster-catcher	10	nd	nd	nd	nd	nd	nd	0.00 ± 0.00 (nd - 0.03)	0.05 ± 0.02 (0.01 - 0.14)
Bacton	guillemot	6	nd	nd	nd	0.03 ± 0.01 (nd - 0.08)	0.00 ± 0.00 (nd - 0.01)	nd	nd	0.21 ± 0.08 (0.03 - 0.55)
Orkney	mute swan	4	nd	nd	nd	nd	nd	nd	0.01 ± 0.01 (nd - 0.03)	0.00 ± 0.00 (nd - 0.01)

Table 11b: Mean PCB congener levels (mg/kg wet weight) in livers of birds from incident investigations. Figures are arithmetic means ± 1 SE. Figures in parenthesis show the range. nd = none detected.

Area	Species	Sample size	126	128	138	149	153	169	170	180
Shetland	shag	15	nd	0.01 ± 0.00 (nd - 0.05)	0.08 ± 0.23 (nd - 0.31)	0.00 ± 0.00 (nd - 0.02)	0.16 ± 0.06 (nd - 0.75)	nd	0.02 ± 0.01 (nd - 0.09)	0.03 ± 0.01 (nd - 0.19)
Shetland	guillemot	9	nd	0.02 ± 0.01 (nd - 0.09)	0.12± 0.05 (nd - 0.40)	0.00 ± 0.00 (nd - 0.03)	0.09 ± 0.03 (nd - 0.21)	0.00 ± 0.00 (nd - 0.01)	0.02 ± 0.01 (nd - 0.09)	0.02 ± 0.01 (nd - 0.05)
Shetland	puffin	5	nd	0.04 ± 0.01 (nd - 0.07)	0.37 ± 0.14 (0.03 - 0.66)	0.02 ± 0.01 (nd - 0.05)	0.45 ± 0.17 (0.03 - 0.77)	0.00 ± 0.00 (nd - 0.01)	0.07 ± 0.01 (0.01 - 0.17)	0.15 ± 0.07 (nd - 0.05)
Shetland	razorbill	2	nd	0.20 (0.06, 0.33)	1.11 (0.33, 1.88)	0.20 (0.08, 0.32)	1.44 (0.41, 2.48)	0.19 (0.00, 0.03)	0.02 (nd, 0.04)	0.31 (0.08, 0.54)
Shetland	kittiwake	10	nd	0.02 ± 0.01 (nd - 0.05)	0.10 ± 0.02 (0.03 - 0.21)	0.01 ± 0.00 (nd - 0.04)	3.33 ± 0.71 (0.46 - 6.65)	0.02 ± 0.09 (0.02 - 0.04)	0.43 ± 0.09 (0.07 - 0.89)	1.18 ± 0.27 (0.15 - 2.64)
The Wash	oyster-catcher	10	0.00 ± 0.00 (nd - 0.02)	0.04 ± 0.01 (0.01 - 0.38)	0.24 ± 0.08 (0.05 - 0.74)	0.00 ± 0.00 (nd - 0.01)	0.35 ± 0.12 (0.05 - 1.04)	0.01 ± 0.00 (nd - 0.03)	0.03 ± 0.00 (0.02 - 0.04)	0.08 ± 0.02 (0.02 - 0.16)
Bacton	guillemot	6	0.00 ± 0.00 (nd - 0.01)	0.17 ± 0.07 (0.02 - 0.38)	1.00 ± 0.43 (0.09 - 2.78)	0.02 ± 0.01 (nd - 0.06)	1.01 ± .54 (0.06 - 3.60)	0.01 ± 0.00 (nd - 0.03)	0.14 ± 0.06 (0.01 - 0.38)	0.21 ± 0.10 (0.01 - 0.68)
Orkney	mute swan	4	nd	nd	0.04 ± 0.02 (nd - 0.09)	0.00 ± 0.00 (nd - 0.01)	0.00 ± 0.00 (nd - 0.02)	0.00 ± 0.00 (nd - 0.01)	nd	0.00 ± 0.00 (nd - 0.00)

Table 12: Mean metal levels (mg/kg dry weight) in livers of birds from incident investigations. Figures are arithmetic means ± 1SE. Figures in parenthesis are the range. nd = not detected.

Area	Species	Sample size	Mg	Cu	Zn	Rb	Sr	Ag	Cd	Pb	Hg
Shetland	shag	15	1550± 258 (681 - 4020)	41 ± 7 (19 - 122)	215 ± 23 (108 - 374)	3.7 ± 0.4 (1.1 - 5.6)	11.5 ± 3.2 (1.1 - 46.2)	nd	2.3 ± 0.6 (0.2 - 9.1)	0.03 ± 0.02 (nd - 0.24)	2.3 ± 0.5 (0.7 - 7.7)
Shetland	guillemot	9	1550 ± 432 (651 - 4640)	45 ± 9 (15 - 109)	157 ± 28 (77 - 356)	3.9 ± 0.7 (1.2 - 4.8)	9.6 ± 3.8 (2.3 - 14.9)	nd	4.0 ± 1.4 (0.2 - 6.7)	0.01 ± 0.01 (nd - 0.07)	1.2 ± 0.3 (0.2 - 1.8)
Shetland	puffin	5	2720 ± 847 (782 - 4880)	40 ± 5 (26 - 50)	121 ± 10 (91 - 150)	2.0 ± 0.7 (0.5 - 3.7)	24.1 ± 9.6 (2.3 - 55.7)	nd	9.7 ± 4.0 (0.2 - 6.7)	nd	2.6 ± 0.4 (1.4 - 3.4)
Shetland	razorbill	2	4161 (35810, 4740)	50 (44, 57)	152 (143, 161)	1.1 (0.7, 1.4)	42.7 (29.2, 56.3)	nd	3.7 (1.7, 5.7)	nd	1.9 (1.4, 2.4)
Shetland	kittiwake	10	3170 ± 1180 (977 - 13400)	47 ± 6 (16 - 77)	228 ± 26 (88 - 319)	5.5 ± 019 (3.0 - 12.7)	26.5 ± 17.6 (1.6 - 181)	nd	53 ± 14 (3 - 122)	0.2 ± 0.1 (nd - 1.1)	5.2 ± 0.8 (1.6 - 8.7)
The Wash	oyster-catcher	10	738 ± 58.3 (390 - 980)	18 ± 2 (8 - 28)	276 ± 15 (214 - 357)	9.0 ± 0.9 (4.4 - 13.5)	4.5 ± 1.1 (0.7 - 12)	nd	12.2 ± 5.5 (2.5 - 59.7)	1.1 ± 0.2 (0.4 - 2.4)	3.9 ± 0.5 (1.3 - 6.7)
Bacton	guillemot	6	633 ± 90.6 (36 4 - 956)	60 ± 12 (12 - 104)	179 ± 23 (127 - 264)	3.4 ± 0.4 (1.5 - 4.7)	0.2 ± 0.0 (0.1 - 0.3)	nd	2.1 ± 0.4 (0.9 - 3.2)	0.004 ± 0.004 (nd - 0.02)	4.7 ± 0.8 (2.0 - 7.9)
Orkney	mute swan	4	634 ± 36 (546 - 722)	1140 ± 55 (1050 - 1280)	282 ± 102 (124 - 581)	19.8 ± 5.1 (5.6 - 28.2)	0.9 ± 0.1 (0.8 - 1.3)	2.2 ± 1.6 (0.4 - 7.0)	2.0 ± 0.5 (1.5 - 3.4)	0.40 ± 0.21 (0.02 - 0.90)	1.1 ± 0.5 (0.4 - 2.4)

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