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- **survey and evaluation**
- **ecological studies**
- **environmental impact assessment**

Funding for basic research comes through NERC from the Department of Education and Science but a very substantial proportion also comes from customers who commission work. These customers include the World Health Organisation, United Nations Environment Programme, the European Economic Community, the Department of the Environment, the Nature Conservancy Council and a range of other public and private organisations.

The geographical distribution of 250 staff in six Research Stations throughout Britain allows efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics.

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BIRDS AND POLLUTION

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

Annual report to Nature Conservancy Council

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M C FRENCH & I WYLLIE

Monks Wood Experimental Station
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Part 1 Organochlorines and mercury in predatory birds, 1989

2 Organochlorines and mercury in peregrine eggs, 1989

3 Organochlorines and mercury in merlin eggs, 1989

4 Organochlorines and mercury in golden eagle eggs, 1963-86

5 Organochlorines and mercury in gannet eggs, 1989

6 Rodenticides in barn owls

7 Incident investigations

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C O N T E N T S

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1 ORGANOCHLORINES AND MERCURY IN PREDATORY BIRDS, 1989

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 (poly-chlorinated 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.

1.2 Results

During 1989, the livers from 184 birds were analysed, including those from 63 kestrels, 91 sparrowhawks, 116 herons, 8 kingfishers, 2 great-crested grebes and 34 others. These totals included some birds which had died in other years, but which were analysed in 1989. In particular, the unusually large total for heron was due to a batch of 99 birds received from Scotland, where they had been collected throughout the 1980s. The results from all these birds are listed in Table 1, and the geometric means for each chemical from the main species (1989 specimens only) are given in Table 2.

Seven significant differences in geometric mean values were found between the 1989 and 1988 results, out of 20 comparisons (Table 3). These included a decrease in HEOD and Hg levels in kestrel, a decrease in DDE, HEOD and Hg levels in sparrowhawk, and a decrease in DDE and HEOD in heron. It is impossible to say whether these differences reflected real changes in exposure. Occasional birds contained exceptionally high residue levels for their species, for example a Welsh peregrine which contained 292 ppm PCBs and a Scottish merlin which contained 7.51 ppm mercury.

Table 1. Levels of organochlorines (ppm in wet weight) and mercury (ppm in dry weight) in the livers of predatory birds analysed between April 1989 and March 1990. ND=none detected.

Spec. no.	Date found	County	Age	Sex	pp'-DDE	HEOD	PCBs	Hg
Kestrel (*Falco tinnunculus*)								
9667	Oct 86		A	F	0.04	0.29	1.48	ND
9669	Oct 88		A	M	ND	0.19	2.98	ND
9405	Dec 88	Essex	J	F	2.77	1.05	13.93	1.15
9407	Dec 88	Aberdeens	J	F	0.79	0.26	1.51	0.25
9410	Dec 88	Aberdeens	A	M	0.23	0.25	1.81	ND
9415	Jan 89	N'hants	A	M	1.42	0.23	3.70	ND
9416	Jan 89	Aberdeens	J	F	1.13	ND	7.77	0.81
9422	Jan 89	Essex	A	M	3.35	ND	6.70	ND
9426	Jan 89	N. Yorks	A	M	0.21	0.11	1.44	ND
9431	Jan 89	Yorks	J	F	ND	0.14	1.24	ND
9440	Jan 89	Herts	J	M	2.67	0.34	4.68	ND
9450	Feb 89	Oxon	A	M	0.31	0.62	1.79	ND
9837	Feb 89	Norfolk	J	M	0.89	0.49	ND	0.74
9635	Feb 89	Norfolk	J	M	0.11	0.05	1.30	ND
9553	Mar 89	Leics	A	M	1.92	0.28	57.90	0.09
9555	Mar 89	Inverness	J	F	0.24	0.09	3.58	0.11
9565	Mar 89	Aberdeens	J	M	34.06	1.29	9.23	0.60
9576	Mar 89	Hunts	A	M	0.89	0.49	1.44	ND
9585	Apr 89	Norfolk	J	F	12.99	0.41	3.31	ND
9591	Apr 89	Glams	J	M	0.65	0.14	2.16	ND
9597	Apr 89	Aberdeens	A	F	0.05	0.11	0.54	ND
9604	Apr 89	Inverness	A	F	0.08	0.09	0.92	0.82
9622	Jul 89	Staffs	J	M	0.03	ND	1.68	ND
9628	Jul 89	Lincs	J	M	0.10	0.28	1.20	ND
9637	Jul 89	Essex	A	F	0.02	0.15	0.92	0.20
9640	Jul 89	Northants	J	F	0.05	0.45	2.92	ND
9641	Jul 89	Suffolk	J	F	0.09	0.17	2.52	ND
9643	Jul 89	Kent	J	M	0.36	0.51	12.78	0.49
9783	Jul 89	Aberdeens	J	M	0.04	0.37	1.66	ND
9642	Aug 89	Hunts	J	M	0.85	0.38	11.90	0.43
9644	Aug 89	Northants	J	M	0.05	0.37	1.81	ND
9672	Aug 89	Bucks	J	F	0.69	0.28	1.81	ND
9739	Aug 89	Norfolk	J	F	0.17	0.19	1.82	ND
9838	Aug 89	Norfolk	J	F	2.85	ND	0.93	1.28
9699	Sep 89	Dorset	J	F	0.18	0.22	5.85	0.36
9715	Sep 89	Moray	A	M	0.03	0.12	3.11	0.14
9718	Sep 89	Essex	A	F	0.35	0.23	127.37	ND
9723	Sep 89	Cambs	J	M	0.29	0.32	10.56	ND
9724	Sep 89	Norfolk	J	F	0.13	0.12	1.73	ND
9729	Sep 89	Sussex	J	F	0.03	0.10	2.88	ND
9735	Sep 89	Aberdeens	A	F	0.11	0.19	2.51	ND
9746	Oct 89	Notts	J	-	0.24	2.21	5.14	ND
9747	Oct 89	Salop	J	F	0.03	0.18	1.01	ND
9752	Oct 89	Cambs	-	-	1.15	0.74	6.36	ND
9758	Oct 89	Yorks	A	M	0.07	0.19	3.33	0.21
9763	Oct 89	Northants	A	M	0.05	ND	3.24	ND
9765	Oct 89	Cambs	A	F	0.11	0.16	1.11	ND

9768	Oct 89	Carmarthen	J	M	ND	0.04	1.06	ND
9779	Nov 89	Cambs	J	F	0.17	0.81	2.53	ND
9792	Nov 89	Glamorgan	J	F	0.03	0.31	2.31	ND
9811	Nov 89	Leics	-	M	0.02	1.17	12.95	0.13
9847	Nov 89	Herts	J	F	1.09	ND	2.13	2.10
9810	Dec 89	Aberdeen	J	F	0.05	0.25	2.89	ND
9812	Dec 89	Sussex	J	F	0.26	0.32	2.21	0.29
9814	Dec 89	Aberdeens	A	F	0.03	0.05	0.87	0.09
9825	Dec 89	Lincs	J	M	ND	0.03	0.64	0.05
9827	Dec 89	Salop	J	F	0.05	0.32	1.03	ND
9832	Dec 89	Lanark	A	M	0.35	1.04	2.48	1.21
9834	Dec 89	Kent	J	F	0.14	ND	0.49	0.49
9859	Dec 89	Cheshire	J	F	0.25	ND	9.61	2.05
9860	Dec 89	Lincs	J	F	8.29	ND	30.09	13.78
9836	Jan 90	Glos	J	F	0.40	ND	0.35	0.66
9846	Jan 90	Hants	J	F	ND	0.00	0.86	1.36
9884	Feb 90	Lincs	J	F	1.33	0.38	4.10	2.71

Sparrowhawk (Accipiter nisus)

9558	Aug 88	Northants	J	F	0.10	0.03	0.47	ND
9654	Sep 88	Ross & Crom	J	F	4.16	0.19	3.86	0.30
9655	Sep 88	Ross & Crom	J	M	0.31	0.04	1.83	0.20
9798	Sep 88	Brecon	J	M	0.15	0.13	0.60	ND
9409	Nov 88	Glamorgan	J	F	0.15	0.07	0.64	0.11
9411	Dec 88	Cambs	J	M	8.31	0.78	4.32	ND
9418	Jan 89	Cambs	J	M	2.07	0.32	1.47	0.58
9420	Jan 89	Aberdeens	J	M	34.71	0.31	7.13	0.50
9427	Jan 89	Kent	J	F	52.87	0.37	20.76	0.16
9657	Jan 89	Ross & Crom	A	M	0.32	0.04	0.60	ND
9799	Jan 89	Brecon	A	M	2.61	0.30	15.77	0.34
9435	Feb 89	Leics	J	F	11.38	0.36	5.60	0.51
9436	Feb 89	Gloucs	J	M	25.82	2.11	44.71	0.30
9438	Feb 89	Salop	J	M	1.15	0.13	1.55	0.33
9441	Feb 89	IOM	A	F	0.37	0.18	0.81	0.32
9442	Feb 89	Oxon	J	F	0.45	0.19	1.59	0.09
9447	Feb 89	Argyll	J	M	2.39	0.27	8.95	3.45
9452	Feb 89	IOM	A	M	0.52	0.60	1.91	0.40
9454	Feb 89	Hereford	J	M	0.69	1.07	0.70	0.11
9549	Feb 89	Yorks	J	M	5.61	0.26	13.24	1.46
9551	Feb 89	Gwynedd	J	M	0.46	0.05	1.30	3.02
9560	Feb 89	Argyll	J	F	8.87	ND	10.83	3.33
9554	Mar 89	Norfolk	A	M	2.59	0.10	1.92	0.25
9556	Mar 89	Yorks	A	F	0.50	0.10	1.80	0.24
9557	Mar 89	Northants	A	F	0.71	0.17	0.91	ND
9561	Mar 89	Surrey	A	F	16.16	0.98	143.22	1.73
9562	Mar 89	Argyll	A	F	10.41	0.87	25.49	2.99
9571	Mar 89	Northants	J	M	1.31	0.17	3.66	0.26
9573	Mar 89	Norfolk	A	M	4.44	0.76	2.75	0.26
9577	Mar 89	Cardigans	-	M	0.76	0.13	2.35	1.89
9580	Mar 89	Brecon	J	M	1.43	0.15	2.75	0.41
9646	Mar 89	Worcs	J	M	6.76	0.97	3.31	0.11
9584	Apr 89	Sussex	A	M	1.31	0.21	0.91	0.64
9586	Apr 89	Surrey	A	M	22.44	ND	51.33	1.38
9740	Apr 89	Yorks	J	M	6.01	1.60	13.00	ND

9888	Apr	89	Midlothian	J	M	2.68	ND	9.13	1.80
9602	May	89	Herts	A	M	2.13	ND	3.91	1.70
9603	May	89	Northants	A	M	3.75	0.49	8.88	0.62
9605	May	89	Brecon	A	M	1.31	0.28	4.64	0.12
9606	May	89	Staffs	A	M	2.40	0.32	6.76	0.17
9607	May	89	Stirlings	J	M	1.52	0.15	3.48	0.50
9620	Jun	89	Anglesey	J	F	1.54	0.95	3.63	0.61
9656	Jul	89	Ross & Crom	J	M	2.02	0.14	1.43	0.34
9648	Aug	89	Merioneth	J	M	2.11	0.31	8.21	0.58
9649	Aug	89	Wilts	J	F	0.13	0.05	2.16	0.32
9651	Aug	89	Dorset	J	F	0.05	0.05	1.93	ND
9660	Aug	89	Herts	J	M	0.47	0.10	0.68	ND
9661	Aug	89	Leics	J	F	0.14	0.30	0.85	0.23
9662	Aug	89	Yorks	J	M	0.08	0.06	1.17	ND
9671	Aug	89		A	F	0.39	0.31	1.95	0.21
9673	Aug	89	Herts	J	M	0.16	ND	3.06	0.19
9674	AUG	89	Cardigans	J	M	3.46	0.38	14.52	1.75
9675	Aug	89	Lincs	J	F	0.18	ND	0.32	0.14
9677	Aug	89	Oxon	J	F	0.17	0.13	0.42	0.06
9714	Aug	89	Inverness	J	F	0.90	ND	0.30	0.64
9820	Aug	89	Caithness	J	F	0.31	0.05	1.24	0.25
9693	Sep	89	Lincs	A	M	11.84	0.35	4.34	0.12
9713	Sep	89	Wilts	J	F	0.39	ND	0.69	ND
9722	Sep	89	-	J	M	0.16	0.09	1.45	ND
9726	Sep	89	Lancs	J	F	0.09	ND	0.33	ND
9738	Sep	89	Notts	J	F	1.13	0.85	1.87	0.14
9887	Sep	89	Fife	J	F	0.37	ND	ND	0.93
9889	Sep	89	Midlothian	J	M	0.84	ND	ND	2.21
9727	Oct	89	Dorset	J	M	0.33	ND	0.82	0.21
9745	Oct	89	Essex	J	F	1.51	0.08	0.29	0.33
9748	Oct	89	Herts	J	F	0.09	ND	0.31	0.32
9762	Oct	89	Montgom	J	F	0.28	ND	0.32	0.06
9764	Oct	89	Argyll	J	F	3.76	0.42	7.62	1.56
9766	Oct	89	Ayrshire	A	F	1.78	0.15	1.59	0.42
9772	Oct	89	IOW	J	F	0.15	0.06	0.50	0.07
9774	Oct	89	Bucks	J	M	1.31	ND	2.65	ND
9781	Oct	89	Kent	A	F	1.05	0.16	1.07	0.06
9822	Oct	89	Salop	A	F	1.19	0.42	5.50	ND
9775	Nov	89	Somerset	A	F	14.08	0.79	6.41	0.16
9780	Nov	89	Salop	J	F	0.12	0.06	0.60	0.14
9784	Nov	89	Surrey	J	F	0.05	0.04	0.32	0.05
9788	Nov	89	Cambs	A	F	51.54	1.68	18.51	0.28
9791	Nov	89	Leics	J	M	0.16	0.12	4.72	ND
9795	Nov	89	Hants	J	F	0.23	0.04	2.15	ND
9800	Nov	89	Gwent	J	F	26.65	2.60	12.29	0.49
9801	Nov	89	Gwent	J	F	0.93	ND	1.24	ND
9808	Nov	89	Yorks	A	F	0.28	0.07	4.46	ND
9813	Nov	89	Ross & Crom	J	M	0.21	0.03	1.11	0.18
9870	Jan	90	Sussex	A	M	6.36	ND	32.08	5.94
9871	Jan	90	Bucks	J	M	1.88	ND	2.59	1.77
9876	Jan	90	Devon	J	F	2.59	ND	4.02	7.22
9877	Jan	90	Hants	J	F	0.49	0.10	0.43	0.42
9880	Jan	90	Northants	J	F	0.53	ND	1.01	1.88
9881	Jan	90	Staffs	J	M	0.73	ND	1.83	0.15
9883	Jan	90	Derby	J	M	0.13	ND	1.80	2.11
9886	Feb	90	Berks	A	M	4.98	ND	35.12	9.21

Peregrine falcon (Falco peregrinus)

9408	Jul 88	Glamorgan			0.41	0.07	2.63	0.22
9698	Jul 88	Inverness	-	-	8.71	0.56	195.92	0.48
9609	May 89	Caernarvon	A	M	24.28	1.98	292.16	4.50
9753	Oct 89	Cumbria	J	M	1.41	0.10	3.73	1.63
9858	Jan 90	Pembroke	J	M	1.16	ND	5.03	3.08
9891	Jan 90	Norfolk	-	-	0.92	ND	6.24	6.52
9666			-	M	0.20	0.07	2.79	ND

Merlin (Falco columbarius)

9680	May 88		-	F	19.29	ND	0.87	0.10
9445	Feb 89	Lincs	J	M	9.53	0.42	4.66	0.09
9568	Mar 89	Radnor	A	F	6.54	0.37	6.75	0.82
9582	Apr 89	Argyll	A	M	ND	0.62	70.49	3.04
9626	Jul 89	Lincs	A	M	1.21	0.19	2.80	0.50
9757	Oct 89	Renfrew	J	F	2.87	ND	5.26	7.51
9789	Nov 89	Pembroke	J	M	0.40	ND	2.35	2.67
9829	Dec 89	Orkney	J	F	0.23	0.06	0.57	4.14
9668			J	M	6.97	ND	5.39	0.15

Buzzard (Buteo buteo)

9583	Mar 89	Herefords	-	M	0.01	0.17	1.32	2.32
9608	May 89	Cardigans	-	-	0.06	0.13	0.90	0.88
9616	May 89	Dorset	-	-	ND	0.32	0.48	1.93
9625	Jul 89	Radnor	A	F	0.04	0.20	0.57	1.67
9631	Jul 89	Cardigans	-	-	ND	ND	0.47	4.10
9702	Sep 89	Carmathen	-	-	ND	ND	0.28	1.06
9720	Sep 89	Argyll	J	F	ND	ND	0.45	6.30
9743	Oct 89	Cornwall	J	F	ND	ND	0.47	0.53
9797	Nov 89	Cardigans	A	F	ND	0.00	0.99	1.11

Red Kite (Milvus milvus)

9600	Apr 89	-	-	F	0.16	ND	1.43	0.73

Hen Harrier (Circus cyaneus)

9816	Jun 89	Sutherland	J	F	0.03	ND	0.49	0.70
9818	Jun 89	Moray	J	M	0.19	ND	0.49	0.38
9819	Jun 89	Moray	J	M	0.14	ND	0.48	0.36
9769	Oct 89	Kircud	A	M	0.48	0.48	0.49	8.50

Montagu's Harrier (Circus pygargus)

9623	Jul 89	-	J	-	0.11	ND	0.34	0.23
9624	Jul 89	-	J	-	0.09	ND	0.39	0.13

Hobby (Falco subbuteo)

9639	Jul 89	Northants	A	M	3.09	0.26	4.32	1.79

Goshawk (Accipiter gentilis)

9682	Nov 86		A	F	0.24	ND	3.07	ND

Heron (Ardea cinerea)

9485	Feb 73	Argyll	J	-	55.18	ND	55.59	21.04
9477	Nov 79	Fife	J	-	2.25	15.05	0.82	7.50
9463	Apr 80	Angus	-	-	56.65	1.88	14.31	11.69
9500	Jul 80	Angus	A	-	9.38	ND	26.69	43.85
9468	Oct 81	Kincardine	-	-	0.26	0.07	0.74	2.22
9483	Nov 81	Perths	J	-	0.25	ND	ND	4.95
9491	Nov 81	Kinross	J	-	0.17	ND	1.41	6.08
9472	Jan 82	Angus	J	-	16.02	1.52	5.70	28.89
9487	Feb 82	Perths	J	-	33.43	2.40	20.07	23.63
9456	Jun 82	Fife	-	-	0.32	0.11	1.54	50.00
9478	Oct 82	Fife	-	-	4.75	2.05	3.64	17.81
9495	Dec 82	Roxburgh	-	-	0.65	0.12	ND	26.09
9496	Jan 82	Kinross	J	-	0.63	ND	0.61	7.05
9503	May 82	Kirkcudbr	J	-	0.02	ND	1.94	5.50
9461	Feb 83	Arran	J	-	0.26	ND	0.34	4.50
9476	Feb 83	Perths	-	M	23.91	1.04	6.54	33.70
9504	Feb 83	Perths	J	-	99.71	29.13	2.10	184.16
9501	Mar 83	Fife	-	-	4.37	ND	2.44	20.40
9482	Apr 83	Perths	A	-	0.54	ND	1.46	13.86
9460	May 83	Fife	-	-	10.45	0.62	3.17	20.16
9502	Sep 83	Bute	A	-	0.42	ND	0.48	10.10
9470	Oct 83	Kinross	J	-	0.10	ND	0.41	3.40
9458	Nov 83	Bute	-	-	0.17	ND	0.33	7.27
9467	Jan 84	Dumfriess	J	-	0.40	0.15	0.52	24.23
9488	Jan 84	Ayrs	J	-	0.02	ND	39.22	39.60
9462	Feb 84	Argyll	-	-	0.19	0.11	2.35	2.89
9490	Feb 84	Orkney	J	-	8.01	ND	10.05	135.01
9464	Apr 84	Dumfriess	-	-	0.69	ND	0.73	4.51
9480	Apr 84	Perths	A	-	1.87	ND	1.93	32.89
9469	May 84	Dundee	A	-	2.57	0.28	1.35	35.11
9489	May 84	Fife	-	-	0.72	ND	4.30	33.00
9492	Jun 84	Angus	-	-	0.42	0.12	ND	9.22
9475	Oct 84	Aberdeens	-	-	1.94	0.27	0.62	20.71
9479	84/85	Angus	-	-	2.25	1.04	0.35	4.46
9471	Jan 85	Dumfriess	J	-	1.55	0.32	1.00	15.46
9497	Jan 85	Kinross	J	-	0.05	ND	ND	20.52
9457	Feb 85	Dumfriess	-	-	42.94	4.93	40.24	73.33
9455	Mar 85	W. Ross	-	-	0.24	0.09	1.18	9.47
9499	Mar 85	Fife	J	-	3.34	ND	4.88	1.80
9466	Aug 85	Angus	-	-	68.38	8.21	19.05	20.50
9493	Oct 85	E. Lothian	J	-	0.13	0.10	ND	7.83
9481	Feb 86	Kinross	A	-	22.99	ND	36.17	151.43
9484	Feb 86	Angus	J	-	86.91	ND	67.72	89.82
9486	Feb 86	Kinross	J	-	98.18	ND	36.32	42.35
9498	Feb 86	Ayrshire	J	-	5.71	ND	2.63	79.21
9465	Apr 86	Angus	-	-	3.74	0.46	3.95	32.61
9474	Apr 86	Inverness	A	-	0.38	0.11	1.99	19.26
9473	Sep 86	Ross	-	-	3.69	0.28	1.14	15.62
9505	Nov 86	Argyll	A	M	0.01	0.09	4.84	4.19
9506	Nov 86	Argyll	A	F	0.05	0.03	1.76	30.10
9507	Nov 86	Argyll	A	M	0.06	0.02	0.36	9.63
9508	Dec 86	Argyll	J	M	0.06	0.05	0.25	11.52
9509	Dec 86	Argyll	J	M	0.07	0.04	1.88	23.16
9459	- 86	Aberdeens	-	-	39.19	0.73	3.16	16.57

9544	86/87	Perths	J	F	0.63	0.30	2.10	23.54
9545	86/87	Perths	J	M	0.32	0.25	ND	5.98
9546	86/87	Perths	J	M	0.06	0.06	0.59	12.93
9494	Jan 87	Peebles	J	-	0.04	ND	ND	19.49
9510	Jan 87	Argyll	J	M	0.03	0.02	0.45	16.23
9511	Jan 87	Argyll	J	M	0.01	0.03	0.33	11.34
9523	Jan 87	Perths	J	-	0.25	0.04	0.23	22.07
9548	Jan 87	Argyll	J	F	ND	ND	2.78	6.21
9512	Feb 87	Argyll	J	M	0.05	0.07	0.23	8.74
9513	Feb 87	Argyll	A	F	0.05	ND	1.09	10.25
9514	Feb 87	Argyll	J	M	0.04	0.04	2.28	7.98
9524	Mar 87	Perths	J	M	0.25	0.03	1.46	12.45
9525	Mar 87	Perths	J	M	3.58	0.57	2.04	17.80
9526	Mar 87	Perths	J	F	0.07	0.03	0.38	9.62
*9515	Apr 87	Argyll	A	F	0.02	0.03	1.10	31.25
9547	Apr 87	Perths	J	F	0.98	0.21	ND	13.46
9543	May 87	Perths	J	F	1.07	ND	0.87	7.56
*9516	Jun 87	Argyll	A	M	0.01	ND	3.87	8.72
9517	Jun 87	Argyll	J	F	0.10	ND	0.48	7.69
9518	Jun 87	Argyll	J	M	0.11	0.11	0.40	3.73
9519	Jul 87	Argyll	J	-	0.02	0.03	1.46	4.76
9520	Jul 87	Argyll	J	-	0.17	0.16	1.24	5.05
9527	Jul 87	Perths	J	M	0.05	0.03	1.47	9.26
9528	Jul 87	Perths	J	M	0.01	0.03	0.43	4.49
9529	Sep 87	Perths	J	-	0.04	0.03	1.75	2.47
9530	Sep 87	Perths	J	-	0.08	0.27	2.35	3.39
9531	Sep 87	Perths	J	-	0.12	0.07	2.18	4.30
9532	Sep 87	Perths	J	-	ND	ND	ND	4.84
9533	Sep 87	Perths	J	-	0.18	ND	ND	4.42
9534	Sep 87	Perths	J	-	0.17	ND	ND	5.38
9535	Sep 87	Perths	J	-	0.04	ND	ND	2.35
9536	Sep 87	Perths	J	-	0.22	0.18	ND	8.64
9537	Sep 87	Perths	J	-	0.09	0.13	ND	10.43
9538	Sep 87	Perths	J	-	ND	ND	ND	4.95
9539	Sep 87	Perths	J	-	0.39	0.10	2.12	3.44
9540	Sep 87	Perths	J	-	0.11	0.04	ND	6.03
9541	Sep 87	Perths	J	-	0.26	0.22	ND	4.41
9542	Sep 87	Perths	J	-	0.07	ND	2.82	2.76
9521	Feb 88	Argyll	J	-	0.16	0.05	1.93	11.93
9522	Feb 88	Argyll	A	M	0.07	0.02	0.30	84.48
9652	Sep 88	Ross & Crom	J	F	2.12	ND	2.52	10.76
9417	Jan 89	W Sussex	A	M	0.07	0.04	0.65	19.13
9432	Jan 89	Caithness	J	M	0.24	0.13	0.54	24.68
9439	Feb 89	Durham	A	M	0.10	0.05	0.85	5.41
9567	Mar 89	IOM	A	F	0.04	0.04	0.67	45.48
9572	Mar 89	Derbys	A	M	0.92	0.26	9.66	15.06
9579	Mar 89	Hunts	J	M	1.51	0.20	2.88	4.57
9802	Mar 89	Monmouth	A	M	0.20	0.13	2.08	9.10
9581	Apr 89	Anglesey	A	M	2.15	32.37	23.34	22.97
9610	May 89	Leics	J	F	0.22	ND	4.16	7.08
9618	Jun 89	Cheshire	J	M	0.03	ND	1.15	3.42
9633	Jul 89	Carmarthen	J	F	0.97	ND	4.11	3.87
9638	Jul 89	Cardigans	J	M	0.19	ND	0.82	5.64
9697	Sep 89	Carmarthen	J	F	0.31	ND	1.75	2.42
9700	Sep 89	Hereford	J	M	0.23	ND	0.73	17.42
9755	Sep 89	Devon	J	M	0.24	ND	3.10	6.82

9730	89	Lancs	J	M	0.13	ND	0.68	1.40
9731	89	Lancs	J	F	0.33	ND	2.77	3.40
9873	Jan 90	Radnor	J	M	0.02	ND	0.16	2.52
9879	Jan 90	Perths	J	M	0.58	0.11	ND	35.18

Great Crested Grebe (Podiceps cristatus)

9595	Apr 89	Cheshire	A	F	0.16	ND	0.60	2.55
9645	Aug 89	Warwicks	A	M	0.18	ND	0.53	3.55

Slavonian grebe (Podiceps auritus)

9759	Jul 88	Inverness	J	F	0.01	ND	0.42	2.76

Kingfisher (Alcedo atthis)

9613	Jun 89	Denbigh	J	F	0.30	0.57	17.32	0.49
9621	Jul 89	Bedfords	J	F	1.10	1.13	3.40	1.04
9629	Jul 89	Middx	J	F	0.44	1.64	11.96	ND
9665	Aug 89	Berks	J	M	0.27	0.52	2.40	1.74
9690	Sep 89	Beds	J	F	1.05	ND	5.80	1.95
9733	Oct 89	Derbys	A	M	ND	ND	2.93	2.01
9862	Jan 90	Carmarthen	A	F	0.26	0.25	ND	0.28
9874	Jan 90	Hants	A	F	0.31	0.24	0.88	0.74

*These birds showed detectable amounts of pp'DDT as follows (ppm wet weight):

	pp'-TDE	pp'-DDT
Heron		
9515	-	0.70
9516	-	0.55

Table 2. Geometric mean levels of pollutants in the various species in Table 1, for 1989 specimens only.

	pp'-DDE	HEOD	PCBs	Hg
Kestrel				
Mean	0.20	0.15	2.60	0.04
N	56	56	56	56
Range within 1 SE	0.15 - 0.25	0.12 - 0.18	2.17 - 3.11	0.03 - 0.06
Sparrowhawk				
Mean	1.14	0.12	2.23	0.19
N	77	77	77	77
Range within 1 SE	0.90 - 1.38	0.10 - 0.14	1.86 - 2.68	0.15 - 0.23
Merlin				
Mean	1.04	0.08	4.69	1.04
N	8	8	8	8
Range within 1 SE	0.45 - 2.37	0.04 - 0.14	2.92 - 7.56	0.59 - 1.84
Heron				
Mean	0.24	0.04	1.84	7.71
N	17	17	17	17
Range within 1 SE	0.18 - 0.32	0.02 - 0.07	1.42 - 2.38	6.14 - 9.70
Kingfisher				
Mean	0.27	0.19	5.53	0.57
N	6	6	6	6
Range within 1 SE	0.13 - 0.55	0.08 - 0.51	3.98 - 7.69	0.25 - 1.32

Great-crested Grebes were omitted because only two carcases were received during 1989.

Table 3. Comparison of geometric mean residue levels (log values) from birds collected in 1988 and 1989; t-values are shown. Minus values indicate a decrease from 1988.

	pp'-DDE	HEOD	PCBs	Hg
Kestrel	t_{77}=-0.50	t_{77}=-2.13*	t_{77}=0.75	t_{77}=-6.50***
Sparrowhawk	t_{136}=-3.19**	t_{136}=-5.37***	t_{136}=0.12	t_{136}=-11.60***
Merlin	t_{14}=-0.13	t_{14}=-0.78	t_{14}=2.11	t_{14}=-1.11
Kingfisher	t_{7}=-0.78	t_{7}=-0.81	t_{7}=1.77	t_{7}=-1.10
Heron	t_{29}=-2.89**	t_{29}=-2.11*	t_{29}=-1.25	t_{29}=0.07

Notes: Zero values were taken as 0.01 for all residues.

Significance values * = $P<0.05$ ** = $P<0.01$ *** = $P<0.001$

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BIRDS AND POLLUTION

Part 2 Organochlorines and mercury in peregrine eggs, 1989

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August 1990

2 ORGANOCHLORINES AND MERCURY IN PEREGRINE EGGS, 1989

2.1 Introduction

The findings from all peregrine eggs analysed between 1961 and 1986 have recently been summarised in Newton et al (1989); those from eggs analysed in 1987 and 1988 are given in previous reports in this series, and those from eggs analysed in 1989 are given in Table 4. Other peregrine eggs from these years are awaiting analysis at the Glasgow University Veterinary School, and are outwith our programme.

2.2 Results

The eggs from 22 clutches analysed in 1989 add little to the findings of previous years, except to confirm the continuing contamination of peregrines with organochlorines and mercury (Table 5). All the values found were within the range of previous figures, and no particularly high values were found, apart from 64 ppm PCBs in a Shetland egg.

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 1989. ND=none detected.

Egg No.	Year	County	Shell index	pp'-DDE	HEOD	PCBs	Hg
SOUTH WEST ENGLAND							
E3569	1989	Cornwall	1.98	0.66	ND	7.12	0.19
CENTRAL ENGLAND							
E3584	1989	Shropshire	1.93	1.29	ND	1.32	ND
WALES							
E3876	1989	Glamorgan	1.78	0.80	ND	2.62	ND
NORTHERN ENGLAND							
E3582	1989	Yorkshire	1.79	1.19	ND	2.35	ND
E3649		Cumbria	1.88	1.49	0.22	4.02	1.41
E3650		Cumbria	1.55	1.68	0.21	4.47	1.44
E3651		Cumbria	1.68	2.68	0.25	13.80	0.55
E3653		Cumbria	1.83	1.72	0.32	5.23	1.30
E3654		Cumbria	2.11	1.54	0.22	2.56	0.38
E3655		Cumbria	1.87	0.93	0.15	2.01	0.07
E3656		Cumbria	1.95	1.42	0.39	3.14	0.06
E3873		Cumbria	1.79	2.00	ND	1.19	ND
E3874		Cumbria	1.82	0.03	0.30	14.85	ND
CENTRAL AND EASTERN HIGHLANDS							
E3397	1988	Shetland	1.48	ND	ND	64.33	2.45
E3722	1989	Orkney	2.06	1.49	0.30	5.58	3.74
E3571		Grampian	1.70	0.71	0.18	3.17	ND
E3572		Grampian	1.75	0.09	0.08	4.10	ND
E3746		Grampian	2.04	0.37	ND	1.80	0.16
E3835		Grampian	2.03	0.74	0.17	3.87	ND
E3635		Tayside	1.63	2.38	ND	6.21	0.42
E3636		Tayside	1.82	0.29	0.12	1.89	ND
E3842		Tayside	1.65	0.46	0.15	0.67	ND

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BIRDS AND POLLUTION

Part 3 Organochlorines and mercury in merlin eggs, 1989

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3 ORGANOCHLORINES AND MERCURY IN MERLIN EGGS, 1989

3.1 Introduction

The findings from most previous analyses of merlin eggs were given in Newton & Haas (1988), those from 1987 and 1988 in previous reports in this series, while those from 1989 are summarised in Table 5.

3.2 Results

As in the peregrine, the results from these additional 39 merlin eggs add little to the findings from previous years, except to confirm a continuing high contamination of British merlins with organochlorines and mercury. Occasional eggs, mainly from eastern Scotland, contained exceptionally high levels of organochlorines.

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 in lipid; mercury ppm in dry weight) and shell indices for Merlin eggs analysed in 1989.

C=clutch size; F=brood size; ND=non detected

Year	County	C	F	Shell index	pp'-DDE	HEOD	PCBs	Hg
SOUTHERN ENGLAND								
1989	Somerset	4	2	1.14	30.95	3.40	143.20	2.25
	Somerset	4	2	1.13	33.10	4.14	115.86	2.04
NORTHERN ENGLAND								
1989	N'berland	3	2	1.01	76.64	ND	67.21	1.74
	N. Yorkshire	4	0	1.04	61.61	6.19	70.90	1.81
	N. Yorkshire	5	2	-	122.93	10.51	96.18	2.00
	W. Yorkshire	4	3	1.13	53.18	3.81	69.70	0.59
	Durham	-	-	1.28	40.54	ND	58.56	1.12
	Durham	-	-	1.20	48.76	ND	41.74	1.10
	Durham	-	-	1.16	45.93	4.23	15.96	1.11
	Durham	-	-	1.23	37.28	3.94	77.06	1.60
	Durham	-	-	1.19	68.15	5.41	78.98	2.84
	Durham	-	-	1.02	58.45	6.28	60.87	2.94
	Durham	-	-	1.16	57.38	8.36	37.60	3.42
	Durham	-	-	1.18	71.63	4.49	84.83	2.21
GALLOWAY AND SOUTHERN UPLANDS								
1989	Lothians	5	3	0.93	134.21	ND	157.46	2.52
	Lothians	4	0	1.17	52.67	ND	80.33	1.34
	Lothians	5	4	-	70.78	ND	64.61	3.43
	Lothians	5	2	0.96	155.91	13.26	21.33	1.20
	Strathclyde	5	3	-	38.56	ND	59.48	4.48
	Strathclyde	5	0	1.07	128.09	ND	84.64	3.82
	Strathclyde	4	0	1.06	34.05	3.94	91.76	3.44
	Strathclyde	-	2	1.18	140.59	7.29	39.93	2.37
	Strathclyde	5	4	-	211.34	6.07	179.35	4.50
	D. & G.	4	3	1.31	35.00	3.16	43.95	3.22
	D. & G.	5	3	1.19	45.08	4.37	62.57	1.95
HIGHLANDS								
1988	Inverness	2	0	1.13	53.14	ND	43.00	1.46
	Inverness	-	-	1.30	58.72	5.69	29.53	2.52
	Inverness	-	-	1.15	59.79	39.86	40.21	2.71
1989	Aberdeenshire	5	4	1.09	97.67	8.14	78.29	1.79
	Aberdeenshire	4	2	1.22	126.02	3.52	152.44	0.69
	Aberdeenshire	5	3	1.17	61.09	2.57	64.63	2.41
	Aberdeenshire	5	3	1.22	52.70	ND	46.62	1.87
	Aberdeenshire	5	3	-	100.78	3.49	51.94	2.46
	Angus	-	-	1.04	144.10	ND	24.89	2.84
	Angus	-	-	0.95	222.15	34.81	536.08	2.34
	Argyll	-	-	1.28	35.65	ND	14.83	3.55
	Argyll	-	-	1.23	8.51	ND	4.26	4.18
	Argyll	-	-	1.26	24.65	1.24	12.77	3.67
	Banffshire	4	0	1.01	118.80	5.20	54.00	4.66

	Kincardines	-	2	0.90	157.97	7.46	57.63	2.11
	Kincardines	5	4	1.35	44.17	ND	32.77	2.24
	Perthshire	-	-	1.27	34.84	ND	34.84	3.27
	Perthshire	4	3	1.02	72.16	ND	63.77	2.61
	Perthshire	5	0	1.10	62.50	ND	96.65	1.38
	Perthshire	4	1	1.28	94.34	ND	65.48	2.07
ORKNEY								
1989		-	-	1.02	119.85	9.16	50.38	4.97
		-	-	1.05	35.71	2.65	29.63	5.77

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BIRDS AND POLLUTION

Part 4 Organochlorines and mercury in golden eagle eggs, 1963-86

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4 ORGANOCHLORINES AND MERCURY IN GOLDEN EAGLE EGGS, 1963-86

4.1 Introduction

In this section we examine the organochlorine levels in 234 unhatched Golden Eagle Aquila chrysaetos eggs collected in Scotland during 1963-86. These eggs incorporate earlier samples from 1963-68 examined by Lockie et al (1969) and from 1963-74 examined by Cooke et al (1981). Since these earlier studies, sample sizes have increased greatly, and we are able to investigate trends in residues over a longer time period, together with differences between coastal and inland areas. The chemicals of interest include HEOD (from the insecticides aldrin and dieldrin), DDE (from the insecticide DDT) and PCBs (industrial polychlorinated biphenyls). For a small proportion of eggs, obtained in the 1980s, mercury levels were also determined.

Golden Eagles are distributed throughout the mountainous parts of Scotland, and around cliffs on the western coasts and islands. They feed mainly on medium-sized birds, such as grouse; on medium-sized mammals, such as hares; and on the young and dead of larger mammals, such as deer and sheep (Brown & Watson 1964, Watson et al 1987). Of the chemicals examined, both DDT and dieldrin were used in quantity within the eagles' range. After 1947 DDT came into wide use in sheep dips, but sometime after 1956 it was largely replaced by the more effective dieldrin. From 1966, however, because of concern about the amount of dieldrin present in mutton intended for human consumption, the use of this chemical in sheep dips was banned voluntarily, its place being taken by less persistent organophosphorus compounds. Smaller quantities of dieldrin may have been used after 1966, until stocks ran out. Nevertheless, following the ban, the mean level of HEOD in samples of mutton fat dropped from about 0.8 ppm (maximum 12.4 ppm) in 1964 and 1.1 (maximum 8.2 ppm) in 1965 to 0.4 ppm (maximum 5.3 ppm) in 1966 (Egan 1967). Sheep are more numerous in the hills of western Scotland, and form a larger part of the diet of Golden Eagles there, than in eastern Scotland (Brown & Watson 1964, Watson et al 1987). Not surprisingly, therefore, earlier studies confirmed that DDT and HEOD levels were highest in eagle eggs from the west (Lockie et al 1969, Cooke et al 1982). These and other chemicals probably reached eagles not only from local sheep, but also from other prey species which had become contaminated locally or elsewhere.

4.2 Methods

Chemical analyses were performed at Monks Wood Experimental Station, the Veterinary School of Glasgow University, and the Laboratory of the Government Chemist, using methods described in Newton et al (1990). In the early years consistency in analytical findings between these three laboratories was confirmed on the same samples.

The distribution of concentrations within the egg population examined was skewed, with a few eggs containing unusually high concentrations. Following the convention with residue data, individual values were converted to a $\log_{10}$ scale, and means expressed in the geometric form. In contrast, shell-indices were distributed normally in the statistical sense, so no transformation was used and means are arithmetic. Throughout this section, organochlorine levels are expressed as ppm in wet weight and mercury levels as ppm in dry weight. For most of the period under review, levels of DDE and HEOD could be quantified down to 0.1 ppm, and PCBs to 1.0 ppm, so for computational purposes traces below these levels were taken as 0.05 ppm for DDE and HEOD, and 0.5 ppm for PCBs. Occasional 'nil detected' values were taken arbitrarily as 0.01 ppm for all organochlorines. Mercury could be detected and quantified down to 0.01 ppm. In general, the lower the level of any of these chemicals in the egg content the greater the measurement error. Shell-indices, which reflected the degree of shell-thinning, were calculated as shell weight (mg)/length (mm) x breadth (mm), after Ratcliffe (1970). Although Golden Eagles usually lay two eggs per clutch, no more than one egg from each clutch was included in the computations which follow.

Eggs were sent for analysis by observers in various parts of Scotland. Only unhatched (deserted and addled) eggs were collected. Although such eggs did not represent a random cross-section of those laid, they formed a consistent sample throughout, for examination of regional and time trends. For present purposes, eastern Scotland is taken as regions A and B in Dennis et al (1987), and western Scotland as regions C-H.

4.3 Results

Geographical and time trends

Among the sample of Golden Eagle eggs examined, HEOD was mostly present at less than 0.5 ppm, but occasionally up to 6.0 ppm; DDE was mostly present at less than 1.0 ppm, but occasionally up to 7.8 ppm; while for PCB the equivalent values were less than 1 ppm and 43 ppm. Most of the high PCB levels were from coastal eggs, but one exceptional inland egg from near Aviemore contained 18 ppm PCB.

In general, organochlorines were found at highest level in eggs from western coastal areas, with those from western inland areas being substantially lower, and those from eastern Scotland lower still (Table 6). This geographical trend held in all three successive time periods 1963-70, 1971-80 and 1981-86.

Over the whole study period (1963-86), HEOD levels declined in eggs from western Scotland, both from coastal and inland sites (Table 7). The decline was most marked in the late 1960s, following the ban on dieldrin as a sheep dip (Figure 1). In eastern Scotland, where HEOD was lower throughout, levels did not decline over the study period. The levels of DDE declined during the study period in all three regions, but the trend was significant only in eastern Scotland. In contrast, PCB levels showed a slight upward trend, which emerged as significant only in eggs from western inland areas (the largest sample). The PCB data cover only the post-1970 periods. These chemicals were not found in 21 eagle eggs analysed from inland sites in the late 1960s (Lockie et al 1969). However, analytical techniques were less good then, so PCBs may have been present but below the level of detection, which was slightly higher then. A significant improvement in eggshell index was apparent only in eastern Scotland (Table 7), coinciding with decline in levels of DDE, the main causative agent (Newton 1979).

Relationship with breeding success

Ratcliffe (1970) was able to demonstrate a reduction of 9.9% in the mean shell index of Golden Eagle eggs from western Scotland in 1951-65 compared with pre-DDT (= pre-1947) values, but no similar reduction in eastern Scotland. None of the mean values in Table 6 for post-1970 eggs was significantly lower than the pre-DDT means for those regions, implying that eggshells in western Scotland improved between the 1960s and 1970s, coinciding with the reduction in DDE and HEOD levels. Also, we had no reports of egg breakage after the 1960s.

For 80 of the eggs examined here, we knew whether the pairs concerned had raised no young or one young. No significant difference in the levels of any organochlorines was apparent between these two categories, although the sample size for coastal broods of one chick was small (Table 8). Nor was any such difference apparent among the smaller samples from western Scotland in the period 1963-70.

Mercury levels

In 1981-86 single eggs from 66 clutches were analysed for mercury residues. Of 29 from western coastal districts, ten contained mercury at detectable levels (>0.01 ppm); these eggs had a geometric mean level of 0.39 ppm in dry weight (range 0.10-1.41). Of 27 eggs from western inland districts, only two contained mercury (0.21 and 0.56 ppm); while of ten eggs from eastern districts none contained detectable mercury. Clearly, mercury was a more frequent contaminant in eggs from western coastal areas than in those from elsewhere, fitting with findings from feather analyses (Furness et al 1989).

4.4 Discussion

The regional pattern in organochlorine contamination of Golden Eagle eggs fitted with the regional variations in eagle diet, with more contaminated prey-species being eaten in the west than in the east, and more contaminated prey on the coast than inland. In eastern districts, grouse and hares predominate in the diet, and grouse analysed at Monks Wood Experimental Station were free of organochlorine residues, apart from low levels of PCBs (Newton et al 1989). Further west, the eagles take a wider range of prey, including a greater proportion of sheep carrion, and on the coast, they also eat various seabirds, which are often heavily contaminated with organochlorines and mercury (Bourne 1976, Anon. 1983, Newton et al 1989).

Golden Eagle breeding success is also generally poorer in the west than in the east (Dennis et al 1984), matching the trend in organochlorine contamination. However, it is unlikely that organochlorines are the cause of poor breeding in the west, and more likely that both breeding success and organochlorine levels are dependent on the quantity and type of food available. In the west, food suitable for breeding eagles is not only scarcer than in the east (leading to poorer breeding success, Watson et al 1987, Watson & Langslow 1989), but also different in composition, with more contaminated prey species (leading to more contaminated eagle eggs). This is not to say that Golden Eagles are immune to the effects of organochlorines, only that levels in Scottish birds were generally too low for such effects to be expected. The presence of mercury in western coastal eggs probably also resulted from the inclusion of sea birds in the diet, but again all levels recorded here were lower than those found to influence reproduction in other bird species (Newton et al 1989). Possibly, however, a larger sample of coastal eggs might have revealed occasional clutches with mercury at embryotoxic levels.

The declines in HEOD and DDE levels over the study period were associated with general reductions in the agricultural use of these chemicals over the years, as well as with the cessation of their use in sheep dips. The lack of a decline in PCB levels over the study period must presumably reflect the high persistence of PCBs, together with a continuing input to the environment.

Compared to those raptor species whose numbers and breeding success are known to have been markedly reduced by organochlorines in Scotland, namely the Peregrine Falco peregrinus, Merlin F. columbarius and Sparrowhawk Accipiter nisus, Golden Eagles showed much lower levels of DDE, but similar levels of HEOD (Ratcliffe 1980, Cooke et al 1982, Newton et al 1983, Newton et al 1986, Newton et al 1989). In the 1960s, HEOD levels were as high in some eagle eggs from western Scotland as in Peregrine eggs from elsewhere in Britain, where Peregrines were at that time declining. No decline was noticed in eagle numbers, but as well as lower levels of DDE, eagles presumably had a longer mean natural lifespan. Both species had a substantial surplus of non-breeders, able to replace rapidly any adults lost from nesting territories. Hence, although we have no evidence that HEOD has affected eagle survival in Scotland, if it did do so, its effects would have taken longer to become manifest in a reduction in breeding numbers, and possibly dieldrin use was stopped before any such effect could occur.

It is also hard to say to what extent, if at all, organochlorines reduced eagle breeding success in the 1950s and 1960s. In their initial study, Lockie & Ratcliffe (1964) stated that, 'of seven pairs whose eggs were analysed, the record of breeding success during the last two or three years is worst in the territories where the eggs contained the largest amounts of insecticide'. In their later study, Lockie et al (1969) observed an improvement in breeding success in western Scotland between 1963-65 and 1966-68, coincident with a drop in the HEOD levels in eagle eggs and mutton fat. On the basis of their results, they concluded that HEOD had adversely affected eagle breeding. In our study we could produce no evidence for an effect of organochlorines (at the levels found) on eagle breeding, over and above that produced by Lockie at al (1969). In recent years, however, HEOD and DDE were present at such low levels in almost all eggs that they were unlikely to have caused a noticeable reduction in productivity.

There is no doubt, however, that in some coastal areas, Golden Eagles can accumulate very high levels of organochlorines and mercury. One bird which was found dead on Lewis in October 1986 and had been known to feed heavily on Fulmars Fulmarus glaciodes, had in its liver 50 ppm HEOD, 182 ppm DDE, 447 ppm PCBs and 76 ppm mercury, making it the most contaminated raptor we have ever examined. Another eagle from the same island in April 1986, was much less contaminated, with 2 ppm HEOD, 7 ppm DDE, 17 ppm PCBs and 29 ppm mercury.

4.5 Summary

1. Organochlorine levels in unhatched eggs from 234 Scottish Golden Eagle clutches from 1963-86 are presented.

2. Levels were highest in eggs from western coastal districts, somewhat lower in eggs from western inland districts, and lower still in eggs from eastern districts. These regional trends were associated with corresponding dietary changes. Low levels of mercury were also found in some eggs from western coastal areas.

3. Levels of HEOD declined in western districts during the period 1963-86, but not in eastern districts where they were low throughout. Levels of DDE declined generally, but significantly only in eastern districts. In contrast, levels of PCBs increased generally, but significantly only in western inland districts.

4. No difference in organochlorine levels was found between clutches that produced no young and those that produced one young.

4.6 Acknowledgements

We are grateful to all the observers, too numerous to mention individually, who sent in eggs for analysis over the years, to Dr J Watson for helping us over the location of sites, and to Dr A S Cooke for constructive comments on the manuscript.

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Table 6. **Organochlorine levels (ppm) and shell indices in Golden Eagle eggs from different regions and time periods. For the organochlorines the figures show the geometric means (and range within one geometric standard error), while for shell indices the figures show the arithmetic means and arithmetic standard error.**

	West coastal			West inland			East inland		
	1963-70	**1971-80**	**1981-86**	**1963-70**	**1971-80**	**1981-86**	**1963-70**	**1971-80**	**1981-86**
N	24	33	28	37	40	34	8	11	15
DDE	0.483 (0.371-0.630)	0.300 (0.240-0.375)	0.316 (0.228-0.436)	0.146 (0.114-0.186)	0.183 (0.163-0.205)	0.072 (0.058-0.090)	0.095 (0.066-0.135)	0.054 (0.042-0.07)	0.032 (0.022-0.047)
HEOD	0.463 (0.364-0.590)	0.0969 (0.080-0.117)	0.0568 (0.041-0.078)	0.178 (0.135-0.235)	0.062 (0.053-0.072)	0.0664 (0.053-0.083)	0.037 (0.027-0.049)	0.023 (0.018-0.029)	0.035 (0.026-0.047)
PCB	-	1.220 (0.951-1.565)	1.527 (1.061-2.198)	-	0.6739 (0.577-0.788)	1.454 (1.232-1.718)	-	0.151 (0.102-0.224)	0.443 (0.261-0.753)
Shell-Index	-	3.028 ± 0.069	2.990 ± 0.092	-	3.055 ± 0.043	3.120 ± 0.065	-	2.932 ± 0.066	3.255 ± 0.043

Note* Pre-1974 (pre-DDT), the mean shell index in western Scotland was 3.146 ± 0.035, and in eastern Scotland 3.164 ± 0.032 (Ratcliffe 1970).

Table 7. **Trends in organochlorine levels and shell-indices in Golden Eagle eggs from different regions over the period 1963-86. Figures show linear regression coefficients, and minus values indicate declines. Computation on $\log_{10}$ transformed values for organochlorines.**

Region	**Number of Clutches**	**HEOD**	**DDE**	**PCBs**	**Shell index**
Western Scotland coastal	88	-0.057***	-0.013	0.027	-0.007
Western Scotland inland	111	-0.019**	-0.011	0.033**	0.012
Eastern Scotland	39	0.003	-0.028*	0.038	0.031**

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

<u>Note</u>: In some analyses the data may have been better fitted by a polynomial relationship than a linear one. However, the aim of these analyses was not to find the best fitting trend line, but to examine whether there had been a net decline in levels over the period concerned.

Table 8. Organochlorine levels (ppm) in eggs from clutches which produced 0 and 1 young respectively.

Figures show geometric mean levels (and range within one geometric standard error).

	West, coastal		West, inland	
	Brood 0	Brood 1	Brood 0	Brood 1
N	33	3	32	12
DDE	0.269 (0.214-0.337)	0.210 (0.135-0.326)	0.138 (0.113-0.169)	0.166 (0.144-0.192)
HEOD	0.099 (0.081-0.122)	0.111 (0.072-0.169)	0.063 (0.050-0.078)	0.034 (0.024-0.048)
PCB*	1.153 (0.800-1.664)	1.358 (1.145-1.609)	0.552 (0.421-0.723)	0.810 (0.672-0.976)

* For PCB, sample sizes were 23, 3, 21 and 11 respectively.

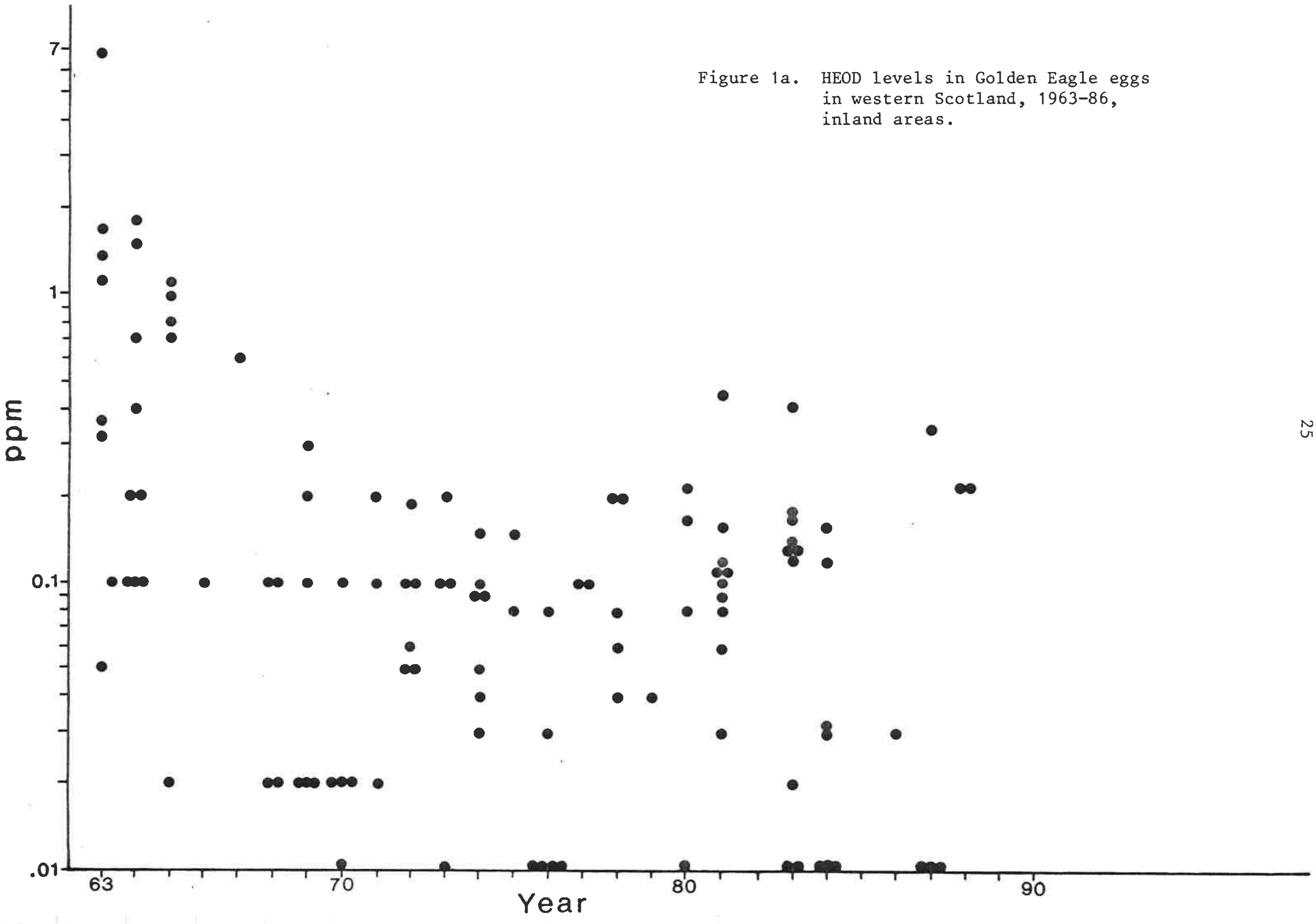

Figure 1a. HEOD levels in Golden Eagle eggs in western Scotland, 1963-86, inland areas.

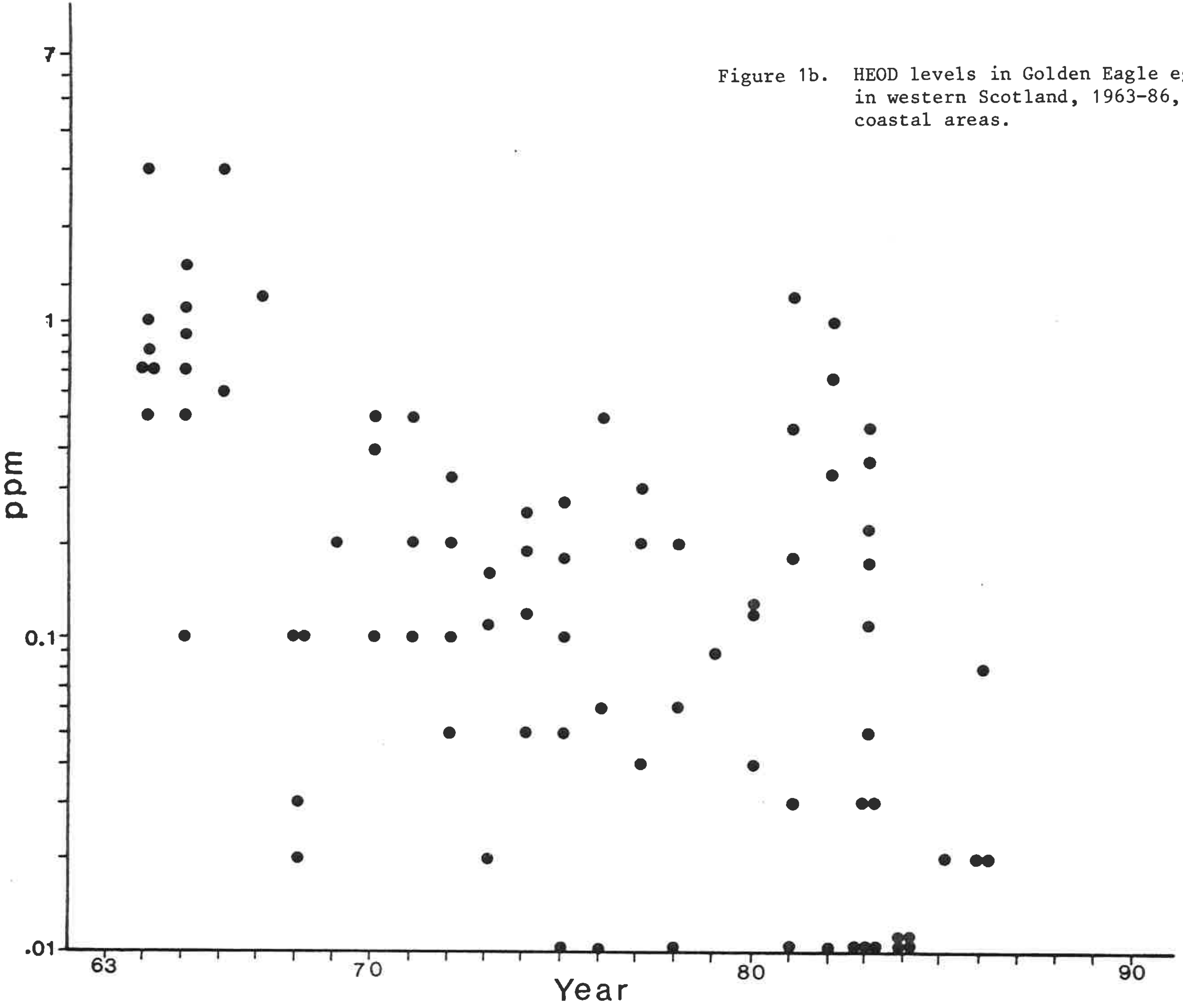

Figure 1b. HEOD levels in Golden Eagle eggs in western Scotland, 1963-86, coastal areas.

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BIRDS AND POLLUTION

Part 5 Organochlorines and mercury in gannet eggs, 1989

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5 ORGANOCHLORINES AND MERCURY IN GANNET EGGS, 1989

5.1 Introduction

The findings from all gannet eggs previously analysed, covering the period 1971-87, were summarised in Newton et al (1989), repeated in our report for 1988. Since then only ten further eggs have been received, all from Ailsa Craig (Table 9).

5.2 Results

The main feature of the 1989 eggs was the relatively high proportion of 'nil detected' values for organochlorines. The reduction in geometric mean PCB levels from Ailsa Craig eggs collected in 1987 was statistically significant. The four contaminated eggs contained small amounts of organochlorines, mostly less than 1 ppm. In contrast, mercury was present in every egg at similar level to 1987.

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 9 . Residues of organochlorines (ppm wet weight) and mercury (ppm dry weight) in the eggs of Gannets (*Sula bassana*), 1989. ND=None detected.

Colony	Shell-index	pp'-DDE	HEOD	PCBs	Hg
AILSA CRAIG					
	2.70	0.13	0.24	1.85	2.84
	3.06	ND	ND	ND	2.21
	3.05	0.16	0.20	0.97	3.28
	3.18	ND	ND	ND	4.64
	2.87	ND	ND	ND	2.28
	2.92	0.11	ND	0.37	4.40
	3.08	0.22	0.33	0.84	2.94
	2.65	ND	ND	ND	1.39
	2.86	ND	ND	ND	2.21
	2.93	ND	ND	ND	5.39
Mean*	2.93	0.03	0.03	0.06	2.93
SD	0.17	0.61	0.68	1.01	0.18
Range within 1 SE	2.88-2.98	0.02-0.05	0.02-0.04	0.03-0.12	2.57-3.34

*Means: arithmetic for Shell-index; geometric otherwise.

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

Compared with 1987 eggs, the reduction in geometric mean PCB level to 1989 was significant (t_{18} =-3.30, $P<0.01$).

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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. Results from 145 birds obtained from March 1984 to March 1989 were given in our report of 1988, and results from 30 birds examined since then are summarised in Table 7.

6.2 Results

Residues were detected in only two of the 30 birds examined, about the same frequency as in previous specimens. One bird contained difenacoum alone, and the other contained both difenacoum and brodifacoum. The brodifacoum was close to the level expected to cause death.

Table 10. Levels of rodenticides (ppm in wet wt) in the livers of 25 wild Barn Owls (Tyto alba) analysed in 1989 - 90.
J = Juvenile in first year; A = Adult older than one year;
M = male; F = female; brod = brodifacoum; difen = difenacoum;
brom = bromadiolone; floc = flocoumafen.

No.	Date	County	Age	Sex	brod	difen	brom	floc
9679	- 86	-	A	M	ND	ND	ND	ND
9684	- 87	-	-	F	ND	ND	ND	ND
9653	Nov 87	Nairn	J	M	ND	ND	ND	ND
9587	Apr 89	Notts	A	F	0.1661	0.0122	ND	ND
9592	Apr 89	Essex	A	-	ND	ND	ND	ND
9593	Apr 89	Essex	J	-	ND	ND	ND	ND
9617	Jun 89	Dyfed	J	-	ND	ND	ND	ND
9630	Jul 89	Dorset	J	M	ND	ND	ND	ND
9632	Jul 89	Oxon	A	M	ND	0.0878	ND	ND
9634	Jul 89	Carmarthen	A	M	ND	ND	ND	ND
9737	Jul 89	Norfolk	J	M	ND	ND	ND	ND
9741	Aug 89	Norfolk	J	F	ND	ND	ND	ND
9701	Sep 89	Norfolk	J	F	ND	ND	ND	ND
9706	Sep 89	Dorset	J	F	ND	ND	ND	ND
9710	Sep 89	Devon	A	F	ND	ND	ND	ND
9719	Sep 89	Yorkshire	J	F	ND	ND	ND	ND
9725	Sep 89	Herts	J	F	ND	ND	ND	ND
9732	Sep 89	Hereford	J	M	ND	ND	ND	ND
9754	Sep 89	Cambs	J	F	ND	ND	ND	ND
9736	Oct 89	Dorset	J	F	ND	ND	ND	ND
9749	Oct 89	Surrey	J	F	ND	ND	ND	ND
9750	Oct 89	Wilts	A	M	ND	ND	ND	ND
9756	Oct 89	Herts	J	M	ND	ND	ND	ND
9761	Oct 89	Clwyd	J	F	ND	ND	ND	ND
9767	Oct 89	Lincs	J	M	ND	ND	ND	ND
9770	Oct 89	Sussex	A	F	ND	ND	ND	ND
9771	Oct 89	Yorks	J	M	ND	ND	ND	ND
9773	Nov 89	Salop	J	M	ND	ND	ND	ND
9776	Nov 89	Lincs	J	F	ND	ND	ND	ND
9777	Nov 89	Norfolk	J	F	ND	ND	ND	ND

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BIRDS AND POLLUTION

Part 7 Incident Investigations

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7 INCIDENT INVESTIGATIONS

7.1 Introduction

A number of incidents were reported to ITE, Monks Wood during the past few months. All these concerned coastal birds or seabirds. In addition, following a parliamentary question there has been renewed interest in bird mortalities that happened in 1988 near a gas plant at Bacton, Norfolk.

Public and media interest in incidents appears to be on the increase, partly because of the number of voluntary animal welfare bodies that are being formed in various parts of the country and partly because of general media interest in the environment.

7.2 The Bacton Incident: January 1988

In mid- to late-January 1988 a number of birds, mostly auks, were found dead in the Bacton area of Norfolk. Some were sent to ITE, Monks Wood for analysis and post-mortem investigation to see if the cause of death could be established.

No single cause of death could be found at post-mortem and standard analytical screening was done for the following:

i. a range of industrial and agricultural organic chemicals;

ii. the toxic metals cadmium, mercury and lead.

The results of these standard analyses are given in Table 11. Taken singly, none of the residues are considered high enough to have caused death.

During the analysis for organic chemicals evidence for the presence of some compounds not included in the standard analyses was found, but as yet these have not been identified. These substances did not appear to be the glycols that local people considered could have caused the incident (it appears glycols are used by the Bacton plant).

7.3 Auks and other birds on the west coast

Following a period of high winds in the first months of 1990, reports were received of birds, mostly auks, being washed up dead and dying along the west coast. Reports were received from members of the public, from the RSPB, and from MAFF VIC's who passed material to us. Several small groups of birds came ashore in the middle of April between north-Wales and Cornwall.

Analysis of some of this material has been done. Results are in Table 12. Both cormorants contained sufficient mercury to have caused some tissue damage, but it is not certain what caused the deaths of these birds.

Further analysis may be done once investigations by other laboratories looking at these birds are complete - one verbal post-mortem report from a veterinarian suggested the kidney's of some of these birds had unusual lesions that might have been caused by a toxic agent. For example, in the guillemot from the north Welsh coast with a high residue of PCB in its liver, there was an a unusual peak with a gas-chromatographic retention time similar to HEOD, but confirmatory analysis showed the peak was another substance that remains to be positively identified. More work on organic residues in this bird are required. In addition, more metal analysis (eg for cadmium) may also be undertaken, since a number of metals other than mercury can damage this tissue.

7.4 Deaths of kittiwakes near Scarborough

In mid to late July 1990 between 400 and 600 kittiwakes (mostly juveniles) were washed ashore between Filey and Righton on the east coast. The incident first came to our attention through the local authority at Scarborough, who sent carcasses for examination.

Five birds were received. All were emaciated and had probably starved. 4 others were sent to the Institute of Zoology in London. A veterinary pathologist's findings there were similar to our own.

Chemical analysis completed to date (Table 13) suggests that no organic pollutant that our methods are able to detect was responsible for the deaths.

These deaths may have been nothing more than an unusual aggregation of the birds that would normally die in the area, or they may have reflected a more general food shortage for seabirds in the North Sea. Kittiwakes, and other species, bred poorly on the Isle of May in 1989 and in Shetland, as a result of a known food shortage. It is likely that breeding this year will also have been poor.

Table 11A. Residues of organic compounds (ppm wet wt) in tissues of birds from near Bacton, Norfolk. nd = none detected.

Sample	HCB	HCH	DDE	HEOD	PCB
Guillemot					
Liver	0.13	nd	1.2	nd	5.2
Liver	nd	nd	0.6	nd	3.3
Liver	0.06	nd	1.2	nd	3.5
Liver	0.38	nd	5.6	nd	33.3
Liver	nd	nd	2.3	nd	9.4
Little grebe					
Liver	0.03	nd	1.0	nd	12.9
Shag					
Liver	0.19	nd	1.95	nd	11.3
Gannet					
Liver	nd	nd	0.05	0.06	0.6
Fat	nd	0.15	3.17	2.05	61.4

Table 11B. Residues of toxic metals (ppm dry wt) in the tissues of birds from near Bacton, Norfolk. nd = none detected

Sample	Mercury	Cadmium	Lead*
Guillemot			
Liver	4.82	9.34	nd
Liver	4.00	0.89	nd
Liver	9.86	3.06	nd
Liver	13.4	1.52	nd
Liver	-	-	-
Little grebe			
Liver	9.77	nd	nd
Shag			
Liver	12.7	1.88	nd
Gannet			
Liver	6.44	1.55	nd
Fat	0.11	nd	nd

Table 12A. Residues of organic compounds (ppm wet wt) in tissues of birds from incidents on the west coast, spring 1990

Sample	HCB	HCH	DDE	HEOD	PCB
Guillemots from Cornwall					
Liver	0.19	nd	1.35	nd	17.1
Liver	0.08	nd	1.12	nd	13.1
Liver	0.16	nd	1.01	nd	7.6
Liver	0.12	nd	0.77	nd	7.8
Liver	nd	nd	0.09	nd	0.7
Liver	nd	nd	0.12	nd	1.3
Guillemots from Wales					
Liver	0.01	nd	0.12	nd	4.8
Liver	0.12	nd	0.87	nd	13.2
Liver	0.16	nd	1.75	*	79.8
Cormorants from Wales					
Liver	0.06	nd	0.47	nd	11.3
Liver	0.02	nd	0.36	0.26	10.5

Notes: The result for HEOD marked with an asterisk awaits confirmation.

Table 12B. Residues of mercury (ppm dry wt) in tissues of birds from the West coast incidents.

Guillemots from Cornwall	
Liver	5.27
Liver	4.81
Liver	4.49
Liver	4.22
Liver	4.14
Liver	6.21
Guillemots from Wales	
Liver	4.93
Liver	5.97
Liver	8.61
Cormorants from Wales	
Liver	64.7
Liver	42.7

Table 13. Organochlorine residues (ppm wet wt) found in kittiwakes from Scarborough, July 1990

Sample	HCB	HCH	DDE	HEOD	PCB
Liver	nd	nd	nd	nd	0.2
Liver	nd	nd	nd	nd	0.1
Liver	nd	nd	0.1	nd	0.3
Liver	nd	nd	nd	nd	0.1
Liver	nd	nd	nd	nd	0.1

Notes: Work on metal residues has not yet been completed

The **Institute of Terrestrial Ecology (ITE)** is a component body of the Natural Environment Research Council which was established in 1965. ITE has the facilities and expertise to undertake the objective study of a wide range of environmental problems involving the ecology of plants and animals and their interaction with man's activities. The organisation's research can be described simply under the headings.

- **survey and evaluation**
- **ecological studies**
- **environmental impact assessment**

Funding for basic research comes through NERC from the Department of Education and Science but a very substantial proportion also comes from customers who commission work. These customers include the World Health Organisation, United Nations Environment Programme, the European Economic Community, the Department of the Environment, the Nature Conservancy Council and a range of other public and private organisations.

The geographical distribution of 250 staff in six Research Stations throughout Britain allows efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics.

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