INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS AND POLLUTION

Part 1 Monitoring
2 Residues in collected kestrels
3 Sparrowhawk survey
4 Heron survey
5 Seabird eggs
6 Mersey bird mortalities
7 Puffins and PCBs
8 Incident investigations

I NEWTON, A A BELL, K R BULL, P FREESTONE, D J GORE, M B HAAS, J R HALL, H M HANSON, M P HARRIS, D V LEACH, D OSBORN, I WYLLIE & W J YOUNG

Monks Wood Experimental Station
Abbots Ripton
Huntingdon
Cambs. PE17 2LS

August 1984

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1 MONITORING

1.1 Organochlorines and metals in predatory birds

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. During 1983, the livers from 185 birds were analysed, including those from 64 kestrels, 71 sparrowhawks, 22 herons, 10 kingfishers, 9 great crested grebes and 9 others. These totals included a few birds received in earlier years, but analysed in 1983. The results from all these birds for DDE, HEOD, PCBs and Hg are given in Table 1. For the 5 main species, mean levels of these various pollutants did not differ significantly from those found in 1982 (Table 2).

A kestrel with a particularly large burden of DDE (172 ppm in wet weight) came from Kent, a county from which heavily contaminated birds have come in previous years. The sparrowhawk with most DDE also came from Kent, though other fairly heavily contaminated birds came from various parts of the country. Particularly high HEOD and PCB levels (620 and 119 ppm) were found in a grebe from Fife, and a high PCB level (275 ppm) in a heron from Northumberland.

1.2 Cadmium in little owls

In recent years, there has been growing concern about the amount of cadmium which is reaching farmland, from sewage sludge, fertilizers and industrial sources. Several soil animals are known to accumulate cadmium, particularly earthworms, and little owls feed extensively on earthworms. We therefore took the opportunity in 1983 to analyse for cadmium livers of the little owls which had been sent in. A total of 23 was examined, 10 having been received in 1983, from various parts of England.

In most of these birds, cadmium could not be detected, but 6 had residues in excess of 1 ppm in dry weight, including one with more than 6 ppm (Table 3). These levels were about the same as found previously at Monks Wood in starlings and ducks, but lower than in seabirds from St Kilda. They did not suggest widespread or heavy contamination of little owls.

1.3 Acknowledgments

We are grateful to all the contributors, unfortunately too many to mention individually, who sent us specimens during the period concerned.

TABLE 1. Residues of organochlorine insecticides (ppm wet weight) and heavy metals (ppm dry weight) in the livers of birds of prey, results reported April 1983-March 1984.

Specimen number	Collection date	pp'-DDE	HEOD	PCBs	Hg
Kestrel (Falco tinnunculus)					
7831	Jul 71	1.44	0.27	3.25	1.25
7839	Nov 75	4.36	0.31	20.34	ND
7837	Feb 80	2.06	0.36	20.62	0.39
7836	Apr 80	0.22	1.04	2.40	0.26
7707	Nov 81	0.05	0.28	0.13	5.20
7708	Dec 81	2.77	0.05	0.34	4.06
7709	Dec 81	0.77	0.57	0.39	0.58
7882	82	2.27	0.32	5.11	1.08
7710	Feb 82	5.46	0.79	1.56	1.75
7711	Feb 82	1.59	0.29	0.59	1.23
7749	Mar 82	172.20	1.21	9.65	3.56
7740	Jul 82	1.44	0.67	0.94	1.28
7870	Oct 82	0.44	0.33	0.05	0.29
7871	Oct 82	0.05	0.37	0.36	0.19
7872	Oct 82	ND	0.95	0.31	0.65
7651	Jan 83	11.24	ND	0.72	1.12
7652	Jan 83	0.21	0.40	0.34	4.86
7655	Jan 83	ND	0.02	1.53	1.26
7656	Jan 83	1.40	0.22	0.28	1.62
7668	Jan 83	0.34	0.17	2.65	0.20
7712	Jan 83	1.37	1.57	2.31	0.24
7669	Feb 83	1.17	0.24	0.64	0.66
7673	Feb 83	4.91	1.52	18.43	3.14
7674	Feb 83	0.12	0.09	0.55	1.27
7681	Feb 83	1.20	0.38	1.71	1.34
7683	Feb 83	1.66	ND	13.50	0.61
7684	Feb 83	5.10	0.55	4.58	1.18
7690	Feb 83	1.38	0.30	6.11	2.91
7691	Feb 83	0.12	0.17	0.09	0.50
7724	Feb 83	0.24	0.19	1.46	0.56
7890	Feb 83	0.18	0.24	0.82	0.74
7873	Mar 83	0.64	0.46	0.63	0.40
7874	Mar 83	1.97	0.58	0.25	1.34
7761	Apr 83	1.23	0.35	0.54	0.49
7762	Apr 83	2.90	0.74	1.22	0.91
7768	Apr 83	2.13	0.59	2.43	0.19
7770	Apr 83	1.53	0.82	0.32	0.63
7771	Apr 83	2.39	1.35	0.99	0.91
7805	Apr 83	14.53	3.26	9.92	1.80
7772	May 83	1.11	1.71	1.26	0.13
7791	Jun 83	3.53	0.93	3.51	1.49
7816	Jun 83	1.38	0.68	0.39	2.63
7806	Jul 83	1.49	1.13	0.54	2.34
7877	Jul 83	1.46	2.60	5.59	0.86
7817	Aug 83	0.47	2.52	1.34	0.35
7822	Sep 83	0.33	0.31	1.06	ND
7842	Sep 83	0.05	0.28	5.90	0.10
7850	Oct 83	1.20	0.41	0.57	2.59
7855	Oct 83	0.14	0.86	0.26	0.10
7856	Oct 83	0.76	0.37	0.17	0.11
7857	Oct 83	0.27	0.21	0.05	0.24
7858	Oct 83	0.64	0.48	2.32	4.06

Specimen number	Collection date	pp'-DDE	HEOD	PCBs	Hg
Kestrel (contd)					
7881	Oct 83	0.52	1.13	4.10	0.24
7865	Nov 83	0.28	0.16	0.24	1.09
7866	Nov 83	2.25	0.75	0.87	1.66
7876	Nov 83	0.88	0.49	0.99	ND
7885	Dec 83	1.30	1.11	1.41	0.63
7888	Dec 83	2.91	1.11	5.76	0.55
7892	Dec 83	ND	0.74	1.59	0.18
7893	Dec 83	ND	1.13	1.35	0.33
7894	Dec 83	2.89	0.58	2.27	4.71
7899	Dec 83	1.19	1.57	3.08	0.71
7900	Dec 83	ND	0.99	7.19	7.81
7901	Dec 83	6.27	1.79	5.13	1.56
Sparrowhawk (*Accipiter nisus*)					
7889	-	2.32	0.42	3.25	4.79
7732	Feb 77	28.66	12.36	37.38	4.08
7838	Mar 77	18.33	1.03	51.45	6.95
7832	Nov 77	2.11	0.93	6.86	1.78
7731	Dec 77	1.29	0.30	1.41	0.68
7693	Feb 79	1.07	ND	3.77	4.74
7834	Apr 79	2.07	0.80	2.79	1.38
7835	Apr 79	2.17	0.71	5.74	2.45
7734	Aug 79	0.59	0.41	1.82	1.17
7726	Feb 80	32.46	2.02	141.27	7.70
7694	Nov 80	2.13	1.06	21.37	1.45
7729	Mar 81	1.63	0.44	7.13	9.48
7730	Mar 81	1.82	0.49	1.81	5.21
7736	Aug 81	0.50	0.23	0.98	0.80
7833	Aug 81	2.57	1.02	4.54	1.95
7695	Oct 81	4.70	0.98	3.43	3.68
7742	Oct 81	3.06	0.75	0.42	0.70
7696	Nov 81	11.90	0.73	8.99	8.44
7697	Nov 81	1.04	0.26	3.75	3.58
7830	Dec 81	3.08	0.73	5.42	1.96
7735	Feb 82	7.72	0.63	2.53	4.55
7738	Feb 82	0.49	0.31	0.55	1.75
7739	Feb 82	0.83	0.52	1.44	1.75
7698	Mar 82	2.32	2.20	2.23	5.52
7699	Mar 82	2.27	0.68	0.72	5.72
7700	Mar 82	6.56	1.49	38.22	11.68
7737	Mar 82	3.04	0.58	1.11	3.95
7840	Mar 82	29.84	3.09	53.56	2.98
7701	Apr 82	3.33	0.64	8.51	4.51
7702	Apr 82	2.99	0.31	3.85	7.55
7703	Apr 82	20.05	5.16	6.13	10.30
7841	Apr 82	1.30	0.58	2.66	1.45
7704	Aug 82	0.87	0.40	3.65	1.98
7705	Aug 82	1.99	0.37	11.61	6.14
7733	Oct 82	2.39	0.90	2.39	2.41
7880	Oct 82	3.62	0.54	4.56	2.31
7750	Nov 82	0.12	0.02	ND	0.38
7667	Dec 82	0.39	0.22	4.20	0.41

Table 1 (contd)

Specimen number	Collection date	pp'-DDE	HEOD	PCBs	Hg
Sparrowhawk (contd)					
7706	Dec 82	2.40	0.56	5.03	2.92
7852	Dec 82	3.44	0.87	5.28	1.14
7657	Jan 83	2.33	0.63	0.69	7.07
7658	Jan 83	1.65	0.38	0.48	2.64
7660	Jan 83	0.76	0.29	1.37	1.90
7661	Jan 83	1.62	0.11	0.03	0.90
7664	Jan 83	2.59	0.24	5.48	5.92
7675	Feb 83	1.38	0.44	5.65	5.52
7679	Feb 83	0.89	0.32	4.03	1.79
7686	Feb 83	2.55	0.39	7.66	1.84
7688	Feb 83	1.71	0.19	1.17	2.14
7769	Feb 83	51.47	2.52	8.99	3.05
7692	Mar 83	1.64	0.29	1.47	3.77
7745	Mar 83	2.20	0.39	0.26	2.01
7746	Mar 83	22.50	3.02	50.65	7.95
7748	Mar 83	3.73	1.44	0.79	1.52
7753	Mar 83	32.91	5.40	21.41	4.18
7754	Mar 83	9.64	2.33	20.92	11.09
7777	Mar 83	19.49	1.14	17.85	3.88
7853	Mar 83	0.99	0.73	2.49	0.35
7767	Apr 83	5.84	6.36	1.39	5.38
7796	Apr 83	1.29	2.83	0.72	2.10
7775	May 83	21.90	1.03	37.85	9.49
7789	May 83	10.65	16.24	32.14	3.47
7807	Aug 83	0.44	0.36	0.68	0.27
7811	Aug 83	0.39	0.22	0.39	1.16
7812	Aug 83	0.30	0.10	0.09	0.77
7813	Aug 83	0.49	0.16	2.92	3.35
7814	Aug 83	ND	ND	5.63	1.89
7818	Aug 83	1.82	21.59	2.09	0.83
7821	Sep 83	1.13	0.46	0.77	0.53
7824	Sep 83	ND	0.16	0.62	1.85
7827	Sep 83	2.79	1.51	8.48	2.56
Peregrine (*Falco peregrinus*)					
7798	Apr 82	2.27	0.85	4.72	1.97
7689	Feb 83	14.78	0.38	19.15	1.52
7751	Mar 83	3.88	0.99	0.95	3.85
Merlin (*Falco columbarius*)					
7869	Jul 80	3.29	0.96	10.76	9.32
7844	Jun 83	1.40	0.79	3.46	3.18
7843	Aug 83	0.45	0.41	2.58	0.37
7887	Sep 83	0.23	0.19	2.85	6.56
7862	Oct 83	0.10	ND	11.42	8.55
Long-eared owl (*Asio otus*)					
7671	Feb 83	3.18	0.93	7.17	3.86

Table 1 (contd)

Specimen number	Collection date	pp'-DDE	HEOD	PCBs	Hg
Heron (Ardea cinerea)					
7755	-	7.38	1.65	19.99	25.00
7868	-	0.07	0.02	0.10	14.29
7741	May 81	3.02	5.71	23.49	106.00
7716	Dec 81	14.60	2.44	74.55	43.79
7717	Apr 82	9.12	1.76	95.72	44.80
7677	Jun 82	0.30	0.31	3.07	2.67
7718	Aug 82	0.82	10.96	1.53	9.29
7678	Nov 82	8.98	ND	73.29	36.38
7829	Dec 82	0.11	ND	2.77	10.92
7665	Jan 83	0.76	ND	2.51	37.67
7685	Feb 83	36.33	2.76	38.55	23.71
7687	Feb 83	7.71	15.33	27.13	53.67
7725	Mar 83	0.38	0.20	2.38	3.94
7760	Apr 83	4.11	14.57	150.25	6.19
7763	Apr 83	0.46	0.21	4.29	2.68
7764	Apr 83	0.82	0.19	5.08	110.00
7795	Jun 83	0.33	0.09	0.50	3.98
7801	Jul 83	0.29	ND	4.55	4.72
7867	Nov 83	0.35	ND	5.21	16.30
7878	Nov 83	0.11	ND	1.17	14.16
7891	Dec 83	20.71	0.91	275.27	54.94
7897	Dec 83	0.38	0.24	6.05	8.53
Great crested grebe (Podiceps cristatus)					
7745	Jun 75	62.05	1.45	119.25	14.93
7828	Mar 82	1.27	0.45	6.74	2.66
7744	Spr. 82	8.30	ND	35.14	15.98
7721	Jul 82	4.92	ND	7.00	15.15
7722	Oct 82	2.25	0.23	11.28	6.15
7790	May 83	2.16	ND	4.31	8.75
7803	Jul 83	0.46	0.18	0.02	-
7804	Jul 83	0.33	0.13	0.02	-
7826	Sep 83	19.41	0.29	15.28	7.92
Kingfisher (Alcedo atthis)					
7719	Jun 80	0.54	0.56	0.19	5.10
7720	82	2.49	2.34	2.10	1.69
7663	Jan 83	3.07	1.64	29.56	4.49
7723	Mar 83	26.24	4.48	20.63	10.03
7779	Jun 83	0.83	0.58	1.61	<0.10
7783	Jun 83	0.31	0.14	0.34	<0.10
7823	Aug 83	2.11	1.35	1.57	<0.10
7825	Sep 83	1.10	0.86	4.28	2.06
7851	Oct 83	1.28	3.06	2.03	1.05
7859	Oct 83	2.86	1.10	5.49	2.54

Note: ND - None detected.

TABLE 2. Comparison of geometric mean residue levels (log values) from birds collected in 1982 and 1983; t values are shown. Minus values indicate a decrease.

	Sparrowhawk	Kestrel	Heron	Kingfisher	Great-crested grebe
DDE	$t_{45} = -1.68$	$t_{110} = -0.58$	$t_{22} = 1.51$	$t_{11} = -1.24$	$t_{9} = 1.32$
HEOD	$t_{91} = 1.32$	$t_{110} = 1.48$	$t_{22} = 0.94$	$t_{11} = -0.38$	$t_{9} = 0.13$
PCBs	$t_{91} = 0.96$	$t_{112} = 1.03$	$t_{22} = 1.80$	$t_{11} = 0.82$	$t_{9} = -1.35$
Hg	$t_{91} = -1.77$	$t_{112} = -1.71$	$t_{22} = 0.31$	$t_{11} = -0.22$	——

Note: Zero values for DDE and HEOD were taken as 0.001, for PCBs and Hg as 0.01.

None of the changes detected were statistically significant.

TABLE 3. Residues of cadmium (Cd) found in the livers of little owls (*Athene noctua*) reported in April 1983-March 1984.

Specimen number	Collection date	Cd ppm dry weight
7714	Dec 81	6.08
7532	Mar 82	1.38
7534	May 82	1.15
7541	Jun 82	ND
7542	Jun 82	ND
7551	Jul 82	ND
7552	Jul 82	ND
7554	Jul 82	ND
7556	Jul 82	ND
7558	Jul 82	ND
7561	Jul 82	ND
7576	Jul 82	2.35
7715	Nov 82	ND
7626	Dec 82	ND
7641	Dec 82	ND
7787	Jun 83	ND
7788	Jun 83	ND
7792	Jun 83	ND
7793	Jun 83	1.93
7846	Jun 83	ND
7847	Jun 83	ND
7808	Aug 83	2.71
7810	Aug 83	ND

Note: ND - None detected.

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2 RESIDUES IN COLLECTED KESTRELS

2.1 Successive analyses on the same tissues

Birds used in the monitoring programme are mostly found dead, and have lain for varying periods before their discovery and receipt at Monks Wood. For some time, we have been concerned to find whether any change takes place in the concentration of pollutants during the period between death and receipt for freezing. In 1983, 3 kestrels were allowed to remain in the field for periods up to 18 days, and pieces of liver were removed at intervals for analysis.

For the most part, successive analyses on each bird revealed similar concentrations of each type of organochlorine (Table 4). No consistent changes in concentrations were apparent and the variations recorded were mostly within the limits of analytical error. It seemed, therefore, that no systematic change in organochlorine content occurred in tissues for at least 18 days after death.

2.2 Analyses of specially collected kestrels

A frequent criticism of the monitoring programme has been that it is based entirely on birds found dead, without knowledge of how the pollutant levels in such birds compare with those in live birds. During 1979-83, some 36 kestrels were caught near Monks Wood, and deliberately killed for analysis, some in autumn and others in spring. These birds would probably have included some local residents and others that were migrants from other parts of Britain. Four tissues were analysed from each bird, with the addition of adipose tissue (ie fat) where present (Table 5).

For birds killed at a particular season, no significant differences in residue levels were found between years, but in each year residues were higher in the spring-caught birds than in the autumn ones. This seasonal increase was significant for DDE in all tissues, but not for mercury (Table 6). In a large proportion of birds, no HEOD or PCBs were detected (Table 5).

When residues in these specially collected birds were compared with those in birds found dead in the same months and years, no significant differences in mean levels of DDE, HEOD or Hg were found, either in spring or autumn, but PCBs were at significantly lower levels in the collected birds in spring (Table 7). In general, it seemed that the 'live' birds showed no important differences in residue levels from those found dead, and that the latter could therefore be regarded as representative of the whole population.

In the collected birds, opportunity was taken to investigate the extent to which the pollutant levels in different tissues were correlated (Table 8). For DDE, levels in all tissues were significantly correlated, except for brain versus fat. For HEOD and PCBs, fewer significant correlations were found, and for Hg none. We do not understand why there is such variation between compounds, even between the fat-soluble organochlorines. The liver is the tissue that has been used throughout the monitoring programme.

TABLE 4. Results from successive analyses on the same tissues, kept in field conditions (ppm wet weight).

Specimen number	Date sampled	DDE	HEOD	PCBs
7873	9 Mar 83	0.64	0.46	0.63
	11 Mar 83	0.76	0.56	0.41
	14 Mar 83	0.64	0.49	<0.10
7874	10 Mar 83	1.97	0.58	0.25
	14 Mar 83	3.17	0.96	0.44
	28 Nov 83	3.84	0.96	0.58
7876	8 Nov 83	0.88	0.49	0.99
	11 Nov 83	1.04	0.70	2.85
	18 Nov 83	0.30	0.30	2.28

TABLE 5. Results from tissues of kestrels deliberately collected for analysis (ppm

Spec no.	Coll date	A/S	Pro-tein	Fat	DDE						
					L	K	B	M	F	L	K
6721	Nov 79	J♂	3.26	13.54	0.49	0.60	0.57	6.52	6.52	ND	ND
6722	Nov 79	A♂	3.45	9.72	0.83	0.56	1.06	1.24	3.09	ND	ND
6723	Nov 79	J♀	3.79	6.70	1.31	0.97	0.75	0.73	–	ND	ND
6724	Nov 79	A♂	3.92	14.08	1.21	0.87	0.16	1.83	18.85	ND	ND
6725	Mar 80	A♂	3.44	4.46	1.88	1.86	2.43	2.19	–	ND	ND
6726	Mar 80	J♂	3.12	9.20	1.83	4.68	1.79	2.76	37.29	ND	ND
6727	Mar 80	A♂	3.42	5.71	0.82	0.98	0.68	1.55	28.44	ND	ND
6728	Apr 80	A♂	3.12	6.03	1.67	1.77	1.51	2.94	–	ND	ND
6729	Apr 80	A♀	3.38	11.59	0.75	0.98	0.48	1.26	15.59	ND	ND
6730	Apr 80	J♀	2.98	3.83	1.41	0.38	0.33	0.58	–	ND	ND
6841	Nov 80	J♀	3.25	15.40	0.35	ND	<0.10	1.39	–	ND	ND
6842	Nov 80	J♀	3.95	30.59	0.27	ND	ND	0.30	4.06	ND	ND
6843	Nov 80	J♂	2.91	13.89	1.08	0.36	0.13	0.69	11.90	ND	ND
6844	Nov 80	J♀	3.28	15.35	1.05	1.15	0.15	1.52	8.78	ND	ND
6845	Dec 80	J♂	2.85	8.21	3.97	1.14	0.37	2.57	–	ND	ND
6846	Mar 81	J♀	3.84	14.44	0.32	1.01	0.35	0.21	6.07	ND	ND
6847	Mar 81	J♂	3.14	11.52	0.99	0.24	0.13	0.32	9.29	ND	ND
6848	Mar 81	A♂	2.61	3.05	2.08	1.63	1.12	3.11	–	ND	ND
6849	Mar 81	J♀	3.47	10.27	1.96	1.39	0.76	1.61	50.90	ND	ND
6850	May 81	J♂	3.03	4.97	<0.10	<0.10	<0.10	<0.10	–	ND	ND
7608	Oct 81	J♂	2.72	4.16	ND	<0.10	<0.10	<0.10	–	0.24	<0.10
7609	Dec 81	A♂	3.06	7.99	ND	<0.10	ND	0.19	4.05	0.40	<0.10
7610	Dec 81	J♀	3.00	5.19	<0.10	<0.10	<0.10	0.38	–	0.16	<0.10
7611	Mar 82	A♀	3.25	14.80	0.58	0.47	0.25	0.86	33.94	0.18	<0.10
7612	Mar 82	A♀	3.93	15.51	2.53	3.53	1.30	5.00	43.65	0.23	0.23
7613	Mar 82	A♂	3.31	9.79	0.86	0.87	0.14	–	36.44	0.40	0.15
7614	Mar 82	J♀	2.15	2.20	4.48	3.40	2.68	3.80	–	0.80	0.44
7615	Apr 82	J♂	3.20	9.77	0.28	0.21	0.18	0.42	11.84	0.31	<0.10
7616	Apr 82	A♂	2.87	8.60	0.94	0.67	0.43	1.57	46.00	0.80	0.18
7617	May 82	J♂	2.74	7.37	1.52	1.17	0.38	2.63	57.66	0.41	0.12
7870	Oct 82	J♂	2.95	2.32	0.44	0.19	<0.10	0.26	–	0.33	<0.10
7871	Oct 82	A♂	3.34	3.33	<0.10	0.23	<0.10	<0.10	–	0.37	0.19
7872	Oct 82	J♂	3.19	6.56	ND	<0.10	<0.10	<0.10	2.50	0.95	<0.10
7873	Mar 83	J♂	3.20	9.07	0.64	0.17	<0.10	0.36	5.61	0.46	<0.10
7874	Mar 83	J♀	3.07	8.94	1.97	1.70	0.71	5.66	108.86	0.58	0.23
7876	Nov 83	A♂	3.50	6.83	0.88	0.28	<0.10	0.48	7.73	0.49	<0.10

Notes: L = Liver; K = Kidney; B = Brain; M = Muscle and F = Fat.

– = no sample; ND = none detected.

wet weight).

HEOD			PCBs					Hg				
B	M	F	L	K	B	M	F	L	K	B	M	F
ND	ND	ND	ND	ND	ND	ND	ND	0.18	0.23	1.13	0.13	0.20
ND	ND	ND	ND	ND	ND	ND	ND	1.40	0.19	0.16	0.08	0.10
ND	ND	-	ND	ND	ND	ND	-	0.28	0.28	0.06	0.79	-
ND	ND	ND	ND	ND	ND	ND	ND	0.17	0.40	0.08	0.08	0.32
ND	ND	-	ND	ND	ND	ND	-	0.22	1.55	0.09	0.13	-
ND	ND	ND	ND	ND	ND	ND	ND	0.20	0.26	0.11	0.11	0.08
ND	ND	ND	ND	ND	ND	ND	ND	0.14	0.19	0.06	0.09	0.10
ND	ND	-	ND	ND	ND	ND	-	0.20	0.18	0.08	0.06	9.60
ND	ND	ND	ND	ND	ND	ND	ND	0.24	0.23	0.13	0.14	0.07
ND	ND	-	ND	ND	ND	ND	-	0.21	0.18	0.15	0.11	-
ND	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	-
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	-
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.24	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	-
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	0.56	0.56	1.01	0.30	ND
ND	<0.10	-	0.19	<0.10	0.35	<0.10	-	0.15	ND	ND	ND	-
ND	<0.10	0.84	0.23	<0.10	1.31	<0.10	5.63	0.12	<0.05	ND	ND	ND
ND	<0.10	-	1.06	<0.10	0.62	0.55	-	0.17	0.17	0.09	ND	-
ND	<0.10	1.00	0.50	0.20	0.48	0.27	24.47	0.23	0.17	0.07	ND	ND
0.21	<0.10	1.25	9.89	0.24	1.29	0.42	24.33	0.13	0.25	ND	<0.05	ND
ND	-	0.91	3.25	0.22	0.22	-	70.10	0.12	0.12	ND	ND	ND
0.30	0.32	-	1.71	0.25	0.59	0.41	-	0.37	0.35	0.13	0.11	-
<0.10	<0.10	0.64	0.50	<0.10	0.67	0.19	6.80	0.07	ND	ND	<0.05	ND
0.13	0.23	4.64	0.59	0.37	0.49	0.83	64.71	0.08	ND	<0.05	<0.05	ND
ND	0.20	2.77	0.64	0.70	0.76	1.45	71.79	1.11	0.80	0.14	0.38	ND
ND	<0.10	-	<0.10	0.20	1.53	0.22	-	0.09	ND	ND	ND	-
<0.10	<0.10	-	0.36	<0.10	0.67	0.45	-	0.06	ND	ND	ND	-
<0.10	<0.10	0.85	0.31	0.27	1.29	0.20	1.31	0.18	0.15	ND	ND	ND
ND	<0.10	0.72	0.63	0.38	0.66	0.21	3.81	0.11	0.10	0.04	<0.05	ND
0.13	0.51	10.10	0.25	<0.10	0.66	0.83	39.81	0.46	0.39	0.11	0.26	ND
<0.10	<0.10	<0.10	0.99	0.22	0.34	0.43	5.07	ND	0.71	0.20	0.22	ND

TABLE 6. Significance of differences in residues in autumn-collected 'special collection' kestrels compared with spring-collected specimens.

	Liver	Kidney	Brain	Muscle	Fat
DDE	$t_{18} = -2.46$ *	$t_{23} = -2.88$ **	$t_{34} = -3.30$ **	$t_{33} = -2.35$ *	$t_{21} = -4.08$ ***
Hg	$t_{12} = -1.11$ NS	$t_{25} = -1.20$ NS	$t_{25} = -1.20$ NS	$t_{24} = -0.61$ NS	-

* significance of difference, $P<0.05$; ** $P<0.01$; *** $P<0.001$.

- indicates lower mean in autumn birds.

TABLE 7. Significance of differences in residues in livers of 'special collection' kestrels compared with kestrels found dead in the same months.

	Autumn		Spring	
DDE	$t_{48} = -0.36$	NS	$t_{39} = -1.84$	NS
HEOD	$t_{30} = +1.55$	NS	$t_{18} = +0.70$	NS
PCBs	$t_{32} = -0.34$	NS	$t_{24} = -2.30$	*
Hg	$t_{23} = -1.03$	NS	$t_{44} = -1.47$	NS

* significance of difference $P < 0.05$.

- indicates 'special collection' lower mean than birds found dead.

TABLE 8. Coefficients of linear correlation between concentrations of pollutants in different tissues of 'special collection' kestrels.

	DDE				HEOD				PCBs				Hg			
	Kidney	Brain	Muscle	Fat	Kidney	Brain	Muscle	Fat	Kidney	Brain	Muscle	Fat	Kidney	Brain	Muscle	Fat
Liver	0.71 ***	0.69 ***	0.75 ***	0.70 ***	0.40 NS	0.43 NS	0.44 NS	0.29 NS	0.05 NS	0.19 NS	-0.01 NS	0.09 NS	0.25 NS	0.18 NS	0.32 NS	-0.05 NS
Kidney		0.81 ***	0.77 ***	0.47 *		0.87 ***	0.66 **	0.68 *		-0.06 NS	0.61 *	0.49 NS		0.20 NS	0.37 NS	-0.04 NS
Brain			0.64 ***	0.40 NS			0.53 *	0.43 NS			-0.34 NS	-0.43 NS			0.24 NS	-0.04 NS
Muscle				0.84 ***				0.99 ***				0.91 ***				-0.04 NS

*P<0.5; **P<0.01; ***P<0.001.

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BIRDS AND POLLUTION

Part 3 Sparrowhawk survey

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August 1984

3 SPARROWHAWK SURVEY

3.1 Introduction

The sparrowhawk suffered a marked population decline in the late 1950s, following the widespread introduction of cyclodiene pesticides in agriculture. Since 1964, in each of 7 study areas, potential territories have been checked periodically for occupation and breeding success. In this way it was hoped to find whether sparrowhawks were recovering in numbers, following successive restrictions in cyclodiene use. The Anglesey and East Midlands areas were surveyed in 1983, for the sixth and ninth times respectively, and the findings are summarized in Table 9.

3.2 Anglesey

As noted by Newton et al. (1982), the apparent low occupation current in Anglesey is puzzling, at a time when the species is generally recovering and recolonizing other parts of Britain. Although the area has held sparrowhawks throughout the period of the survey, the number of breeding pairs located has fluctuated from 7 in 1967, when poor breeding success was frequent, to nil in 1979, which followed an unusually severe winter. Consequently, 25 potential territories, some new, were surveyed in June and July, 1983. Evidence of non-breeding or hunting birds was found at 4 sites, and nests were located at 3 others (one more than in 1981): clutches of 5 and 6 produced 4 and 6 young respectively; the third nest was found only when fledged young remained in the vicinity, there being no evidence of egg-loss or failure. Thus, although only a small sample, the last 2 surveys here do suggest an improvement in breeding success, with broods of up to 6 fledging, and, again, no recent evidence of clutch depletion.

Of the 88 territory searches made to date, 53 (60%) were in broad-leaved sites, 22 (25%) in mixed woodland, and 13 (15%) in coniferous. Although broad-leaved territories held the greatest number of nests, 11, this constituted an occupation rate of only 21% for this type of woodland, whereas 27% of mixed woods (6) contained nests, with the greatest proportion, 31% (4 nests), being in conifers. Conversely, signs of sparrowhawk presence where no nest was found were seen in only 8% of the coniferous territories, but in 27% of mixed woods, consistent with normally greater prey availability in the latter.

3.3 East Midlands

The East Midlands study area, although primarily arable, is similar to that of Anglesey in having appreciable numbers of broad-leaved woods and copses, but, in contrast, has little suitable coniferous habitat. In view of the anticipated return of breeding sparrowhawks there, the search area was increased to 25 potential territories in 1983, comprising 21 broad-leaved, 2 mixed, and 2 coniferous woods. Searching was undertaken from April to July. One of 3 territories showing the first evidence of summering birds in 1982 was again occupied, as was one new area, both broad-leaved sites, but still no nests were found.

3.4 Discussion

Based on the limited Anglesey evidence, but dependent also on prey abundance, it might be expected that about 5 (20%) of these territories would hold breeding sparrowhawks once recolonization is complete. However, during the initial survey of this area, in 1942, only 13% of potential territories were occupied (Cooke et al. 1979); since then, much of the then abundant hedgerow cover available for prey species has been lost through changes in agricultural practice.

3.5 References

COOKE, A.S., BELL, A.A. & HAAS, M.B. 1979. Birds of prey and pollution. (Part I). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

NEWTON, I., BELL, A.A. & HAAS, M.B. 1982. Birds of prey and pollution. (Part I). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

TABLE 9. Occupation of sparrowhawk territories, 1983.

	Anglesey	East Midlands
Total territories checked	25	25
Number with successful nests	3	0
Number with failed nests	0	0
Number with no nest, but other signs	4	2
Number with no signs	18	23
Number of territories with old nests	4	0
Proportion of territories with old nests	0.16	0

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BIRDS AND POLLUTION

Part 4 Heron survey

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4 HERON SURVEY

4.1 Introduction

Since 1964, observations have been made periodically at these 2 Lincolnshire heronries, mainly to count the nests and to obtain eggs, broken shells and dead young for analysis. These birds had shown shell-thinning, apparently caused by DDE, but, unlike some birds of prey, had not suffered a marked population decline. In 1983, the opportunity was taken to collect a further sample of eggs, dead young as available, and to maintain observations, at various dates between March and July.

4.2 Troy

The number breeding at Troy had increased to 80, 13% more than in 1982, but egg breakage had more than doubled, at 19% (Figure 1). Nine of the existing nests were unoccupied, and there were 13 newly-built. Clutch size averaged 4.25 in a sample of 20 nests monitored by mirror prior to egg collection (Table 10). Sixteen eggs, representing 16 clutches, were removed for analysis and determination of eggshell index; results were similar to those of 1977 (Figure 2). Ground-level observation later confirmed broods of up to 3 at 48 nests, with definite evidence of success at 19 others. A few young which grounded uninjured during attempted recovery of dead chicks from nest edges were successfully replaced.

Of a total of 20 young recorded dead at 14 nests between mid-May and early July, 4 of those recovered showed head- and leg-wounds suggestive of attack by siblings. Only those of medium age seemed to be affected, smaller birds presumably not being strong enough to sustain such an attack, and older ones able to escape. The weather at this time was not adverse, and if food shortage initiated the behaviour, it might be expected to occur at many nests, particularly those with larger broods. The injuries were of 2 types: numerous, small red peck-marks to the tarsi, presumably directed as the victim retreated to the nest perimeter, often falling over; and/or massive head-damage, obviously causing rapid death, and evidently resulting from sustained attack on young attempting to maintain a hold on the nest edge. Several of the dead young were observed in this peripheral situation, and recovery of one resulted in a sibling's furious attack on both the corpse and the retrieving mirror. This phenomenon was last recorded at Troy in the mid-1960s, a period of high organochlorine contamination and chick mortality at this colony, although the reasons for this behaviour are not clear.

4.3 Willoughby

At Willoughby, 15 nests, 2 newly-built, were seen occupied on 13 April. This was a decrease of 3 on the previous year. Examination of nest contents was not possible, but a total of 30 hatched shells found beneath 11 nests gave a minimum average hatch rate of 2.7. Egg breakage had occurred at 3 nests (20%) (including 2 of those showing evidence of hatching), an increase over 1982. A single dead young was also found then.

No egg sample was obtained from Willoughby, and so it is not known if egg residue levels there have altered since the last analyses in the 1970s, which might account for the continuing decline of this colony. This decline began in 1967, coinciding with the start of an increase at the much smaller Muckton colony nearby, suggesting a transfer of birds from Willoughby (Cooke et al. 1979). Although this transfer remains a possibility, Muckton, at 42 nests, is now almost 3 times the size of Willoughby, which, in turn, has contracted to only one-third of its 1967 maximum. Up to that time, the 2 colonies fluctuated roughly in parallel, and during that period Willoughby suffered an identical, but much more abrupt, reduction in the number of breeding pairs. This reduction reached its minimum of 15 nests immediately after the severe winter of 1963, and thereafter, as usual, recovery was rapid, peaking, again at 49 nests, only 4 seasons later (Figure 1).

4.4 Discussion

Although the total Lincolnshire and South Humberside breeding population is presently stable, at more than 300 pairs, it is conceivable that some external factor other than pesticides could affect a single colony such as Willoughby; eg, reduction in feeding areas may reduce breeding success or the winter survival of adults; measures against trout-farm predation may also constitute a long-term drain on the population. Although analysis of eggs from Willoughby has been minimal in recent years, mainly due to difficulties in collection, a fairly rapid bioassay of pollution levels within the Willoughby and Muckton colonies could probably be achieved in a single season by analysis of young collected dead. Although this analysis might be biassed towards polluted birds, a direct comparison would be available with similar material from the early years of high contamination.

4.5 Reference

COOKE, A.S., BELL, A.A. & HAAS, M.B. 1979. Birds of prey and pollution. (Part I). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

TABLE 10. Clutch size of 20 nests at Troy heronry.

	Number of nests with the following number of eggs				Mean clutch size
	3	4	5	6	
Number of nests	2	12	5	1	4.25

Fig. 1. Population size and egg-breaking frequency at 2 heronries in Lincolnshire, 1965-1983. (●, Troy; ○, Willoughby).

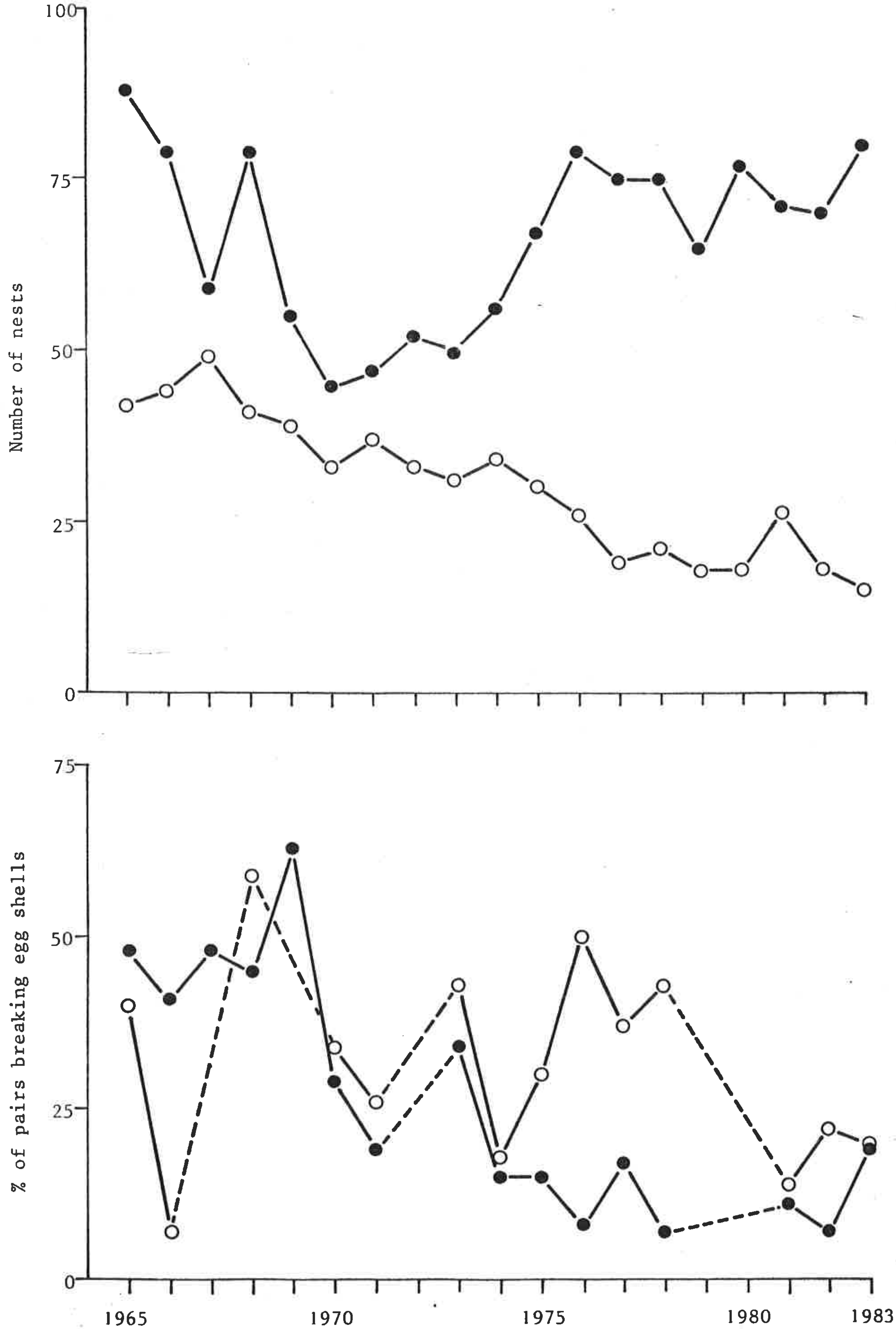
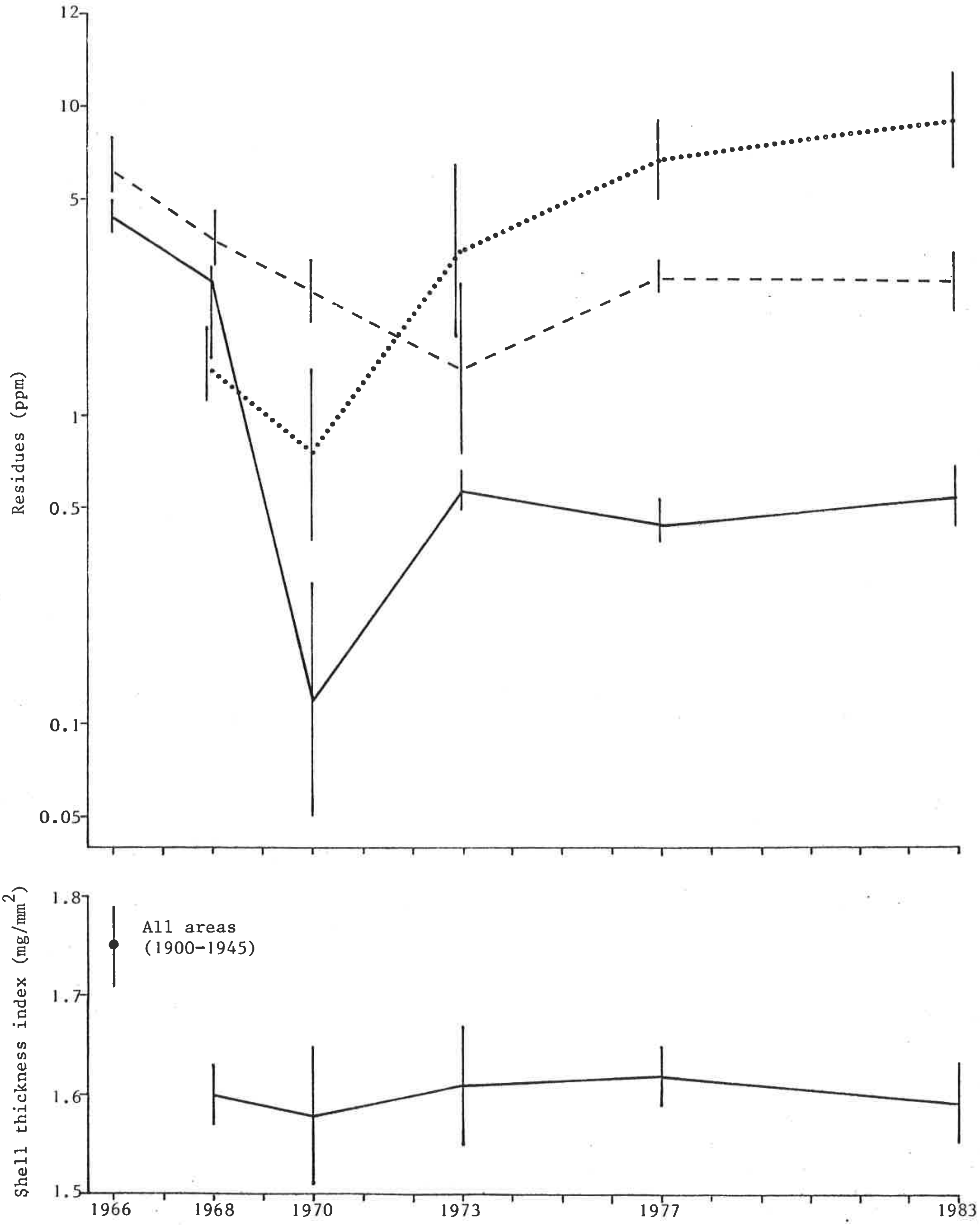


Fig. 2. Organochlorine residue levels and shell indices from Troy heron eggs in 5 different years. Geometric means ± 1 SE are used for pesticides, and arithmetic for shell index. (——, HEOD; – – –, DDE, ········, PCBs).



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BIRDS AND POLLUTION

Part 5 Seabird eggs

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5 SEABIRD EGGS

5.1 Pollutants in gannet eggs

In 1983, gannet eggs were obtained from 4 sites: Scare Rocks and Ailsa Craig off south-west Scotland, Bass Rock off south-east Scotland, and Hermaness in Shetland. These eggs were analysed for residues of DDE, HEOD, PCBs and Hg (Table 11). Significant variation between colonies was found in all residues, but not in shell index (Table 12).

For the 2 most frequently sampled colonies, Ailsa Craig and Bass Rock, all the data back to 1971 are presented to check for long-term trends (Figures 3-10). Despite considerable year-to-year fluctuations, regressions of residue levels on years revealed significant declines in DDE, PCB and Hg residues at both colonies, together with improvements in shell indices.

5.2 Pollutants in guillemot eggs

In 1982, guillemot eggs were obtained from Skomer (south-west Wales), Scare Rocks (south-west Scotland), St Kilda (north-west Scotland), Fair Isle (Shetland) and Isle of May (south-east Scotland). These were analysed for organochlorines and metals (Table 13). As in the gannet eggs, significant variations in residues, but not in shell indices, were found between colonies (Table 14). The highest levels of all pollutants were found at Scare Rocks. HEOD was detected in only one of the 40 eggs examined, again from Scare Rocks (Table 13). Comparing 1983 eggs from 4 colonies with 1980, 1981 or 1982 eggs from the same sites, significant increases were evident in Hg at Scare Rocks and St Kilda, and significant declines were evident in DDE at 4 sites and in PCBs at 3 sites (Table 15).

Year-to-year changes in egg residues are always hard to interpret on small samples. Perhaps the most salient point, however, was that, in both guillemot and gannet, levels of pesticide residues were lower in 1980-83 than they were about 10 years previously. Such longer term and general declines were consistent with known reductions in organochlorine usage, and known improvements in pollution control for mercury.

5.3 Acknowledgments

We are grateful to the following Nature Conservancy Council staff for organizing the collection of eggs from study colonies: Dr M E Ball and W Wright (St Kilda); Dr Cameron Easton and F Marr (Bass Rock); S Evans and M Alexander (Skomer); J B Pendlebury, A I Laing and R M Wright (Ailsa Craig and Scare Rocks); and Dr M G Richardson and N J Riddiford (Hermaness and Fair Isle).

TABLE 11. Residues of organochlorine insecticides (ppm wet weight) and heavy metals (ppm dry weight) in the eggs of gannets (Sula bassana).

Specimen number	Shell index	pp'-DDE	HEOD	PCBs	Hg
Scare Rocks					
G591	3.36	0.15	0.07	0.33	6.22
G592	2.34	0.51	0.49	1.43	8.34
G593	2.72	0.15	<0.05	0.41	3.47
G594	2.82	0.63	0.41	5.35	4.68
G595	2.77	0.17	0.11	0.84	2.37
G596	2.48	0.30	0.23	0.80	7.47
G597	3.08	0.26	0.07	1.33	6.97
G598	2.75	0.36	0.30	0.37	7.21
G599	3.08	0.52	0.36	1.90	10.64
G600	2.96	0.48	0.45	1.66	9.31
Mean*	2.84	0.31	0.18	1.01	6.12
SD	0.30	0.24	0.44	0.38	0.20
Range within 1 SE	2.74-2.93	0.26-0.37	0.13-0.24	0.77-1.33	5.29-7.10
Ailsa Craig					
G561	2.98	0.21	0.07	0.30	2.66
G562	2.79	0.60	0.15	0.99	3.10
G563	2.89	0.43	0.31	0.56	2.89
G564	2.62	0.15	0.08	0.89	1.97
G565	2.78	0.22	0.11	0.41	3.89
G566	3.06	0.10	0.06	<0.10	2.75
G567	2.91	0.09	0.07	0.20	2.88
G568	2.76	0.11	0.05	0.24	3.03
G569	2.95	0.22	0.06	0.69	3.32
G570	3.28	0.17	0.10	0.45	2.45
Mean*	2.90	0.19	0.09	0.34	2.85
SD	0.18	0.27	0.24	0.36	0.08
Range within 1 SE	2.84-2.96	0.16-0.23	0.08-0.11	0.26-0.43	2.69-3.02
Hermaness					
G511	2.70	0.26	ND	0.43	2.74
G512	2.77	0.36	0.12	1.45	2.83
G513	2.91	0.21	ND	0.42	2.48
G514	3.06	0.13	ND	0.10	1.64
G515	2.67	0.12	ND	0.40	2.47
G516	3.04	0.07	ND	<0.10	2.40
G517	2.94	0.10	ND	<0.10	2.95
G518	3.34	0.13	ND	<0.10	3.34
G519	2.95	ND	ND	<0.10	1.92
G520	2.97	0.08	ND	<0.10	2.48
Mean*	2.94	0.09		0.14	2.48
SD	0.20	0.72		0.55	0.09
Range within 1 SE	2.87-3.00	0.05-0.14		0.09-0.21	2.32-2.65

Table 11 (contd)

Specimen number	Shell index	pp'-DDE	HEOD	PCBs	Hg
Bass Rock					
G551	2.80	0.10	ND	<0.10	0.79
G552	3.05	0.18	0.05	0.76	3.91
G553	3.07	0.11	0.06	<0.10	3.52
G554	3.10	0.12	<0.05	<0.10	2.36
G555	3.37	0.43	0.08	2.60	2.09
G556	3.14	0.18	0.08	0.64	2.31
G557	3.08	0.20	0.08	0.39	2.17
G558	2.86	0.17	0.13	0.24	1.77
G559	3.05	0.19	<0.05	0.27	1.40
G560	3.26	0.15	ND	0.29	1.49
Mean*	3.08	0.17	0.03	0.26	2.51
SD	0.17	0.18	0.78	0.58	0.39
Range within 1 SE	3.03-3.13	0.15-0.19	0.01-0.05	0.17-0.39	1.89-3.34

Notes: Organochlorine values are expressed as ppm wet weight, metals in ppm dry weight.

*Means: arithmetic for shell index; geometric otherwise.

TABLE 12. Analysis of variance on residues and shell indices in gannet eggs.

	Source	df	Sum of squares	Mean square	F-ratio	Significance of variance between colonies
HEOD	within colonies	2	3.6225	1.8112	6.38	P<0.01
	between colonies	27	7.6647	0.2839		
DDE	within colonies	3	1.5922	0.5307	3.17	P<0.05
	between colonies	36	6.0366	0.1677		
PCBs	within colonies	3	3.8383	1.2794	5.58	P<0.01
	between colonies	36	8.2593	0.2294		
Hg	within colonies	3	1.3470	0.4490	18.82	P<0.001
	between colonies	36	0.8587	0.0239		
Shell index	within colonies	3	0.3131	0.1044	2.20	NS
	between colonies	36	1.7054	0.0474		

Note: ND values are taken as 0.001 ppm for DDE, and 0.01 ppm for PCBs. Analyses for residues use $\log_{10}$ values.

TABLE 13. Residues of organochlorine insecticides (ppm wet weight) and heavy metals (ppm dry weight) in the eggs of guillemots (*Uria aalge*).

Specimen number	Shell index	pp'-DDE	HEOD	PCBs	Hg
Skomer					
G531	3.20	0.31	ND	<0.10	2.93
G532	3.17	0.29	ND	ND	2.74
G533	3.25	0.39	ND	0.67	2.80
G534	3.01	0.29	ND	ND	2.77
G535	3.07	0.44	ND	0.69	3.28
G536	2.90	0.51	ND	0.31	2.82
G537	2.97	0.66	ND	1.32	2.84
G538	3.42	0.29	ND	ND	2.39
G539	3.11	0.41	ND	ND	2.42
G540	3.14	0.34	ND	ND	2.05
Mean*	3.12	0.38		0.06	2.68
SD	0.15	0.12		0.92	0.06
Range within 1 SE	3.08-3.17	0.35-0.41		0.13-0.12	2.58-2.80
Scare Rocks					
G581	3.13	0.95	ND	0.63	4.53
G582	2.95	1.29	ND	1.34	5.25
G583	2.92	0.71	ND	<0.10	3.43
G584	2.84	1.60	ND	9.54	4.90
G585	3.05	0.55	ND	0.56	3.51
G586	3.15	0.58	ND	0.75	4.04
G587	2.97	0.58	ND	ND	6.45
G588	2.56	1.15	ND	1.48	4.84
G589	3.12	0.52	0.20	1.84	2.36
G590	3.11	0.39	ND	0.17	2.49
Mean*	2.98	0.75		0.45	4.00
SD	0.18	0.20		0.83	0.14
Range within 1 SE	2.92-3.04	0.65-0.87		0.24-0.82	3.61-4.43
St Kilda					
G541	2.66	0.27	ND	<0.10	1.57
G542	3.01	0.19	ND	<0.10	1.69
G543	3.06	0.24	ND	<0.10	1.65
G544	2.90	0.22	ND	<0.10	1.75
G545	2.63	0.18	ND	<0.10	1.11
G546	3.06	0.24	ND	<0.10	1.73
G547	3.12	0.30	ND	ND	1.59
G548	2.78	0.27	ND	<0.10	1.84
G549	3.31	ND	ND	18.20	2.28
G550	3.28	0.19	ND	<0.10	1.45
Mean*	2.98	0.13		0.08	1.64
SD	0.24	0.75		0.86	0.08
Range within 1 SE	2.91-3.06	0.08-0.23		0.04-0.14	1.55-1.74

Table 13 (contd)

Specimen number	Shell index	pp'-DDE	HEOD	PCBs	Hg
Fair Isle					
G501	2.99	0.23	ND	<0.10	0.75
G502	3.26	0.20	ND	ND	0.69
G503	3.09	0.17	ND	ND	1.05
G504	3.39	0.29	ND	ND	0.67
G505	3.02	0.21	ND	<0.10	0.68
G506	3.10	0.21	ND	ND	0.60
G507	3.12	0.27	ND	<0.10	0.75
G508	2.87	0.22	ND	<0.10	0.83
G509	3.42	0.29	ND	<0.10	0.87
G510	3.49	0.20	ND	<0.10	0.73
Mean*	3.18	0.23			0.75
SD	0.21	0.08			0.07
Range within 1 SE	3.11-3.24	0.21-0.24			0.72-0.79
Isle of May					
G521	2.99	0.49	ND	<0.10	0.97
G522	3.20	0.48	ND	<0.10	1.08
G523	3.07	0.70	0.17	0.63	1.03
G524	3.01	0.49	ND	<0.10	1.13
G525	3.20	0.87	ND	1.89	1.77
G526	3.40	0.45	ND	0.64	1.00
G527	2.98	0.52	ND	0.95	1.03
G528	3.10	0.48	ND	<0.10	1.07
G529	3.04	0.60	ND	0.61	0.94
G530	2.94	0.67	ND	<0.10	1.09
Mean*	3.09	0.56		0.21	1.09
SD	0.14	0.09		0.66	0.08
Range within 1 SE	3.05-3.14	0.53-0.60		0.13-0.33	1.03-1.16

Notes: Organochlorine values are expressed as ppm wet weight, metals in ppm dry weight.

*Means: arithmetic for shell index; geometric otherwise.

TABLE 14. Analyses of variance on residues and shell indices in guillemot eggs.

	Source	df	Sum of squares	Mean square	F-ratio	Significance of variance between colonies
DDE	within colonies	4	3.6620	0.9155	7.24	P<0.001
	between colonies	45	5.6892	0.1264		
PCBs	within colonies	4	9.6287	2.4072	4.18	P<0.01
	between colonies	45	25.9099	0.5758		
Hg	within colonies	4	3.3915	0.8479	106.20	P<0.001
	between colonies	45	0.3591	0.0080		
Shell index	within colonies	4	0.3049	0.0762	2.21	NS
	between colonies	45	1.5525	0.0345		

Note: ND values are taken as 0.001 ppm for DDE, and 0.01 ppm for PCBs. Analyses for residues use $\log_{10}$ values.

TABLE 15. Comparison of geometric mean residue levels ($\log_{10}$ values) and arithmetic mean shell indices from guillemot eggs. D shows a decrease from previous period, I an increase.

	Skomer 1981-1983	Scare Rocks 1980-1983	St Kilda 1982-1983	Fair Isle 1981-1983	Isle of May 1982-1983
Shell index	$t_{18} = 1.04$ I	$t_{18} = 1.17$ D	$t_{18} = 0.10$ I	$t_{15} = 0.65$ D	$t_{18} = 1.26$ D
DDE	$t_{18} = 4.02^{***}$ D	$t_{12} = 3.10^{**}$ D	$t_{9} = 2.82^{*}$ D	$t_{6} = 1.57$ D	$t_{18} = 5.29^{***}$ D
HEOD	-	-	-	-	-
PCBs	$t_{10} = 3.38^{**}$ D	$t_{10} = 4.02^{**}$ D	$t_{18} = 0.22$ I	-	$t_{13} = 3.03^{**}$ D
Hg	$t_{18} = 1.22$ D	$t_{18} = 2.51^{*}$ I	$t_{18} = 3.01^{**}$ I	$t_{15} = 0.76$ D	$t_{18} = 1.55$ I

Note: *Significance of difference, $P<0.05$, **$P<0.01$, ***$P<0.001$.

Fig. 3. DDE concentrations in gannet eggs from Ailsa Craig, 1971-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

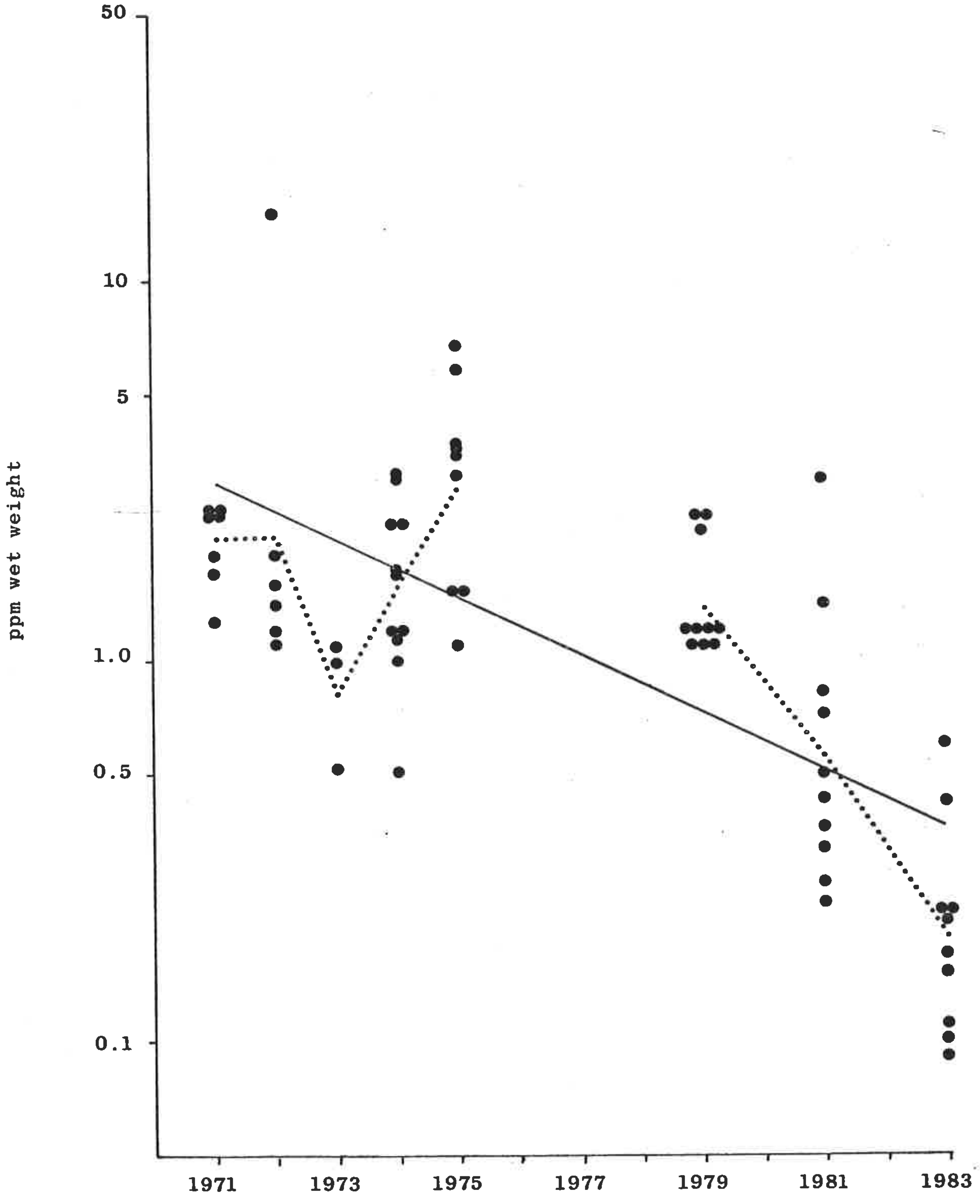


Fig. 4. PCB concentrations in gannet eggs from Ailsa Craig, 1971-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

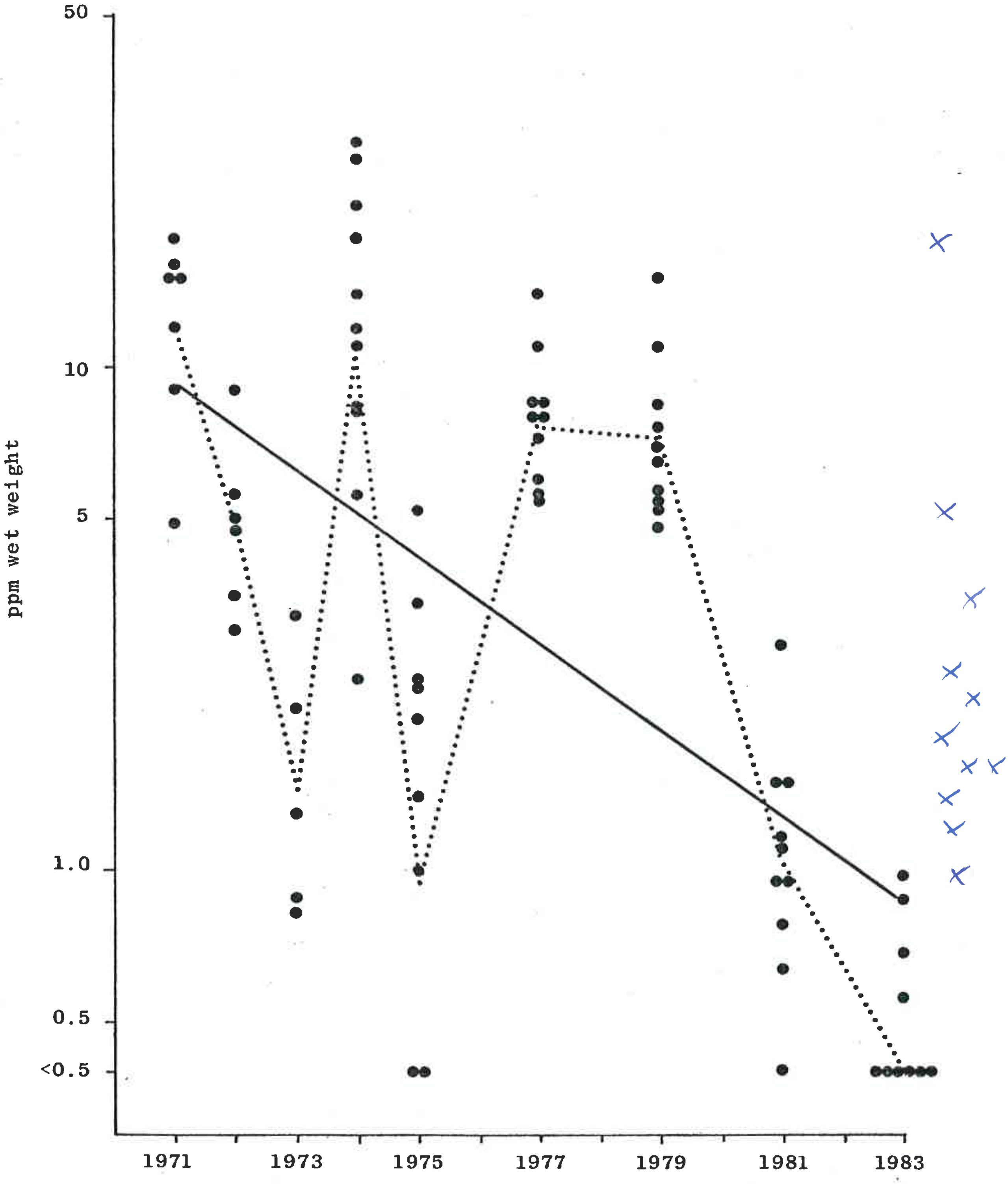


Fig. 5. Mercury concentrations in gannet eggs from Ailsa Craig, 1971-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

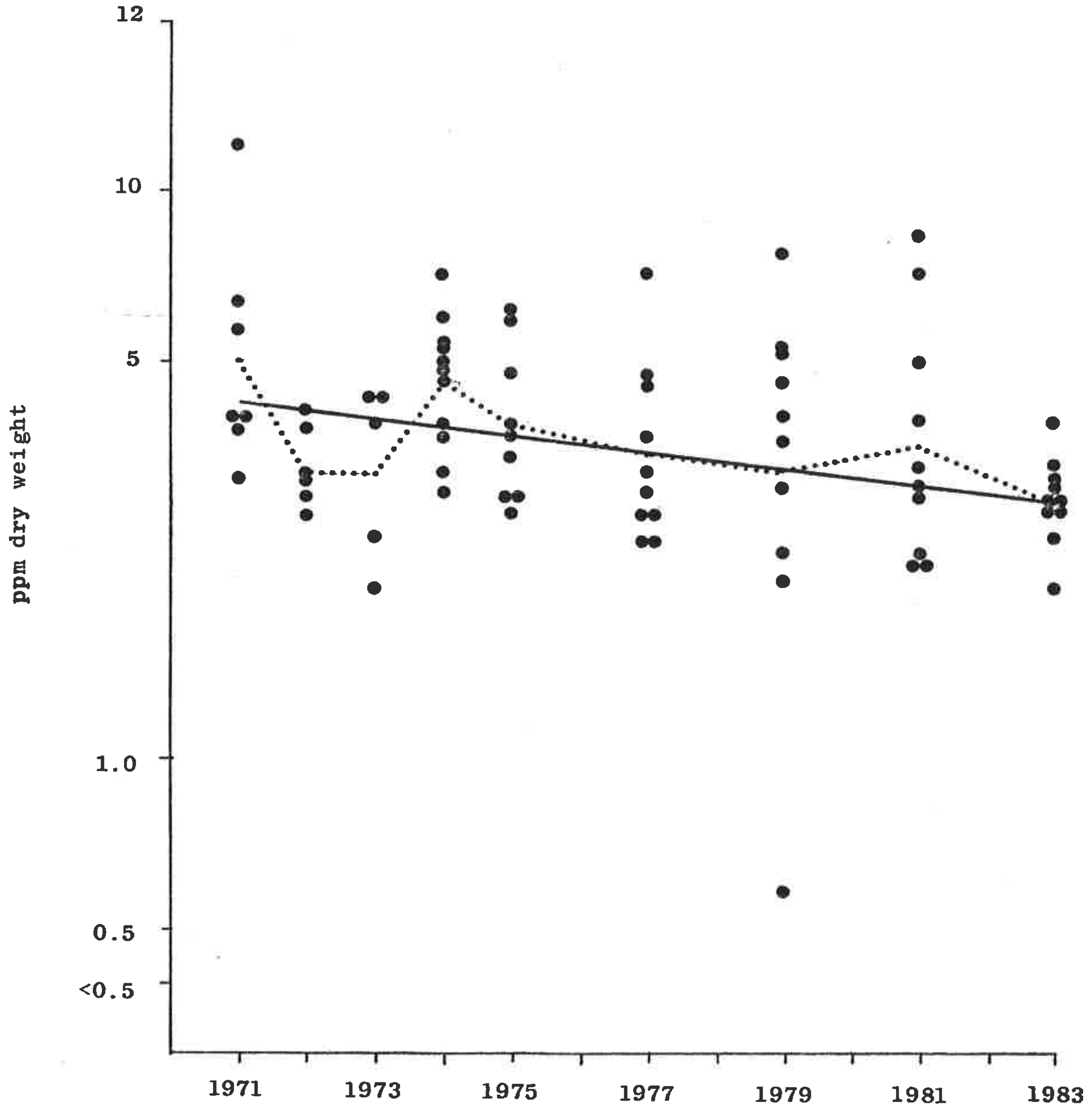


Fig. 6. Shell indices of gannet eggs from Ailsa Craig, 1971-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

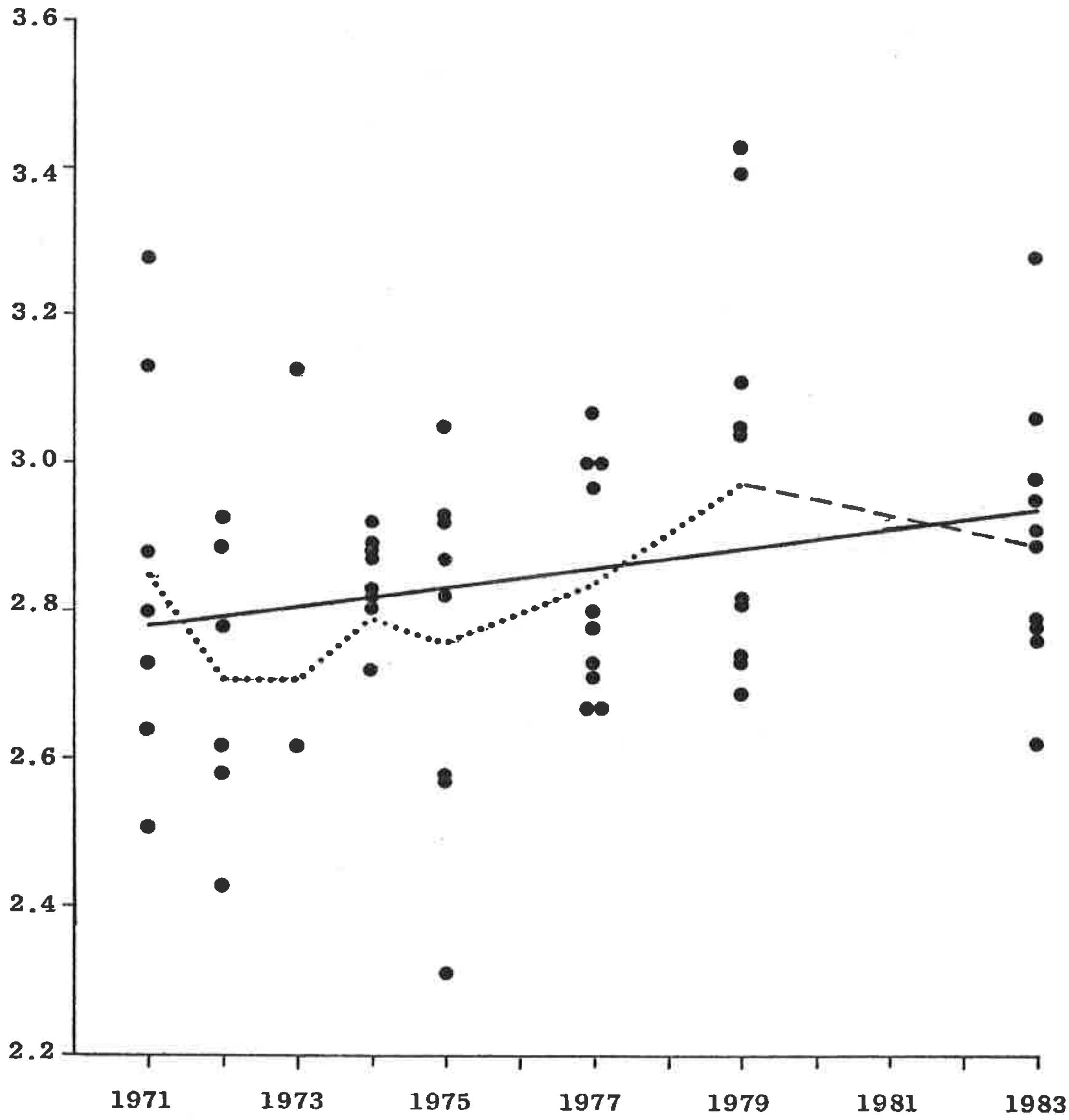


Fig. 7. DDE concentrations in gannet eggs from Bass Rock, 1973-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

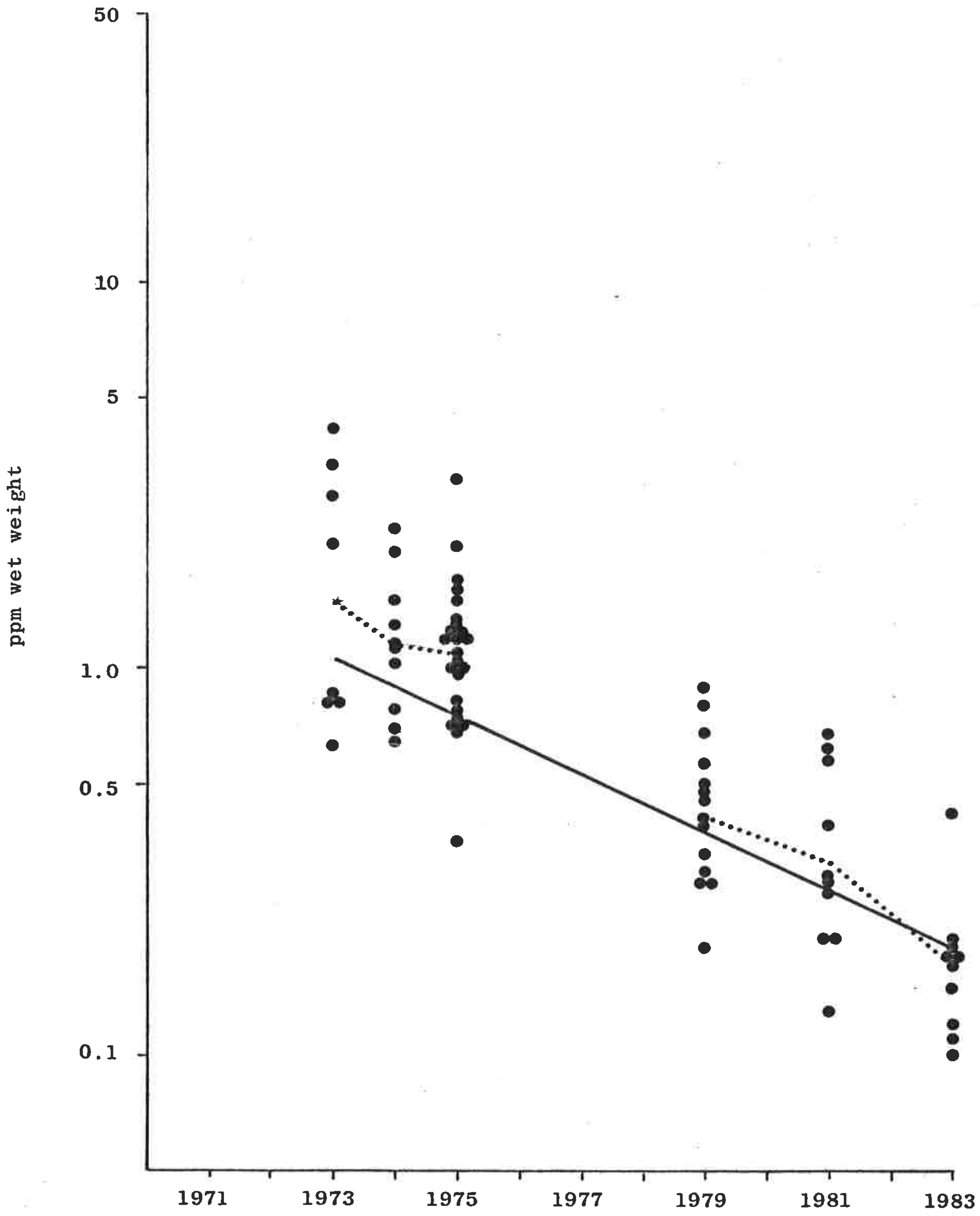


Fig. 8. PCB concentrations in gannet eggs from Bass Rock, 1973-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

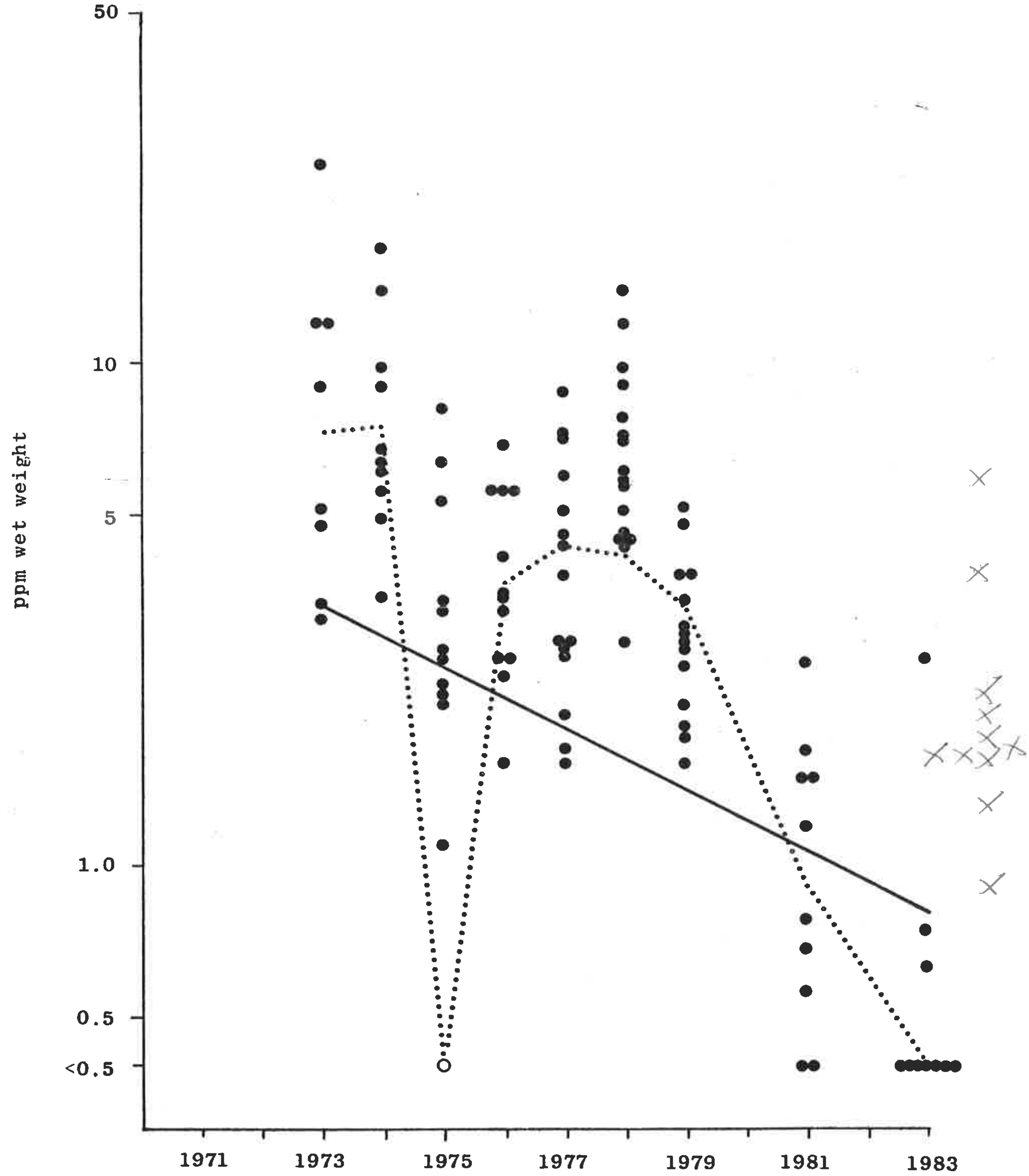


Fig. 9. Mercury concentrations in gannet eggs from Bass Rock, 1973-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.

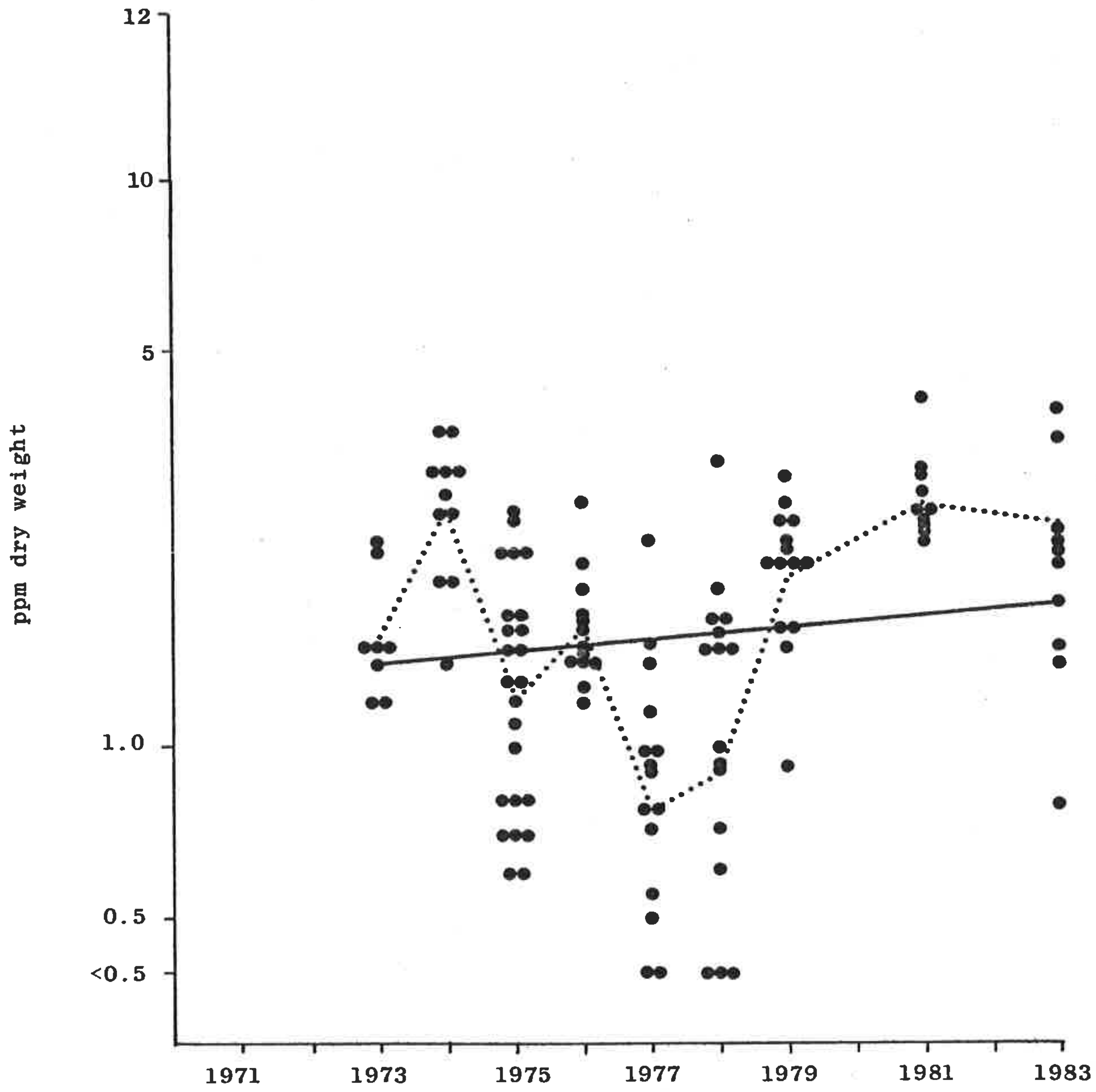
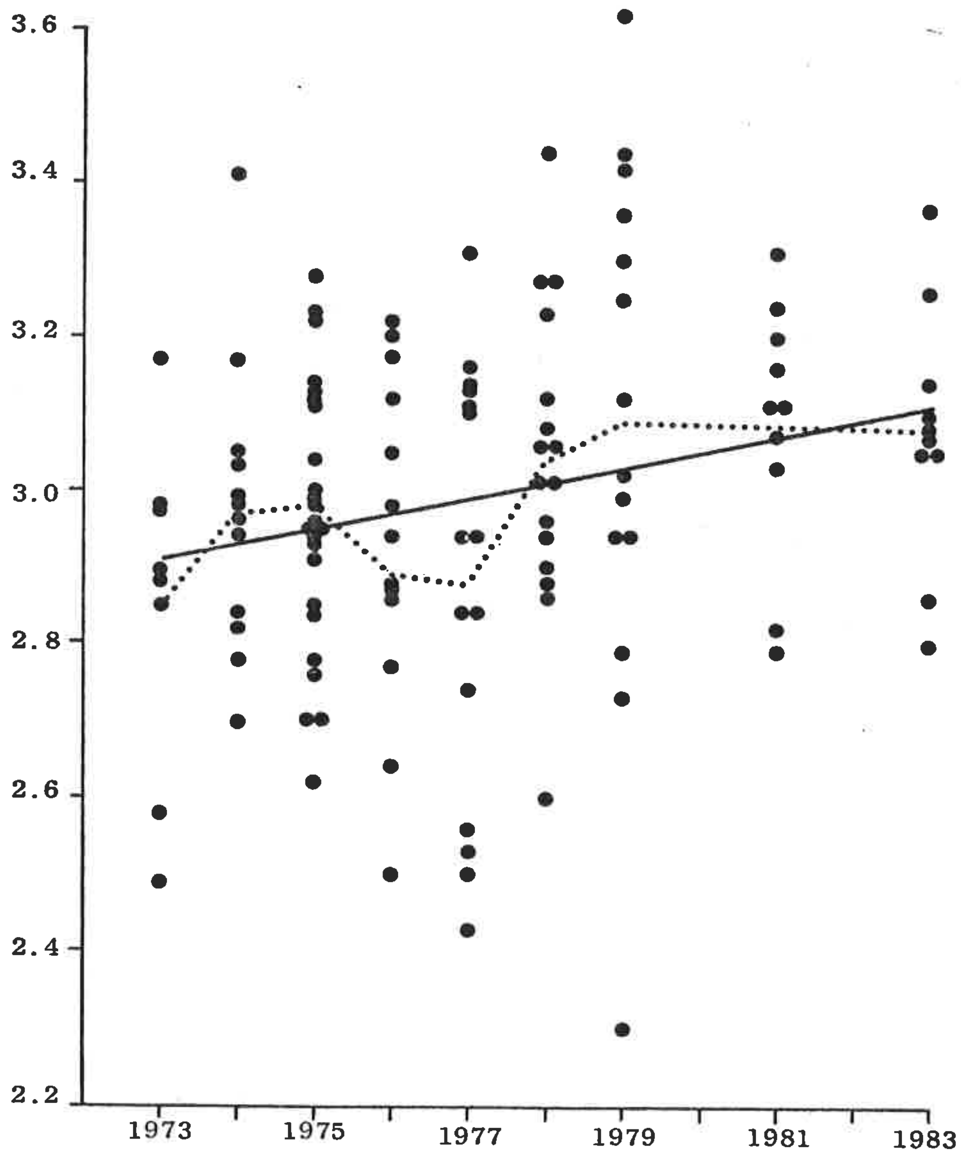


Fig. 10. Shell indices of gannet eggs from Bass Rock, 1973-1983. Dotted line joins annual means, and continuous line shows long-term trend from regression analysis.



INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS AND POLLUTION

Part 6 Mersey bird mortalities

D OSBORN, W J YOUNG, K R BULL & J R HALL

Monks Wood Experimental Station
Abbots Ripton
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August 1984

6 MERSEY BIRD MORTALITIES

6.1 Introduction

6.1.1 Work has again centred on: (i) measuring alkyl-lead levels in dead and sick birds to find whether the sickness or death could have been caused by alkyl-lead; and (ii) monitoring levels of alkyl-lead in the livers of teal.

6.1.2 Co-operation with the North West Water Authority has continued as before, with NWWA acting as a 'clearing house' for the birds, collected mainly by BASC members. All the analytical and post-mortem methods have been described previously.

6.2 Mortalities in 1983-84

Table 16 shows the alkyl-lead levels found in the dead and sick birds sent to ITE for analysis. All birds were dead when received by NWWA. One dunlin and one gull were found sick and died some time later.

Only 5 of the 19 birds had alkyl-lead levels in their livers exceeding 1 ppm wet weight and in only 2 cases does it seem reasonable to suggest that the alkyl-lead level may have been high enough to have contributed to death.

Post-mortem examination of the remaining birds revealed few morphological signs that the birds had suffered any adverse effects of alkyl-lead.

6.3 Monitoring alkyl-lead levels in teal and dunlin

6.3.1 Collection of birds

For various reasons, despite efforts to the contrary, it proved impossible to obtain shot teal samples during the shooting season 1982-83. Unfortunately, this did not become clear until it was too late for other agencies to collect useful samples.

Collections in the 1983-84 season have been regular, and liver analyses have been completed for all birds sampled up to the end of January 1984. Another batch of birds covering the remainder of 1983-84 has recently been received and awaits analysis.

No live dunlin have been collected in the period covered by this report.

6.4 Alkyl-lead in livers of Mersey teal

Figure 11 shows all the data, on a month by month basis. Discerning trends in the data is still difficult, partly because the apparent fall in mean alkyl-lead levels in December 1983 and January 1984 could be similar to those seen in December 1981 and February 1982. Some statistical analysis of the data will be done once the rest of the 1983-84 samples have been analysed. It is, perhaps, too early to conclude that alkyl-lead levels in the teal declined at the end of 1983.

6.5 Post-mortem findings on Mersey teal

Birds collected in the monitoring scheme were given a brief post-mortem examination. Interestingly, the former strong association of abnormal morphological features with liver alkyl-lead concentrations of more than 1 ppm wet weight appears to be breaking down. This is another point needing further study once the rest of the 1983-84 birds have been sampled. At present it is difficult to explain this apparent discrepancy between these birds and birds collected earlier. However, it could be that birds are now exposed to important amounts of alkyl-lead for only short periods and that the residence time of alkyl-lead in their tissues is too short to cause gross morphological changes.

6.6 Mechanism by which alkyl-lead induces morphological changes

In a small, ITE-funded study, measurements of Cu, Fe and Zn were made in a number of tissues from starlings used in the experimental work on alkyl-lead. The results suggest that Zn metabolism is less affected than that of Fe and Cu. A short communication about this work will shortly appear in the proceedings of the 'Fifth International Symposium on Trace Elements in Man and Animals' held in Aberdeen in June 1984.

The results of this study may help to 'unify' the underlying toxic mechanisms of lead poisoning, as there is evidence that other birds poisoned by inorganic lead have altered Cu and Fe concentrations.

6.7 Numbers of birds on the estuary 1983-84

Table 17 shows the number of birds present on the estuary. As in previous years, the number of dunlin present in September remained low, compared with the mean counts obtained in the pre-incident years 1971-77. Similarly, redshank numbers were lower throughout the winter in the years after the 1979 incident than during the 1971-77 period. The proportion of the Mersey populations of dunlin and redshank involved in the 1979 incident was higher than that of the other species. Thus, the reductions in numbers of dunlin and redshank may be a direct result of the 1979 incident.

6.8 Conclusions and recommendations

6.8.1 Few, if any, of the birds received in recent months had died as a result of alkyl-lead poisoning.

6.8.2 Alkyl-lead concentrations showed little sign of any decline in the period February 1982 to November 1983. There was some evidence that levels declined in December 1983 and January 1984.

6.8.3 Evidence was obtained to suggest that the relationship between elevated alkyl-lead levels and abnormal morphological features had changed. Interpreting the results fully will necessitate experimental work aimed at studying the residence time of alkyl-lead in bird tissues.

6.8.4 We recommend that the analysis of carcasses should continue for at least one more season and that the monitoring programme should be reviewed early in the season 1984-85 with a view to terminating it, if no serious mortalities have occurred and if alkyl-lead levels in teal liver remain low. If possible, some live dunlin should be collected to check on the levels in these animals.

6.9 Acknowledgments

We are most grateful to Mr D Jones of the Frodsham & District Wildfowlers' Club (BASC) who collected the teal for analysis, and to Dr K Wilson of NWWA for storing birds and transferring them to Monks Wood in bulk.

TABLE 16. Alkyl-lead levels in birds found dead and sick in the Mersey estuary area.

Species (Scientific names)	Date	Tissue	Alkyl-lead (ppm wet wt)
Dunlin (*Calidris alpina*)	-/ 8/83	Liver	2.5*
Dunlin	"	"	0.7
Dunlin	"	"	0.7
Dunlin	"	"	0.6
Redshank (*Tringa totanus*)	3/12/83	"	5.0*
Greenshank (*Tringa nebularia*)	-/ 8/83	"	<0.1
Mallard (*Anas platyrhynchos*)	-/ 8/83	"	<0.1
Shelduck (*Tadorna tadorna*)	26/ 9/83	"	4.7*
Herring gull (*Larus argentatus*)	-/ 8/83	"	<0.1
Herring gull†	11/ 8/83	"	0.8
Lesser black-backed gull (*Larus fuscus*)	-/ 8/83	"	0.9
Black-headed gull (*Larus ridibundus*)	-/ 8/83	"	0.12
Black-headed gull	11/ 5/83	"	<0.1
Black-headed gull	24/ 7/83	"	<0.1
Black-headed gull	"	"	0.7
Black-headed gull	"	"	1.6
Black-headed gull	"	"	<0.1
Dunlin†	10/12/83	Liver	1.1*
		Kidney	2.2*
		Muscle	0.4
Kittiwake (*Rissa tridactyla*)	24/ 8/82	Liver	0.6

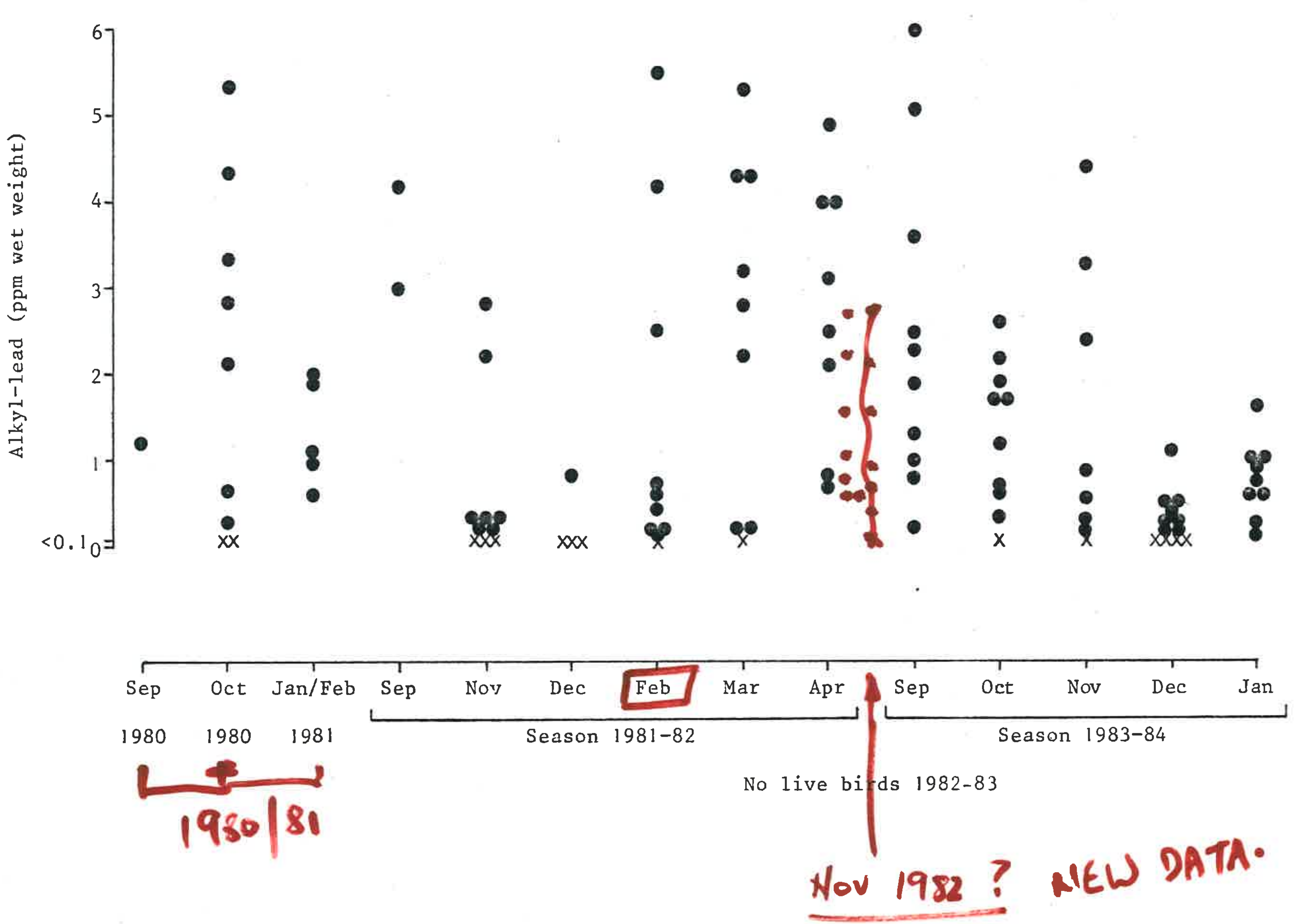
Note: *Alkyl-lead may have contributed to death.
†Found sick.

TABLE 17. Winter numbers of selected duck and wader species on the Mersey estuary: mean for 1971-1977 compared with counts for 1979-80, 1980-81, 1981-82, 1982-83, 1983-84 (G Thomason and others pers comm).

		Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mallard (*Anas platyrynchos*)	1971-77	920	740	910	1350	1150	890	500
	1979-80	310	770	850	1250	1750	1400	560
	1980-81	1250	1700	2400	1750	2400	1300	660
	1981-82	190	660	2300	800	1200	1300	800
	1982-83	550	1350	1250	2300	1100	1100	430
	1983-84	460	1200	980	940	1500	770	540
Teal (*Anas crecca*)	1971-77	2400	4200	6900	7100	7900	6100	3400
	1979-80	460	1000	1250	13000	17500	14000	6800
	1980-81	2500	7200	11000	18000	20000	26000	13000
	1981-82	5400	7300	9400	35000	8000	6100	2300
	1982-83	2700	6700	16500	26000	10500	7200	2100
	1983-84	1200	7400	9500	11000	11000	4100	3200
Pintail (*Anas acuta*)	1971-77	1200	3300	6200	8500	7700	5300	1250
	1979-80	110	4200	4700	9800	10000	2800	165
	1980-81	1950	13000	18500	8000	3900	12500	4000
	1981-82	260	4200	11500	6000	4900	2100	52
	1982-83	820	5500	4000	10000	14000	640	33
	1983-84	170	6600	6200	6100	8000	1750	185
Shelduck (*Tadorna tadorna*)	1971-77	180	360	700	1300	2300	2500	2600
	1979-80	120	390	2700	7400	3600	4000	920
	1980-81	1000	1300	8100	11000	9400	12000	3900
	1981-82	360	2200	12000	6500	4900	4000	1850
	1982-83	750	2500	6900	7100	3900	2000	1600
	1983-84	660	2400	6900	3300	1350	4700	3500
Dunlin (*Calidris alpina*)	1971-77	3900	11500	25000	23000	26000	25000	11500
	1979-80	1800	2400	22000	21000	22000	29000	2500
	1980-81	63	10000	21000	40000	24000	31000	18500
	1981-82	720	7100	18000	13500	12000	1850	430
	1982-83	200	5000	26000	30000	13500	12000	1500
	1983-84	530	600	9000	21000	28000	14500	2000
Redshank (*Tringa totanus*)	1971-77	670	860	1400	960	1100	870	900
	1979-80	160	300	260	670	530	480	290
	1980-81	250	510	670	380	210	1050	600
	1981-82	98	780	550	530	460	460	600
	1982-83	125	900	390	330	170	440	480
	1983-84	330	530	390	890	420	1000	730
Curlew (*Numenius arquata*)	1971-77	900	520	400	570	480	560	720
	1979-80	530	210	230	135	220	780	450
	1980-81	1250	430	490	91	330	300	880
	1981-82	810	780	390	145	570	400	120
	1982-83	640	440	67	310	210	570	380
	1983-84	340	350	320	250	520	670	1100

Graham Thomason commented on the winter of 1983-84, that the Mersey tended to hold lower numbers of most species, but the Dee Estuary had large numbers of pintail throughout.

Fig. 11. Alkyl-lead levels in teal livers, September 1980 - January 1984.



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NCC/NERC CONTRACT HF3/08/01
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS AND POLLUTION

Part 7 Puffins and PCBs

M P HARRIS, D OSBORN & D J GORE

Monks Wood Experimental Statio
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August 1984

7 PUFFINS AND PCBs

7.1 Work in 1983-84 on the Isle of May

In 1983, 10 PCB-dosed puffins were collected to determine residue levels in their tissues. No control puffins were captured this year. Table 18 gives the results.

Not all birds had enough fat at the mesenteric sampling site to enable a tissue sample to be obtained.

Notably, in liver, kidney, muscle and brain, PCB values were much higher in 1983 than they had been in recent years in both dosed and control birds. The reason for this is uncertain. Further studies have been initiated to determine whether this difference is associated with unusually low reserves of body fat. Birds with low body fat might be expected to "dump" PCBs from their fat into other tissues. Another possible explanation could be that the birds have become exposed to increased concentrations of PCBs. We would not ascribe the PCB concentrations in the tissues to the effects of the dosing as the liver, kidney, muscle and brain of dosed birds have contained no detectable PCB for some years.

This apparent increase in PCB concentrations necessitates continuing the puffin sampling programme for another year, possibly obtaining a larger sample. The total data resulting from this study will be examined and a recommendation made in due course.

TABLE 18. Levels (ppm wet weight) of PCB in tissues of puffins killed at various times after implantation of PCB (dosed) or sucrose (control).

	Months after implantation	Fat	Liver	Kidney	Muscle	Brain
Dosed	1	301	43.1	ND	6.9	ND
	1	299	24.5	2.6	3.9	ND
	1.5	251	9.9	ND	7.3	ND
	3.5	280	ND	ND	ND	ND
	3.5	347	48.4	ND	21.1	50.9
	3.5	612	16.4	9.9	20.4	4.0
	3.5	610	21.5	12.5	20.1	ND
	3.5	516	24.0	11.3	25.2	ND
	3.5	451	23.1	11.6	17.8	13.0
	9	654	6.3	4.7	2.3	<1.0
	9	371	2.1	<1.0	2.6	<1.0
	9	429	14.0	<1.0	6.3	1.2
	12	284	10.0	4.5	8.1	ND
	12	105	3.5	2.6	4.0	ND
	12	294	17.3	2.8	10.2	4.5
	12	141	9.8	2.7	3.4	1.0
	12	457	10.5	8.2	14.8	6.0
	16	341	ND	ND	ND	ND
	16	200	ND	ND	ND	ND
	16	128	<1.0	ND	ND	ND
	16	211	30.3	14.1	12.4	8.2
	16	214	ND	ND	ND	ND
	16	118	1.2	1.0	7.7	2.7
	34	–	7.7	1.6	3.2	7.6
	34	93.5	2.4	ND	ND	ND
	34	124	3.2	ND	2.0	ND
	34	82.2	ND	ND	ND	ND
	34	97.1	2.6	ND	ND	ND
	34	97.1	1.0	ND	ND	ND
	48	7.8	ND	ND	ND	ND
	48	12.2	ND	ND	ND	ND
	48	8.6	ND	ND	ND	ND
	48	0.6	ND	ND	ND	ND
	48	1.3	ND	ND	ND	ND
	48	9.9	ND	ND	ND	ND
	48	32.0	ND	ND	ND	ND
	57	0.6	ND	ND	ND	ND
	58	6.9	ND	ND	ND	ND
	58	6.2	ND	ND	ND	ND
	58	8.6	ND	ND	ND	ND
	58	11.1	ND	ND	ND	ND
	58	28.0	ND	ND	ND	ND
	60	11.8	ND	ND	ND	ND
	60	89.6	2.5	ND	1.0	4.6
	60	–	1.2	1.6	0.8	1.2
	60	40.7	2.5	ND	0.5	0.6
	60	23.0	2.4	ND	ND	0.5

Table 18 (contd)

	Months after implantation	Fat	Liver	Kidney	Muscle	Brain
Dosed	65	47.0	0.9	2.6	0.9	0.7
	65	-	1.1	1.1	0.8	ND
	65	25.4	1.0	0.6	1.1	0.6
	72	9.4	3.1	3.3	0.4	6.4
	77	84.1	3.6	0.8	0.7	0.2
	77	-	0.6	0.8	0.8	0.2
Control	3	ND	ND	ND	ND	ND
	24	25.7	ND	ND	ND	ND
	24	69.9	1.3	1.9	1.0	1.4
	24	34.5	ND	ND	ND	ND
	26	49.4	ND	ND	ND	ND
	28	38.5	ND	ND	ND	ND
	34	57.0	ND	ND	ND	ND
	34	73.6	ND	ND	ND	ND
	34	28.7	ND	ND	ND	ND
	34	28.1	ND	ND	ND	ND
	48	0.4	ND	ND	ND	ND
	48	0.6	ND	ND	ND	ND
	48	0.3	ND	ND	ND	ND
	48	3.0	ND	ND	ND	ND
	60	14.1	ND	ND	ND	ND
	60	8.2	ND	ND	ND	ND

Note: ND - none detected (< 0.5 ppm) ; -, no fat present at sampling site.

INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

NCC/NERC CONTRACT HF3/08/01
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS AND POLLUTION

Part 8 Incident investigations

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8 INCIDENT INVESTIGATIONS

8.1 Introduction

We have had unusually numerous requests this year to comment on, or investigate, bird mortality incidents. None of these incidents has involved more than 500 birds. Some have involved individual birds (Table 19).

8.2 Results of investigations

8.2.1 Thames estuary gulls and geese

Reports of gull mortality incidents (involving many tens of birds at a time) on the north side of the Thames estuary were received in January 1984, and focussed attention on an area where, for the past few years, Brent geese had been found dead. MAFF investigations of the Brent geese incidents strongly implicated lead. We have checked liver and kidney samples from these geese for alkyl-lead. All samples contained less than 0.1 ppm of alkyl-lead, ie less than the limit of detection of the technique, so alkyl-lead has been eliminated as a causative agent in this case.

The incidents involving geese and those involving gulls seem to be separate in both time and exact location, so a separate investigation was conducted on the gulls. As MAFF had already examined pesticide residues in birds from the gull incidents, which occurred in late 1983, we concentrated on analysis of 3 toxic metals most commonly found in bird tissues in appreciable quantities, namely Pb, Cd and Hg. The results show that none of these metals was present in sufficient amounts to have caused death (Table 20).

Alkyl-lead analysis was done on the livers of these gulls, but, if any was present, it was below the limit of detection of the technique, and so could not have been the cause of the gull incidents.

These results thus gave no indication as to the cause of the incidents. However, post-mortem examination revealed that the birds had adequate fat and protein reserves, so they must have died relatively suddenly. Further investigations will be carried out if similar incidents recur in this area.

8.2.2 Peterborough gulls

Only 3 gulls were provided for analysis by an official of a public utility. One certainly would have been in difficulty from fishing line and weights tangled in the primary feathers. The others showed no unusual features on post-mortem. Preliminary results of chemical analysis provided no evidence to suggest that toxic chemicals had caused the incident. No further reports of mortalities have been received.

8.2.3 Holkham sea eagle

A sea eagle carcass was received via NCC warden David Henshilwood on 18 May 1984. The bird had been taken into "veterinary care" on 11 May 1984. It had been found on agricultural land on the Holkham estate, alive but in an unco-ordinated condition, by estate gamekeepers. When examined by a veterinarian, the bird was found to be "paralysed" in all parts of the body except the head which still could rotate. The bird had an abnormal pupil reflex. After preliminary discussions with staff at Monks Wood, it was thought possible that the bird had been poisoned. Subsequently, the vet gave the bird a steroid stimulant, β-methazone, and atropine sulphate, to counteract the suspected organophosphorus poisoning. Despite this attention and the provision of carrion food, the bird died.

Post-mortem examinations at Monks Wood were conducted with due care for the scientific value of the carcass. The carcass weighed 5.43 kg and carried a West German ring.

The gizzard was empty, the muscles were in reasonable condition and, while mesenteric fat reserves were depleted, the subcutaneous fat was at least adequate. So, although the bird had not eaten for some time, it seemed unlikely that it had starved to death.

The gut was rather dark and looked in poor condition. The liver and kidney were normal in appearance but the kidneys were at the limit of the normal range, being rather dark and slightly oedematous. There was a cloacal "impaction", of uncertain significance.

Chemical analysis on a liver sample was conducted. On packed column GC a large peak was observed. The peak remained unidentified but was not one of the organochlorine pesticides normally encountered in birds, and neither was it any one of the following compounds: carbophenothion, demeton-S-methyl, dichlorvos, chlorfenvinphos. Further chemical analysis will be undertaken by MAFF laboratories.

On X-ray, it was found that the bird contained a number of pieces of shot. One piece had lodged in the neck and another in the brain. Using the X-ray photograph as a guide, the skin over the head was opened and a hole in the skull located.

We conclude that this bird was shot, and that, if the peak on the GC is not a poison, shooting was the cause of death.

Further ITE investigations have been postponed until the results of MAFF analysis are known. A full report will be provided at that time.

8.2.4 Durleigh Reservoir starlings

South-west Region NCC staff, and Wessex Water Authority staff contacted ITE concerning an unusual incident involving starlings. The birds had been found floating amongst the withies at the west end of Durleigh Reservoir.

Post-mortem examination revealed that all of the 10 birds sent to us had fractured skulls. The fractures were all similar in type and no other abnormalities were found. It was concluded that the birds had died as a result of colliding with the water, with submerged vegetation, or with low vegetation in early morning mist. Possibly they were startled by a predator on leaving a nearby roost. No other investigations were conducted into this incident.

8.2.5 Stranraer gannets

An SSPCA Inspector has recently contacted ITE about recurrent gannet mortality incidents near Stranraer. Initial results suggest that the deaths are likely to be caused by starvation, although the birds do seem to contain considerable amounts of PCBs. A fuller report will be provided once analytical work is complete.

8.2.6 Other incidents

ITE involvement in the other incidents listed in Table 19 has been relatively minor, and has principally been limited to providing advice and/or passing information to MAFF laboratories.

TABLE 19. Wildlife incidents 1983-84.

Species	Scientific names	Area	Date	Incident	No. of animals involved	Cause
Gulls*,[1] (Herring, black-headed, lesser black-backed)	Larus argentatus Larus ridibundus Larus fuscus	Thames Estuary	Dec 1983-Feb 1984	Groups of gulls dead on shore	100+	?
Brent geese*	Branta bernicla	Thames Estuary	Autumn 1983 and earlier years	Number of individuals on shore	c10	Lead
Gulls (mainly black-headed)		Peterborough	Oct-Nov 1983	Groups of gulls dead at roost	100+	Various (see text)
Sea eagle**	Haliaeetus albicilla	Norfolk	c.11 May 1983	Bird sick; died in care	1	Shot
Starlings	Sturnus vulgaris	Durleigh Reservoir	31 Jan 1984	Birds dead on water	c200	Collision suspected
Starlings[2]		Basildon	Autumn 1983 and earlier	"Walking starlings"	c50?	Lead?
Gannets	Sula bassana	Stranraer	During winter 1984 and previous years	Dead bird, sick birds on shore	?	Starvation?

Table 19 (contd)

Species	Scientific names	Area	Date	Incident	No. of animals involved	Cause
Heron (and others)	*Ardea cinerea*	Aberystwyth	July 1984	Sick bird died in care	Few	Dived into oil lagoon. Probably died of shock
Geese** (semi-domestic)	?	Abbots Ripton	Spring 1984	Sick birds in field	2	Aldicarb suspected
Geese**	Not informed	Saltfleetby	Spring 1984	Dead birds near sea wall	c50	Pesticides suspected
Earthworms[2]	?	Cambridge	Autumn 1983	Many dead worms on soil surface	?	Phorate suspected

Notes: *MAFF investigation to date. Now passed to ITE, except for botulism tests.
**Investigation passed to MAFF for various reasons.
[1]Incident also involves Essex University Environmental Unit.
[2]Incident reported as a result of ITE projects. They have been included for completeness.

These incidents have been reported by NCC staff, RSPCA Inspectors, MAFF VIC staff, members of the public, and officials of other bodies.

TABLE 20. Pb, Cd and Hg levels in liver and kidney of gulls found dead in the Thames estuary. All values ppm wet weight.

Date bird found dead	Tissue	Pb	Cd	Hg
?	Liver	<1	0.9	<1.5
	Kidney	<1	11.1	<1.5
11/2/84	Liver	<1	1.8	<1.5
	Kidney	<1	14.1	<1.5
18-19/2/84	Liver	<1	1.4	<1.5
	Kidney	<1	9.5	<1.5
"	Liver	<1	1.1	<1.5
	Kidney	<1	10.7	<1.5
"	Liver	<1	0.6	<1.5
	Kidney	<1	8.7	<1.5
"	Liver	<1	0.9	<1.5
	Kidney	<1	6.9	<1.5
12/2/84	Liver	<1	0.2	<1.5
	Kidney	<1	3.1	<1.5