INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

NCC/NERC CONTRACT HF3/03/199
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS OF PREY AND POLLUTION

Part	I	Monitoring
	II	Pollutant residues in seabird eggs
	III	Mersey estuary bird mortalities
	IV	PCB residues in PCB-dosed puffins
	V	Incident investigations

I NEWTON, M B HAAS, D OSBORN, A A BELL,
W J EVERY, H M HANSON, M P HARRIS & I WYLLIE

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

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Part I Monitoring

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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 in livers. During 1982, the livers from 135 birds were analysed, including those from 55 kestrels, 50 sparrowhawks, 6 herons, 4 kingfishers, and 20 others. These totals included some birds received in earlier years, but analysed in 1982. The results from all these birds are given in Table 1, and, for easy comparison, those from the 4 main species are shown in Figures 1-12, alongside results from previous years back to 1975. The calculation of 3-year moving averages includes data from 1974 and 1983 as well.

To test for trends with time, the regressions of residue levels on years of collection were calculated, giving the results in Table 2. Over the period involved, negative regression slopes were found for all residues in all species (except for PCBs in kestrel), but these regressions were significant only for DDE in kestrel, HEOD in sparrowhawk, kestrel and heron, PCBs in sparrowhawk, and mercury in sparrowhawk and heron. Despite this general downward trend since 1975, residues of mercury had increased significantly in sparrowhawks between 1981 and 1982 (Table 3).

One kestrel received in 1982 was the most contaminated ever examined in the Monks Wood scheme. A repeat analysis of this bird confirmed a DDE content of around 1500 ppm in fresh liver, and an HEOD content of around 17 ppm. This bird was found dead in Kent in April, bearing a Dutch ring. It would be surprising if recent DDT use in Britain or Holland had produced such high residues, and possibly this bird had wintered in Spain and was on its way back to Holland when it died. The bird was in good physical condition.

The general long term declines in organochlorine residues were encouraging, and presumably reflected the various controls which have come into effect in recent years. The decline in mercury residues since the mid-1970s followed reductions in the use of mercurial fungicides in agriculture (Sly 1981).

1.2 Sparrowhawk survey

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 several areas, known territories have been checked periodically for details of occupation and breeding success. In this way, it was hoped to find whether sparrowhawks were recovering in numbers, following successive restrictions in cyclodiene use.

In 1982, attention was concentrated on the East Midlands area, which includes Monks Wood. There have been 7 previous surveys in this area, of which the last was in 1979.

Situated in one of the most intensively farmed arable regions of Britain, the East Midlands area has long remained unique among the 7 regional study areas in showing no evidence of sparrowhawk presence during the breeding season. Wintering birds, presumably immigrants, were recorded occasionally throughout the period, and with increasing frequency in recent years. Spring sightings began to be reported as early as 1973, and then erratically in subsequent years. Recolonization is probably imminent. During the 1982 breeding season, 20 suitable territories were searched in June and July. No nests were found, but single kills of small birds (blackbird, chaffinch, robin) indicated the presence of sparrowhawks, probably males, hunting in 3 widely separated woods. This was the first evidence of summering sparrowhawks which we have obtained within this area. Additional evidence came from a farmer's account of a cuckoo-like bird taking a fledgling blackbird from his garden in June.

1.3 Observations at Troy and Willoughby heronries

Throughout the 1960s and early 1970s, periodic visits were made to two Lincolnshire heronries, mainly to count the nests and to obtain eggs and broken shells for analysis. These birds had shown shell-thinning, apparently caused by DDE, but, unlike some birds-of-prey, had not shown a marked population decline. In 1982, the opportunity was taken to check these heronries again, at various dates between March and June.

At Troy, 70 occupied nests were found, only one less than in 1981, and egg breakage was evident at 5 (7%). Clutch size averaged 3.9 in a sample of 28 nests examined by mirror, and, although fledging success could not be determined accurately, the number of well grown nestlings visible in 19 nests confirmed a minimum average of 2.1 (Table 4).

At Willoughy, 18 nests were found to be occupied, 8 less than in 1981. Clutch sizes and brood sizes were not determined, but broken eggs were found below 4 (22%) nests.

1.4 Acknowledgments

We are grateful to all the many people who sent us carcasses and eggs for analysis.

1.5 References

BAILEY, N.T.J. 1959. *Statistical methods in biology.* London: English Universities Press.

SLY, J.M.A. 1981. *Review of usage of pesticides in agriculture, horticulture and forestry in England and Wales, 1975-1979.* Survey Report 23, Pinner, Middlesex: Ministry of Agriculture, Fisheries and Food.

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 1982–March 1983.*

Specimen number	Collection date	*pp'*-DDE	Dieldrin	PCBs	Hg
Kestrel *(Falco tinnunculus)*					
7606	Oct 81	0.48	0.15	3.63	0.14
7638	Oct 81	ND	0.88	0.27	0.33
7449	Nov 81	0.35	0.38	0.14	0.52
7450	Nov 81	0.43	2.95	0.95	0.52
7451	Nov 81	0.32	0.14	0.15	0.52
7452	Dec 81	1.68	0.18	0.78	0.67
7448	Jan 82	46.71	8.06	1.39	1.66
7457	Jan 82	0.80	0.23	0.68	0.50
7470	Jan 82	17.90	3.97	2.23	4.36
7478	Feb 82	573.00	5.05	61.50	3.31
7484	Mar 82	300.00	4.65	38.60	2.64
7487	Jan 82	0.71	0.19	0.34	1.38
7492	Mar 82	9.06	24.20	2.34	7.04
7495	Mar 82	ND	ND	0.69	0.81
7505	Mar 82	14.70	0.54	10.70	12.30
7508	Mar 82	16.40	0.33	6.39	3.34
7512*	Apr 82	1470.00	17.30	5.94	4.74
7521	Apr 82	0.05	0.24	2.63	0.37
7523	Apr 82	1.95	0.19	1.60	0.20
7524	Apr 82	0.08	0.05	1.90	0.31
7531	Mar 82	0.51	0.62	2.14	0.77
7533	May 82	126.00	ND	36.40	3.72
7537	May 82	5.68	0.22	1.29	1.66
7538	May 82	1.97	0.96	1.90	1.58
7544	Mar 82	0.14	0.54	1.27	ND
7545	Jun 82	0.78	0.54	3.42	1.00
7559	Jul 82	2.86	0.34	5.93	2.07
7564	Aug 82	56.90	1.69	6.26	1.78
7567	Aug 82	0.46	0.23	2.71	1.99
7577	Sep 82	ND	0.35	0.42	0.86
7579	Sep 82	0.16	0.49	0.48	0.51
7580	Sep 82	0.79	0.38	1.44	0.79
7582	Oct 82	0.21	2.20	1.45	0.49
7586	Oct 82	13.20	0.56	0.89	1.41
7588	Oct 82	0.61	0.38	0.43	1.59
7590	Oct 82	0.29	0.35	1.29	0.48
7592	Mar 82	ND	0.58	0.68	2.77
7594	Oct 82	1.86	0.47	0.64	0.77
7596	Oct 82	0.17	0.48	1.56	1.21
7598	Nov 82	1.43	ND	0.72	2.68
7600	Nov 82	0.58	ND	0.43	1.16
7601	Nov 82	ND	0.15	0.37	0.72

*Also contained 518.00 ppm TDE

Table 1 (contd)

Specimen number	Collection date	*pp'*-DDE	Dieldrin	PCBs	Hg
Kestrel (contd)					
7602	Nov 82	0.59	0.64	0.66	3.28
7603	Nov 82	0.07	ND	0.55	2.05
7605	Nov 82	0.15	0.18	0.57	1.52
7620	Apr 82	384.00	ND	0.79	2.41
7621	Nov 82	0.50	0.50	0.32	0.56
7622	Nov 82	ND	ND	0.05	ND
7631	Dec 82	0.55	0.42	0.32	0.54
7644	Dec 82	0.20	0.39	1.99	0.31
7646	Dec 82	7.46	1.04	0.22	0.60
7647	Dec 82	ND	0.41	0.35	1.93
7648	Dec 82	6.08	0.39	0.35	3.86
7653	Dec 82	0.64	ND	2.61	1.12
7662	Jan 82	0.73	0.55	1.74	3.12
Sparrowhawk *(Accipiter nisus)*					
7639	Feb 77	3.20	0.23	0.33	5.61
7636	Apr 77	4.13	0.72	0.46	1.95
7632	May 78	135.00	7.41	25.40	5.48
7633	Apr 80	12.90	0.66	1.06	4.99
7634	Nov 80	1.16	ND	0.12	3.69
7568	Dec 80	62.20	0.65	0.43	1.73
7637	Apr 81	4.30	1.40	0.68	1.51
7640	Apr 81	81.50	8.81	12.10	5.61
7458	Nov 81	2.22	ND	0.20	3.98
7464	Jan 82	1.74	0.11	0.12	3.52
7468	Feb 82	1.37	0.20	0.47	1.45
7471	Feb 82	1.80	0.11	0.16	4.59
7472	Feb 82	25.40	3.12	10.10	19.60
7474	Feb 82	1.76	0.18	0.51	4.21
7476	Feb 82	4.31	0.58	0.36	4.21
7480	Feb 82	42.40	2.87	5.40	2.07
7481	Feb 82	106.00	4.23	10.20	9.21
7482	Feb 82	21.80	1.21	4.64	6.52
7483	Feb 82	0.94	0.28	0.08	2.67
7488	Feb 82	0.66	0.04	0.21	1.66
7489	Mar 82	14.90	2.59	6.46	9.06
7490	Mar 82	3.10	0.74	0.44	1.82
7491	Mar 82	3.06	0.46	0.42	2.69
7493	Mar 82	1.40	0.18	0.07	2.94
7494	Mar 82	2.55	0.37	1.38	4.92
7509	Mar 82	12.60	3.32	12.30	4.05
7510	Apr 82	15.90	4.65	4.19	3.34
7513	Apr 82	3.48	4.04	3.77	5.73
7515	Apr 82	12.50	1.51	13.70	46.90

Table 1 (contd)

Specimen number	Collection date	*pp*'-DDE	Dieldrin	PCBs	Hg
Sparrowhawk (contd)					
7516	Apr 82	39.90	5.06	4.16	6.30
7517	Apr 82	17.40	ND	10.80	5.66
7518	Apr 82	33.30	3.99	3.20	7.77
7519	Apr 82	24.60	2.57	18.30	4.97
7520	Apr 82	1.72	0.10	0.73	1.33
7535	Apr 82	1.34	0.10	0.71	3.77
7536	Apr 82	120.00	4.24	44.40	11.40
7553	Jul 82	0.37	0.10	0.02	0.38
7560	Jul 82	0.29	ND	0.11	1.16
7566	Aug 82	0.12	ND	0.46	0.97
7571	Aug 82	0.64	ND	1.39	0.69
7574	Sep 82	0.10	0.07	0.57	2.26
7575	Apr 82	1.75	0.15	0.65	4.64
7583	Jul 82	20.00	0.87	13.10	5.73
7591	Mar 82	14.30	ND	3.45	5.28
7593	Mar 82	14.10	ND	8.88	11.40
7623	Dec 82	35.80	1.61	132.00	3.38
7625	Dec 82	36.30	1.10	1.52	7.76
7642	Sep 82	0.50	0.48	0.02	0.93
7643	Dec 82	1.80	ND	0.72	0.69
7654	Dec 82	0.78	0.15	0.06	1.21
Little Owl (*Athene noctua*)					
7532	Mar 82	0.25	ND	1.19	0.72
7534	May 82	1.10	ND	0.64	ND
7541	Jun 82	0.38	0.12	1.00	0.94
7542	Jun 82	1.17	ND	1.24	0.46
7551	Jul 82	ND	ND	ND	ND
7552	Jul 82	0.44	0.05	0.07	0.41
7554	Jul 82	ND	ND	0.24	ND
7556	Jul 82	0.63	ND	0.49	0.76
7558	Jul 82	ND	ND	ND	ND
7561	Jul 82	0.15	ND	0.06	0.60
7576	Jul 82	ND	ND	1.02	0.55
7626	Dec 82	ND	ND	ND	0.33
7641	Dec 82	0.74	0.03	0.04	0.67
Long-eared Owl (*Asio otus*)					
7486	Jan 82	216.00	2.14	9.82	3.07
7539	Apr 82	0.24	0.11	0.24	0.55
7627	Dec 82	ND	0.04	0.02	ND
7630	Dec 82	ND	ND	2.19	ND

Table 1 (contd)

Specimen number	Collection date	*pp'*-DDE	Dieldrin	PCBs	Hg
Heron *(Ardea cinerea)*					
7453	Dec 81	2.31	0.11	0.40	10.50
7555	Jul 82	0.24	0.03	0.08	3.26
7589	Oct 82	1.04	0.30	0.48	18.70
7595	Oct 82	0.08	ND	0.36	4.41
7618	Nov 82	ND	ND	1.48	7.25
7628	Dec 82	0.04	0.06	0.57	75.10
Great crested grebe *(Podiceps cristatus)*					
7459	Jan 82	1.40	ND	1.21	73.50
7466	Feb 82	ND	ND	0.04	1.50
7578	Sep 82	29.30	ND	28.60	20.50
Kingfisher *(Alcedo atthis)*					
7454	Jan 82	23.10	11.90	16.40	3.93
7546	Jun 82	1.14	0.90	0.14	2.38
7562	Aug 82	6.32	0.52	0.48	ND
7585	Oct 82	4.84	0.47	5.38	3.17

TABLE 2. *Results from regression of individual residue levels (log values) on years, 1975-82. Minus values indicate a downward trend with time.*

	Sparrowhawk		Kestrel		Heron		Kingfisher	
	n	slope	*n*	slope	*n*	slope	*n*	slope
DDE	282	-0.03	285	-0.06*	97	-0.08	48	-0.04
HEOD	282	-0.13***	285	-0.12***	97	-0.18***	48	-0.05
PCBs	266	-0.06**	276	+0.02	97	-0.03	48	-0.05
Hg	227	-0.05***	284	-0.09***	75	-0.05*	25	-0.15

*Slope significantly different from horizontal $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$

TABLE 3. *Comparison of geometric mean residue levels (log values) from birds collected in 1981 and 1982; t values are shown, together with significance levels, and whether the change between years involved an increase (I) or a decrease (D).*

	Sparrowhawk	Kestrel	Heron	Kingfisher
DDE	$t_{94} = 0.59$ I	$t_{103} = 1.58$ I	$t_{19} = 1.54$ D	$t_{15} = 1.47$ I
HEOD	$t_{93} = 0.06$ I	$t_{103} = 0.42$ I	$t_{19} = 2.00$ D	$t_{15} = 0.18$ I
PCBs	$t_{94} = 0.02$ D	$t_{98} = 0.55$ I	$t_{19} = 0.96$ D	$t_{15} = 0.28$ I
Hg	$t_{92} = 2.28^{*}$ I	$t_{103} = 1.95$ I	$t_{21} = 0.75$ I	$t_{3} = 0.83$ D

Note: Degrees of freedom were calculated using the formula given in Bailey (1959) for the comparison of means of two samples where the variances were unequal.

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

*Significance of difference $P < 0.05$.

TABLE 4. *Clutch and brood size at Troy heronry*

	Number of nests with following number of eggs or young						Mean clutch or brood size
	0	1	2	3	4	5	
Eggs	0	0	2	3	18	5	3.9
Nestlings	1	5	5	8	0	0	2.1

Fig. 1. DDE concentrations in livers of sparrowhawks, 1975-82. 3-yearly geometric mean values (———) are shown. Tr - trace values, ND - nil determined.

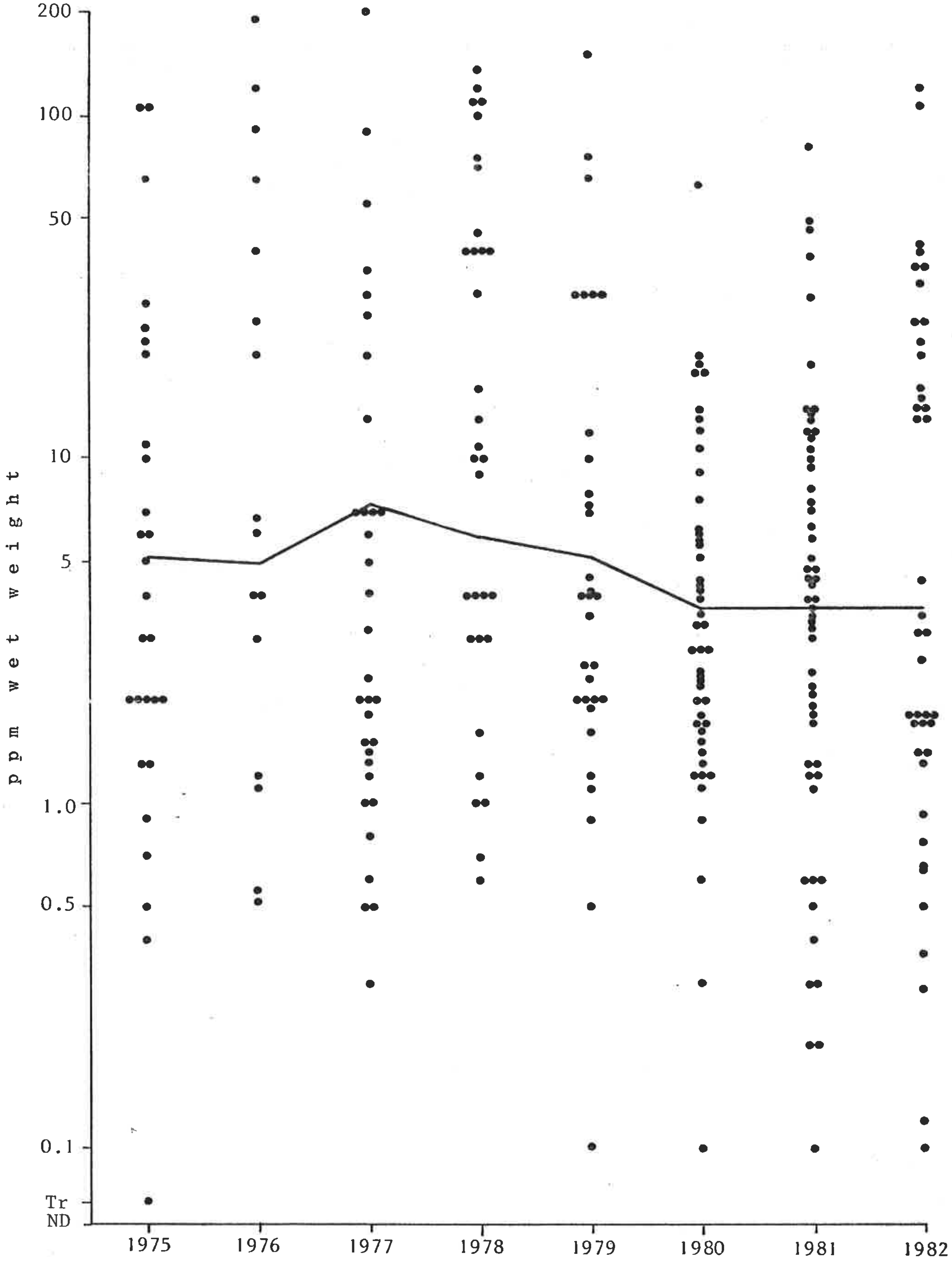


Fig. 2. HEOD concentrations in livers of sparrowhawks, 1975-82. 3-yearly geometric mean values (⟷) are shown. Tr - trace values, ND - nil determined.

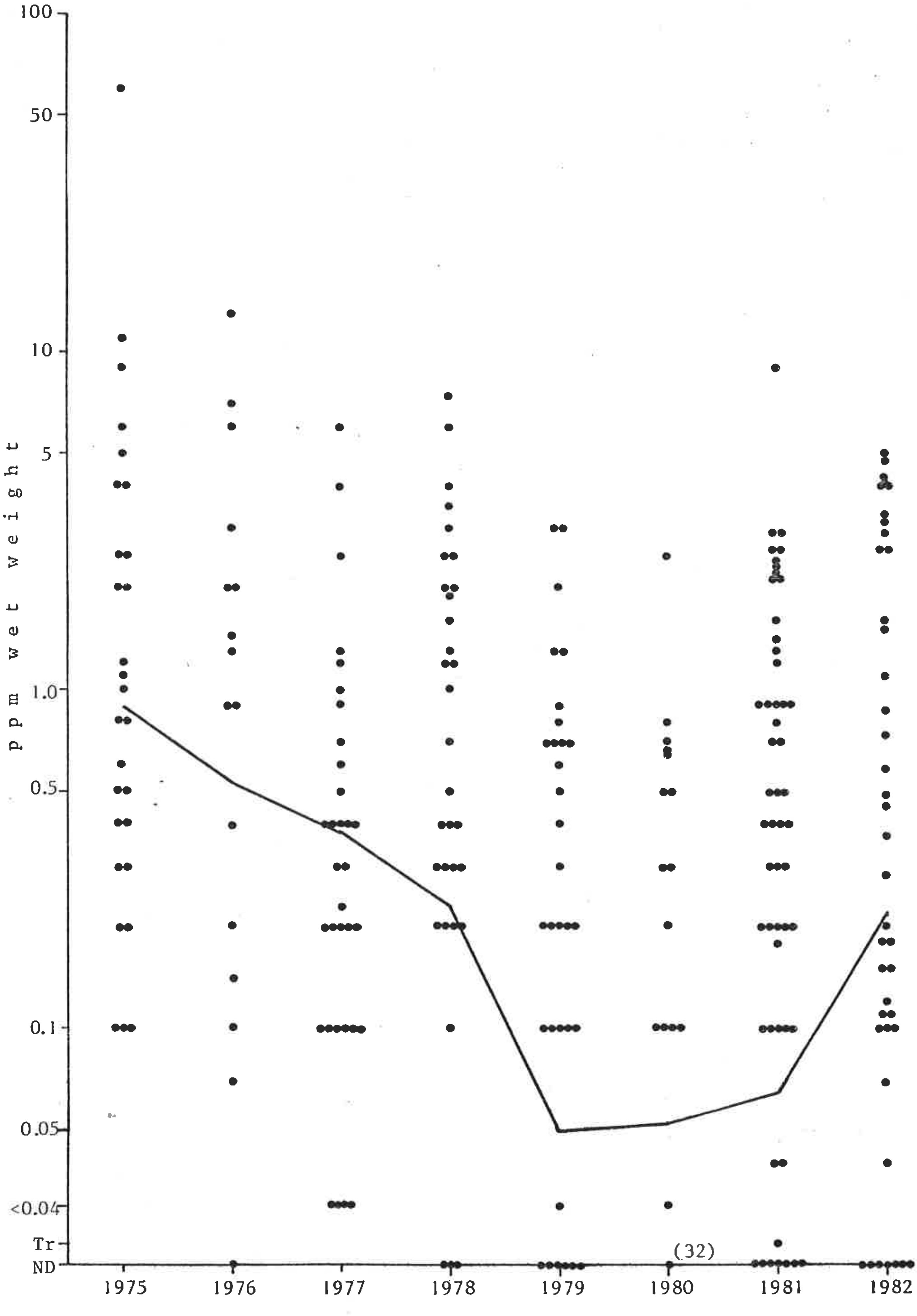


Fig. 3. PCB concentrations in livers of sparrowhawks, 1975-82. 3-yearly geometric mean values (———) are shown. ND - nil determined.

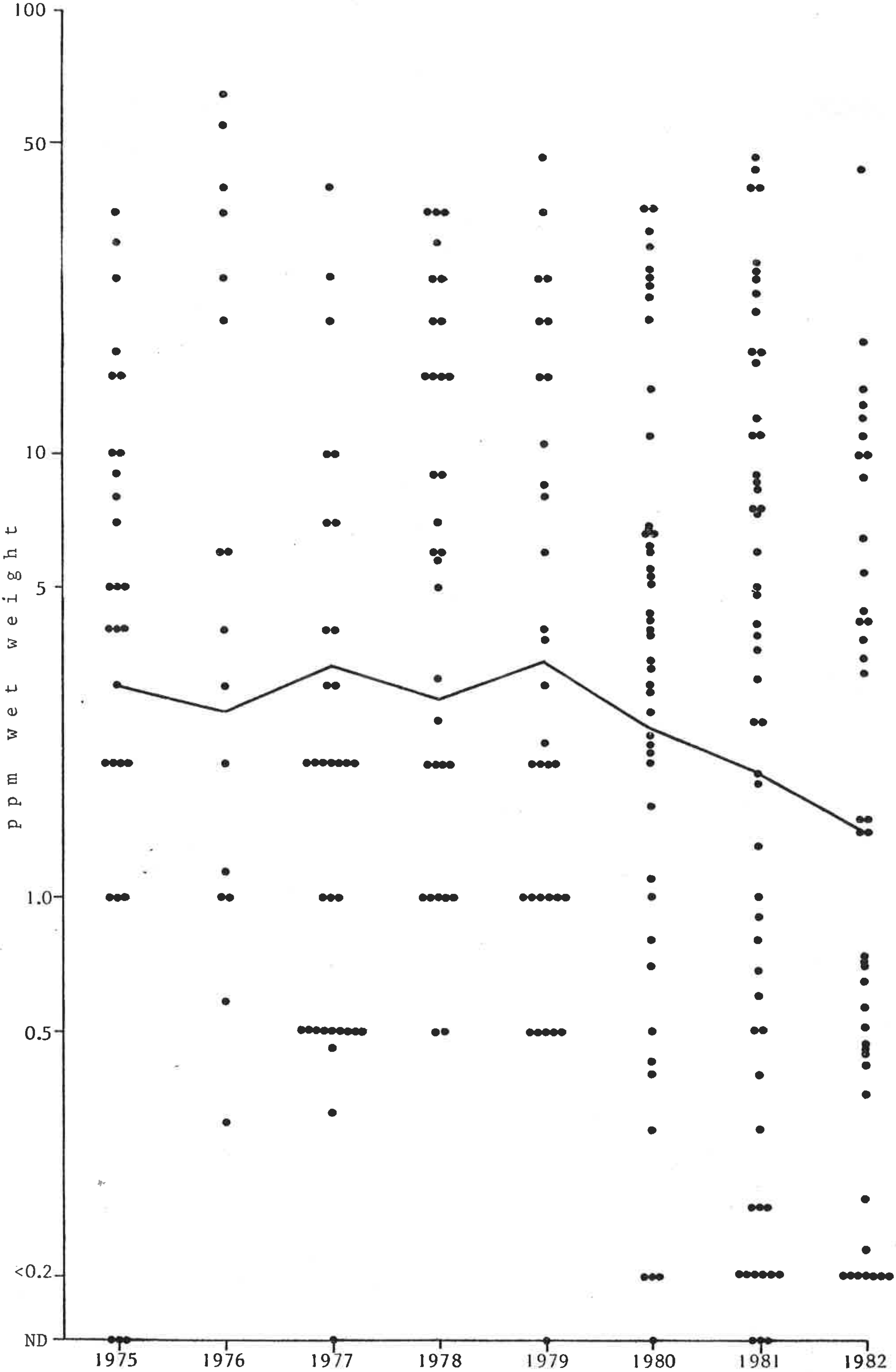


Fig. 4. Mercury concentrations in livers of sparrowhawks, 1975-82. 3-yearly geometric mean values (———) are shown. ND - nil determined.

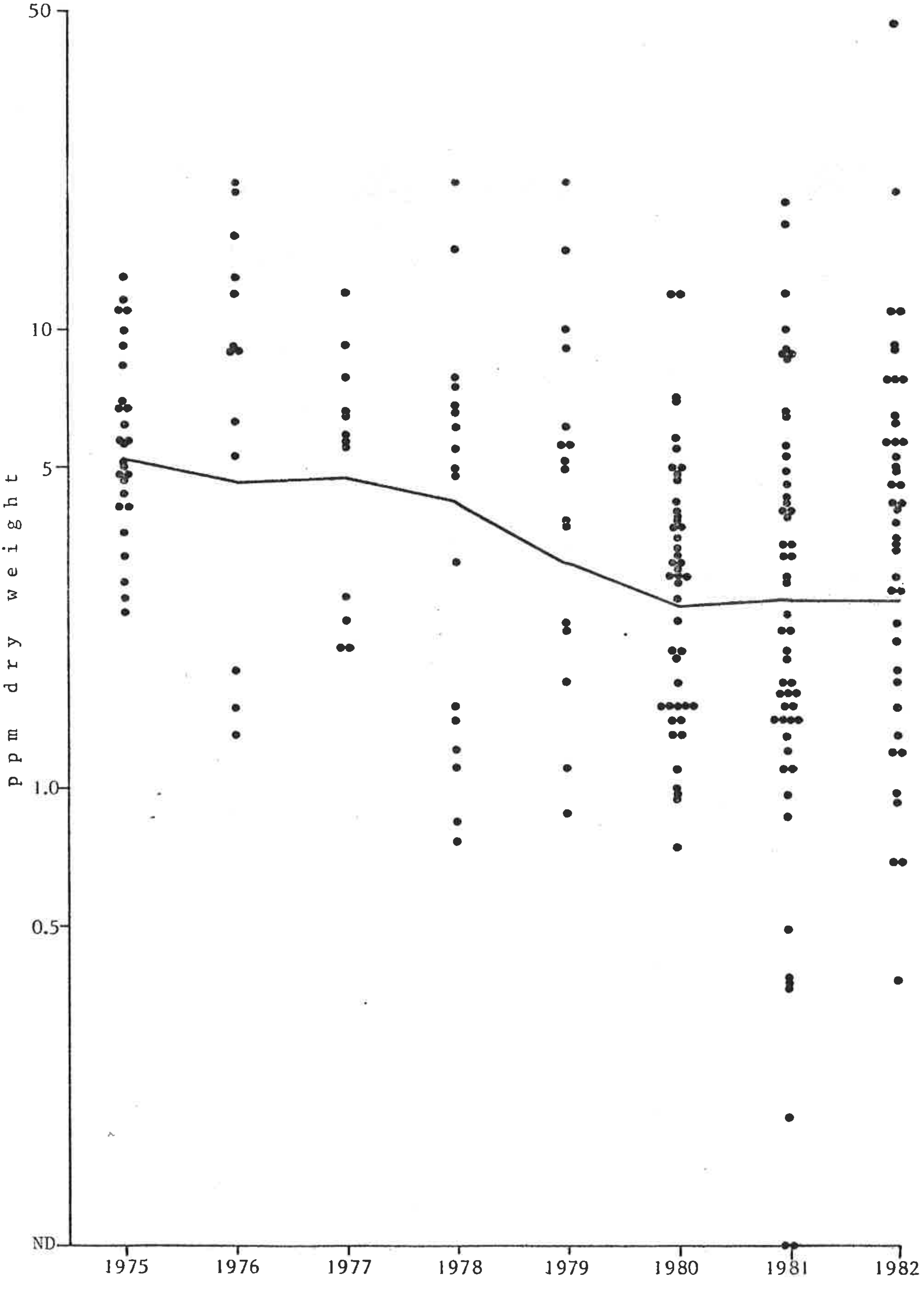


Fig. 5. DDE concentrations in livers of kestrels, 1975-82. 3-yearly geometric mean values (———) are shown. Tr - trace values, ND - nil determined.

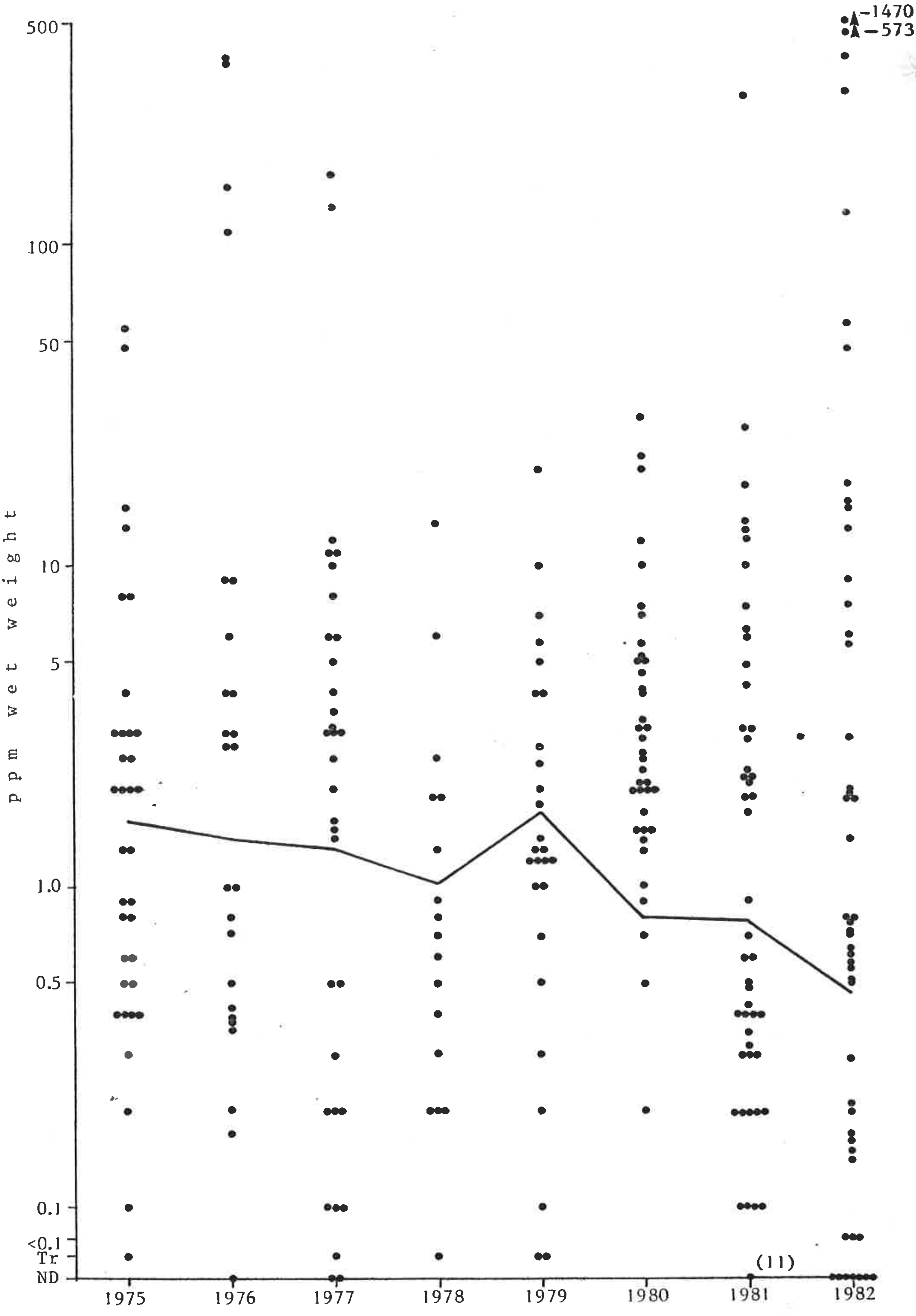


Fig. 6. HEOD concentrations in livers of kestrels, 1975-82. 3-yearly geometric mean values (———) are shown. Tr - trace values, ND - nil determined.

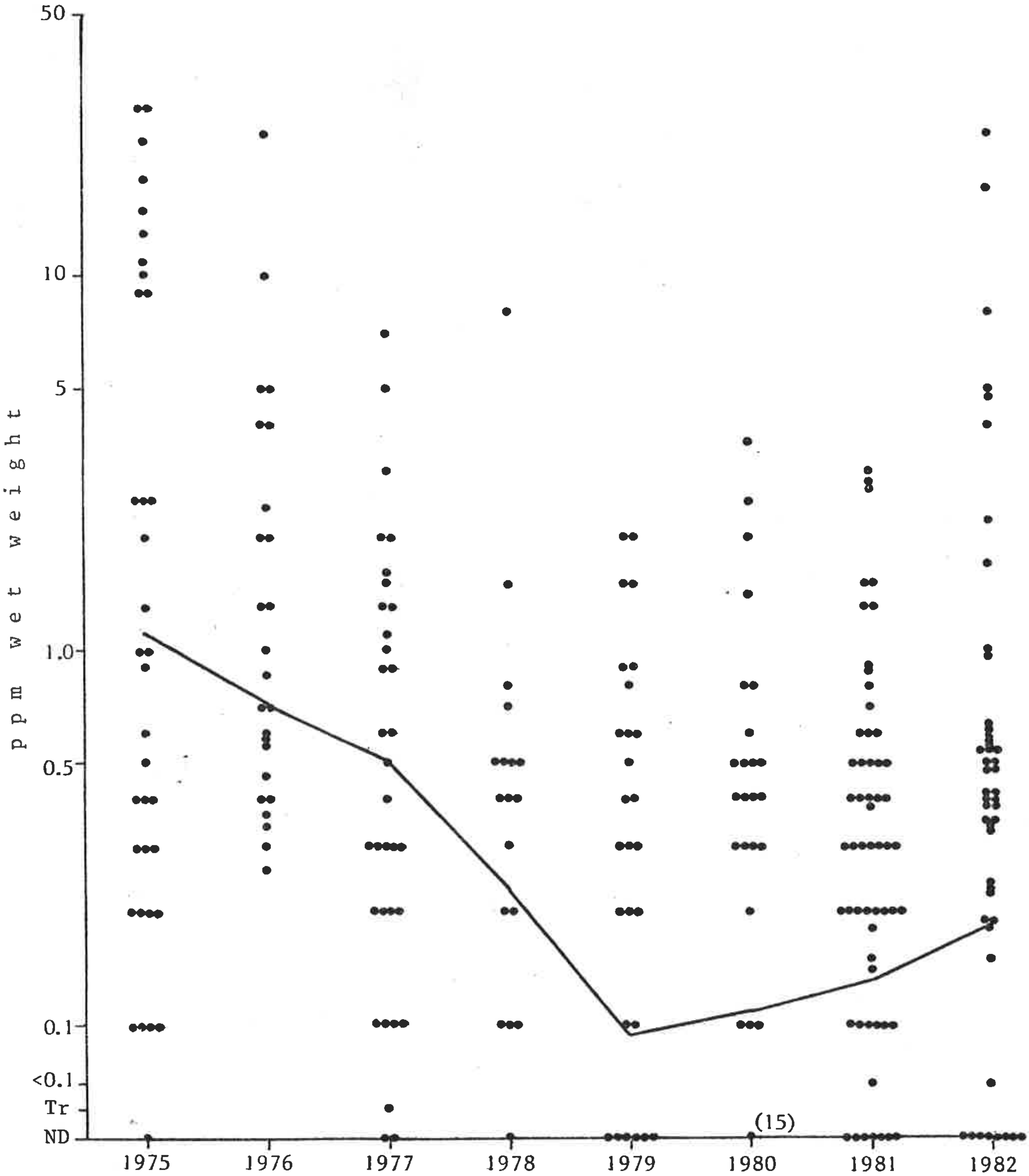


Fig. 7. PCB concentrations in livers of kestrels, 1975-82. 3-yearly geometric mean values (———) are shown. Tr - trace values, ND - nil determined.

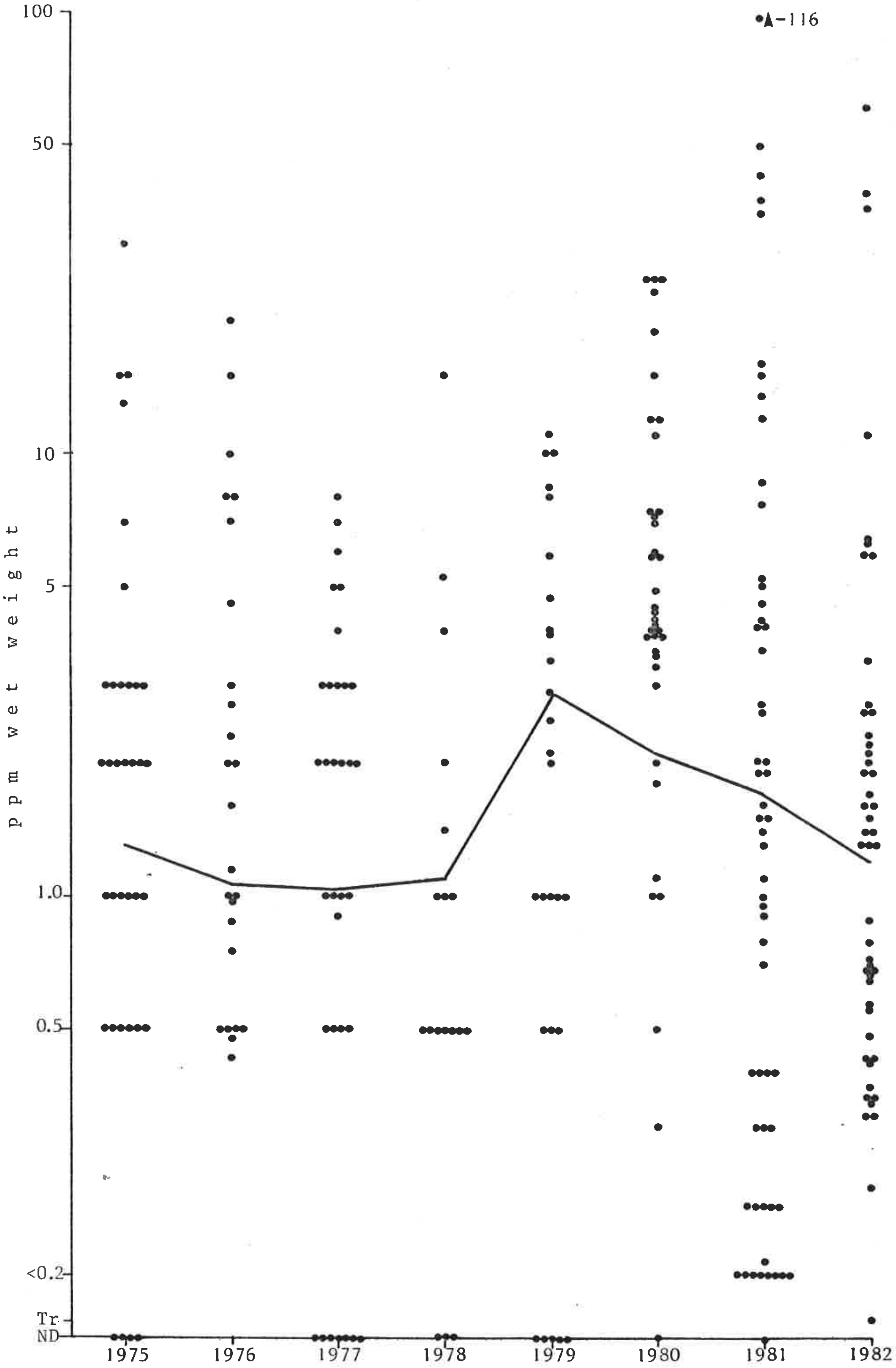


Fig. 8. Mercury concentrations in livers of kestrels, 1975-82. 3-yearly geometric mean values (———) are shown. ND - nil determined.

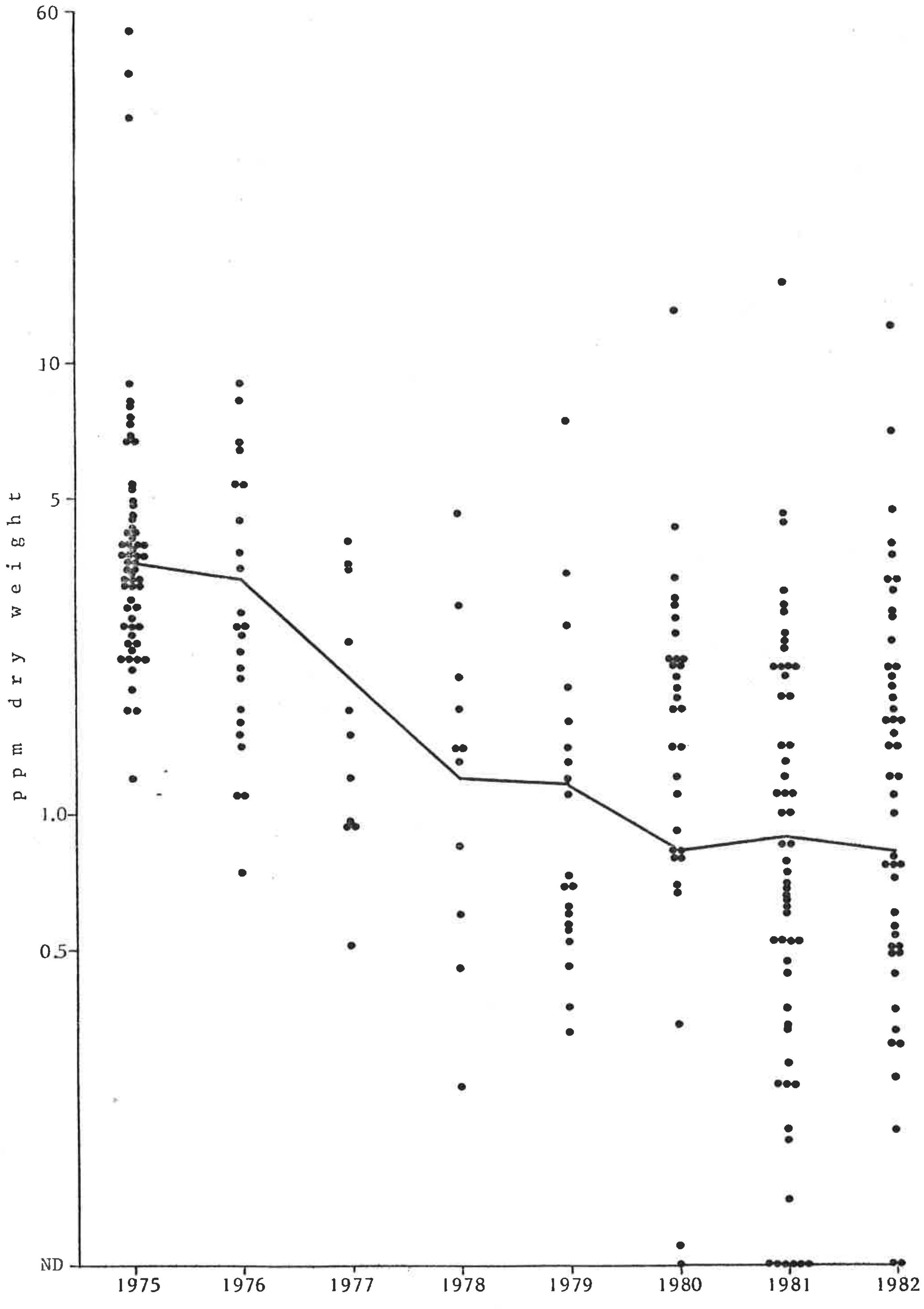


Fig. 9. DDE concentrations in livers of herons, 1975-82. 3-yearly geometric mean values (———), (2-year – – – –) are shown. Tr - trace values, ND - nil determined.

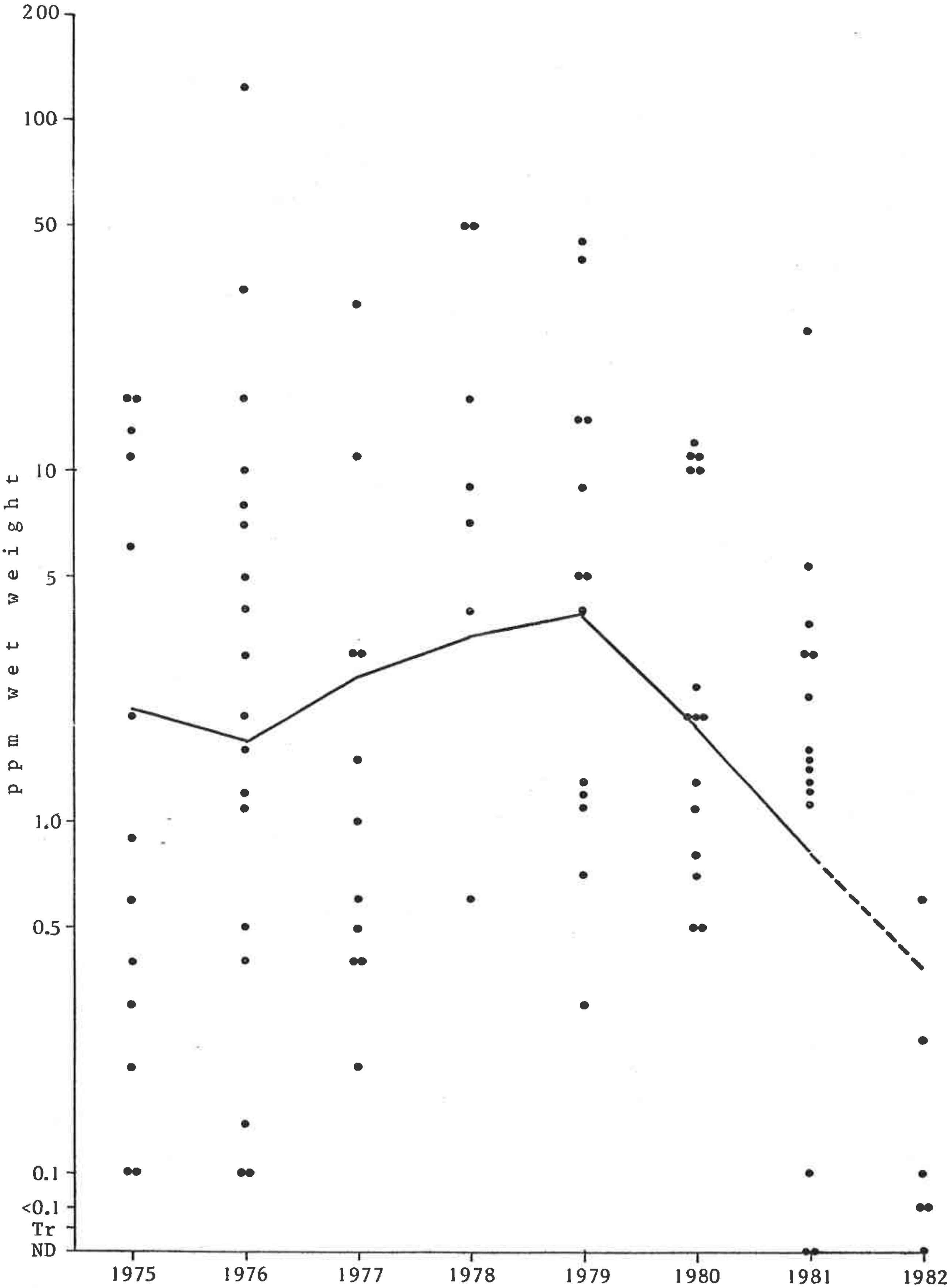


Fig. 10. HEOD concentrations in livers of herons, 1975-82. 3-yearly geometric mean values (———), (2-year– – –) are shown. Tr - trace values, ND - nil determined.

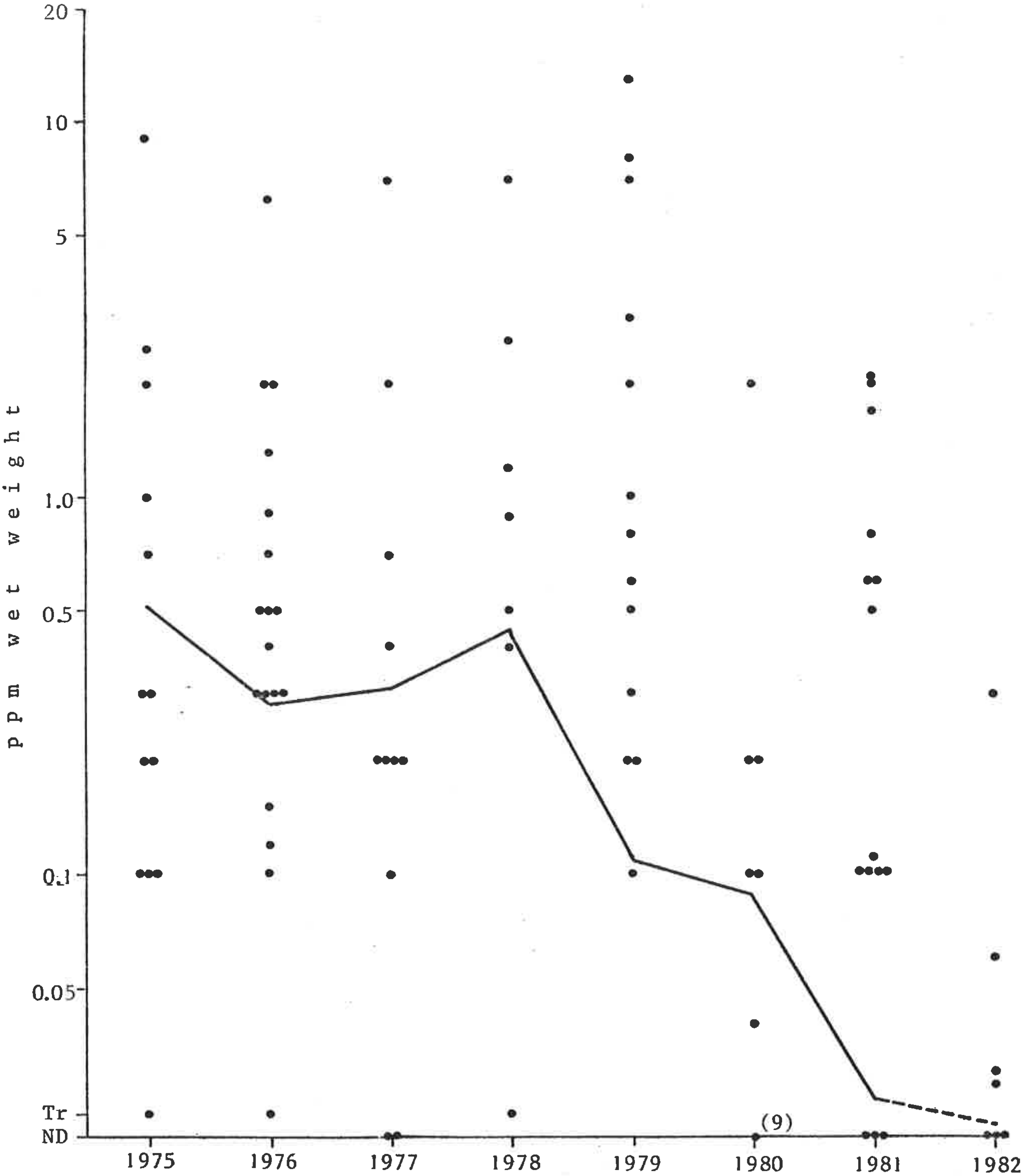


Fig. 11. PCB concentrations in livers of herons, 1975-82. 3-yearly geometric mean values (———), (2-year – – –) are shown. ND - nil determined.

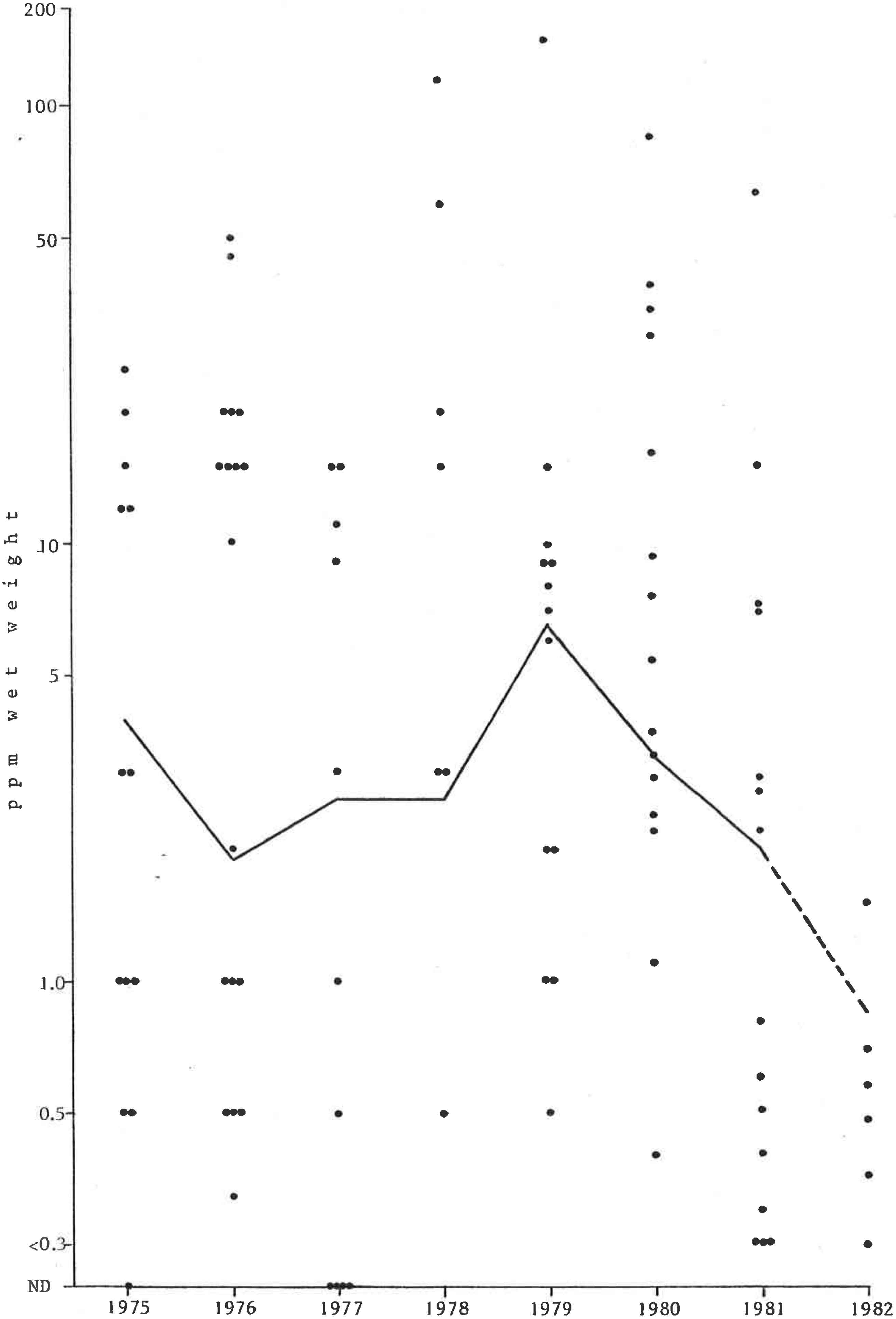


Fig. 12. Mercury concentrations in livers of herons, 1975-82. 3-yearly geometric mean values (———), (2-year - - -) are shown.

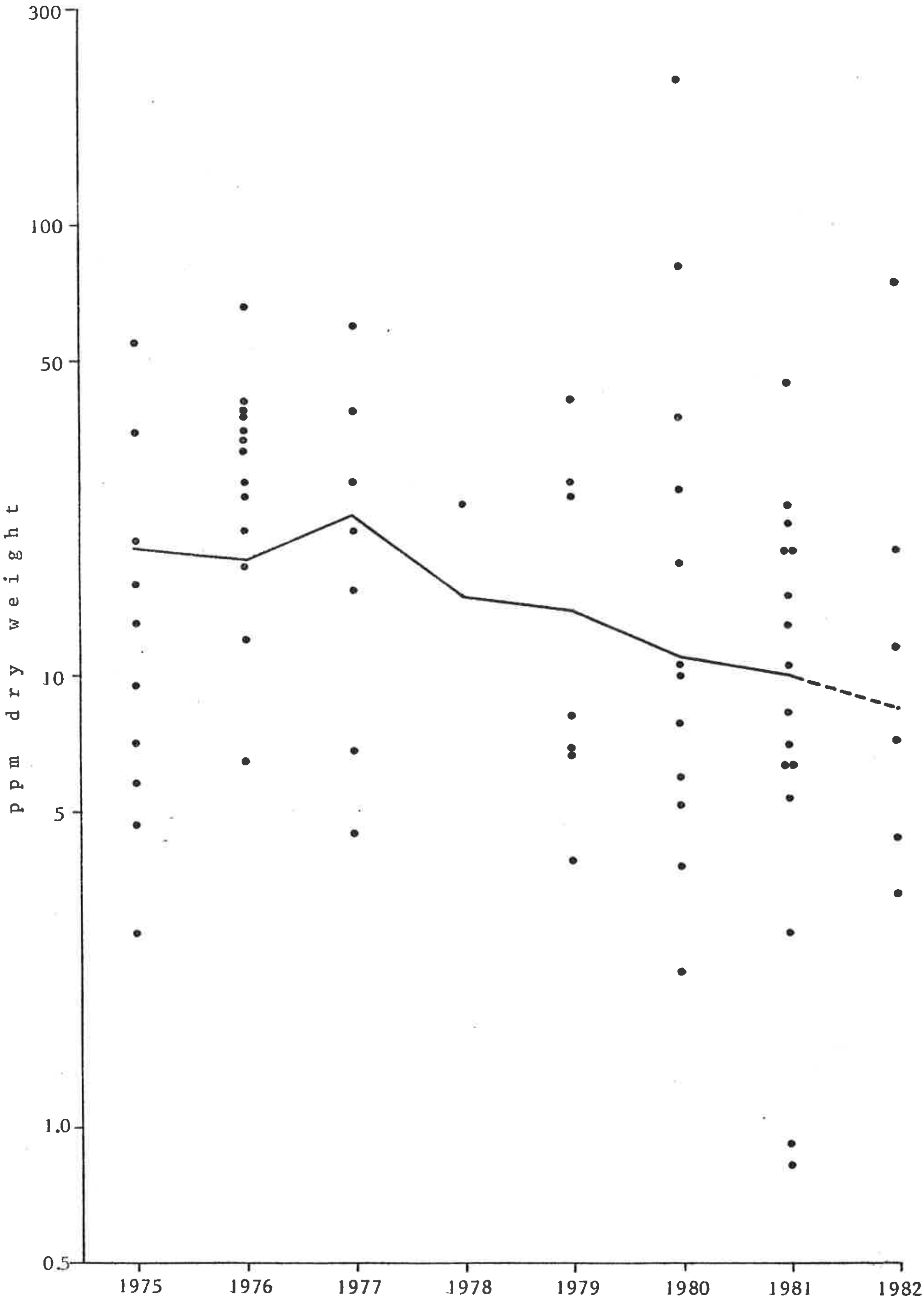


Fig. 13. DDE concentrations in livers of kingfishers, 1975-82. 3-yearly geometric mean values (———), (2-year - - -) are shown. ND - nil determined.

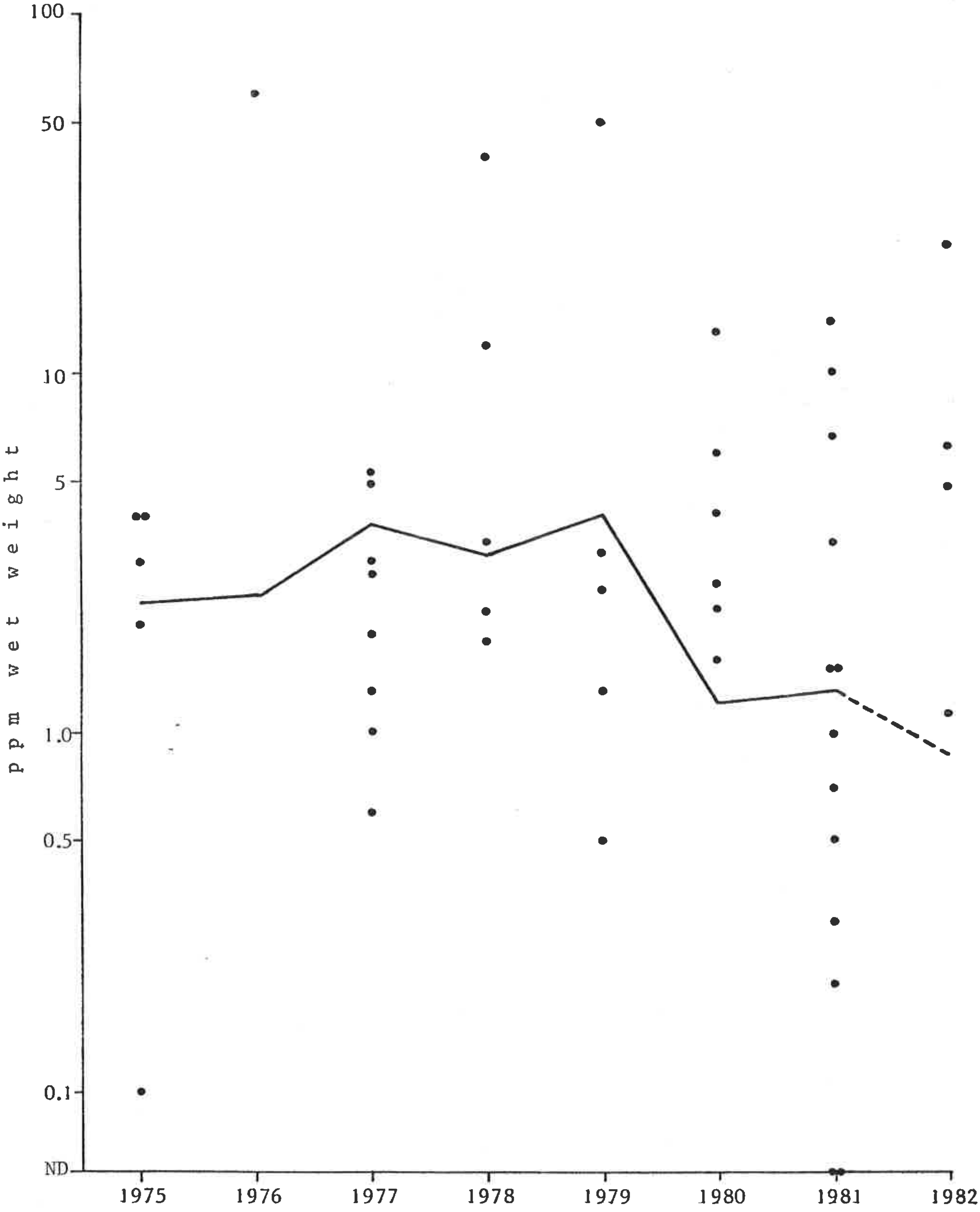


Fig. 14. HEOD concentrations in livers of kingfishers, 1975-82. 3-yearly geometric mean values (———), (2-year – – –) are shown. ND - nil determined.

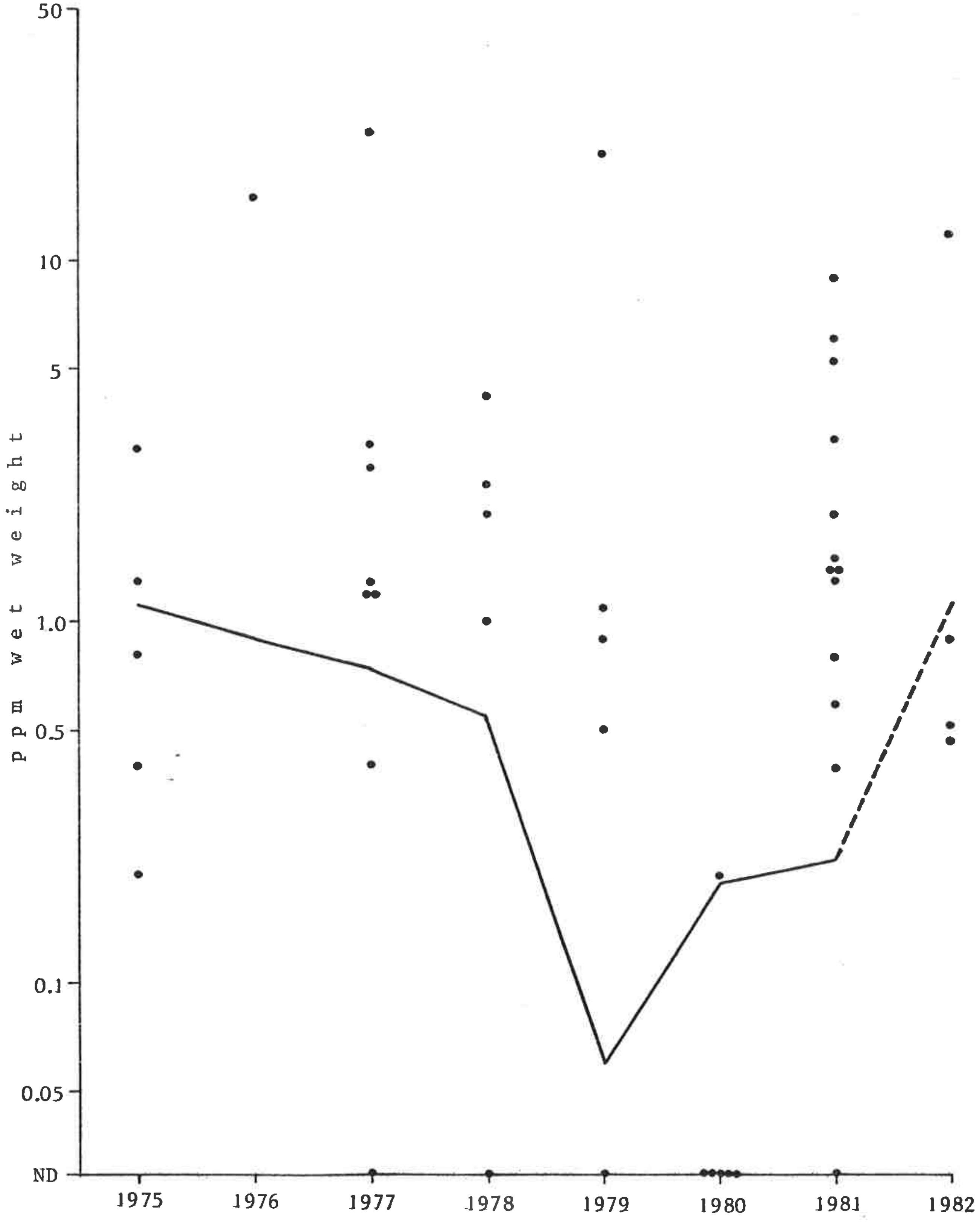


Fig. 15. PCB concentrations in livers of kingfishers, 1975-82. 3-yearly geometric mean values (———), (2-year– – –) are shown. ND - nil determined.

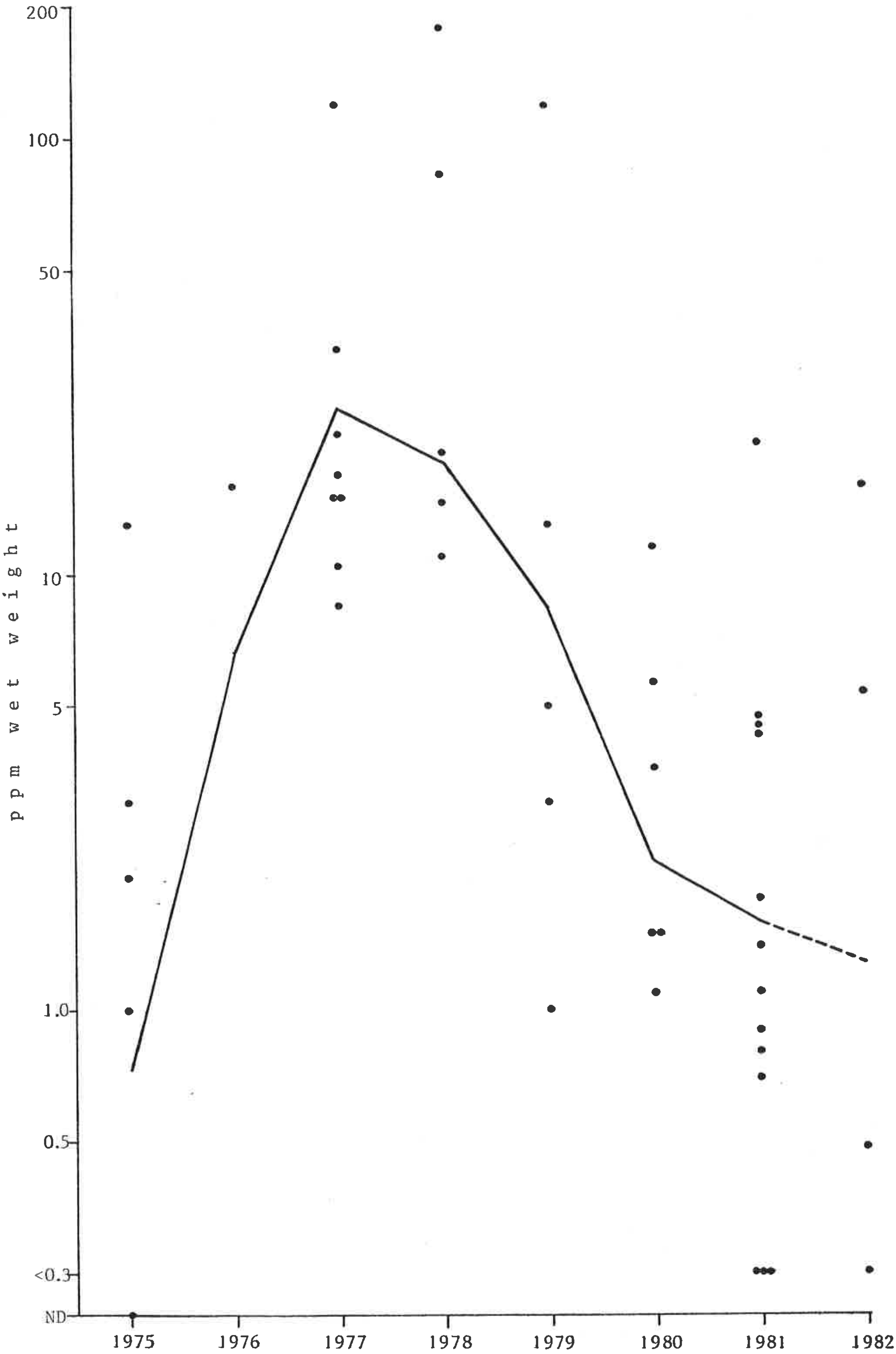
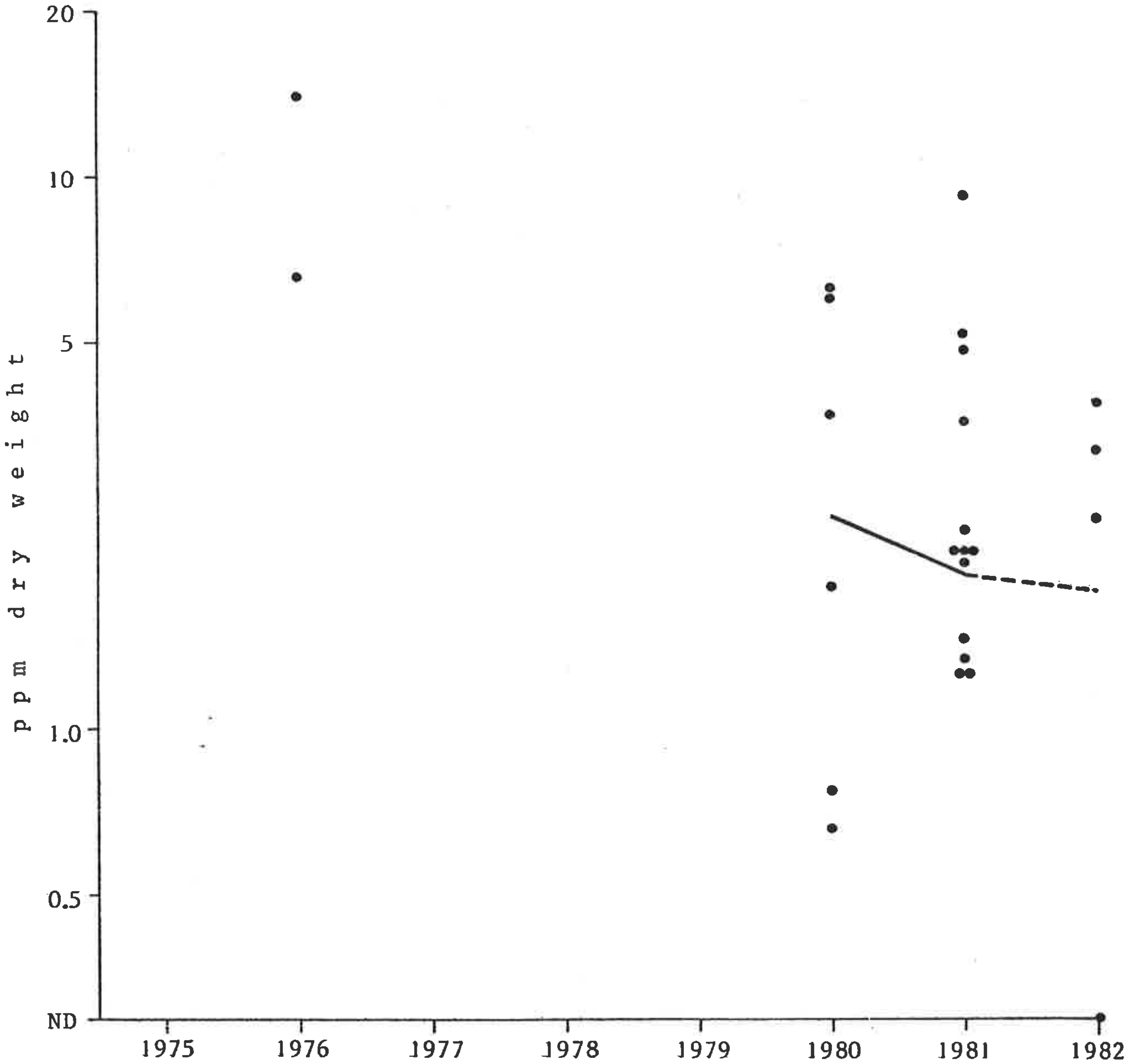


Fig. 16. Mercury concentrations in livers of kingfishers, 1975-82. 3-yearly geometric mean values (———), (2-year - - -) are shown only for later years with adequate samples.



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ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS OF PREY AND POLLUTION

Part II Pollutant residues in seabird eggs

I NEWTON & M B HAAS

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

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2 POLLUTANT RESIDUES IN SEABIRD EGGS

2.1 Pollutants in gannet eggs

In 1982, gannet eggs were obtained from only one colony, at Hermaness in Shetland. These eggs were analysed for residues of DDE, HEOD, PCBs and mercury (Table 5). In no case was any significant change detected from the levels found here in 1981 (Table 6). The eggs were also analysed for cadmium, which was not detected in either year.

2.2 Pollutants in guillemot eggs

In 1982, guillemot eggs were obtained from St Kilda (north-west Scotland), Fair Isle (Shetland), and Isle of May (south-west Scotland). These were analysed for organochlorines and metals, but, as in the gannet eggs, no cadmium was detected (Table 7).

Comparing colonies, significant variation was evident for all 4 pollutants, with higher DDE and PCB residues in eggs from Isle of May than in those from other colonies, and higher mercury levels in eggs from St Kilda (Tables 8 and 9). Comparing 1982 eggs with 1980 or 1981 eggs from the same colonies, significant increases were evident in DDE at Isle of May and PCB at St Kilda. Shell indices, but not DDE levels, had declined significantly at St Kilda.

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 1980-82 than they were about 10 years previously. Such longer term and general declines were consistent with known reductions in organochlorine usage. It is intended soon to prepare a paper for publication summarizing all the results obtained from seabirds in recent years.

TABLE 5. *Residues of organochlorine insecticides (ppm wet weight) and heavy metals (ppm dry weight) in the eggs of gannets* **(Sula bassana)**

Specimen number	*pp'*-DDE	Dieldrin	PCBs	Hg
<u>Hermaness</u>				
E59	0.28	0.10	0.24	1.89
E60	0.49	0.11	0.24	2.45
E61	0.32	0.10	0.33	2.43
E62	0.76	ND	1.00	2.64
E63	0.49	0.11	0.77	2.43
E64	0.08	0.03	0.11	1.79
E65	0.17	0.05	0.23	1.45
E66	0.43	0.15	1.50	2.02
E67	0.94	0.40	0.80	1.45
E68	0.03	ND	0.01	3.24
Geometric mean	0.28	0.04	0.29	2.11
Range within 1 S.E.	0.20-0.39	0.02-0.07	0.19-0.46	1.95-2.30

TABLE 6. *Comparison of geometric mean residue levels (log_{10} values) and arithmetic mean shell indices from Hermaness gannet eggs collected in 1981 and 1982. All those given showed a decrease, but not a significant one. HEOD was not detected in 1981, but appeared in 1982, see Table 5.*

DDE	$t_{14} = 1.08$
PCBs	$t_{12} = 0.74$
Hg	$t_{14} = 1.29$
Shell index	$t_{13} = 1.40$

Note: Degrees of freedom were calculated using the formula given in Bailey (1959) for the comparison of means of two samples where the variances were unequal.

TABLE 7. *Residues of organochlorine insecticides (ppm wet weight) and heavy metals (ppm dry weight) in the eggs of guillemots* (Uria aalge)

	Specimen number	*pp*-DDE	Dieldrin	PCBs	Hg
St Kilda					
	E330	0.85	ND	0.41	1.15
	E331	0.55	ND	0.06	0.76
	E332	0.78	ND	0.11	0.77
	E333	0.60	ND	0.34	1.64
	E334	0.85	ND	0.20	1.31
	E335	0.71	ND	0.01	1.23
	E336	0.43	ND	ND	1.38
	E337	0.37	ND	ND	1.15
	E338	0.76	ND	0.04	1.09
	E339	0.68	ND	0.17	1.41
Geometric mean		0.64	-	0.06	1.16
Range within 1 S.E.		0.58-0.70		0.04-0.10	1.07-1.26
Fair Isle					
	E8	0.44	ND	0.07	0.58
	E9	0.25	ND	0.02	0.68
	E10	0.54	ND	0.81	0.92
Geometric mean		0.39	-	0.10	0.71
Range within 1 S.E.		0.31-0.49		0.02-0.67	0.62-0.82
Isle of May					
	E371	0.88	ND	1.26	0.75
	E372	0.92	ND	0.45	1.14
	E373	1.39	ND	2.73	1.50
	E374	1.01	ND	1.48	0.96
	E375	1.31	0.18	2.13	0.80
	E376	1.09	ND	1.83	1.05
	E377	0.77	ND	0.53	0.54
	E378	0.83	ND	1.31	1.13
	E379	0.66	ND	0.25	1.06
	E380	0.90	ND	1.08	0.66
Geometric mean		0.95	-	1.05	0.92
Range within 1 S.E.		0.89-1.02		0.83-1.34	0.84-1.01

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

TABLE 8. *Analyses of variance on residues and shell index in guillemot eggs.*

	Source	d.f.	Sum of squares	Mean square	F-ratio	Significance of variance between colonies
DDE	within colonies	2	0.3886	0.1943	13.53	$P < 0.001$
	between colonies	20	0.2873	0.0144		
PCBs	within colonies	2	7.7654	3.8827	13.03	$P < 0.001$
	between colonies	20	5.9605	0.2980		
Hg	within colonies	2	0.1190	0.0595	4.21	$P < 0.05$
	between colonies	20	0.2827	0.0141		
Shell index	within colonies	2	0.6002	0.3001	7.02	$P < 0.005$
	between colonies	20	0.8547	0.0427		

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 9. *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.*

	Fair Isle 1981 and 1982		Isle of May 1981 and 1982		St Kilda 1980 and 1982	
DDE	$t_8 = 0.07$	D	$t_{18} = 3.57^{**}$	I	$t_{12} = 1.98$	D
PCBs	$t_8 = 1.45$	D	$t_{18} = 1.32$	I	$t_{18} = 5.74^{***}$	I
Hg	$t_8 = 0.88$	D	$t_{18} = 0.92$	D	$t_{18} = 2.06$	I
Shell index	$t_8 = 1.84$	D	$t_{19} = 0.19$	I	$t_{18} = 2.81^{*}$	D

Note: Degrees of freedom were calculated using the formula given in Bailey (1959) for the comparison of means of two samples where the variances were unequal.

*Significance of difference, $P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

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Part III Mersey estuary bird mortalities

D OSBORN & W J EVERY

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3 MERSEY ESTUARY BIRD MORTALITIES

3.1 Introduction

3.1.1 Constructive co-operation between staff of NWWA, NCC, RSPB and ITE has continued throughout the year. Mr G Thomason has kindly provided counts of birds on the estuary. Mr R Cockbain and colleagues have provided dunlin and Mr D Jones of the BASC Frodsham & District Wildfowlers' Club has collected more teal.

3.1.2 Investigations by the NWWA and ITE have continued as before, with NWWA monitoring levels of alkyl lead in water and invertebrates and ITE doing post-mortem work on birds and determinations of alkyl lead in bird tissues.

3.1.3 Once again, all values are given in wet weight terms to allow comparisons to be made with results from other laboratories.

3.2 Mortalities in 1982

3.2.1 Numbers found dead

As in 1981, mortalities were observed in late summer/early autumn. Table 10, compiled by RSPB, gives the casualties. Herons *(Ardea cinerea)* were particularly prominent, perhaps because a large number of these birds were seen feeding near the Weaver bend area.

3.2.2 Alkyl lead in dead birds

Alkyl lead in casualties sent to ITE for analysis is shown in Table 11. Birds containing sufficient alkyl lead for this chemical to have been the probable primary cause of death are indicated, as are those individuals which contained alkyl lead at a concentration sufficient to have been an important contributory cause of death.

3.2.3 Morphological changes in casualties

Where whole bodies were available for examination, these often showed internal morphological abnormalities, like those seen in previous specimens (Bull *et al.* 1983).

3.2.4 Botulism

Some of the gulls sent to ITE via NWWA were thought to be botulism victims. Where we have information about the results of botulism tests, it is indicated in Table 11.

3.3 Alkyl lead in Mersey wildfowl and wader tissues

3.3.1 Wildfowl

Figure 17 shows the levels of alkyl lead (using trimethyl lead as the analytical standard) found in the livers of Mersey teal *(Anas crecca)* collected for monitoring work since 1980. Although there may have been some decline in levels, no sharp trend is apparent. Table 12 lists all the available analytical results for alkyl lead obtained for wildfowl caught for monitoring purposes since 1980.

3.3.2 Waders

Figure 18 shows the levels of alkyl lead found in the livers of Mersey dunlin *(Calidris alpina)* collected live on the estuary since 1979. Again, over the whole period, no sign of any decline in alkyl lead has been evident. Levels of alkyl lead in overwintering dunlin are much higher than the 0.5 mg/kg suggested as the maximum concentration that could be considered environmentally "safe" (Bull *et al.* 1983; Osborn *et al.* 1983). The very low levels found in the August 1980 sample can probably be accounted for, as these birds were members of the resident dunlin population which is thought to feed in a part of the estuary different from that used by the wintering birds.

Table 13 lists all available analytical results for alkyl lead obtained for waders caught for monitoring since 1979.

3.4 Sublethal effects on Mersey birds

3.4.1 Sublethal effects of alkyl lead compounds on birds from the Mersey

Osborn *et al.* (1983) have identified a number of sublethal effects of trialkyl lead compounds on laboratory birds:

i. interference with feeding
ii. loss of body condition; either reduction in fat or protein content (pectoral muscle lean dry weight)
iii. green discolouration of the liver and intestine and contents
iv. enlarged gall bladder with brilliant green bile
v. reddening (activation) of bone marrow

Effects iii, iv and v have also been observed in wild birds which, on average, contained 2.3 mg/kg (wildfowl) and 0.8 mg/kg (waders) trialkyl lead in the liver (Bull *et al.* 1983).

Studies of body condition have not previously been done on Mersey birds, so 17 teal *(Anas crecca)* from February 1982 and November 1982 were examined to see whether, in addition to effects iii and iv, body condition (effect ii) was poorer in birds containing higher levels of alkyl lead. To reduce the possibility of introducing any bias into the post-mortem studies, Ms H Hanson of ITE, who is experienced in bird dissection but has had no previous involvement with the Mersey studies, did the post-mortems.

a. Sublethal effects on teal

Table 14 shows the results obtained from this study. There was no discernible relationship between alkyl lead concentrations in liver and measures of body condition, although the range of size in the teal was substantial and made comparisons difficult. Comparing mean alkyl lead levels in the birds which showed morphological abnormalities (effects iii and iv) produced a result similar to that obtained previously, in that arithmetic mean values of alkyl lead in affected birds was 1.7 mg/kg, whereas unaffected birds had a mean value of 1.0 mg/kg. There was some indication that the data were not normally distributed. Thus, geometric means might provide a more useful basis for comparison, at 1.1 mg/kg and 0.4 mg/kg for the two groups respectively. Ten of the 17 teal had sublethal abnormalities.

b. Sublethal effects on dunlin

No studies of body condition were made on dunlin, because too few specimens have been obtained to date. However, effects on liver colour, gall bladder and bile were observed, these being very pronounced in the most recent sample, collected in October 1982.

3.5 Numbers of birds on the estuary

Table 15 shows the numbers of certain bird species on the estuary in different months. These data continue to suggest that the dunlin population in the early part of the period is lower after the major 1979 incident than it was in 1971/77. However, the data also suggest that dunlin may leave the estuary sooner now than in earlier times, and this emphasises the need to interpret the data cautiously.

3.6 Conclusions

3.6.1 Some birds are still being killed by alkyl lead compounds on the Mersey estuary.

3.6.2 There is no evidence, as yet, that the body condition of Mersey birds is affected by alkyl lead, but the internal morphological changes seen in both wildfowl and waders suggest that many birds on the estuary are still suffering from sub-lethal effects of alkyl lead.

3.6.3 Levels of alkyl lead in wader tissues are still high enough in the wintering birds to cause concern. If these levels are maintained, a further substantial mortality of dunlin is possible.

3.7 Acknowledgments

We must gratefully acknowledge the additional financial support provided for the wildfowl monitoring work by Cheshire County Council.

3.8 References

BULL, K.R., EVERY, W.J., FREESTONE, P., HALL, J.R., OSBORN, D., COOKE, A.S. & STOWE, T.J. 1983. Alkyl lead pollution and bird mortalities on the Mersey Estuary, UK, 1979-1981. *Environ. Pollut. (A)* 31, 239-259.

OSBORN, D., EVERY, W.J. & BULL, K.R. 1983. The toxicity of trialkyl lead compounds to birds. *Environ. Pollut. (A)* 31, 261-275.

TABLE 10. *Mersey mortalities 1982 : birds found dead or dying*

These figures have been extracted from data collated by the RSPB

Heron	(*Ardea cinerea*)	14
Dunlin	(*Calidris alpina*)	2
Redshank	(*Tringa totanus*)	2
Sandpiper	(*Tringa hypoleucos*)	1
Mallard	(*Anas platyrhynchos*)	7
Shelduck	(*Tadorna tadorna*)	2
Razorbill	(*Alca torda*)	1
Guillemot	(*Uria aalge*)	1
Pigeon	(*Columba livia*)	2
Herring gull	(*Larus argentatus*)	39
Black-headed gull	(*Larus ridibundus*)	23
Lesser black-backed gull	(*Larus fuscus*)	4
Common gull	(*Larus canus*)	2
Unidentified gulls		16
Total		116
Unidentified birds		c.25
Grand total		c.140

TABLE 11. *Alkyl lead (mg/kg wet wt) in tissues of birds found dead in the Mersey area, August-December 1982.*

Birds listed in order analysed.

Species/Bird Code	Date found	Muscle	Liver	Kidney
Heron (B174)	?/8/82	-	16.3**	36.5
Heron (B181)	?/8/82	-	10.2**	-
Heron	6/8/82	3.4	10.1**	25.5
Mallard	7/8/82	3.6	8.1*	7.4
Herring gull	7/8/82	-	0.2	-
Herring gull	7/8/82	-	0.1	-
Herring gull	7/8/82	-	0.3	-
Herring gull	7/8/82	-	0.7	-
Common gull	7/8/82	-	14.1**	-
Black-headed gull	7/8/82	-	6.0*	-
Heron (12/11)	1/12/82	-	0.1	-
Dunlin (12/9)	23-25/8/82	-	12.1**	-
Herring gull (B220)	10/9/82	-	0.2	-
Black-headed gull (12/7)	10/9/82	-	0.8	-
Common gull (12/3)	21/8/82	-	0.4	-
Herring gull (12/3)	21/8/82	-	1.3*	-
Lesser black-backed gull (12/8 B228)	16/9/82	-	0.7	-
Tern (12/10)	27/8/82	-	2.8*	-
Herring gull (12/2)	16/9/82	-	0.3	-
Herring gull (12/2)	16/9/82	-	12.1**	-
Herring gull (12/2)	16/9/82	-	0.1	-
Herring gull (12/2)	16/9/82	-	0.2	-
Curlew	16/11/82	-	9.9**	-

Notes: * Alkyl lead concentration probably contributed to death.

** This bird probably died of alkyl lead poisoning.

\- Indicates tissue not sampled.

Not all botulism data yet received (see text).

TABLE 12a. *Alkyl lead (mg/kg wet wt) in tissues of Mersey teal caught for monitoring, October 1980-present.*

Birds listed in order analysed.

Date	Location	Muscle	Liver	Kidney
19/10/80	Mersey No 4 Pool	0.3	0.6	1.3
		0.1	0.2	0.4
23/10/80	Mersey (Weaver)	0.8	2.1	3.0
		< 0.1	< 0.1	< 0.1
		< 0.1	< 0.1	< 0.1
13/10/80	Mersey	1.8	4.3	4.2
		1.1	3.3	3.3
		2.2	5.3	7.7
		1.1	2.8	4.4
?/9/90	Mersey	0.7	1.2	2.5
26/9/81	Mersey	1.7	4.2	7.9
18/9/81	Mersey	1.0	3.0	-
?/1/81-?/2/82	Mersey	1.0	1.9	2.9
		0.4	1.0	2.1
		0.7	1.1	2.2
		0.4	1.6	2.4
		0.4	0.6	1.6
		0.8	2.0	3.1
?/11/81	Mersey	-	< 0.1	-
		-	< 0.1	-
		-	0.3	-
		-	0.2	-
		-	0.2	-
		-	0.3	-
		-	2.2	-
		-	2.8	-
		-	< 0.1	-
		-	0.3	-
?/12/81	Mersey	-	< 0.1	-
		-	0.9	-
		-	< 0.1	-
		-	< 0.1	-
?/2/82	Mersey	1.2	5.5	6.9
		< 0.1	0.2	0.5
		0.1	0.6	1.3
		1.1	2.5	4.1
		0.2	0.5	0.6
		0.2	0.2	0.7
		-	0.1	0.1
		0.9	4.2	6.8
		-	< 0.1	< 0.1
		0.2	0.7	1.5
?/11/82	Mersey	2.6	2.8	5.4
		0.6	1.0	3.0
		1.8	2.1	4.0
		0.7	1.6	3.6
		0.3	0.5	1.0
		0.5	0.7	1.9
		0.2	0.5	1.0

TABLE 12b. *Alkyl lead levels (mg/kg wet wt) in tissues of other wildfowl caught on the Mersey during monitoring work.*

Date	Species	Location	Muscle	Liver	Kidney
19/10/80	Mallard	Mersey No 4 Pool	0.4	0.2	0.5
			0.7	0.8	3.0
			0.1	0.1	0.4
23/10/80	Mallard	Mersey Weaver	2.8	2.6	13.0
?/9/80	Tufted duck	Mersey No 4 Pool	3.4	3.4	5.6
?/9/80	Shoveler	Mersey	2.5	3.2	3.6
?/12/81	Mallard	Mersey	-	0.1	-
			-	0.1	-

TABLE 13. *Alkyl lead (mg/kg wet wt) in tissues of dunlin caught for monitoring, July 1981-present.*

	Location	Muscle	Liver	Kidney
31/7/81	Mersey	0.4	0.4	1.0
		0.3	1.0	1.4
		0.1	0.2	0.4
		0.3	0.9	1.1
		0.1	0.2	0.5
		0.5	1.4	2.8
		0.3	0.7	0.9
		0.2	0.3	0.6
		0.9	1.9	2.6
		0.1	0.3	0.5
24/2/82	Mersey	0.5	1.5	2.9
		0.8	3.5	9.2
		1.0	3.1	9.7
		1.2	4.4	9.8
		1.0	5.5	9.8
19/10/82	Mersey	1.3	4.9	11.8
		1.2	4.2	9.8
		1.0	3.8	9.3
		1.1	4.7	9.1
		1.1	5.1	8.6

TABLE 14. *Measures of body condition and organ weights in 17 teal collected for alkyl lead monitoring.*

Date collected	Sternum length (mm)	Body Lean dry (g)	Body Lipid (g)	Muscle Lean dry (g)	Muscle Lipid (g)	Liver Wt (g)	Kidney Wt (g)	Sex
Feb 1982	71	82.7	71.1	9.3	1.2	11.7	4.4	M
	73	92.2	46.4	9.6	0.6	6.9	3.1	M
	66	96.1	67.9	8.7	1.3	7.1	2.7	F
	66	66.8	16.9	7.1	0.5	10.1	3.1	F
	73	126.4	79.7	10.6	1.2	7.6	2.9	M
	69	95.2	32.7	10.0	0.6	14.9	3.6	M
	73	90.9	50.4	9.8	0.6	6.1	2.4	M
	63	71.7	34.9	7.5	0.5	15.0	3.8	F
	70	87.8	39.3	9.1	0.7	9.4	3.3	M
	65	70.9	32.4	8.3	0.5	12.4	4.2	F
Nov 1982	67	91.7	76.4	9.4	0.9	16.8	4.1	F
	71	103.4	71.1	9.2	0.9	10.9	3.3	M
	71	115.1	79.8	10.5	1.2	15.4	4.0	M
	67	98.3	72.9	9.4	1.0	12.6	-	M
	74	88.7	57.4	9.3	0.5	13.8	3.8	M
	70	107.7	63.9	9.5	0.7	10.9	3.5	M
	66	81.0	36.7	8.3	0.6	10.3	-	F

Notes: Sternum length is an index of body size in ducks.

Birds are listed in this Table in the same order as in Table 12a.

\- = kidney badly damaged by shot.

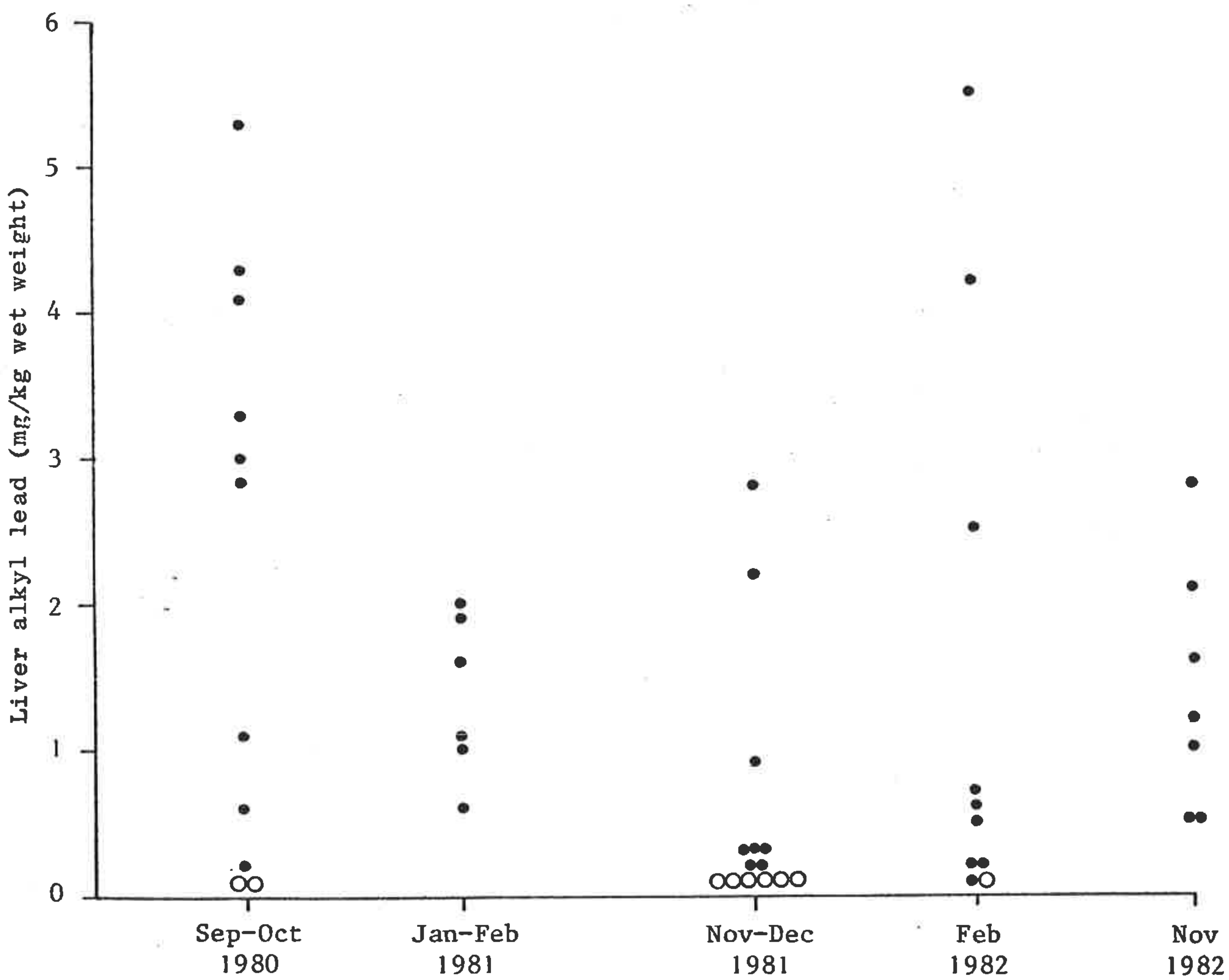
TABLE 15. *Winter numbers of selected duck and wader species on the Mersey estuary: mean for 1971/1977 compared with counts for 1979/80, 1980/81, 1981/82 and 1982/83 (G Thomason and others pers. comm.)*

		Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mallard	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
Teal	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
Pintail	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
Shelduck	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
Dunlin	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
Redshank	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
Curlew	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

<u>December 1981 count:</u> Because of the weather conditions, totals for some species were rough estimates, while some areas were not counted, eg Ince Marsh. Counts marked * are believed to be under-estimates. On an extra count on 27.12.81, totals included 10700 pintail and 25000 dunlin.

<u>1982 counts:</u> The low counts for several species, eg dunlin, might be blamed on the bad weather.

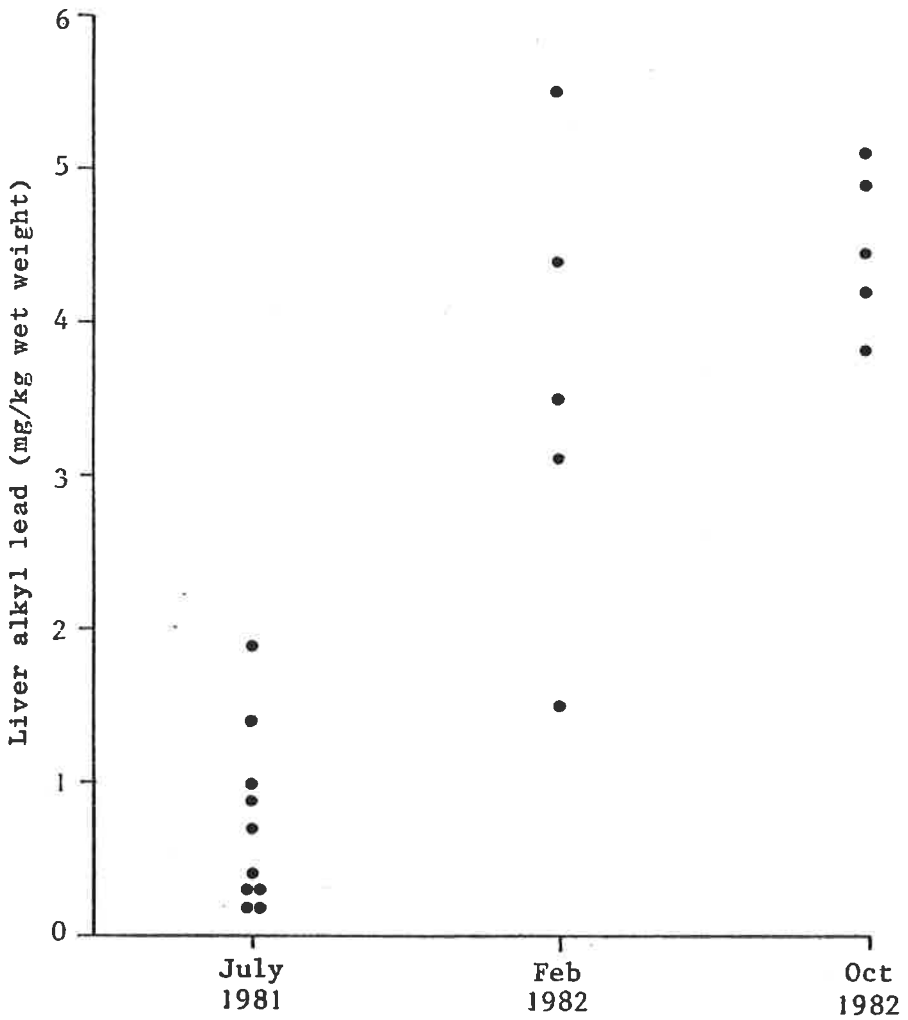
Fig. 17. Alkyl lead levels (mg/kg wet weight) in the livers of Mersey teal.



Notes: More birds must be analysed before statistical tests can be done or conclusions about trends in the data can be drawn.

O = <0.1 mg/kg

Fig. 18. Alkyl lead levels (mg/kg wet weight) in the livers of Mersey dunlin.



Notes: More birds must be collected before statistical tests can be done or conclusions about trends in the data can be drawn.

INSTITUTE OF TERRESTRIAL ECOLOGY
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NCC/NERC CONTRACT HF3/03/199
ITE PROJECT 181
Interim Report to Nature Conservancy Council

BIRDS OF PREY AND POLLUTION

Part IV PCB residues in PCB-dosed puffins

M P HARRIS & D OSBORN

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

August 1983

4 PCB RESIDUES IN PCB-DOSED PUFFINS *(Fratercula arctica)*

4.1 Work in 1982-83

In 1982 puffins from the Isle of May that had been dosed with PCBs and puffins that were experimental controls were again collected for chemical analyses. So few controls are now available that only 2 control birds were found, together with 8 dosed birds.

As in previous years, fat was analysed. Other tissues are in the process of being analysed in case they unexpectedly contain PCBs.

Although only 2 control birds were obtained in 1982, it now appears that levels in dosed birds were similar to those in the controls (Table 16) and similar to those found in the normal population (Osborn & Harris, unpublished). It has therefore taken 5-6 years for the dosed birds to excrete the PCBs they were given.

Levels in the fat of both control and dosed birds are higher than most of those collected in 1981, but lower than those analysed from collections in earlier years (Newton *et al.* 1982). This, together with other unpublished data of our own, suggests that there has been a decline in PCBs in fat of puffins from the Isle of May between the late 1970s and early 1980s.

4.2 Reference

NEWTON, I., HARRIS, M.P., BULL, K.R., OSBORN, D., BELL, A.A., HAAS, M.B. & EVERY, W.J. 1982. *Birds of prey and pollution.* (Part IV). Natural Environment Research Council contract report to the Nature Conservancy Council. Abbots Ripton: Institute of Terrestrial Ecology.

TABLE 16. *PCBs (mg/kg wet wt) in the body fat of dosed and control puffins from the Isle of May.*

Bird No		PCB
1	Dosed	6.9
2	Dosed	9.9
3	Dosed	32.0
4	Dosed	6.2
5	Dosed	8.6
6	Dosed	11.1
7	Dosed	28.0
8	Dosed	11.8
9	Control	14.1
10	Control	8.2

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BIRDS OF PREY AND POLLUTION

Part V Incident investigations

D OSBORN & W J EVERY

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

August 1983

5 INCIDENT INVESTIGATIONS

5.1 North Sea seabird wreck, late winter 1983

5.1.1 Introduction

A large wreck of seabirds involving about 25 000 birds occurred in the North Sea in late winter 1983. Razorbills *(Alca torda)* were the worst common casualties (50-60%), but substantial numbers of little auks *(Alle alle)* were also found along with some guillemots and puffins.

ITE received carcasses from both RSPB and MAFF (Dr Keymer) to examine tissues for chemical contaminants.

5.1.2 Results

a. Metals in livers of dead birds

The levels of metals found were insufficient to have caused death, or to have made a significant contribution to death (Table 17).

As with all our incident investigations, metal levels are given in mg/kg wet wt.

b. Organochlorine insecticides , PCBs and OCs in livers of dead birds

Because of the high levels of organochlorine compounds found in the bodies of auks wrecked in the Irish Sea in 1969, more specimens were analysed for organochlorine compounds than for metals.

Table 18 shows the organochlorine levels found in puffins, Table 19 the levels in little auks, and Tables 20 and 21 the levels in guillemots and razorbills respectively. Again, chemical levels are given in mg/kg wet wt.

The levels of organochlorine insecticides and PCBs in the livers of these birds can be compared to values found by other workers in these and other species of seabirds sampled in the North Atlantic and North Sea areas since the late 1960s.

In general, the levels of OCs in livers of birds from the 1983 wreck were not high.

However, levels of OCs in puffin livers were higher than normally found in live caught puffins from the Isle of May (Harris & Osborn 1981; Osborn & Harris, unpublished) and also higher than found in puffins collected on St Kilda in 1976 and 1977 (Osborn *et al.*, unpublished). In these St Kilda birds, DDE concentrations ranged from non-detected (ND) to 0.1 mg/kg wet wt and PCB concentrations from 0.1-3.5 mg/kg wet wt. In an earlier study (Bourne & Bogan 1972) of puffins from several locations in the north Atlantic, PCB levels ranged from 0.01-0.7 mg/kg wet wt.

Levels of OCs in guillemots from the 1983 wreck are at the very bottom of the range of values obtained for livers of guillemots found dead in the 1969 Irish Sea wreck (NERC 1971), where DDE, PCB and HEOD levels (mg/kg wet wt) ranged between 1.7-25.0, 2-880, and "trace"-0.8 respectively. Bourne and Bogan (1972) found live guillemots had 0.04-7.6 mg/kg PCB (wet wt) in their livers.

Similarly, OC levels in livers of razorbills from the 1983 wreck had lower liver OC levels than razorbill livers from the 1969 incident (NERC 1971). Again, Bourne and Bogan (1972) found still lower levels of PCB in all but one of their razorbills.

There appear to be no data for little auks with which to compare these results.

Two other interesting features of the liver data were as follows.

i. All livers contained small amounts of γ-BHC and many samples contained HEOD. These two chemicals are usually not found in the livers and muscles of live seabirds (Osborn *et al.*, unpublished).

ii. Nine out of the 10 razorbill livers contained low levels of HEOD, whereas only 2 of the 10 guillemots contained detectable amounts.

c. Organochlorine insecticides and PCBs in muscles of dead birds

The muscles of puffins, razorbills and guillemots were examined for OCs, because in live birds muscle usually contains as much OC as liver (Bourne & Bogan 1972; Osborn *et al.*, unpublished). However, in these birds, muscle levels were lower than those of liver.

d. Wider context

If the OC levels in the wreck birds' livers were to be placed in the wider context of the contamination of seabirds by OCs, then it should be noted: (i) the highest levels of OCs in the livers of seabirds of which we are currently aware (excluding gulls) are probably found in fulmars (*Fulmarus glacialis*). Osborn *et al.* (unpublished) have found levels of DDE between 0.8-5.4 mg/kg wet wt, and PCB levels between 1.2-16.7 mg/kg wet wt, the later values being very similar to those found by Bourne and Bogan (1972). All the fulmars in these two studies were caught live; and (ii) PCB levels in tissues from puffins dosed with these chemicals reached higher levels than were found in any other seabirds, save those found dead in the 1969 wreck and those reported for dead gannets (Parslow, Jefferies & Hanson 1973; Parslow & Jefferies 1977). Harris and Osborn (1981) found no effect of these high PCB levels on either the reproduction or survival of Isle of May puffins.

5.1.3 Post-mortem observations

All birds were emaciated. They had badly wasted muscles and little or no visible body fat. (Carcasses have yet to be processed to obtain figures for organ weights and fat content.)

Dr Keymer drew our attention to a dark oily fluid in the gizzard and proventriculus of several of the auks.

We checked our post-mortem records and with the assistance of Ms Hanson, who dissected many of the birds from the 1969 wreck, were able to confirm the material was very similar to what had been seen in a number of these auks. Parslow, Jefferies & French (1972) also refer to a dark fluid, found in puffins that had starved. We believe this dark fluid is a result of starvation - possibly bile fluids - and not a contributory cause of death.

5.1.4 Conclusions

Neither OCs nor metal levels were high enough to have contributed to the deaths of the birds. Only one razorbill (R3) contained enough PCB to give some cause for concern, and this level was similar to that found in puffins that had been dosed with PCB some months before (Harris & Osborn 1981).

The post-mortem findings were consistent with the birds having starved to death. As MAFF vets (principally Dr Keymer) could find no disease that could have accounted for the deaths, we conclude that these birds died because of lack of food.

5.1.5 References

BOURNE, W.R.P, & BOGAN, J. 1972. Polychlorinated biphenyls in North Atlantic seabirds. *Mar. Pollut. Bull.*, 3, 71-75.

HARRIS, M.P. & OSBORN, D. 1981. Effect of a polychlorinated biphenyl on the survival and breeding of puffins. *J. appl. Ecol.*, 18, 471-479.

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PARSLOW, J.F.L. & JEFFERIES, D.J. 1977. Gannets and toxic chemicals. *Br. Birds*, 70, 366-372.

PARSLOW, J.F.L., JEFFERIES, D.J. & FRENCH, M.C. 1972. Pollutants in puffins and their eggs. *Bird Study*, 19, 18-33.

PARSLOW, J.F.L., JEFFERIES, D.J. & HANSON, H.M. 1973. Gannet mortality incidents in 1972. *Mar. Pollut. Bull.*, 4, 41-44.

5.2 Minor incidents

5.2.1 Gulls on Welsh coast (Aberystwyth)

Aberystwyth Veterinary Investigation Centre submitted gull livers and kidneys for analysis, as some 10-20 herring gulls *(L. argentatus)* had been found dead and dying on the shore in January 1983. The birds were not emaciated and liver and kidneys received were of normal weight and appearance.

No significant amounts of any toxic chemicals could be found. OCs were all below the limits of detection. Metals were detected (Table 22), but none in sufficient amounts to have contributed to death. Metal results have been given in Table 22 to allow some comparison with gulls analysed from other areas (eg Mersey).

5.2.2 Other incidents

Monks Wood staff (principally Mr M C French) have been involved in other small-scale investigations during the year. Few analyses were performed at Monks Wood but tissues were occasionally sent to MAFF, as the carcasses had been found on agricultural land.

The two most notable incidents involved (i) geese from East Anglia killed by carbophenothion (some analysed at Monks Wood), and (ii) some passerines from Newborough which MAFF analysed identifying "Temik" (aldicarb) as the cause of death.

TABLE 17. *Toxic metals in livers of birds from 1983 North Sea wreck (mg/kg wet wt).*

Species	Hg	Cd	Pb
Little auk	1.2	2.1	<1
Little auk	0.5	1.7	<1
Little auk	0.8	0.7	<1
Puffin	1.8	4.2	<1
Puffin	1.7	2.9	<1
Guillemot	1.3	1.8	<1
Guillemot	0.8	0.6	<1
Razorbill	2.8	1.3	<1
Razorbill	1.7	1.2	<1

TABLE 18. *OCs (mg/kg wet wt) in puffins from the 1983 North Sea wreck.*

Code	Tissue	γBHC	HEOD	DDE	PCB
P1	Liver	0.6	0.1	2.0	3.5
P3	Liver	0.3	0.3	1.6	4.0
P2	Liver	0.6	0.4	2.5	3.9
P4	Liver	0.5	0.3	2.0	3.7
P5	Liver	0.4	0.4	0.9	0.9
B27/2/83 1	Liver	0.3	0.4	1.0	1.2
2	Liver	0.4	0.2	1.6	3.4
3	Liver	0.3	0.2	1.9	7.3
4	Liver	0.3	0.1	1.1	3.2
5	Liver	0.4	0.1	2.2	4.8
6	Liver	0.3	1.1	2.2	0.7
B27/2/83 1	Muscle	0.1	ND	0.2	ND
2	Muscle	0.1	ND	0.3	0.1
3	Muscle	0.1	ND	0.3	ND
4	Muscle	0.1	ND	0.3	0.1
5	Muscle	0.2	ND	0.6	0.8
6	Muscle	0.1	ND	0.1	ND

Notes: ND = none detected. For γBHC, HEOD and PCB limits of detection are 0.02 mg/kg wet wt. This applies to all Tables for the 1983 North Sea wreck.

TABLE 19. *OCs (mg/kg wet wt) in little auks from the 1983 North Sea wreck.*

Code	Tissue	γBHC	HEOD	DDE	PCB
L1	Liver	0.5	0.2	0.9	1.7
L2	Liver	0.6	0.5	1.8	5.3
L3	Liver	0.6	0.6	1.4	4.7
L4	Liver	0.4	0.1	0.4	1.4
L5	Liver	1.1	0.6	1.7	4.7
B22/2/83 1	Liver	0.9	ND	2.6	5.5
2	Liver	1.2	0.9	2.7	6.8
B28/2/83 1	Liver	0.8	0.4	2.8	6.8

TABLE 20. *OCs (mg/kg wet wt) in guillemots from the 1983 North Sea wreck.*

Code	Tissue	γBHC	HEOD	DDE	PCB
G1	Liver	0.6	ND	2.7	10.2
G9	Liver	0.3	ND	0.7	0.1
G2	Liver	0.3	ND	1.6	3.0
G3	Liver	0.5	ND	3.3	6.9
G4	Liver	0.4	0.2	1.5	0.9
B21/2/83 1	Liver	0.5	ND	3.3	1.9
2	Liver	0.4	ND	1.7	6.3
3	Liver	0.4	ND	3.6	5.3
4	Liver	0.4	0.2	1.9	0.6
5	Liver	0.6	ND	1.9	2.4
B21/2/83 1	Muscle	0.1	ND	0.6	0.1
2	Muscle	0.1	ND	0.3	0.1
3	Muscle	0.1	ND	0.6	0.1
4	Muscle	0.1	ND	0.5	ND
5	Muscle	0.1	ND	0.3	ND

TABLE 21. *OCs (mg/kg wet wt) in razorbills from the 1983 North Sea wreck.*

Code		Tissue	γBHC	HEOD	DDE	PCB
R6		Liver	0.6	0.7	2.2	5.1
R10		Liver	0.5	0.8	3.1	7.0
R1		Liver	0.6	0.7	2.8	5.4
R2		Liver	0.6	0.5	2.8	6.0
R3		Liver	0.7	ND	4.1	57.0
B20/2/83	1	Liver	0.8	0.4	2.6	3.9
	2	Liver	0.3	0.6	2.6	4.9
	3	Liver	0.6	0.9	3.6	4.3
	4	Liver	0.7	0.7	3.1	4.6
	5	Liver	0.5	0.3	2.0	3.6
B20/2/83	1	Muscle	0.2	ND	0.5	0.2
	2	Muscle	0.2	0.1	0.9	1.7
	3	Muscle	0.2	ND	0.7	0.2
	4	Muscle	0.2	<0.1	0.5	1.5
	5	Muscle	0.1	ND	0.3	0.1

TABLE 22. *Metals in Welsh herring gulls, January 1983 (mg/kg wet wt).*

Species	Tissue	OC	Cd	Pb	Hg
Herring gull	Liver 1	ND	0.7	<1	0.4
Herring gull	Kidney 1	ND	3.4	<1	0.4
Herring gull	Liver 2	ND	0.5	<1	0.4
Herring gull	Kidney 2	ND	4.1	<1	0.3
Herring gull	Liver 3	ND	0.5	<1	0.3
Herring gull	Kidney 3	ND	3.5	3.7	0.4