ENVIRONMENTAL PROTECTION

National Rivers Authority
South West Region

ORGANO-CHLORINE PESTICIDE RESIDUES IN FRESHWATER FISH

January 1989
EP/WQ/89/2
Author: B. Milford

GORDON H BIELBY BSc
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NRA

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SOUTH WEST WATER

ENVIRONMENTAL PROTECTION

ORGANO-CHLORINE PESTICIDE RESIDUES IN FRESHWATER EELS

B. Milford
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South West Water
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EXETER

January 1989

ENVIRONMENTAL PROTECTION REPORT EP/WQ/89/2

ORGANO-CHLORINE PESTICIDE RESIDUES IN FRESHWATER EELS

SUMMARY

A survey of pesticide residues in freshwater eels was commissioned through November 1988 at thirteen locations in Cornwall and Devon.

At eleven locations aldrin concentrations were not detected above the limit of detection of 1 microgram per kilogram (wet weight). One of the ten eels collected from the River Tamar at North Tamerton contained aldrin to 6 micrograms per kilogram (wet weight).

All ten eels collected from the Newlyn River near Stable Hobba had aldrin, dieldrin and endrin concentrations in excess of the limit of detection.

Cyclodiene Pesticide	Concentration micrograms per kilogram (wet weight)	
	Mean	Maximum
Aldrin	110	230
Dieldrin	7,492	22,000
Endrin	132	320

At two locations, River Clyst (Clyst Honiton) and Calenick Stream (Calenick), mean concentrations of dieldrin exceeded 100 ug/kg (wet weight) being 108 and 124 ug/kg respectively with maximum values of 340 and 460 ug/kg respectively.

At two other locations, Tamar (North Tamerton) and Allen (Idless) maximum concentrations of dieldrin exceeded 100 ug/kg with values of 140 and 370 ug/kg respectively.

Immediate investigations should commence in the Newlyn River catchment to locate the source or sources of aldrin, dieldrin and endrin with an objective of preventing their entry to the aquatic environment.

The Environmental Health Officer of Penwith District Council should be informed of the concentrations of cyclodiene pesticides found in eels collected from the Newlyn River near Stable Hobba.

Investigations should be undertaken in the River Allen, Calenick Stream, River Clyst and River Tamar catchments to identify the source or sources of organochlorine pesticides which have accumulated in eel flesh.

The Environmental Health Officers of the District Councils with the catchments of the River Allen, Calenick Stream, River Clyst and River Tamar (North Tamerton) should be informed of the dieldrin concentrations found in eels collected from these localities.

B.L. Milford
Water Quality Planner
January 1989

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1. Introduction

In October 1988, a national survey commissioned by the Working Party on Pesticide Residues was published giving details of organo-chlorine pesticide residues in freshwater eels. Following this report, the Ministry of Agriculture, Fisheries and Food (MAFF) requested that water authorities should consider further monitoring of pesticide residues in eels. Where appropriate, results should be forwarded to Environmental Health Officers of Local Authorities.

2. 1988 Pesticide Bioaccumulation Survey

The routine pesticide bioaccumulation survey planned for the autumn of 1988 was re-examined. It was decided to undertake a widespread regional survey instead of concentrating on known locations where organo-chlorine pesticides residues had been monitored previously.

Thirteen locations were selected as indicated on the map in Appendix 1. Each location was visited during November 1988. It was planned that ten eels, generally of a length greater than 300mm, should be collected at each location. At twelve locations it was possible to collect 10 eels. Only seven eels could be collected from the Siblyback Stream, a tributary of the River Fowey.

The fatty flesh of eels accumulates fat soluble residues such as those from persistent organo-chlorine pesticides. A portion of the flesh from each eel collected from the thirteen locations was analysed for organo-chlorine pesticides.

3. Results

The 127 eels collected were analysed for the cyclodiene pesticides (aldrin, dieldrin and endrin), DDT isomers and metabolites, and hexachlorocyclohexane (HCH) isomers. The results are summarised in Appendix 2. Individual analytical results for each eel are included in Appendices 3 to 15.

At eleven locations, aldrin concentrations were not detected above the limit of detection of 1 microgram per kilogram (wet weight). Similarly, endrin concentrations at twelve locations were not detected above the limit of detection of 3 microgram per kilograms (wet weight). One of the ten eels collected from the River Tamar at North Tamerton contained aldrin at 6 micrograms per kilogram.

All ten eels collected from the Newlyn River near Stable Hobba had aldrin and endrin concentrations in excess of the limits of detection as indicated in Appendix 13. The mean concentration of aldrin was 110 micrograms per kilogram (wet weight) and the maximum concentration was 230 micrograms per kilogram (wet weight). The mean concentration of endrin was 132 micrograms per kilogram (wet weight) and the maximum concentration was 320 microgram per kilograms (wet weight).

Dieldrin concentrations were found in 107 (84%) of the 127 eels collected above the limit of detection of 3 micrograms per kilogram (wet weight). The only location at which all ten eels had dieldrin concentrations less than the limit of detection was the River Tamar below Tamar Lakes.

At the eleven other sites the mean concentration of dieldrin in eels above the limit of detection was 49 micrograms per kilograms (wet weight). At two locations, River Clyst at Clyst Honiton and Calenick Stream at Calenick, mean concentrations exceeded 100 micrograms per kilogram (wet weight) (108 and 124 micrograms per kilogram respectively), as indicated in Appendices 4 and 12.

As for aldrin and endrin concentrations, all ten eels collected from the Newlyn River near Stable Hobba had dieldrin concentrations in excess of the limit of detection as indicated in Appendix 13. The mean concentration of aldrin was 7492 micrograms per kilogram (wet weight) and the maximum concentration was 22,000 micrograms per kilogram (wet weight).

At five locations organochlorine pesticide concentrations in individual eels exceeded 100 micrograms per kilogram (wet weight) as indicated in Table 1 below:

TABLE 1

Concentrations of Organo-Chlorine Pesticide > 100 ug/kg (wet weight)

River-Location	Total Number Eels	Number of Eels > 100 ug/kg (wet weight)			
		Aldrin	Dieldrin	Endrin	gamma - HCH
Clyst-Clyst Honiton	10	0	4	0	0
Tamar - North Tamerton	10	0	1	0	0
Allen - Idless	10	0	1	0	0
Calenick - Calenick	10	0	2	0	0
Newlyn - Stable Hobba	10	5	10	5	0

Hexachlorocyclo hexane (HCH) concentrations measured as gamma-HCH were found in 66 (52%) of the 127 eels collected, above the limit of detection of 1 microgram per kilogram (wet weight). The mean concentration of gamma-HCH in eels above the limit of detection was 5 micrograms per kilogram (wet weight).

The maximum concentration of gamma - HCH was 29 micrograms per kilograms (wet weight) and was found in an eel from the River Clyst at Clyst Honiton as indicated in Appendix 4.

DDT measured as the pp-DDT isomer was not detected above the limit of detection of 5 micrograms per kilogram (wet weight) in any of the 127 eels from the thirteen locations.

At four locations (Dart - Staverton Mill Leat, Tamar - North Tamerton, Allen - Idless and Taw - Umberleigh) the metabolite pp-DDE was detected above the limit of detection of 5 micrograms per kilogram

(wet weight). The mean concentration of pp-DDE in the twenty-six (20%) eels above the limit of detection was 35 micrograms per kilogram (wet weight). The maximum concentration of 100 micrograms per kilogram (wet weight) was found in an eel from the River Taw at Umberleigh.

At five locations (Dart - Staverton Mill Leat, Tamar - North Tamerton, Allen - Idless, Calenick - Calenick and Taw - Umberleigh) the metabolite pp-TDE was detected above the limit of detection of 5 micrograms per kilogram (wet weight). The mean concentration of pp-TDE in the nineteen (15%) fish above the limit of detection was 27 micrograms per kilogram (wet weight). The maximum concentration of 150 micrograms per kilogram (wet weight) was found in a fish from the River Tamar at North Tamerton.

4. Discussion

The results from the survey have shown that organo-chlorine pesticide residues can be absent in the flesh of freshwater eels as in the fish collected from the River Tamar below Tamar Lakes. At other locations (Axe, Teign, Dart, Siblyback (Fowey), Fal tributary, Torridge and Taw) these residues can be relatively low indicating a low level of contamination of the aquatic environment.

The Department of Health have advised Environmental Health Officers of local authorities that where eels are caught regularly and eaten frequently with dieldrin concentrations in excess of 100 micrograms per kilogram (wet weight), regular eel consumers should restrict their intake of eels. Where concentrations of dieldrin in eels exceed 100 micrograms per kilogram (wet weight), water authorities should notify local authorities of the results.

At four locations, (Clyst - Clyst Honiton, Tamar - North Tamerton, Allen - Idless and Calenick - Calenick), concentrations of dieldrin were in excess of 100 micrograms per kilograms (wet weight).

The exceptionally high concentrations of dieldrin found in the batch of eels collected from the Newlyn River have been confirmed by independent analysis at Burnham-on-Crouch Laboratory of the Ministry of Agriculture, Fisheries and Food.

The mean concentration of the batch from the Newlyn River is 7492 micrograms per kilogram and is six times higher than the highest equivalent value (1200 ug/kg) reported in the survey by the Working Party on Pesticide Residues. The maximum concentration of 22,000 micrograms per kilogram is five times higher than the highest equivalent value (4,100 ug/kg) reported in the above survey.

The mean concentration of the batch exceeds the Department of Health guideline by 70-fold and the maximum concentration by 220-fold.

The dieldrin concentrations reported in the recent national survey by the Working Party on Pesticide Residues were from 21 locations in England. These were based on the analysis of 206 eels and indicated a range of mean concentrations from 10 to 1000 micrograms per kilogram (wet weight) with an overall mean for England of 300 micrograms per kilogram (wet weight).

The only location in this current survey to exceed the national mean is the Newlyn River at Stable Hobba which exceeds this mean figure by 25-fold.

The mean concentration of the 97 eels which exceed the limit of detection was 49 micrograms per kilogram (wet weight) and the overall mean for the 117 eels (less those collected from the Newlyn River) was 41 micrograms per kilogram (wet weight). The overall mean from these 12 locations is 7-fold less than the national mean.

The presence of aldrin in all ten fish collected from the Newlyn River indicates that the source of contamination could be recent agricultural use of the substance. The abnormally high concentrations of dieldrin found in the fish tissues could have resulted from this

use of aldrin, as aldrin degrades to dieldrin in the environment. The use of aldrin is approved for the control of narcissus fly and wireworm. There will be no approved agricultural uses of dieldrin from 31 March 1989.

The detection of the presence of endrin in all ten fish collected from the Newlyn River is the first occasion this substance has ever been found above the limits of detection of the analytical method. The reason for the use of this substance is unknown.

The levels of gamma-HCH reported in the recent national survey indicated a range of mean concentrations between 1 and 200 micrograms per kilogram (wet weight) with an overall mean for England of 50 micrograms per kilogram (wet weight).

The mean concentration of sixty-six eels which exceeded the limit of detection was 5 micrograms per kilogram (wet weight) and the overall mean for all 127 fish was 3 micrograms per kilogram (wet weight). The overall mean figure is 17-fold less than the national mean.

Levels of DDT as its isomer, pp-DDT, and its metabolites, pp-DDE and pp-TDE, were reported for 21 locations in the recent national survey. For pp-DDT a range of mean concentrations between not detected and 400 micrograms per kilogram (wet weight) were reported with an overall mean for England of 70 micrograms per kilogram (wet weight). The presence of this DDT isomer was not detected in the tissue of the 127 fish as part of this current report.

The levels of pp-DDE were in the range from 6 to 400 micrograms per kilogram (wet weight) with an overall national mean for England of 100 micrograms per kilogram (wet weight).

The mean value of the twenty-six eels which exceeded the limit of detection was 35 micrograms per kilogram (wet weight) and the overall mean for all 127 eels was 11 micrograms per kilogram (wet weight). The overall mean figure is 9-fold less than the national mean.

The levels of pp-TDE were in the range from not detected to 300 micrograms per kilogram (wet weight) with an overall national mean for England of 50 micrograms per kilogram (wet weight).

The mean value of the nineteen eels which exceeded the limit of detection was 27 micrograms per kilogram (wet weight) and the overall mean for all 127 eels was 8 micrograms per kilogram (wet weight). The overall mean figure is 6-fold less than the national mean.

5. Conclusions

A survey of pesticide residues in freshwater eels was undertaken through November 1988 at thirteen locations in Cornwall and Devon. At twelve locations it was possible to collect 10 eels of a length generally greater than 300 mm. Only seven eels could be collected from the Siblyback Stream, a tributary of the River Fowey. In total, 127 eels were analysed individually for the cyclodiene pesticides (aldrin, dieldrin and endrin), DDT isomers and metabolites, and for hexachlorocyclohexane (HCH) isomers.

At eleven locations aldrin concentrations were not detected above the limit of detection of 1 microgram per kilogram (wet weight). One of the ten eels collected from the River Tamar at North Tamerton contained aldrin at 6 micrograms per kilogram (wet weight).

All ten eels collected from the Newlyn River near Stable Hobba had aldrin, dieldrin and endrin concentrations in excess of the limit of detection as indicated in the table below.

Cyclodiene Pesticide	Concentration ug/kg (wet weight)	
	Mean	Maximum
Aldrin	110	230
Dieldrin	7,492	22,000

Endrin	132	320

At two locations, River Clyst (Clyst Honiton) and Calenick Stream (Calenick), mean concentrations exceeded 100 micrograms per kilogram (wet weight) being 108 and 124 micrograms per kilogram respectively with maximum values of 340 and 460 micrograms per kilogram respectively.

At two other locations, River Tamar (North Tamerton) and River Allen (Idless) maximum concentrations of dieldrin exceeded 100 micrograms per kilogram (wet weight) with values of 140 and 370 micrograms per kilogram respectively.

Therefore at five locations River Allen (Idless), Calenick Stream (Calenick), River Clyst (Clyst Honiton), Newlyn River (Stable Hobba) and River Tamar (North Tamerton), dieldrin concentrations have found in the flesh of freshwater eels in excess of the advisory standard of 100 micrograms per kilogram (wet weight) set by the Department of Health.

Metabolites of DDT in excess of 100 micrograms per kilogram (wet weight) were found at two locations. Concentrations of pp-TDE up to 150 micrograms per kilogram (wet weight) were found in eels collected from the River Tamar at North Tamerton. Similarly, concentrations of pp-DDE up to 100 micrograms per kilogram (wet weight) were found in eels collected from the River Taw at Umberleigh.

The pathways by which these organochlorine pesticides are entering the aquatic environment are not known and consequently the sources and uses are equally not known.

Eels uncontaminated by organochlorine pesticides can be found as indicated by the ten fish collected from the River Tamar below Tamar Lakes. Concentrations of cyclodiene pesticides, DDT isomers and metabolites and HCH isomers were all less than the limits of detection.

6. Recommendations

1. Immediate investigations should commence in the Newlyn River catchment to locate the source or sources of aldrin, dieldrin and endrin with an objective of preventing their entry to the aquatic environment.

2. The Environmental Health Officer of Penwith District Council should be informed of the concentrations of cyclodiene pesticides found in eels collected from the Newlyn River near Stable Hobba.

3. Investigations should be undertaken in the River Allen, Calenick Stream, River Clyst and River Tamar catchments to identify the source or sources of organochlorine pesticides which have accumulated in eel flesh.

4. The Environmental Health Officers of the District Councils with the catchments of the River Allen, Calenick Stream, River Clyst and River Tamar (North Tamerton) should be informed of the dieldrin concentrations found in eels collected from these localities.

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7. Appendices

Appendix

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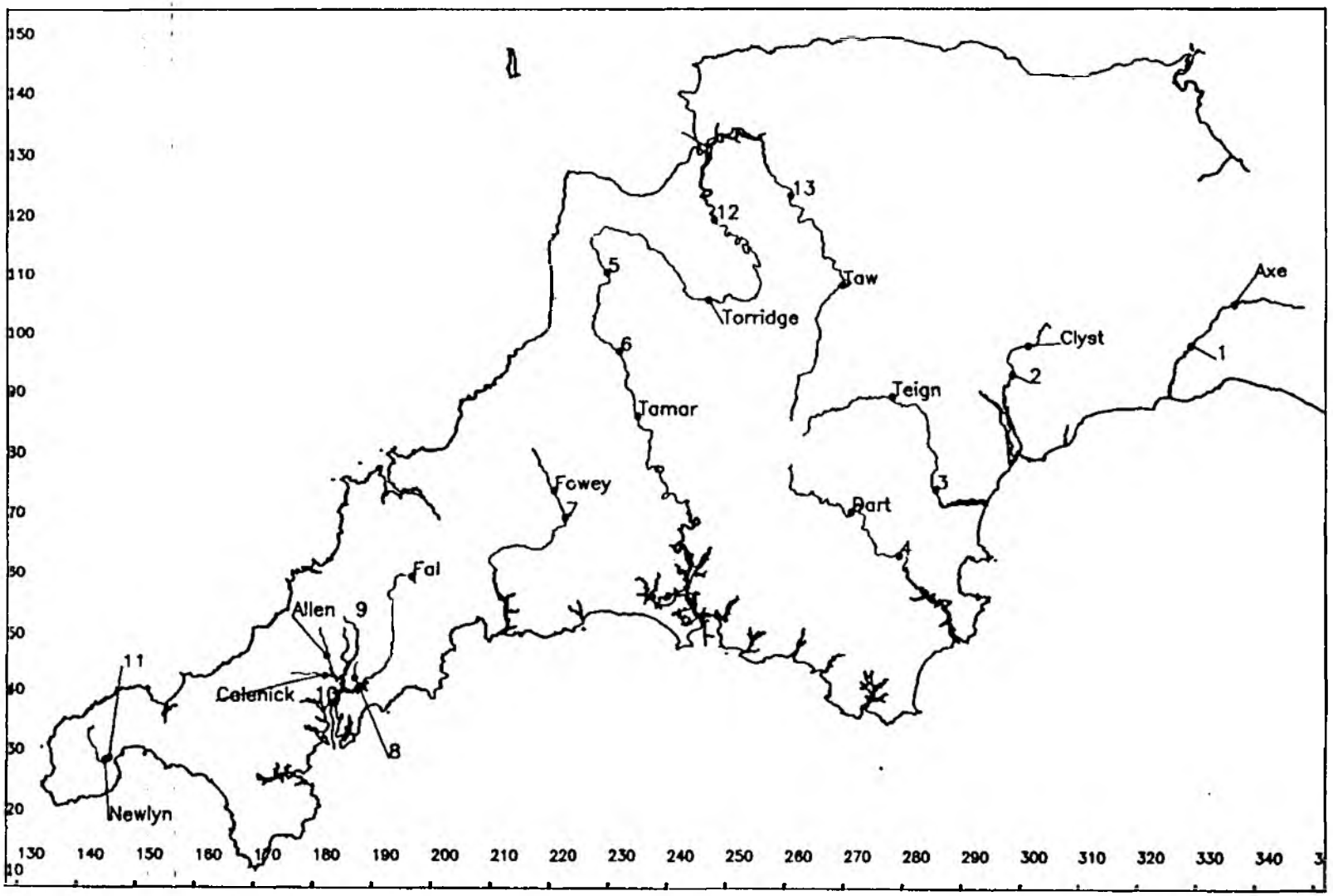
APPENDIX 1

ORGANOCHLORINE PESTICIDE RESIDUES IN FRESHWATER EELS : SAMPLING POINTS



SCALE

10.0 Km

APPENDIX 3

SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Summary of Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

Map ref.	River	Site Name	N.G.R.	Length Mean (cm)	Weight Mean (g)	Aldrin Mean	Aldrin Max	Dieldrin Mean	Dieldrin Max	Endrin Mean	Endrin Max	gamma-HCH Mean	gamma-HCH Max	pp DDE Mean	pp DDE Max	pp DDT Mean	pp DDT Max	pp TDE Mean	pp TDE Max
1	Axe	Bow Bridge	SY 2900 9830	438	170	< 1	< 1	10	36	< 3	< 3	< 1	3	< 5	< 5	< 5	< 5	< 5	< 5
2	Clyst	A30 Bridge Clyst Honiton	SX 9850 9350	413	142	< 1	< 1	108	340	< 3	< 3	13	29	< 5	< 5	< 5	< 5	< 5	< 5
3	Teign	Preston	SX 8550 7460	364	108	< 1	< 1	40	83	< 3	< 3	4	9	< 5	< 5	< 5	< 5	< 5	< 5
4	Dart	Staverton Mill Leat	SX 7930 6873	286	43	< 1	< 1	28	57	< 3	< 3	3	5	34	71	< 5	< 5	12	27
5	Tamar	Below Tamar Lakes	SS 2962 1078	442	145	< 1	< 1	< 3	< 3	< 3	< 3	1	5	< 5	< 5	< 5	< 5	< 5	< 5
6	Tamar	North Tamerton	SX 3180 9740	365	93	1	6	40	140	< 3	< 3	2	6	12	47	< 5	< 5	26	150
7	Fowey	Siblyback Stream	SX 2267 6999	337	62	< 1	< 1	5	10	< 3	< 3	3	6	< 5	< 5	< 5	< 5	< 5	< 5
8	Fal	Lamorran	SW 9698 4276	268	43	< 1	< 1	31	70	< 3	< 3	1	2	< 5	< 5	< 5	< 5	< 5	< 5
9	Allen	Idless	SW 8229 4701	297	52	< 1	< 1	51	379	< 3	< 3	3	11	14	62	< 5	< 5	6	16
10	Calenick	Calenick	SW 8202 4320	319	64	< 1	< 1	124	460	< 3	< 3	3	14	< 5	< 5	< 5	< 5	8	39
11	Newlyn	Stable Hobba	SW 4545 2945	398	136	110	230	7492	22000	132	320	2	4	< 5	< 5	< 5	< 5	< 5	< 5
12	Torridge	Rothern Bridge	SS 4790 1970	322	68	< 1	< 1	11	24	< 3	< 3	1	4	< 5	< 5	< 5	< 5	< 5	< 5
13	Taw	Umberleigh	SS 6080 2370	346	87	< 1	< 1	31	87	< 3	< 3	2	7	39	100	< 5	< 5	15	33

APPENDIX 3

SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER AXE AT BOW BRIDGE MAP REFERENCE : 1

LOCATION (N.G.R.) : SY 2900 9830 NUMBER OF EELS : 10

DATE OF CAPTURE : 01 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	pp TDE
18289	480	185.7	< 1	< 3	< 3	< 1	< 5	< 5	< 5
18290	340	62.0	< 1	6	< 3	< 1	< 5	< 5	< 5
18291	440	147.1	< 1	36	< 3	3	< 5	< 5	< 5
18292	340	54.3	< 1	19	< 3	1	< 5	< 5	< 5
18293	420	110	< 1	5	< 3	< 1	< 5	< 5	< 5
18294	360	62.6	< 1	4	< 3	< 1	< 5	< 5	< 5
18295	370	89.4	< 1	14	< 3	3	< 5	< 5	< 5
18296	570	373	< 1	6	< 3	< 1	< 5	< 5	< 5
18297	600	462	< 1	5	< 3	< 1	< 5	< 5	< 5
18298	460	154	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Mean	438	170	< 1	10	< 3	< 1	< 5	< 5	< 5
Minimum	340	543	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	600	462	< 1	36	< 3	3	< 5	< 5	< 5
S.Dev	92	139	-	10	-	0.8	-	-	-

APPENDIX 4
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER CLYST AT A30 BRIDGE, CLYST HONITON MAP REFERENCE 2

LOCATION (N.G.R.) : SX 9850 9350 NUMBER OF EEL 10

DATE OF CAPTURE : 01 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	pp TDE
18279	540	283	< 1	19	< 3	2	< 5	< 5	< 5
18280	330	73.9	< 1	90	< 3	13	< 5	< 5	< 5
18281	360	83	< 1	200	< 3	29	< 5	< 5	< 5
18282	510	249	< 1	340	< 3	21	< 5	< 5	< 5
18283	330	64.9	< 1	85	< 3	11	< 5	< 5	< 5
18284	320	60.7	< 1	120	< 3	20	< 5	< 5	< 5
18285	550	305	< 1	98	< 3	15	< 5	< 5	< 5
18286	325	68.9	< 1	110	< 3	16	< 5	< 5	< 5
18287	480	138.7	< 1	12	< 3	< 1	< 5	< 5	< 5
18288	385	95.7	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Mean	413	142	< 1	108	< 3	13	< 5	< 5	< 5
Minimum	330	60.7	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	550	305	< 1	340	< 3	29	< 5	< 5	< 5
S.Dev	96	98	-	101	-	9	-	-	-

APPENDIX 5
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER TEIGN AT PRESTON MAP REFERENCE : 3

LOCATION (N.G.R.) : SX 8550 7460 NUMBER OF EELS : 10

DATE OF CAPTURE : 03 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
18309	530	350	< 1	50	< 3	3	< 5	< 5	< 5
18310	340	81.2	< 1	50	< 3	7	< 5	< 5	< 5
18311	360	105	< 1	74	< 3	6	< 5	< 5	< 5
18312	320	54.8	< 1	39	< 3	3	< 5	< 5	< 5
18313	330	70.1	< 1	6	< 3	< 1	< 5	< 5	< 5
18314	360	93.9	< 1	83	< 3	9	< 5	< 5	< 5
18315	330	63.5	< 1	21	< 3	1	< 5	< 5	< 5
18316	320	68.3	< 1	58	< 3	6	< 5	< 5	< 5
18317	330	69.2	< 1	3	< 3	< 1	< 5	< 5	< 5
18318	420	119.4	< 1	12	< 3	< 1	< 5	< 5	< 5
Mean	364	108	< 1	40	< 3	4	< 5	< 5	< 5
Minimum	320	548	< 1	3	< 3	< 1	< 5	< 5	< 5
Maximum	530	350	< 1	83	< 3	9	< 5	< 5	< 5
S.Dev	66	88	-	28	-	3	-	-	-

APPENDIX 6
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : STAVERTON MILL LEAT FROM RIVER DART MAP REFERENCE : 4

LOCATION (N.G.R.) : SX 7930 6373 NUMBER OF EELS : 10

DATE OF CAPTURE : 03 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	pp TDE
18269	280	37.5	< 1	13	< 3	1	22	< 5	27
18270	280	39.4	< 1	13	< 3	1	17	< 5	< 5
18271	310	61.4	< 1	51	< 3	4	64	< 5	19
18272	260	32.6	< 1	10	< 3	< 1	11	< 5	< 5
18273	290	40.8	< 1	22	< 3	< 1	24	< 5	< 5
18274	300	53.9	< 1	57	< 3	4	71	< 5	19
18275	280	38.4	< 1	47	< 3	4	54	< 5	15
18276	260	32.2	< 1	4	< 3	< 1	< 5	< 5	< 5
18277	280	39.2	< 1	39	< 3	4	43	< 5	13
18278	290	44.2	< 1	23	< 3	5	27	< 5	< 5
Mean	286	43	< 1	30	< 3	2	33.8	< 5	11.8
Minimum	260	32.2	< 1	4	< 3	< 1	< 5	< 5	< 5
Maximum	310	61.4	< 1	57	< 3	5	71	< 5	27
S.Dev	16	10	-	20	-	2	22	-	7.6

APPENDIX 7
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER TAMAR BELOW TAMAR LAKES MAP REFERENCE : 5

LOCATION (N.G.R.) : SS 2962 1078 NUMBER OF EELS : 10

DATE OF CAPTURE : 07 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
17121	380	94.2	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17122	380	101	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17123	430	128	< 1	< 3	< 3	1	< 5	< 5	< 5
17124	440	133	< 1	< 3	< 3	1	< 5	< 5	< 5
17125	560	239	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17126	560	245	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17127	440	105	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17128	410	85.8	< 1	< 3	< 3	1	< 5	< 5	< 5
17129	330	70.5	< 1	< 3	< 3	5	< 5	< 5	< 5
17130	490	247	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Mean	442	145	< 1	< 3	< 3	1	< 5	< 5	< 5
Minimum	330	70.5	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	560	247	< 1	< 3	< 3	5	< 5	< 5	< 5
S.Dev	76	71	-	-	-	1	-	-	-

APPENDIX 8
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER TAMAR AT NORTH TAMERTON MAP REFERENCE : 6

LOCATION (N.G.R.) : SX 3180 9740 NUMBER OF EELS : 10

DATE OF CAPTURE : 07 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (ganma)	pp DDE	pp DDT	ppTDE
17131	400	115	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17132	320	65.5	< 1	44	< 3	2	13	< 5	18
17133	350	81.0	< 1	140	< 3	5	47	< 5	150
17134	290	43.1	0	17	< 3	1	< 5	< 5	11
17135	450	159	< 1	59	< 3	4	21	< 5	22
17136	380	97.5	6	72	< 3	6	< 5	< 5	< 5
17137	400	108	< 1	17	< 3	2	< 5	< 5	< 5
17138	390	112	< 1	19	< 3	< 1	7	< 5	33
17139	380	104	< 1	8	< 3	< 1	< 5	< 5	< 5
17140	290	44.5	< 1	18	< 3	< 1	< 5	< 5	< 5
Mean	365	93	1	40	< 3	2	11.8	< 5	25.9
Minimum	290	43.1	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	450	159	6	140	< 3	6	47	< 5	150
S.Dev	52	35	2	42	-	2	13	-	42

APPENDIX 9
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : SIBLYBACK STREAM MAP REFERENCE : 7

LOCATION (N.G.R.) : SY 2267 6999 NUMBER OF EELS : 7

DATE OF CAPTURE : 21 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
18362	260	21.9	< 1	< 3	< 3	1	< 5	< 5	< 5
18363	290	34.3	< 1	< 3	< 3	< 1	< 5	< 5	< 5
18364	320	35.2	< 1	3	< 3	2	< 5	< 5	< 5
18365	310	41.5	< 1	3	< 3	2	< 5	< 5	< 5
18366	330	52.5	< 1	10	< 3	6	< 5	< 5	< 5
18367	400	114	< 1	3	< 3	1	< 5	< 5	< 5
18368	450	136	< 1	9	< 3	5	< 5	< 5	< 5
Mean	337	62	< 1	5	< 3	3	< 5	< 5	< 5
Minimum	260	21.9	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	450	136	< 1	10	< 3	6	< 5	< 5	< 5
S.Dev	66	44	-	3	-	2	-	-	-

APPENDIX 10
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER FAL AT LAMORRAN

MAP REFERENCE : 8

LOCATION (N.G.R.) : SW 8698 4276

NUMBER OF EELS : 10

DATE OF CAPTURE : 10 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
17567	270	40.9	< 1	55	< 3	2	< 5	< 5	< 5
17568	310	61.9	< 1	70	< 3	2	< 5	< 5	< 5
17569	230	19.9	< 1	10	< 3	< 1	< 5	< 5	< 5
17570	310	56.1	< 1	43	< 3	2	< 5	< 5	< 5
17571	330	75.7	< 1	28	< 3	< 1	< 5	< 5	< 5
17572	240	27.1	< 1	36	< 3	< 1	< 5	< 5	< 5
17573	220	19.4	< 1	24	< 3	< 1	< 5	< 5	< 5
17574	230	21	< 1	10	< 3	< 1	< 5	< 5	< 5
17575	230	44.8	< 1	6	< 3	< 1	< 5	< 5	< 5
17576	310	66.2	< 1	33	< 3	< 1	< 5	< 5	< 5
Mean	268	43	< 1	31	< 3	1	< 5	< 5	< 5
Minimum	220	19.4	< 1	6	< 3	< 1	< 5	< 5	< 5
Maximum	330	75.7	< 1	70	< 3	2	< 5	< 5	< 5
S.Dev	43	21	-	21	-	-	-	-	-

APPENDIX 11
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER ALLEN AT IDLESS MAP REFERENCE : 9

LOCATION (N.G.R.) : SW 8229 4701 NUMBER OF EELS : 10

DATE OF CAPTURE : 10 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
17547	280	53.3	< 1	26	< 3	3	12	< 5	< 5
17548	300	44.3	< 1	13	< 3	1	5	< 5	< 5
17549	290	50.1	< 1	5	< 3	< 1	< 5	< 5	< 5
17550	310	44.4	< 1	3	< 3	< 1	< 5	< 5	< 5
17551	270	34.1	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17552	250	34.4	< 1	11	< 3	< 1	7	< 5	< 5
17553	300	41.8	< 1	< 3	< 3	< 1	< 5	< 5	< 5
17554	380	116.3	< 1	65	< 3	8	62	< 5	< 5
17555	280	36.6	< 1	8	< 3	< 1	5	< 5	< 5
17556	310	59.9	< 1	370	< 3	11	28	< 5	18
Mean	297	52	< 1	51	< 3	3	13.9	< 5	6.3
Minimum	250	34.1	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	380	116.3	< 1	370	< 3	11	62	< 5	18
S.Dev	35	24	-	114	-	4	17	-	4

APPENDIX 12
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : CALENICK STREAM AT CALENICK MAP REFERENCE : 10

LOCATION (N.G.R.) : SW 8202 4320 NUMBER OF EELS : 10

DATE OF CAPTURE : 10 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
17557	330	65.4	< 1	83	< 3	< 1	< 5	< 5	< 5
17558	280	39.1	< 1	28	< 3	< 1	< 5	< 5	< 5
17559	300	51.2	< 1	70	< 3	< 1	< 5	< 5	< 5
17560	360	101.4	< 1	35	< 3	14	< 5	< 5	< 5
17561	320	63.8	< 1	460	< 3	4	< 5	< 5	39
17562	330	66.1	< 1	34	< 3	5	< 5	< 5	< 5
17563	280	47.7	< 1	84	< 3	< 1	< 5	< 5	< 5
17564	300	51.6	< 1	36	< 3	< 1	< 5	< 5	< 5
17565	330	68.2	< 1	350	< 3	< 1	< 5	< 5	< 5
17566	360	81.3	< 1	60	< 3	< 1	< 5	< 5	< 5
Mean	319	64	< 1	124	< 3	3	< 5	< 5	8.4
Minimum	280	39.1	< 1	28	< 3	< 1	< 5	< 5	< 5
Maximum	360	101.4	< 1	460	< 3	14	< 5	< 5	39
S.Dev	29	18	-	152	-	4	-	-	10.2

APPENDIX 13
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER NEWLYN AT STABLE HOBBA MAP REFERENCE : 11

LOCATION (N.G.R.) : SW 4545 2945 NUMBER OF EELS : 10

DATE OF CAPTURE : 14 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
17748	340	87.8	220	10000	200	3	< 5	< 5	< 5
17749	390	108	2	420	17	< 1	< 5	< 5	< 5
17750	580	400	81	3300	43	1	< 5	< 5	< 5
17751	410	108	3	900	26	< 1	< 5	< 5	< 5
17752	490	218	74	3000	61	1	< 5	< 5	< 5
17753	390	120	130	22000	320	4	< 5	< 5	< 5
17754	360	98	140	9300	170	3	< 5	< 5	< 5
17755	340	79.4	230	13000	220	2	< 5	< 5	< 5
17756	320	53.5	22	1000	47	< 1	< 5	< 5	< 5
17757	360	92	200	12000	180	3	< 5	< 5	< 5
Mean	398	136	110	7492	132	2	< 5	< 5	< 5
Minimum	320	53.5	22	420	17	< 1	< 5	< 5	< 5
Maximum	580	400	230	22000	320	4	< 5	< 5	< 5
S.Dev	80	102	87	7024	100	1	-	-	-

APPENDIX 14
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER TORRIDGE AT ROTHERN BRIDGE MAP REFERENCE : 12

LOCATION (N.G.R.) : SS 4790 1970 NUMBER OF EELS : 10

DATE OF CAPTURE : 02 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
18319	410	145	< 1	15	< 3	< 1	< 5	< 5	< 5
18320	330	82.1	< 1	24	< 3	4	< 5	< 5	< 5
18321	270	35.5	< 1	5	< 3	< 1	< 5	< 5	< 5
18322	410	109	< 1	7	< 3	< 1	< 5	< 5	< 5
18323	310	54.1	< 1	12	< 3	< 1	< 5	< 5	< 5
18324	260	37.4	< 1	20	< 3	< 1	< 5	< 5	< 5
18325	280	44.8	< 1	9	< 3	< 1	< 5	< 5	< 5
18326	340	69.7	< 1	6	< 3	< 1	< 5	< 5	< 5
18327	300	46.9	< 1	5	< 3	< 1	< 5	< 5	< 5
18328	310	50.7	< 1	4	< 3	< 1	< 5	< 5	< 5
Mean	322	68	< 1	11	< 3	< 1	< 5	< 5	< 5
Minimum	260	35.5	< 1	4	< 3	< 1	< 5	< 5	< 5
Maximum	410	145	< 1	24	< 3	4	< 5	< 5	< 5
S.Dev	53	35	-	7	-	-	-	-	-

APPENDIX 15
SOUTH WEST WATER - ENVIRONMENTAL PROTECTION

Organo-Chlorine Pesticide Residues in Freshwater Eels (ug/kg wet weight)

SITE : RIVER TAW AT UMBERLEIGH MAP REFERENCE : 13

LOCATION (N.G.R.) : SS 6080 2370 NUMBER OF EELS : 10

DATE OF CAPTURE : 02 NOVEMBER 1988

Sample Ref No	Length (mm)	Weight (g)	Aldrin	Dieldrin	Endrin	HCH (gamma)	pp DDE	pp DDT	ppTDE
18299	340	81.2	< 1	30	< 3	2	43	< 5	20
18300	420	154	< 1	< 3	< 3	< 1	< 5	< 5	< 5
18301	320	74.7	< 1	39	< 3	4	52	< 5	19
18302	370	109	< 1	< 3	< 3	< 1	< 5	< 5	< 5
18303	360	90.7	< 1	4	< 3	< 1	< 5	< 5	< 5
18304	340	69.0	< 1	87	< 3	1	100	< 5	33
18305	330	67.2	< 1	36	< 3	2	48	< 5	19
18306	330	70.6	< 1	13	< 3	1	18	< 5	7
18307	330	83.4	< 1	61	< 3	7	69	< 5	29
18308	320	68.6	< 1	37	< 3	2	50	< 5	11
Mean	346	87	< 1	31	< 3	2	39.5	< 5	15.3
Minimum	320	67.2	< 1	< 3	< 3	< 1	< 5	< 5	< 5
Maximum	420	154	< 1	87	< 3	7	100	< 5	33
S.Dev	31	27	-	27	-	2	29	-	8