Institute of Terrestrial Ecology

# JNCC Report No. 248

## WILDLIFE AND POLLUTION:
## 1994/95 Annual Report

Natural Environment Research Council

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**JNCC Report No. 248**

# WILDLIFE AND POLLUTION: 1994/95 Annual Report

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INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENTAL RESEARCH COUNCIL)
JNCC PROJECT 018 (Contract F71-12-153)
ITE PROJECT T08054c5

Annual report to Joint Nature Conservation Committee

Monks Wood Experimental Station
Abbots Ripton
Huntingdon
Cambs
PE17 2LS

July 1995

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CONTENTS

# 1 PREFACE AND SUMMARY

## 1.1 Introduction

The Wildlife and Pollution contract covers a long-term monitoring programme to examine the levels of pollutants in some wildlife in Britain. The programme was started more than 30 years ago, when there were serious concerns over the effects of organochlorine insecticides and organomercury fungicides on several birds and mammals. This early work demonstrated the effects of the organochlorines, and eventually contributed to the ban on their use in this country and abroad. The programme has measured levels of these compounds in predatory and fish-eating birds since then. Investigations have also been made into the levels of polychlorinated biphenyls (PCBs), following their identification as pollutants in 1966. Mercury levels, derived from both agricultural and industrial sources, have also been tracked. In addition, the contract supports a wildlife incident investigation service, which can examine the causes of unexpected mortality incidents (that are not obviously related to oil pollution or to farm chemicals). In recent years, investigations have been made into the effects of the newest generation of rodenticides on barn owls.

Annual reports give an interim summary of results derived from both agricultural and industrial sources. Every 3 years these annual results are gathered together into a more substantial report in which they are integrated with previous findings. In addition, results are periodically published in the scientific literature. Recent key papers are listed in this report under sub-project summaries.

The Wildlife and Pollution contract was the subject of scientific assessment within JNCC's rolling programme of peer review in autumn 1993.

Each subproject within the Wildlife and Pollution contract is summarised below. Each is dependent on the provision of material from amateur naturalists and other interested parties, and it is not always possible to obtain desired material for analysis, especially from remote areas.

## 1.2 Organochlorines and mercury in predatory birds

The main objective of this work was to analyse the bodies of predatory and fish-eating birds, supplied by members of the public, in order to continue the monitoring of organochlorine and mercury residues in livers. This enables us to keep a watch on the effects of previous hard-won withdrawals of permitted uses of some of these chemicals, and to examine geographical variation in residues. For 1994, the livers from 194 birds were analysed, including those from 33 kestrels, 98 sparrowhawks, 12 herons, and 51 birds of various other species. These birds came from various localities in England, Scotland and Wales. Over the whole monitoring period (1963-94), the overall data for most species have revealed significant long-term downward trends in residues (except for PCBs in three species). Declines may be levelling off for DDE (the main metabolite of DDT) and HEOD (derived from aldrin and dieldrin). Two significant changes in geometric mean levels between 1993 and 1994 were noted, involving decreases in HEOD residues in kestrels and herons. It is impossible to say whether these differences reflected real year-to-year changes in exposure.

### 1.3 Organochlorines and mercury in peregrine eggs

Eggs from 30 peregrine clutches were analysed in 1994, from various parts of England, Scotland and Wales. The organochlorine levels in British peregrines continue to decline, but occasional high PCB levels appear.

### 1.4 Organochlorines and mercury in merlin eggs

Eggs from 55 merlin clutches were analysed in 1994, from various parts of England, Scotland and Wales. The results confirm that the merlin remains the most contaminated of the British raptors, but residue levels are declining. Mercury in eggs from the Northern Isles continues to be at high levels.

### 1.5 Organochlorines and mercury in golden eagle eggs

Eggs from seven clutches (six from Scotland and one from England) were analysed. These confirm the low levels of contamination in eggs from inland districts found in recent years.

### 1.6 Organochlorines and mercury in sea eagle eggs

The one egg obtained in 1994 (from an inland district) contained low levels of pollutants.

### 1.7 Organochlorines and mercury in gannet eggs

Eggs from four colonies were analysed in 1994. Residue levels were low and within the range of previous ones from these colonies. Over the long term (1971-94), eggs from Ailsa Craig showed declines in all residues, those from Bass Rock showed declines in HEOD and DDE, and those from Hermaness in DDE. Eggs from St Kilda showed the lowest levels of contaminants and no long-term trends. The gannet is the only British seabird in which residue levels have been monitored continuously over the past 25 years, so has become a key indicator species of marine pollution.

### 1.8 Rodenticides in barn owls

The aims of this study were to find (i) to what extent barn owls in Britain are contaminated with certain rodenticide residues, and (ii) whether such residues are likely to cause significant mortality. As barn owl numbers are thought to have declined this century, it is important to assess any role that secondary poisoning from rodenticides might have on the British population. The second-generation anticoagulant rodenticides (currently difenacoum, bromadiolone, brodifacoum, flocoumafen) are likely to pose the greatest threat. These are rapidly replacing Warfarin and are both more toxic and more persistent. Ninety-seven birds were examined in 1994. The residues of one or more rodenticides were found in the livers of 28 (29%). The proportion of contaminated owls has remained at around one-third for the past five years, following an earlier apparent increase. Despite widespread exposure to these chemicals, there is yet no evidence that these chemicals have caused appreciable mortality or have had any serious impact on barn owl numbers in Britain.

## 1.9 Incident investigations during 1994-95

No major mortality incidents occurred during the year that could be attributed to pollutants other than oil. However, two swans and two moorhens were received for examination, and no obvious cause of death could be ascertained.

INSTITUTE OF TERRESTRIAL ECOLOGY
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JNCC/NERC CONTRACT HF3/08/01
JNCC PROJECT 018 (Contract F71-12-153)
ITE PROJECT T08054c5

Annual report to the Joint Nature Conservation Committee

# WILDLIFE AND POLLUTION

## Part 2 Organochlorines and mercury in predatory birds, 1994

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July 1995

## 2 ORGANOCHLORINES AND MERCURY IN PREDATORY BIRDS

### 2.1 Introduction

The main objective of this work was to analyse the carcasses of predatory birds, supplied by members of the public, in order to continue the monitoring of organochlorine and metal residues in livers. The chemicals of interest included DDE (from the insecticide DDT). HEOD (from the insecticides aldrin and dieldrin), PCBs (polychlorinated biphenyls from industrial products) and Hg (mercury from agricultural and industrial sources). Throughout this section the levels of organochlorines are given as ppm in wet weight and of mercury as ppm in dry weight.

The main species involved included the sparrowhawk and kestrel, representing the terrestrial environment, and the fish-eating heron, kingfisher and great-crested grebe, representing the aquatic environment. The findings from various other species received during the year are also included.

### 2.2 Results from 1994

During the past year, the livers from 194 birds were analysed, including those from 33 kestrels, 98 sparrowhawk, 12 herons, 1 kingfisher, 1 great-crested grebe and 47 others. These totals included some birds which had died in earlier years, but which were analysed in the current year. The results from all these birds are listed in Table 1, and the geometric means for each chemical from the main species (1994 specimens only) are given in Table 2.

Several birds from 1994 contained unexpectedly high levels of pollutants (for their species). They included one kestrel (from Kent) with 13 ppm DDE, one kestrel (from Strathclyde) with 79 ppm PCBs and three kestrels (two from Grampian and one from Essex) with 7 ppm Hg; three sparrowhawks (from Kent, Essex and Humberside) with 5-6 ppm HEOD, seven sparrowhawks (from various counties) with 33-197 ppm PCBs, and five sparrowhawks (from various counties) with 10-19 ppm Hg; one Peregrine (from Lothian) with 95 ppm PCBs and 13 ppm Hg; one short-eared owl (from Norfolk) with 7 ppm DDE; one merlin (from Orkney) with 12 ppm Hg, one heron (from Orkney) with 126 ppm Hg, and one bittern (from Suffolk) with 40 ppm Hg. Hence, although the levels of these various pollutants have generally declined since the 1970s (see below), occasional heavily contaminated birds continue to appear.

Another major change of recent years has been the increasing relative importance of PCBs. In some species these chemicals have not declined since the 1970s (see below), so in many specimens they now predominate among organochlorine residues.

The high level of mercury in the merlin was in line with previous findings from the northern Isles (Newton *et al.* 1988) and it is interesting that the heron from Orkney should also show high mercury levels. We assume that this is natural in the area, resulting from high levels of mercury in seawater and (via sea spray) on land.

Out of 12 comparisons, two significant differences in geometric mean values were found between the 1993 and 1994 results. Both include a reduction in HEOD levels, in kestrel and heron respectively (Table 3). It is impossible to say whether these differences reflected real changes in exposure, especially as levels were generally low. Because only one kingfisher was received in 1994, no comparisons could be made for this species.

## 2.3 Long-term trends

An earlier analysis of long-term trends in residue levels in the five main species to 1988 was included in the 1989 report, and to 1991 in the 1992 report (see also Newton *et al.* 1993). The analysis has been repeated here, incorporating the extra data from 1992-1994. The nationwide trends for each species are shown in Figures 1-5 by 3-year moving geometric means. Analyses for DDE and HEOD were started in 1963-64, analyses for PCB in 1967-69, and for Hg in 1969-80, depending on species.

In each case the significance of the long-term trend was assessed by regression analyses of individual residue levels on years (Table 4), covering the whole analytical period for each chemical. Separate regression analyses covered the last six years (1989-94) in order to examine the most recent trends, independently of earlier results.

Among the terrestrial-feeders, the bird-eating sparrowhawk had generally higher levels of most residues than the mammal-eating kestrel (Figure 1 & 2). Among the fish-eaters, the heron contained the highest levels of all residues (Figure 3), while the great-crested grebe contained the lowest.

Over the whole monitoring period, the overall data for most species revealed significant downward trends in residues (Figures 1-5, Table 4). The only exceptions were kestrel which showed no long-term decline in PCB levels, and kingfisher and grebe in which the downward trends in PCB (kingfisher only) and mercury (both species) were not statistically significant. However, samples for these species were much smaller than for the others.

Over the shorter period (1989-94), when levels of most chemicals were generally low, few significant trends emerged. They included an increase in HEOD residues in sparrowhawk, increases in PCBs in sparrowhawk and great-crested grebe (but on small samples), and increases in mercury in sparrowhawk, kestrel and kingfisher.

## 2.4 Conclusions

The general picture is of long-term declines in pesticide and mercury residue levels. This would be expected from the progressive restrictions placed on the use and release over the years of the parent chemicals. In contrast, PCB levels have shown significant long-term declines in only three of the five species, and in two showed a significant increase over the past six years. In view of the PCB situation, and the continuing occurrence of occasional high levels of all chemicals, it seems prudent to maintain the monitoring for some further years. As this programme is now the longest-running of its kind anywhere in the world, the findings stimulate considerable interest internationally, as well as in Britain.

## 2.5 References

Newton, I. & Haas, M.B. 1988. Pollutants in Merlin eggs and their effects on breeding. Brit. Birds. 81: 258-268.

Newton, I, Wyllie, I. & Asher, A. 1993. Long term trends in organochlorine and mercury residues in some predatory birds in Britain. Environ. Pollut. 79: 143-151.

**Table 1.** **Levels of organochlorines (ppm in wet weight) and mercury (ppm in dry weight) in the livers of predatory birds analysed between April 1994 and March 1995.**

ND=none detected; J=juvenile in first year; A=adult other than first year; M=male; F=female; D & G=Dumfries & Galloway; H & W=Hereford & Worcester.

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| **Kestrel (*Falco tinnunculus*)** | | | | | | | | |
| 11420 | Jun 93 | D & G | J | M | 0.013 | 0.083 | 0.185 | 0.654 |
| 11535 | Sep 93 | Lincolnshire | - | - | 0.069 | 0.207 | 0.435 | 1.225 |
| 11603 | Nov 93 | Strathclyde | J | M | 0.030 | 0.051 | 0.782 | 2.771 |
| 11468 | Dec 93 | Lincolnshire | - | - | 4.092 | 0.490 | 11.172 | 2.122 |
| 11422 | Jan 94 | Salop | J | F | 0.097 | 0.258 | 2.629 | 2.262 |
| 11424 | Jan 94 | Grampian | J | M | 3.656 | 0.143 | 9.262 | 6.675 |
| 11452 | Feb 94 | Sussex | J | F | 0.026 | 0.074 | 0.746 | 0.389 |
| 11453 | Feb 94 | Essex | J | M | 9.968 | 0.705 | 11.950 | 2.301 |
| 11455 | Feb 94 | Cambs | A | M | 0.335 | 0.275 | 0.757 | 0.291 |
| 11508 | Mar 94 | Bucks | J | M | 9.686 | 0.278 | 5.207 | 0.966 |
| 11531 | Apr 94 | Oxfordshire | J | F | 0.086 | 0.132 | 2.481 | 1.594 |
| 11552 | Apr 94 | Lothian | A | F | 0.007 | 0.038 | 0.297 | 0.623 |
| 11561 | May 94 | Suffolk | J | M | 0.081 | 0.142 | 0.765 | 4.791 |
| 11593 | Jun 94 | Durham | A | M | 0.469 | 0.115 | 2.476 | 1.162 |
| 11595 | Jul 94 | Leics | A | M | 0.112 | 0.366 | 3.946 | 2.245 |
| 11609 | Jul 94 | Lothian | J | F | 0.534 | 0.159 | 0.675 | 0.615 |
| 11659 | Jul 94 | Devon | A | M | 0.022 | 0.229 | 0.421 | 1.547 |
| 11611 | Aug 94 | Midlothian | J | F | 0.014 | 0.023 | 0.201 | 1.495 |
| 11620 | Aug 94 | D & G | J | F | 0.013 | 0.052 | 0.276 | 0.524 |
| 11630 | Aug 94 | Berkshire | J | F | 0.008 | 0.021 | 0.265 | 0.837 |
| 11649 | Sep 94 | Cambs | J | F | 0.022 | 0.652 | 0.408 | 0.822 |
| 11650 | Oct 94 | Essex | A | M | 2.901 | 1.029 | 4.600 | 0.828 |
| 11653 | Oct 94 | Lincolnshire | J | F | 0.087 | 0.076 | 2.125 | 1.747 |
| 11663 | Oct 94 | Cumbria | J | F | 0.034 | 0.041 | 0.580 | 3.409 |
| 11670 | Oct 94 | Kent | J | M | 13.243 | 1.498 | 3.979 | 1.024 |
| 11672 | Nov 94 | Cambs | J | F | 5.912 | 0.294 | 4.118 | 2.290 |
| 11683 | Nov 94 | Gwent | A | M | 0.062 | 0.129 | 2.492 | 0.448 |
| 11685 | Nov 94 | Essex | J | F | 0.084 | 0.164 | 0.976 | 7.398 |
| 11694 | Nov 94 | Essex | A | M | 0.117 | 0.096 | 0.374 | 0.355 |
| 11697 | Nov 94 | Lincolnshire | J | M | 0.026 | 0.014 | 0.101 | 0.924 |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| Kestrel (*Falco tinnunculus*) cont. | | | | | | | | |
| 11711 | Nov 94 | Wilts | J | F | 0.021 | 0.028 | 0.982 | 0.598 |
| 11688 | Dec 94 | Grampian | J | F | 0.214 | 0.094 | 3.560 | 6.518 |
| 11708 | Dec 94 | Strathclyde | J | F | 0.104 | 0.028 | 79.018 | 0.838 |
| **Sparrowhawk (*Accipiter nisus*)** | | | | | | | | |
| 11573 | Jul 83 | Tyne & Wear | J | M | 0.036 | 0.026 | 0.387 | ND |
| 11570 | Feb 84 | N'humberland | J | M | 0.021 | 0.016 | 0.067 | ND |
| 11571 | Dec 84 | Cumbria | J | M | 0.376 | 0.061 | 1.495 | 1.799 |
| 11574 | Nov 85 | N'humberland | J | M | 0.224 | 0.063 | 0.958 | 1.641 |
| 11567 | Aug 86 | N'humberland | J | M | 0.075 | 0.052 | 0.549 | 2.749 |
| 11575 | Mar 88 | N'humberland | J | M | 5.944 | 0.385 | 34.209 | 10.603 |
| 11572 | Aug 89 | Tyne & Wear | J | F | 0.022 | 0.021 | 0.361 | 0.340 |
| 11568 | Aug 91 | N'humberland | J | M | 0.039 | 0.012 | 0.107 | 0.490 |
| 11576 | Aug 91 | Tyne & Wear | J | M | 0.131 | 0.045 | 0.960 | 3.015 |
| 11370 | Feb 92 | N'humberland | A | M | 0.748 | 0.085 | 1.538 | 6.128 |
| 11368 | Mar 92 | Strathclyde | J | M | 0.188 | 0.037 | 1.632 | 5.161 |
| 11367 | Nov 92 | Strathclyde | J | F | 0.474 | 0.054 | 1.622 | 5.161 |
| 11371 | Jul 93 | Salop | J | F | 0.250 | 0.034 | 0.072 | 0.515 |
| 11369 | Aug 93 | Strathclyde | J | F | 0.285 | 0.059 | 0.727 | 4.478 |
| 11379 | Sep 93 | Oxfordshire | A | M | 6.749 | 0.268 | 23.195 | 1.386 |
| 11469 | Sep 93 | H & W | J | F | 0.172 | 0.081 | 0.122 | 1.054 |
| 11466 | Oct 93 | Gwynedd | J | F | 0.595 | 0.076 | 4.102 | 3.497 |
| 11467 | Oct 93 | Lincolnshire | J | M | 0.088 | 0.038 | 0.090 | 0.218 |
| 11569 | Oct 93 | N'humberland | J | F | 2.539 | 2.692 | 7.258 | 4.243 |
| 11384 | Nov 93 | Essex | J | M | 2.246 | 0.096 | 0.080 | 0.713 |
| 11385 | Nov 93 | Middlesex | J | M | ND | 0.186 | 27.422 | 0.324 |
| 11389 | Nov 93 | Bucks | J | F | 0.876 | 0.047 | 1.280 | 0.423 |
| 11402 | Nov 93 | Warwicks | J | M | 7.193 | 0.197 | 4.136 | 1.155 |
| 11474 | Nov 93 | H & W | A | F | 0.101 | 0.030 | 0.729 | 0.307 |
| 11440 | Jan 94 | Avon | J | F | 0.341 | 0.031 | 0.798 | 0.353 |
| 11443 | Jan 94 | Dorset | A | M | 0.353 | 0.124 | 1.058 | 1.636 |
| 11447 | Jan 94 | Norfolk | J | M | 0.571 | 0.051 | 1.636 | 2.591 |
| 11473 | Jan 94 | Gwynedd | J | F | 2.881 | 0.081 | 4.471 | 9.671 |
| 11503 | Jan 94 | Grampian | J | F | 0.373 | 0.034 | 0.062 | 4.016 |
| 11457 | Feb 94 | Lincolnshire | A | F | 0.421 | 0.267 | 5.129 | 1.687 |
| 11458 | Feb 94 | Notts | J | M | 1.177 | 0.238 | 1.251 | 1.026 |
| 11478 | Feb 94 | Dorset | A | F | 5.134 | 0.096 | 10.516 | 4.979 |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| Sparrowhawk (*Accipiter nisus*) cont. | | | | | | | | |
| 11485 | Feb 94 | Lincolnshire | J | F | 0.453 | 0.042 | 0.198 | 0.996 |
| 11486 | Mar 94 | Essex | J | F | 14.628 | 0.344 | 5.490 | 3.344 |
| 11490 | Mar 94 | Grampian | A | M | 2.030 | 0.046 | 1.399 | 3.985 |
| 11492 | Mar 94 | Essex | J | F | 11.481 | 5.388 | 13.061 | 7.505 |
| 11497 | Mar 94 | Herts | A | M | 10.944 | 0.266 | 1.622 | 1.943 |
| 11498 | Mar 94 | Strathclyde | J | M | 7.375 | 0.973 | 16.727 | 4.955 |
| 11500 | Mar 94 | Dorset | J | F | 1.183 | 0.042 | 0.604 | 4.545 |
| 11502 | Mar 94 | Cambs | J | F | 1.314 | 0.164 | 0.579 | 0.641 |
| 11505 | Mar 94 | Devon | A | F | 7.615 | 1.596 | 48.314 | 0.638 |
| 11506 | Mar 94 | Norfolk | J | F | 1.700 | 0.060 | 0.985 | 1.054 |
| 11507 | Mar 94 | D & G | J | M | 0.417 | 0.026 | 2.453 | 5.494 |
| 11517 | Mar 94 | Herts | J | F | 3.396 | 0.673 | 84.472 | 2.502 |
| 11537 | Mar 94 | Cambs | - | - | 0.969 | 0.109 | 0.443 | 1.413 |
| 11544 | Mar 94 | Surrey | J | F | 3.695 | 0.635 | 196.748 | 1.796 |
| 11555 | Mar 94 | Kent | J | F | 11.502 | 4.644 | 7.481 | 3.178 |
| 11563 | Mar 94 | Highland | A | F | 0.204 | 0.041 | 0.509 | 1.412 |
| 11520 | Apr 94 | Oxfordshire | A | F | 0.244 | 0.047 | 7.484 | 2.985 |
| 11521 | Apr 94 | Middlesex | J | F | 1.790 | 2.656 | 7.127 | 10.473 |
| 11522 | Apr 94 | Powys | J | M | 5.193 | 0.390 | 84.790 | 18.521 |
| 11526 | Apr 94 | Surrey | J | F | 6.330 | 4.040 | 32.827 | 3.217 |
| 11527 | Apr 94 | Sussex | J | M | 18.162 | 0.303 | 20.951 | 4.826 |
| 11528 | Apr 94 | Devon | J | M | 5.982 | 2.646 | 34.997 | 7.324 |
| 11532 | Apr 94 | Cheshire | J | F | 2.077 | 0.146 | 4.514 | 3.334 |
| 11540 | Apr 94 | Sussex | J | M | 3.020 | 0.089 | 20.952 | 3.678 |
| 11541 | Apr 94 | Dyfed | A | M | 0.184 | 0.090 | 0.739 | 3.868 |
| 11543 | Apr 94 | D & G | A | M | 0.159 | 0.035 | 0.243 | ND |
| 11579 | Apr 94 | Sussex | A | M | 8.030 | 0.257 | 4.447 | 1.950 |
| 11560 | May 94 | Beds | J | M | 2.081 | 0.128 | 5.083 | 2.551 |
| 11566 | May 94 | Fife | J | F | 5.125 | 1.674 | 14.349 | 7.711 |
| 11585 | May 94 | Dorset | J | F | 0.365 | 0.089 | 1.541 | 4.954 |
| 11581 | Jun 94 | Orkney | A | F | 0.245 | 0.030 | 0.803 | 5.276 |
| 11587 | Jun 94 | Wilts | J | F | 0.425 | 0.037 | 0.806 | 2.142 |
| 11590 | Jun 94 | Humberside | J | F | 5.593 | 6.088 | 24.476 | 7.935 |
| 11591 | Jun 94 | Central | J | F | 3.022 | 0.810 | 13.102 | 13.806 |
| 11605 | Jul 94 | Oxfordshire | A | F | 0.391 | 0.122 | 4.523 | 2.018 |
| 11606 | Jul 94 | Sussex | J | M | 5.597 | 0.555 | 10.306 | 2.257 |
| 11612 | Jul 94 | Dyfed | J | F | 0.023 | 0.008 | 0.180 | 1.280 |
| 11613 | Jul 94 | Dyfed | A | F | 3.781 | 0.306 | 11.658 | 3.331 |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| Sparrowhawk (*Accipiter nisus*) cont. | | | | | | | | |
| 11616 | Aug 94 | Norfolk | J | M | 2.236 | 0.068 | 1.518 | 3.127 |
| 11617 | Aug 94 | H & W | J | M | 0.051 | 0.020 | 0.198 | 1.622 |
| 11619 | Aug 94 | Sussex | J | F | 0.319 | 0.089 | 3.649 | 1.309 |
| 11621 | Aug 94 | D & G | J | F | 1.546 | 0.073 | 1.959 | 3.890 |
| 11631 | Aug 94 | Leics | J | F | 0.264 | 0.036 | 0.908 | 0.570 |
| 11657 | Aug 94 | Northants | J | F | 0.048 | 0.010 | 0.083 | 0.852 |
| 11636 | Sep 94 | Herts | J | F | 0.092 | 0.016 | 0.131 | 0.357 |
| 11637 | Sep 94 | Cheshire | J | M | 0.033 | 0.031 | 0.240 | 0.455 |
| 11640 | Sep 94 | Lincolnshire | J | M | 0.970 | 0.036 | 0.373 | 0.364 |
| 11648 | Sep 94 | Cambs | J | M | 3.660 | 0.623 | 2.758 | 0.293 |
| 11659 | Sep 94 | Dyfed | J | F | 0.279 | 0.024 | 1.485 | 0.214 |
| 11660 | Sep 94 | D & G | J | F | 0.055 | 0.017 | 1.087 | 2.468 |
| 11689 | Sep 94 | Grampian | J | F | 0.249 | 0.013 | 0.529 | 1.006 |
| 11690 | Sep 94 | Grampian | J | M | 0.982 | 0.021 | 0.416 | 2.248 |
| 11656 | Oct 94 | Grampian | J | F | 1.637 | 0.040 | 1.010 | 0.321 |
| 11662 | Oct 94 | Cambs | J | M | 0.259 | 0.009 | 0.211 | 0.627 |
| 11684 | Oct 94 | Gwynedd | J | M | 0.100 | 0.020 | 0.388 | 1.071 |
| 11693 | Oct 94 | Oxfordshire | J | M | 0.095 | 0.031 | 1.278 | 1.396 |
| 11682 | Nov 94 | Derbyshire | J | M | 0.085 | 0.021 | 0.550 | 2.975 |
| 11691 | Nov 94 | Cambs | J | M | 0.611 | 0.020 | 0.988 | 0.442 |
| 11696 | Nov 94 | Herts | J | F | 4.969 | 0.140 | 13.331 | 2.598 |
| 11699 | Nov 94 | Hampshire | A | F | 6.201 | 0.493 | 20.899 | 1.545 |
| 11700 | Nov 94 | Warwicks | J | M | 2.215 | 0.168 | 3.534 | 2.141 |
| 11702 | Nov 94 | Derbyshire | J | M | 1.329 | 0.193 | 4.668 | 2.807 |
| 11705 | Nov 94 | Grampian | J | M | 1.369 | 0.028 | 4.648 | 1.196 |
| 11706 | Dec 94 | Lancashire | A | M | 0.335 | 0.036 | 6.644 | 1.170 |
| 11713 | Dec 94 | Salop | J | M | 0.358 | 0.032 | 0.601 | 2.212 |
| 11715 | Dec 94 | Northants | J | F | 0.197 | 0.021 | 0.205 | 1.765 |
| **Peregrine Falcon (*Falco peregrinus*)** | | | | | | | | |
| 11421 | May 93 | D & G | J | F | 0.201 | 0.025 | 0.524 | 0.723 |
| 11438 | Jan 94 | Highland | - | - | 0.055 | 0.029 | 0.184 | 0.289 |
| 11655 | May 94 | Lothian | J | M | 4.990 | 3.365 | 95.143 | 13.254 |
| 11610 | Aug 94 | Avon | A | M | 0.682 | 0.120 | 18.770 | 0.096 |
| 11671 | Oct 94 | Wales | A | M | 0.672 | 0.051 | 1.047 | 1.994 |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| **Merlin (*Falco columbarius*)** | | | | | | | | |
| 11513 | Mar 94 | Orkney | - | - | 2.203 | 0.232 | 5.275 | 11.928 |
| 11681 | May 94 | Derbyshire | A | F | 1.450 | 0.212 | 1.810 | 2.845 |
| 11596 | Jun 94 | Borders | A | F | 1.711 | 0.980 | 2.061 | 4.559 |
| 11597 | Jun 94 | Borders | J | - | 0.146 | 0.024 | 0.155 | 0.511 |
| 11598 | Jun 94 | Borders | J | - | 0.306 | 0.030 | 0.217 | 0.123 |
| 11599 | Jun 94 | Borders | J | - | 0.203 | 0.028 | 0.186 | 0.498 |
| 11600 | Jun 94 | Borders | J | - | 0.100 | 0.032 | 0.186 | 0.132 |
| **Hobby (*Falco subbuteo*)** | | | | | | | | |
| 11559 | May 94 | Glos | A | F | 2.314 | 0.149 | 10.848 | 1.085 |
| **Golden Eagle (*Aquila chrysaëtos*)** | | | | | | | | |
| 11594 | Jun 94 | Western Isles | J | F | 0.096 | 0.012 | 2.005 | 0.024 |
| **Buzzard (*Buteo buteo*)** | | | | | | | | |
| 11454 | Jan 94 | Cumbria | A | F | 0.015 | 0.020 | 0.020 | 0.128 |
| 11479 | Feb 94 | Kent | J | F | 0.044 | 0.043 | ND | 2.160 |
| 11483 | Feb 94 | W. Midlands | J | M | ND | 0.013 | ND | ND |
| 11547 | Mar 94 | Avon | A | F | 0.016 | 0.020 | 1.786 | 0.220 |
| 11529 | Apr 94 | Norfolk | - | - | 0.518 | 0.056 | 1.000 | 0.176 |
| 11550 | Apr 94 | Powys | - | - | 0.031 | 0.016 | 0.308 | 0.384 |
| 11551 | Apr 94 | Powys | - | - | 0.006 | 0.013 | 0.608 | 0.927 |
| 11554 | May 94 | Strathclyde | J | F | 0.039 | 0.011 | 1.604 | 0.824 |
| 11578 | Jun 94 | Clwyd | A | F | 0.008 | 0.010 | 0.083 | 0.242 |
| 11589 | Jun 94 | Cornwall | J | M | 0.012 | 0.034 | 0.815 | 0.694 |
| 11634 | Aug 94 | Glos | A | F | 0.046 | 0.014 | 1.177 | 0.192 |
| **Red Kite (*Milvus milvus*)** | | | | | | | | |
| 11514 | Apr 94 | Wales | - | - | 0.096 | 0.099 | 2.960 | 0.129 |
| 11556 | May 94 | Wales | - | - | 0.077 | 0.014 | 0.593 | ND |
| 11580 | May 94 | Wales | J | - | 0.137 | 0.086 | 5.115 | ND |
| 11601 | Jun 94 | Wales | J | - | 0.010 | 0.007 | 0.312 | ND |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| **Marsh Harrier (*Circus aeruginosus*)** | | | | | | | | |
| 11635 | Aug 94 | Norfolk | J | F | 0.453 | 0.031 | 0.184 | 0.397 |
| **Hen Harrier (*Circus cyaneus*)** | | | | | | | | |
| 11442 | Jan 94 | Lancashire | J | F | 0.057 | 0.026 | 0.086 | 1.164 |
| 11687 | Nov 94 | Lincolnshire | A | F | 0.017 | 0.004 | 0.310 | ND |
| **Montagu's Harrier (*Circus pygargus*)** | | | | | | | | |
| 11607 | Jul 94 | Norfolk | J | M | 0.468 | 0.129 | 1.459 | 0.102 |
| 11608 | Jul 94 | Norfolk | J | F | 0.304 | 0.019 | 0.187 | 0.084 |
| **Long-eared Owl (*Asio otus*)** | | | | | | | | |
| 11441 | Jan 94 | Cambs | J | F | 0.044 | 0.019 | ND | 0.171 |
| 11482 | Feb 94 | Wiltshire | A | F | 0.062 | 0.013 | 1.475 | 0.044 |
| 11504 | Mar 94 | Leics | A | F | 5.989 | 0.275 | 11.116 | 7.119 |
| 11519 | Mar 94 | Cambs | A | F | 0.219 | 0.024 | 0.925 | 0.632 |
| **Short-eared Owl (*Asio flammeus*)** | | | | | | | | |
| 11588 | Apr 94 | Norfolk | J | F | 7.006 | 0.079 | 13.788 | 3.499 |
| 11582 | May 94 | Orkney | A | M | 0.158 | 0.010 | 0.213 | 0.693 |
| 11583 | May 94 | Orkney | A | M | 0.108 | 0.006 | 0.231 | 1.146 |
| 11604 | Jul 94 | Isle of Man | J | M | 0.327 | 0.037 | 1.017 | 1.118 |
| 11701 | Nov 94 | Lincolnshire | A | M | 2.180 | 0.027 | 6.551 | 1.580 |
| **Little Owl (*Athene noctua*)** | | | | | | | | |
| 11545 | Apr 94 | Surrey | A | F | 0.016 | 0.020 | 1.786 | 0.225 |
| 11584 | Jun 94 | Norfolk | A | F | 0.104 | 0.005 | 0.435 | 0.899 |
| 11602 | Jul 94 | Cambs | A | F | 0.268 | 0.006 | 13.721 | 1.198 |
| **Heron (*Ardea cinerea*)** | | | | | | | | |
| 11450 | Jan 94 | Tayside | A | F | 0.527 | 0.100 | 1.741 | 10.016 |
| 11480 | Feb 94 | Orkney | A | F | 1.541 | 0.029 | 18.338 | 125.933 |
| 11481 | Feb 94 | Orkney | J | M | 0.592 | 0.038 | 15.660 | 20.539 |

| Specimen no. | Date Found | County | Age | Sex | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|---|
| Heron (*Ardea cinerea*) cont. | | | | | | | | |
| 11489 | Mar 94 | Clwyd | J | F | 0.488 | 0.047 | 1.398 | 11.213 |
| 11499 | Mar 94 | Norfolk | A | M | 0.842 | 0.152 | 4.248 | 7.378 |
| 11530 | Mar 94 | Orkney | J | F | 0.673 | 0.028 | 3.582 | 10.730 |
| 11577 | Jun 94 | Oxfordshire | J | M | 0.263 | 0.070 | 0.920 | 0.507 |
| 11582 | Jun 94 | Cambs | J | M | 0.772 | 0.513 | 0.920 | 0.209 |
| 11614 | Jul 94 | Dyfed | J | F | 0.026 | 0.003 | 0.153 | 0.138 |
| 11615 | Jul 94 | Dyfed | J | F | 0.035 | 0.020 | 0.579 | 3.293 |
| 11623 | Aug 94 | Dyfed | J | M | 0.036 | 0.022 | 0.387 | 3.751 |
| 11698 | Nov 94 | Highland | J | F | 0.018 | 0.012 | 0.319 | 3.030 |
| **Bittern (*Botaurus stellaris*)** | | | | | | | | |
| 11465 | Feb 94 | Suffolk | A | M | 0.180 | 0.004 | 0.586 | 40.102 |
| **Kingfisher (*Alcedo atthis*)** | | | | | | | | |
| 11651 | Sep 94 | Humberside | J | F | 0.384 | 0.410 | 7.244 | 2.225 |
| **Great-crested Grebe (*Podiceps cristatus*)** | | | | | | | | |
| 11538 | Feb 94 | Lincolnshire | - | - | 1.577 | 0.022 | 16.194 | 9.227 |
| 11536 | Mar 94 | H & W | - | - | 0.163 | 0.002 | 1.172 | 3.838 |
| 11710 | Dec 94 | Derbyshire | A | F | 1.326 | 0.017 | 20.038 | 9.270 |

**Table 2. Geometric mean levels of pollutants in the various species in Table 1, for 1994 specimens only.**

| | HEOD | pp'- DDE | PCB | Hg |
|---|---|---|---|---|
| **Kestrel** | | | | |
| Mean | 0.11 | 0.09 | 1.09 | 1.33 |
| N | 22 | 22 | 22 | 22 |
| Range within 1 SE | 0.09-0.15 | 0.06-0.14 | 0.80-1.50 | 1.13-1.57 |
| **Sparrowhawk** | | | | |
| Mean | 0.11 | 0.94 | 2.25 | 1.74 |
| N | 73 | 73 | 73 | 73 |
| Range within 1 SE | 0.09-0.14 | 0.77-1.14 | 1.82-2.77 | 1.49-2.04 |
| **Heron** | | | | |
| Mean | 0.04 | 0.22 | 1.46 | 3.91 |
| N | 12 | 12 | 12 | 12 |
| Range within 1 SE | 0.03-0.06 | 0.14-0.36 | 0.95-2.24 | 2.22-6.88 |
| **Great-crested Grebe** | | | | |
| Mean | 0.01 | 0.7 | 7.25 | 6.9 |
| N | 3 | 3 | 3 | 3 |
| Range within 1 SE | 0.004-0.02 | 0.34-1.45 | 2.91-18.05 | 5.15-9.25 |

Note: none detected values were taken as 0.001 for all residues

**Table 3.** **Comparison of geometric mean residue levels (log values) from birds collected in 1993 and 1994.**

t-values are shown. Minus values indicate a decrease and plus values an increase from 1993. *=P<0.05; **=P<0.01; ***=P<0.001.

| | HEOD | pp'-DDE | PCB | Hg |
|---|---|---|---|---|
| Sparrowhawk | $t_{181}$=-1.92 | $t_{181}$=+0.42 | $t_{181}$=-1.18 | $t_{181}$=+0.25 |
| Kestrel | $t_{81}$=-2.23* | $t_{81}$=-1.13 | $t_{81}$=-1.54 | $t_{81}$=+0.91 |
| Heron | $t_{27}$=-2.37* | $t_{27}$=-1.08 | $t_{27}$=-1.58 | $t_{27}$=-1.63 |
| Great-crested Grebe | $t_{4}$=-1.69 | $t_{4}$=+1.02 | $t_{4}$=+1.57 | $t_{4}$=+0.93 |

Note: None detected values were taken as 0.001 for all residues

**Table 4.** **Trends in pollutant levels in livers of predatory birds during 1963 - 1994 and 1989 - 1994. Figures show sample sizes (N) and linear regression coefficients (b) based on log values regressed against year.**
*P=<0.05; **P=<0.01; ***P<0.001; ns=not significant.

| | 1963 - 1994 | | 1989 - 1994 | |
|---|---|---|---|---|
| | N | b | N | b |
| **Sparrowhawk** | | | | |
| HEOD | 1524 | -0.0326 ** | 594 | 0.0443 * |
| pp'-DDE | 1523 | -0.3760 ** | 594 | -0.0001 ns |
| PCB | 1480 | -0.0072 * | 594 | 0.0574 * |
| Hg | 1279 | -0.0298 ** | 573 | 0.1267 *** |
| **Kestrel** | | | | |
| HEOD | 1289 | -0.0351 ** | 293 | 0.0293 ns |
| pp'-DDE | 1316 | -0.0432 ** | 293 | -0.0525 ns |
| PCB | 1175 | 0.0036 ns | 293 | -0.0376 ns |
| Hg | 984 | -0.0389 ** | 293 | 0.2397 *** |
| **Heron** | | | | |
| HEOD | 769 | -0.0510 ** | 110 | 0.0312 ns |
| pp'-DDE | 778 | -0.0442 ** | 110 | 0.0057 ns |
| PCB | 645 | -0.0242 ** | 110 | 0.0675 ns |
| Hg | 482 | -0.0238 ** | 110 | -0.0439 ns |
| **Kingfisher** | | | | |
| HEOD | 199 | -0.0229 ** | 42 | 0.1050 ns |
| pp'-DDE | 200 | -0.0440 ** | 42 | 0.0786 ns |
| PCB | 194 | -0.0165 ns | 42 | 0.1055 ns |
| Hg | 121 | -0.0008 ns | 42 | 0.1474 ** |
| **Great-crested Grebe** | | | | |
| HEOD | 158 | -0.024293 ** | 17 | 0.0400 ns |
| pp'-DDE | 179 | -0.0216 ** | 17 | 0.1841 ns |
| PCB | 166 | -0.0291 ** | 17 | 0.2365 * |
| Hg | 98 | -0.0126 ns | 17 | 0.0627 ns |

Notes: Analyses for Hg in Sparrowhawk, Kestrel, and Heron were started in 1970, in Kingfisher in 1980 and in Great-crested Grebe in 1979.

Analyses for PCBs in Sparrowhawk, Kestrel and Heron were started in 1967, and in Kingfisher and Great-crested Grebe in 1968.

Figure 1. Trends in pollutant residues in livers of Sparrowhawks, 1963-1994.
Three year moving geometric means with one geometric standard error on either side.

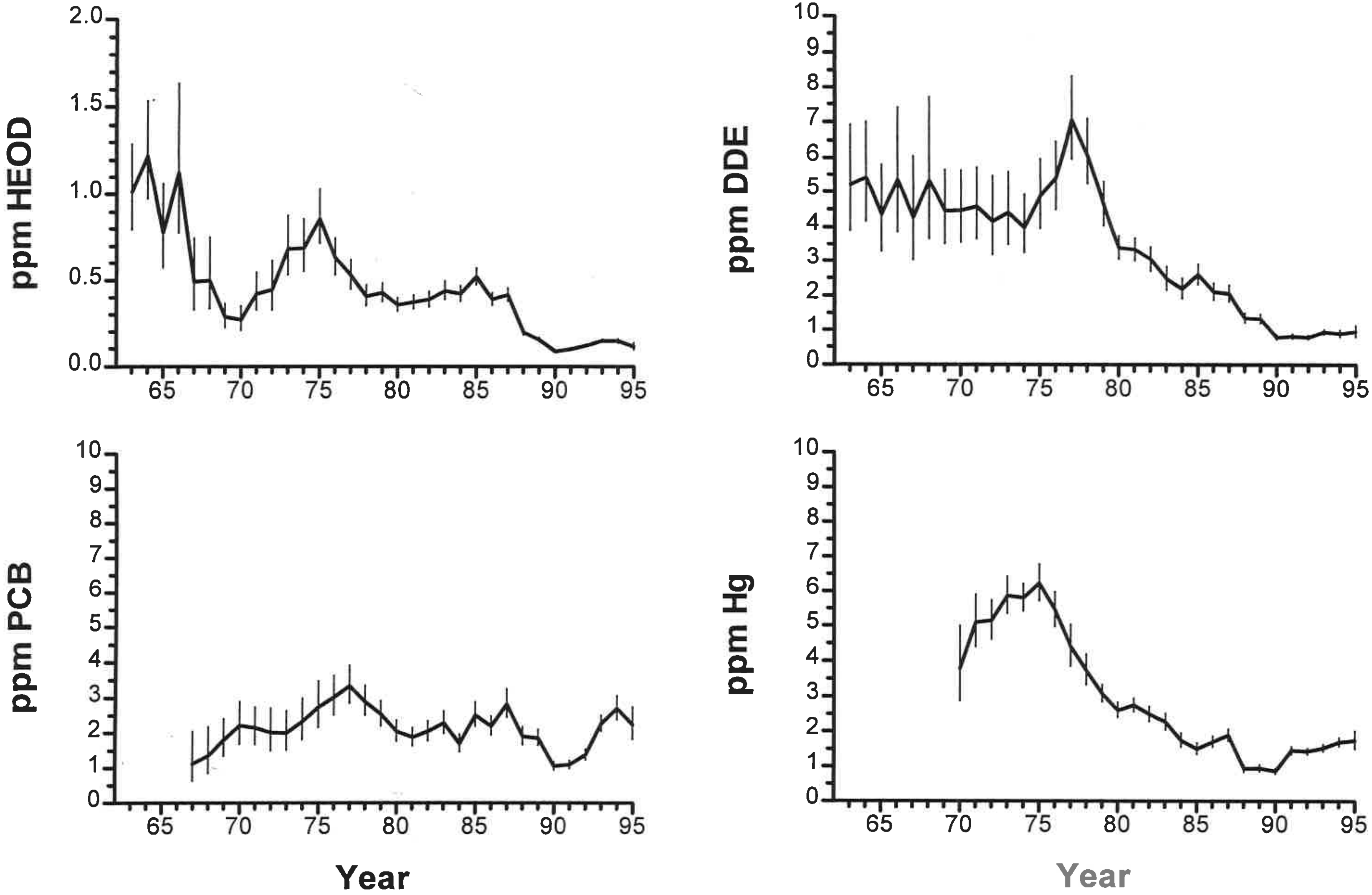


Figure 2. Trends in pollutant residues in livers of Kestrels, 1963 - 1994.
Three year moving geometric means with one geometric standard error on either side.

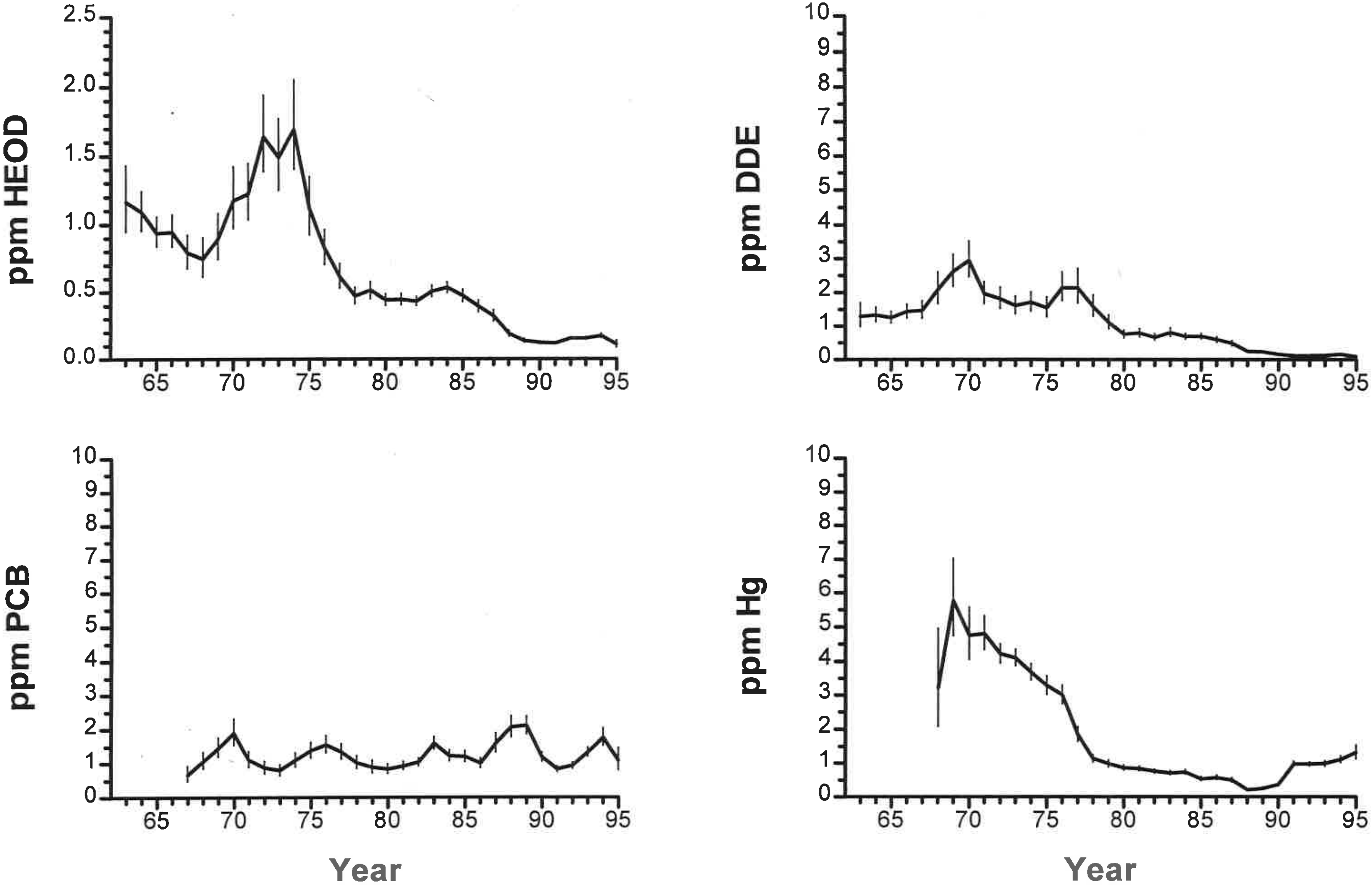


**Figure 3.** **Trends in pollutant residues in livers of Herons, 1963-1994.
Three year moving geometric means with one geometric standard error on either side.**

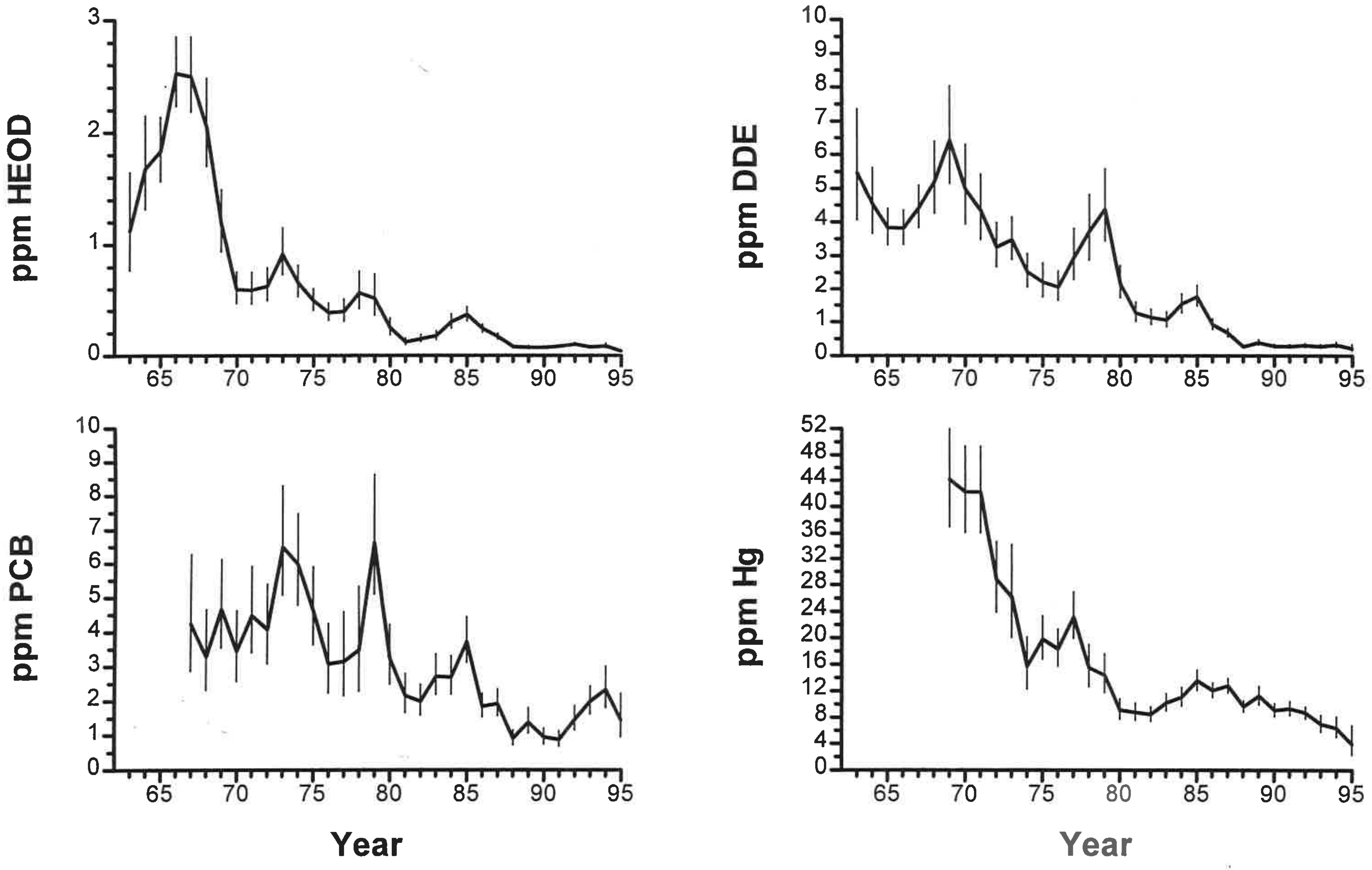


**Figure 4.** **Trends in pollutant residues in livers of Kingfishers, 1963 - 1994.
Three year moving geometric means with one geometric standard error on either side.**

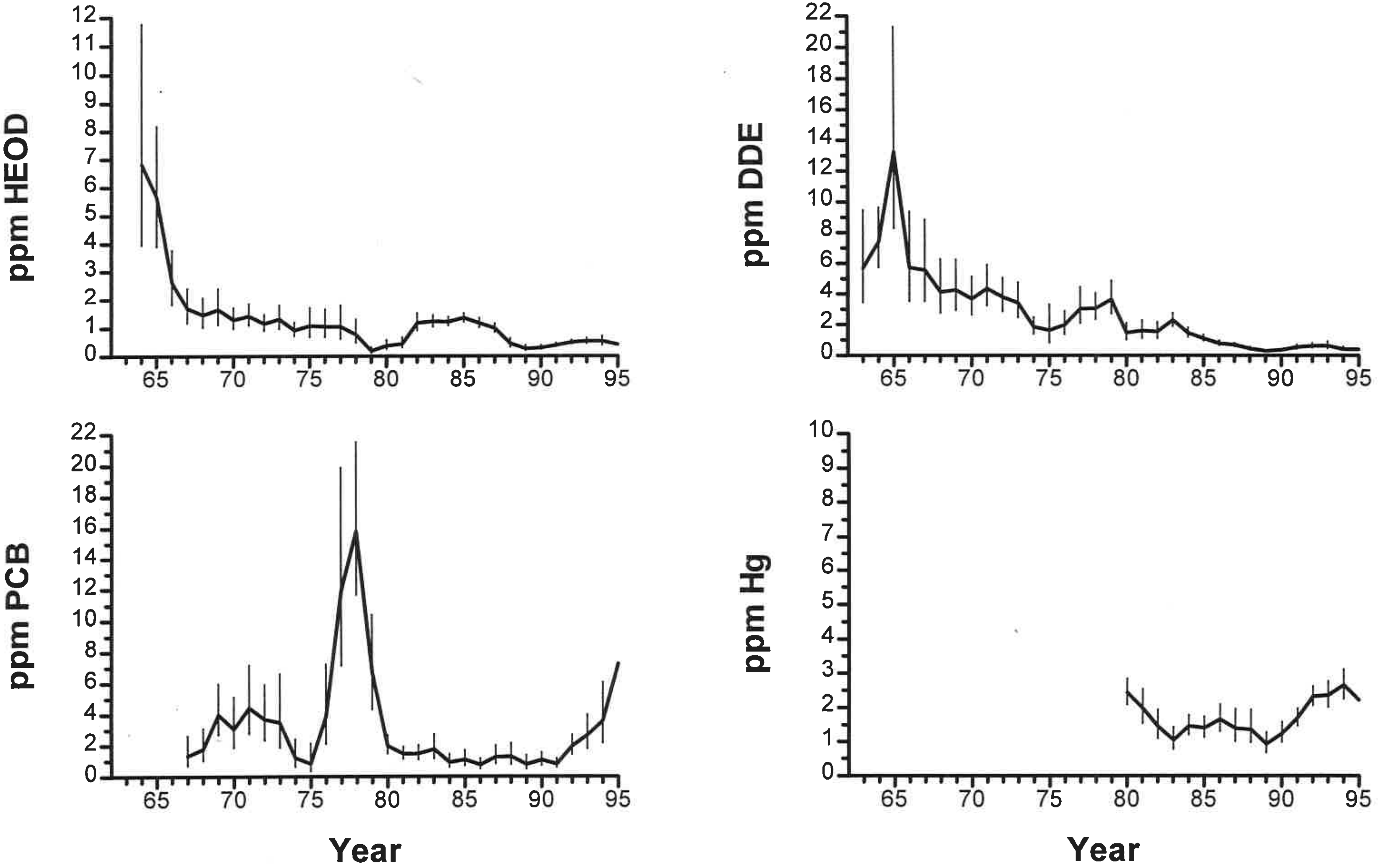
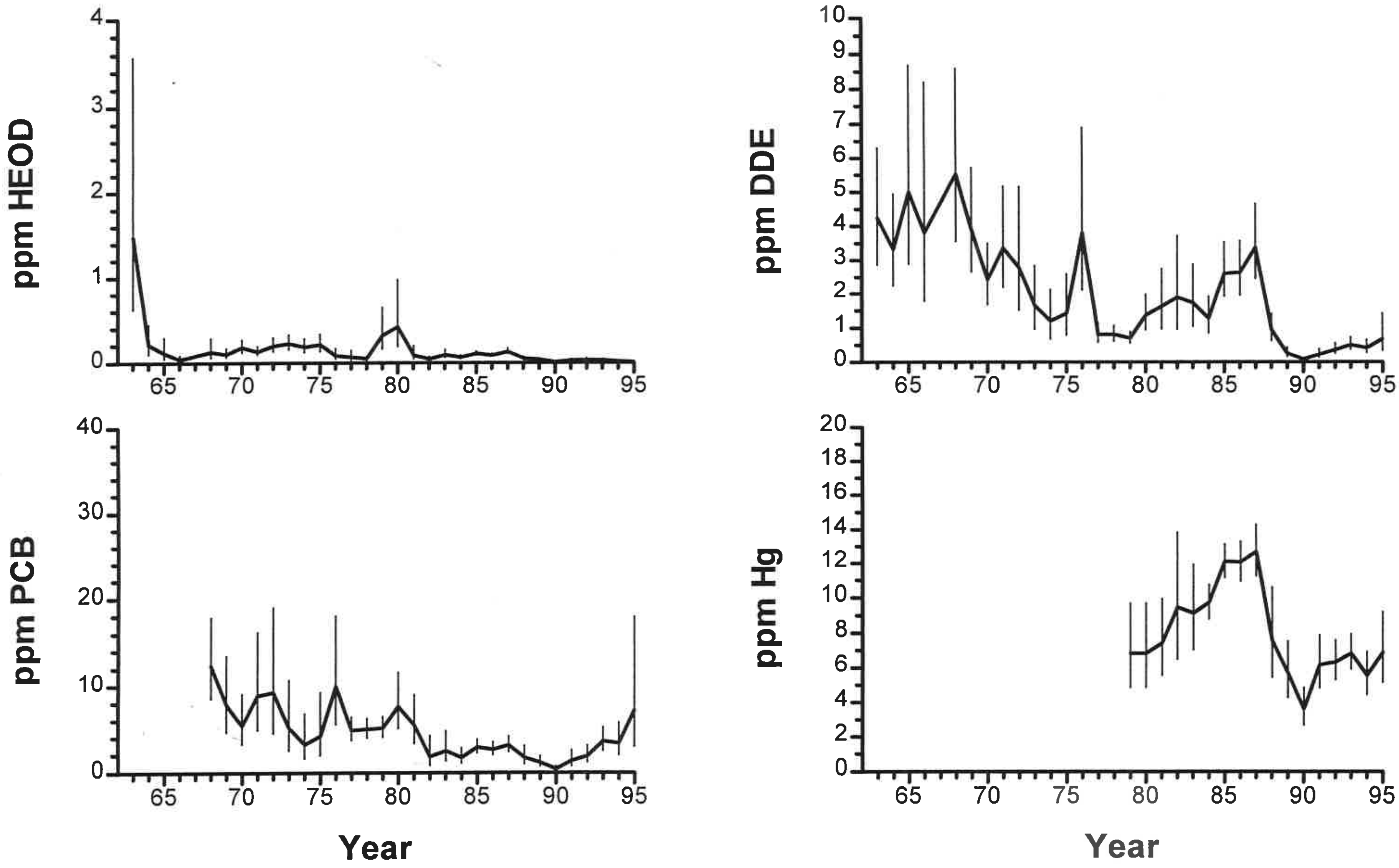


Figure 5. Trends in pollutant residues in livers of Great-crested Grebes, 1963-1994.
Three year moving geometric means with one geometric standard error on either side.
Note that no birds were received in 1967.



INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

JNCC/NERC CONTRACT HF3/08/01
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# WILDLIFE AND POLLUTION

## Part 3 Organochlorines and mercury in peregrine eggs, 1994

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July 1995

## 3 ORGANOCHLORINES AND MERCURY IN PEREGRINE EGGS, 1994

### 3.1 Introduction

The findings from all peregrine eggs analysed between 1961 and 1986 were summarised in Newton *et al.* (1989); those from eggs analysed during 1987-93 are given in previous reports in this series, and those from 30 eggs (one per clutch) analysed in 1994 are given in Table 5. Unfortunately no coastal eggs were represented.

### 3.2 Results

The findings confirm continuing widespread contamination of British peregrine eggs with organochlorines and mercury. However, most of the residues were present at relatively low level. The highest DDE and HEOD levels recorded in 1994 were 2.0 and 0.3 ppm wet weight (both in an egg from Powys), the highest PCB level was 19 ppm (in an egg from Strathclyde) and the highest mercury level was 3 ppm in dry weight (also Strathclyde).

There seems little doubt that organochlorine levels in British peregrines are continuing to decline. Over most of the country, the population recovered some years ago from its pesticide-induced decline

### 3.3 Reference

Newton, I., Bogan, J.A. & Haas, M.B. 1989. Organochlorines and mercury in British Peregrine eggs. Ibis 131: 355-376.

**Table 5.** **Residue levels (organochlorine ppm wet weight (lipid weight); mercury ppm dry weight) and shell indices (SI) for Peregrine eggs received in 1994.** ND=none detected; D & G=Dumfries & Galloway.

| Number | Year | County | SI | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|
| **SOUTHERN SCOTLAND** | | | | | | | |
| E6148 | 94 | Lothian | 1.88 | 0.35 (7.01) | 0.03 (0.60) | 2.51 (49.58) | ND |
| E6159 | 94 | Borders | - | 1.11 (20.76) | 0.13 (2.45) | 4.59 (85.87) | 1.39 |
| E6160 | 92 | Borders | - | 0.42 (19.05) | 0.07 (3.07) | 1.33 (59.90) | ND |
| E6163 | 94 | Borders | - | 0.13 (3.84) | 0.04 (1.09) | 1.29 (38.27) | 0.35 |
| E6164 | 94 | Borders | 1.97 | 0.20 (4.06) | 0.05 (1.02) | 1.64 (33.53) | 0.37 |
| E6169 | 94 | Borders | 1.75 | 0.15 (2.49) | 0.05 (0.88) | 2.05 (34.27) | 0.22 |
| E6170 | 94 | Borders | 1.85 | 0.11 (2.16) | 0.02 (0.37) | 1.08 (20.61) | ND |
| E6210 | 94 | Borders | 1.95 | 0.32 (5.81) | 0.03 (0.54) | 1.03 (18.71) | 1.46 |
| E6271 | 94 | D & G | 1.95 | 0.41 (9.00) | 0.03 (0.67) | 0.97 (21.10) | 0.72 |
| E6275 | 94 | D & G | - | 0.20 (6.89) | 0.02 (0.81) | 0.93 (31.89) | 0.58 |
| E6328 | 94 | Strathclyde | 1.82 | 1.17 (21.33) | 0.20 (3.68) | 18.51 (336.39) | 0.77 |
| E6329 | 94 | Strathclyde | 1.72 | 1.68 (63.36) | 0.17 (6.38) | 13.37 (505.34) | 3.23 |
| E6372 | 94 | Borders | 1.74 | 0.38 (8.93) | 0.02(0.41) | 1.11 (26.17) | 0.18 |
| E6373 | 94 | Borders | 2.00 | 0.37 (6.17) | 0.02 (0.38) | 1.02 (16.97) | 0.20 |
| E6374 | 94 | Borders | - | 0.64 (8.36) | 0.03 (0.41) | 1.61 (21.01) | 0.14 |
| E6375 | 94 | Borders | - | 0.85 (9.28) | 0.04 (0.38) | 1.76 (19.23) | 0.10 |
| **CENTRAL AND EASTERN HIGHLANDS** | | | | | | | |
| E6166 | 90 | Tayside | 1.91 | 0.05 (0.84) | 0.02 (0.33) | 0.88 (16.58) | ND |
| E6167 | 90 | Tayside | - | 0.09 (1.85) | 0.02 (0.35) | 1.24 (25.49) | ND |
| E6168 | 91 | Tayside | 1.87 | 0.05 (0.67) | 0.02 (0.28) | 0.91 (13.41) | ND |
| E6240 | 94 | Grampian | - | 0.08 (1.34) | 0.02 (0.34) | 0.22 (3.64) | 0.17 |
| E6241 | 94 | Grampian | 1.74 | 0.60 (10.49) | 0.02 (0.34) | 0.49 (8.53) | ND |
| E6411 | 94 | Tayside | 1.96 | 0.05 (0.85) | 0.01 (0.10) | 0.44 (8.32) | 0.15 |
| E6412 | 94 | Tayside | 1.82 | 0.86 (13.75) | 0.03 (0.41) | 1.30 (20.70) | 0.48 |
| E6414 | 94 | Tayside | 1.54 | 0.02 (0.40) | 0.01 (0.10) | 0.16 (3.20) | 0.14 |
| E6416 | 94 | Tayside | 1.90 | 0.46 (7.49) | 0.02 (0.33) | 1.43 (23.27) | 0.37 |
| **NORTHERN ENGLAND** | | | | | | | |
| E6360 | 94 | N'humberland | 1.99 | 0.57 (11.51) | 0.04 (0.86) | 2.09 (42.22) | 0.72 |
| E6361 | 94 | N'humberland | 1.90 | 0.33 (4.52) | 0.03 (0.45) | 0.69 (7.29) | 0.43 |
| **WALES** | | | | | | | |
| E6425 | 94 | Gwent | 1.96 | 0.65 (11.31) | 0.04 (0.78) | 7.72 (135.24) | 0.14 |
| E6427 | 94 | Powys | 1.86 | 0.30 (4.74) | 0.03 (0.51) | 1.73 (27.05) | 0.32 |
| E6428 | 94 | Powys | 1.76 | 2.04 (42.29) | 0.25 (5.15) | 1.75 (36.40) | 0.77 |

# 4 ORGANOCHLORINES AND MERCURY IN MERLIN EGGS, 1994

## 4.1 Introduction

The findings from most previous analyses of merlin eggs were given in Newton & Haas (1988), those from 1987-1993 in previous reports in this series, while those from 1994 (one egg per clutch) are summarised in Table 6.

## 4.2 Results

The results from these additional 55 merlin eggs serve to confirm the continuing widespread contamination of British merlins with organochlorines and mercury. Levels of all contaminants were generally higher than those in peregrine eggs, but levels of all chemicals continue to decline slowly. The highest DDE and HEOD levels recorded in 1994 were 12 and 2 ppm (both in an egg from Tayside), the highest PCB level was 13 ppm (two eggs from Yorkshire) and, as in previous years, Hg was present at highest level (3-7 ppm) in eggs from the Northern Isles. An egg from Grampian also contained 6 ppm Hg.

Together with previous findings, these data indicate a continuing downward trend in organochlorine residues in merlins, but occasional high levels still occur, and mercury remains at high level in eggs from the Northern Isles. Decline in residues over the past 10-15 years has coincided with a substantial recovery in merlin numbers over much of the country.

## 4.3 Reference

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

**Table 6.** **Residue levels (organochlorine ppm wet weight (lipid weight); mercury ppm dry weight) and shell indices (SI) for Merlin eggs received in 1994.** ND=none detected; D & G=Dumfries & Galloway.

| Number | Year | County | SI | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|
| **SOUTHERN SCOTLAND** | | | | | | | |
| E6036 | 93 | Lothian | 1.07 | 6.14 (121.35) | 0.53 (10.61) | 2.47 (48.85) | 3.32 |
| E6037 | 92 | Lothian | 0.76 | 6.25 (84.42) | 0.12 (1.71) | 3.26 (46.66) | 1.35 |
| E6039 | 92 | Lothian | 1.17 | 4.15 (42.37) | 0.13 (1.32) | 3.37 (34.41) | 1.94 |
| E6040 | 92 | Lothian | 1.16 | 6.85 (122.22) | 0.07 (1.21) | 3.93 (70.07) | 2.73 |
| E6042 | 92 | Lothian | 1.20 | 1.64 (36.93) | 0.07 (1.52) | 1.52 (31.99) | 2.47 |
| E6074 | 93 | D & G | 0.92 | 5.41 (50.74 | 0.12 (1.14) | 3.68 (35.15) | 3.60 |
| E6075 | 93 | Strathclyde | 1.18 | 2.61 (26.53) | 0.04 (0.37) | 0.83 (8.42) | 3.48 |
| E6149 | 94 | Lothian | 1.30 | 1.95 (30.90) | 0.12 (1.97) | 4.14 (65.68) | 3.84 |
| E6205 | 94 | Borders | 1.26 | 1.72 (37.99) | 0.09 (2.07) | 2.60 (57.38) | 2.64 |
| E6209 | 94 | Borders | 1.19 | 2.52 (32.28) | 0.15 (1.97) | 3.35 (42.88) | 1.96 |
| E6446 | 94 | Strathclyde | 1.23 | 1.99 (34.59) | 0.05 (0.938) | 3.13 (54.29) | 3.52 |
| **CENTRAL AND EASTERN HIGHLANDS** | | | | | | | |
| E6031 | 93 | Tayside | 1.08 | ND | ND | ND | 1.66 |
| E6032 | 93 | Tayside | 1.25 | 2.58 (39.54) | 0.16 (2.47) | 1.96 (30.04) | 1.30 |
| E6033 | 93 | Tayside | 1.13 | 12.42 (100.42) | 1.87 (15.11) | 6.67 (53.95) | 2.61 |
| E6043 | 93 | Grampian | 1.15 | 4.08 (79.40) | 0.14 (2.79) | 4.63 (90.10) | 3.06 |
| E6044 | 93 | Grampian | 1.24 | 2.40 (32.31) | 0.07 (0.92) | 2.52 (33.94) | 1.79 |
| E6046 | 93 | Grampian | - | 3.17 (56.95) | 0.07 (1.26) | 2.80 (50.28) | 5.95 |
| E6048 | 93 | Grampian | 1.03 | 6.66 (99.02) | 0.21 (3.15) | 2.28 (33.82) | 2.05 |
| E6049 | 92 | Tayside | 1.04 | 3.67 (97.40) | 0.32 (8.53) | 2.96 (78.49) | 4.15 |
| E6050 | 92 | Tayside | 1.29 | 2.58 (33.40) | 0.09 (1.14) | 2.97 (38.46) | 1.90 |
| E6051 | 92 | Tayside | 1.24 | 3.26 (47.02) | 0.09 (1.28) | 3.68 (53.15) | 1.57 |
| E6055 | 93 | Highland | 1.24 | 1.40 (20.39) | 0.08 (1.11) | 2.01 (29.31) | 6.21 |
| E6070 | 93 | Tayside | 1.13 | 6.82 (95.09) | 1.67 (23.33) | 5.30 (73.90) | 2.42 |
| E6072 | 93 | Tayside | 1.19 | 3.72 (56.90) | 0.06 (0.90) | 4.30 (65.71) | 1.63 |
| E6073 | 93 | Tayside | 1.05 | 6.69 (100.16) | 1.57 (23.56) | 4.99 (74.68) | 2.56 |
| E6158 | 91 | Tayside | 1.30 | 2.87 (39.66) | 0.42 (5.79) | 5.34 (73.83) | 1.76 |
| E6450 | 92 | Tayside | 1.24 | 1.68 (26.91) | 0.07 (1.16) | 2.22 (35.64) | 1.50 |
| E6451 | 94 | Grampian | 1.23 | 2.74 (49.91) | 0.08 (1.44) | 4.02 (73.26) | 2.46 |
| E6452 | 94 | Tayside | 1.19 | 5.09 (86.26) | 0.12 (2.10) | 1.93 (32.65) | 1.65 |
| E6453 | 94 | Grampian | 1.17 | 1.93 (33.94) | 0.03 (0.50) | 2.14 (37.66) | 1.86 |
| E6454 | 94 | Grampian | - | 1.96 (35.30) | 0.06 (1.10) | 2.34 (41.83) | 2.42 |
| E6455 | 94 | Grampian | 1.14 | 2.29 (50.68) | 0.04 (0.90) | 1.80 (39.83) | 2.01 |

| Number | Year | County | SI | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|---|---|
| **CENTRAL AND EASTERN HIGHLANDS cont.** | | | | | | | |
| E6456 | 94 | Grampian | 1.27 | 1.44 (34.16) | 0.03 (0.61) | 1.93 (45.84) | 1.62 |
| E6457 | 94 | Grampian | 1.27 | 2.08 (52.14) | 0.17 (4.29) | 3.02 (75.68) | 1.61 |
| E6458 | 94 | Grampian | 1.20 | 2.81 (79.35) | 0.17 (4.89) | 3.48 (98.29) | 2.21 |
| E6459 | 94 | Tayside | 1.15 | 1.60 (33.15) | 0.05 (1.06) | 1.69 (34.97) | 1.96 |
| E6461 | 94 | Tayside | 1.24 | 1.66 (40.43) | 0.04 (0.86) | 1.97 (47.98) | 1.67 |
| **NORTHERN ENGLAND** | | | | | | | |
| E6153 | 94 | N Yorkshire | 1.21 | 1.57 (24.64) | 0.10 (1.60) | 12.72 (199.87) | 2.00 |
| E6173 | 94 | N Yorkshire | 1.08 | 2.07 (34.56) | 0.21 (3.50) | 6.54 (109.06) | 1.03 |
| E6212 | 94 | N Yorkshire | 1.18 | 1.87 (24.86) | 0.10 (1.26) | 2.41 (31.99) | 2.34 |
| E6214 | 94 | N Yorkshire | 1.09 | 2.73 (37.22) | 0.62 (8.51) | 13.41 (182.77) | 2.37 |
| E6362 | 94 | Northumberland | 1.13 | 1.70 (26.43) | 0.07 (1.04) | 2.13 (33.12) | 4.30 |
| E6363 | 94 | Durham | 1.29 | 1.38 (13.08) | 0.06 (0.57) | 2.77 (26.310) | 1.76 |
| E6364 | 94 | Durham | 1.15 | 2.57 (38.63) | 0.26 (3.83) | 4.28 (64.25) | 1.80 |
| E6365 | 94 | Durham | 1.22 | 2.37 (38.10) | 0.06 (1.00) | 3.31 (53.25) | 2.09 |
| E6367 | 94 | Durham | 1.08 | 2.45 (41.64) | 0.32 (5.48) | 31.17 (529.18) | 6.65 |
| E6419 | 94 | S Yorkshire | - | 0.73 (17.00) | 0.17 (3.84) | 1.19 (27.50) | 0.95 |
| **NORTHERN ISLES** | | | | | | | |
| E6283 | 94 | Shetland | 1.23 | 1.86 (26.95) | 0.05 (0.74) | 3.11 (45.03) | 6.90 |
| E6284 | 94 | Shetland | 1.19 | 1.12 (16.65) | 0.04 (0.65) | 2.98 (44.39) | 4.61 |
| E6285 | 94 | Shetland | 1.11 | 0.90 (14.65) | 0.11 (2.11) | 3.10 (50.45) | 3.46 |
| E6286 | 94 | Shetland | 1.22 | 1.49 (30.16) | 0.05 (0.91) | 3.44 (69.60) | 8.61 |
| E6287 | 94 | Shetland | 1.08 | 2.08 (36.70) | 0.11 (2.02) | 6.08 (107.48) | 5.36 |
| E6288 | 94 | Shetland | 1.19 | 1.57 (24.55) | 0.06 (0.90) | 3.78 (58.94) | 3.01 |

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# WILDLIFE AND POLLUTION

## Part 5 Organochlorines and mercury in golden eagle eggs, 1994

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July 1995

# 5 ORGANOCHLORINES AND MERCURY IN GOLDEN EAGLE EGGS, 1994

## 5.1 Introduction

The findings from analyses of golden eagle eggs obtained during 1963-86 were given in Newton & Galbraith (1991), and from 1987-93 in previous reports in this series. Eggs from seven clutches were received in 1994, and the results are given in Table 7. Unfortunately, no coastal eggs were received.

## 5.2 Results

The new analyses serve to confirm the low levels of contamination found in recent years in golden eagle eggs (Table 7). All residue levels were low, and well within the range of previous values.

## 5.3 Reference


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

**Table 7.** **Residue levels (organochlorine ppm wet weight (lipid weight); mercury ppm dry weight) and shell indices (SI) for Golden Eagle eggs received in 1994.** ND=none detected; D & G=Dumfries & Galloway.

| Number | Year | County | SI | pp'-DDE | | HEOD | | PCB | | Hg |
|---|---|---|---|---|---|---|---|---|---|---|
| **SOUTHERN SCOTLAND** | | | | | | | | | | |
| E6293 | 94 | D & G | 2.90 | 0.04 | (0.69) | 0.03 | (0.63) | 0.52 | (10.16) | 0.21 |
| E6311 | 94 | Strathclyde | 2.82 | 0.01 | (0.65) | 0.01 | (0.64) | 0.27 | (12.29) | ND |
| E6313 | 94 | Strathclyde | 2.57 | 0.07 | (1.54) | 0.03 | (0.58) | 3.06 | (66.91) | 0.19 |
| E6315 | 94 | Strathclyde | 3.06 | 0.01 | (0.37) | 0.01 | (0.28) | 0.35 | (9.39) | 0.12 |
| E6317 | 94 | Strathclyde | 2.98 | 0.05 | (0.88) | 0.02 | (0.37) | 0.67 | (13.02) | 0.10 |
| E6464 | 94 | Strathclyde | 2.72 | 0.01 | (0.95) | 0.01 | (0.23) | 0.21 | (9.61) | ND |
| **NORTHERN ENGLAND** | | | | | | | | | | |
| E6146 | 94 | Cumbria | 3.16 | 0.03 | (0.36) | 0.01 | (0.16) | 0.29 | (5.74) | 0.15 |

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# WILDLIFE AND POLLUTION

## Part 6 Organochlorines and mercury in sea eagle eggs, 1994

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# 6 ORGANOCHLORINE AND MERCURY IN SEA EAGLE EGGS

## 6.1 Introduction

So far, the Sea Eagles *Haliaetus albicilla* introduced to western Scotland in the period 1976-85 have breed with poor success. Most breeding attempts have failed completely. One of the possible problems might be contamination with organochlorine and mercury residues, which the birds could acquire particularly from the marine component of their diet, various fish and seabirds. Some of the nests have been on inaccessible sea-cliffs, and in 1994 only one unhatched egg was obtained for analysis, from an inland site occupied by a lone female.

## 6.2 Results

This egg had a shell index of 3.50 (within the range of pre-DDT values), and was found to contain 0.79 ppm DDE, 0.02 ppm HEOD and 10.90 ppm PCBs in wet weight, and 0.34 ppm Hg in dry weight. Apart from PCBs, these values are low; none of the residues give cause for concern. They reflect the fact that this bird would have fed mainly on land-based prey.

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# WILDLIFE AND POLLUTION

## Part 7 Organochlorines and mercury in gannet eggs, 1994

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# 7 ORGANOCHLORINES AND MERCURY IN GANNET EGGS, 1994

## 7.1 Introduction

The findings from all gannet eggs examined to 1987 were summarised in the report for 1989, and in published form in Newton *et al.* (1990). Subsequent results were given in previous reports in this series, and those for 38 eggs examined in 1994 are given in Table 8. They include 9-10 eggs from each of the four colonies at Hermaness, Ailsa Craig, Bass Rock and St Kilda. For eggs from each colony, mean residues are compared with previous eggs from that colony, both in the short term (comparing with Hermaness, Ailsa Craig and Bass Rock in 1992 and with St Kilda in 1990 (Table 8), and in the long-term (1971-94 and 1984-94) in Table 9.

## 7.2 Results

Low levels of DDE, HEOD, PCBs and Hg were found in all the eggs from all four colonies. Compared with the previous annual samples from the same colonies at Hermaness, Ailsa Craig and Bass Rock, HEOD had declined significantly, while at Ailsa Craig mean shell-index (which responds to DDE), had improved significantly. No other significant short-term changes were found.

Over the longer term (1971-94), eggs from Ailsa Craig showed a significant decline in residues of all four chemicals, those from Bass Rock showed significant declines in HEOD and DDE, while those from Hermaness showed a significant decline in DDE (Table 9). Eggs from St Kilda showed no significant trends in residues. Colonies showing significant declines in residues were those where residue levels were highest in the earlier years of monitoring (Newton *et al.* 1990).

Over the more recent period (1984-94), the only significant change detected was a decline in DDE at Bass Rock. At all colonies, however, all residues were low and unlikely to have adverse effects on gannet reproduction or survival.

The importance of continued monitoring of gannet eggs is that this is the only seabird of British coasts in which residue levels have been measured continuously over the past 25 years. It therefore provides a useful baseline, as well as revealing long-term trends.

## 7.3 Reference

Newton, I., Haas, M.B. & Freestone, P. 1990. Trends in organochlorine and mercury levels in Gannet eggs. Environ. Pollut. 63: 1-12.

**Table 8.** **Residue levels (organochlorine ppm wet weight; mercury ppm dry weight) and shell indices (SI) for gannet eggs *(Sula bassana)* received in 1994.**

| Colony | SI | pp'-DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|
| **Hermaness** | 2.97 | 0.132 | 0.025 | 2.145 | 2.222 |
| | 2.96 | 0.043 | 0.021 | 1.265 | 3.410 |
| | 3.12 | 0.106 | 0.022 | 2.055 | 2.027 |
| | 3.07 | 0.031 | 0.016 | 1.129 | 2.152 |
| | 3.18 | 0.039 | 0.016 | 0.814 | 2.477 |
| | 3.11 | 0.048 | 0.012 | 0.773 | 1.916 |
| | 3.08 | 0.061 | 0.020 | 1.614 | 2.253 |
| | 2.98 | 0.131 | 0.026 | 1.670 | 2.407 |
| | 3.00 | 0.066 | 0.018 | 1.595 | 2.613 |
| | 3.17 | 0.113 | 0.025 | 2.222 | 2.425 |
| Mean | 3.06 | 0.07 | 0.02 | 1.44 | 1.53 |
| SD | 0.08 | 0.11 | 0.23 | 0.17 | 0.62 |
| Range within 1 SE | 2.74-2.79 | -0.01-0.14 | 0.02-0.02 | 1.27-1.62 | 0.97-2.41 |
| **Ailsa Craig** | 2.95 | 0.090 | 0.043 | 3.388 | 1.766 |
| | 3.08 | 0.022 | 0.023 | 0.755 | 1.071 |
| | 2.96 | 0.121 | 0.056 | 4.952 | 2.357 |
| | 2.89 | 0.073 | 0.043 | 2.818 | 3.363 |
| | 2.92 | 0.072 | 0.036 | 2.529 | 2.210 |
| | 3.02 | 0.077 | 0.077 | 3.753 | 1.688 |
| | 3.15 | 0.076 | 0.047 | 3.867 | 2.482 |
| | 3.24 | 0.085 | 0.056 | 6.732 | 4.241 |
| | 3.29 | 0.063 | 0.069 | 3.826 | 2.333 |
| Mean | 3.06 | 0.07 | 0.05 | 3.08 | 2.23 |
| SD | 0.14 | 0.20 | 0.16 | 0.27 | 0.17 |
| Range within 1 SE | 3.01-3.10 | 0.001-0.14 | 0.04-0.05 | 2.51-3.77 | 1.95-2.55 |
| **Bass Rock** | 2.98 | 0.064 | 0.042 | 1.900 | 1.500 |
| | 3.08 | 0.049 | 0.037 | 1.063 | 1.518 |
| | - | 0.209 | 0.076 | 2.977 | 2.115 |
| | 2.90 | 0.197 | 0.077 | 4.485 | 3.129 |
| | 3.10 | 0.065 | 0.043 | 1.972 | 1.576 |
| | 2.90 | 0.092 | 0.063 | 3.149 | 2.560 |
| | 2.78 | 0.165 | 0.048 | 2.981 | 1.642 |
| | 3.01 | 0.073 | 0.039 | 1.542 | 1.759 |
| | 2.80 | 0.199 | 0.043 | 2.479 | 2.353 |
| | 3.04 | 0.061 | 0.052 | 2.155 | 3.313 |
| Mean | 2.28 | 0.10 | 0.05 | 2.30 | 2.06 |
| SD | 0.12 | 0.25 | 0.12 | 0.18 | 0.13 |
| Range within 1 SE | 2.24-2.32 | 0.02-0.18 | 0.05-0.06 | 2.01-2.62 | 1.87-2.26 |

| Colony | SI | DDE | HEOD | PCB | Hg |
|---|---|---|---|---|---|
| **St Kilda** | 3.01 | 0.669 | 0.058 | 8.392 | 3.065 |
| | 3.26 | 0.043 | 0.038 | 1.305 | 2.788 |
| | 3.12 | 0.024 | 0.029 | 0.916 | 2.147 |
| | 3.04 | 0.065 | 0.047 | 1.984 | 2.326 |
| | 3.17 | 0.037 | 0.030 | 1.163 | 2.110 |
| | 3.00 | 0.022 | 0.023 | 0.843 | 1.824 |
| | 3.15 | 0.150 | 0.070 | 3.806 | 3.032 |
| | 2.87 | 0.396 | 0.064 | 6.114 | 3.178 |
| | 2.81 | 0.022 | 0.021 | 0.883 | 1.761 |
| Mean | 3.05 | 0.07 | 0.04 | 1.95 | 2.41 |
| SD | 0.14 | 0.56 | 0.14 | 0.38 | 0.10 |
| Range within 1 SE | 3.00-3.10 | -0.11-0.26 | 0.03-0.04 | 1.45-2.61 | 2.24-2.61 |

NB: Means are arithmetic for shell index; geometric for residues

**Comparison of shell index and geometric mean residue levels from gannet eggs collected from Hermaness, Ailsa Craig and Bass Rock in 1992 and 1994; and from St Kilda in 1990 and 1994.**

t values shown. Minus values indicate a decrease and plus values an increase from previous eggs from the same site.

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

| | Hermaness | Ailsa Craig | Bass Rock | St Kilda |
|---|---|---|---|---|
| Shell index | $t_{18}=-1.22$ | $t_{17}=+3.30$** | $t_{17}=-2.08$ | $t_{17}=+1.01$ |
| pp'-DDE | $t_{18}=-1.62$ | $t_{17}=-1.39$ | $t_{18}=+0.46$ | $t_{17}=+1.57$ |
| HEOD | $t_{18}=-11.77$*** | $t_{17}=-2.71$* | $t_{18}=-5.11$*** | $t_{17}=+1.58$ |
| PCB | $t_{18}=-0.79$ | $t_{17}=+0.13$ | $t_{18}=+0.08$ | $t_{17}=+2.37$ |
| Hg | $t_{18}=-1.47$ | $t_{17}=+0.50$ | $t_{18}=+2.05$ | $t_{17}=-1.84$ |

**Table 9. Long term trends in pollutants in Gannet eggs based on regression analyses of annual geometric mean values on year.**

Figures show linear regression coefficients (b) based on log values regressed against year. *P=<0.05; **P=<0.01; ***P=>0.001; ns=not significant.

| | 1971 - 1994 | 1984 - 1994 |
|---|---|---|
| **Ailsa Craig** | | |
| HEOD | -0.0269 *** | -0.0234 ns |
| pp'-DDE | -0.0895 *** | -0.0324 ns |
| PCB | -0.2768 * | 0.0903 ns |
| Hg | -0.0967 *** | -0.0379 ns |
| **Bass Rock** | | |
| HEOD | -0.0175 * | -0.0137 ns |
| pp'-DDE | -0.0514 *** | -0.0317 * |
| PCB | -0.1583 ns | -0.1204 ns |
| Hg | 0.0138 ns | 0.0039 ns |
| **Hermaness** | | |
| HEOD | -0.0048 ns | -0.0257 ns |
| pp'-DDE | -0.0239 * | -0.0186 ns |
| PCB | 0.0556 ns | 0.2493 ns |
| Hg | 0.0414 ns | -0.5829 ns |
| **St Kilda** | | |
| HEOD | -0.0059 ns | -0.0546 ns |
| pp'-DDE | -0.0163 ns | -0.0305 ns |
| PCB | 0.0119 ns | -0.2053 ns |
| Hg | 0.1265 ns | 0.0276 ns |

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# WILDLIFE AND POLLUTION

## Part 8 Rodenticides in barn owls

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# 8 RODENTICIDE RESIDUES IN BARN OWLS

## 8.1 Introduction

The aims of this study were to find (1) to what extent barn owls *Tyto alba* in Britain are contaminated with certain rodenticide residues, and (2) whether such residues are likely to represent a significant source of mortality. As barn owl numbers are thought to have declined in Britain during the present century (Bunn *et al.* 1982, Shawyer 1987, Percival 1991), it is important to assess any role that secondary poisoning from rodenticides might have.

It is the so-called 'second-generation' anticoagulant rodenticides which are likely to pose the greatest threat, as these are rapidly replacing warfarin and other 'first generation' rodenticides, to which rats and mice in many areas have become resistant. Four second generation rodenticides are currently in use in Britain. Difenacoum was introduced in 1975, bromadiolone in 1980, brodifacoum in 1982 and flocoumafen in 1986. All these chemicals are more toxic than warfarin, and also more persistent, giving the possibility of secondary poisoning in rodent predators and scavengers. As the barn owl often nests and hunts around farm buildings where these chemicals are commonly used, it would seem to be at particular risk.

We began analysing barn owls for rodenticide residues in 1983, and the findings from 145 carcasses examined up to March 1989 were summarised in Newton *et al.* (1990), and from subsequent carcasses in previous reports in this series.

In 1994 a further 95 carcasses were analysed, giving a total of 496 for the whole 12-year period 1983-94, and 351 for 1990-94, the results from which are brought together here. Carcasses came from various parts of the country, and from all months of the year.

## 8.2 Results

Of the 95 birds examined in 1994, residues of one or more rodenticides were detected in 28 (Table 10). Difenacoum was found in 18 birds, bromadiolone in 14 birds and brodifacoum in one. None contained residues of the most recently introduced compound, flocoumafen. Of the 28 contaminated birds, eight contained residues high enough to have killed them (two with difenacoum at 0.16 (Kent), 0.21 (Norfolk), and six with bromadiolone at 0.37 (Norfolk), 0.61 (Oxon), 0.55 (Essex), 0.12 (Wilts), 0.63 (Isle of Man) and 0.37 (Oxon). However, not all the owls with residues in the lethal range necessarily died of rodenticide poisoning (see below).

In terms of the proportion of birds in which residues were detected, the findings from 1994 were similar to those in 1990-93. In this period, 32% of the 351 owls examined contained detectable residues of one or more chemicals (Table 11). An increase in the proportion of contaminated birds through the 1980s would have been expected, as the sales of these various chemicals increased. Although our findings do suggest an upward trend over this period, interpretation is complicated by a change to more sensitive analytical equipment in 1990 (see report for 1991 (dated 1992). This means that extremely low residue levels may have been missed before 1990, compared with 1990-94. None-the-less, the fact that rodenticides were detected in about one third of all barn owls received in 1990-94 indicates how widespread the exposure to these chemicals now is.

Over the 1990-94 period, difenacoum was found in 70 (20%) birds, bromadiolone in 48 (14%), brodifacoum in 13 (4%) and flocoumafen in 6 (2%). Interestingly, these figures closely matched the usage frequency of the four chemicals on British farms (Table 11), as revealed by a survey in 1988-89 by the Ministry of Agriculture, Fisheries and Food (Olney *et al.* 1991a, 1991b). This survey was based on questionnaires sent to a large sample of farms throughout England and Wales, asking for details of the types of rodenticides used. It seems, therefore, that barn owls accumulated a more or less representative cross-section of the second generation rodenticides in use.

Difenacoum was found in liver at concentrations of 0.002-0.135 $\mu g\ g^{-1}$ (mean 0.029 $\mu g\ g^{-1}$), bromadiolone at 0.004-0.319 $\mu g\ g^{-1}$ (mean 0.099 $\mu g\ g^{-1}$), brodifacoum at 0.002-0.515 $\mu g\ g^{-1}$ (mean 0.109 $\mu g\ g^{-1}$), and flocoumafen at 0.003-0.144 $\mu g\ g^{-1}$ (mean 0.045 $\mu g\ g^{-1}$). The frequency distributions of different residue levels among contaminated owls are summarised in Table 12. The majority of birds in which residues were detected contained less than 0.1 mg $kg^{-1}$. Because of the likely chemical persistence in the liver of contaminated birds, these owls could have been exposed for up to several months previously or on more than one occasion.

Of the five birds diagnosed on autopsy as likely rodenticide victims, analytical results were not always conclusive. One bird contained 0.437 mg $kg^{-1}$ brodifacoum in its liver (within the lethal range); another contained 0.002 mg $kg^{-1}$ flocoumafen; a third contained 0.068 mg $kg^{-1}$ difenacoum and 1.720 mg $kg^{-1}$ bromadiolone; while two others contained 1.066 and 0.332 mg $kg^{-1}$ bromadiolone. All these birds had extensive internal haemorrhaging of heart, lungs, liver, brain and subcutaneous areas which were not associated with any impact and no other cause of death was apparent. Other birds had residues exceeding 0.2 mg $kg^{-1}$, but were known to have died of other causes, namely accidents of some form (9 birds) or starvation (8 birds).

## 8.3 Discussion

About 111 (32%) of the 351 barn owls examined in 1990-94 had residues of one or more rodenticide in their bodies, but this sample may not reflect the true exposure of owls to rodenticides in the regions concerned. Almost certainly the owls in our sample did not form a representative cross-section of barn owl deaths. They were probably biased towards those forms of mortality most associated with people, accounting for the high proportion of accident victims. On the other hand, the sample may have under-estimated the proportion of deaths due to rodenticides because, some hours before death, affected animals become lethargic. Any affected owls are therefore likely to die on their roost sites, in tree holes or roof cavities, where they are less likely to be found by the casual observer than are birds that die in the open. This statement is entirely conjectural, however, and as yet there is no evidence one way or the other.

Despite any possible bias in the sampling procedure, it is clear that contamination of barn owls with second generation rodenticides is now widespread. Contaminated specimens came from all major regions of Britain, and were not restricted to the warfarin-resistance areas, as depicted by Shawyer (1987). Nevertheless, the residues in most specimens were well below lethal levels, and less than 2% of all owls examined appeared from their symptoms to have died directly from rodenticide poisoning. As some owls which died of other causes had rodenticide levels within the known lethal range (above 0.2 $\mu g\ g^{-1}$), rodenticide may have pre-disposed their deaths or reduced the chance of recovery from accidents. Alternatively if they had not died of some other cause, they may have later succumbed to rodenticide. Either way, the likely maximum proportion of deaths to rodenticide is still small (at most 2% of all specimens). As yet, therefore, we have no evidence that second-generation rodenticides contribute appreciably to the overall mortality in British barn owls, and hence no evidence that they are affecting population levels.

## 8.4 References


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**Table 10. Levels of rodenticides (ppm in wet weight) in the livers of Barn Owls *(Tyto alba)* received in 1994.**

ND=none detected; J=juvenile in first year; A=adult other than first year; M=male; F=female; brod=brodifacoum; difen=difenacoum; brom=bromadialone; floc=flocoumafen; D & G=Dumfries & Galloway; H & W=Hereford & Worcester.

| Specimen No. | Date | County | Age | Sex | brod | difen | brom | floc |
|---|---|---|---|---|---|---|---|---|
| 11373 | Aug 92 | Strathclyde | J | M | ND | ND | ND | ND |
| 11374 | Oct 92 | Strathclyde | A | F | ND | ND | ND | ND |
| 11403 | Dec 92 | Powys | J | F | ND | ND | ND | ND |
| 11460 | Apr 93 | Norfolk | J | M | ND | ND | ND | ND |
| 11332 | Jul 93 | Highland | J | M | ND | ND | ND | ND |
| 11336 | Aug 93 | Lincs | J | M | ND | ND | ND | ND |
| 11459 | Aug 93 | Norfolk | J | M | ND | ND | 0.373 | ND |
| 11333 | Sep 93 | Highland | J | F | ND | ND | ND | ND |
| 11461 | Sep 93 | Norfolk | J | F | ND | ND | ND | ND |
| 11326 | Oct 93 | Cheshire | - | - | ND | ND | ND | ND |
| 11327 | Oct 93 | Borders | J | F | ND | ND | ND | ND |
| 11342 | Oct 93 | Norfolk | J | F | ND | ND | ND | ND |
| 11346 | Oct 93 | Norfolk | J | F | ND | ND | ND | ND |
| 11347 | Oct 93 | H & W | J | M | ND | ND | ND | ND |
| 11353 | Oct 93 | Sussex | J | F | ND | ND | ND | ND |
| 11375 | Oct 93 | Strathclyde | A | F | ND | ND | 0.020 | ND |
| 11386 | Oct 93 | Dyfed | J | F | ND | ND | ND | ND |
| 11401 | Oct 93 | Clwyd | J | M | ND | ND | ND | ND |
| 11357 | Nov 93 | Kent | J | F | ND | ND | ND | ND |
| 11365 | Nov 93 | Dyfed | J | M | ND | ND | ND | ND |
| 11366 | Nov 93 | Powys | J | F | ND | ND | ND | ND |
| 11380 | Nov 93 | Lincs | J | F | ND | ND | 0.017 | ND |
| 11382 | Nov 93 | Kent | J | F | ND | 0.015 | ND | ND |
| 11383 | Nov 93 | Essex | J | M | ND | ND | ND | ND |
| 11390 | Nov 93 | Kent | J | F | ND | 0.160 | 0.039 | ND |
| 11391 | Nov 93 | Northants | J | M | ND | ND | ND | ND |
| 11392 | Nov 93 | Highland | J | M | ND | 0.056 | ND | ND |
| 11396 | Nov 93 | Wiltshire | J | - | ND | ND | ND | ND |
| 11398 | Nov 93 | Powys | J | F | ND | ND | ND | ND |
| 11413 | Nov 93 | - | J | F | ND | ND | ND | ND |
| 11415 | Nov 93 | Wilts | J | M | ND | ND | ND | ND |
| 11462 | Nov 93 | Norfolk | J | F | ND | ND | ND | ND |
| 11463 | Nov 93 | Norfolk | J | M | ND | ND | ND | ND |

| Specimen No. | Date | County | Age | Sex | brod | difen | brom | floc |
|---|---|---|---|---|---|---|---|---|
| 11642 | Nov 93 | Oxfordshire | J | F | ND | 0.019 | ND | ND |
| 11409 | Dec 93 | Lothian | A | M | ND | ND | ND | ND |
| 11410 | Dec 93 | Gtr Manchester | J | M | ND | ND | 0.091 | ND |
| 11411 | Dec 93 | Somerset | - | - | ND | ND | ND | ND |
| 11423 | Dec 93 | Powys | J | M | ND | ND | ND | ND |
| 11645 | Dec 93 | Oxfordshire | A | M | ND | ND | ND | ND |
| 11437 | Jan 94 | D & G | J | F | ND | ND | ND | ND |
| 11439 | Jan 94 | Anglesey | J | M | ND | ND | ND | ND |
| 11446 | Jan 94 | Hants | J | M | ND | 0.025 | ND | ND |
| 11448 | Jan 94 | Anglesey | A | F | ND | 0.029 | ND | ND |
| 11472 | Jan 94 | Lincs | J | F | ND | ND | ND | ND |
| 11449 | Feb 94 | Warwicks | J | F | ND | 0.011 | ND | ND |
| 11451 | Feb 94 | Oxon | J | F | ND | ND | ND | ND |
| 11456 | Feb 94 | Strathclyde | J | M | ND | ND | ND | ND |
| 11464 | Feb 94 | Worcs | A | F | ND | 0.019 | ND | ND |
| 11475 | Feb 94 | Yorks | J | F | ND | ND | ND | ND |
| 11484 | Feb 94 | Wilts | A | F | ND | ND | ND | ND |
| 11494 | Feb 94 | Cornwall | A | F | ND | ND | ND | ND |
| 11646 | Feb 94 | Oxfordshire | J | M | ND | 0.012 | ND | ND |
| 11487 | Mar 94 | Powys | A | F | ND | ND | ND | ND |
| 11491 | Mar 94 | Highland | J | M | ND | ND | 0.098 | ND |
| 11493 | Mar 94 | Notts | J | M | ND | ND | ND | ND |
| 11496 | Mar 94 | Isle of Man | J | F | ND | ND | ND | ND |
| 11509 | Mar 94 | Lincs | A | F | ND | ND | ND | ND |
| 11510 | Mar 94 | Lincs | J | M | ND | ND | ND | ND |
| 11512 | Mar 94 | Oxon | A | F | 0.024 | ND | 0.614 | ND |
| 11515 | Mar 94 | Warwicks | A | F | ND | ND | ND | ND |
| 11518 | Mar 94 | Glos | J | F | ND | ND | ND | ND |
| 11643 | Mar 94 | Oxfordshire | J | F | ND | 0.025 | ND | ND |
| 11523 | Apr 94 | Cheshire | J | F | ND | ND | ND | ND |
| 11533 | Apr 94 | Lincolnshire | - | - | ND | ND | 0.045 | ND |
| 11534 | Apr 94 | Worcestershire | - | - | ND | 0.026 | ND | ND |
| 11539 | Apr 94 | Herefordshire | - | - | ND | ND | ND | ND |
| 11546 | Apr 94 | Essex | J | M | ND | 0.007 | 0.550 | ND |
| 11548 | Apr 94 | Anglesey | J | F | ND | ND | ND | ND |
| 11558 | May 94 | Devon | J | M | ND | ND | ND | ND |
| 11564 | May 94 | Wiltshire | J | M | ND | 0.006 | 0.118 | ND |
| 11586 | Jun 94 | Wiltshire | J | M | ND | ND | ND | ND |
| 11618 | Aug 94 | Grampian | J | M | ND | ND | ND | ND |
| 11632 | Aug 94 | Hampshire | J | F | ND | ND | ND | ND |

| Specimen No. | Date | County | Age | Sex | brod | difen | brom | floc |
|---|---|---|---|---|---|---|---|---|
| 11638 | Sep 94 | Suffolk | J | M | ND | ND | ND | ND |
| 11639 | Sep 94 | W. Midlands | J | F | ND | 0.052 | ND | ND |
| 11641 | Sep 94 | Oxfordshire | J | M | ND | ND | ND | ND |
| 11644 | Sep 94 | Oxfordshire | J | F | ND | ND | ND | ND |
| 11654 | Oct 94 | Isle of Man | J | M | ND | ND | 0.628 | ND |
| 11661 | Oct 94 | Lancashire | J | F | ND | 0.045 | ND | ND |
| 11674 | Nov 94 | Oxfordshire | J | F | ND | ND | ND | ND |
| 11675 | Nov 94 | Beds | J | M | ND | ND | ND | ND |
| 11676 | Nov 94 | Cambs | J | F | ND | 0.007 | ND | ND |
| 11677 | Nov 94 | Channel Islands | - | - | ND | ND | ND | ND |
| 11678 | Nov 94 | Channel Islands | - | - | ND | ND | 0.079 | ND |
| 11679 | Nov 94 | Oxfordshire | J | M | ND | ND | ND | ND |
| 11686 | Nov 94 | Lincs | J | F | ND | 0.024 | 0.028 | ND |
| 11692 | Nov 94 | Lincs | J | M | ND | ND | ND | ND |
| 11695 | Nov 94 | Wilts | J | F | ND | ND | ND | ND |
| 11703 | Nov 94 | Dyfed | J | F | ND | ND | ND | ND |
| 11704 | Dec 94 | Norfolk | J | F | ND | 0.212 | ND | ND |
| 11707 | Dec 94 | Strathclyde | A | M | ND | ND | ND | ND |
| 11712 | Dec 94 | Wilts | J | M | ND | ND | ND | ND |
| 11714 | Dec 94 | Oxfordshire | J | M | ND | ND | 0.369 | ND |
| 11721 | Dec 94 | Gwynedd | J | M | ND | ND | ND | ND |
| 11722 | Dec 94 | Gwynedd | J | M | ND | ND | ND | ND |

Table 11. Incidence of rodenticide residues in Barn Owls in relation to usage on farms.

| | Number sampled | Number of occurrences of second generation rodenticides | Number (%) with: | | | |
|---|---|---|---|---|---|---|
| | | | Difenacoum | Bromadiolone | Brodifacoum | Flocoumafen |
| Barn Owls | 353 | 137 | 70 (62%) | 48 (42%) | 13 (12%) | 6 (5%) |
| Farms growing* arable crops 1988 | 565 | 431 | 269 (62%) | 138 (32%) | 22 (5%) | 2(0.5%) |
| Farms growing grass* and fodder crops | 459 | 404 | 217 (54%) | 151 (37%) | 30 (7%) | 6 (1.5%) |

*From Olney *et al*. 1991a, 1991b.

**Table 12.** **Frequency of Barn Owl contamination by second generation rodenticides at different levels.**

| Liver Residue range mg $kg^{-1}$ | Number of owls containing residues of: | | | |
|---|---|---|---|---|
| | Difenacoum | Bromadiolone | Brodifacoum | Flocoumafen |
| 0.001 - 0.009 | 18 | 1 | 4 | 2 |
| 0.01 - 0.099 | 45 | 20 | 6 | 3 |
| 0.1 - 0.999 | 7 | 25 | 3 | 1 |
| > 1.0 | 0 | 2 | 0 | 0 |

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# WILDLIFE AND POLLUTION

## Part 9 Incident investigations during 1994

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July 1995

# 9 INCIDENTS INVESTIGATED DURING 1994-95

## 9.1 Introduction

Two small wildlife incidents were investigated during the reporting year, the first involving swans from Kent and the second involving moorhens from Cambridgeshire.

## 9.2 Kent swan mortalities

During late November / early December 1994, two mute swan (*Cygnus olor*) carcasses were found in the River Stour by the NRA. The carcasses were of a juvenile and an adult. The adult carcass was too decayed for detailed examination, although some sub-cutaneous fat was present. The juvenile carcass had no signs of injury or damage. There was some subcutaneous fat present, with abundant mantle fat. Haemorrhaging around the liver was evident. Livers from both carcasses were analysed for the presence of heavy metals, organochlorine insecticides and PCBs. The kidneys were also analysed for the presence of heavy metals.

Organochlorines were present in trace amounts far too low to have caused death (Table 13). Heavy metal concentrations were not quantified, although the ICP-MS scan suggested that they were not present at levels thought to exert toxic effects. The cause of the deaths was therefore unknown.

## 9.3 Cambridgeshire moorhen mortalities

During December 1994, three moorhens (*Gallinula chloropus*) were found dead in the same locality, near Huntingdon. Two carcasses were received at Monks Wood. They appeared to be in good condition, with abundant sub-cutaneous and depositional fat. The only abnormality evident was haemorrhaging around the liver of one individual. Livers from both carcasses were analysed for the presence of heavy metals, rodenticides, organochlorine insecticides and PCBs. Fat samples were analysed for organochlorine insecticides and PCBs.

Heavy metal concentrations were not quantified, although the ICP-MS scan suggested that they were not present at levels thought to exert toxic effects.

The rodenticides bromadiolone, difenacoum, flocoumafen and brodifacoum were not detected, and organochlorine levels were too low to suggest death by organochlorine poisoning (Table 13). The cause of death therefore remains unknown.

**Table 13.** Levels of organochlorine compounds (mg/kg wet weight) in livers and subcutaneous fat from birds received as part of wildlife incident investigations. Data are expressed as ranges. PCB-MAT is the total PCB expressed using only the peaks corresponding to those found in Aroclor 1254. PCB-TOT is the total PCB expressed using all the peaks found in the GC trace in the region in which PCB congeners normally occur. HCH refers to hexachlorocyclohexane.

| Area | Species | Numbers | Tissue | HCB | α-HCH | γ-HCH | DDE | HEOD | TDE | DDT | PCB-MAT | PCB-TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kent | mute swan | 2 | liver | <0.003 | <0.003 | <0.002- 0.002 | 0.002 - 0.004 | 0.023 - 0.026 | <0.004 | <0.004 | <0.02 | 0.102 - 0.119 |
| Cambridgeshire | moorhen | 2 | liver | <0.003 | <0.003 | <0.002 - 0.014 | 0.101 - 0.170 | 0.023 - 0.029 | 0.014 - 0.028 | <0.004 | <0.02 | 0.031 - 0.172 |
| Cambridgeshire | moorhen | 2 | fat | <0.003 | <0.003 | <0.002- 0.016 | 0.175 - 0.229 | 0.114 - 0.193 | <0.004 | <0.004 | <0.02 | 2.121 - 2.678 |

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