Pesticides 2000:

a summary of monitoring of the aquatic environment in England and Wales

ENVIRONMENT AGENCY

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National Centre for Ecotoxicology and Hazardous Substances

This is the seventh in a series of reports on monitoring pesticides in the aquatic environment produced by the Environment Agency at the National Centre for Ecotoxicology and Hazardous Substances (NCEHS).

The NCEHS is one of a number of specialist centres created by the Environment Agency. Its purpose is to provide scientific expertise and strategic direction in respect of chemicals in the environment. The centre is based at Wallingford in Oxfordshire, and it also has a laboratory at Waterlooville near Portsmouth (accredited by the UK Accreditation Service).

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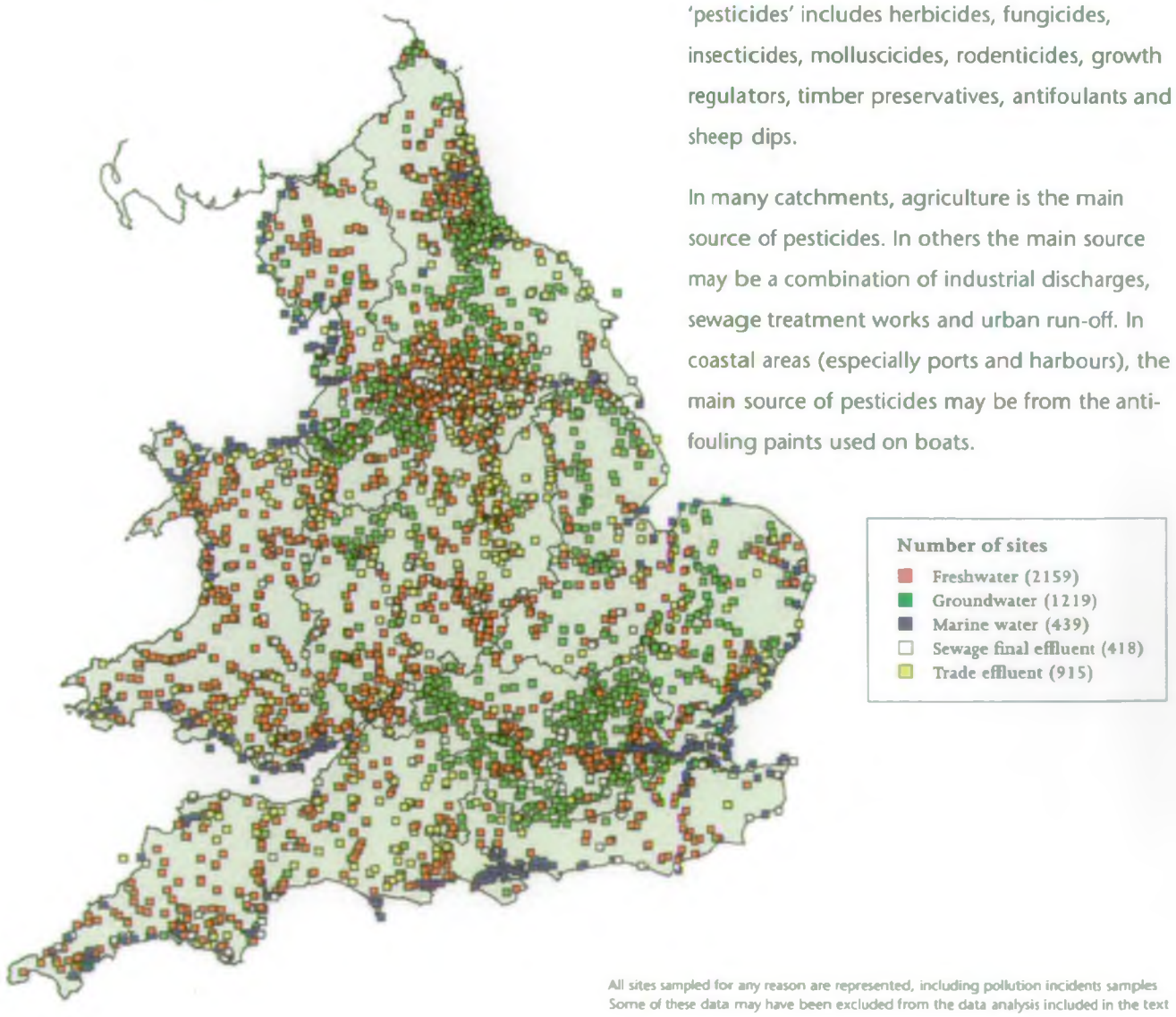
The Environment Agency's pesticide monitoring programme

Purpose of the report

The Agency is aiming to reduce the impacts of pesticides on the environment. This report summarises the 1999 and 2000 Environment Agency data for pesticide monitoring of environmental waters in England and Wales. The report informs users, manufacturers, the Government and the public about our main pesticide concerns in the aquatic environment, and how they are changing. The information also helps the Agency to target its activities on pesticides including work in the following areas: product approvals, the Government's pesticides policy, the Crop Protection Association's voluntary programme, sheep dips and the textile industry and Research and Development.

Introduction

Figure 1.
Pesticide monitoring points in 2000



All sites sampled for any reason are represented, including pollution incidents samples
Some of these data may have been excluded from the data analysis included in the text

Pesticides in environmental waters come from a number of point and diffuse sources. The term 'pesticides' includes herbicides, fungicides, insecticides, molluscicides, rodenticides, growth regulators, timber preservatives, antifoulants and sheep dips.

In many catchments, agriculture is the main source of pesticides. In others the main source may be a combination of industrial discharges, sewage treatment works and urban run-off. In coastal areas (especially ports and harbours), the main source of pesticides may be from the anti-fouling paints used on boats.

The Agency monitors pesticide levels in environmental waters for statutory and non-statutory purposes, both routinely and on a targeted basis. We take samples from a range of sources, including surface freshwaters, groundwaters, marine waters, trade effluents and discharges from sewage treatment works (**Figure 1**). We do not necessarily analyse the same pesticides at a particular point each time, but we usually analyse a sample for several pesticides.

The Agency analyses some 180 different pesticides (including metabolites and isomers) and visits over 3,000 locations to take samples, at a frequency of either 4 or 12 times a year. A total of almost 400,000 determinations are made each year; **Figures 2 and 3** show the percentage of monitoring sites visited and the percentage analyses made by sample type in 2000, respectively. The range of analyses made at a particular monitoring point depends on the reason for monitoring; only a limited range is undertaken at many sites.

The amount of groundwater monitoring increased significantly in 2000, with more than double the number of analyses performed in 1999 and at approximately 300 more sites. This is part of a six-year programme by the Agency to extend its groundwater monitoring network to cover the whole of England and Wales.

Figure 2. Percentage of monitoring sites by sample type 2000

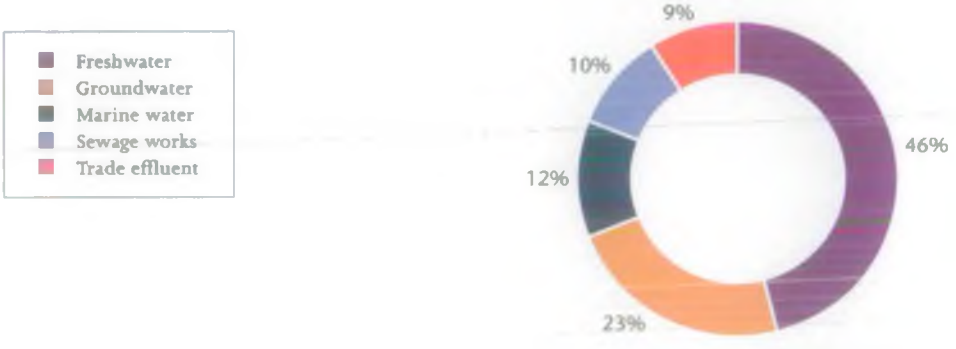
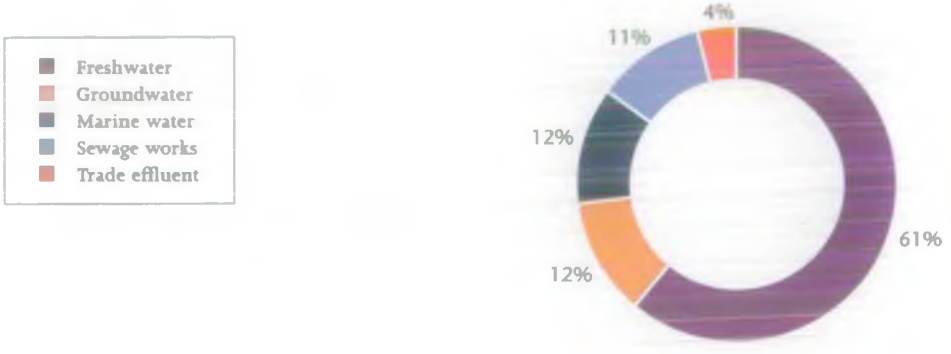


Figure 3. Percentage of analyses by sample type 2000



Where possible, monitoring data for a particular pesticide are compared with its Environmental Quality Standard (EQS). This is the concentration of an individual substance which should not be exceeded in the aquatic environment and is set according to either a Maximum Allowable Concentration (MAC) or an Annual Average (AA) concentration. EQSs are set for both surface freshwater and marine waters. There are no groundwater EQS values. Pesticide monitoring undertaken during pollution incidents is excluded from EQS analyses. These data are assessed separately.

Monitoring data are also compared with the 0.1 µg/litre pesticide standard in the EC Drinking Water Directive. This is done to provide an indication of those pesticides likely to require action or treatment in order to comply with this Directive. This report deals only with environmental waters and not drinking waters, but comparing the data with the drinking water standard is a useful way of looking at trends in water contamination. Historically contaminated sites are excluded from this analysis to enable background levels from current pesticide use at diffuse or point sources to be examined. Such sites are mainly contaminated landfill/waste disposal sites and former pesticide manufacturing/chemical plants. In some cases, high levels of pesticides are leaching from these sites and the data are not representative of inputs arising from current pesticide use. Data from monitoring sites that include releases from current pesticide manufacture are included in the comparison.

Various factors can affect the occurrence and levels of pesticides detected in different years. For pesticides used predominantly in agriculture, the amounts used, annual changes in cropping patterns, the timing of applications and the weather all have an effect. Pesticides for home, garden and amenity use are detected around the times of year they are used. Point source inputs such as sewage treatment works and industrial discharges can contribute to the pesticide load throughout the year.

Pesticides in surface freshwaters

Figure 4 shows freshwater sites that failed to comply with a pesticide EQS in 2000. Nine per cent of freshwater sites monitored (137 out of 1,456) and 29 pesticides failed their EQS at least once. This compared with 164 sites out of 1,586 (10 per cent) in 1999 (30 pesticides) and 223 sites out of 1,461 (14 per cent) in 1998 (32 pesticides). These data suggest that there may be a downward trend in the number of EQS failures. However, because different sites are monitored each year and the intensity of monitoring also varies, it is not possible to confirm this apparent trend statistically. The majority of EQS failures are caused by sheep dip chemicals such as cypermethrin and diazinon from dipping activities (mostly Wales and the North East) and through discharges from wool and textile processing industries (Yorkshire and the Midlands). Sheep dip pollution is discussed in more detail later.

Another major cause of EQS failures in the past has been mothproofers such as permethrin and cyfluthrin from the carpet industry. There was a significant reduction in the number of EQS failures in 1999 and 2000 from this source (a total of 158 EQS failures in 1998 down to 27 in 1999, and 20 in 2000). This trend is probably due to reduced levels of these chemicals in effluents as a result of the use of improved application technologies by the industry.

Figure 4. Freshwater sites failing pesticides EQSs in 2000

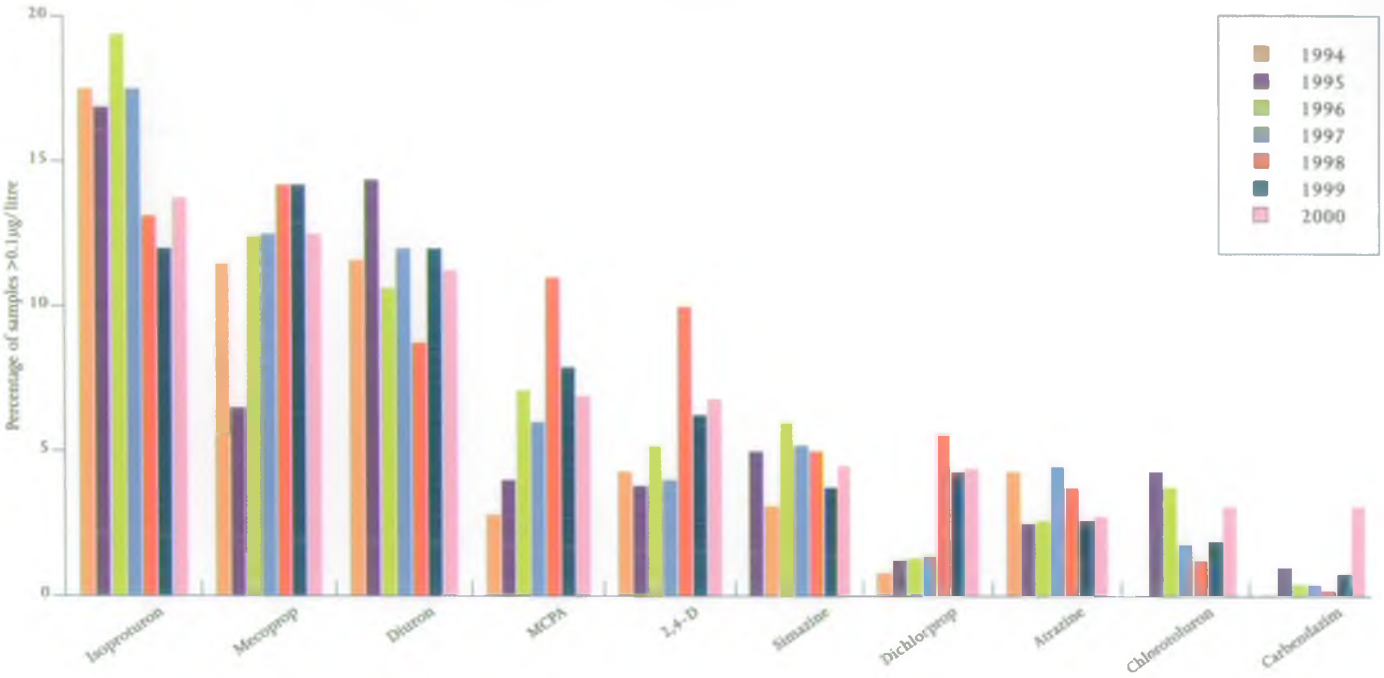
Samples <minimum reporting value (MRV) treated as zero
Sites with fewer than four samples excluded from annual mean concentration calculations
Samples recorded as pollution incidents excluded
Sites failing more than once for a single pesticide are counted as one failure

In surface freshwaters, 408 sites out of 1,407 monitored (29 per cent) were found to have at least one pesticide present at above 0.1 µg/litre on at least one sampling occasion. **Figure 5** shows the 10 most frequently occurring pesticides at levels > 0.1 µg/litre in surface waters. Many of these are solely or mainly used as agricultural pesticides.

In 2000, isoproturon (IPU) was found most frequently, with nearly 14 per cent of samples containing >0.1 µg/litre. Isoproturon is a widely used cereal herbicide and has been one of the most frequently detected pesticides in freshwater for many years. The long-running stewardship campaign that aims to educate farmers about good practice appears to have had some success in reducing levels from those found in 1994–1997, but the levels are still high and of concern.

Other major contaminants of surface freshwaters are mecoprop, diuron, MCPA, 2,4-D and simazine. Mecoprop is used as an agricultural and amenity herbicide, but also has significant home and garden use. Diuron levels in 1998 seemed to have decreased from previous years, but levels in 1999 and 2000 are similar to those pre-1998. This is disappointing since there is an agreement with Railtrack, one of the major users of diuron, not to use it in particularly sensitive areas. The diuron stewardship scheme set up to encourage best practice by amenity users has also been running for some time.

Figure 5. Trends in the pesticides occurring most frequently in freshwaters 1994-2000



NB Excludes pesticides with less than 500 analyses performed per year.

Pesticides in marine waters and groundwaters

The Agency's programme for monitoring pesticides in marine waters and groundwaters is much smaller than that of surface freshwaters as pesticides usually occur to a lesser extent in these waters.

MARINE WATERS

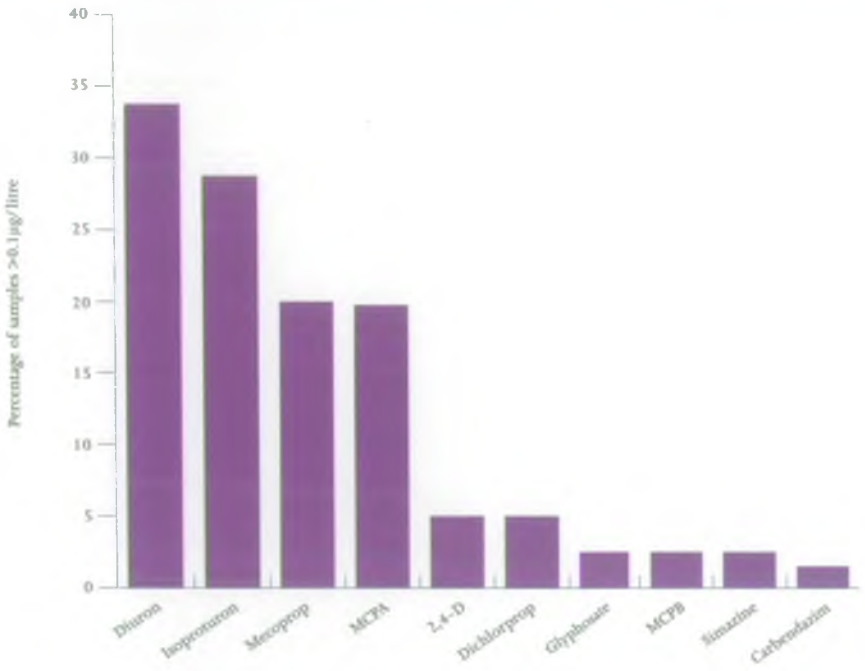
In 2000, 402 marine and estuarine sites were monitored and 108 of these (29 per cent) failed an EQS for at least one pesticide (**Figure 6**). In 1999, 502 sites were monitored and 124 sites failed an EQS (25 per cent). In 1998, 157 out of 467 sites (34 per cent) failed an EQS for at least one pesticide. The most significant pesticide issue for marine waters is tributyl tin (TBT), which is used as an anti-fouling treatment for boats. In 2000, there were 106 TBT failures, in 1999 there were 118 and, in 1998, 134 failures. Most of these failures were concentrated around estuaries and ports such as the Tyne, the Humber, the Mersey, the Thames, Falmouth and Southampton Water.

Figure 6. Estuarine and marine water sites failing pesticide EQSs in 2000

Because of its severe ecological impact in estuarine and marine areas, TBT has been banned since 1987 from use on vessels less than 25 metres in length. In many areas with high densities of small craft, there has been a significant biological improvement. The International Maritime Organisation (IMO) has agreed a global ban on TBT application on boats from 2003, and a ban on TBT being present as an antifoulant on any boat from 2008.

In 2000, the Agency carried out monitoring for 107 pesticides in marine waters; only 19 were found at above 0.1 µg/litre in at least one analysis. Many of the same pesticides found in freshwater were detected in marine waters (**Figure 7**). Diuron, isoproturon and mecoprop were found most frequently. Most of the monitoring for diuron in 2000 took place in the Thames, the Tees, the Tyne and the Wear – all areas with traditionally high shipping activity. There has been concern about the use of diuron both as an anti-fouling treatment and for land-based applications. A recent review of all anti-fouling treatments by the Advisory Committee on Pesticides (ACP) resulted in the withdrawal of diuron as an anti-fouling treatment.

Figure 7. Percentage of estuarine and marine analyses > 0.1 µg/litre in 2000



GROUNDWATER

In 2000, 147 pesticides were monitored in groundwater. Only 24 of these were found at levels >0.1 µg/litre in at least one analysis. Of the 667 groundwater sites monitored, 78 of these had at least one pesticide present at >0.1 µg/litre. **Figure 8** shows the 10 most frequently detected pesticides in groundwater at >0.1 µg/litre.

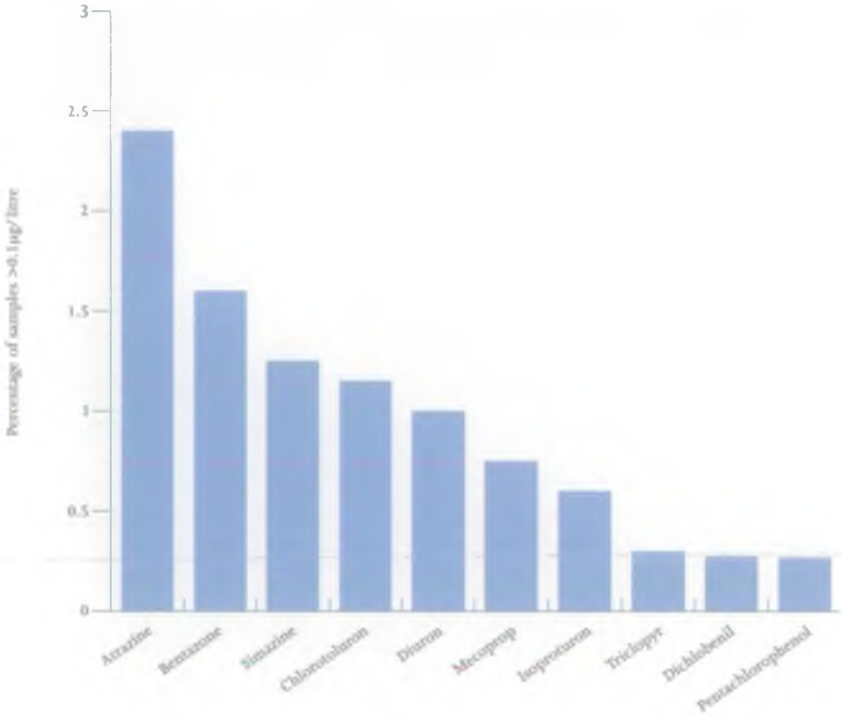
The most frequently found pesticide in 2000 was atrazine, probably due to its historical use as a herbicide for total vegetation control in non-crop areas. However, the frequency of exceedences of 0.1 µg/litre has decreased markedly from approximately 11 per cent in 1998 to 4 per cent in 1999 and less than 3 per cent in 2000. This significant decrease is believed to be partly due to the ban on atrazine for non-agricultural use in 1992. Although these atrazine data are encouraging, they demonstrate that once pesticides contaminate groundwater they will be present for many years.

The data presented excludes pesticides where less than 200 samples were taken. However, small groundwater surveys have flagged up some specific concerns. For example, monitoring for metazachlor (a herbicide used on field crops, in nurseries and in forestry) at a site in Wales revealed a significant percentage of samples exceeding 0.1 µg/litre; further investigations are being carried out.

In addition, a historically contaminated landfill site in the Agency's Anglian Region was excluded from the national analysis. This landfill is situated to the north of Peterborough, where high and variable concentrations of mecoprop occur in the Lincolnshire limestone aquifer. The concentrations detected in the aquifer range from <1 µg/litre to >1,000 µg/litre. The source of the contamination has been investigated and found to be a series of old landfill sites. We have developed and implemented an interim management plan, and remediation work at the site is ongoing.

Figure 8. Percentage of groundwater analyses > 0.1 µg/litre in 2000

NB Excludes pesticides with less than 200 analyses performed per year.



Pesticide pollution incidents

Many pesticides are toxic to aquatic life and can have devastating effects on rivers if spilt, used carelessly or disposed of inappropriately. Analysis of reported pollution incidents helps the Agency to:

- identify the main sources and causes of pesticide pollution
- develop its pesticide policy
- target its pollution prevention activities effectively.

Pollution incidents are generally reported by members of the public or the emergency services. In particular, the fire service notifies the Agency of incidents such as major fires and road traffic accidents that may require advice on the containment and disposal of spilt chemicals. Because the

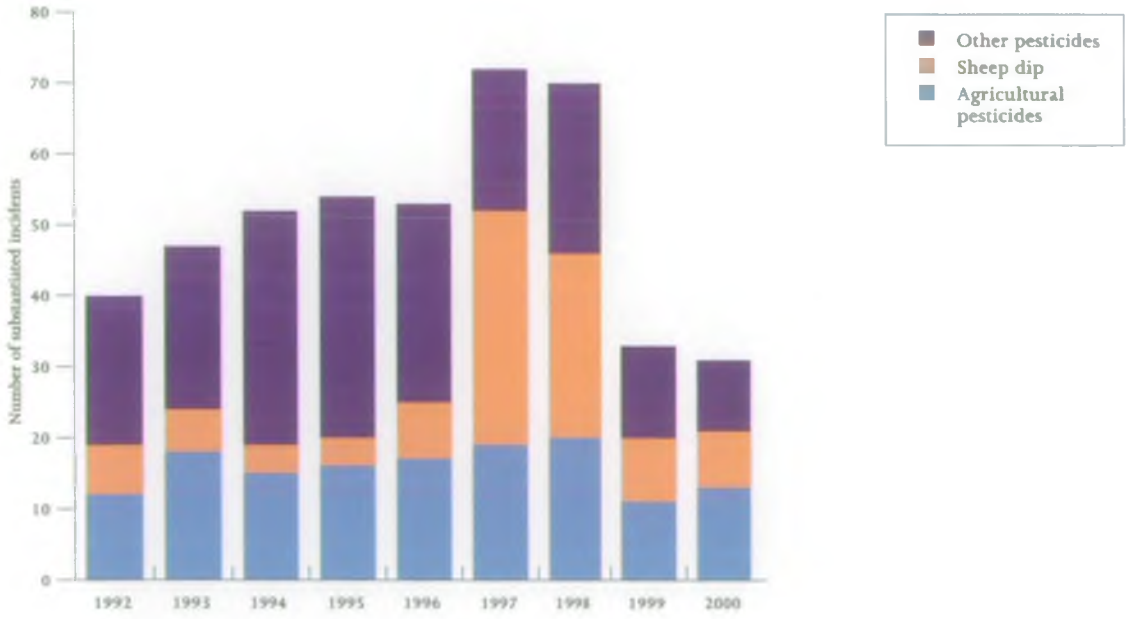
Agency largely relies on members of the public reporting incidents, it is generally the most visible ones that are reported such as those caused by oil, sewage, silt and dyes. If there is no visible pollutant or no fish are killed, the incident is likely to go unnoticed and unreported. This is especially true for pesticides where there is often no visible sign of pollution. Therefore, the incidents covered by this report are likely to represent only a fraction of actual pesticide pollution incidents.

Incidents investigated by the Agency are recorded and classified using the Agency's Common Incident Classification System (CICS). This takes account of their severity and the level of resources used by the Agency to manage the incident. The categories for environmental impact of a pollution incident range from category 1 (major pollution incident) through to category 3 (minor incident with limited impact). When an incident has occurred but there is no apparent environmental impact, it is classified as category 4.

The Agency changed its system of classifying and recording pollution incidents in 1999. This means that pollution incident data from before 1999 are not directly comparable with those for 1999 and 2000.

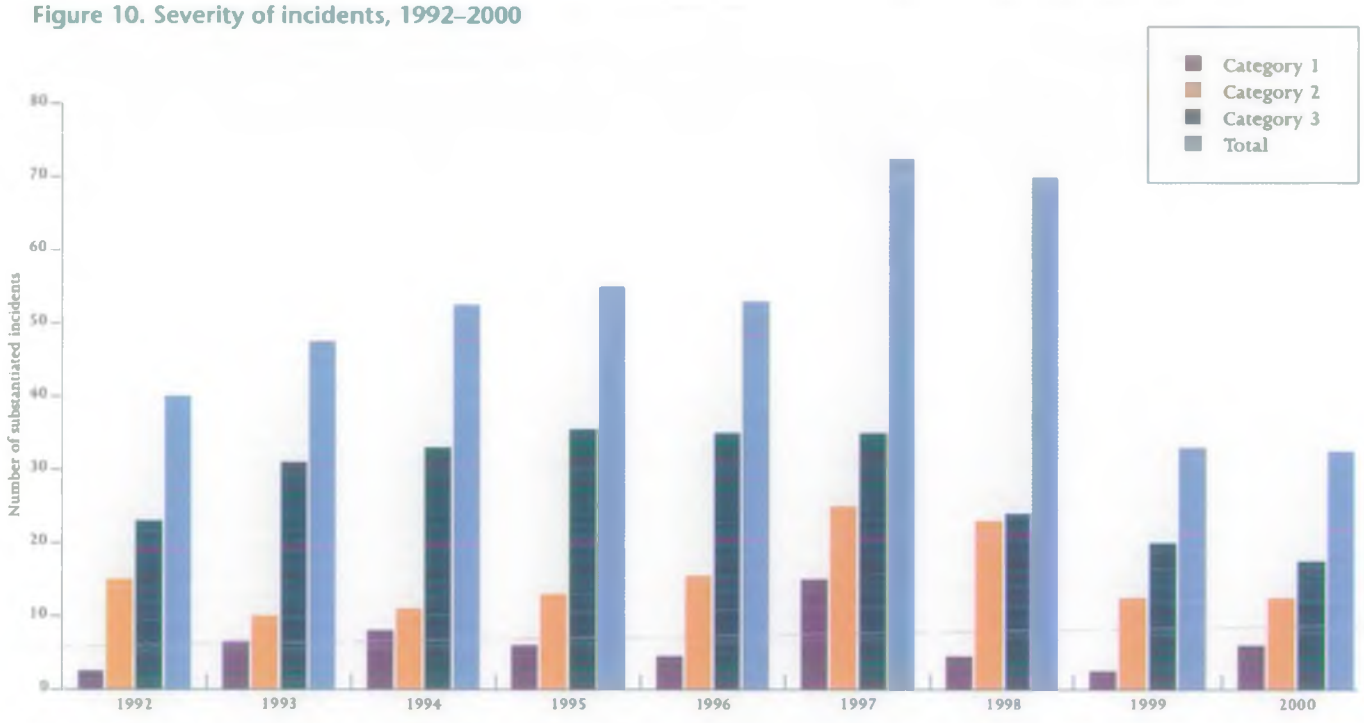
The number of substantiated pesticide pollution incidents reported to the Agency for the years between 1992 and 2000 is shown in **Figure 9.** In 2000, 32 pesticide pollution incidents were reported. This is similar to 1999, when 33 pesticide pollution incidents were reported. These figures represent a significant reduction in reported pesticide pollution incidents compared with previous years. This decrease may be partly due to increased awareness of the risks associated with using pesticides, particularly Sheep dip, brought about by the Agency's pollution prevention campaigns.

Figure 9. Aquatic pesticide pollution incidents reported to the Agency 1992–2000



In 2000, 5 pesticide pollution incidents (15 per cent) were classified as category 1, 11 incidents (34 per cent) were category 2 and 16 incidents (50 percent) were category 3. Overall, the number of minor pesticide pollution incidents reported to the Agency in 1999 and 2000 was significantly less than in previous years **(Figure 10)**. The decrease in the total number of pesticide pollution incidents reported to the Agency in 1999 and 2000 reflects the decrease in the number of category 3 incidents. Five prosecutions have been brought for incidents that occurred in 2000 and investigations are ongoing for a further incident.

Figure 10. Severity of incidents, 1992–2000



Monitoring of plant protection products

Pesticides that are used or have been used as plant protection products (PPPs) dominate the Agency's pesticide monitoring programme. These include insecticides, fungicides, herbicides and plant growth regulators used on agricultural or horticultural crops and those with amenity, home and garden uses. Potential sources of contamination include:

- spray drift onto watercourses during application
- run-off from fields and hard surfaces
- leaching into groundwater
- poor disposal practice
- spillages during mixing and handling
- losses from washdown areas.

Plant protection products are responsible for much of the pesticide contamination in surface freshwaters and groundwaters. Over 30 of the 50 pesticides found most frequently above

0.1 µg/litre in surface freshwaters in 2000 were PPPs; in addition, 9 out of the top 10 pesticides were PPPs. These PPPs are mostly herbicides, which tend to be applied in large quantities and at particularly sensitive times of the year.

Of particular note are MCPA, dichlorprop and 2,4-D. The number of exceedences of 0.1 µg/litre of these three pesticide actives increased significantly in 1998. This trend was not repeated in 1999 and 2000, but levels were still higher than in the years before 1998. These pesticides are used in many home and garden products. Further investigation is necessary to determine the reasons for the increased levels.

In 2000, carbendazim was the tenth most frequently found pesticide at > 0.1 µg/litre. Carbendazim is a cereal and field crop fungicide found in a variety of different products, formulated with various other pesticides. Only a few exceedences of 0.1 µg/litre were previously detected, but the number increased to 2.5 per cent (23 samples) in 2000. The vast majority of these occurred in the Thames Region, but the reason for these exceedences is unknown.

Figure 11. Sites failing EQSs for plant protection products in 2000

Samples <minimum reporting value (MRV) treated as zero
Sites with fewer than four samples excluded from annual mean concentration calculations
Samples recorded as pollution incidents excluded
Sites failing more than once for a single pesticide are counted as one failure

Figure 11 shows EQS failures for PPPs in 2000. Compared with some other pesticide types, there are much fewer failures. However, this information may be misleading as relatively few samples are taken from small watercourses in rural areas where PPPs may be failing EQSs. The detected plant protection product EQSs are mostly linked to sites where pesticides used to be manufactured and formulated (Southern Region and North East Region) and other point sources such as landfills and contaminated land. A diuron problem in Thames Region highlighted in 1998 continues to be a problem. A source for this pollution has not yet been identified, but information and advice targeted at users appears to be having some effect.

AGRICULTURAL AND NON-AGRICULTURAL PESTICIDE POLLUTION INCIDENTS

The majority of incidents in 2000 (40 per cent) were caused by agricultural pesticides. This is a slight decrease from previous years. A breakdown of agricultural pesticide pollution incidents by cause **(Figure 12a)** indicates that structural/containment failure, transport accidents and inappropriate use or disposal of pesticides were responsible for most incidents. Similarly, the majority of non-agricultural pesticide pollution incidents **(Figure 12b)** were caused by either inappropriate/ unauthorised disposal (27 per cent of incidents) or transport accidents (28 per cent).

Figure 12a. Causes of agricultural pesticide pollution incidents

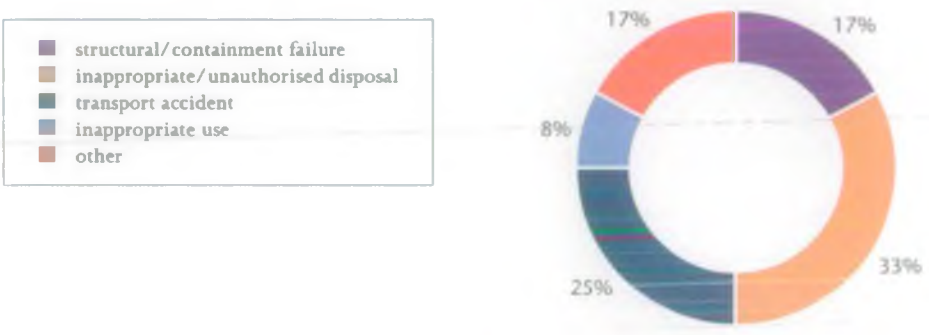
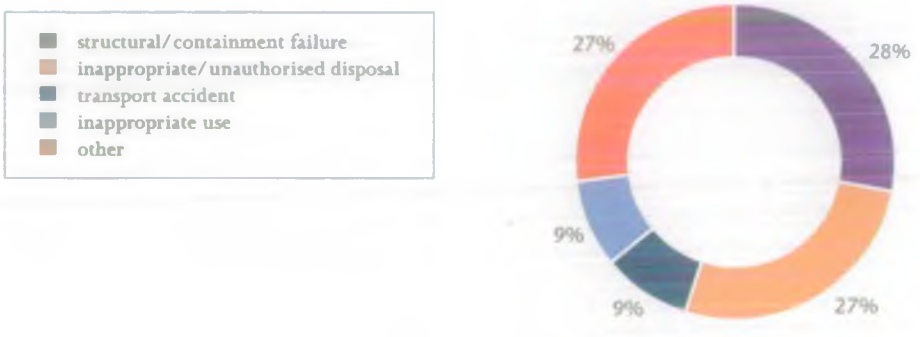


Figure 12b. Causes of non-agricultural pesticide pollution incidents



Monitoring of sheep dips

Organophosphate (OP) and synthetic pyrethroid (SP) sheep dips such as diazinon, propetamphos, cypermethrin, flumethrin and the now banned chlorfenvinphos are included in the Agency's pesticide monitoring programme. In 2000, we performed over 17,000 analyses for sheep dips.

Figure 13 shows the sheep dip EQS failures in 2000. The map indicates a large number of cypermethrin and diazinon EQS failures in Wales and the North East. Many of these are associated with sheep farming, but there are also a significant number of EQS failures associated with discharges from the textile industry (particularly in Yorkshire). This is because washing of sheep fleeces releases sheep dip residues into the effluent discharged from these plants.

The number of EQS failures has decreased dramatically since 1998. Previously there were a large number of sheep dip EQS failures in Northumbria and Cumbria, but only a few were detected in 1999 and 2000. This downward trend may indicate that the various sheep dip awareness campaigns have proved successful and sheep farmers are improving their sheep dipping practices. The temporary ban on the use of OP sheep dips during 2000 (due to concerns over operator exposure) may also have contributed to the sharp decline in the number of OP sheep dip EQS failures (from 97 in 1998 to 61 in 1999, and 36 in 2000). As SPs were the only sheep dip available to farmers during part of 2000 and these are much more toxic to aquatic life than OP dips, it might have been expected that cypermethrin EQS failures would increase. This occurred to some extent (there were 47 failures in 2000 compared with 36 detected in 1999), but this number was considerably less than in 1998 (112 failures). Better practice may be responsible for this improvement.

Another factor in the apparent decline in the incidence of sheep dip EQS failures may be the new authorisation of sheep dip disposal since early 1999 under the Groundwater Regulations 1998 (some 12,000 disposal sites authorised). Although the main driver behind the regulations is groundwater protection, we have also looked at surface water protection when authorising disposals.

SHEEP DIP POLLUTION INCIDENTS

Pollution incidents caused by sheep dipping in 1999 and 2000 show a significant reduction compared with 1998 and earlier years (**Figure 9**). The increased use of SP dips due to the temporary ban in 2000 could potentially have resulted in an increase in the number of pollution incidents, however this does not appear to be the case.

Many sheep dip pollution incidents were found through routine biological surveys of watercourses by the Agency. Although chemical analyses indicate the presence of sheep dip chemicals, it can be difficult to trace why the pollution incident occurred because several days or weeks may have elapsed between the sheep dipping activity and the detection of pollution. However, the location of dipping and draining facilities close to watercourses is a common cause of sheep dip pollution incidents.

In recent years, the Agency has undertaken pollution prevention campaigns and farm visits to raise user awareness of the potential risks to the environment associated with sheep dips. The data suggest that increased user awareness may have resulted in a reduction in the number of pollution incidents caused by sheep dipping.

Figure 13. Sites failing EQSs for sheep dips in 2000

Environment Agency pesticide issues and activities in 1999/2000

The Agency aims to reduce the levels of pesticides reaching environmental waters. In 1999 and 2000, we were involved in various pesticide-related activities. Some of these are summarised below.

PESTICIDE AND VETERINARY MEDICINE APPROVALS

We advise on the approval and review of pesticides and veterinary medicines through the Advisory Committee on Pesticides (ACP) and the Veterinary Products Committee (VPC). We raise issues of environmental concern and these are taken into account during the approvals process.

BIOCIDE APPROVALS

The Biocidal Products Directive was implemented in April 2001 and aims to review all biocides over the next 10 years. We will advise on the environmental assessment of these chemicals.

THE GOVERNMENT'S PESTICIDE POLICY

We are a member of the Government's Pesticide Forum, which was set up to advise on and to develop policy on minimising pesticides risks to the environment. We also advise the Government on specific pesticide policy issues such as buffer zones.

CROP PROTECTION ASSOCIATION (CPA) VOLUNTARY PACKAGE

The possible introduction of a pesticide tax has been shelved for the time being while the CPA promotes a voluntary programme. This programme includes improving practice, use of technology, information provision and training. The Agency has advised on the content of this programme and forms part of the group overseeing its implementation.

PESTICIDES IN THE ENVIRONMENT WORKING GROUP (PEWG)

This group was set up by the Agency to look at the overall balance of monitoring activities on pesticides in the environment. Its recent review of pesticide monitoring in the UK, *Monitoring of Pesticides in the Environment*, is available from the National Centre for Ecotoxicology and Hazardous Substances.

SHEEP DIPS

We have been tackling the pollution problems associated with the use of sheep dips through our sheep dip strategy (March 1999). We assisted the then Department of the Environment, Transport and the Regions (DETR) with the production of a sheep dipping code of practice under the Groundwater Regulations 1998.

To combat pollution from wool washing plants and carpet manufacturing, the Agency has formed the Sheep Dip and Textiles Working Group. This group has developed a strategy (May 1999), which includes the need to review ways of reducing pesticide pollution from this source. Areas that need to be explored include sheep farming practices to reduce dip chemical residues in fleeces, pollution prevention measures at processing plants and effluent treatment technologies.

VETERINARY MEDICINES REVIEW

We are carrying out a review of the use and potential risks of veterinary medicines in the environment. One outcome of this review will be an initial prioritisation of veterinary medicines.

TIMBER TREATMENTS

In collaboration with English Nature, we are currently undertaking a review of treated timber and timber treatment chemicals with the aim of advising Agency staff of the best practicable environmental option (BPEO) for timber that may come into contact with water or the ground.

RESEARCH & DEVELOPMENT

The Agency has an R&D budget of around £100,000 for 2000/2001 to quantify and mitigate pesticide pollution problems . Much of this work is in collaboration with other funders. Current projects include work on reducing sheep dip impacts, development of pesticide waste disposal systems, and guidelines on washdown and handling areas for agricultural pesticides.

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