ENVIRONMENT AGENCY

THE QUALITY OF RIVERS IN ENGLAND AND WALES

(1990 TO 1995)

A Report by the Environment Agency

November 1996

ENVIRONMENT AGENCY

EA - Water Quality

Guardians of the Environment

OUR AIMS ARE:

To achieve significant and continuous improvement in the quality of air, land and water, actively encouraging the conservation of natural resources, flora and fauna.

To maximise the benefits of integrated pollution control and integrated river basin management.

To provide effective defence and timely warning systems for people and property against flooding from rivers and the sea.

To achieve significant reductions in waste through minimisation, reuse and recycling and improve standards of disposal.

To manage water resources to achieve the proper balance between the needs of the environment and those of abstractors and other water users.

To secure, with others, the remediation of contaminated land.

To improve and develop salmon and freshwater fisheries.

To conserve and enhance inland and coastal waters and their use for recreation.

To maintain and improve non-marine navigation.

To develop a better informed public through open debate, the provision of soundly based information and rigorous research.

To set priorities and propose solutions that do not impose excessive costs on society.

Foreword

The Environment Agency has responsibilities for the regulation of waste, the control of pollution, the management of water resources, and for flood defence, freshwater fisheries and conservation. We have obligations for surveillance, and a duty to publish information on the state of our environment.

Our prime object is to protect or enhance the environment and so ensure that development can be sustainable. One part of this aim is to safeguard or improve the quality of rivers by controlling the risk from pollution. The benefits of this are that we, and future generations, can have development, but with water supplies that are reliable and risk-free. At the same time we can protect wildlife, and enjoy our environment for recreation.

Sound monitoring is an essential part of a strategy for the environment. Otherwise we cannot know where we started, what progress is being made, and whether we are getting good value from investment. We report here on the results of our monitoring of rivers.

This report describes the state of the Nation's rivers and how this has changed since 1990. In the main it is a good story of improvements achieved as the result of investment by the Water Industry, other industry and agriculture. This investment is targeted at reducing pollution and controlling the risk of pollution.

In the future we plan to hold on to these gains whilst seeking further improvements wherever the cost can be justified by the benefits to present and future generations.

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SECTION 1: SUMMARY

The Environment Agency is a public body whose aim is to protect and improve the environment. One of our key tasks is to improve rivers by controlling the risk of pollution. This will protect our water supplies, our wildlife, and the centre of much of our recreation, both for ourselves and for future generations.

It is vital to know the true state of our rivers and to assess correctly which rivers have good quality and which need improvement. Otherwise investment will be inadequate or wasted.

In terms of chemical quality, 91% of river length was graded from Very Good to Fair for 1995. Eight percent was Poor and 1% was Bad. River water quality improved by 28% from 1990 to 1995. These statements are based exactly and entirely on data collected and processed by fixed and published rules and placed on Public Registers.

Over the same period, the biological quality improved by 26%. 93% of rivers were graded Very Good to Fair for 1995. 5% of rivers were Poor and 2% were Bad. In fixing a Biological Class to a river we use the same, strictly defined rules throughout England & Wales.

Part of the improvement was brought about by reductions in pollution, particularly from sewage treatment works. We have also seen success in measures to prevent the pollution associated with agriculture, and in action to reduce the impacts of other uses of land. Another factor was the dry weather which affected the results for 1990 more than the dry summer of 1995 influenced the results for that year - though we provide evidence that this factor has not been so influential as previously thought. We provide maps showing the present quality of rivers, and maps showing where quality has changed significantly.

We introduce results for a scheme for grading rivers according to concentrations of phosphate. We seek views on this. River quality also improved when assessed for phosphate. We describe our scheme for grading rivers according to aesthetic criteria like smell and litter. We aim to use the scheme to plan action at selected sites that face particular risks.

For the future, we hope that the Government will introduce Statutory Water Quality Objectives. This would underpin recent improvements, and help prevent the deterioration of good rivers. Our proposals for future improvements, whether or not these are to be supported by Statutory Objectives, will be a part of the consultation on our Local Environment Agency Plans.

We shall continue to enforce measures to prevent pollution by the use of special teams to investigate catchments, and by programmes of visits to sites that could pose risks.

Toxicity Based Consents will provide another way of controlling the impact of discharges.

We expect further improvements as Water Companies complete schemes for improved sewage treatment. Also, the requirements under Directives to reduce nutrients in certain rivers will be met by Water Companies through sewage treatment. We are considering priorities for the future investment programmes of the Water Companies.

The prospect of climate change makes it even more important to ensure that water quality places no barrier on the proper deployment of water resources.

SECTION 2: ENGLAND AND WALES

Introduction

The purpose of this report is to provide an assessment of the state of our rivers, to describe the pressures on rivers, and to explain recent changes in the quality of rivers. This assessment must be based on information that is accurate and consistent. We do this through the scheme known as the General Quality Assessment (GQA)[1].

The GQA consists of a number of parallel assessments, each providing a separate window through which we view the state of water quality. The first used was the Chemical GQA. This describes the quality of rivers in terms of the measurements which detect the most common types of pollution - discharges of *organic* wastes from sewage treatment works, from agriculture and from industry.

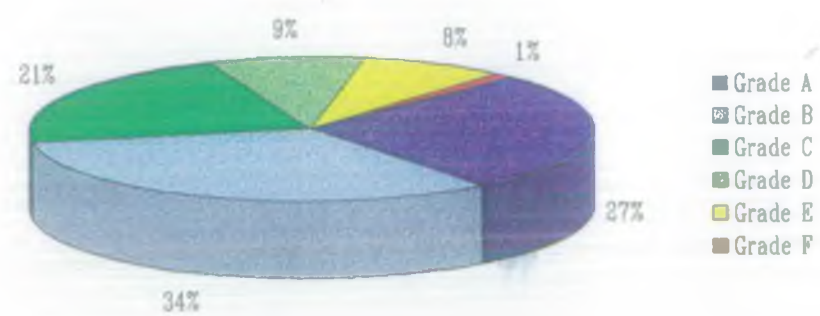
The Biological GQA is a new and broader measure of quality based on the monitoring of the small animals which live on the bed of the river. Biological monitoring can provide information about types of pollution that would be missed by chemical monitoring.

For the first time, we present results for the *Nutrient* GQA. This shows the concentrations of phosphate in our rivers.

The GQA for Chemistry

This is described in Appendix C. Tables of results are in Appendix A. For 1995, 91% of rivers were graded from Very Good to Fair (Grades A to D). 8% of rivers were Poor (Grade E) and 1% were Bad (Grade F) (Figure 1).

Figure 1: Chemical Quality in England and Wales for 1995



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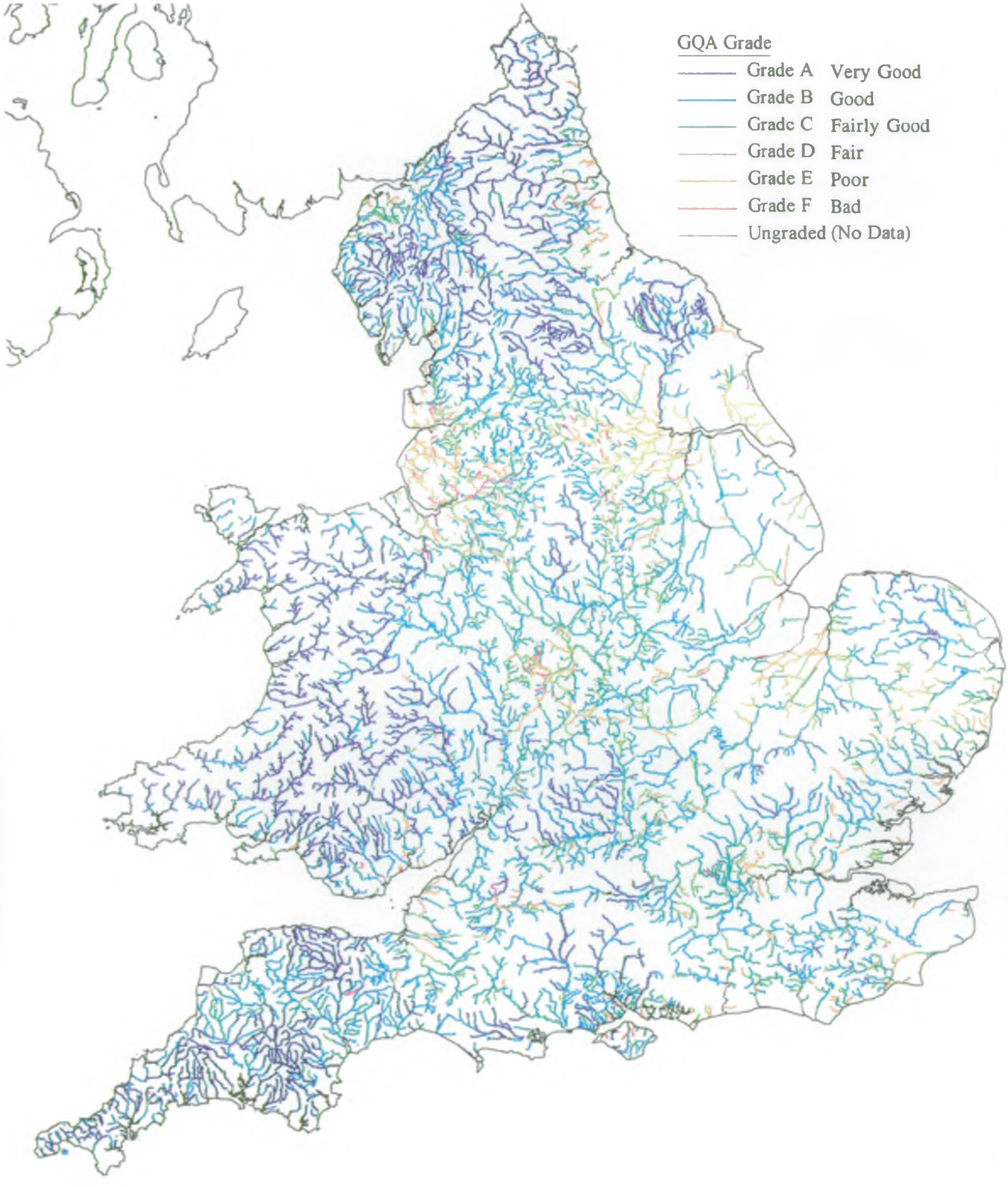
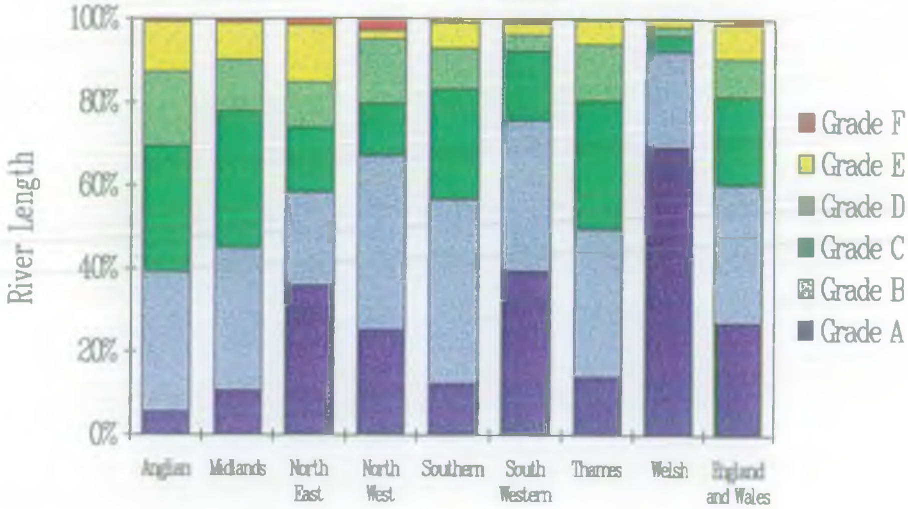
[1] We make occasional use of technical terms and have provided a Glossary of these.

Map 1 River Quality in 1995 according to the Chemical Classification.



The results for different parts of England and Wales in 1995 are shown in Figure 2. The results for individual rivers are shown on Map 1.

Figure 2: Chemical Grading in Regions for 1995



Are Rivers Getting Better Chemically?

Figure 3 compares 1990 with 1995. When we count up all the rivers that have changed grade from 1990 to 1995 we record a net upgrading of 28% of the total length of river surveyed. As discussed below, we recorded a similar improvement in the biological quality. The change in quality in different parts of the country is indicated in Figure 4.

The figure of 28% is the net result of an improvement in 40% (13,300 kilometres) of river length and a deterioration of 12% (4200 kilometres). A lot of these changes are small. We say that such changes to individual sites are insignificant. However, the figure of 28%, an aggregate for 8000 sites and 600,000 measurements, is a categoric demonstration that river quality has improved on the national scale. We discuss its precision below.

Which Rivers Have Really Got Worse Chemically ?

River quality varies along the length of the river and over time. For total accuracy for every river we would have to sample everywhere, all the time. No responsible agency could want or need to sample anything like this extensively. The resources are better put towards cleaning up pollution.

We sample, on average, 12 times a year, at intervals of 6 kilometres and use three years' samples for the GQA The fact that a lot of rivers lie close to the edge of a class boundary, coupled with the uncertainty produced by monitoring less than all the time, gives an average risk of 19% that a **particular** stretch of river sampled 36 times is placed in the wrong grade [1].

The impact of this on our estimate of the 28% net improvement is to give 28 ± 0.3 %. The small error in the national figure, ± 0.3 %, compared with the large error for an individual stretch of river, 19%, stems from the fact that the former is based on 600,000 samples and the latter on about 70.

Figure 3: Chemical Quality in England and Wales – 1990 and 1995

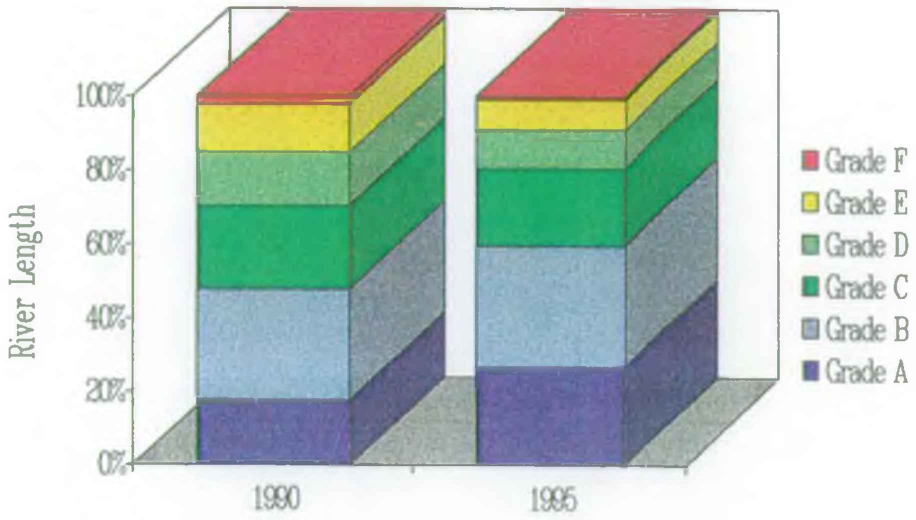
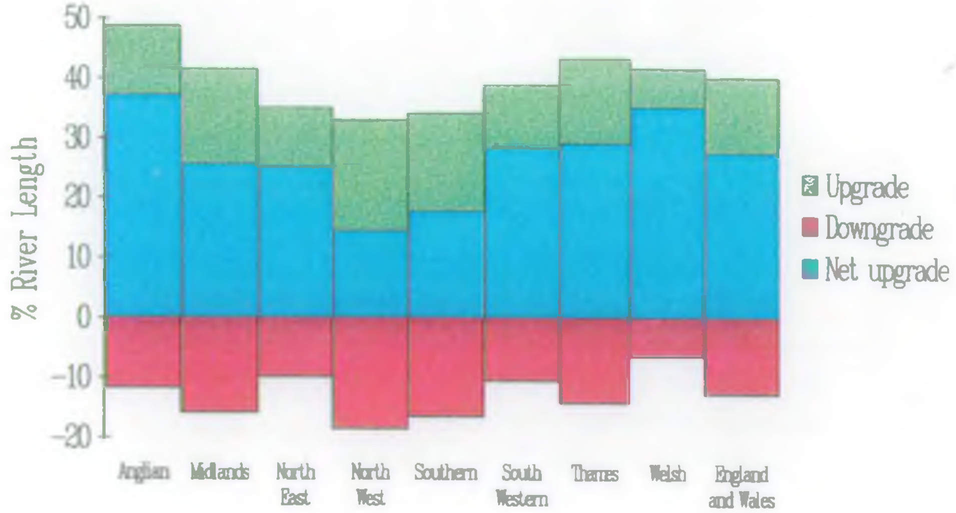


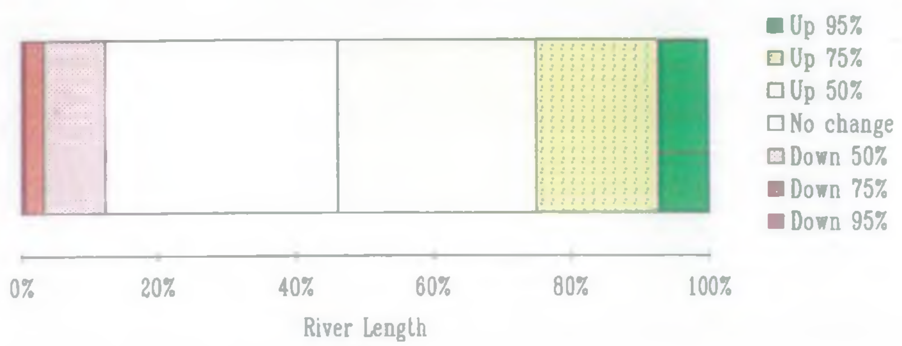
Figure 4: Change in Chemical Quality in Regions since 1990



We note above that the risk of 19% that a stretch of river is given the wrong grade. This produces a risk of 25% that a river may be declared wrongly to have **changed** class from one survey to the next [1]. This error means that reported changes of a single grade are rarely *significant* because too many such changes are produced by error.

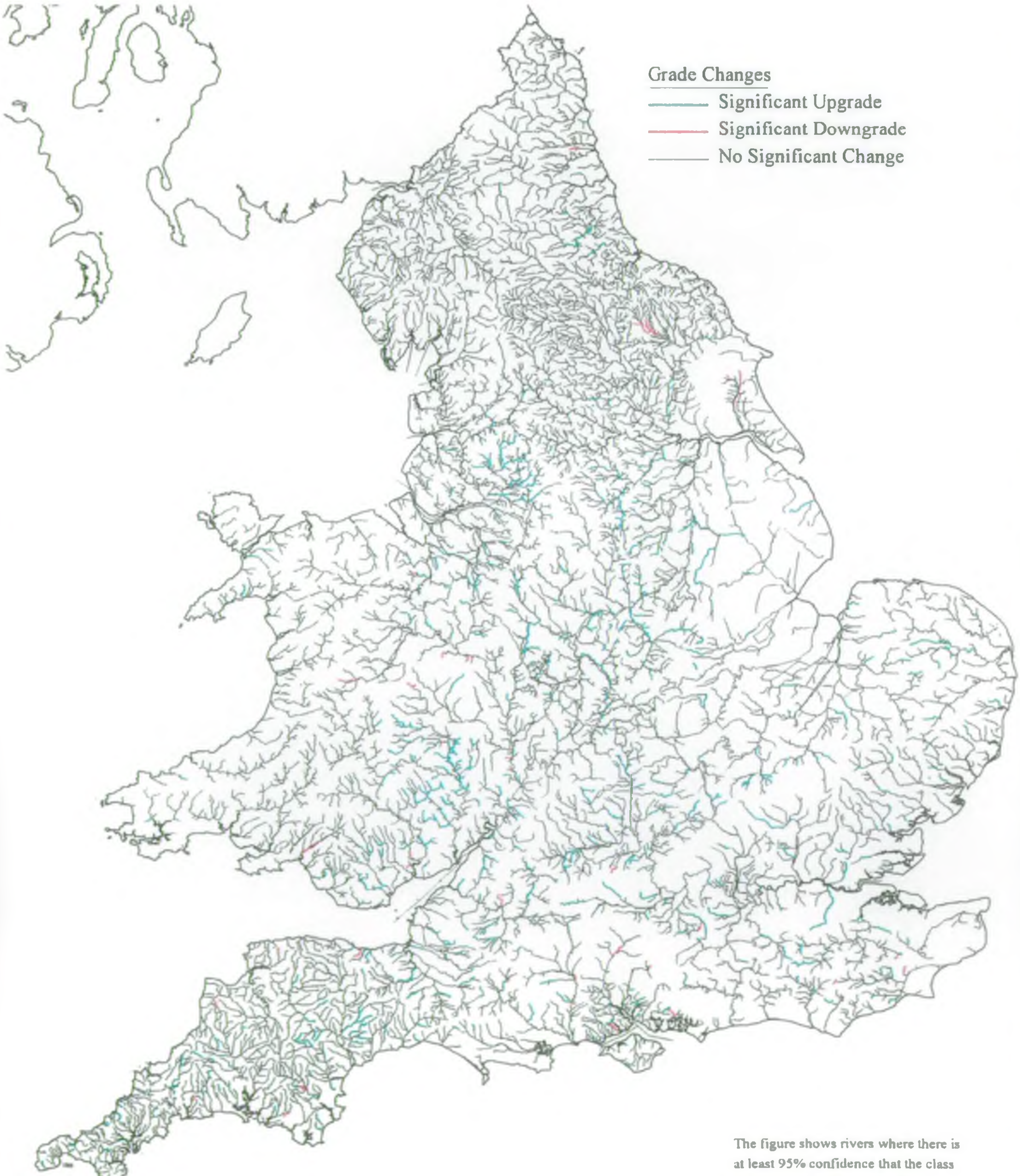
We calculate, for every stretch of river, the statistical confidence that a change is real (Appendix D). Stretches of river that have *significantly* changed in chemical quality are shown in Map 2. It is for these stretches that it is most sensible to ask why the particular change has occurred. The total lengths to have changed grade significantly are indicated in Figure 5 and the total lengths listed in Table A.5 in Appendix A.

Figure 5: Change in Chemistry at Various Levels of Statistical Significance



A feature of Figure 5 and Map 2 is that in only 226 kilometres out of a total of 34,000 was there a drop in grade that was significant at the 95% level of confidence. In contrast, over 3000 kilometres of river length showed an improvement in grade that was significant at more than 95% confidence. Details are in Table 1.

Map 2 Significant Changes in River Quality from 1990 to 1995 according to the Chemical Classification.



The figure shows rivers where there is at least 95% confidence that the class changed by at least one grade.

Table 1: Significant Changes in Chemical Grade from 1990 to 1995				
Region	Upgraded Length (km)		Downgraded Length (km)	
	with at least 50% confidence	with at least 95% confidence	with at least 50% confidence	with at least 95% confidence
Anglian	2231	488	534	3
Midlands	2353	666	896	34
North East	1458	268	414	65
North West	1052	302	589	0
Southern	747	188	359	41
South West	2280	591	617	47
Thames	1532	405	501	8
Welsh	1677	501	257	27
Total	13331	3408	3408	226

The Biological GQA

Operating alone, the Chemical GQA allows a river to achieve a good grade in spite of:

- pollutants not included in the Chemical GQA; or,
- intermittent pollution not detected by the routine samples taken for chemical analysis.

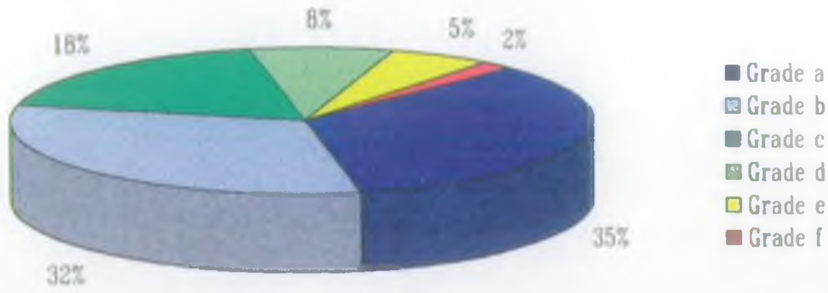
The Biological Class is based on the monitoring of tiny animals that live on the bed of the river. If the river is polluted, even for only a few minutes, then some or all of these animals may die. Recovery may take several months. This means that biological monitoring provides information about pollution that may have been missed by chemical monitoring.

In fixing a Biological Class to a river we use the same, strictly defined procedures throughout England & Wales. Details are in Appendix B and tables of results are in Appendix A.

Figure 6 shows that 93% of rivers were graded in the range of grades from Very Good to Fair for 1995 (Grades **a** to **d**). Six percent were Poor (Grade **e**) and 2% were Bad (Grade **f**).

The results for different parts of England and Wales in 1995 are shown in Figure 7 and Appendix A. The results for individual rivers are shown on Map 3.

Figure 6: Biological Quality in England and Wales in 1995



Are Rivers Getting Better Biologically?

Figure 8 compares 1990 with 1995. From 1990 to 1995 we record a net apparent upgrading of 34% of the total length of river surveyed.

In biological monitoring, the biologist collects a sample and searches for all the types of creature in the sample (Appendix B). One of the possible sources of error is that the biologist may fail to notice all the Taxa collected. We single out this error because, unlike other errors in Biology or Chemistry, it introduces a bias and means that our assessments of biology tend to be pessimistic.

Also, our procedures for measuring the quality of our work showed that our biologists missed fewer species in 1995 than in 1990. This means that some of the improvement of 34% is caused by improved technique.

We have been careful to measure all our errors in 1990 and 1995 (Appendix E). When we take account of bias, the apparent improvement of 34% is reduced to a real improvement of 26%. The figure of 26%, an aggregate for 8000 sites, corrected for the bias, is a categoric demonstration that river quality has improved on the national scale. It is this figure, 26%, that we put forward as our estimate of the true change in quality.

Map 3 River Quality in 1995 according to the Biological Classification.

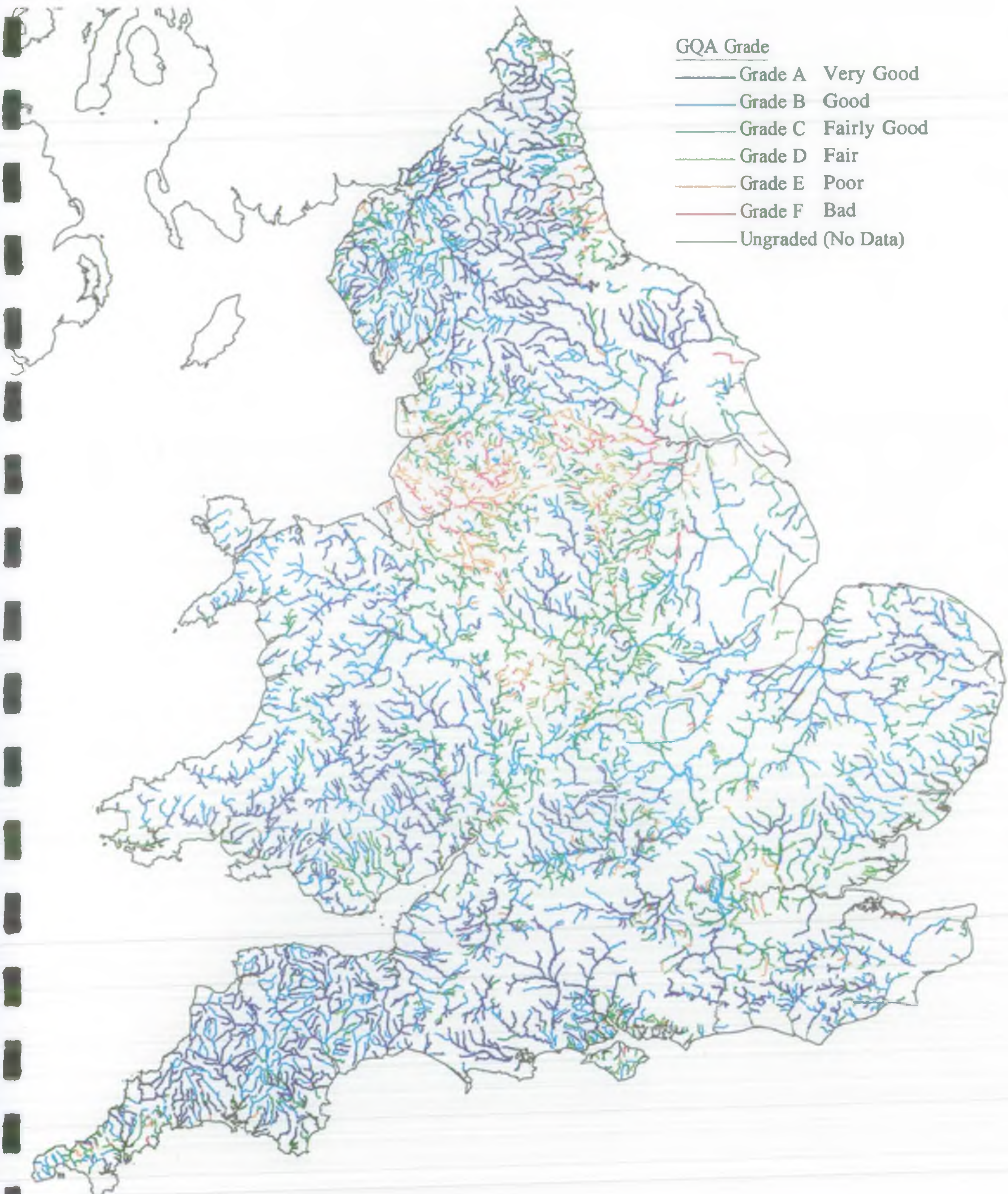


Figure 7: Biological Quality in Regions in 1995

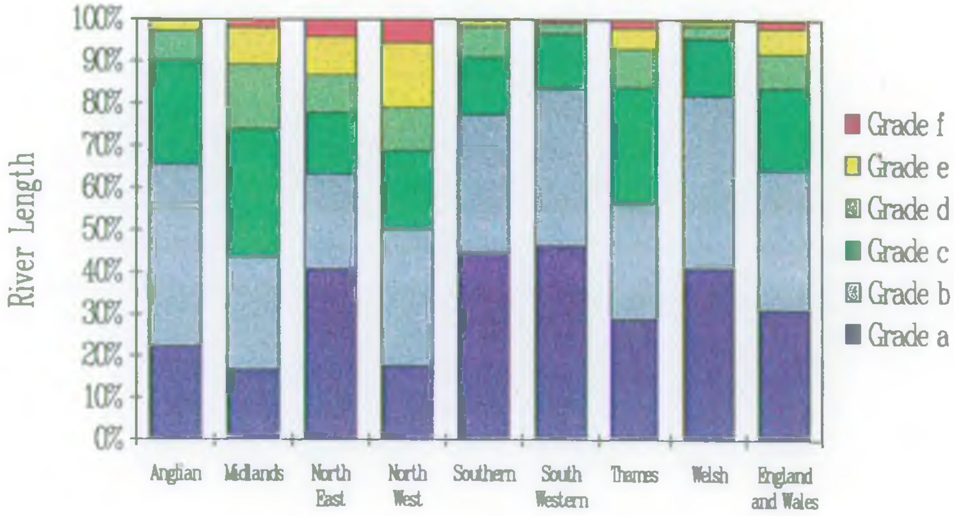
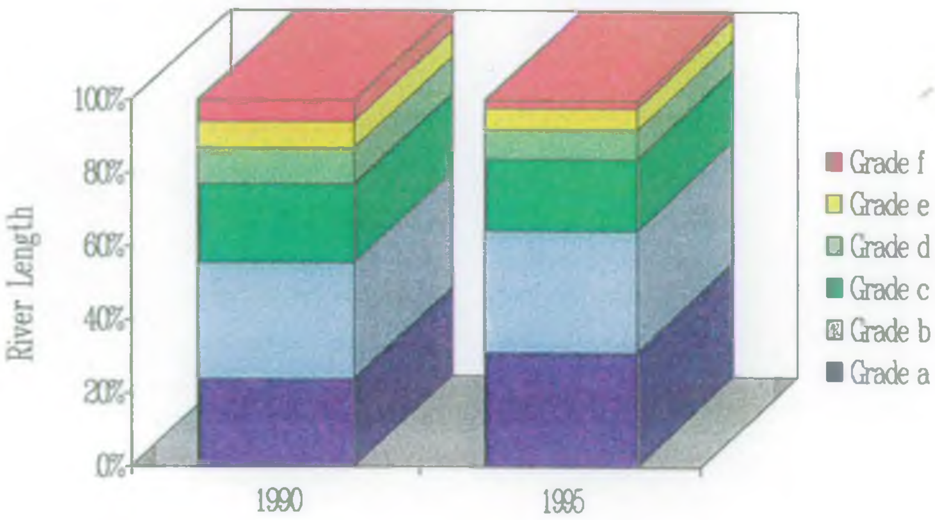
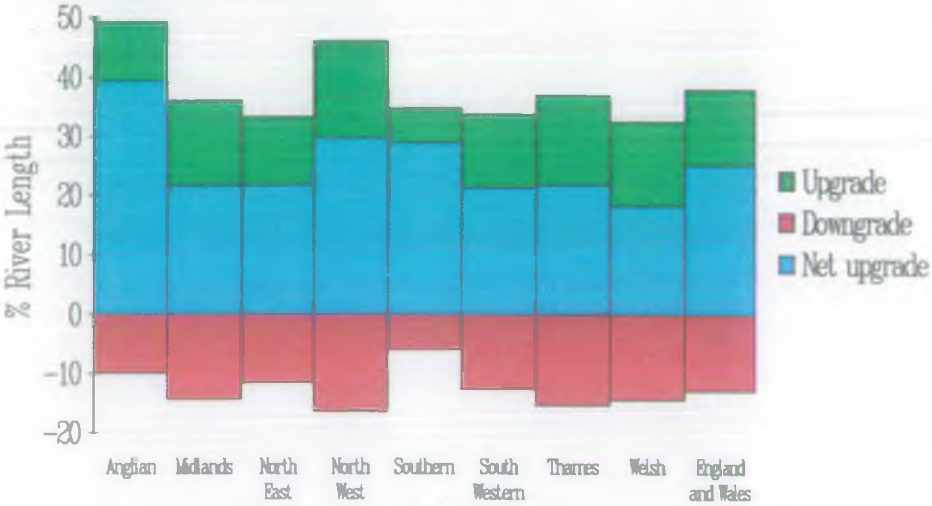


Figure 8: Biological Quality in England and Wales - 1990 and 1995



The figure of 26% is the net result of an improvement in 38% (11,500 kilometres) of river length and a deterioration of 12% (3800 kilometres) (Table A.8a in Appendix A). The change in quality in different parts of the country is in Figure 9.

Figure 9: Change in Biological Quality in Regions since 1990



The fact that a lot of rivers lie close to the edge of a grade boundary, coupled with the uncertainty produced by monitoring, gives an average risk of 22% that a **particular** stretch of river is placed in the wrong grade [1].

The impact of this on our estimate of the 26% net improvement is to give 26 ± 0.3 %. The small error in the national figure, ± 0.3 %, compared with the large error for an individual stretch of river, 22%, stems from the fact that the former is based on 30,000 samples and the latter on 4.

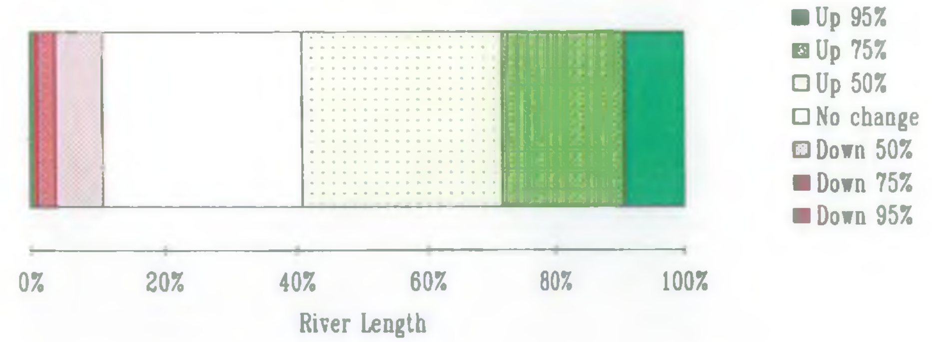
Which Rivers Have Really Got Worse Biologically ?

We reported above that there is an average risk of 22% that a stretch of river is given the wrong grade. This produces a risk of 29% that a river may be declared wrongly to have changed grade from one survey to the next [1]. This error means that most of the reported changes involving a shift of a single grade are *insignificant* because they may have been produced by error.

We manage this error by calculating, for every stretch of river, the statistical confidence that the change is real (Appendix E). Stretches of river that have *significantly* changed in quality are shown in Map 4. The total lengths to have changed grade significantly are indicated in Figure 10.

A feature of Figure 10 and Map 4 is that in only 450 kilometres out of a total of 30,000 was there a drop in grade that was significant at the 95% level. In contrast, over 4200 kilometres of river length showed an improvement in grade that was significant at more than 95% confidence (Appendix A).

Figure 10: Change in Biology at Various Levels of Statistical Significance



Differences Between Biology and Chemistry

Map 5 shows stretches where there is a *significant* difference between biology and chemistry. There is a pattern. There are more places in the north and west where biology is worse than chemistry and more places in the south and east where the opposite holds.

Changes in biology have generally mirrored the changes in chemistry. Where there are differences between chemistry and biology it is more common for the biology to be worse than the chemistry. The reasons include:

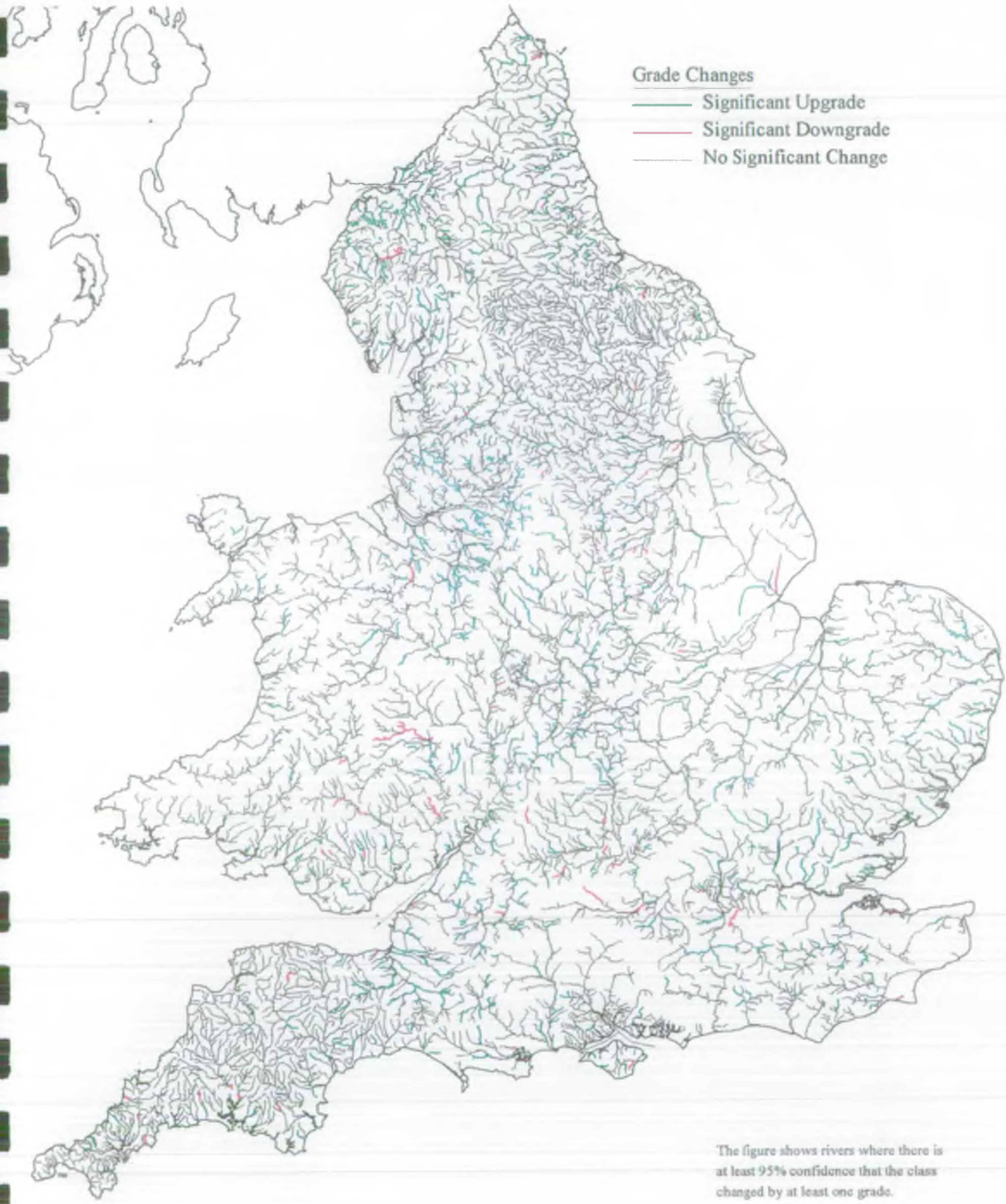
- intermittent pollution not detected by chemical sampling;
- pollutants not in the Chemical GQA. For example, pesticides, metals and acid rain; or,
- poor quality sediments on the river bed, perhaps the result of historic pollution. This affects the biology but not the quality of the flowing water.

These reasons mean that comparisons between chemistry and biology can help pick up the causes of pollution.

It is less clear why chemical quality should be worse than biological quality. One of the reasons will lie in monitoring. Biology was monitored only in 1995 whereas chemistry was assessed for data collected from 1993 to 1995. Some improvements early in 1995 would not be reflected in the chemical grade but would show up for biology.

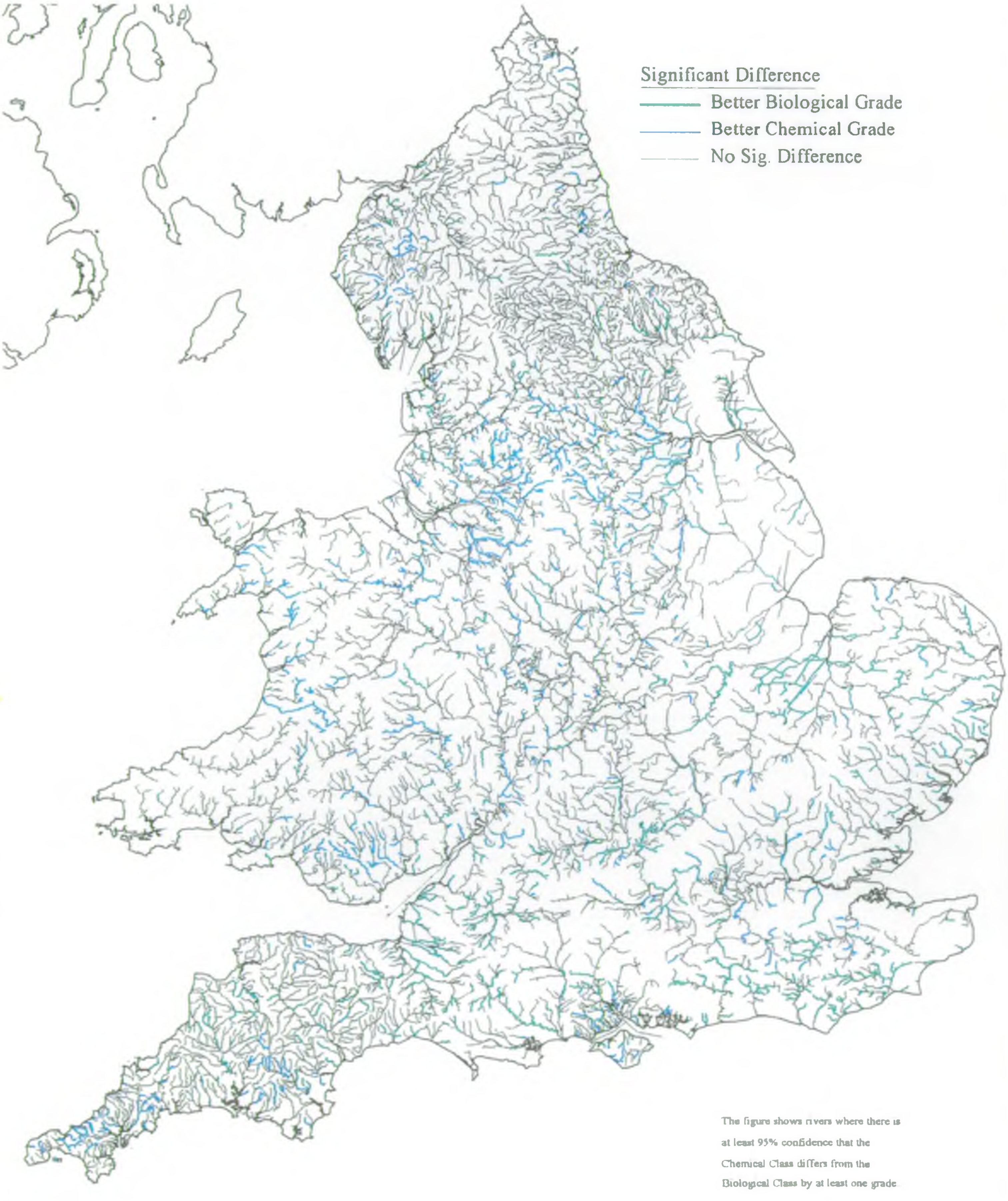
Another reason, common in the south and east of England is the corrupting effect of algae on the test for BOD. This leads to pessimistic estimates of the Chemical Grade. Similarly, Dissolved Oxygen may be suppressed at times and places of low flow and high temperature, though the changes may not be so big or variable as to affect the biology.

Map 4 Significant Changes in River Quality from 1990 to 1995 according to the Biological Classification.



The figure shows rivers where there is at least 95% confidence that the class changed by at least one grade.

Map 5 Significant Differences between the Chemical and Biological Quality of Rivers in 1995.



The GQA for Nutrients

We introduce results for a pilot scheme for classifying rivers according to concentrations of the nutrient, phosphate. We seek views on this. The Nutrient GQA and the results are described in Appendix F and Appendix A. Map 6 shows the results.

In the north and west we find most of the rivers have the grades with the lowest concentrations of phosphate. In the south and east many rivers are in the grades with the higher concentrations of phosphate.

Unlike the GQA for Chemistry or Biology, it is not always so clear as what is good or bad. It can be worse for one river to drift from Grade 1 to Grade 2 than for another river to move from Grade 3 to Grade 6.

The GQA for Aesthetic Pollution

Many rivers draining urbanised catchments, particularly in Wales and the west of England, have poor aesthetic quality even though the chemical quality is Grade A or B. Often this is the result of general litter and sewage derived litter emanating from the discharge of *combined sewer overflows*.

The aesthetic quality of a river is determined by a mix of perceptions including the clarity of the water, odour, stagnation, colour, and the presence of oil, litter, foam and excess weeds and algae. Our scheme for classifying rivers is outlined in Appendix G.

The results of a trial involving 500 sites have demonstrated the poor quality of some rivers. Monitoring has indicated the link between the measurement of litter, oil, odour and known sources of pollution such as combined sewer overflows. We plan to use this aspect of the GQA to check progress in improving sewerage systems and tackling other aesthetic problems.

We have not produced maps of the results of our surveys of aesthetic pollution. This is because we deliberately selected sites that would test the system. On a map these results would not show a representative picture of the true quality of our rivers.

The Reasons for the Change in Quality

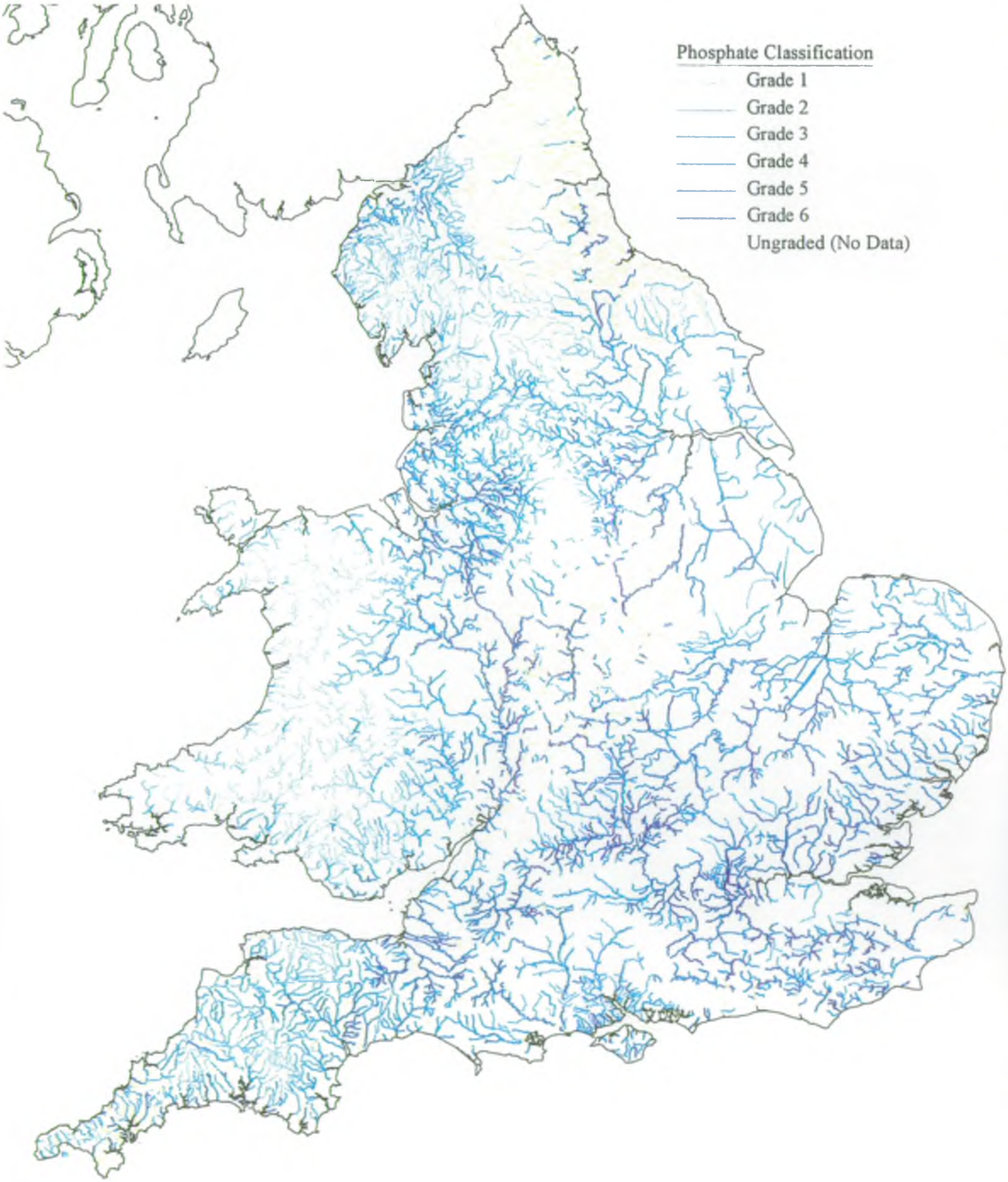
Trends in the Polluting Load from Sewage Treatment Works

Part of the improvement has been caused by reductions in pollution, particularly from sewage treatment works. The change in the pollution load from sewage treatment works is shown in Figures 11 and 12 (and Table A.15 in Appendix A).

Figure 11 shows the average concentration of BOD and Ammonia discharged to rivers from 3700 sewage treatment works. Figure 12 shows how these have reduced since 1990. Over England and Wales the load of BOD has reducd by 25% and Ammonia by 36%

In calculating these averages the value for each works was scaled by the population served by the works. This means that the reductions in concentration are good estimates of the reduction in the polluting load discharged to rivers.

Map 6 River Quality in 1995 according to the Phosphate Classification.



Expressed in terms of the Consents in force in 1995, the population served by works that fail the prime 95-percentile standards in Consents has declined from 18.7 to 6.4 %. The number of failed works has come down from 12.9 to 1.9%.

Statistically, a value of 1.9%, derived from our monitoring, is compatible with a true situation in which all works comply[2].

The Effect of the Weather

Another factor was the dry weather for 1990. On balance, a period with high river flows will usually provide better river quality than one with lower flows because of the dilution of effluent and because the river is more turbulent. This leads to higher concentrations of Dissolved Oxygen in the years with high flows. Oxygen is also more soluble in cooler water.

The beneficial effect of high river flows can be offset by the fact that effluent treatment is less efficient in cooler weather, and by the fact that the flows of effluent and storm sewage tend to be greater when conditions are wet.

There are other factors that give the appearance that water quality was less good for 1990 than normal. Some clean rivers with low velocity are poorly graded because of the effect of algae on the measurement of BOD. (This is a corruption of the test for BOD. The oxygen demand is not exerted in the river, although the amount of algae may depend on nutrients discharged in effluents). Also, during periods of low flow, some rivers have low concentrations of dissolved oxygen. This is the result of natural processes and does not always indicate pollution.

The application of the GQA to the 1980s, as illustrated later in this report for Thames and Anglian Regions, suggests that the dry weather in 1990 was not a big factor, and that quality now is better than for at least 20 years.

The Department of the Environment publishes data on trends since 1980 for 200 of the 6000 monitoring points on bigger rivers in Great Britain. These points are located generally towards the seaward end of rivers [2]. Figures 13 and 14 gives results from the report for 1995. The improvement for BOD and Ammonia since 1980 is indicated, but Dissolved Oxygen has remained little changed in these rivers. Overall these figures add weight to the suggestion that the improvement reported since 1990 by the GQA is not caused, in the main, by the weather in 1990.

Initiatives to Prevent Prevention

Many improvements are the result of our initiatives to prevent pollution through campaigns, site visits, farm inspections and action on enforcement. Pollution was also reduced because of the take up by farmers of grants to improve drainage systems.

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[2] This is because the legal definition of a failed discharge tolerates a risk of 5% that a compliant discharge will be reported wrongly to have failed.

Figure 11: Average Quality of Sewage Effluents in 1995

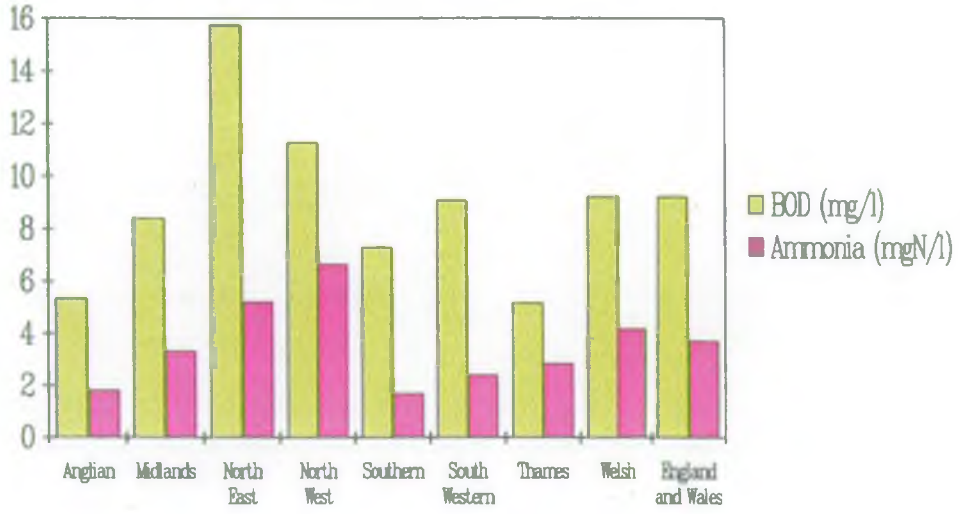


Figure 12: Average Improvement in Quality of Sewage Effluents since 1990

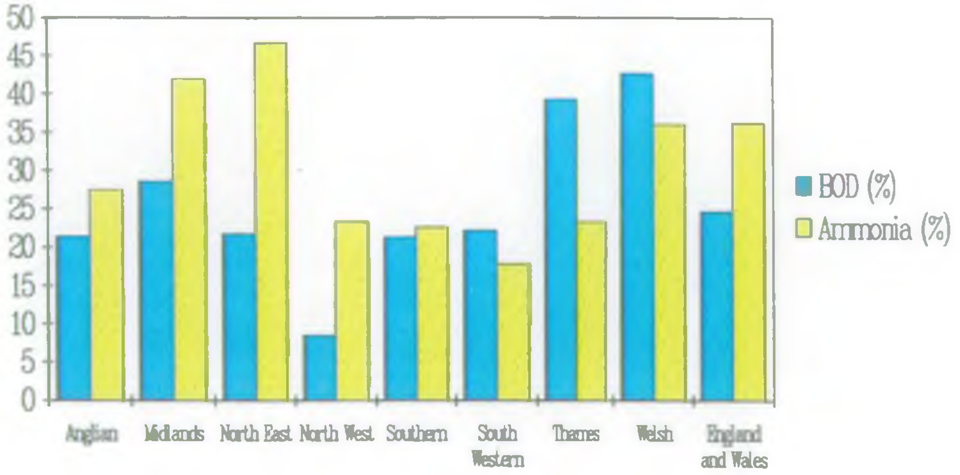


Figure 13: Change in Certain Rivers Since 1980

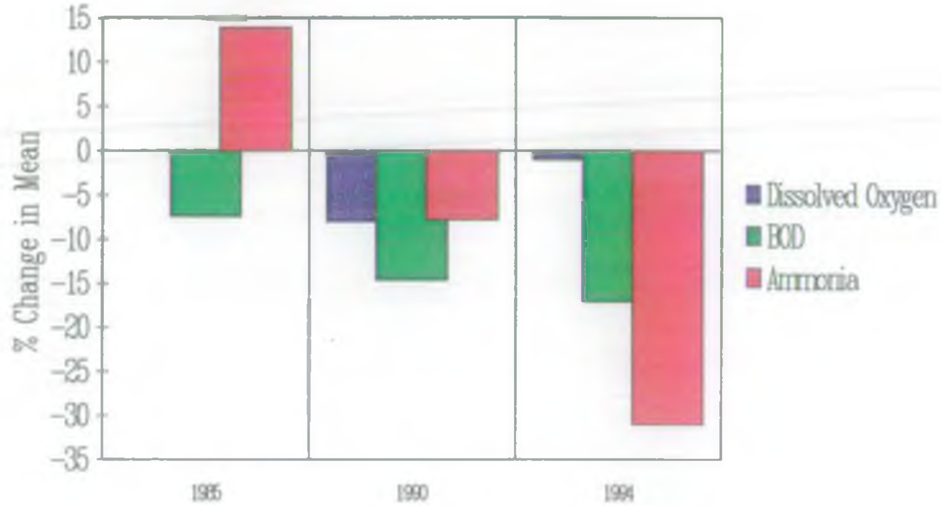
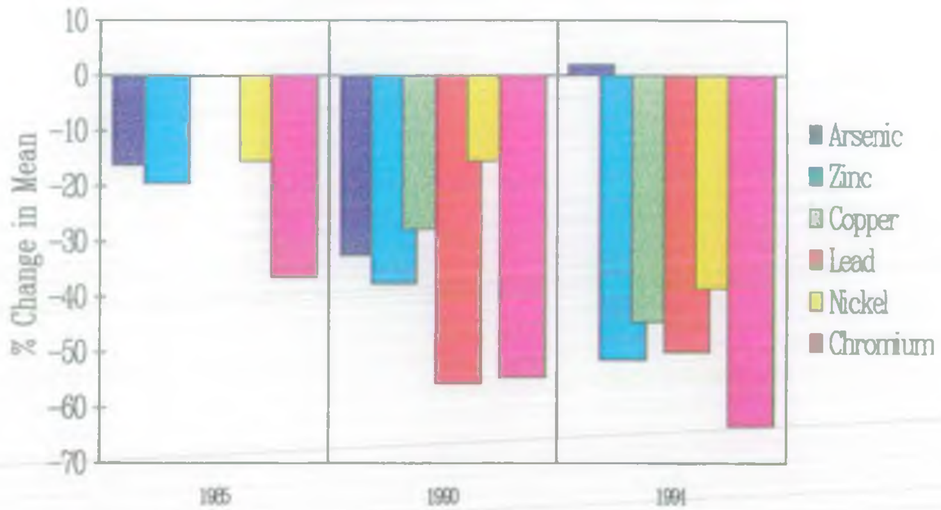


Figure 14: Change in Metals since 1980



Supporting Information

Directives

Compliance with the Fisheries Directive has also improved [3]. We have also recorded a reduction in the number of breaches of Environmental Quality Standards for List 1 and 2 Substances. Figure 14 indicates an improvement for metals at points that are located towards the seaward end of rivers [2].

Pollution Incidents

In the past when we have reported good news on the quality of rivers, our critics have usually been able to point to some recent case where a particular river has suffered heavy damage because of a short interval of pollution cause by a accident, vandalism or neglect.

Unfortunately there remains a small risk that rivers will suffer the effects of an isolated incident. The good news is that the number of serious incidents in England and Wales has dropped by 70% from 1990 to 1995. There are now about 200 per year.

Serious incidents of pollution from farms dropped by 86% over the same period. There are now about 30 of these in a year [4].

Prospects for the Future

River Quality Objectives

A river in a good grade, chemically and biologically, will generally be a good fishery and suitable for other uses like the supply of drinking water. But this cannot be guaranteed because a use can be affected by pollutants which are not in the GQA system and which do not affect the biology.

Therefore, in addition to the GQA, we have River Quality Objectives (RQOs). RQOs have been used since the 1970's and are set for all rivers They ensure that river quality is checked directly against all the quality standards that are needed to support the particular uses that apply to each stretch of river. Improvements to river quality, for example by negotiating a better quality for a discharge, aim to ensure that RQOs are met and maintained.

The Agency is hoping that the Government will introduce a scheme of Statutory Water Quality Objectives (SWQOs) for all river stretches. A period of public consultation on our proposals for eight pilot catchments we completed in 1996. SWQOs would underpin the recent improvements in water quality, and help prevent deterioration of good rivers [5]

We plan to use the Biological GQA to set targets and monitor their achievement.

Local Environment Agency Plans

The need for and delivery of improvements is considered by our Local Environment Agency Plans (LEAPs). These are being developed for all catchments, in consultation with local people and local interests. These plans will cover our duty to have regard to costs and benefit.

Agriculture

The benefits of the 1991 Farm Waste Regulations are clear in terms of contribution to water quality. However, the Grant Aid underpinning the work ended in 1994. Since then there has been a reduction in the number of improvement schemes and Farm Management Waste Plans submitted to the Agency. This is a concern. We shall continue to promote the benefits to farmers, and shall remain vigilant. We shall enforce measures to prevent pollution by the use of our task forces to investigate catchments, and by programmes of visits to farms.

Water Industries

We expect further improvements as Water Companies complete schemes for improved sewage treatment. A sum of £522m has been assigned to over the next four years as part of the capital programme agreed for special improvements to river quality. This is the so-called *Discretionary Spend*. Other large sums are being spent to improve combined sewer overflows and for the Directive on *Urban Waste Water Treatment*

Many of the sewage treatment works produce effluents that are better than required by their Consents. Whilst it is likely that these effluents will continue to be operated to give the present high quality, the Agency has no legal power to insist that this happens. Were effluent quality to deteriorate to the level defined in the Consents, this would lead to downgrades for several hundreds kilometres of rivers. This issue will be one of our priorities for discussions on the future investment programme of the Water Companies. At the same time we shall seek improvements to more combined sewer overflows.

Another area of concern for sewage treatment works, is where determinands are presently not consented. A large number of works, especially in the midlands and the north, are not consented for Ammonia. This is despite the fact that the works have always been operated to remove Ammonia. Although we expect the Water Companies to continue the present degree of treatment, this is not legally enforceable at present. River quality may decline if these works were to cease treating to remove Ammonia.

Aesthetic Pollution

We plan to use this aspect of the GQA to check progress in improving sewerage systems and tackling other aesthetic problems.

Toxicity Based Consents

The introduction of Toxicity Based Consents will provide another way of controlling discharges. The purpose of these Consents is to control mixtures of pollutants in complex discharges - pollutants that may be difficult to detects or monitor chemically, and which could have unpredictable effects in combination.

We expect that these Consents will help control the risk of low levels of pollutants that tend to accumulate in the environment. These can delay improvements to the biology for several years. This approach, coupled with new Authorizations under Integrated Pollution Control and more general initiatives to minimise all the waste produced by industry (Waste Minimisation), will mean that we can be confident that when improvements occur, the change will improve the biology in rivers and increase confidence in the quality of water supplies.

Nutrients

The requirements under the Urban Waste Water Directive to reduce nutrients in certain rivers will be met by Water Companies through the provision of additional sewage treatment. This will reduce phosphorus, and improve other aspects of the effluents.

Climate Change

It appears that our climate may gradually move closer to that currently experienced in France. If this happens there will be increased pressure on our water resources. It will be even more important to ensure that water quality places no barrier on the proper deployment of water resources.

In terms of quality itself, we shall have a higher proportion of years like 1990 and 1995 when water quality is depressed by the impact of low flow and high temperature.

SECTION 3: COMMENTS ON REGIONS

Introduction

In the last Section we looked generally at England and Wales. In this section we discuss the results for individual Regions. We avoid repeating general points that apply to all Regions, like the purposes of Statutory Water Quality Objectives and our Local Environment Agency Plans.

We look at the reasons for changes in river quality and discuss prospects for the future. We highlight examples of lengths of rivers where a change has occurred and suggest reasons for the change. These examples have been chosen to illustrate the different causes of change and are not exhaustive.

Changes noted as *significant* are those that are statistically significant at the 95% confidence level - we are at least 95% sure that a change is real.

We have included extra information about Nutrients and Aesthetic Quality for those Regions where these issues have a special importance.

This sections does not repeat the detail that is in Appendix A. Changes in monitoring since 1990 are referred to if they have been substantial. Otherwise, the details are in Appendix A.

ANGLIAN

Pressures on Water Quality

Anglian faces relatively high rates of growth and development and is under pressure from the impacts of intensive agriculture. The average rainfall is less than 75% of the average for England and Wales and there is increasing competition for scarce water resources.

A consequence of the nature of the rivers is that background water quality appears worse than in fast-flowing streams. The growth of algae is encouraged by the nutrient-rich, slow-moving flow. This can lead to algal activity in the laboratory test for BOD, and to spurious, elevated results which give pessimistic Chemical Grades in some cases.

State of River Quality and the Causes of Change

We have recorded overall improvements of 37% (1697 km) for chemistry. Of the upgrades, 11% (488 km) are statistically significant, while only 0.07% (3 km) of downgrades are significant.

The corresponding figures for biology are an improvement of 39%, of which 11% are statistically significant. Only 0.6% (26 km), of the biology downgrades are significant. These improvements are reflected in improvements in fisheries.

The improvements have been achieved by combinations of initiatives to prevent pollution, substantial investment in effluent treatment, and increased river flows since the middle of 1992.

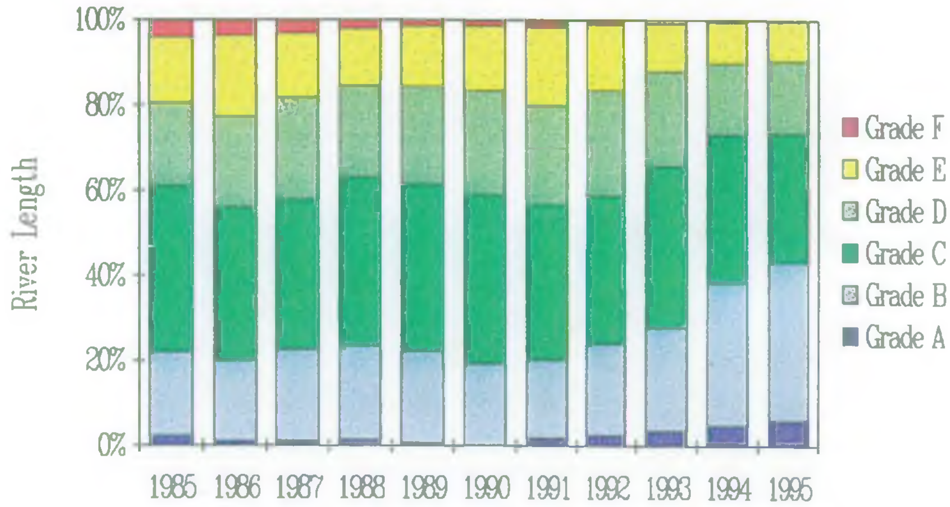
The number of serious pollution incidents has halved since 1990. This is an indication of reduced pressure on our rivers.

We have examined the pollution loads in discharges to rivers from sewage treatment works operated by Anglian Water. We have recorded reductions in the loads since 1990 - 21% for BOD, and 28% for Ammonia (Table A.15 in Appendix A).

The impact of low flow is particularly pronounced in the lowland rivers in Anglian Region. Overall, river flows were greater in the three years ending 1995 than in the three years ending 1990. This contributed to the improved chemical and biological river quality.

When we have reported in the past some of our critics have chosen to attribute all of the improvement to the effect of dry weather on the river quality reported for 1990. Figure 2.1 which shows the change in the GQA since 1985 indicates that this cannot be the case. River flows were important - but not the whole story.

Figure 2.1: Chemical Quality in Anglian Region Since 1983/5



Although most improvements are usually due to combinations of factors, we can differentiate the relative effects of river flows and reduced effluent loads. For example, we recorded an overall improvement of 7% in the biology following the heavy rain in the autumn of 1992. Conversely, taking data for the single calendar years of 1994 and 1995, the dry summer in 1995 is reflected in a net reduction in chemical quality since 1994 of 8.6% of length. This indicates the scale of the effect of year-on-year changes in flow - the pollution load from effluents remained stable from 1994 to 1995. (The effect is reduced for the Chemical GQA by basing results on three years' data).

Also, the average river flows, during the years from 1987 to 1989, were similar to those from 1993 to 1995 but river quality is much better in the recent years. The combination of all the facts supports our contention that the recorded improvements in river quality cannot be ascribed to the weather. They are the results of real reductions in pollution.

Comments on Particular Rivers

Tighter discharge standards, and capital investment by Anglian Water at Marston Sewage Treatment Works, serving Grantham, have resulted in 38 km of the Witham being upgraded from Fair or Fairly Good to Good.

Similarly, improvements at Dunstable have lead to significant chemical and biological improvements to Ouzel Brook, which is part of the Bedford Ouse system. Improvements to 3.5 km of the Yare from Grade D to B, chemically, and **d** to **b**, biologically, followed extensions to Whitlingham Sewage Treatment Works (which serves Norwich).

Improvements can also be achieved by moving a discharge. For example, the diversion of the Harcross industrial discharge from Deanshanger Brook, near Milton Keynes, to the Great Ouse has resulted in big reductions in ammonia concentrations. The biological quality is now Grade **b**, and the relocation has had no detrimental effect on the quality of the Ouse (which also improved for other reasons).

Upgradings have followed improvements to trade discharges, as exemplified by the Wang, in Suffolk. This benefitted from better discharge quality from the Bernard Matthews factory at Holton.

Increased summer flows through the Gwash to Glen river transfer scheme were the main cause of chemical and biological upgrades in the Glen, near Bourne in Lincolnshire. Also in Lincolnshire, the biological and chemical quality of 14 km of the naturally slow-flowing and nutrient-rich Ancholme improved, largely due to increased flows.

The Sincil Dyke, in Lincoln, had previously been Poor along its entire length of 15.3 km. Chemistry and biology grades rose, due to the improved management of sluices, ensuring better flows during dry periods, and also because of reduced loads from Lincoln Sewage Treatment Works.

Similarly, there has been a big improvement in chemical and biological quality throughout most of the Great Ouse catchment, mainly because of the improved quality of effluents discharged by sewage treatment works operated by Anglian Water, but also through improvements to trade discharges, and measures taken to prevent pollution as a result of our inspections of sites.

As expected, not all changes in chemical and biological grades are in the same direction. For example, for 3 km of the Colne upstream of Sible Hedingham, there was a significant deterioration in the Chemical Grade, while the same stretch improved biologically. In this case, the biology responded to reduced concentrations of ammonia, but thick growths of duckweed, coupled with lower flows, resulted in reduced concentrations of Dissolved Oxygen which, although affecting chemical grades, did not limit the animals. Improved river management should alleviate the problem.

A variety of factors caused the three biological downgrades that were statistically significant. These are outlined below.

- Although it improved in chemical quality, a short length of the Grand Union Canal, south of Leighton Buzzard, deteriorated, probably because of poorer habitat.

- About 15 km of Hobhole Drain, near Fishtoft in Lincolnshire, deteriorated from 1990 to 1995. The stretch suffers from low flows, stagnant conditions and sporadic, intermittent organic enrichment.

- Finally, 11 km of the North Gwash in Lincolnshire deteriorated because of storm sewage and urban run-off. Remedial measures are being planned.

Nutrients

From 1990 to 1995, the load of phosphate discharged by the sewage treatment works operated by Anglian Water reduced by 35%. We believe that this is due to a combination of better treatment and reduced use of phosphate in detergents. The change in load contributed to a net move since 1990 of 45% of river length towards grades in the Phosphate Classification characterised by low concentration. Figure F.3 (in Appendix F) indicates that recent values are the lowest since at least 1980.

Prospects

With the reductions in Grant Aid, we may not maintain progress in preventing pollution from farms.

Mostconsents for industrial discharges consents are already set to match the needs of rivers. We shall pursue improvements where necessary.

The overall effect of Anglian Water's present investment programme is expected to be neutral, with reduced impacts from better intermittent discharges being balanced by growth within Consents, at sewage treatment works. We do expect to see improvements to about 100 km of rivers as a result the special part of the investment programme targeted specifically at improvements to river quality.

MIDLANDS

Pressures on Water Quality

This Region comprises the catchments of the Severn and the Trent. It has the second largest area and population of the Agency's regions. It has land use and climate types that range from clean uplands to industrial urban areas. Agriculture is important. Water quality reflects land use and the patterns in the density of population. There are many high quality rivers used for water supply or game fishing, and other rivers suffering from the legacy of industrialisation.

Regeneration and redevelopment of urban areas, particularly the East Midlands, will pose continuing demand on the amount and quality of water resources.

To permit the most appropriate catchment management, the part of the Severn catchment lying in Wales, together with the rest of the Severn is managed by this Region. Conversely the Wye and Dee, though lying partly in England, are managed entirely by Welsh Region.

State of River Quality and the Causes of Change

Since 1990 there has been a sustained improvement. There has been a 26% net upgrading in chemical quality and 22% net upgrading in biological quality.

The trend began in 1991 with a 10% net upgrade in the chemistry. This was repeated in 1992 and 1993 before checking in 1994. A further 3% upgrade between 1994 and 1995 brought the aggregate change of 26% for the period from 1990 to 1995.

Between 1990 and 1995 there was a reduction of more than 50% in the length of Chemical Grade F and a 20% reduction in E. (There was also a 50% reduction in the length in Biological Grade e). These rivers improved mainly to Grades D and C with some to B. Grade A went up by nearly 50% to 10% of the total length.

The improvement of Grade E rivers was seen clearly in 1991 and 1992 when big schemes of capital expenditure were completed by Severn Trent Water. After 1992 there was further movement towards Grade C or better.

The numbers of serious pollution incident has fallen since 1990, despite an increase in the total number of incidents reported.

Pollution was reduced because of the take up by farmers of grants to improve drainage systems. This gave good water quality in rural areas such as the Upper Severn.

1989 and 1990 were dry years with flows down to 75% of the long term average. As a dry year, 1990 was ranked third to 1976. 1991 was also dry with the Trent catchment drier than the Severn. 1992 to 1994 were average or wetter than average years. 1995 was second to 1976 in the severity of its drought. Net upgradings reported for 1991, 1992 and 1993 are caused by a combination of improvements at sewage works which were largely complete by 1992, and by the loss of data from drought years from the three year blocks used for grading.

Comments on Particular Rivers

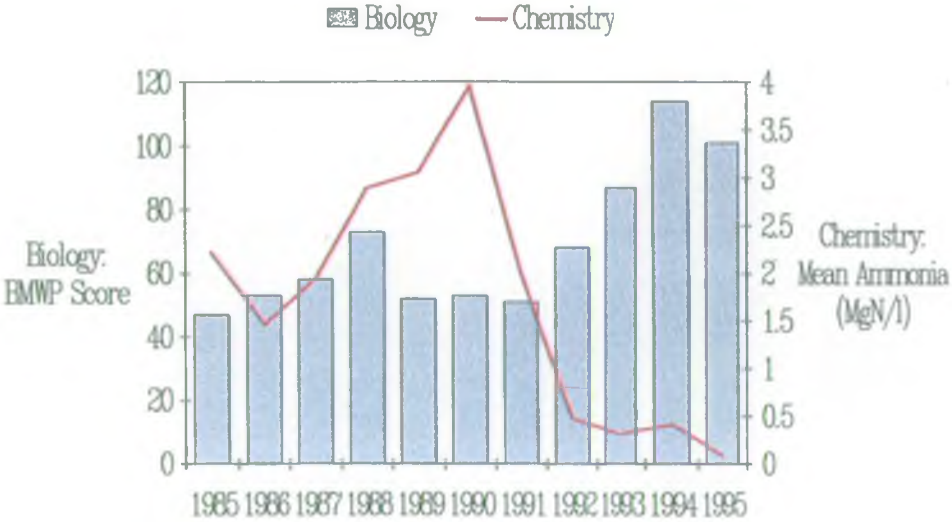
Deteriorations in the Avon, Trent and Soar were reversed following expenditure by Severn Trent Water on sewage treatment at Nottingham, Coventry and Leicester. Improvements at more than 400 sewage works has resulted in better effluents, high levels of compliance with Consents, and better rivers. This effect is more marked in the Trent catchment that the Severn because the Trent drains a greater population and the sewage effluents have more influence.

The control of drainage from industry and mine spoil heaps has led to biological improvements in the Afon Cerist in mid Wales. Baker Lane Brook near Nottingham has shown a progressive biological improvement since 1987. Biological tracing of intermittent pesticide pollution has led to improvement, for example, in the Noe in the Peak District.

For most of its length the Trent has enhanced biology and an improved fishery. In the area of Stoke there has been an improvement of two Grades in the chemistry but biological quality is only Grade f because of effects like intermittent discharges from *combined sewer overflows*.

From the Tame confluence to its tidal limit, the Trent is at least 2 Chemical Grades better and the biology is much improved. The quality of the Wreake improved because of better effluent from Melton Mowbray Sewage Treatment Works (Figure 2.2).

Figure 2.2: Improvement in the River Wreake at Kirby Bellars



Saredon Brook, south of Stafford, flows into the Penk, which is a tributary of the Sow. It has been Poor or Bad for several years. Following the rebuilding of Cannock Sewage Treatment Works and work to control pollution upstream of Cannock, 4 km of river improved from F to C and 33 km of E or D improved to C or better. The fishery and amenity value of the river is enhanced. Some biological improvement has occurred but the biology has not responded as quickly as the chemical quality possibly due to storm overflows. Further improvements are expected by the next five year survey.

In Staffordshire, the Churnet was badly polluted through Leek and Cheddleton prior to improvements at the sewage works. The river is now Good with a diverse biology. Downstream, this secures the use of the Dove as a source of drinking water.

No clear pattern is seen in the reasons for downgradings in chemistry. Some are because of a single unusual result. In the upper part of the Severn, low flows in 1995 affected quality. Scotia Brook in the Burslem area was downgraded to F because of combined sewer overflows, which have now been rectified.

The worst downgradings biologically have occurred below sewage works in small streams where there have been low flows and little dilution during the drought year (for example, Blakedown Brook near Kidderminster). Two stretches on the Eau near Scunthorpe were downgraded due to a farm pesticide traced by biological investigation.

Some lowland rivers like the Avon at Stratford and the Meese in Shropshire have diverse fauna but algae increased the BOD giving a poor chemical grade.

Chemical grades are based on data from 3 years but only one year is used for biology. A new sewage treatment works at Eccleshall on the Sow was commissioned in 1994 giving improved quality in 1995, which was reflected in the biology but not the chemistry.

There are a number of reasons for several sites where the Biology is worse than Chemistry. These include overflows from sewers and urban run-off in the Trent at Stoke, low flows in the Worfe near Telford, toxic effects not detected by the Chemical GQA in Cannop Brook in the Forest of Dean, agricultural problems from diffuse sources in the Leadon in Herefordshire, and disturbance to the river bed by road construction in the Longton Brook in Stoke.

In the headwaters of the Severn there is acidification. Afon Twrch near Lake Vyrnwy was Grade A chemistry with biology of **c**. Use of lime has now improved the biology to **b**.

Nutrients

Concentrations of phosphate have decreased since 1990. In some cases they have halved. However many of our rivers and canals are typical of nutrient enriched watercourses. This is because of their lowland nature and the high proportion of treated effluent, particularly in the Trent catchment.

Aesthetic

Monitoring at 200 sites has shown a link between the measurement of litter, oil, odour (and other factors important to the public perception of amenity) and known sources of pollution such as combined sewer overflows. We plan to use this aspect of the GQA to check progress in improving sewerage systems and tackling other aesthetic problems.

Prospects

As a result of expenditure on sewage treatment by Severn Trent Water of £194m on the Tame, Erewash, Stour and Chelt, 220 km of river are expected to improve. This will remedy long standing problems and will also benefit the downstream stretches of the Severn and Trent.

The requirements under the Urban Waste Water Directive to reduce nutrients in the Avon will be met by Severn Trent Water through the provision of treatment at several works. This will reduce phosphorus, and improve other aspects of the effluents. Reduction in colour on the Soar may make it more susceptible to eutrophication. This will require careful monitoring.

As a result of the move to better water quality in the Trent it is becoming a more likely that the river will be suitable for large scale use for public water supply.

Farm grants have led to improvements in rural areas. These grants have now ended and there is a risk that upgradings will reverse as farm schemes become less effective. Extra action by the Agency will be needed to counter this risk.

Most of the larger sewage treatment works produce effluents that are better than required by their Consents. Whilst it is likely that these effluents will continue to operated to give the present high quality, the Agency has no legal power to insist that this happens. Were effluent quality to deteriorate to the level defined in the Consents, this would lead to downgrades for several hundred kilometres of rivers. This issue will be one of our priorities for discussions on the future investment programme of Severn Trent Water. At the same time we shall seek improvements to more combined sewer overflows.

NORTH EAST

Pressures on Water Quality

This Region combines areas reported separately in previous surveys as Northumbria and Yorkshire. Discharges of sewage effluent have a big impact on river water quality because of low dilution.

Yorkshire Water applied for Drought Orders on several catchments. This resulted in lower river flows because of reductions in the compensation flows released to rivers by reservoirs. The low flows continued through the dry summer and equally dry winter. This caused a reversal in 1995 of some of the improvements recorded from 1990 to 1994.

Monitoring

We have increased chemical coverage from 4350 km in 1990 to 6008 km in 1995. Coverage for biology has changed since 1990 from 4132 km to 5463 km in 1995.

State of River Quality and the Causes of Change

We have recorded net improvement of 25% in the chemical quality of rivers and a parallel improvement of 25% in the biology (Appendix A.9a)[3].

The length of river graded Bad chemically has reduced by over 50%. The length now graded Good (A or B) is over 50% of the total (3702 km). These rivers are mainly in the north of the Region.

The improvement in river quality is supported by an equivalent improvement in the performance of sewage treatment works operated by the Water Companies (the number of failed works has reduced from 16.4% to 4.6% since 1990).

The number of substantiated pollution incidents fell from 3243 in 1990 to 2576 in 1995.

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[3] As for other Regions, the figure for biology is corrected for bias. The apparent improvement shown by the uncorrected figures for the rivers in the old Northumbria Region (Northumberland plus the Tees) is due in part to an improvement in analytical quality and should be treated with caution.

Comments on Particular Rivers

Almost 40 km of the Rother (Chesterfield) improved from E and F to D. This is because of the upgrading by Yorkshire Water of Old Whittington Sewage Treatment Works, improvements at Rhone Poulenc Chemical Works, and improvements in the quality of a major tributary, the Doe Lea. The latter is the result of better effluents from Stavely Sewage Treatment Works and Coalite Chemicals.

There have been big improvements in the industrial rivers in West and South Yorkshire. Twenty-four km of the Don (Sheffield and Doncaster) have improved chemically from E to D and 7 km from F to E and D. This is mainly the result of improved effluent quality at Blackburn Meadows Sewage Treatment Works. There has been a similar, though smaller, improvement biologically. The Don now supports a thriving population of coarse fish.

For the Wear, 9.5 km improved chemically from C to A, 11 km from D to B, and 21.7 km from C to B. These improvements reflect the better effluent quality from Bishop Auckland (Vinovium) Sewage Treatment Works.

Improvements did occur despite Drought Orders where sewage treatment works have tight Consents and where dilution is high. An example is the Wharfe (Otley, near Leeds) where improvements have reversed recent worrying trends of deterioration. Better sewage treatment led to 10.3 km of improvements from C to A.

Stretches of the Hull and the West Beck (Driffield, Yorkshire) were downgraded from B to D for 14 km. This was due to low flows and over abstraction in 1995, resulting in lack of dilution for the effluents from fish farms.

For the Dodworth Dyke (Barnsley), a reduction in minewater flows due to cessation of pumping following the closure of collieries resulted in a chemical downgrading from Grade E to F for 1 km. This may also have an impact on Worsborough Reservoir, a high class coarse fishery. This situation should improve when a scheme involving Dodworth Sewage Treatment Works is commissioned in 1997.

Improvements in biology have generally mirrored the improvements in chemistry. Where there are discrepancies then these are usually explained by:

- intermittent pollution not well captured by chemical sampling;
- pollutants not part of the Chemical GQA but which affect biology. For example pesticides and heavy metals; or,
- poor quality sediments on the river bed, resulting from historic pollution. This affects the biota not the water quality.

We have recorded a reduction in the number of breaches of *Environmental Quality Standards* for List 1 and 2 Substances - 27 failures in 1995 compared with 42 in 1993. These reductions, particularly for mothproofers, have resulted in improvements in biology because these compounds are insecticides. The big users of mothproofers are in the Calder Catchment. The tributaries here show the biggest differences between chemistry and biology, probably because the sediments are still contaminated. This may continue to influence the biology for several years. We are looking at measures to deal with the contaminated sediments.

Prospects

The Aire is influenced by the effluents from sewage treatment works that contain a high proportion of industrial effluent. The quality has improved over the last 5 years and further improvements will follow capital schemes by Yorkshire Water for sewage treatment works at Esholt (Bradford), Marley (Keighley) and ultimately Knostrop (Leeds). These will be commissioned as we approach 2000.

This work coupled with a scheme at Huddersfield will change lengths of Grade E and F to Grades C and D and make them capable of supporting fish.

We expect further improvements as Yorkshire Water and Northumbria Water complete schemes for improved sewage treatment and action on combined sewer overflows. Yorkshire Water was allowed to spend £60 million over the next four years as part of the capital programme agreed for special improvements to river quality.

Schemes at the larger sewage treatment works started in 1996 with a view to completion by 1998. Additionally, expenditure for the *Urban Waste Water Treatment* Directive and on combined sewer overflows will improve river quality over the next five years.

Campaigns to target pollution Hot-Spots will continue and may result in local benefits but are unlikely to lead to improvements as big as those produced by expenditure by the Water Companies.

The introduction of Toxicity Based Consents will be particularly beneficial in this Region. Also, new Authorizations under Integrated Pollution Control and more general initiatives to minimise all the waste produced by industry (Waste Minimisation), should mean further improvements.

NORTH WEST

Pressures on Water Quality

Water quality ranges from the high quality salmon rivers in the Lake District to the more polluted areas of the Mersey Basin. Some of our densely populated areas are characterised by pollution from overflows from sewers, discharges from large sewage works and the impacts of major industries. The rural areas can be affected by acid rain and by pollution from farms.

There is a comprehensive network of motorways and the number of transport-related pollution incidents has increased from 66 to 221 from 1993 to 1995.

In addition, demands on water resources have been substantial during 1995 and Drought Orders have been issued in several areas of Lancashire, Cheshire and the Lake District.

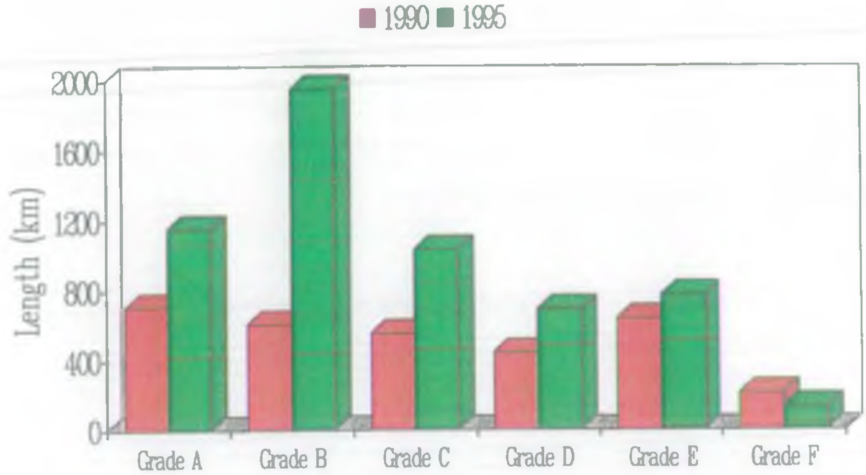
Monitoring

There has been an increase of 2500 km since 1990 in the length of river monitored chemically for the GQA. The total length is now 5745 km.

State of River Quality and the Causes of Change

Since 1990, 33% of classified river length has improved in chemical quality while 18.5% has deteriorated. The net overall improvement is therefore 14.5%. Figure 2.3 shows the length of river in each grade in 1990 and 1995. The length classed as Poor or Bad (Grades E and F) has fallen from 209 km to 132 km despite an increase in the length of river monitored.

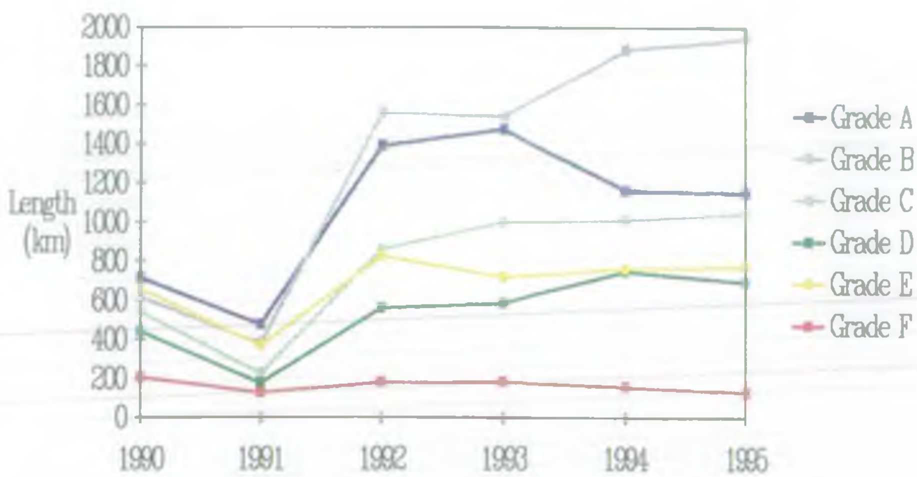
Figure 2.3: Length of River in Each Chemical Grade in North West Region



Within the 33% of improvement, 302 km of river length has improved with 95% confidence (Table A.5 in Appendix A). There are no significant downgrades.

Although the net change from 1990 to 1995 has been an improvement, water quality fluctuated from year to year within these five years (Figure 2.4). For example, from 1994 to 1995 there was a net deterioration in chemical quality. A lot of this was caused by low flows during the summer of 1995, particularly in the smaller rivers in the north of our Region.

Figure 2.4: Quality in North West Region in each year from 1990 to 1995



The large net improvement in biological quality of 53% (Table A.9, Appendix A) is attributable, in part, to a change in this Region in the way biological data are collected. When corrected for this difference the net change is 30% (Table A.9a, Appendix A).

Comments on Particular Rivers

The main improvements are associated with investment by North West Water in sewerage and sewage treatment. The Oldham Deep Interceptor sewer scheme produced an improvement in chemical quality of 6.8 km of the Medlock from Grade F to C. Improvements at Rochdale Sewage Treatment Works, together with improvements in sewerage, account for an upgrading in chemical quality of 15.2 km of the Roch from F to D.

Also of note is an improvement from E to C of 7 km of the Yarrow. This was due to better effluent quality from Chorley Sewage Treatment Works. Work at Hyndburn Sewage Treatment Works has resulted in improvements to 10 km of the Calder. Young salmon have recently been found for the first time.

The tighter control of sewage discharges has meant an improvement in compliance with Consents of nearly 9% since 1990. Our pollution control activities including liaison with farmers and enforcement campaigns together with targeting of industrial sites have also been instrumental in effecting improvements. For example, 1.2 km of Cargo Beck near Carlisle improved from 1994 to 1995 due to work at an industrial estate.

Similarly, Croxteth Brook, a tributary of the Alt, improved due to action centred on a number of trade premises on Knowsley industrial estate. Several watercourses in the Brock catchment have shown improvements as a result of our special campaigns to control pollution control and farm wastes.

Although none of the 18.5% of chemical downgrades was statistically significant, some of these downgrades appeared due to storm overflows. Others appeared to result from diffuse pollution from agriculture, and the effect of algae on the measurement of BOD.

The effect of algae on the measurement of BOD contributed to a deterioration of over 60 km of the Leeds and Liverpool Canal.

We have a number of sites where the chemical and biological quality differs. In some this is due to intermittent pollution. In other cases, it is the effect of pollutants not included in the Chemical GQA. For example, the upper reaches of the Esk are affected by acid rain, and the quality of the Irwell reflects toxic effluents from industry. (The total of industrial pollution incidents within the Region has increased from 1990 to 1995).

Solids can affect biological communities. In the Whit Beck the river bed is smothered by powdery solids. This produces poor biology, whilst the Chemical Grade remains good.

Aesthetic

The results have demonstrated the poor quality of some rivers. Monitoring at 40 sites has indicated the link between the measurement of litter, oil, odour (and other factors important to the public perception of amenity) and known sources of pollution such as combined sewer overflows.

Prospects

Despite a reduction in the length rivers graded Bad there are still some stretches which need attention in the future. We have boosted our chemical monitoring so that we are better placed to develop plans for action.

A continuing level of investment in sewage disposal and the application of tighter standards to industry should help to continue the trend of improvement. In particular, £450 million is to be spent on resolving unsatisfactory storm overflows, and sewerage schemes in Greater Manchester will lead to improvements in the Irk and Medlock.

£130 million of expenditure by North West Water on sewage treatment, concentrated on the area of the Mersey Basin, will also improve water quality. *Alt 2000*, a campaign to restore one of Merseyside's major rivers to an acceptable standard of water quality, will involve schemes at Hillhouse, Liverpool North and Ainsdale Sewage Treatment Works.

In addition, as part of the investment by North West Water for the Directive on *Urban Waste Water Treatment*, nutrient removal will be carried out at a number of sewage treatment works including Keswick, Windermere, Barnoldswick, Horwich and Settle.

The withdrawal of government grants for investment in pollution control at farms could affect water quality in future and we shall maintain our initiatives to control pollution from agriculture. Pollution incidents from agriculture have decreased by 40% since 1991.

Other future initiatives include a campaign on rural sewage, campaigns to investigate contaminated surface waters, and a project on the problems with sediments in the Manchester Ship Canal. We shall continue to develop our present range of pollution control activities and apply them to the risks imposed from industry, sewage and agriculture

SOUTHERN

Pressures on Water Quality

The Region has a high resident population of 4.6 million which rises to 10.5 million in the holiday season. Rivers are used heavily for water abstraction, effluent disposal, and amenity.

We have looked in detail at the stretches of rivers that need improvement. Generally the problems are caused by sewage treatment works, farm drainage, or waste disposal sites.

Monitoring

The biological network was revised for 1995 to ensure comparability with the chemical sampling points. This resulted in 345 of the 528 stretches (1526.1 km) being comparable for 1990 and 1995. However, these are representative of the Region.

State of River Quality and the Causes of Change

Table 11 shows that there has been a 17.8% net improvement in chemical quality since 1990. For the biology, there was a net improvement of 29%.

92% of river length is Very Good to Fair. The length of Poor and Bad quality fell, whilst the length of Grade A and B rose. Only 20 km remains in Grade F. 78.8% of rivers and canals were in Biological Grades **a** or **b**. Only 1.5% were in **e** or **f**.

The net chemical improvement of 22.4% recorded between 1990 and 1994 was bigger than that recorded from 1990 to 1995. The reduction between 1994 and 1995 was due to the drought which resulted in less dilution for discharges in 1995.

Our policy of targeting discharges of poor performance, pollution prevention campaigns and site visits, farm inspections, and enforcement action, together with capital investment made by Southern Water, Industry, and Agriculture also contributed to the improvement. In 1995, 98.6% of Southern Water's discharges complied with the key standards in today's Consents compared with 92.6% in 1990 (Figure 12; and Table A.15 in Appendix A give background)

From 1993 to 1995, the number of substantiated pollution incidents declined from 1355 to 1235 but incidents attributable to pollution from sewage increased from 215 to 351.

Some of the improvement in the biology was due to recovery from the low flows of 1990 when increased siltation degraded river habitats.

Comments on Particular Rivers

Water quality in Hampshire was generally very good throughout 1988/90 and 1993/5. The major chalk streams suffered some minor reduction in quality during droughts, but the flows were always sufficient to maintain good quality. The minor catchments were also affected by low flows, notably in 1994. However, unlike in other parts of the Region, increased rainfall in Hampshire in 1995 restored quality.

Catchments in the Isle of Wight followed a similar pattern. Water quality for the Hamble benefited from the construction of the new sewage treatment works at Bishops Waltham, and action to prevent farm pollution. 4.8 km improved from Grade D to B. Two km of the Lymington changed from D to C because of improvements at Brockenhurst Sewage Treatment Works. Improvements by industry and at farms led to better quality in many other catchments.

Biological quality in Hampshire in 1995 was generally very good with 518 km (of a total of 707 km) in Grades **a** or **b**, only 8.8 km in Grade **e** and none in **f**. The invertebrate communities in the Test and Itchen are among the most diverse to be found anywhere in England and Wales. All sites were Biological Grade **a** except the two sites on the Test below the discharge from Portals (Holdings) Ltd which were Grade **b**.

Improvements in Hampshire totalled 95 km, many being small rivers that were affected by low flows in 1990. Both sites on the Hamble had excellent biological quality and other surveys have shown a significant improvement after construction of the new works for Bishops Waltham.

The biological quality of the Isle of Wight was generally unsatisfactory in 1995 with no class **a** stretches, only 16.7 km in **b**, and 10 km in **e** and **f** (of a total; of 87.5 km). In addition, there was a small deterioration between 1990 and 1995. Much of the poor quality was in small streams offering minimal dilution to discharges of sewage.

The effects of low flows were also noticeable in Sussex. Increased algal productivity led to poorer quality. Improvements by Southern Water to Uckfield Sewage Treatment Works improved 5.2 km of the Uck. The diversion of flows from Burgess Hill Sewage Treatment Works improved 2.2 km of the Adur East to Grade C chemically whilst the biology was Grade **a**. Improvements at sewage treatment works at Pulborough and Liss improved a further 5.7 km.

Biological quality was consistently good in Sussex with 90.6% of stretches in **a** or **b** and none worse than **d**. In addition, there was a net upgrade of 154 km (26.2%). Some of the sites on the West Sussex Rother are outstanding. The Sussex Rifes are generally only of moderate biological quality due largely to run-off from an area of intensive agriculture.

Low flows had their greatest impact in Kent. Conversely, Kent benefited most from increased rainfall. Investment by Southern Water in sewage treatment was also a factor. An additional 40 km achieved Grade A and an additional 120 km reached B.

Biological quality in Kent was generally good with 77% of a total of 812 km in Grades **a** and **b**, and only 14.8 km in **e** and **f**. Most of the poorer stretches are on small streams receiving effluent from sewage treatment works but giving little dilution.

Improvements in Kent were noted as a result of increased investment by Southern Water, and our initiative of targeting discharges of poor quality and enforcing consent conditions. Water quality improvements were noted downstream of sewage treatment works at Tenterden, Redgate Mill, Leeds, Tunbridge Wells South, Iden Green, West Hoathly, Wadhurst, Guestling, Luxfords Lane, Battle, Lenham, Canterbury, Sellindge, Charing, Kilndown, and Lingfield.

Improvements by Southern Water at sewage treatment works at Robertsbridge and Biddenden also improved river quality, whilst the diversion of flows from Boughton Sewage Treatment Works improved the White Drain. Biological quality also improved downstream of many of these works notably Luxfords Lane which changed from **e** to **b**.

Further improvements took place at sewage treatment works at Bank, Eastry, Romsey, Calbourne, Ham Street, and Shrub Lane/Burwash. Farm campaigns and improvements to discharges have resulted in better quality in the Alver, Beult, Eden, Eden Brook, Len, Little Stour, and Rodge Brook. Leachate from Lynn Bottom refuse tip is now discharged to sewer. This secured improvements in the Palmers Brook on the Isle of Wight. Action is being taken to deal with problems of leachate in the Weston Common Stream in Southampton.

For the significant downgrades, many were due to natural variation in water quality, or resulted from low flows which encouraged exceptional growth of algae or duckweed in 1995.

In other instances, illegal discharges were responsible, but action has been taken already to stop these. Examples are 1.3 km of the Alre in Hampshire where quality fell from A to D and 1.5 km of the High Halden Stream in Kent changed from E to F. In other cases, action is in hand, or investigations are planned, to examine why quality has declined.

Only 10 stretches in Kent and 22 in the Region deteriorated biologically, all by one grade except for the Jury's Gut Sewer (which runs through the Romney Marshes) which changed from Grade a to c possibly because of saline influences.

Nutrients

Phosphate concentrations show a net reduction of approximately 36% between 1990 and 1995. We believe that this due to a combination of increased river flows and reduced use of phosphate.

Prospects

£10 million is available under the Southern Water's capital programme for achieving River Quality Objectives. This sum will be spent at sewage treatment works at Paddock Wood, Pembury, and Tunbridge Wells North.

There are two sites for which approval has been given by the Secretary of State for nutrient stripping under the *Urban Waste Water Treatment* Directive. This will require additional treatment by Southern Water at sewage works at Andover which discharges to the Test, and Ashford, which discharges to the Great Stour. These developments will take place by the end of 1998. Studies are under way for other works to establish whether nutrient removal is required under the Directive.

SOUTH WEST

Pressures on Water Quality

This Region combines areas reported separately in previous surveys as South West and Wessex.

The Region contains a rich and varied landscape including the National Parks of Exmoor, Dartmoor and part of the New Forest together with 27 Areas of Outstanding Natural Beauty. The countryside supports a rich diversity of animals and plants much of which depends on the quality of rivers.

State of River Quality and the Causes of Change

Since 1990, there has been a 28% net improvement in chemical quality and a net improvement of 21% in biology. More than a third of all improvements were detected both chemically and biologically. The 1995 results show that 92.7% of river lengths are classified as Very Good to Fairly Good chemically, and 97% was Fairly Good or better, biologically.

The length of river showing a statistically significant improvement is 10.1% chemically (Table A.5) and 8.4% biologically (Table A.10a)[4]. Compliance with the Fisheries Directive has also improved, further supporting the trend.

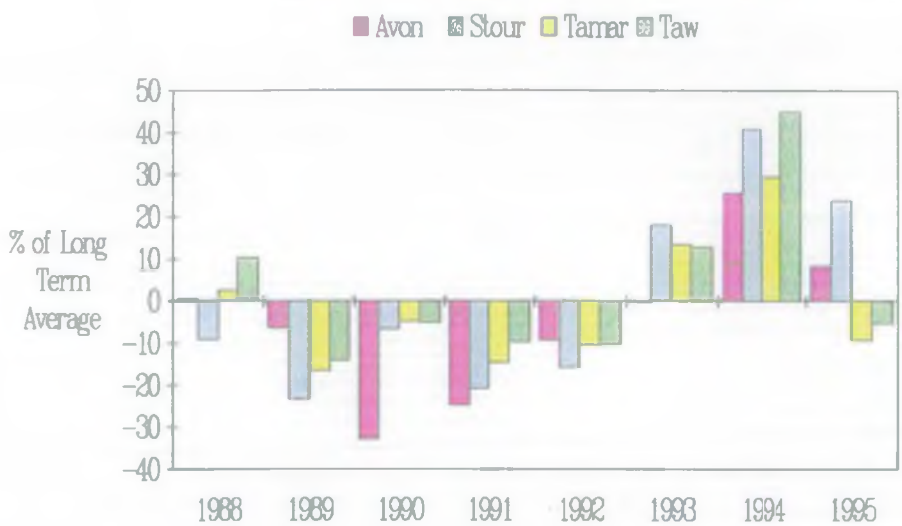
In 1995, about 1% of river length appeared to have a Chemical Grade that was statistically different from its Biological Grade. Most of these differences are due to one of the following:

- pollution from mining, affecting many Cornish streams;
- the effects of contaminated land; or,
- the impact of industrial discharges (such as the China Clay industry).

These three types of pollution are not always detected up by the Chemical GQA, but the Biological GQA is very sensitive to them.

Both surveys included periods of drought. River flows were below the long term average during 1989-92 and again in 1995 (Figure 2.5). Low flows, high water temperatures and lack of dilution during 1995 encouraged algal blooms. Significant blooms were detected in the Tamar (Cornwall), Taw, Torridge (Devon), Frome (Somerset) and Bristol Avon. Recovery from the 1989/90 droughts was slow, particularly in the groundwater fed catchments in Wiltshire, Avon and Dorset.

Figure 2.5: Average River Flows in South West Region



Our inspection of data for the individual years from 1990 to 1995 shows that the rate of improvement may be slowing down. This is not surprising given the significant improvements in the quality made earlier in the period.

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[4] As for other Regions, the figure for biology is corrected for bias. The apparent improvement shown by the uncorrected figures for the rivers in the old Wessex Region is due in part to an improvement in analytical quality and should be treated with caution.

The total number of serious pollution incidents and the number of these caused by agriculture decreased between 1991 and 1995. The introduction of the Farm Waste Regulations in 1991 has contributed to better water quality. However, remedies for transient or diffuse pollution present a longer term challenge.

Comments on Particular Rivers

Since 1990 there has been a net improvement of 55% (164 km) in the Bristol Avon. Today 38% (115 km) of the Upper Bristol Avon is Good or Very Good. A further 40% (121 km) is Fairly Good. These improvements have been complemented by our enforcement action, by working with dischargers on initiatives to prevent pollution, and by campaigns to reduce pollution from farms in the Daunstsey catchment.

As a result of poor quality in the Naddrid Water (Devon), we worked with the industrial discharger (Caberboard Ltd) and a treatment plant was installed in 1993. 7.8 km of river improved from Fair to Good.

We set up a special task force to work on the Kensey (Cornwall). The group identified problems at farms and pollution risks from industry. This led to action and improvements. The sewage treated at the Tregadillet Works has been redirected to Launceston. The river is now Good or better along its 10.2 km length.

South West Water has carried out works at Mylor Bridge Sewage Treatment Works (Cornwall). This has resulted in the upgrading from E to A of 1.6 km of the Mylor Stream.

In 1992 Wessex Waters' Palmersford Sewage Treatment Works was diverted from the Moors River to the Stour (Dorset). Since then, water quality in the Moors River has improved to Good particularly the 4.1 km nearest the site of the old works.

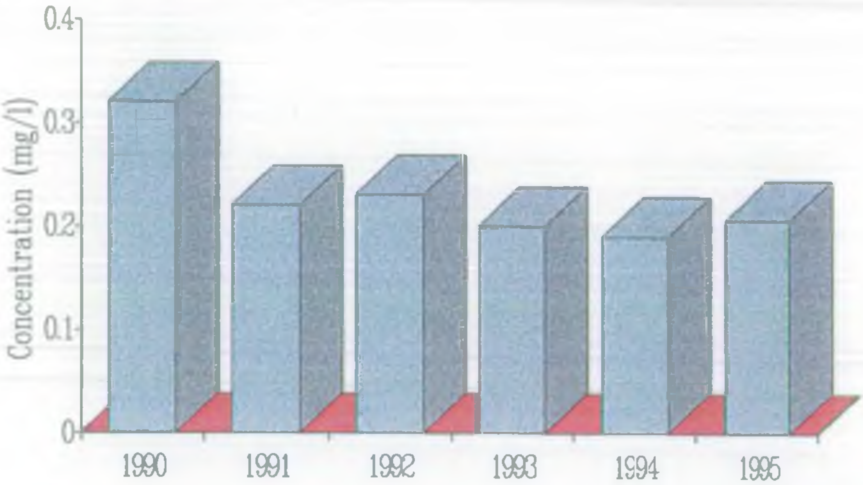
Many of the stretches that were reported poor in 1990 have been investigated and remedial measures are now in place. For example the downgrading of 3.3 km of the Hampshire Avon was attributed to Salisbury Sewage Treatment Works. This receives inadequate dilution for much of the year because of variable river flows. The flow regime is affected by the frequent flooding of water meadows and a licensed abstraction for a fish farm. These can remove more that half the river flow. Improvements are being made to the sewage works. These will completed in 1996. We shall also control river flow to ensure sufficient dilution is maintained.

A mink farm adjacent to the Tamar (Cornwall, above the Upper Tamar Lake) was recently identified as contributing to high ammonia during wet weather. This resulted in 4.4 km of Poor quality. The causes of pollution were inadequate drainage and poor interception of waste. A successful prosecution has resulted in improvements.

Nutrients

We recorded a net improvement of 22% towards grades in the Phosphate Classification characterised by low concentration. Phosphate concentrations were elevated in 1984, 1989 and 1990 (Figure 2.6), periods associated with drought, but the trend is towards reduced phosphate loading to rivers.

Figure 2.6: Annual Average Phosphate in Rivers in South West Region



Prospects

Measures are being planned to address a number of deteriorations. As an illustration, 18 km of the Yeo (Barnstaple) has deteriorated from Good to Fair. An investigation has revealed sources of agricultural pollution. A programme of works has been agreed which will be completed in 1996.

Another example is the plan to resolve problems associated with high levels of nutrients in the King Sedgemoor Drain (Somerset Levels). These originate from farms. We expect that enforcement will prevent further pollution.

The Aesthetics GQA will help us monitor the impacts from intermittent discharges such as *combined sewer overflows*, and help target resources to tackle the priorities.

The benefits of the 1991 Farm Waste Regulations are clear in terms of contribution to water quality. However, the Grant Aid underpinning the work ended in 1994. Since then there has been a reduction in the number of improvement schemes and Farm Management Waste Plans submitted to the Agency. This is a concern. We shall continue to promote the benefits to farmers, and shall remain vigilant. We shall enforce measures to prevent pollution by the use of our task forces to investigate catchments, and by programmes of visits to farms.

The full benefits of capital investment by the Wessex Water and South West Water have yet to be realised. We anticipate these will come through over the next few years. We are planning for the next cycle of investment.

We expect to make further nominations in 1997 for Eutrophic Sensitive Waters and Nitrate Vulnerable Zones (under the Urban Waste Water Treatment Directive and the Nitrate Directive, respectively). These will lead to more control of inputs of nutrients.

THAMES

Pressures on Water Quality

With 11.8 million people living in the Region the main pressures continue to stem from urbanisation and development, and the increasing demand on water resources. Rivers are used heavily for water abstraction, effluent disposal, and amenity.

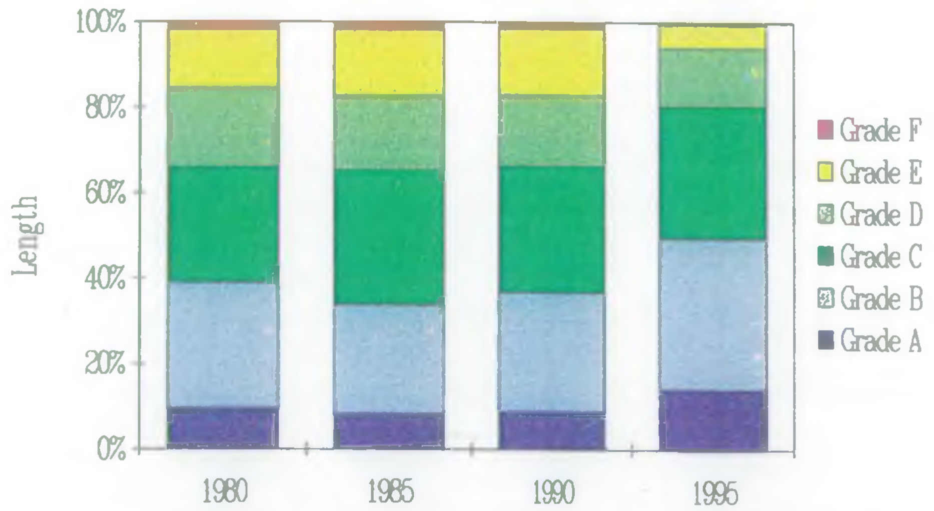
State of River Quality and the Causes of Change

The quality of rivers and canals has improved since 1990. This has been brought about by substantial investment by the Water Companies in improved sewage treatment, increased river flows since the end of the drought in 1990 and 1991, and initiatives to prevent pollution.

Since 1990, 43% of classified river length has improved in quality while 14% has deteriorated. The net overall improvement has therefore been 29%. In particular, the length classed as Very Good or Good (Grades A and B) has increased from 37% to 49%, while the length classed as Poor or Bad (Grades E and F) has fallen from 17% to 6%. There has also been a corresponding net improvement in biological quality of 22%. The length graded Poor or Bad (Grades e and f) has fallen from 11% to 5%.

The improvement in river water quality can also be seen over a longer period of time. Figure 2.7 below shows that river quality is now better than at anytime since at least the late 1970s (the earliest date for which we can assess the GQA from past data).

Figure 2.7: Chemical Quality in Thames Region Since 1980



Since 1990, the quality of effluent discharged from sewage treatment works has improved. The percentage of sewage treatment works which fail to meet the quality conditions in today's discharge consents has fallen from 12% to 2%.

Comments on Particular Rivers

The chemical and biological quality of the Lee improved for 80% (74 km) and 66% (61 km) of its length respectively. The upgrade can be attributed to a number of factors including measures in the Luton Area to prevent pollution, improved quality from Luton Sewage Treatment Works, and river flows that are bigger than for 1990.

The Blackwater improved both chemically and biologically due to extensions by Thames Water at Aldershot and Camberley Sewage Treatment Works, as did the Chess due to substantial improvements in the quality of effluent discharged from Chesham Sewage Treatment Works. Higher groundwater levels also increased base flow in the Chess.

The Ray in Wiltshire has shown improvements to both biology and chemistry over a 17 km length due to the upgrading by Thames Water of Swindon Sewage Treatment Works. This was also reflected in an improvement in the chemical quality of the Thames for 37 km between its confluence with the Ray and Shifford Weir.

The upgrade from E to C in the quality of 17 km of the Cherwell below Banbury (Oxfordshire) is attributed to improved effluent quality from Banbury Sewage Treatment Works following investment by Thames Water in new plant.

The quality of 12 km of the Burstow stream above Burstow (Surrey) improved from F to C following the closure of Copthorne sewage works in 1989. A new sewage treatment plant at Rhone Poulenc resulted in an improvement in the biological quality of the Roding at High Ongar (Essex) from **d** to grade **a**.

Deteriorations in quality have been much fewer than the improvements, and where they occur are generally on short lengths of tributary streams. In a number of cases, the downgrading was caused by algal growth in the summer months which resulted in highly variable concentrations of dissolved oxygen and elevated measurements of BOD.

Specific rivers where this has occurred are the Kennet & Avon Canal between Crofton and Kintbury (20 km), the Thames between the Kennet at Reading and the Fawley Court Stream (15 km), and the Tykeswater (Hertfordshire) between Aldenham and the Colne (8 km).

The upper stretch of the Fleet Brook (Hampshire) above Fleet Sewage Treatment Works (6 km) deteriorated due to groundwater leachate from a landfill site. Plans are in preparation to carry out remedial work at the landfill site by 2001.

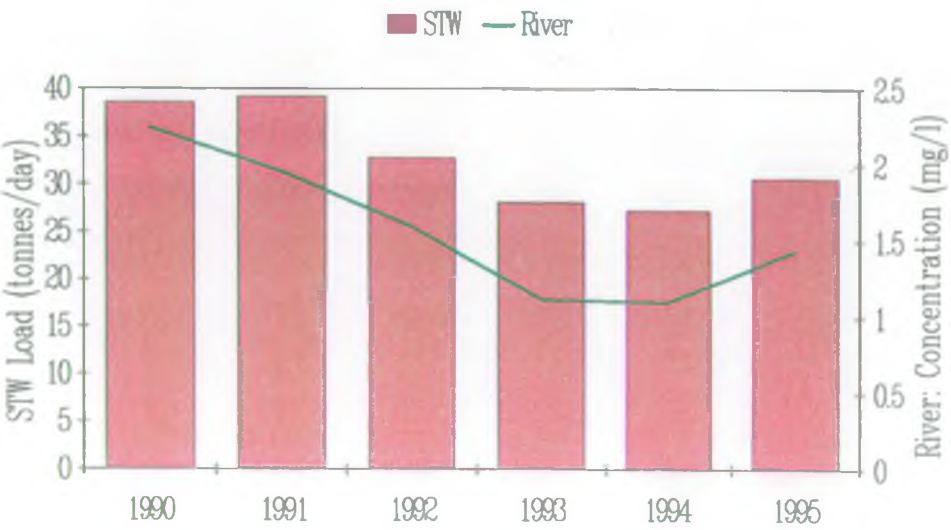
In some urban streams, biological quality is worse than chemical quality due to the intermittent effects of urban run-off and storm overflows. This is evident in the Salmon Brook and Pymmes Brook (Enfield).

A 5 km stretch of the Letcombe Brook above Wantage (Oxfordshire) was downgraded chemically due to intermittent storm discharges from the foul sewer in 1993. Remedial measures have been undertaken more recently and this is reflected in an upgrading in biological quality in 1995.

Nutrients

The concentration of phosphate in rivers has also fallen since 1990. Between 1990 and 1994 the average concentration of phosphate at a number of strategic monitoring points fell by 50%. The concentration of phosphate in discharges from sewage treatment works operated by Thames Water decreased over the same period. We believe this is may be a bi-product of better sewage treatment and to the reduced use of phosphate in detergents. Figure 2.8 shows the reduction in the load of phosphate discharged in total by sewage treatment works serving more than 10,000 people, and the reduction in the river of the average concentration of phosphate. Figure F.3 (in Appendix F) indicates that recent concentrations in rivers are the lowest since 1981.

Figure 2.8: Phosphate in Effluents and Rivers in Thames Region



Prospects

Thames Water has agreed a programme of capital expenditure over the next ten years which includes extensions or improvements to 137 sewage treatment works discharging to rivers. This should further improve and maintain river water quality, although this may be offset by development pressures and an increasing demand on water resources.

As has already been emphasised, year to year changes in the reported quality of rivers can be caused by patterns in the weather. The dry summer of 1995 reduced the overall net improvement in water quality to 29% from the 35% we reported for 1994. Future climate change may reduce base river flows which would adversely affect water quality, particularly in headwaters fed by groundwater springs.

Under the *Urban Waste Water Treatment* Directive, phosphate removal is required at qualifying sewage treatment works discharging to *eutrophic* rivers. Four sewage treatment works have been identified: Aldershot Town, Aldershot Military and Ash Vale which discharge to the Blackwater, and Alton which discharges to the Wey. Work by Thames Water is expected to be completed by the end of 1998. The reduction in phosphate loads discharged to rivers should ensure long term improvements to water quality by limiting excessive growths of aquatic plants and algae during the summer months.

WELSH

Pressures on Water Quality

Welsh Region has a relatively low density of population which is concentrated in South and North Wales. Centres of population tend to be located near the coast and the sewage discharged to estuaries and coastal waters.

To permit the most appropriate catchment management, the part of the Severn catchment lying in Wales, together with the rest of the Severn, is managed by Midlands Region. Conversely the Wye and Dee, though lying partly in England, are managed entirely by Welsh Region

In South Wales, large populations located in the urbanised valleys are served by antiquated sewer systems which are often overloaded. This results in the frequent operation of combined sewage overflows.

Agriculture is one of the main uses of land and is dominated by livestock rearing (sheep and cattle). The intensification of agriculture in the 1970s led to an increase in pollution from the discharge of waste (silage liquor and slurry). Although improvements have occurred, this source of pollution still presents a threat.

The decline of heavy industry and coal mining in South Wales has had a beneficial effect on water quality although discharges from abandoned mines pose a new problem. There is a growing risk of pollution from the increase in small manufacturing industries, located on industrial estates.

In the uplands of Mid- and North Wales acid rain has a serious impact which may be exacerbated by the types of land use, such as forestry, which are common in the region. We shall complete a review of acidification in 1996.

State of River Quality and the Causes of Change

For 1995, 91.4% of river length was of Very Good or Good chemical quality (Grades A and B) whilst 79.2% was of the same biological quality. Only 1.7% was chemically Poor or Bad (E or F) whilst 0.9% was the same biologically.

There was an overall improvement in chemical quality of 35% of total river length. Of the upgrades 12% (501 km) were statistically *significant*, while only 0.7%(27 km) of downgrades were significant. Correspondingly, 18% of river length improved in biological quality. 13% (581 km) of the upgrades were statistically significant, while 3% (140 km) of downgrades were significant

Improvements in the storage and handling of agricultural waste following the introduction of *The Control of Pollution (Silage, Slurry and agricultural Fuel Oil) Regulations* in 1991 have resulted in big improvements in the rural catchments. We have done a lot of work since 1990, aimed at identifying and correcting problems of pollution from farms.

During the period from 1990 to 1995 there has been a marked improvement in the compliance of effluents with their Consents. The number of samples which exceeded consent conditions for ammonia has fallen from 4.9% in 1990 to 1% in 1995. The exceedence for BOD has dropped from 6.9% to 2.4%. The improvement in compliance has been accompanied by a reduction in the loads discharged both from industrial discharges and from those from the Water Industry.

Comments on Particular Rivers

In the Cleddau catchment near Haverfordwest in West Wales there has been a net increase in chemical quality of 39% of river length, largely as a result of work in preventing agricultural pollution. Similar improvements have occurred in the Wye (South Wales), parts of the Dee (North Wales) and the Nevern in West Wales.

Some of the most dramatic improvements have occurred where individual discharges have been improved. In South Wales on the Llynfi, near Maesteg, a new treatment plant for a paper mill effluent resulted in an improvement to 4.8 km of river from Grade E and F to B. The biological quality improved from **c** and **d** to **b**.

In the Wye, the quality of 5.1 km of the Yazor Brook has improved from Grade E to B. The biology improved from **d** to **a**. This follows improvements by Dŵr Cymru Welsh Water at Burghill Sewage Treatment Works and the resolution of some problems of pollution from farms.

Nearly 15 km of the Neath Canal deteriorated from Grade A to D due to a new discharge from an abandoned coal mine. Research is currently underway to solve this problem.

In North Wales the chemical quality of the Gwenfro, near Wrexham, has deteriorated because of discharges from a combined sewer overflow. This is due for improvement in the current investment programme of Dŵr Cymru Welsh Water.

A comparison of chemical and biological grades shows that for 42.3% of river length, chemical quality is better than biology. Only 15.7% of rivers have a chemical quality which is worse than the corresponding biological quality.

Acid rain is one of the factors causing biological quality to be lower than chemical quality. The affected rivers include tributaries of the Wye such as the Irfon, Elan and Claerwern, in South Wales, the upper Tywi in Mid-Wales, and the Clwyd in North Wales. A good example of recovery from acidification is the upper Tywi in West Wales. Here the biology has improved from **d** to **a** as a result of the Agency's reservoir liming programme at Llyn Brianne.

The chemical quality may also be better than biology because of intermittent discharges from combined sewer overflows. This is particularly noticeable in the South Wales Valleys such as the Rhondda, the Sirhowy and the Taff. Other factors causing a difference between chemistry and biology include discharges from abandoned coal and metal mines. These are a particular problem in this Region.

Aesthetics

Most of the length of rivers draining largely rural catchments has good aesthetic quality. These include the Wye and Usk in South Wales, the Tywi and Teifi in West Wales and the Conwy in North Wales.

A different picture emerges for rivers draining urbanised catchments in the South Wales Valleys. Rivers like the Rhymney, Rhondda, Ogmore and Taff had poor aesthetic quality even though the chemical quality was Grade A or B. This is the result of the large quantities of general litter and sewage derived litter emanating from the frequent discharge of combined sewer overflows. Dŵr Cymru Welsh Water is planning to make improvements to a large number of these.

Nutrients

Nutrient levels are naturally and generally low because the rivers drain areas of land which have low densities of population and which are not characterised by the extensive use of fertilisers. In 1995, 82.6% of river length was either Grade 1 or 2, an increase of 21.5% since 1990.

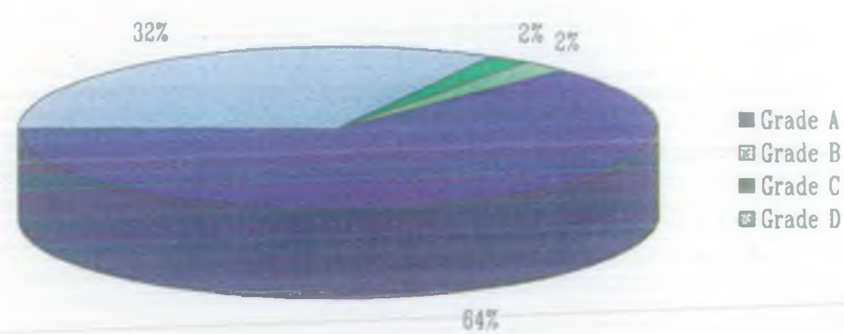
Only 2% of river length fell into Grades 5 and 6. The apparent move from 1990 to 1995, of 59.7% of river length from Grade 2 to 1, is mainly the result of improved analytical methods.

Eutrophication may occur downstream of large sewage discharges. Part of the middle and lower Wye has been designated as a *Sensitive Area* under the *Urban Waste Water Treatment Directive*.

Prospects

Four percent of river length is significantly worse than required by our River Quality Objectives. Ten percent is marginally worse. The worst set of GQA Grades consistent with meeting our objectives is shown in Figure 2.9.

Figure 2.9: Target River Quality in Welsh Region



The current investment programme (1995-2000) of Dŵr Cymru Welsh Water will address some of the improvements. A large investment is being made in upgrading *combined sewer overflows*. This will result in chemical, biological and aesthetic improvements.

Although major investment has been made by the agricultural industry there is a need to continue with inspection programmes to ensure that waste handling systems continue to operate well. With the removal of Grant Aid in 1994, we are concerned that little new investment may take place and that a downturn in water quality will result.

We are also concerned at the likelihood of an increase in the number of discharges from abandoned coal mines and their impact on water quality.

Appendix A: Tables of Results

Table A.1: Chemical Results for 1990

Region	Length of River in Each Chemical Grade (km) in 1988-90						
	A	B	C	D	E	F	Total
Anglian	36.0	758.8	1691.3	1189.3	785.2	102.1	4562.7
Midlands	449.9	1514.0	1610.2	992.7	1002.8	130.7	5700.3
North East	852.3	1619.7	554.1	447.0	606.0	170.3	4249.4
North West	718.6	618.2	556.1	442.8	648.0	208.7	3192.4
Southern	237.8	713.1	668.9	292.0	238.3	32.8	2182.9
South West	1644.7	2670.8	1239.9	737.1	358.0	68.0	6718.5
Thames	315.9	981.2	1050.3	577.6	560.6	46.2	3531.8
Welsh	1782.5	1412.9	426.6	228.7	133.3	39.2	4023.2
England & Wales	6037.7	10288.7	7797.4	4907.2	4332.2	798.0	34161.2

Region	% Length of River in Each Chemical Grade in 1988-90					
	A	B	C	D	E	F
Anglian	.8	16.6	37.1	26.1	17.2	2.2
Midlands	7.9	26.6	28.2	17.4	17.6	2.3
North East	20.1	38.1	13.0	10.5	14.3	4.0
North West	22.5	19.4	17.4	13.9	20.3	6.5
Southern	10.9	32.7	30.6	13.4	10.9	1.5
South West	24.5	39.8	18.5	11.0	5.3	1.0
Thames	8.9	27.8	29.7	16.4	15.9	1.3
Welsh	44.3	35.1	10.6	5.7	3.3	1.0
England & Wales	17.7	30.1	22.8	14.4	12.7	2.3

Table A.2: Chemical Results for 1995

Region	Length of River in Each Chemical Grade (km) in 1993-5						
	A	B	C	D	E	F	Total
Anglian	269.8	1619.0	1473.7	840.9	582.4	28.0	4813.8
Midlands	764.8	2175.9	2126.7	912.7	542.6	66.1	6588.8
North East	2008.0	1687.3	855.3	594.7	731.1	81.9	5958.3
North West	1156.8	1952.4	1036.3	694.4	773.5	131.9	5745.3
Southern	275.8	968.5	589.0	213.8	152.0	20.0	2219.1
South West	2312.4	2251.8	1058.1	218.3	193.9	27.2	6061.7
Thames	538.2	1338.8	1178.3	517.6	211.0	13.2	3797.1
Welsh	3468.2	1142.1	240.2	106.7	79.6	6.1	5042.9
England & Wales	10794.0	13135.8	8557.6	4099.1	3266.1	374.4	40226.9

Region	% Length of River in Each Chemical Grade in 1993-5					
	A	B	C	D	E	F
Anglian	5.6	33.6	30.6	17.5	12.1	.6
Midlands	11.6	33.0	32.3	13.9	8.2	1.0
North East	33.7	28.3	14.4	10.0	12.3	1.4
North West	20.1	34.0	18.0	12.1	13.5	2.3
Southern	12.4	43.6	26.5	9.6	6.8	.9
South West	38.1	37.1	17.5	3.6	3.2	.4
Thames	14.2	35.3	31.0	13.6	5.6	.3
Welsh	68.8	22.6	4.8	2.1	1.6	.1
England & Wales	26.8	32.7	21.3	10.2	8.1	.9

Table A.3: Comparison of 1990 and 1995: Chemistry

Comparison of 1990 Chemistry on 1995 Chemistry (km)

		1988/90 A	B	C	D	E	F	Total
1993/5	A	4492.5	3425.3	453.6	59.6	60.8	4.4	8496.2
	B	1160.1	5154.8	3240.7	1072.4	353.2	33.7	11014.9
	C	156.1	1192.6	3063.0	1864.1	963.4	88.0	7327.2
	D	19.3	104.5	717.1	1235.2	1218.3	137.1	3431.5
	E	.0	25.3	141.0	566.0	1578.8	356.1	2667.2
	F	.0	2.5	8.3	5.9	68.1	156.1	240.9
Total		5828.0	9905.0	7623.7	4803.2	4242.6	775.4	33177.9

Length of river upgraded = 13330.7 km.
Length of river downgraded = 4166.8 km.
Net improvement = 9163.9 km.

Comparison of 1990 Chemistry on 1995 Chemistry (% Length)

		1988/90 A	B	C	D	E	F	Total
1993/5	A	13.5	10.3	1.4	.2	.2	.0	25.6
	B	3.5	15.5	9.8	3.2	1.1	.1	33.2
	C	.5	3.6	9.2	5.6	2.9	.3	22.1
	D	.1	.3	2.2	3.7	3.7	.4	10.3
	E	.0	.1	.4	1.7	4.8	1.1	8.0
	F	.0	.0	.0	.0	.2	.5	.7
Total		17.6	29.9	23.0	14.5	12.8	2.3	100.0

Length of river upgraded = 40.2 %
Length of river downgraded = 12.6 %
Net improvement = 27.6 %

Table A.4: Summary of Changes from 1990 and 1995: Chemistry

Summary of Net Changes from 1988/90 to 1993/5

(% Length changing Grade)

Region	Up	Down	Net Change
Anglian	48.9	11.7	37.2
Midlands	41.5	15.8	25.7
North East	35.0	9.9	25.1
North West	33.0	18.5	14.5
Southern	34.2	16.4	17.8
South West	38.9	10.5	28.4
Thames	43.4	14.2	29.2
Welsh	41.7	6.4	35.3
England & Wales	40.2	12.6	27.6

Table A.5: Length Changing Chemical Grade at Various Levels of Statistical Confidence

Region	Length of River Changing Chemical Grade from 1988-90 to 1993-5								
	----- Confidence of Upgrades ----				--- Confidence of Downgrades ---				
	50%	75%	90%	95%	50%	75%	90%	95%	Total
Anglian	2231.4	1270.2	688.4	488.0	534.0	91.0	32.1	3.0	4562.7
Midlands	2352.5	1524.8	889.4	665.5	895.6	263.3	98.3	33.8	5667.1
North East	1458.2	807.4	395.3	267.5	414.3	158.0	85.2	65.4	4164.3
North West	1052.2	678.6	428.3	302.2	589.4	149.6	44.8	.0	3192.4
Southern	747.2	438.5	230.6	188.0	358.8	104.2	60.4	40.8	2182.9
South West	2280.1	1436.3	824.0	591.3	616.6	244.6	92.3	47.4	5854.7
Thames	1532.2	958.6	576.0	405.1	501.1	124.1	53.1	8.4	3530.6
Welsh	1676.9	1080.4	699.7	500.7	257.0	121.4	56.6	26.8	4023.2
England & Wales	13330.7	8194.8	4731.7	3408.3	4166.8	1256.2	522.8	225.6	33177.9

Table A.6: Biological Results for 1990

Region	Length of River in Each Biological Grade (km) in 1990						
	a	b	c	d	e	f	Total
Anglian	465.3	1420.2	1522.6	482.7	208.8	70.1	4169.7
Midlands	327.8	806.0	1213.6	770.5	469.8	223.6	3811.3
North East	1335.9	1174.4	519.8	409.3	379.4	313.5	4132.3
North West	426.2	1071.4	692.6	333.6	617.5	880.4	4021.7
Southern	397.5	452.6	396.9	128.3	34.0	10.0	1419.3
South West	2142.8	2113.0	826.2	222.9	153.3	88.3	5546.5
Thames	716.9	996.5	689.3	346.5	236.3	107.2	3092.7
Welsh	1395.2	1441.9	613.7	242.8	97.9	15.5	3807.0
England & Wales	7207.6	9476.0	6474.7	2936.6	2197.0	1708.6	30000.5

Region	% Length of River in Each Biological Grade in 1990					
	a	b	c	d	e	f
Anglian	11.2	34.1	36.5	11.6	5.0	1.7
Midlands	8.6	21.1	31.8	20.2	12.3	5.9
North East	32.3	28.4	12.6	9.9	9.2	7.6
North West	10.6	26.6	17.2	8.3	15.4	21.9
Southern	28.0	31.9	28.0	9.0	2.4	.7
South West	38.6	38.1	14.9	4.0	2.8	1.6
Thames	23.2	32.2	22.3	11.2	7.6	3.5
Welsh	36.6	37.9	16.1	6.4	2.6	.4
England & Wales	24.0	31.6	21.6	9.8	7.3	5.7

Table A.7: Biological Results for 1995

Region	Length of River in Each Biological Grade (km) in 1995						
	a	b	c	d	e	f	Total
Anglian	1053.9	2023.3	1166.8	347.6	123.0	16.8	4731.4
Midlands	965.9	1683.7	1788.9	918.5	357.8	122.3	5837.1
North East	2264.4	1201.6	734.0	515.4	479.5	267.6	5462.5
North West	961.1	1534.4	902.9	497.4	808.0	262.1	4965.9
Southern	976.9	718.8	298.3	163.0	29.0	4.6	2190.6
South West	3325.5	1897.0	533.6	103.4	54.5	21.0	5935.0
Thames	1132.2	1116.3	792.9	345.6	157.7	24.3	3569.0
Welsh	2316.7	1682.2	676.0	151.3	32.7	4.9	4863.8
England & Wales	12996.6	11857.3	6893.4	3042.2	2042.2	723.6	37555.2

Region	% Length of River in Each Biological Grade in 1995					
	a	b	c	d	e	f
Anglian	22.3	42.8	24.7	7.3	2.6	.4
Midlands	16.5	28.8	30.6	15.7	6.1	2.1
North East	41.5	22.0	13.4	9.4	8.8	4.9
North West	19.4	30.9	18.2	10.0	16.3	5.3
Southern	44.6	32.8	13.6	7.4	1.3	.2
South West	56.0	32.0	9.0	1.7	.9	.4
Thames	31.7	31.3	22.2	9.7	4.4	.7
Welsh	47.6	34.6	13.9	3.1	.7	.1
England & Wales	34.6	31.6	18.4	8.1	5.4	1.9

Table A.8: Comparison of 1990 and 1995: Biology

Comparison of 1990 Biology on 1995 Biology (km)

		1990						
		a	b	c	d	e	f	Total
1995	a	5358.3	4338.3	1096.8	144.3	63.3	38.4	11039.4
	b	1649.4	4352.0	2985.9	501.2	146.3	44.7	9679.5
	c	191.5	712.5	2053.9	1431.9	718.2	174.2	5282.2
	d	8.4	69.2	277.2	702.3	761.3	315.9	2134.3
	e	.0	4.0	60.9	155.3	451.4	739.6	1411.2
	f	.0	.0	.0	1.6	56.5	395.8	453.9
Total		7207.6	9476.0	6474.7	2936.6	2197.0	1708.6	30000.5

Length of river upgraded = 11511.0 km.
Length of river downgraded = 3851.1 km.
Net improvement = 7659.9 km.

Comparison of 1990 Biology on 1995 Biology (% length)

		1990						
		a	b	c	d	e	f	Total
1995	a	17.9	14.5	3.7	.5	.2	.1	36.8
	b	5.5	14.5	10.0	1.7	.5	.1	32.3
	c	.6	2.4	6.8	4.8	2.4	.6	17.6
	d	.0	.2	.9	2.3	2.5	1.1	7.1
	e	.0	.0	.2	.5	1.5	2.5	4.7
	f	.0	.0	.0	.0	.2	1.3	1.5
Total		24.0	31.6	21.6	9.8	7.3	5.7	100.0

Length of river upgraded = 45.0 %
Length of river downgraded = 10.6 %
Net improvement = 34.4 %

Table A.9: Summary of Changes from 1990 and 1995: Biology

	(% Length changing Grade)		
Region	Up	Down	Net Change
Anglian	49.1	9.7	39.4
Midlands	50.4	9.2	41.1
North East	40.5	10.0	30.5
North West	60.3	7.1	53.2
Southern	40.0	7.0	32.9
South West	39.3	11.5	27.9
Thames	42.7	13.0	29.7
Welsh	35.9	15.6	20.3
England and Wales	45.0	10.6	34.4

Table A.10: Length Changing Biological Grade at Various Levels of Statistical Confidence

Region	Length of River Changing Grade from 1990 to 1995								
	----- Confidence of Upgrades ----				--- Confidence of Downgrades ---				
	50%	75%	90%	95%	50%	75%	90%	95%	Total
Anglian	2046.4	1163.5	609.9	452.6	404.7	182.9	44.5	27.0	4169.7
Midlands	1919.4	1269.1	803.0	607.2	352.1	109.7	52.1	27.6	3811.3
North East	1672.7	1123.0	737.3	499.8	412.3	126.4	45.6	44.1	4132.3
North West	2425.3	1792.2	1314.1	1154.6	284.4	105.2	51.5	27.0	4021.7
Southern	567.2	340.0	213.7	159.2	99.8	26.2	14.8	10.4	1419.3
South West	2180.5	1288.2	882.9	656.1	635.3	193.7	82.7	61.8	5546.5
Thames	1321.3	817.9	525.4	411.6	402.6	202.2	119.8	108.3	3092.7
Welsh	1367.5	752.9	412.4	294.7	595.3	242.4	163.6	139.7	3807.0
England & Wales	13500.3	8546.8	5498.7	4235.8	3186.5	1188.7	574.6	445.9	30000.5

Table A.8a: Comparison of 1990 and 1995: Biology (Corrected)

Comparison of 1990 Biology on 1995 Biology (km)

		1990						
		a	b	c	d	e	f	Total
1995	a	6599.6	4255.3	899.3	58.9	56.5	10.7	11880.3
	b	2097.3	4308.4	2616.0	347.9	66.8	24.3	9460.7
	c	253.0	720.2	2126.0	1424.8	429.5	46.3	4999.8
	d	11.2	60.5	416.6	784.3	688.6	163.5	2124.7
	e	.0	7.1	28.6	138.7	627.1	422.6	1224.1
	f	.0	.0	.0	25.4	92.5	196.2	314.1
Total		8961.1	9351.5	6086.5	2780.0	1961.0	863.6	30003.7

Length of river upgraded = 11511.0 km.
Length of river downgraded = 3851.1 km.
Net improvement = 7659.9 km.

Comparison of 1990 Biology on 1995 Biology (% length)

		1990						
		a	b	c	d	e	f	
1995	a	22.0	14.2	3.0	.2	.2	.0	39.6
	b	7.0	14.4	8.7	1.2	.2	.1	31.5
	c	.8	2.4	7.1	4.7	1.4	.2	16.7
	d	.0	.2	1.4	2.6	2.3	.5	7.1
	e	.0	.0	.1	.5	2.1	1.4	4.1
	f	.0	.0	.0	.1	.3	.7	1.0
Total		29.9	31.2	20.3	9.3	6.5	2.9	100.0

Length of river upgraded = 38.4 %
Length of river downgraded = 12.8 %
Net improvement = 25.5 %

Table A.9a: Summary of Changes from 1990 and 1995: Biology (Corrected)

	(% Length changing Grade)		
Region	Up	Down	Net Change
Anglian	49.3	9.9	39.4
Midlands	36.0	14.3	21.7
North East	36.1	10.7	25.4
North West	46.0	16.3	29.6
Southern	34.7	5.9	28.8
South West	33.7	12.5	21.2
Thames	36.9	15.2	21.8
Welsh	32.6	14.4	18.2
England and Wales	38.4	12.0	25.5

Table A.10a: Length Changing Biological Grade at Various Levels of Statistical Confidence (Corrected)

Region	Length of River Changing Grade from 1990 to 1995								
	----- Confidence of Upgrades ----				--- Confidence of Downgrades ---				
	50%	75%	90%	95%	50%	75%	90%	95%	Total
Anglian	2055.3	1116.7	516.7	295.2	414.2	178.7	86.7	28.5	4169.7
Midlands	1370.3	824.0	488.6	323.7	543.5	189.4	92.9	55.7	3811.3
North East	1491.8	986.5	610.7	378.5	442.7	136.7	45.8	37.8	4132.3
North West	1849.1	1145.5	727.0	491.5	656.4	300.7	103.0	90.7	4023.2
Southern	492.3	302.2	199.1	136.8	83.5	19.0	16.3	4.5	1419.3
South West	1870.4	1113.1	645.4	463.3	693.4	261.8	94.9	73.9	5548.2
Thames	1142.5	687.2	450.9	269.7	469.8	242.8	123.7	111.1	3092.7
Welsh	1239.3	763.4	389.0	296.6	547.6	236.4	157.2	124.0	3807.0
England & Wales	11511.0	6938.6	4027.4	2655.3	3851.1	1565.5	720.5	526.2	30003.7

Table A.11: Comparison of 1995 Chemical Grade with 1995 Biological Grade

Comparison of Chemical GQA on Biological GQA (km) for England & Wales in 1995

Biology	Chemistry A	B	C	D	E	F	
a	5788.9	4874.1	1556.1	319.3	162.3	8.3	12709.0
b	3552.1	4603.4	2540.6	713.6	334.5	7.0	11751.2
c	893.5	2192.3	2116.0	834.7	722.1	42.9	6801.5
d	130.7	656.5	860.9	768.8	493.9	50.9	2961.7
e	56.4	329.0	454.1	498.4	590.9	67.5	1996.3
f	6.7	20.2	96.6	123.0	332.3	112.8	691.6
Total	10428.3	12675.5	7624.3	3257.8	2636.0	289.4	36911.3

Biology better than Chemistry = 12727.8 km.
Chemistry better than Biology = 10202.7 km.
Difference = 2525.1 km.

Comparison of Chemical GQA on Biological GQA (% length) for England & Wales in 1995

Biology	Chemistry A	B	C	D	E	F	
a	15.7	13.2	4.2	.9	.4	.0	34.4
b	9.6	12.5	6.9	1.9	.9	.0	31.8
c	2.4	5.9	5.7	2.3	2.0	.1	18.4
d	.4	1.8	2.3	2.1	1.3	.1	8.0
e	.2	.9	1.2	1.4	1.6	.2	5.4
f	.0	.1	.3	.3	.9	.3	1.9
Total	28.3	34.3	20.7	8.8	7.1	.8	100.0

Biology better than Chemistry = 34.5 %
Chemistry better than Biology = 27.6 %
Difference = 6.8 %

Table A.12: Phosphate Results for 1990

Summary of Results for all Regions ...

Region	Length of River in Each Chemical Grade (km) in 1988-90						
	1	2	3	4	5	6	Total
Anglian	.0	189.1	268.5	381.1	1794.9	1766.0	4399.6
Midlands	11.5	102.3	64.0	162.5	471.1	682.4	1493.8
North West	841.5	712.0	419.1	349.0	643.9	386.8	3352.3
S.Western	750.8	1602.0	868.3	1234.0	1840.1	406.5	6701.7
Southern	3.5	260.8	313.5	359.6	647.2	521.3	2105.9
Thames	55.0	246.1	161.5	225.1	700.8	1433.9	2822.4
Welsh	182.9	960.2	262.1	310.2	346.6	65.1	2127.1
England & Wales	1845.2	4072.5	2357.0	3021.5	6444.6	5262.0	23002.8

Region	% Length of River in Each Chemical Grade in 1988-90					
	1	2	3	4	5	6
Anglian	.0	4.3	6.1	8.7	40.8	40.1
Midlands	.8	6.8	4.3	10.9	31.5	45.7
North West	25.1	21.2	12.5	10.4	19.2	11.5
S.Western	11.2	23.9	13.0	18.4	27.5	6.1
Southern	.2	12.4	14.9	17.1	30.7	24.8
Thames	1.9	8.7	5.7	8.0	24.8	50.8
Welsh	8.6	45.1	12.3	14.6	16.3	3.1
England & Wales	8.0	17.7	10.2	13.1	28.0	22.9

Table A.13: Phosphate Results for 1995

Summary of Results for all Regions ...

Region	Length of River in Each Chemical Grade (km) in 1993-5						
	1	2	3	4	5	6	Total
Anglian	11.3	658.4	344.1	703.1	2348.9	742.4	4808.2
Midlands	.0	497.1	302.5	432.8	991.6	946.7	3170.7
North East	733.8	1073.4	435.3	609.8	989.0	325.5	4166.8
North West	1099.4	1697.9	779.8	594.2	1084.2	416.0	5671.5
S.Western	716.2	1838.9	804.7	996.7	1539.1	115.0	6010.6
Southern	.0	454.8	416.4	411.7	662.4	258.4	2203.7
Thames	.0	392.2	256.7	510.7	1658.3	978.2	3796.1
Welsh	2577.1	1275.7	492.5	376.8	259.9	54.1	5036.1
England & Wales	5137.8	7888.4	3832.0	4635.8	9533.4	3836.3	34863.7

Region	% Length of River in Each Chemical Grade in 1993-5					
	1	2	3	4	5	6
Anglian	.2	13.7	7.2	14.6	48.9	15.4
Midlands	.0	15.7	9.5	13.6	31.3	29.9
North East	17.6	25.8	10.4	14.6	23.7	7.8
North West	19.4	29.9	13.7	10.5	19.1	7.3
S.Western	11.9	30.6	13.4	16.6	25.6	1.9
Southern	.0	20.6	18.9	18.7	30.1	11.7
Thames	.0	10.3	6.8	13.5	43.7	25.8
Welsh	51.2	25.3	9.8	7.5	5.2	1.1
England & Wales	14.7	22.6	11.0	13.3	27.3	11.0

Table A.14: Comparison of 1990 and 1995: Phosphate

Comparison of 1988/90 Grade on 1993/5 Grade (km)....

		1988/90						
		1	2	3	4	5	6	Total
1993/5	1	1103.6	800.8	74.6	35.8	7.5	6.2	2028.5
	2	525.8	2419.4	1061.6	481.7	162.0	27.0	4677.5
	3	57.9	340.5	823.5	893.9	355.8	37.0	2508.6
	4	38.6	72.5	224.5	1272.9	1389.9	53.9	3052.3
	5	3.0	42.6	41.6	151.5	4209.7	2540.0	6988.4
	6	.0	1.2	8.1	3.9	76.4	2522.5	2612.1
Total		1728.9	3677.0	2233.9	2839.7	6201.3	5186.6	21867.4

Length of river upgraded = 7927.7 km.
Length of river downgraded = 1588.1 km.
Net improvement = 6339.6 km.

Comparison of 1988/90 Grade on 1993/5 Grade (% length)....

		1988/90						
		1	2	3	4	5	6	
1993/5	1	5.0	3.7	.3	.2	.0	.0	9.3
	2	2.4	11.1	4.9	2.2	.7	.1	21.4
	3	.3	1.6	3.8	4.1	1.6	.2	11.5
	4	.2	.3	1.0	5.8	6.4	.2	14.0
	5	.0	.2	.2	.7	19.3	11.6	32.0
	6	.0	.0	.0	.0	.3	11.5	11.9
Total		7.9	16.8	10.2	13.0	28.4	23.7	100.0

Length of river upgraded = 36.3 %
Length of river downgraded = 7.3 %
net improvement = 29.0 %

Table A.15: Performance of Sewage Treatment Works from 1990 to 1995

Region	Mean BOD in 1995 (mg/l)	Reduction since 1990 (%)	Mean Ammonia in 1995 (mgN/l)	Reduction since 1990 (%)
Anglian	5.3	21	1.8	28
Midlands	8.4	29	3.3	42
North East	15.7	22	5.2	47
North West	11.3	8	6.6	23
Southern	7.3	21	1.7	23
South Western	9.1	22	2.4	18
Thames	5.2	39	2.8	23
Welsh	9.2	43	4.2	36
Total	9.2	25	3.7	36

Appendix B: The Biological Grading Scheme

The biological scheme is based on the macro-invertebrate communities. Macro-invertebrates are small animals that can be seen with the naked eye. They include insect larvae such as mayflies and caddis-flies, together with snails, shrimps, worms and many others. The macro-invertebrates are the most widely used organisms for biological assessment because they do not move far, and respond to everything contained in the water. They can be affected by pollutants which occur only infrequently, or in very low concentrations. These can be missed by chemical sampling.

The variety of macro-invertebrates differs in different rivers even when there is no damage. This is because of the nature of the stream bed, the natural patterns and sequences of river flows, and the geology of the catchment. This fact suggests that it is best to describe the biology as a shortfall from that expected under natural conditions. We take up this idea by using a computer based system to predict the macro-invertebrates which should be found in a clean river. The system is called RIVPACS [6]. It was set up by the Institute of Freshwater Ecology.

There are over 200 species of aquatic invertebrate. These are grouped into Families. A key piece of information is the number of different Families (or, Taxa) found at a site. The Number of Taxa is an index of general pollution (organic and toxic, but it also responds to physical effects such as siltation, and is affected by damage to habitats or the river channel).

Some animals are more susceptible than others to pollution and the presence of the more sensitive individuals is a sign that water quality is good. This fact is taken into account by the BMWP System [1,7]. This assigns points to Taxa according to their sensitivity to pollution. The BMWP Score for a site is the sum of the points for each family found.

The Average Score per Taxon, or ASPT, is the BMWP Score divided by the Number of Taxa. This gives a measure of the average sensitivity to pollution, of the Families found at a site. ASPT was aimed mainly as an index of organic pollution. Low values indicate pollution. The most useful way of summarising the biological data was found to be one which combined the Number of Taxa and the ASPT. One reason for including the Number of Taxa was to help cover types of pollution from non-organic sources.

For each site, RIVPACS is used to predict the Number of Taxa and the ASPT which would be expected under conditions of natural water quality. The biological quality is then expressed as the fraction of these predictions formed by the actual results measured by sampling. Such a ratio is called an Ecological Quality Index or EQI.

A value for the EQI of 1.0 or more indicates that the types of animals found in the river are those expected under conditions of natural water quality. Lower scores may indicate that the biota are stressed or that the river is polluted.

The Biological Grades are based on the values of the EQIs set out in Table B.1. As with the Chemical GQA, a consistent discipline is adopted across the country for sampling and analysis. This includes systems for auditing the quality of the data.

Classification

The best quality is indicated by a diverse variety of Families especially those that are sensitive to pollution. Poorer quality can be indicated by a reduction in the number of Families that are sensitive to pollution or in an increasing dominance of Families that tolerate pollution.

Table B.1: Biological Grades

GRADE	EQI FOR ASPT	EQI FOR TAXA
a	1.00	0.85
b	0.90	0.70
c	0.77	0.55
d	0.65	0.45
e	0.50	0.30
f	-	-

In setting up a system that applies to all types of rivers, we started from the fact that it is easy to recognise the best and the worst quality. The system represented by Table B.1 started out as a consensus of biologists in Regions on the optimal, yet simple, way of giving the appropriate grade to rivers recognised as poor or bad. We then drew up a similar consensus for rivers of best quality. This work involved trials of numerous versions of Table B.1.

Between the extremes of good and bad we chose intermediate Grades that allow us to detect and report gradual changes so that we can act on deteriorations before they go too far. The biology of these intermediate Grades will differ from site to site in terms of the actual Families that are present, but they will be similar for all rivers in their relative position on a scale between the best and worst possible quality.

The grades are described below. There will be some rivers where water quality might permit a high Grade were it not for limits imposed by poor habitat, the nature of the river channel, or the pattern of river flows.

Grade a - VERY GOOD

The biology is similar to (or better than) that expected for an average and unpolluted river of this size, type and location. There is a high diversity of Families, usually with several species in each. It is rare to find a dominance of any one Family.

Grade b - GOOD

The biology shows minor differences from Grade A and falls a little short of that expected for an unpolluted river of this size, type and location. There may be a small reduction in the number of Families that are sensitive to pollution, and a moderate increase in the number of individuals in the Families that tolerate pollution (like worms and midges). This may indicate the first signs of organic pollution.

Grade c - FAIRLY GOOD

The biology is worse than that expected for an unpolluted river of this size, type and location. Many of the sensitive Families are absent or the number of individuals is reduced, and in many cases there is a marked rise in the numbers of individuals in the Families that tolerate pollution.

Grade **d** - FAIR

The biology shows big differences from that expected for an unpolluted river of this size, type and location. Sensitive Families are scarce and contain only small numbers of individuals. There may be a range of those Families that tolerate pollution and some of these may have high numbers of individuals.

Grade e - POOR

The biology is restricted to animals that tolerate pollution with some families dominant in terms of the numbers of individuals. Sensitive families will be rare or absent.

Grade **f** - BAD

The biology is limited to a small number of very tolerant families, often only worms, midge larvae, leeches and the water hoglouse. These may be present in very high numbers. Even these may be missing if the pollution is toxic. In the very worst case there may be no life present in the river.

As discussed in Appendix E, the classification of waters is not precise and that there is an average risk of 22% that rivers may be classed wrongly. It is unusual, however, for this error to extend beyond the neighbouring grade.

There is a CONCLASS for Biology (see Appendix C for a description of the version for the Chemistry) based on the work of the Institute of Freshwater Ecology [7]. This is mentioned in Appendix E.

Sampling

Each biological site corresponds to a stretch of river characterised by a chemical site. Although the biological and chemical sites are not always coincident, they are subject to the same water quality, and as far as possible are not separated by tributaries, discharges, weirs or other potential influences on water quality.

Two biological samples were collected in 1995, one in Spring (March - May) and one in Autumn (September - November). Strictly defined protocols were followed to ensure that the data were comparable around England and Wales, and compatible with RIVPACS.

To take account of natural seasonal variations, the lists of Families from samples collected in Spring and Autumn were pooled for the calculation of ASPT and the Number of Taxa at each site.

The samples were collected by three minutes active sampling with a pond net. At some deep sites this was not possible, so the samples were collected by 3 to 5 trawls with a Medium Naturalist's Dredge or by air-lift, followed in both cases by a 1 minute sweep with a pond-net. Every sample was supplemented by a 1 minute visual search for individuals living on the water surface, or attached to rocks, logs or vegetation.

All the samples were analysed in laboratories. The methods used to wash and sort the samples were standardised as far as possible, allowing only local variations in sample type in different places (largely determined by the amount of silt or weed in the samples).

A scheme of quality control was established in every laboratory, to ensure that an average of no more than two taxa were missed. This involved re-inspecting 10% of all samples. There was also a second audit, in which 60 samples from each Region were re-analysed by the Institute of Freshwater Ecology. This demonstrated that an average of 1.9 taxa were missed during analysis.

Information collected for RIVPACS comprised the width and depth of the stream, the alkalinity of the water, and the percentage cover on the river bed of boulders, gravel, sand and silt. All these items were expressed as estimates of annual averages. RIVPACS also required information from maps about the sampling site. This included the grid reference, the slope of the river, its altitude, and the distance of the site from the source of the river.

Every biologist attended a training workshop just before the survey began. All the procedures are documented.

As noted above, one of the possible sources of error is that the biologist may fail to notice all the Taxa collected. This introduces a bias and means that our assessments of biology tend to be pessimistic estimates of true quality in the river.

The Agency's predecessors inherited its biological laboratories from the Regional Authorities and these laboratories had different approaches to controlling the reliability and accuracy of their data. In 1992, uniform procedures were introduced throughout England and Wales.

The standardisation of the quality of the work done by our laboratories caused a reduction in the number of missed taxa and this bias led to a spurious indication the water quality had improved between 1990 and 1995. This was particularly the case for North West Region and for parts of North East and South West.

We have been careful to measure all our errors in 1990 and 1995 (Appendix E). As discussed in Section 2, when we take account of bias, an apparent improvement of 34% is reduced to a real improvement of 26%. It is this figure, 26%, that we put forward as our estimate of the true change in quality.

Appendix C: The Chemical Grading Scheme

In fixing a Grade to a river we use the same, strictly defined procedures throughout England and Wales [1]. The process is set out below.

- To each sampling site, we assign the stretch of river which the site will characterise. In the main, these sites, and the monitoring, are the same as those used to take decisions on developments that may affect water quality - discharges, abstractions and changes in the use of land. We have harmonised the sampling frequencies, the determinands analysed, and how the data are processed into information.

- We use only the results from the routine pre-planned sampling programmes and analyzed by properly accredited laboratories. We ignore all extra data collected for special surveys or in response to incidents or accidents. The routine programme involves monthly sampling at 8000 monitoring points on 40,000 kilometres of river.

- We use the data collected over three years because this produces a number of samples per site that matches the required precision in making judgements about particular rivers, bearing in mind the cost of monitoring.

- Within these programmes, all the results collected over the three years are included. No outlier is excluded. All the data are placed on Public Registers.

- Everyone uses the same method to estimate summary statistics like percentiles.

- The estimates of the percentiles are compared with the standards in Table C.1. A Grade is assigned to each river length according to the worst determinand. This defines the Face-value Grade. These are shown as colours on Map 1.

- All data and all results for all rivers are made available to the Public.

The grade is defined in Table C.1 by standards for the BOD, Ammonia and Dissolved Oxygen. These determinands are indicators of pollution which apply to all rivers first because of the ubiquitous nature of the risk of pollution from sewage or farms and second because of the general desire that rivers should sustain healthy populations of fish. Table C.2 describes the general characteristics of each grade.

Table C.1: Standards for the Chemical GQA□			
GQA Grade	Dissolved Oxygen (% saturation) 10-percentile	Biochemical Oxygen Demand (mg/l) 90-percentile	Ammonia (mgN/l) 90-percentile
A	80	2.5	0.25
B	70	4	0.6
C	60	6	1.3
D	50	8	2.5
E	20	15	9.0
F	<20	-	-

Table C.2: Grades of River Quality for the Chemical GQA	
Chemical Grade	Likely Uses & Characteristics□
A **Very Good**	■ All abstractions ■ Very good salmonid fisheries ■ Cyprinid fisheries ■ Natural ecosystem
B **Good**	■ All abstractions ■ Salmonid fisheries ■ Cyprinid fisheries ■ Ecosystem at or close to natural
C **Fairly Good**	■ Potable supply after advanced treatment ■ Other abstractions ■ Good cyprinid fisheries ■ A natural ecosystem, or one corresponding to a good cyprinid fishery
D **Fair**	■ Potable supply after advanced treatment ■ Other abstractions ■ Fair cyprinid fisheries ■ Impacted ecosystem
E **Poor**	■ Low grade abstraction for industry ■ Fish absent, sporadically present, vulnerable to pollution⊠ ■ Impoverished ecosystem⊠
F **Bad**	■ Very polluted rivers which may cause nuisance ■ Severely restricted ecosystem

□ Provided other standards are also met.
⊠ Where the Grade is caused by discharges of organic pollution

Appendix D: Which Rivers Have Really Got Worse Chemically ?

River quality varies. For total accuracy for all rivers we would have to sample everywhere, all the time. No responsible agency could want or need to sample anything like this. The resources are better put towards cleaning up pollution.

We sample, on average, 12 times a year, at intervals of 6 kilometres. The fact that a lot of rivers lie close to the edge of a grade boundary, coupled with the uncertainty produced by monitoring less than all the time, gives an average risk of 19% that a particular stretch of river sampled 36 times is placed in the wrong grade.

We calculate, for every stretch of river showing an upgrade or downgrade, the statistical confidence that the change is real. This is the **Risk of Mis-classification**.

In only 300 kilometres out of a total of 34,000 was there a drop in grade that was significant at the 95% level. In contrast, over 3000 kilometres of river length showed an improvement in grade that was significant at more than 95% confidence.

A computer program, CONCLASS, provides these assessments of confidence. The output is a statement of the confidence that a site is in any of the Grades. An example is shown at Table D.1. In this, the Face-value Grade is Grade C and this is determined by the BOD. There is 60% confidence that Grade C is the True Grade. The Risk of Mis-classification is therefore 40%. A dash, '-', indicates zero.

In Table D.1, the **Confidence of Grade,** or the CoG, is zero for Grade A and Grade B. We can state that the river is significantly worse than Grades A or B. Similarly we are 40% confident that the True Grade is worse than C, zero % confident that it is worse than D, and zero % confident that Grade is better than C.

Table D.1: CONCLASS for the Chemical GQA

Determinand	Mean	Standard Deviation	Number of Samples	90%tile	Confidence of Grade (%)					
					A	B	C	D	E	F
BOD	3.8	1.6	62	5.85	-	-	60	40	-	-
Ammonia	.30	.25	64	.58	-	57	43	-	-	-
Diss. Oxygen	95.8	9.6	64	83.34	97	3	-	-	-	-
All Determinands					-	-	60	40	-	-

Calculating the Significance of a Change in Grade

Suppose CONCLASS gave for 1990 and 1995, the results shown in Table D.2.

Table D.2: Illustration of Confidence of Grade

GQA Grade	Confidence (%)	
	1990	1995
A	0	0
B	0	40
C	20	**60**
D	**70**	0
E	10	0
F	0	0

Table D.2 shows that from 1990 to 1995 there is a change, at Face-value, from D to C. The actual confidence of a change from D to C is the product of the values of the Confidence of Grade, or CoG, for Grade D in 1990 and for Grade C in 1995. This is 0.7 times 0.6, or 42%.

The full range of possibilities is given by all the possible combinations. These are in Table D.3. Table D.3 shows the 42% confidence of the change from D in 1990 to C in 1995. It also shows the 8% confidence of a change from C to B, the 12% confidence that the river stayed in Grade C, the 4% confidence of a change from E to B and the 6% change from E to C.

The sum of the diagonal elements in Table D.3 gives the confidence of no change in Grade. This is 12%. The sum of the adjacent upper diagonal gives the confidence of a drop of one Grade. This is zero.

Similarly in Table D.3, the lower diagonals give the confidence of an upgrade. There is 50% confidence of an improvement by one Grade. This is made up from 42% confidence of a change from C to B and 8% confidence for a change from C to B.

The shaded portion of Table D.3 shows that 88% is the confidence of an improvement of one Grade of more. Following this logic we can summarise the full picture as 11 numbers, one for each diagonal, as in Table D.3a.

Table D.3: Illustration of Confidence of a Change in Grade							
GRADE IN 1990	GRADE IN 1995						COG IN 1990:
	A	B	C	D	E	F	
A	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-
C	-	8	12	-	-	-	20
D	-	28	42	-	-	-	70
E	-	4	6	-	-	-	10
F	-	-	-	-	-	-	-
COG IN 1995 IS:	-	40	60	-	-	-	100

Table D.3a: Illustration of Confidence of a Change in Grade	
CHANGE	CONFIDENCE (%)
Down 5 Grades	0
Down 4 Grades	0
Down 3 Grades	0
Down 2 Grades	0
Down 1 Grade	0
No change	12
Up 1 Grade	50
Up 2 Grades	34
Up 3 Grades	4
Up 4 Grades	0
Up 5 Grades	0

The interpretation of Table D.3a, for example, is that there is 50% confidence that quality improved by one Grade. We can present the same data as an accumulating sum, from the bottom, stopping at the middle, to give the six numbers in Table D.3b.

Table D.3.b shows, for example, that there is 88% confidence that quality improved by at least one Grade. We can also accumulate in the opposite direction to give the 5 values for the confidence that quality deteriorated by at least one grade, at least two grades, and so on.

A full set of all 11 numbers is produced for all 8000 stretches in England and Wales. These are used to rank upgrades and downgrades and so construct Hit Lists for action.

Table D.3b: Illustration of Confidence of a Change in Grade

CHANGE	CONFIDENCE (%)
No downgrade	100
Up at least 1, 2, 3, 4 or 5 Grades	88
Up 2, 3, 4, or 5 Grades	38
Up 3, 4 or 5 Grades	4
Up 4 or 5 Grades	0
Up 5 Grades	0

Appendix E: Which Rivers Have Really Got Worse Biologically ?

Like the Chemistry, the fact that a lot of rivers lie close to the edge of a class boundary, coupled with the uncertainty produced by monitoring, gives an average risk of 22% that a **particular** stretch of river is placed in the wrong class.

For biology, one of the possible errors is the risk that Taxa may be collected in a sample yet remain unnoticed by the sampler when the sample is examined. This produces a risk of bias and means that in the general error of 22% the risk of assigning a grade which is too low is about 12% compared with the risk of an over-estimate, which is 10%.

In calculating the effect of error we have made use of the results of research by the Institute of Freshwater Ecology [8].

There is also a CONCLASS for Biology [9]. The principles are similar to those discussed in Appendix D for Chemistry. An example of the output is in Table E.1. The Face-value is Grade **b**. This is dictated by the ASPT. The bottom row of the table shows that there is confidence of 4% that the true grade is better than **b** and a risk of 15% that the true grade is worse than **b**.

Table E.1: CONCLASS for the Biological GQA

Biological Measure	Value	Standard Error	Number of Samples	EQI	Confidence of Biological Grade (%)					
					a	b	c	d	e	f
ASPT	4.50	0.18	2	0.94	4	81	15	-	-	-
No. of Taxa	22	1.56		0.88	67	33	-	-	-	-
Both ...					4	81	15	-	-	-

Lists of statistically significant upgrades and downgrades are produced for every stretch in England and Wales. Similar lists are also made to show which stretches have the strongest differences between the Chemical and Biological GQA. These point to particular types of pollution. In creating these lists the technique is the same as described for Chemistry in Appendix D (Tables D.2, D.3a and D.3b).

Appendix F: Classification by Phosphate

Nutrients are important indicators of water quality because of their role in eutrophication.

Research by the Water Research Centre for the National Rivers Authority concluded that nitrogen and phosphorus were the two most important nutrients in rivers, with phosphorus being more likely to limit eutrophication [10]. The research also recommended that nitrogen and phosphorus had to be considered separately in order to get a sensible classification.

There are uncertainties about eutrophication and about the role of nutrients. There is a lot of research, opinion and assertion, but little agreement on the general relation between the concentrations of nutrients and their effect on the ecology of rivers.

In 1992 the NRA proposed a classification based on a set of average concentrations of phosphate thought by many (but not by some) to indicate the rough boundaries between effects in many types of rivers. This set included a guideline value put forward by the DoE as one component of a set of criteria for selecting possible candidates for *Sensitive Areas* under the Directive on *Urban Waste Water Treatment* [11].

The Water Research Centre stressed the need for a flexible system where the classifications recorded in past years could be re-worked into new classification in the light of developments in knowledge and a consensus on standards. At the same time, the system must be able to pick up and report on changes, whether or not they hold significance for eutrophication.

We present here a classification based on average concentrations of phosphorus (Table F.1). The classification uses "standards" that are being talked about at present, and augments them for high concentrations, with "standards" that break up the national set of rivers into groups [10,11].

Table F.1: Boundaries for the Phosphate Classification

Category	Grade Limit (Annual Average Concentration of Phosphate - mg/l)
1	0.02
2	0.06
3	0.1
4	0.2
5	1.0
6	-

These "standards" cannot be regarded as anything like as generally prescriptive of good or bad quality as the standards for the Chemical and Biological GQA. Indeed the degree to which high levels of phosphorus are considered bad depends on where the river is and on physical factors like the flow regime, altitude and the size of the river. The significance of a Grade 3 river in Wales is quite different from a Grade 3 in East Anglia. And a shift from 2 to 1 in the Lake District can be much more important than the fact that a river in East Anglia remains in Grade 5 or 6.

The classification for 1995 is shown in Map 6 (page 26). Tables of results are in Appendix A. A summary is in Figures F.1 and F.2

Map 6 shows the drift from low concentrations in the west and north west of England and Wales to the higher values in the south and east. This reflects differences in the level and type of human activity, and differences in geomorphology and land use.

The procedure used for the Phosphate classification is very similar to that recorded in Appendix C for the Chemical GQA. For example, three years' data are used - the Grade for 1995 being based on samples taken in 1993, 1994 and 1995.

As for the Chemical GQA, the Phosphate GQA makes use of data collected for the general management of water quality and taking decisions to protect the environment. Very little of the monitoring for the GQA is new monitoring except where we have imposed standard procedure across England and Wales.

The methods of chemical analysis used before 1994 were not always required to detect very low concentrations. Accordingly, the use of the classification to show change since 1990, is hampered for Grades characterised by low levels of phosphate, by the precision of chemical analysis. Some of the methods are unable to distinguish Grade A from B. Also, in a few catchments, phosphate was not measured routinely.

Nonetheless there is clear evidence of a strong move since 1990 towards grades characterised by lower phosphate. From 1990 to 1995, 36% of river moved into a grade characterised by smaller concentrations of phosphate. Seven percent of rivers moved the other way. This gives a net improvement of 29% (Table A.14 in Appendix A).

In calculating these figures we have eliminated all rivers not assessed for 1990. The figures cover 22,000 km of rivers.

Table F.3 gives trends in Anglian and Thames Regions over the past 15 years. The numbers plotted are the median (middle) values, for each year, of the 10,000 values recorded for all rivers in each calendar year. As such, this median is precise estimate from which to gauge trend. Figure F.3 shows the improvement since 1990 but places it in the context of the high values recorded in 1989 and 1990. Recent values are the lowest, at least since 1980.

Figure F.1: Phosphate Grading in 1995

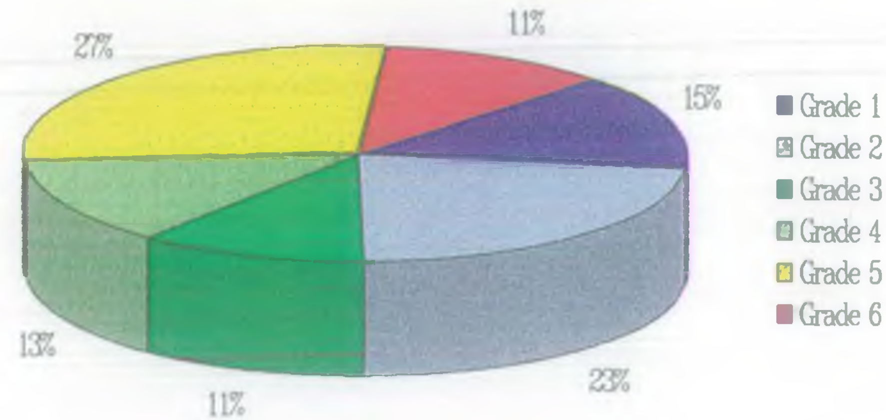


Figure F.2: Phosphate Grading in 1995

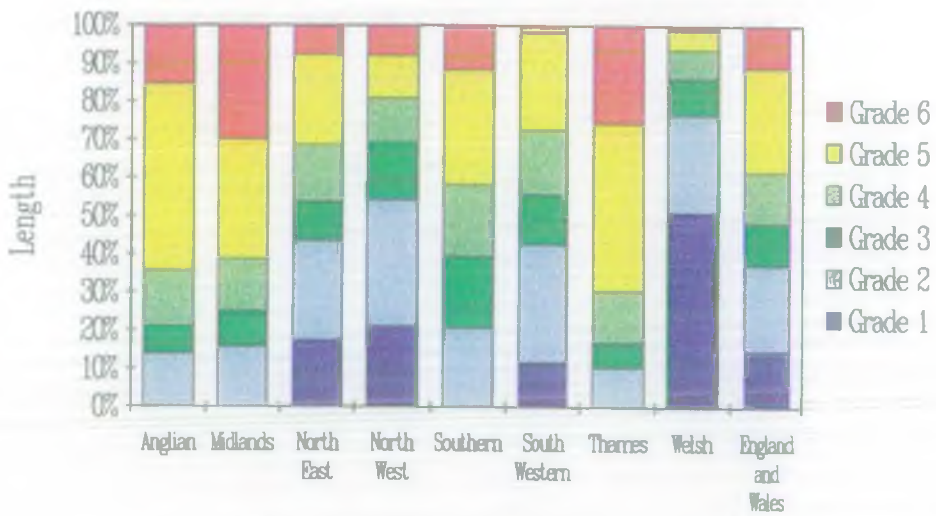
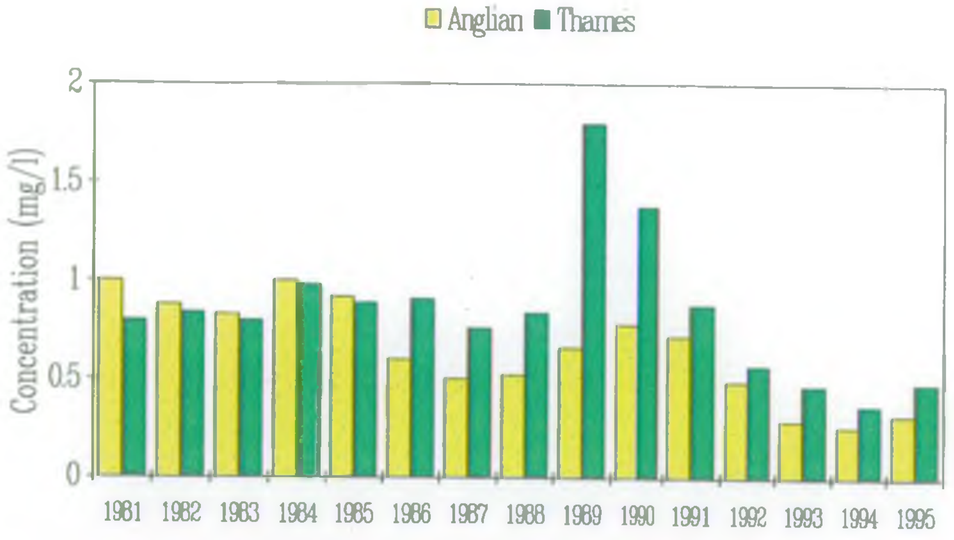


Figure F.3: Trend in Median level of Phosphate



The causes of the improvement are similar to those cited for the Chemical GQA. The weather for 1990 produced higher concentrations of phosphate in rivers than in previous years. At the same time however, some Regions report 40-50% reductions in the load of phosphate discharged in sewage effluents.

There have been few cases where we have aimed deliberately to remove phosphate from sewage effluents. This suggests that observed reduction was a bi-product of improved treatment of effluents to remove organic pollution in terms of BOD and Ammonia. This may have been coupled with reductions in the amount of phosphorus used in detergents.

In the future, the Water Companies will be required to remove more phosphate at certain large sewage effluents in 17 catchments as a result of the Directive on *Urban Waste Water Treatment*. The Agency is looking at whether similar requirements will be needed in 45 other catchments. These big reductions, coupled with those recorded from 1990 to 1995 provide an opportunity to check whether the removal of phosphate in this way brings measurable benefits to water quality.

Errors

The fact that a lot of rivers lie close to the edge of a class boundary, coupled with the uncertainty produced by monitoring less than all the time, gives an average risk of 15% that a **particular** stretch of river sampled 36 times is placed in the wrong grade [1].

The impact of this on our estimate of the 29% net improvement is to give 28 $\pm$ 0.3 %. The small error in the national figure, $\pm$ 0.3 %, compared with the error for an individual stretch of river, 15%, stems from the fact that the former is based on 500,000 samples and the latter on about 70.

There is a risk of 15% that a stretch of river is given the wrong grade and a similar risk of that a river may be declared wrongly to have changed class from one survey to the next [1]. This error means that reported changes of a single grade are often insignificant because too many such changes are produced by error.

Appendix G: The Grading Scheme for Aesthetic Pollution

We make judgements about rivers by looking at them. The appearance of a river is a factor in deciding how a river will be used. Rivers in high grades for chemistry or biology will appear worthless if they look messy or smell bad.

The aesthetic quality of a river is determined by a mix of perceptions including the clarity of the water, odour, stagnation, colour, and the presence of oil, litter, foam and excess weeds and algae. Our scheme for classifying rivers takes account of the factors listed below and weights them according to their importance to people:

- Litter from sewage (like sanitary towels, condoms, human faeces and cotton buds);
- Gross litter like shopping trolleys, traffic cones and dumped cars;
- Other litter like plastics, cans and food wrappings;
- Faeces on non-human origin, for example, from dogs;
- Oil;
- Odour;
- Foam;
- Sewage fungus (a brown, white or pink cotton wool like growth of micro-organisms found downstream of discharges of organic wastes like poor quality effluents from sewage treatment works);
- Ochreous deposits (a reddish brown discolouration of the river bed usually the result of mining);
- Colour

Assessments are made by a survey of the river and its bank. A standard method has been devised. Sites are assessed on both banks, or one, depending on public access.

The unit of survey is a stretch of the bank, 50 metres long and 5 metres wide. We count the numbers of items of litter, make a visual inspection of the cover by oil, foam, fungus and ochre, and note the colour and odour of the water.

Each type of measurement (like litter, odour and colour) is graded from 1 to 4 according to the rules in Table G.1[5] and each is given a weighting for each class according to its acceptability. The weightings are shown in the top half of Table G.2. Sewage litter is the least acceptable.

The weightings of all the parameters are summed to give a total score for the site. This total gives the overall Grade for the site (as shown at the bottom of Table G2). The Grades are described as Good, Fair, Poor and Bad.

In 1995 a selection of 500 sites were surveyed in order to test the scheme. The scheme will be used to address local issues of pollution control issues as well as in more general surveys.

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[5] Table G.1 applies where only one bank is accessible to the public. A slightly different table applies where there is access to both banks.

Table G.1: GQA for Aesthetic Quality				
LITTER (NUMBER OF ITEMS)				
Type of Litter	Class 1	Class 2	Class 3	Class 4
Gross	none	2	6	-
General	5	39	74	-
Sewage	none	5	19	-
Faeces	none	3	12	-

OIL, SCUM, FOAM, SEWAGE FUNGUS, OCHRE (Percentage Cover)			
Class 1	Class 2	Class 3	Class 4
0	5	25	-

COLOUR			
Intensity	Blue / Green	Red / Orange	Brown / Yellow / Straw
Colourless	Class 1	Class 1	Class 1
Very Pale	Class 1	Class 2	Class 1
Pale	Class 3	Class 3	Class 2
Dark	Class 4	Class 4	Class 3

ODOUR	
We define the following types of odour	
Group I	Tolerated or less indicative of water quality. Musty, Earthy, Woody.
Group II	Indicators of poor quality. Farmy, Disinfectant, Gas, Chlorine.
Group III	Indicators of very poor quality. Sewage, Polish or Cleaning Fluids, Ammonia, Oily Smells, Bad Eggs (Sulphide).

And use in them in the classification in the following way .....

Intensity of Odour	Group I	Group II	Group III
None	Class 1	Class 1	Class 1
Faint	Class 1	Class 2	Class 3
Obvious	Class 2	Class 3	Class 4
Strong	Class 3	Class 4	Class 4

Table G.2: Aesthetic Classification Scheme				
Parameter	Allocation of points for each Class			
	Class 1	Class 2	Class 3	Class 4
Sewage Litter	0	4	8	13
Odour	0	4	8	12
Oil	0	2	4	8
Foam	0	2	4	8
Colour	0	2	4	8
Sewage Fungus	0	2	4	8
Faeces	0	2	4	6
Scum	0	1	3	5
Gross Litter	0	0	1	3
General Litter	0	0	1	3
Ochre	0	0	0	1

The points allocated for each parameter are summed to give the Total Score. The Grade is then assigned as:		Total Score
Grade 1	Good	1, 2 or 3
Grade 2	Fair	4, 5,6 or 7
Grade 3	Poor	8, 9, 10 or 11
Grade 4	Bad	more than 11

Glossary

Acidification; Acid Rain	The process by which rainfall is polluted by emissions to the air of gases produced by combustion. This rainfall can affect the acidity of rivers and can damage the biota within them. This is especially the case in areas in the west of England & Wales where the geological strata do not neutralise the acidity.
Algae	Simple microscopic (sometimes larger) plants which are capable of photosynthesis. Algae occur in water and are often discussed in the context of Eutrophication (ibid).
Aquifer	Layers of underground porous rock which contain water and allow water to flow through them.
ASPT	A summary statistic to describe the results of monitoring rivers for the presence of benthic macro-invertebrates (ibid). An acronym for Average Score per Taxon (ibid). The Score refers to the BMWP Score (ibid).
ATU	Allyl Thio-Urea. See Biochemical Oxygen Demand.
Ammonia (or Total Ammonia)	A chemical found in water often as the result of pollution by sewage effluent. Ammonia affects fisheries and abstractions for potable water supply.
AMP2	An acronym for Asset Management Plan, Number 2. These are the plans of the Water Companies for future investment. This expenditure is committed and has been justified as part of the national negotiations with the Water Industry on future charges for water. See also Statutory Expenditure and Discretionary Expenditure.
Benthic	Pertaining to the bed of the river
Biota	A collective term for a community of animals and plants.
BMWP; BMWP Score	BMWP is an acronym for Biological Monitoring Working Party (1,7). Some invertebrates are more susceptible than others to pollution and so the presence of sensitive individuals is a sign that water quality is good. This fact was taken into account by the BMWP, when it set up a method of summarising biological information in the form of a simple index. This became known as the BMWP Score. This system assigns points to each Family (ibid) according to its sensitivity to pollution. For example, many mayfly nymphs and caddis larvae score ten points, water beetles score five, molluscs three, and worms, one. The BMWP Score for a site is the sum of all the scores of all the Families found.
BOD and BOD(ATU) Biochemical Oxygen Demand	A measure of the amount of oxygen consumed in water, usually by organic pollution (ibid). Oxygen is vital for life so the measurement of the BOD tests whether pollution could affect aquatic animals. The value can be misleading because much more oxygen is taken up by Ammonia (ibid) in the test than in the natural water. This effect is suppressed by adding a chemical (Allyl Thio-Urea) to the sample of water taken for testing. Hence BOD(ATU).
Catchment	The area of land over which rainfall drains to the river.
Classified River or Classified Watercourse	Rivers big enough to be included in the national quinquennial reports on river water quality. Generally these are rivers whose flow is bigger than about 5 million litres per day, though smaller rivers may be included if they are particularly important. Only classified rivers are being considered for SWQOs (ibid), though all rivers can have RQOs (ibid).
Combined Sewer Overflows	Most sewers receive flows of sewage and flows of rainfall that run off our roads and paved areas. After heavy rainfall, the flows in the sewer may exceed the capacity of the sewers or the capacity of sewage treatment works. Combined Sewer Overflows allow the dilute and excess flow to discharge to a receiving water. The conditions under which flows may overflow into receiving waters are specified in the Consent (ibid).
Confidence of Failure	The outcome from compliance assessment (ibid). This might conclude with the statement, for example, that we are 93% certain of failure - the Confidence of Failure is 93%. We are often less that 100% sure of failure because we cannot monitor continuously everywhere.
Consent	A statutory document issued by the Agency which defines the legal limits and conditions on the discharge of an effluent to a water.

Copper	See Dissolved Copper
CSO	An acronym for Combined Sewer Overflow (ibid)
Cyprinid Fish	Coarse fish belonging to the carp family (roach, dace, bream, etc).
Dangerous Substances Dangerous Substances Directive	Substances defined by the European Commission as in need of special control because they are toxic, accumulate in plants or animals and are persistent. Subjects of the Dangerous Substances Directive (76/464/EEC).
Deteminand	A general name for a characteristic or aspect of water quality. Usually a feature which can be described numerically as a result of scientific measurement.
Directive	A type of legislation issued by the European Community which is binding on Member States in terms of the results to be achieved but which leaves to Member States the choice of methods.
Discretionary Expenditure	A special category within AMP2 (ibid) for expenditure over and above Statutory Expenditure (ibid). Discretionary Expenditure is targeted at meeting a specific national set of environmental improvements.
Dissolved Copper	A metal, toxic to fish
Dissolved Oxygen	The amount of oxygen dissolved in water. Oxygen is vital for life so this measurement is a test of the health of a river.
Environmental Quality Index (EQI)	A summary of the ecological health expressed as the ratio of the Number of Taxa (ibid) or ASPT (ibid) found in samples to those predicted by RIVPACS (ibid).
Eutrophic	A description of water which is rich in nutrients (ibid). Such waters are sometimes beset with dense growths of algae (ibid).
Eutrophication	The process of nutrient enrichment of waters. This can cause unsightly growths of algae (ibid) and other biological changes in the water environment.
Family	A group in the classification of living organisms, consisting of related genera.
Freshwater Fisheries Directive	A Directive (ibid) that sets water quality standards for rivers designated as freshwater fisheries (78/659/EEC).
Fisheries Directive	The Freshwater Fisheries (ibid) Directive (ibid) (78/659/EEC).
General Quality Assessment (GQA)	The Agency's way of placing waters in categories according to assessments of water quality based on surveys of biology and measurements of chemical quality. Used for the national reporting of trends.
Invertebrates	Animals without backbones. They include, for example, insects, crustaceans, worms and molluscs.
Local Environment Agency Plan (LEAP)	The consultative process by which the Agency plans to meet all the issues in any catchment, and not just water quality and RQOs. It involves the production of a Consultation Report and liaison with local people in forming an Action Plan (ibid). One outcome of the process is draft proposals for SWQOs (ibid)
List I	Dangerous Substances (ibid) which are particularly hazardous and in need of special controls. Standards are set by the European Commission.
List II	Dangerous Substances (ibid) which are less hazardous than List I (ibid) and which are controlled by water quality standards defined by individual Member States of the European Community.
Macro-invertebrates	Invertebrate animals of sufficient size to be retained in a net with a specified mesh (1 mm).
MAFF	Ministry of Agriculture Fisheries and Food.
metals	For example: copper, zinc, chromium, nickel, lead, cadmium and mercury. Now generally covered in the legislation on Dangerous Substances (ibid)
mg/l	Unit of concentration: Milligrammes per litre.

mg/l $CaCO_3$	Unit of concentration: Milligrammes per litre (expressed as Calcium Carbonate).
mgN/l	Unit of concentration: Milligrammes per litre (expressed as nitrogen).
mgP/l	Unit of concentration: Milligrammes per litre (expressed as phosphorus).
Ml/d	Unit of river flow, megalitres per day - millions of litres per day.
Number of Taxa	A summary statistic used to describe the results of monitoring rivers for the presence of benthic macro-invertebrates (ibid). See Taxa (ibid). The Number of Taxa is the number of those Taxa (from those used in the BMWP Score (ibid)) found at a site.
Ochre; Ochreous deposits	A reddish brown discolouration of the river bed usually the result of mining activities
Organic Pollution	A general term used to describe the type of pollution which through the action of bacteria consumes the Dissolved Oxygen (ibid) in rivers. It applies to the effects of sewage, treated sewage effluents, farm wastes and the waste from many types of industry like dairies, breweries and abattoirs. The effects of organic pollution are described by the levels of BOD, Ammonia and Dissolved Oxygen (ibid).
Percent Saturation (% saturation)	Unit of measurement for Dissolved Oxygen. The amount of oxygen expressed as a proportion of the maximum which can be dissolved in pure, sterile, water at the same temperature and pressure as the water in the river.
Percentile	A level of water quality, usually a concentration, which is exceeded for a set percentage of the time. Hence: 90-percentile (ibid).
pH	A measure of the acidity of water.
90-percentile	A level of water quality, usually a concentration, which is exceeded for 10-percent of the time. Similarly, 95-percentile and 10-percentile.
90-percentile Standard	A level of water quality, usually a concentration, which must be achieved for at least 90-percent of the time. Similarly, 95-percentile and 10-percentile.
Nutrient	A chemical essential for life. If present in excess nutrients can produce the effects of eutrophication (ibid). In this report the term, nutrient, implies plant nutrients, primarily, nitrate and phosphate.
Organic Pollution	A term used to describe the type of pollution which through the action of bacteria consumes the Dissolved Oxygen (ibid) in rivers. It applies to the effects of sewage, treated sewage effluent, farm wastes and the waste from many types of industry like dairies, breweries and abattoirs. The effects of organic pollution are described by the levels of BOD, Ammonia and Dissolved Oxygen (ibid).
Organic Chemicals	Typically: solvents, oils, pesticides, herbicides. Several are covered in Directives.
River Quality Objective (RQO)	The category of water quality that a body of water should match, usually in order to be satisfactory for use (ibid) as a fishery or water supply etc. Often expressed as the River Ecosystem Class.
RIVPACS	An acronym for the River Invertebrate Prediction and Classification System. A computer based system used to predict the invertebrate life in a river under natural conditions. Used to calculate the Environmental Quality Index (ibid).
Quality Standard	A level of a substance or any calculated value of a measure of water quality which must be bettered. The pairing of a specific concentration or level of a substance with a summary statistic like a 90-percentile (ibid).
Salmonid Fish	Game fish of the Salmon Family (trout, salmon, etc).
Sensitive Area	Waters that are eutrophic, or at risk from becoming eutrophic, can be designated as Eutrophic Sensitive Areas under the Directive on Urban Waste Water Treatment (ibid). Sewage treatment works that discharge to these Areas may require nutrient removal if they serve more than the equivalent of a population of 10,000.

Site of Special Scientific Interest	A site given a statutory designation by English Nature or the Countryside Council for Wales because it is particularly important on account of its value to nature conservation.
SSSI	Acronym for Site of Special Scientific Interest (ibid).
Statistically significant	A description of a conclusion which has been reached after making proper allowance for the effects of random chance.
Statutory Expenditure	AMP2 (ibid) expenditure which is mainly aimed at meeting legal duties, especially those imposed by European legislation. For sewage treatment, it is dominated by the requirements of the Directive on Urban Waste Water Treatment (ibid).
Statutory Water Quality Objective (SWQO)	A Quality Objective given a statutory basis by Regulations made under the Water Resources Act 1991.
STW	Acronym for Sewage Treatment Works
Surface Water Abstraction (Directive on)	A Directive (ibid) that sets water quality standards for surface waters used, after treatment, as a supply of drinking water to the public (75/440/EEC).
Taxon; (plural: Taxa)	A group of related animals. In the context of this report, the taxonomic level to which most animals have been identified is Family (or Taxon), and only those taxa used for the BMWP Score (ibid) have been considered. Hence the Number of Taxa (ibid) is used as a summary statistic to describe the results of the biological monitoring rivers for benthic macroinvertebrates (ibid). Hence also, ASPT, the Average Score per Taxon (ibid)
Total Ammonia	See Ammonia.
Total Zinc	A metal, toxic to fish.
Toxicity Based Consent	A Consent (ibid) that includes a requirement that the discharge achieve a defined outcome in tests conducted in order to measure the degree of effect on test organisms.
Unionised Ammonia	A species of Ammonia (ibid). A small component of the amount of Total Ammonia which is particularly toxic to fish and which therefore has its own standard.
Urban Waste Water Treatment (Directive on)	A Directive that sets standards for discharges from sewage treatment works and sewerage systems (and similar discharges). The Directive also sets out the dates by which the standards must be achieved.
Use	Attributes of a river like a fishery or a water supply.
Use-related Objective	An aim to achieve a particular Use(ibid).
Use-related Standards	Water quality standards needed to protect a Use (ibid).
Vulnerable Zone	Under the Directive on the Pollution of Waters by Nitrates from Agriculture, Member States must identify *Polluted Waters*. These can be surface waters with elevated nitrate concentrations which are abstracted for drinking water or waters which are eutrophic because of nitrate. Following the identification of Polluted Waters, Nitrate Vulnerable Zones (NVZ's) are designated. These are areas of land draining to the affected waters.
$\mu g/l$	Unit of concentration: Microgrammes per litre - one millionth of a grammes per litre.
Zinc	See Total Zinc

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The Cam Catchment	Anglian Region
The Yarrow Catchment	North West Region
The Aire Catchment	Northumbria and Yorkshire Region
The Worcester Stour Catchment	Severn Trent Region
The Test Catchment	Southern Region
The Upper Bristol Avon	South Western Region
The Loddon Catchment	Thames Region
The Cleddau Catchment	Welsh Region

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