

Nature conservation and pollution from farm wastes



Contents

Foreword	4
1 Introduction	5
Farm waste – an increasing problem	5
The role of the Nature Conservancy Council	5
The framework of water pollution control	5
2 Sources of pollution	6
Changes in farming practices	6
Animal slurry	7
Yard and parlour washings	8
Silage liquor	8
Other sources	9
3 Effects on water bodies and wildlife	10
Organic pollution	10
Nutrient enrichment	10
Aquatic and wetland plants	11
Aquatic invertebrates	11
Fish	12
Birds	12
Grasslands	12
4 The situation in England and Wales	12
Farm pollution incidents 1984-89	12
Serious incidents and prosecutions	14
5 The situation in Scotland	14
6 Damage to sites of nature conservation importance	15
7 Measures to combat the problem	17
Encouragement of good practice	17
Grants and subsidies	18
Regulations to control silage, slurry and agricultural fuel oil installations	18
Prosecutions	18
Creation of buffer strips	19
Re-use of farm waste	19
Control of land-use practices in sensitive catchments	20
8 Conclusions	20
9 Contribution of the NCC	21
10 Recommendations	21
Storage facilities on farms	21
Disposal of wastes	21
Recycling of wastes	21
Preventive and remedial measures	22
Duties of pollution control bodies.	22
11 References	22
SSSIs affected by farm wastes (1986-1990).	23

Acknowledgements

The NCC would like to thank the following for providing information which was used in the preparation of this report:

R Allcock (Tay River Purification Board), M Kelly (West of Scotland College of Agriculture) and F W van der Vegte (Provincial Water Company of North Holland, Netherlands).

The diagrams on pages 9 and 16 were reproduced by kind permission of the National Rivers Authority and Ministry of Agriculture, Fisheries and Food. The diagram on page 20 was drawn by Dr P Kirby. Assistance with diagrams and tables was given by C Mortimer.

Foreword

The NCC believes that the safe storage and proper disposal of farm wastes must be at the forefront of the nation's efforts to control water pollution. Many streams, rivers and lakes in rural areas, which not so long ago provided an unpolluted environment for wildlife, have been shown to have suffered serious pollution. The causes are not only leaks and spillages, which have been reported in unprecedented numbers, but regular run-off of slurry from farm premises and from fields after spreading.

The intensification of dairy farming and livestock rearing means that farmers must give special attention to the increased waste that is produced. Grant aid should be available for repairs and improvements to existing storage facilities, as well as for new installations. Incentives should also be provided for the processing of slurry for use as compost and fertiliser and the production of gas for electricity through digesters.

The NCC supports the efforts of the National Rivers Authority and River Purification Authorities in Scotland in inspecting farms and where appropriate mounting prosecutions. Their role should be fully resourced. We welcome the introduction of regulations by the Government, but we believe that further measures are needed, especially to deal with pollution resulting from run off. Steps should also be taken to rehabilitate lakes and watercourses which are suffering from eutrophication.

This report sets out the NCC's views on farm pollution and gives examples of how it affects nature conservation. The report also seeks to influence, through its recommendations, the farming community, pollution control authorities, Government and Parliament, to take decisions on combating farm pollution which will safeguard the interests of wildlife.

The report has been compiled by David Withrington, the NCC's policy officer responsible for water and pollution issues, together with Robert Irving, an independent consultant. Tribute should also be paid to Dr Roscoe Howells, who has done much to inform and stimulate NCC's involvement in farm pollution matters, first as Chief Scientist of the Welsh Water Authority and latterly as a Member of NCC's Advisory Committee on Science.

Sir William Wilkinson

Chairman, Nature Conservancy Council

February 1991

1 Introduction

Farm waste – an increasing problem

1.1 During the last decade the reported incidence of water pollution from farm waste increased dramatically. Recent surveys of dairy farms in south-west England indicate that the problem is even more widespread than revealed in the official statistics. Apart from "pulses" of pollution, which can cause mass fish deaths, chronic leaks from silage clamps and regular run-off from slurry spreading are affecting aquatic wildlife in formerly clean streams and lakes. This report contains details of a substantial number of Sites of Special Scientific Interest that have been damaged by farm pollution.

1.2 The intensification of dairy and livestock farming and the trend towards feeding cattle silage rather than hay have meant a considerable increase in the amount of slurry and the need to contain quantities of silage liquor. The storage and safe disposal of farm wastes presents problems on a similar scale to those involved in disposing of sewage effluent from human settlements. British farms produce more than 200 million tonnes of animal excreta each year, equivalent in pollution potency to 600 million tonnes of human sewage. Silage liquor is 200 times more polluting than raw human sewage.

1.3 The capacity of the land and watercourses to absorb this effluent has been exceeded in some parts of the country. Recent studies in rural Wales by the Water Research Centre have found some streams in dairying areas to be Class 3 in the national water quality classification, equivalent to the industrial Mersey.

1.4 In some parts of western Europe, such as Denmark and the Netherlands, the storage and disposal of animal slurry are now highly regulated, with legal provision for reductions in herd sizes. It is clear that more effective preventive measures are needed in Britain, with increased investment in improved storage facilities in problem areas. There is also a need to look at alternative uses for farm wastes, in order to reduce the amounts which need to be disposed of on the farm.

1.5 The NCC first drew attention to pollution from farm wastes in 1977 in its evidence to the Royal Commission on Environmental Pollution for their enquiry into agriculture and pollution. At that time the extent of pollution from slurry and, particularly, from silage effluent was not well known. We forecast that if developments towards intensification of agriculture were substantial, radical measures would be needed to contain farm waste. By 1985 this trend had become clear, and the Codes of Good Agricultural Practice had been introduced. In the following year, in response to the Government's consultation paper *The Water Environment: The Next Steps*, the NCC suggested that regulations should be introduced on the storage and disposal of farm wastes to supplement

the Codes. We also recommended that the inspection and advisory role performed by water authorities and ADAS, and the river purification authorities and Colleges of Agriculture, should be stepped up. In 1989 we submitted evidence to the Royal Commission for their enquiry into freshwater quality. Ten pages of NCC's evidence are concerned with pollution from agriculture. Much of this evidence, including relevant recommendations, is incorporated in this report.

The role of the Nature Conservancy Council

1.6 The Nature Conservancy Council (NCC) is the official body responsible for promoting nature conservation in Great Britain. Its functions include giving advice to Ministers and all those whose decisions or activities affect wildlife and geological features in Great Britain. In discharging its functions the NCC must take account of actual or possible ecological changes. It commissions or undertakes research relevant to these functions.

1.7 The NCC's role in combating pollution from farm wastes is not confined to the provision of advice at a national or governmental level. We are directly concerned when polluting activities affect any Site of Special Scientific Interest (SSSI). The NCC has notified farmers who own or occupy land on sensitive SSSIs that they must give notice if they intend to spread slurry within the site. We would not normally give consent for the application of slurry or silage liquor to any grassland of botanical interest. On other fields, we would normally require that the slurry or silage liquor was spread during the growing season and on flat, unfrozen and waterlogged ground at least 10 metres from a watercourse.

1.8 Where pollution from farm sources outside an SSSI is affecting a site, the normal course of action open to the NCC is to ask the National Rivers Authority or River Purification Authority to take appropriate action to remedy it.

1.9 The NRA has a statutory duty to further the conservation of flora and fauna of special interest and to promote the conservation of flora and fauna dependent on an aquatic environment. River Purification Authorities have no equivalent duties, but have been asked by the Scottish Office to observe the spirit of the legislation. The NRA and RPAs have powers to clean up pollution and, where possible, take steps to prevent it from entering watercourses, and to recover the costs from the polluter. The NCC will be formally consulted when statutory Water Quality Objectives are set for lakes and rivers which are SSSIs. The NCC is also involved with a wide range of bodies – from anglers to farming organisations – in discussion of farm waste problems and the best means of tackling them.

The framework of water pollution control

1.10 Comprehensive provisions for control of pollution entering water were contained in Part II of

the Control of Pollution Act 1974 (actually implemented ten years later). Most of these provisions were re-enacted in Part III of the Water Act 1989. In England and Wales responsibility for water pollution control was transferred from the regional water authorities and Secretaries of State to the newly created National Rivers Authority in September 1989. In Scotland responsibility rests with the river purification authorities (seven River Purification Boards and three Islands Councils).

1.11 In relation to farm pollution, Government has a key role to play. The relevant Secretary of State has powers to issue regulations under the Water Act 1989 to prevent or control farm wastes entering watercourses and to designate Water Protection Zones where certain potentially polluting activities may be restricted. The Minister of Agriculture or Secretary of State for Wales or Scotland may designate Nitrate Sensitive Areas under the same Act. The relevant Secretary of State and the Minister of Agriculture may together draw up codes of good agricultural practice. In addition, Agriculture Departments provide grants towards storage facilities for farm waste.

1.12 Under the Water Act 1989 a person commits an offence if he causes or knowingly permits any poisonous, noxious or polluting matter or any solid waste matter to enter a lake, stream, river, coastal or underground waters. It is also an offence to contravene regulations made by the Secretary of State on the storage or disposal of farm wastes.

2 Sources of pollution

Changes in farming practices

2.1 The number of pollution incidents attributable to animal slurry and silage liquor has increased dramatically during the past decade. In the ten water authorities in England and Wales there were 4,141 incidents reported in 1988 compared with 1,484 in 1979 (see figure 1). In Scotland, there were 572 recorded incidents in 1988, compared with 263 in 1982, an increase of 117% (Reports of the Scottish Farm Waste Liaison Group). It is pleasing to note, however, that the total number of incidents for 1989 in England and Wales is down by 30% on the previous year (NRA/MAFF, 1990), though this is largely attributable to the long spell of dry weather during the spring and summer of 1989.

2.2 The reasons behind the overall increase in farm pollution incidents seem self-evident. During the last twenty years there has been a very significant intensification in dairy and beef farming in England and Wales. In 1985, dairy farming was practised at over 42,000 holdings and beef rearing at over 43,000 holdings. In the same year, there were nearly 9.5 million cattle and calves. And, though there has been a decrease in the overall number of farms, those that have survived have done so through increased management, efficiency and productivity.

2.3 During this time, animal husbandry methods have changed: animals are kept indoors in cubicles during the winter, rather than being left outside or

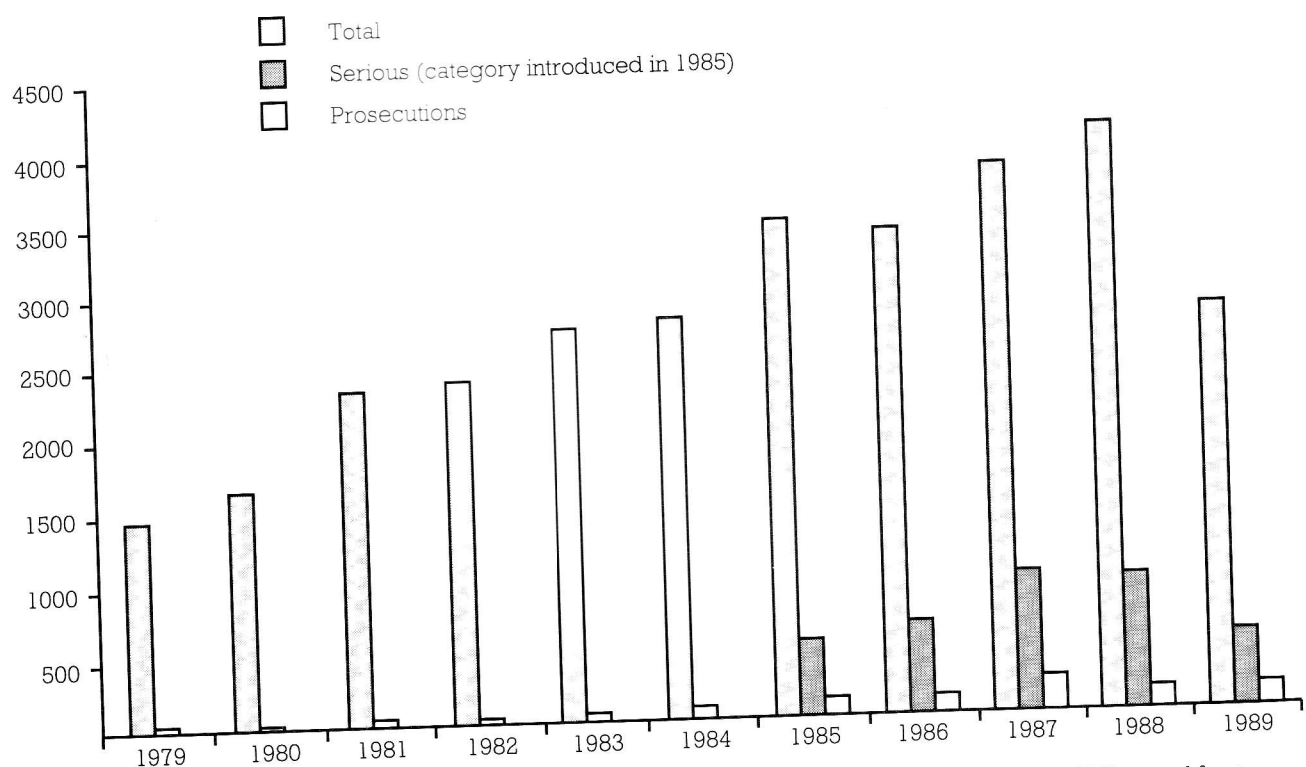


Figure 1 Reported farm pollution incidents in England and Wales 1979–1989. (Source NRA/WAA/MAFF annual farm waste reports)

bedded on straw. There has also been a significant shift away from feeding hay to feeding silage, which is formed by the bacteriological breakdown of grass and other vegetable matter under pressure in silos or clamps. Silage production has increased three or four fold in some areas during the last decade (see figure 2). These changes in practice have resulted in the production of very large quantities of liquid slurry, far more likely to cause pollution than the smaller quantities of relatively dry dung produced previously.

2.4 The improvement of grassland for silage, including underdrainage in many instances, and the removal of hedgerows and riparian vegetation have probably meant that run-off from the land is now much more likely to enter watercourses

2.5 Animal slurry and silage liquor are extremely polluting to freshwater watercourses even when diluted by rainwater. They are either directly toxic to aquatic life or, due to their breakdown by bacteria, remove significant amounts of oxygen from waters, at worst suffocating aquatic life. Farm pollution affects some of the country's cleanest freshwater SSSIs as well as polluting some of the clean rivers found within the wider countryside.

2.6 The 1988 survey of reported water pollution incidents caused by farm wastes in England and Wales states "Pollution from silage effluent and

slurry accounted for 45% of all reported incidents" (Water Authorities Association & Ministry of Agriculture, Fisheries and Food 1989). It goes on to suggest that "...although there was a small reduction in reported silage effluent incidents, the main reasons for continuing problems were the poor construction of silos and ineffective effluent management systems. Increased slurry-related problems were associated with prolonged wet weather early in 1988 and inadequate separation of roof and other clean water, leading to overloading of waste management systems." It remains to be seen whether the improvement in the figures for 1989 will be sustained in future years.

Animal slurry

2.7 Modern farming practices have considerably altered the husbandry methods by which livestock are kept, particularly during the winter months when field grazing is not possible. Though herd sizes of dairy cows have remained fairly constant at about 50 head per farm, the numbers of fattening pigs has steadily increased to an average figure of 350 head per farm. With the continuing industrialisation of farming techniques, the efficiency of farms has also increased. The diet of animals has also changed when confined to being indoors. Cows are fed more silage as opposed to hay, which leads to an increase in the liquid content of the slurry they produce. Far less use is made nowadays of straw, once the traditional bedding

Production (million tonnes)

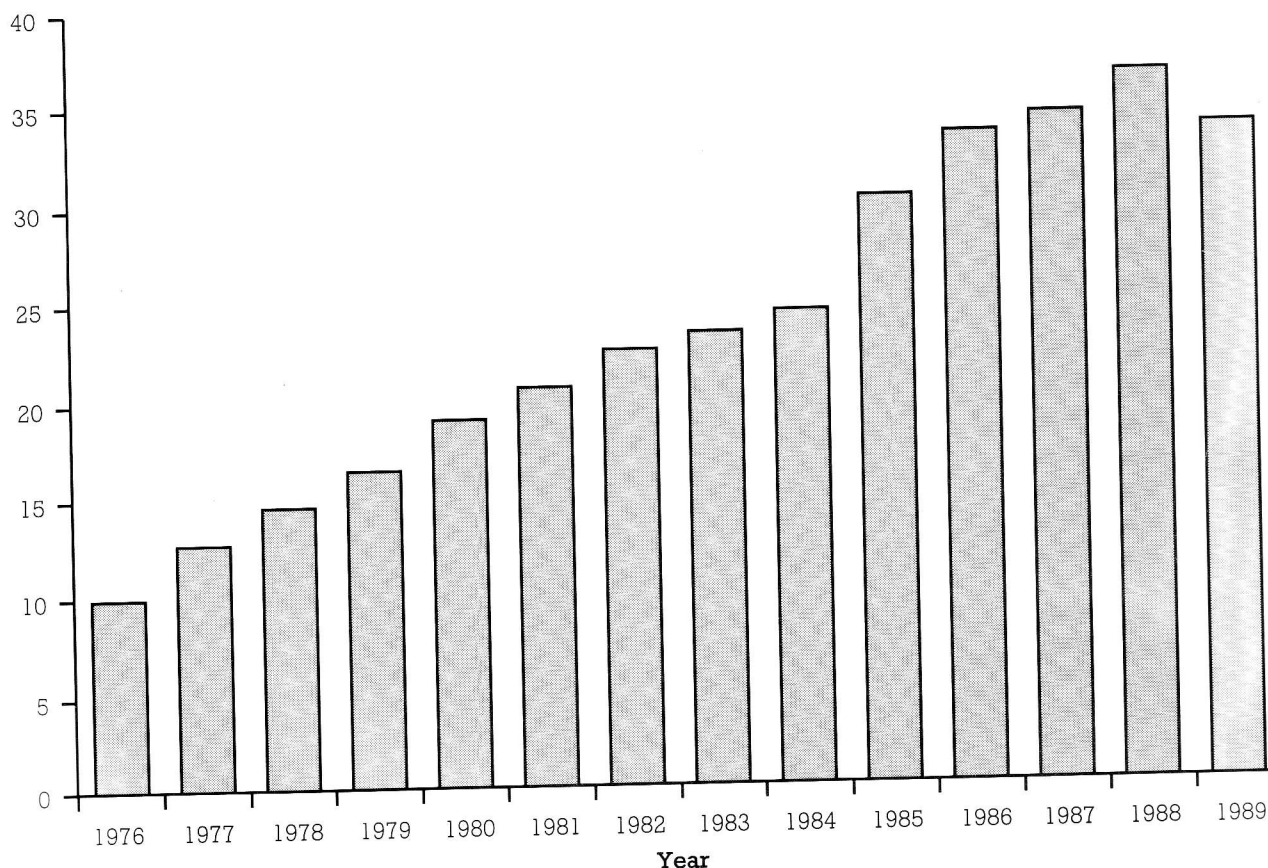


Figure 2 Silage production in England and Wales 1976–1989. (From NRA/MAFF farm waste report 1990)

material for farm animals kept indoors, and consequently less 'solid' waste is available as a manure. The liquid slurry is not all bad news though. It is an important source of plant nutrients, and it can be used as an inexpensive fertiliser on fields. However, it can also be highly polluting if it is allowed to reach ground or surface waters.

2.8 On farms in south-west Wales (Schofield *et al.* 1989), the yearly routine can be summarised as follows: "The cows are housed indoors from October to April during which time slurry is spread on the silage fields. Cows are put out during the day in early April and are out all night by early June. During spring, fertiliser is spread on the fields and from May onwards silage is cut. The number of cuts varies between 2 and 3, and in the intervening periods fertiliser or slurry is spread on the fields. Slurry is not spread on grazing fields."

2.9 Many farmers still apparently do not fully appreciate the polluting nature of slurry, particularly that of the liquid fraction. Animal slurry is rich in phosphates and to a lesser extent in various forms of nitrogen. "...Undiluted farm slurry is, in terms of biochemical oxygen demand (BOD), up to 80-100 times more polluting than untreated human sewage (which is typically treated before discharge so as to remove more than 90% of its polluting load)" (WAA/MAFF 1989). Pig slurry is even stronger (see figure 3).

2.10 The Codes of Good Agricultural Practice produced in 1985 by MAFF (England and Wales) and DAFS (Scotland) both list a number of criteria which should be observed before slurry is applied to the land. These can be summarised as follows –

- Application rates should preferably match the capacity of the crop to utilise the nutrients.
- The timing of application should be similar to that for inorganic fertilizers (i.e. when the crops can utilise the nitrogen, not during autumn or winter).
- Slurry should not be applied to steeply sloping fields or to waterlogged soils, and during periods of hard frost slurry should be applied only to flat or gently sloping land.
- Gradient, soil type, degree of saturation or desiccation, temperature and vegetation will all have effects on the extent to which slurry is absorbed or runs off.
- Care should be taken to ensure that sprayed slurry does not reach the surface of a stream or its banks.
- Slurry should not be applied to land more frequently than once per month and the volume applied in any one application should not exceed 55 cubic metres per hectare (DAFS code).

2.11 A new draft Code was produced by MAFF in January 1991, which emphasises the need to plan for the disposal of farm wastes, including an assessment of the areas of suitable land and avoidance of recently underdrained areas. The Nitrate Sensitive Areas (Designation) Order 1990 indicates that slurry should not be spread on arable land between July and October and on grassland in September and October. A limit of 175 kg of nitrogen per hectare per year in the form of animal slurry is a further requirement. Tighter limits are set for premium scheme agreements in NSAs.

Yard and parlour washings

2.12 The 1989 WAA/MAFF report points out that "Yard washings continue to account for the largest single source of (farm) pollution and highlight the benefits to farmers of following ADAS and water authority advice to separate clean rain water from the dirty yard areas. This in turn can help reduce overloading of slurry storage and management systems". It goes on to say that "...Proper provision to deal with and properly separate rainfall, spring water and other clean water from sources of farm waste is fundamental in the design of any drainage system. If such water is not separated, then the volumes of farm waste can be increased four or five fold and become unmanageable. This is the root cause of a large number of farm pollution incidents. 79% of total farm pollution incidents (in 1988) arose in the five wetter western areas. "Verification of this can be seen in the noticeable decrease in the number of pollution incidents from yard washings for 1989, when there was a particularly dry summer (figure 8).

Silage liquor

2.13 From a herdsman's point of view, there are two main advantages of grass silage over hay. Firstly, the grass can be cut when it is young, tender and more nutritious than that used for hay; and, secondly, damp weather does not interfere with its making. In order to keep silage, it is important to exclude air from the cut grass; this serves to conserve moisture. Silage can be either stored in a purpose-built vacuum tower (a silo), from which the air can be pumped out; or it can be kept in "clamps", where the silage is compressed as much as possible by covering it with an airtight covering held down by weights (often old tyres are used for this).

2.14 Unlike the harvesting of hay, the first silage crop can be taken early in the growing season (typically late April/early May in southern England), and thereafter up to four additional cuttings may be taken, depending on the growing conditions. The Code of Good Agricultural Practice (MAFF/WOAD 1985) recommends that, should weather conditions be favourable, the cut grass is allowed to dry ('wilt') before collection, so that silage is made of at least 25% dry matter. It goes on to say that where it is not practicable to do this, chemical additives will need to be used "...to achieve a good fermentation of wet or over-mature herbage".

2.15 In recent years, there has been a trend towards direct ensiling of cut or less wilted crops, thus reversing the practice of the 1970s. This partly reflects the findings of investigations showing increased milk production, both per animal and per hectare, from direct cut crops compared with even moderate levels of wilting (Small & Gordon 1986). Research in Northern Ireland has also demonstrated that prolonged wilting has adverse effects on crop yield, as does separate mowing and harvesting. As Wilkinson (1988) points out "...the implications of this research are that maximum output per acre is achieved with a system of direct harvesting, in which the crop is cut and picked up in a single operation".

2.16 With silage being held under pressure, the liquid content of the grass is squeezed out. The effluent so produced ('silage liquor') is the most polluting waste produced on a farm in terms of its biochemical oxygen demand (BOD), being up to 200 times more polluting than untreated domestic sewage (see figure 3). An analogy has been made that a single 500 tonnes clamp of unwilted silage has the same polluting potential as the daily untreated sewage production from a town of 200,000 people. Many farms now have stored on them in excess of 1,000 tonnes of silage, and in 1986 in England and Wales there were about 33 million tonnes of silage produced (see figure 2).

B.O.D. (mg/l $\times 10^3$)

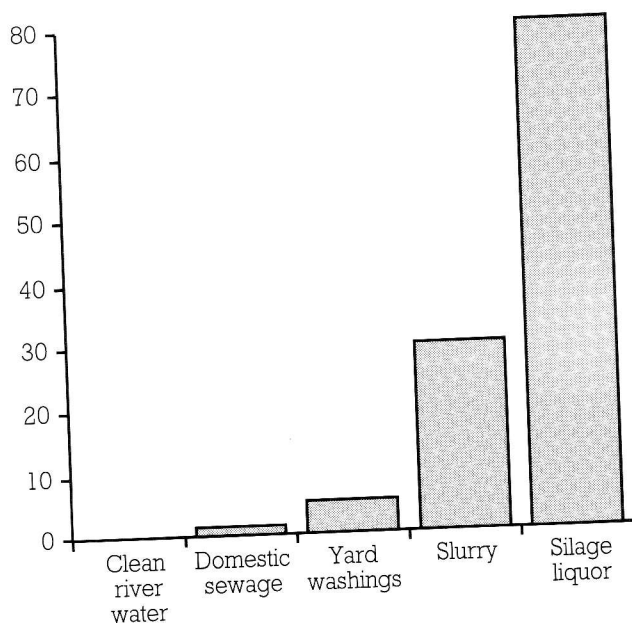


Figure 3 Comparative strengths of wastes. (From NRA/MAFF farm waste report 1990)

2.17 The high level of deoxygenation is caused by bacterial decomposition of the organic matter within the effluent. Silage effluent is also acidic (mainly butyric acid) and contains high concentrations of nutrients, especially ammonia, which give rise to characteristic growths of 'sewage fungus' on the surface of polluted watercourses. Ammonia is directly toxic to fish,

although smaller fish kills can go undetected, as some dead fish may be hidden by the fast growing 'sewage fungus'. The impact of silage liquor is further compounded because discharges predominate in the summer months, when the extent of dilution provided by receiving water courses is generally lower (Merriman 1988).

2.18 Pollution problems arise if silage liquor is not securely contained. There may be insufficient storage facilities, particularly if the intention has been to wilt the crop but then unsuitable weather conditions have made this impossible. The liquor itself is extremely corrosive, leading to leaking silos, leaking storage facilities and leaking collection systems. Concrete floors soon become pitted and the acid may seek out weaknesses in the concrete. In addition cracks often appear in the floors of silos which are 10 to 15 years old. There are a number of factors which may cause this, but frost action and the enormous weights, 25 to 30 tonnes, used to compress the silage are perhaps the most significant.

2.19 Pollution leaks arising in such a way are difficult to stop immediately. As the annual report by Northumbrian Water for 1988 points out (WAA/MAFF 1989) "...Temporary solutions - until repairs can be effected in the short period when the system is empty prior to the following silage-making season - often require the location and intercepting of adjacent land drains. Hence such pollutions tend to persist for extended periods with an increased impact". Though evidence of these failures can usually be seen above ground, they are often not apparent underground, so that serious pollution incidents can occur without the knowledge of the farmer, who may believe the situation to be satisfactory. Silage liquor may seep into land drains adjacent to or even under the base of silos and thence straight into a watercourse.

2.20 The trend for farmers to harvest silage directly into large wrapped bales may well help to keep volumes of silage liquor to a minimum. It is estimated that 10-15% of the crop is now produced in big bales (WAA/MAFF 1989). Farmers should ensure, though, that bales are opened a safe distance away from 'clean water' drains and open watercourses, so that even small amounts of effluent contained within the bales are not discharged inadvertently.

Other sources of pollution

2.21 This report is primarily concerned with pollution derived from animal slurry and silage effluent. There are, however, various other sources of farm pollution which can adversely affect watercourses:

(i) Fertiliser run-off

Application of inorganic fertilisers (particularly nitrogenous fertilisers) should be undertaken when crops are growing and can utilise the additional nutrients. In the absence of such growth, nitrates

and phosphates leach readily into drainage water especially if there is heavy rainfall soon after application.

(ii) Pesticides

The Code of Good Agricultural Practice contains advice on the siting and operation of sheep dips. The disposal of spent dip presents special problems and the NRA/RPA should be consulted. According to press reports, the NRA's first successful prosecution was of a Northumberland farmer for polluting a watercourse with sheep dip. The farmer was fined £1,000, with £1,000 costs.

Until recently, organo-chlorine pesticides, which have been instrumental in the decline of the otter and certain wild birds, were still permitted to be used as bulb dressings. Surveys of the River Newlyn in Cornwall by South-West Water Authority in 1989 showed extremely high levels of dieldrin. One eel taken from the river contained concentrations of dieldrin (which derives from aldrin) 200 times in excess of Department of Health guidelines. The Ministry of Agriculture announced immediate withdrawal of approval for pesticide products containing aldrin, which it had earlier decided need not be phased out until the end of 1992. In May 1990 the Government published a code of practice for the safe use of pesticides on farms and holdings.

(iii) Others

A number of other substances which are used or are produced on farms need to be disposed of with extreme care to avoid the risk of polluting water courses. These include herbicides, disinfectants, oil, water used for vegetable washings and unsaleable whole milk.

3 Effects on water bodies and wildlife

3.1 The pollution of fresh waters – whether they be ditches, ponds, streams, lakes or rivers – may either lead to effects which show themselves in a very short space of time (e.g. direct fish kills as a result of poisoning) or they may be far slower and more insidious (e.g. eutrophication leading to less dissolved oxygen being present). The two main consequences which farm-derived pollution has on freshwater are deoxygenation and nutrient enrichment. Both affect the balance of species interactions, usually by overloading the system in some way, and this then can have 'knock-on' effects throughout the whole complex web of freshwater life.

Organic pollution

3.2 Organic matter in suspension is perhaps the most universal pollutant of water courses. Though the commonest source of this is untreated domestic

sewage, animal slurry also largely consists of organic matter. The immediate effect of these substances is to use up the dissolved oxygen in the water. This is as a direct result of the bacteria which break down the organic compounds and, in doing so, use up oxygen in their respiration. With a plentiful supply of nutritious food, the number of bacteria increase considerably for a time and then decline as the organic matter is converted into harmless substances. The 'pollution potency' of a liquid containing organic matter is given by its biochemical oxygen demand (BOD) reading.

3.3 Obvious signs that a watercourse is suffering from organic pollution include the appearance of 'sewage fungus' – a term used for aggregations not only of various kinds of fungi, but also colonial bacteria, including the sulphur-smelling bacteria, and protozoa such as the ciliates *Carchesium* and *Epistylis*. This becomes visible as white, pinkish or brownish masses on solid objects in the river. Such effects may only be seen at the point of pollution. Further down the river abundant growths of filamentous algae, especially blanket weed *Cladophora glomerata*, may be noticed. As the nutrients on which these organisms feed are used up, the fungi, algae and protozoa decline in succession. Most invertebrate animals and fish disappear or their populations become reduced through lack of oxygen and the blanketing effects of the mats of 'sewage fungus' and algae. However, certain pollution-tolerant species, such as tubificid worms, chironomids and the water hog-louse *Asellus aquaticus*, survive (Clegg 1974).

Nutrient enrichment

3.4 A plant has four main requirements in order to survive: sunlight, water, carbon dioxide and nutrients. An increase in the supply of certain nutrients (notably nitrogen and phosphorus) can encourage additional growth in plants, assuming other requirements are adequately met. In a freshwater environment, phosphorus is usually the limiting factor. The first signs of nutrient enrichment are an increase in the growth of certain species of higher plants. The next stage may be the appearance of filamentous algae and epiphytes (i.e. plants growing on the stems and leaves of other plants). In standing waters there may be a 'bloom' in the phytoplankton population. All of these events lead to an increase in the turbidity of water and to shading of higher plants, many of which may disappear. Phytoplankton will continue to proliferate until the supply of excess nutrients is used up and their numbers are brought in check by zooplankton grazing. The process of enrichment which changes the natural balance of aquatic communities is commonly known as 'eutrophication' (see figure 4), though it should more strictly be termed 'cultural eutrophication'.

3.5 The running water of streams and rivers provides an environment quite different from that in lakes and ponds. The flow can 'flush' and dilute pollutants, though this will depend on a number of factors such as volume of water. There is less

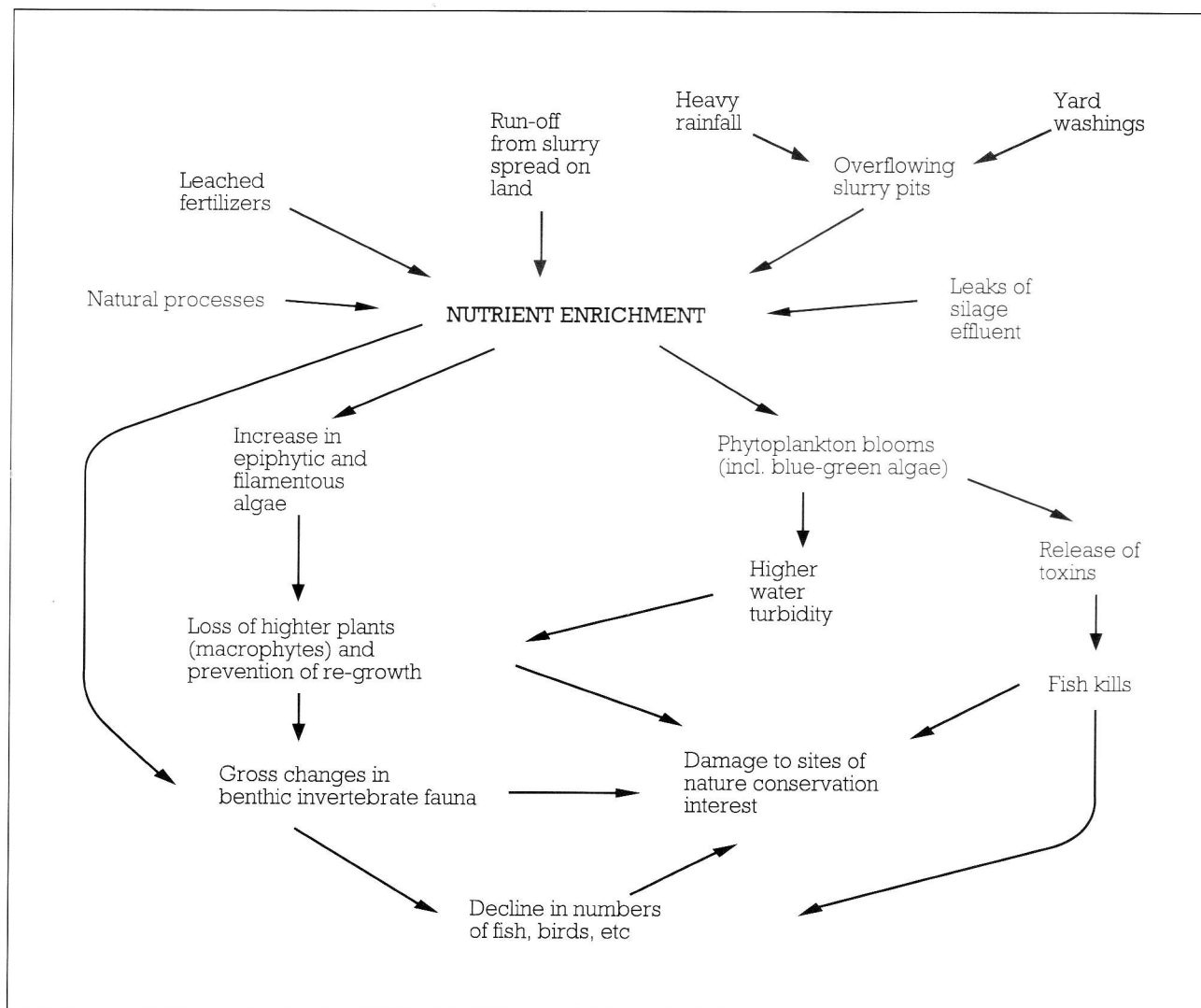


Figure 4 Factors which may lead to eutrophication in lakes: cause and effect

likelihood of 'natural' eutrophication occurring in all but the slowest-moving water. However, both lakes and rivers can be enriched by nutrients, particularly phosphates and nitrates, derived from organic pollution (i.e. run-off from agricultural land of animal slurry and silage liquor, besides sewage) and inorganic pollution (i.e. run-off from fields dressed with artificial fertilisers). Nutrients entering streams may reach lakes or eventually the sea. It has been calculated that a significant amount of the nitrate (up to 40%) in the North Sea derives from agricultural sources.

Aquatic and wetland plants

3.6 The effects of farm waste pollution on the plant communities of lakes and rivers are often wide ranging and long term. Plants characteristic of nutrient-poor waters are replaced by vigorous, fast-growing pondweeds and blanket weeds when nutrient levels are raised by the input of slurry and silage effluent. Uncommon pondweeds such as slender-leaved pondweed *Potamogeton filiformis* and flat-stalked pondweed *P. friesii* are incapable of increasing their growth rate to match the increased nutrient levels and are therefore at a competitive disadvantage to horned pondweed *Zannichellia*

palustris, Canadian pondweed *Elodea canadensis*, fennel pondweed *Potamogeton pectinatus* and similar species which may blanket shallow lakes. The entire flora of a water body may be changed in this way. In particularly severe cases, deoxygenation and algal blooms may eradicate all higher plants as has occurred in certain Norfolk Broads.

3.7 Wetland communities of plants found in fens, mires, bogs and marshy grasslands are similarly vulnerable to nutrient enrichment. Plants characteristic of nutrient-poor conditions are overwhelmed by the larger competitive species that are favoured by heightened nutrient levels. The remains of these fast-growing species together with associated sedimentation 'infill' the wetland, effectively drying it out. The site may become dominated by nettles, thistles, rushes, willow herb and coarse grasses such as *Deschampsia cespitosa* with scrub and trees following. The site has lost the original wetland interest.

Aquatic invertebrates

3.8 In organically polluted watercourses, there is a tendency for the total biomass of invertebrates to

increase accompanied by a decrease in species diversity. Certain species which are pollution tolerant (e.g. chironomid larvae *Chironomus plumosus* and tubificid worms) will do well in such circumstances. Further away from the pollution source, filter and deposit feeders will increase whilst more sensitive species such as mayflies (Ephemeroptera), stoneflies (Plecoptera) and some caddis flies (Trichoptera) are reduced. The presence or absence of certain 'indicator' species which are sensitive to even low levels of pollution, can provide a means of assessing agricultural organic pollution. Examples include certain stoneflies of the family Isoperlidae, the mayfly *Ecdyonurus dispar*, and the riffle beetle *Elmis aenea* (see figure 5).

3.9 Recently, a research study on the impact of farm pollution on river quality has been undertaken by the Water Research Centre on the Eastern Cleddau river and its feeder streams in south west Wales (Schofield *et al.* 1989). This has shown that watercourses which have poor water quality as a result of chronic pollution from farm wastes, possess an extremely limited range of invertebrate species, as might be expected. By contrast a clean watercourse was accidentally polluted (an estimated 500,000 litres of cattle slurry was released into a brook from a breached earth-banked slurry store), and the effects on invertebrate populations was varied. But recovery was relatively rapid, with populations re-establishing from upstream areas over a period of days after the pollutant had been flushed out.

Fish

3.10 Dead fish floating belly-up are an obvious sign that things are not well with the water quality of a particular watercourse. If the source of pollution is sufficiently strong, they will die as a direct consequence of its toxicity. They may die, however, as a result of suffocation – since the available dissolved oxygen in the water would have been consumed by bacteria as they decompose the organic matter content of the pollution.

3.11 In the Eastern Cleddau study mentioned above (Schofield *et al.* 1989), 1200 salmonids were killed along a stretch of river 5 km long after a release of cattle slurry. Fish populations upstream of the pollution source and on other tributaries remained healthy, and it was hoped that recolonisation would occur naturally from these populations. However, this did not seem to be the case, even after several months. In another instance in 1983 in Dyfed, at least 110,000 salmonids were thought to have been killed by farm waste discharges, and cases have been reported where angling associations have had to suspend fishing following serious pollution.

Birds

3.12 Very few studies have been carried out on the direct consequences of farm pollution on birds.

The Royal Society for the Protection of Birds has recently looked at a number of rivers in south-west England to assess which bird species may be affected when pollutants from farms enter rivers. Of the birds studied (which included mallard, grey wagtail, grey heron, kingfisher and dipper), it was found that only dippers were significantly affected. The dipper, uniquely, obtains its insect food by walking under water in rocky rivers and streams. The RSPB concluded that mobility of birds probably serves to reduce the effect of localised episodic pollution incidents, causing only short term losses on sections of a river.

Grasslands

3.13 Although this report deals with water pollution it should be noted that widespread damage has been done to botanically important grasslands by the application of fertilisers and slurries. A rich mosaic of wild flowers, grasses and sedges is replaced by a sward dominated by two or three species which can best utilise the extra nutrients and may degenerate to thistles, nettles and coarse grasses. The NCC does not normally consent to the spreading of animal slurry on grasslands within SSSIs.

4 The situation in England and Wales

4.1 Since 1985 the Water Authorities Association and the Ministry of Agriculture, Fisheries and Food have produced joint annual reports covering farm pollution incidents in England and Wales. The National Rivers Authority replaced the WAA as co-author from 1990. These reports provide statistics on the various sources of pollution (e.g. from animal slurry, silage effluent, etc.), the number of reported incidents and the number of prosecutions, and include a brief resumé for each of the ten water authority/NRA regions. It should be remembered that these statistics only include incidents discovered by or reported to the NRA. There must be many other smaller leaks which go undetected. Run-off from fields where slurry is spread, which accounts for a large proportion of SSSIs adversely affected, is generally over and above the reported incidents.

Farm pollution incidents 1984-89

4.2 The total number of farm pollution incidents from 1984 to 1989 is represented on the chart in figure 6 in such a way as to highlight the number of incidents which result from those sources with which this report is concerned, i.e. yard and parlour washings; silage effluent; and the containment and disposal of animal slurry produced by cows and pigs. These, in any case, represent the vast majority of incidents in any year. It is tempting to analyse trends shown by this chart in successive years, but there are so many factors involved which can influence the statistics that it

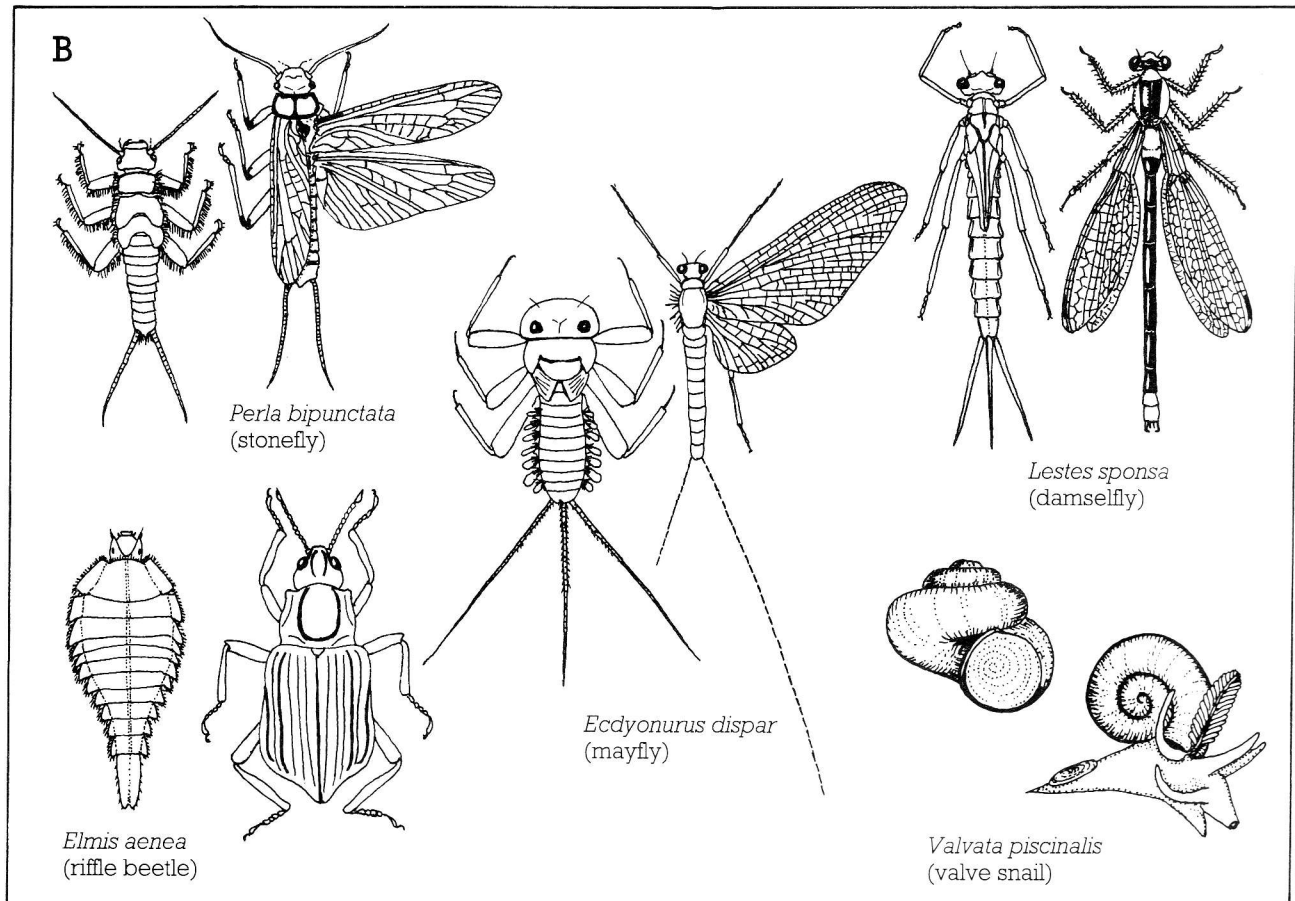
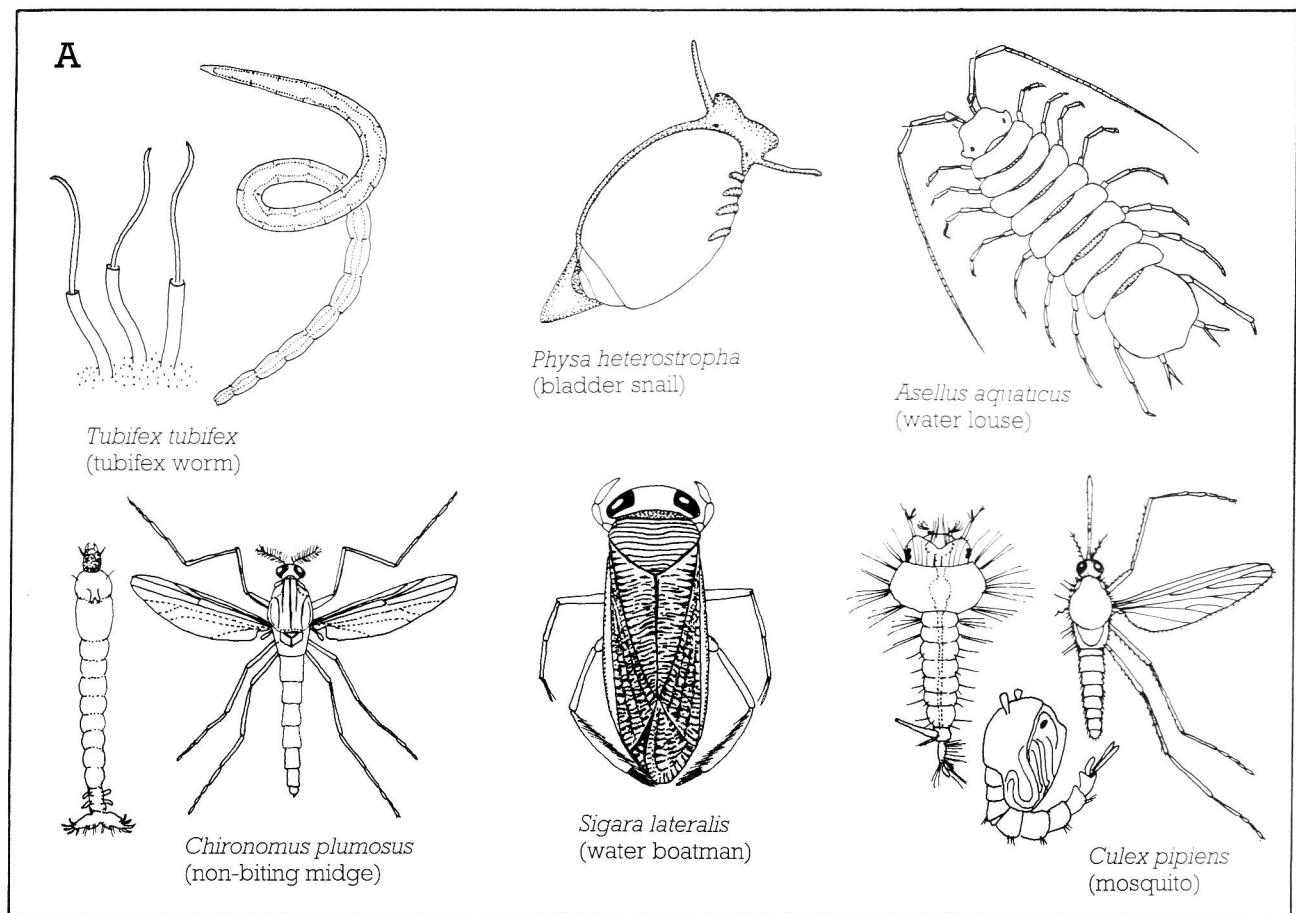


Figure 5 Invertebrates as indicators of organic pollution of freshwater: A – tolerant species B – sensitive species

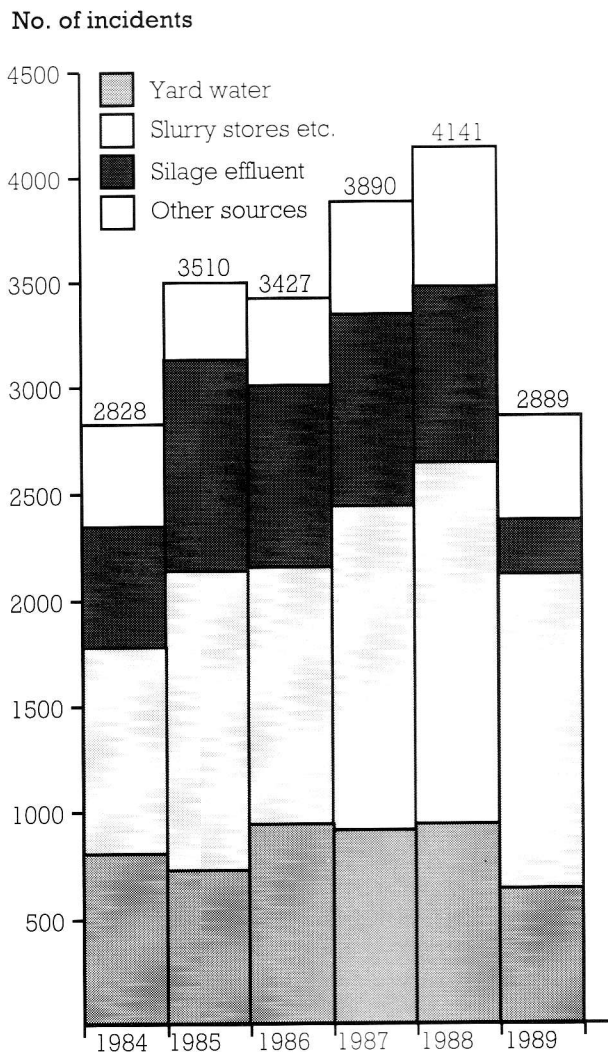


Figure 6 Farm pollution incidents in England and Wales by source (1984–89)

would be unwise to draw detailed conclusions. However, it is appropriate to stress the effect of wet weather during certain times of the year. More than any other factor, rainfall (or the lack of it) has a considerable influence on the year's total of farm pollution incidents. The past two report years (1988 and 1989) provide appropriate contrasts.

4.3 The winter of 1987/88 provided above average rainfall for most areas of England and Wales (though most noticeably in the western regions). The extra rainfall overwhelmed many slurry containment and management systems and highlighted the need for proper separation of rainwater from sources of farm waste in the design of drainage systems. The wet weather continued into the spring and early summer of 1988 and this led to difficulties in allowing silage to wilt prior to collection. The liquid portion of silage held in clamps and silos increased, leading to overloading of drainage systems and escapes of effluent into groundwater through cracks in concrete floors.

4.4 By contrast, 1989 was a dry year; indeed, many parts of the country suffered drought conditions by late summer. Slurry disposal and

silage harvesting took place during months when the rainfall was well below average. This in turn led to far fewer incidents of pollution being caused by overflowing slurry tanks, by land run-off from slurry spreading operations, or by silage effluent because more wilting had taken place. The overall figures for 1989 (a total of 2,889 farm pollution incidents being reported) look quite favourable when compared to 1988 (a total of 4,141): a reduction of 30%. However, this does not necessarily mean that there has been a corresponding improvement in storage facilities and farm practice. Furthermore, those incidents that did occur were often more severe in their effect, primarily because there was less water present in watercourses and so the dilution and flushing rates were reduced.

Serious incidents and prosecutions

4.5 More than 4,000 incidents were reported in 1988. Of these only 148 were taken to court by the water authorities. In 1989 the figure was 163 out of less than 3,000 incidents, perhaps reflecting a more vigilant approach by the newly established National Rivers Authority. Such an approach needs to be encouraged by adequate funding for farm pollution inspectors and for the time and expense involved in taking cases to court.

4.6 The fines imposed by the courts should be sufficient to deter others and to make the offender think twice before polluting again. However, not all farmers may have got the message: a recent article in the *Sunday Times* quoted a Somerset farmer as saying that a fine of £2,000 was "cheap money" when compared with the £200,000 it would cost him to rectify his slurry problems. Lord Crickhowell, in his foreword to the most recent NRA/MAFF report on water pollution from farm waste (NRA/MAFF 1990), says that "...we have made it very clear to farmers and all others who may pollute our rivers that we shall not hesitate to prosecute offenders, and the courts have shown their willingness to impose severe penalties". We welcome the increased fines introduced in the Environmental Protection Act 1990, whereby the maximum fine is raised from £2,000 to £20,000 as from 1 January 1991.

5 The situation in Scotland

5.1 In 1980, the Scottish River Purification Boards Association put forward to the Department of Agriculture and Fisheries for Scotland the idea of forming a farm waste liaison group to try to co-ordinate action at a national level. The Scottish Farm Waste Liaison Group (SFWLG) was set up with membership from the River Purification Boards, the Scottish Colleges of Agriculture and the Department of Agriculture and Fisheries for Scotland.

5.2 The scale of the problem was revealed by a survey of fodder silos undertaken in 1981 by Clyde River Purification Board. Of 100 silos inspected, the

No. of incidents

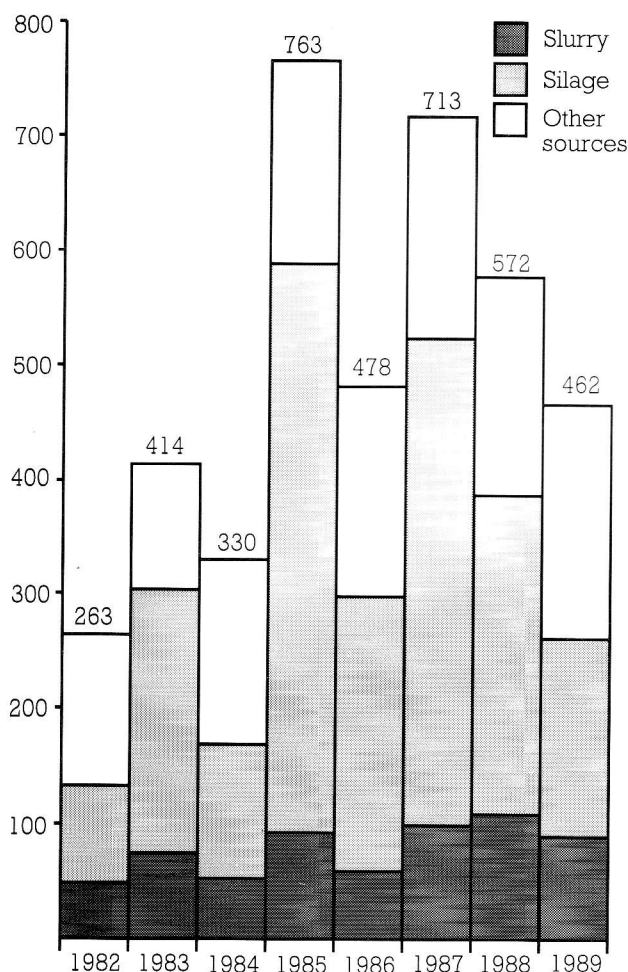


Figure 7 Farm pollution incidents in Scotland by source (1982–89). (Based on reports of Scottish Farm Waste Liaison Group).

vast majority were found to be leaking or had other faults. This was confirmed in a follow-up survey by DAFS and the West of Scotland College of Agriculture. This led to a much greater involvement in farm waste issues by the Colleges and RPBs.

5.3 Annual statistics for farm pollution incidents have been compiled by SFWLG since 1982. They show a similar trend to England and Wales, with the highest figures reported for the wettest years, 1985 and 1987 (see figure 7). Silage effluent accounts for the majority of incidents, the result of structural failure of silage storage units (SFWLG Pollution Review 1988). Reported incidents of pollution from silage effluent fell from 428 in 1987 to 173 in 1989. No such dramatic improvement occurred in relation to pollution from animal slurries.

5.4 Officers from River Purification Boards undertake regular visits to farms to inspect silos and slurry-handling facilities. They report a co-operative attitude from the majority of farmers. Nevertheless, prosecutions are running at the same rate as in England and Wales, with 17 in 1987, 20 in 1988 and again in 1989. This represents a gradually tougher line, particularly with persistent offenders.

The new maximum fine of £20,000 also applies in Scotland.

6 Damage to sites of nature conservation importance

6.1 The most disturbing fact that has come to light in the preparation of this report is the large number of Sites of Special Scientific Interest (SSSIs) affected by farm pollution. A list of 71 SSSIs affected between 1986 and 1990 is given at table 1.

6.2 Incidents of damage included in the NCC's Annual Report involved a total of only 19 SSSIs affected by farm pollution. However, information has since been provided by the NCC's Assistant Regional Officers of sites affected by chronic pollution, often emanating from outside the SSSI boundary. The total of 71 SSSIs comprises 31 lakes, 13 fens and mires, 19 streams and rivers and 8 ditches. The source of pollution in 70% of the cases was slurry, in one form or another, and in 20% it was silage effluent; 10% of cases involved both.

6.3 The true total of SSSIs affected will be considerably higher than 71. NCC staff in only a sample of counties/districts were approached for information. Also, incidents may go overlooked, especially where sites are not visited regularly. We also have reports of eutrophication affecting water bodies on 16 more SSSIs, where the pollution cannot be definitely assigned to farm wastes, though they are suspected.

6.4 Pollution from slurry and silage effluent may occur over a period of several years before the effects are revealed. An instance of this is at Loch of Harray in Orkney, which is suffering the first stages of eutrophication, with dense growths of Canadian pondweed *Elodea canadensis*. Animal husbandry and silage production within the surrounding catchment were intensified in the early 1970s. Loch of Harray is included in *A Nature Conservation Review* (Ratcliffe, 1977), which means that it is of national nature reserve quality and in NCC's opinion should be managed with nature conservation as a prime objective.

6.5 The NCC can attempt to control pollution, for example the application of slurry, if it occurs within an SSSI, by means of consultations with the owner or occupier under the Wildlife and Countryside Act 1981. In the case of a pollutant entering an SSSI and causing damage to aquatic flora and fauna, control is dependent on steps taken by others under the Water Act 1989 (e.g. the NRA) or the Control of Pesticide Regulations 1986 (e.g. MAFF/DAFS).

6.6 Another difficulty is where the pollution derives from several sources. Chemical tests to determine water quality will detect ammoniacal nitrogen from farm waste, from land run-off from fertilizer, and from overflows of septic tanks, without distinguishing between them. In areas which

have a high proportion of dairy or pig farms there is often widespread 'background' seepage of low levels of farm effluents into drains and streams

6.7 The following accounts describe how farm pollution has affected a variety of SSSIs in different parts of the country:

Limpenhoe Meadows, Norfolk

In early 1987 this site on the Norfolk Broads was polluted by slurry overflowing a catchment dyke on the northern side of the SSSI. The slurry emanated from a pig farm with 10,000 pigs. Pollution had occurred before. The slurry polluted ditch fauna and flora as well as vegetation growing on the dyke. A prosecution was brought by Anglian Water Authority, and the offender was fined £200.

Hastings Cliffs to Pett Beach, East Sussex

This is given as an example of a problem that has been going on for a long time – 15 years in fact. An area within this SSSI has been affected by slurry from a farm's holding tank and silage effluent leaking into a stream which runs through the site. Despite continual requests from the NCC over the years for the problem to be remedied, the pollution persists.

South Milton Ley, Devon

This site is of particular interest for birds, with a large reed bed housing populations of reed, sedge and Cetti's warblers. The Ley is also important as a roost for swallows and yellow wagtails on migration. In recent years intermittent pollution of a feeder stream by cattle slurry has killed invertebrates and caused dieback of reed. This appears to be low-grade, long-term pollution which is likely to be cumulative in its effects on the wildlife.

Roding Valley Meadows, Essex

In September 1989, 30,000 fish were killed in the stream running through this SSSI after a major incident involving the collapse of the containing wall of a slurry lagoon. The spill also affected freshwater invertebrates and marginal plants, though the recovery of these was thought to be relatively rapid. The River Roding, which flows into Barking Creek, had suffered previously from a major spill of organo-phosphorus pesticide in the mid 1980s. Chemical and biological parameters have been monitored at a number of stations on the river since 1974 by staff at the Polytechnic of Central London. The farmer responsible for the slurry escape was prosecuted and fined £1,800. He also agreed to pay £8,000 towards monitoring and fish-restocking programmes.

Catcott, Edington and Chilton Moors, Somerset

Some 400 metres of ditches supporting flora and invertebrate fauna of special interest have been badly affected for several years by run-off from

yard and parlour washings. After pressure from the NCC and the involvement of the National Rivers Authority and MAFF, the farmer undertook in 1989 to install a sealed tank to receive all washings. Unfortunately the action taken has been insufficient to prevent continued pollution, albeit at a reduced level, and the NCC has asked the NRA to seek further preventive measures.

Cranberry Bog, Staffordshire

This site is noted for the naturalness of the peat raft and the species-rich fen and carr. However, as a result of pollution from silage effluent initially and, more recently, pig slurry and domestic septic tank overflows, the vegetation has been grossly enriched, with invading weeds and nettles displacing the fen flora. About 20% of the 10-hectare site has been seriously affected. The bordering wet ditches are grossly polluted and have suffered major declines in associated aquatic species. Nutrients are migrating from the ditches to other parts of the site, with the mere within the bog likely to lose rare invertebrates (including dragonflies) due to the pollution. Fortunately the silage pollution has been stopped, and a sealed tank is being installed to contain the pig slurry.

Tabley Mere, Cheshire

This SSSI includes two meres, the smaller of which (about 4 hectares) has received pollution from a nearby farm (the exact source of the pollutant has not been identified). Fortunately, it is downstream of the larger mere, renowned for its aquatic plant community. Organic pollution and silt carried into the smaller mere is causing a gradual clogging of the drainage ditch leading into the mere from the farm and a reduction in the depth of water allowing willow scrub to invade the edges of the fen. Changes to the aquatic plant communities indicate that the mere is becoming eutrophic.

Hatchmere, Cheshire

Here, a field drain entering the site was polluted by farm effluent (probably from yard washings). The fen and carr woodland in the vicinity of the inflow drain are now dominated by nettle and willowherb, and all the vegetation shows a 'luxuriant green growth'. About 5% of the SSSI has been adversely affected. Though the source of the pollution has now been cleared up, it is likely to be many years before the vegetation returns to its former state.

Newby Moor, North Yorkshire

Newby Moor SSSI covers common land which has been used as a dump for slurry from farms with insufficient storage capacity. Direct applications and run-off of the waste are adversely affecting wetland habitats, with coarse plants including nettles, thistles and rushes becoming abundant in the mire and flush communities. The NCC is holding discussions with commoners, the landowner and the NRA in an attempt to find a solution to this problem.

Claife Tarns and Mires, Cumbria

In the last two years run-off from a cattle silage feeder close to this SSSI has caused concern about the water quality of one of the tarns. The NCC held discussions with the landowner and the owner of the tarn which led to the feeder being re-sited. We expect that the special interest of the tarn for flora and fauna will recover now that the source of pollution has been removed.

Rescobie and Balgavies Lochs, Tayside Region

These lochs have been affected by land run-off and incidents of silage and slurry contamination for a number of years. More than seven species of pondweed (*Potamogeton*), including two that are uncommon, used to occur in the two lochs. The NCC commissioned a survey in 1987 to assess the effects of the pollution on the aquatic plant community. No *Potamogeton* species was found in Balgavies Loch and only one of the more common species was seen in Rescobie Loch. The plants appear to have been ousted by more competitive species that thrive in nutrient-rich waters. The NCC intends to use the information gained from vegetation survey together with water quality data to produce a strategy for reducing and controlling nutrient inputs within the catchment.

7 Measures to combat the problem

7.1 There are several possibilities for preventing or reducing pollution from farm wastes –

- encouragement of good practice;
- grants and subsidies;
- regulations and prosecutions;
- creation of buffer strips for watercourses;
- alternative uses for waste; and
- control of land-use practices in catchments.

7.2 The NCC believes that all of these options have merits and should be followed in combination rather than exclusively. We can learn from the experience of other countries, many of whom have gone further than the UK in combating pollution from farm sources.

Encouragement of good practice

7.3 Methods used in Britain to encourage good practice by farmers have included general awareness campaigns and competitions run by water authorities; farm visits and inspections; distribution of advisory leaflets; and the production of official Codes of Good Agricultural Practice.

7.4 As the number of farm pollution incidents

continued to rise during the 1980s, various schemes were devised by the Regional Water Authorities in an attempt to get the message across to farmers of the severity of the situation. All have been aimed at working with the farming community to prevent pollution and remedy deficient systems before serious pollution arises.

7.5 The former Severn Trent Water Authority awarded an annual trophy and cash prize to the livestock farmer showing the greatest initiative in works to prevent pollution. This prize was first given in 1987 in association with the authority's contribution to the European Year of the Environment. Both Anglian Water and South West Water have run campaigns recently under the title of 'Together we can beat it'. All the water authorities have made efforts to promote awareness of the problems through presentations and demonstrations at agricultural shows, seminars, open days, agricultural colleges, and farm discussion groups, and through articles in the farming press. A national 'Safer Silage Competition' is run by ADAS, with winners being rewarded for recognising the environmental and safety aspects of silage making and for introducing measures to prevent pollution on their farms.

7.6 South West Water Authority noted that the introduction of charging by ADAS had dissuaded many farmers from seeking specialist advice. However, the Service's general advice on pollution remains free, although a charge is made for detailed services such as design work or professional drawings (National Audit Office 1989).

7.7 In Scotland, annual publicity campaigns are conducted by the RPBs and Colleges of Agriculture, drawing attention to good practice through articles in the press, leaflets, meetings with farmers groups, and open days on College farms to demonstrate new technology. The Colleges are co-operating with manufacturers on trials of new products, for example new sealants for silos, asphalt coatings, and absorbents such as straw and beet pulp. DAFS has commissioned the Colleges to produce a review of farm pollution research. This is due to be completed in 1991.

7.8 Advice on the storage and disposal of farm wastes is contained in the Codes for Good Agricultural Practice issued under the Control of Pollution Act in 1985. These are supplemented by a range of technical advisory leaflets published by MAFF and the Scottish Agricultural Colleges. Whilst there is detailed advice in the Codes themselves on a wide range of storage facilities, when it comes to disposal general principles are given for the most part, for example, "application rates of manures and wastes to land should match the capacity of the crop to utilise the nutrients as far as practicable". In the Code for Scotland it also states that "slurry should not be applied to steeply sloping fields or to waterlogged soils".

7.9 In the Code for Scotland, a maximum rate of application is specified: not more than 55 cubic

metres/hectare at not less than monthly intervals. In a supplementary MAFF leaflet, the advice is given that a maximum of 50 cubic metres/hectare at no less than 3-weekly intervals should be observed where there is a risk of pollution. There is indirect advice in the Code for England and Wales, by parallel with inorganic fertilisers, that application should be avoided in autumn and winter, unless there is a specific crop requirement. No guidance is given on the timing of silage effluent disposal.

7.10 Neither Code contains specific advice on the siting of slurry stores, though the Code for Scotland states that "silos and their associated effluent collection systems should be sited as far away as practicable from streams. All existing yard or field drains in the vicinity of the selected site should be located and diverted, uplifted, or sealed off as appropriate". There is no advice given about alternative uses for farm wastes or on the creation of buffer strips. It should be noted that a new draft Code was issued for consultation by MAFF and WOAD in January 1991. It seems to rectify some of the omissions referred to above, particularly in respect of advice about spreading on the land.

7.11 The status of the Codes has been changed by Parliament in the Water Act 1989. Adherence to the guidance in the Codes is no longer a defence against prosecution for pollution of watercourses. The Codes have proved generally ineffective and are now largely being overtaken by regulations.

Grants and subsidies

7.12 The Farm and Conservation Grants Scheme was launched in February 1989 and succeeds the Agricultural Improvement Scheme (AIS) introduced in 1985. The AIS was criticised for being geared to increased production, with insufficient account being taken of the "environmental sensitivity" of proposals. Under the AIS scheme, grant-aid was provided for effluent storage (60% in LFAs and 30% in the lowlands), but there was confusion on whether it extended to drainage separation works.

7.13 The Government allocated £50 million for waste handling grants in the first three years of the Farm and Conservation Grants Scheme. The Scheme offers 50% grants (across the board) towards the cost of building new, or improving existing, farm waste management systems. On 1 November 1990, Baroness Trumpington, an Agriculture Minister, reported that 11,500 farmers had announced their intention of claiming grant for farm waste facilities and that some £18 million in grant-aid had been paid out in the UK since February 1989.

7.14 The allocation of grant-aid by the Government is to be welcomed. However, there is cause to believe that a 50% grant is insufficient incentive for many farmers in the present economic situation. The NCC suggests that grants could be increased to 75%, but that the right of farmers to appeal against improvement notices (as proposed in draft regulations) should be removed. The new

grants scheme has resulted in a decrease in the level available in Less Favoured Areas (from 60% to 50%) which also needs to be rectified, as these areas contain many nutrient - poor waters which are especially sensitive to pollution from farm wastes

Regulations to control silage, slurry and agricultural fuel oil installations

7.15 Early in 1990 the Department of the Environment and Welsh Office and, separately, the Scottish Development Department consulted on draft regulations on the storage of farm waste. These are expected to be introduced in March 1991. The NCC had been pressing for the introduction of regulations since the time that the Codes of Good Agricultural Practice were being drawn up. Regulations will enable the NRA and River Purification Authorities to require improvements in storage facilities, on pain of enforcement action, and should make regular programmes of farm visits much more worthwhile.

7.16 We were concerned that the draft regulations applied to new storage facilities and extensions and not to existing installations. Improvements to the latter would require notices to be issued by the NRA or RPAs, against which the farmer could appeal. In NCC's view, an appeal system is not desirable in view of the urgent need to tackle farm pollution at source. To compensate for this, the level of grant-aid available from Agriculture Departments should be increased from 50% to nearer the full cost of specified improvements.

7.17 The effective policing and monitoring of the regulations is likely to require increased resources for the NRA and RPAs. It may be appropriate for the regulations to include a requirement that the pollution control bodies carry out regular inspections. In addition, we would like to see a targeted monitoring programme instituted to assess whether the regulations are bringing about improvements in water quality in the worst hit areas.

7.18 The draft regulations require only 4 months' storage capacity for slurry. The NCC is concerned that this may not be adequate and has requested that it should be increased to 6 months, to cover the winter period.

7.19 There is scope in Section 110 of the Water Act 1989 for regulations to be made on disposal as well as storage. At present, advice on disposal is contained within the Code of Good Agricultural Practice. The NCC would wish to see this incorporated into a further set of regulations to combat the chronic pollution of watercourses which occurs in areas where large amounts of liquid manures are spread on the land.

Prosecutions

7.20 It is an offence under Section 107 of the

Water Act 1989 (Section 31 of the Control of Pollution Act 1974 in Scotland) to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste matter to enter controlled waters. The previous defence of good agricultural practice (Control of Pollution Act 1974) has been removed. The maximum fine in the magistrates' court (sheriff's court in Scotland) was raised from £2,000 to £20,000 on 1 January 1991. It is clear that Government and Parliament see prosecutions as an important instrument in pollution control.

7.21 The number of prosecutions taken by regulatory bodies has increased over the last few years. The NRA signalled its intention in an early case involving a farmer in Suffolk who was convicted of polluting the Sapiston and Little Ouse rivers. Three million gallons of pig slurry were released resulting in the death of some 10,500 fish. A fine of £10,000 was imposed in the Crown Court and the NRA sought £27,000 in damages.

7.22 Until now all prosecutions have been limited to punishing farmers after the pollution has occurred. With the introduction of regulations, the NRA and RPAs will be able to prosecute farmers for not taking adequate precautionary measures in relation to storage and separation facilities. The NCC considers that it would be appropriate for the NRA and RPAs to have a duty to enforce the regulations.

Creation of buffer strips

7.23 The use of buffer strips along watercourses to intercept run-off and absorb nutrients is gaining favour in a number of countries. In New Jersey, USA, a 50-metre buffer zone is now required by law between uplands and wetlands. In New Zealand, under a scheme of riparian retirement, strips of grass have been allowed to grow fallow in pasture land, especially on the steeper riparian slopes. These have been effective in reducing nitrate and phosphate entering streams. Recent research in New Zealand (Quinn *et al.* 1990) has shown that swampy areas bordering hill pasture streams intercept some 90% of the nitrate run-off into watercourses. Unfortunately these areas are often removed to improve drainage.

7.24 Research in the 1980s has shown that riparian woodland is capable of removing more than 50% of the phosphorus and nitrogen in run-off from agricultural land. Pinay and Decamps (1988) suggested that a 20-metre wide strip of riparian woodland may be adequate for this purpose.

7.25 In Britain, land is often cultivated, mown or grazed right to the edge of rivers and lakes. By means of set-aside or a similar agricultural scheme, farmers could be encouraged to leave strips of land uncultivated (Newbold & Rush 1989). These riparian buffer zones can also provide a valuable wildlife habitat.

7.26 In appropriate areas, reed beds could be

planted to filter run-off from farmland. One idea is to create small embayments in ditches at the field drain outlets and plant these with reeds (Petersen 1990). Research has shown that the root systems of the common reed *Phragmites australis* are capable of removing nutrients from the surrounding water. Most work has centred around its use as a secondary treatment of human sewage, with stands of reed being planted in specially prepared beds beside sewage treatment plants. This is known as the "root-zone method" for stripping phosphates and elements of nitrogen from effluent. The rhizosphere surrounding the roots and rhizomes provides an atmosphere for denitrifying bacteria and it is as effective or more effective than conventional sewage treatment. It is approximately 50-80% cheaper when compared with conventional sewage treatment costs.

7.27 However, recent research has shown that the "root zone method" is not as reliable or as efficient at removing phosphates as was once thought. Much depends on the soil chemistry in the prepared bed. If high levels of iron and calcium are mixed with the soil then the method can remove 90% of the phosphates from a sewage effluent. Conventional sewage treatment at best only removes 50% of the phosphates. The 1989 Farm Waste Report (WAA/MAFF 1989) mentions that artificial reed beds are being investigated for the treatment of dilute farm effluents. Monitoring is continuing on one such reed bed established in 1986. As farm effluents are much stronger than sewage, it remains to be seen whether this method will give satisfactory results. The project has been extended, with the construction of a second reed bed, by the Water Research Centre in cooperation with Birmingham University and ARM Engineering, Rugeley.

Reuse of farm waste

7.28 Spreading on the land must remain the principal method of reusing farm wastes – as a fertiliser – provided that proper precautions are taken. Nevertheless, many farms are producing more waste than that for which they have carrying capacity. This is especially the case for large-scale intensive livestock units. In these situations other forms of reuse should be encouraged.

7.29 In the Netherlands, the government introduced a slurry action programme in 1985. One of its principal aims is to find ways of making useful products out of animal slurries. The targets for reuse of slurries are 6 million tons by 1994 and 20 million tons by the year 2000.

7.30 Research has concentrated on the drying of slurry to produce fertilisers and composts. Between 1985 and 1989 the Dutch government spent £10 million on subsidies for pilot plants and research projects. These range from a factory in Weert drying poultry manure with a capacity of 50,000 tons, to the oldest factory for the reuse of pig slurry – Promest BV in Helmond – which is increasing its capacity to 500,000 tons a year.

7.31 Recycling of farm wastes is practised to good effect in Denmark. The village of Veggen has its own wind and bio-gas power station. Each day a tanker collects slurry from the surrounding farms. This is eventually returned to them as fertiliser, after it has been stored for a few weeks in anaerobic digester tanks at the power station. The bio-gas produced is used to drive a generator and supplies electricity and hot water to the local community. Energy can also be produced at a farm level, using digesters. This has proved reasonably popular in Ireland and a number of digesters are on the market.

7.32 The BBC's *Country File* television programme on 25 March 1990 featured a Suffolk farm which had been the subject of complaints about the smell when pig slurry was spread on the fields. The slurry is now processed in an anaerobic digester, where naturally occurring bacteria produce methane gas from it. This fuels a generator that provides electricity for the farm, with any waste heat being piped around the farm offices. The other products are a clean, dry 'organic' manure, which can be sold as compost, and a liquid fertiliser that can be sprayed onto the field without unpleasant odour (though the normal precautions to avoid run-off would still have to be taken).

7.33 An interesting method now being used on many farms involves feeding the sweet silage liquor to cows. The gut flora of cows are capable of dealing with the very high BOD levels of the effluent. Henley Manor Dairy Farm (ICI) practices this method successfully, with all but a few days of peak effluent production being recycled in this manner, at a rate of about 10 litres per head per day (Beck 1989). The feeding of silage liquor to cattle is also being researched in Scotland by the Hannah Research Institute.

Control of land-use practices in sensitive catchments

7.34 The Codes of Good Agricultural Practice state that application rates of manures and wastes to the land should match the capacity of the crop to utilise the nutrients. In the Netherlands maximum rates of application of phosphate in farm wastes are defined by law. Amounts of slurry in excess of this must be stored on the farm and transported away by the National Slurry Bank for reuse or spreading elsewhere. If these measures are not successful in preventing saturation of soils by phosphate, powers may be taken to reduce the number of livestock.

7.35 In Britain, in ecologically sensitive areas, such as semi-natural grasslands and catchments of lake SSSIs, the NCC would recommend against the spreading of slurry and would seek restrictions on applications of farmyard manure, in order to protect the wildlife interest. On relevant SSSIs the NCC would want to negotiate over stocking levels. Increases in stocking levels of cattle in catchments have often been associated with enrichment of water bodies and losses of characteristic plant communities.

7.36 It would seem that the most appropriate means for achieving this type of control over land-use practices is the designation of Water Protection Zones under Section 111 of the Water Act 1989 (Section 31(4) of the Control of Pollution Act 1974 in Scotland). This designation has been available to the Secretary of State since the implementation of the Control of Pollution Act 1974, but has never been used. Enforcement of the controls in WPZs would be carried out by the National Rivers Authority or River Purification Authorities. The designation of WPZs in two or three of the areas most sensitive to farm pollution would enable the Government to judge whether they could be effective as a general control over the problem.

8 Conclusions

8.1 The intensification of livestock production and dairy farming – whereby cattle and pigs are kept indoors and more silage and artificial feeds are used – means that there are much greater quantities of farm waste to be stored and disposed of.

8.2 Animal slurry is rich in phosphates and, to a lesser extent, in various forms of nitrogen. In terms of biochemical oxygen demand it is up to 100 times more polluting than untreated human sewage. Codes of Good Agricultural Practice were issued by Departments in 1985. However, in 1988 there were 4,141 reported incidents of farm pollution affecting watercourses in England and Wales, compared with 1,484 in 1979. Obviously the Codes were not working, and the defence they provided of following good agricultural practice was withdrawn in the Water Act 1989.

8.3 The NCC is particularly concerned about the effects of farm waste on sensitive wildlife habitats. A sample survey has revealed over 70 Sites of Special Scientific Interest deleteriously affected by pollution from farm waste between 1986 and 1990.

8.4 Recent studies by the Water Research Centre in Pembrokeshire have shown that streams in the Cleddau catchment that would be expected to be in class 1 for water quality are actually in classes 3 and 4 because of chronic pollution from dairy farms.

8.5 The Government is introducing regulations on the storage of farm wastes. These are greatly needed, as they will allow the NRA and River Purification Authorities to insist on preventive action. At present they can only take action (prosecution and clean-up) once pollution has occurred.

8.6 No regulations have been issued on disposal of farm wastes. These are in place in Denmark and the Netherlands, where no spreading of slurry is allowed during the winter months and there is a fixed quota for each farm, relating to the carrying capacity of the land.

8.7 It is clear that measures need to be taken to control the spreading of slurry on fields, because of problems of run-off affecting watercourses. Action should be directed initially at sensitive areas and SSSIs.

8.8 The spreading of farm waste on fields will remain the principal means of disposal, but more encouragement should be given to alternative methods, such as drying for production of compost and use of methane for energy generation.

8.9 Looking to the future, we should be moving towards less intensive livestock production and reducing the waste problem. The trend in consumer demand for 'free-range' and 'organic' food may be helpful. The system of headage payments under the Common Agricultural Policy needs revision. We should also be looking at other agricultural schemes, such as 'set-aside', to create riparian buffer zones in river corridors and around lakes.

9 Contribution of the NCC

9.1 In relation to farm-waste problems, the role of the NCC and its successor agencies is principally to provide advice and to undertake relevant research and monitoring. Our research programme already includes studies of nitrogen movements through soils in order to evaluate the effectiveness of buffer strips. We have also undertaken or commissioned remedial work on lakes suffering from eutrophication to which farm waste has been a contributory factor. Our experience here will be valuable in advising on local and national restoration programmes.

9.2 In the future we intend to carry out further studies on remedial treatments for eutrophication; to commission surveys of lake and loch SSSIs reported as suffering from nutrient enrichment; and to carry out more systematic monitoring of SSSIs in general.

9.3 The NCC is involved directly with farmers where they are owners or occupiers of SSSIs. We normally discuss their practices in relation to disposal of farm wastes on SSSI land and seek to agree a management regime which will safeguard the wildlife interest.

9.4 Looking more widely at catchments, the NCC and its successor agencies will have a role in advising on the location of water protection zones and on appropriate management prescriptions, to ensure that wildlife is protected.

10 Recommendations

10.1 The NCC believes that a programme of action is needed to deal with the problem of farm

waste, going beyond the measures currently proposed by Government. Our recommendations are set out below, under five headings.

Storage facilities on farms

10.2 The draft regulations could be improved by removing the right of appeal against improvement notices, whilst increasing the level of grant aid available to farmers from 50% to 75%.

10.3 The required storage capacity for slurry should be increased from 4 to 6 months, to cover the autumn and winter when it may not be desirable to spread slurry on the fields.

10.4 Increased emphasis should be placed on separation of clean and dirty water drainage systems in view of the high incidence of pollution from yard and parlour washings.

10.5 Further research should be undertaken into methods and materials for sealing cracks and joints in silo floors and walls and into the protection of slurry and silage stores from rainwater.

10.6 Farmers' and landowners' organisations should continue to promote and publicise best practice among their members.

Disposal of wastes

10.7 Experimental work should be undertaken into ways of treating farm wastes to make them more easily disposable and less polluting (e.g. mixing with straw, and root-zone treatment in lagoons).

10.8 Regulations should be introduced under Section 110 of the Water Act 1989, on the disposal of farm wastes. These would replace the Codes of Good Agricultural Practice and would stipulate amounts, location and timing of applications to land.

10.9 Water protection zones should be designated under Section 111 of the Water Act 1989 (and the Control of Pollution Act in Scotland) to protect sensitive catchments, including those of certain SSSI lakes and mires.

Recycling of wastes

10.10 Possibilities for beneficial uses of farm wastes as an alternative to spreading on the land should be encouraged by Government. These include:

- drying of large quantities of slurry for use in compost as a substitute for peat (several companies in the Netherlands are making this type of product, and the Dutch government has a target for 20 million tons of slurry to be recycled by the year 2000);
- use of farm-level digesters to produce methane gas for electricity and heating;

- setting up or converting slurry/sewage treatment works to process farm wastes, produce methane and generate electricity for the community; and
- feeding silage liquor to cattle.

Preventive and remedial measures

10.11 Riparian buffer strips should be created under agricultural schemes such as 'set aside' and their effectiveness monitored.

10.12 The system of Hill Livestock Compensation Allowances under the EEC Common Agriculture Policy should be replaced by other forms of support that do not encourage overstocking and intensification of livestock production.

10.13 A programme of restoration of lakes suffering from eutrophication because of farm wastes should be promoted by the Government, in association with the National Rivers Authority and the River Purification Authorities, with advice from the NCC.

Duties of pollution control bodies

10.14 In England and Wales, Ministers and the National Rivers Authority have a duty to further conservation when discharging their functions related to water. The NRA is also required to consult the NCC before undertaking or consenting any operations likely to affect an SSSI. These conservation duties should be extended to Ministers and River Purification Authorities in Scotland.

10.15 It may be appropriate for the NRA and RPAs to be given a duty to inspect farms and enforce the regulations relating to farm waste. They should also be given adequate resources to appoint and train farm pollution officers.

10.16 The NRA and RPAs should undertake regular monitoring of water quality in lakes as well as rivers, in line with their new duties under the Water Act 1989 to monitor the extent of pollution in all controlled waters. These agencies should also undertake monitoring in areas sensitive to farm pollution in order to evaluate the effectiveness of regulations and other pollution control mechanisms.

11 References

- Bastiman, B. 1976. Factors affecting silage effluent production. *Experimental Husbandry*, 31, 40.
- Beck, L. 1989. A review of farm waste pollution. *Institute of Water and Environmental Management Journal*, 467-477.
- Boon, A.G., Davis, R.D., & Huggin, R.J. 1985. *Report of a visit to Germany to investigate the root zone method*. Stevenage, Water Research Centre.
- Burnley, P. 1990. Pollution: a lot to know. *Farmers Weekly*, 29 June 1990.
- Clegg, J. 1974. *Freshwater Life*. London, F. Warne.
- Department of Agriculture and Fisheries for Scotland. 1985. *Code of Good Agricultural Practice*. Edinburgh, HMSO.
- Department of the Environment. 1986. *Agriculture and pollution*. DoE Pollution Paper 21.
- Hellawell, J. 1986. *Biological indicators of freshwater pollution and environmental management*. London, Elsevier Pollution Monitoring Series.
- Merriman, R.P. 1988. Water pollution by silage effluent. *Proceedings silage effluent conference*, (Staffs. Agric. College 1988). Marlow, Chalcombe Publications.
- Ministerie van Landbouw en Visserij. 1987. *Mestwetgeving* (slurry regulations – explanatory booklet). Netherlands.
- Ministry of Agriculture, Fisheries and Food & Welsh Office Agriculture Department. 1985. *Code of Good Agricultural Practice*. Alnwick, MAFF Publications.
- National Audit Office. 1989. *Grants to aid structure of agriculture in Great Britain*. Report by the Comptroller and Auditor General. London, HMSO.
- National Rivers Authority & Ministry of Agriculture, Fisheries and Food. 1990. *Water pollution from farm waste 1989*. (England and Wales). London, National Rivers Authority.
- Netherlands Environment Programme 1991-94*. Tweede Kamer vergaderjaar 1990-91, 21802, nrs. 1-2.
- Newbold, C., & Rush, A. 1989. Set aside and extensification of agricultural production: implications and opportunities for nature conservation and the river engineer. *Proceedings of Institute of Water and Environmental Management annual symposium*. York, 1989. London, IWEM.
- Petersen, R.C. Jr. 1990. A building block model for stream restoration. *Proceedings of NCC conference on Conservation and Management of Rivers, York, 1990*, ed. by P Boon, G Petts and P Calow. London, John Wiley. In press.
- Pinay, G., & Decamps, H. 1988. The role of riparian woods in regulating nitrogen fluxes between the alluvial aquifer and surface water: a conceptual model. *Regulated rivers: research and management*, 2, 507-516.
- Quinn, J. M. et al. 1990. *Riparian vegetation and water quality protection in New Zealand*. (Paper to NCC conference on Conservation and Management of Rivers. York, September 1990).
- Ratcliffe, D.A., Ed. 1977. *A nature conservation review*. Cambridge, Cambridge University Press.
- Royal Society for the Protection of Birds. *The effect of farm pollution of rivers on birds*. In press.

Schofield, K., Whitelaw, K., & Merriman, R.P. 1989. The impact of farm pollution on river quality in the United Kingdom. *River Basin Management – V. Proceedings of an IAWPRC conference held in Rovaniemi, Finland, 1989*. Ed. H. Laikari. Pergamon Press.

Scottish Farm Waste Liaison Group. 1988 and 1989. *Pollution Reviews*. Unpublished synopses.

Small, J., & Gordon, F.J. 1986. *The effects of system of harvesting grass for silage on in-field and in-*

silo losses and milk output per hectare. British Society of Animal Production, Winter Meeting, March 1986.

Water Authorities Association & Ministry of Agriculture, Fisheries and Food. 1989. *Water pollution from farm waste 1988*. (England and Wales). London, WAA.

Wilkinson, M. 1988. Preface. *Proceedings silage effluent conference*, (Staffs. Agric. College, 1988). Marlow, Chalcombe Publications.

SSSIs affected by farm wastes (1986–1990)

ENGLAND

County	Name of SSSI	Type of waste involved
Cheshire	Bagmere	Slurry
	Barmere	Slurry
	Combermere	Silage effluent
	Danes Moss	Slurry, silage effluent, yard washings
	Hallwood Farm Marl Pit	Poultry dung
	Hatchmere	Dairy/parlour washings
	Holly Banks	Dairy/parlour washings, yard washings
	Norbury Meres	Dairy/parlour washings
	Quoisley Meres	Dairy/parlour washings
	Rostherne Mere	Slurry
	Sandbach Flashes	Slurry
	Tabley Mere	Dairy/parlour washings
Cumbria	Wettenhall and Darnhall Woods	Silage effluent, dairy/parlour washings
	Claife Tarns and Mires (Moss Eccles Tarn)	Silage effluent
	Cliburn Moss	Slurry run-off
	Cumwhitton Moss	Slurry run-off
	Duddon Mosses	Slurry application
	Moorthwaite Moss	Slurry run-off
	Newton Reigny Moss	Slurry run-off

County	Name of SSSI	Type of waste involved
Cumbria cont	Siddick Pond	Slurry release into stream
	Sunbiggen	Slurry application
Devon	South Milton Ley	Slurry run-off
	Taw – Torridge Estuary	Slurry run-off, silage effluent
Dorset	Lambert's Castle	Slurry application
East Sussex	Hastings Cliffs to Pett Beach	Slurry tank leak, silage effluent
Essex	Curtis Mill Green	Slurry leak (drains)
	Roding Valley Meadows	Slurry
Greater London	Old Park Wood	Pig slurry
Hertfordshire	Tring Reservoirs	Slurry application
Norfolk	Limpenhoe Meadows	Slurry run-off
North Yorkshire	Austwick and Lawkland Mosses	Slurry
	Keasden Moor	Slurry disposal
	Newby Moor	Slurry application and run-off
Shropshire	Betton Dingle and Gulley Green	Silage effluent
	Bomere, Shomere and Betton Pools	Slurry
	Sweatmere and Crosemere	Yard washings affecting Crosemere

County	Name of SSSI	Type of waste involved
Shropshire cont	Trefonen Marshes	Overflow and leakage from slurry and silage tank
Somerset	Catcott, Edington and Chilton Moors	Parlour and yard washings
	Tealham and Tadham Moors	Slurry and yard washings
	Windsor Hill Marsh	Slurry
Staffordshire	Aqualate Mere	Pig slurry, cattle slurry, yard washings
	Betley Mere	Pig slurry, cattle dunging, dairy/parlour washings, yard washings
	Black Firs and Cranberry Bog	Silage effluent, pig slurry, dairy/parlour washings
	Cop Mere	Silage effluent
	Maer Pool	Silage effluent
Wiltshire	Coate Water	Slurry

WALES

County	Name of SSSI	Type of waste involved
Clwyd	Llay Bog	Slurry, yard/parlour washings, silage effluent
Gwent	Gwent levels – Magor and Undy	Cattle shed washings
	Gwent levels – Nash and Goldcliff	Silage effluent
	Gwent levels – Whitson	Slurry run-off
Powys	Gweunydd Ty Brith	Slurry application

SCOTLAND

Region	Name of SSSI	Type of waste involved
Borders	Coldingham Loch	Intensive pig dunging
	River Tweed	Silage effluent
	Yetholm Loch	Slurry application
Dumfries and Galloway	Lochmaben Lochs	Silage effluent affecting one loch
	Milton Loch	Slurry tank washings

County	Name of SSSI	Type of waste involved
Grampian	Den of Pitlurg	Silage and slurry run-off
	Meikle Loch and Kippit Hills	Silage tank overflow
	Sands of Forvie and Ythan Estuary	Slurry
Lothian	Gladhouse Reservoir	Slurry run-off
Orkney	Lochs of Harray and Stenness	Slurry and silage
Shetland	Loch of Spiggie and Brow	Silage effluent
Strathclyde	Caldarvan Loch	Slurry run-off
	Machrihanish Dunes	Silage effluent in river
	Martnaham Loch and Wood	Effluent effects from former piggery, cattle dunging
Tayside	Hare Myre, Monk Myre and Stormont Loch	Chicken litter run-off
	Loch of Kinnordy	Yard washings
	Loch Leven	Chicken litter run-off, slurry, possibly silage effluent
	Long Loch of Lundie	Slurry application
	Rescobie and Balgavies Lochs	Silage leaks and slurry
	Restenneth Moss	Pig farm leakage, slurry application

The Nature Conservancy Council is the body responsible for advising Government on nature conservation in Great Britain. Its work includes the selection, establishment and management of National Nature Reserves, the selection and management of Marine Nature Reserves; the identification and notification of Sites of Special Scientific Interest; the provision of advice and dissemination of knowledge about nature conservation; and the support and conduct of research relevant to these functions.

This is one of the range of publications produced by Publicity Services Branch, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA.



ISBN 0 86139 709 6
© NCC 1991