

It is estimated that in 2004–2006, 71 per cent of the total river channel length surveyed (13,240 km) was in a satisfactory condition, 18 per cent was slightly polluted, 10 per cent moderately polluted and 0.5 per cent seriously polluted. This represented an improvement compared to the last assessment period, which had shown an increasing spread of slight pollution. These latest figures indicate a slight reduction in moderate and serious pollution but again an increase in slight pollution.

This chapter highlights the need for improved protection of surface waters, especially in the context of achieving good quality for all waters by 2015 as required under the terms of the Water Framework Directive. Recent measures to control phosphorus inputs to surface waters are welcome, but considerable threats from sewage and agricultural sources remain.

## WATER QUALITY OF RIVERS



## Water Quality of Rivers and Streams

National surveys of Irish rivers have been carried out on a continuous basis since 1971, when 2,900 km of river channel was surveyed. The surveys combine general chemical and biological assessments, and in the period 2004–2006 some 13,240 km of river channel was surveyed. The baseline channel surveyed since 1987 is that depicted on the 1958 map 'River Basins of Ireland', published by the Ordnance Survey of Ireland. This gives an overall representative picture of the state of the larger rivers and streams. In addition to this baseline channel some smaller streams are surveyed, especially where there are known pollution problems. The assessment for the 2004–2006 period includes 2,985 sampling locations on 1,151 rivers surveyed biologically and approximately 2,500 sites surveyed chemically.

### River Classification

Biological classification of river quality is based on the well-documented response of aquatic animals and plants to pollution, especially

organic pollution and eutrophication (excessive artificial enrichment of waters). The aquatic life-cycle stages of certain insect species (some mayflies and stoneflies, for example) are particularly sensitive to pollution, while other invertebrates are tolerant to a greater or lesser extent (certain worms, leeches, snails, for example). Depending on the combination of sensitive and tolerant types found in the river, the previous history of pollution at the site can be determined. The fact that these invertebrates are aquatic over most if not all of their life-cycle (which is typically one year) means that they effectively act as continuous monitors of water quality in the river. This allows EPA biologists to assess the pollution history at the site, even when the pollution event occurred some months prior to the date of sampling. EPA biologists continue to use the same biological assessment method (i.e. the EPA Quality Rating System or Q-value) that has been used to assess river quality nationally since the original 1971 surveys. This allows long-term trends to be determined and comparisons to be made between different parts of the country. The results of the individual

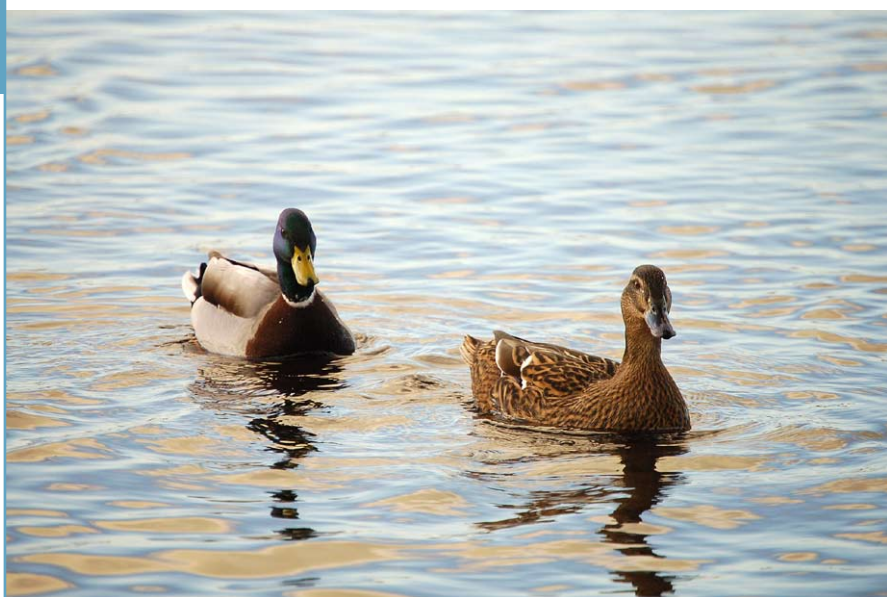
biological assessments are condensed into a biotic index—EPA Quality Rating System for ease of understanding by non-biologists. Up to 2006, a four-class system was used in reporting the results nationally.

Class A (unpolluted) waters include waters of the highest ecological quality and also waters of a less high standard in which existing or potential beneficial uses are judged not to be at risk. Such waters support healthy, natural populations of game fish (salmon and trout), and are suitable for abstraction for potable supply with minimum treatment and for amenity and contact sport uses; they are therefore regarded as being in a 'satisfactory' condition.

Classes B, C and D reflect increasing levels of pollution and ecological impairment, and are consequently regarded as 'unsatisfactory' to a lesser or greater degree.

Class B (slightly polluted) waters are mainly characterised by being eutrophic and frequently also by having excessive deposition of silt on the substratum; eutrophication is the artificial over-enrichment of waters caused by excessive inputs of phosphorus and nitrogen which in rivers may result in excessive growths of rooted plants and filamentous algae. The respiration of these plants may be sufficient to deplete dissolved oxygen (DO) on occasion. DO levels can drop significantly at night when photosynthetic activity has ceased, and in some waters daytime photosynthesis can result in more alkaline conditions due to excessive uptake of carbon dioxide.

Class C (moderately polluted) waters are typically extremely eutrophic and frequently impacted by other influences such as organic pollution (for example in recovery zones below sewage discharges). They may be



subject to other influences such as heavy siltation (due to drainage activities), the toxic effects of mining or forestry-induced acidification in sensitive upland areas.

Class D (seriously polluted) waters are typically characterised by very high concentrations of biodegradable organic waste causing deoxygenation and the growth of unsightly bacterial and fungal slimes ('sewage fungus' or 'bacterial tufts'). In extreme cases the substratum may be blanketed with deposits of malodorous anaerobic sludge. Only the most tolerant invertebrates (e.g. sludge worms) are to be found in such conditions, and virtually all beneficial uses are lost. Where serious toxicity occurs (e.g. due to mining or other sources of toxic spillages or discharges), virtually all aquatic life may be extinguished.

From 2007 onwards a five-class system replaces the four-class system. A new class is created by dividing the existing Class A (unpolluted) category into two new classes – High Status and Good Status waters – in compliance with the Water Framework Directive (WFD) classification requirements. These have already been intercalibrated at European level for a range of biological quality elements to ensure comparability between Irish river status assessments and those of other countries.

### River Quality 2004–2006: National Position

The most recent national compilation of river quality is based on the biological surveys carried out between the years 2004 and 2006 (Clabby *et al.*, 2008). The results showed that most of the 13,240 km of surveyed channel (71.4%) was in a satisfactory (Class A) quality condition (Figure 7.1). Some 18.1 per cent

was slightly polluted (Class B), 10.0 per cent moderately polluted (Class C) and 0.5 per cent showed the characteristic symptoms of serious pollution (Class D).

Long-term trends have demonstrated that the percentage of unpolluted channel fell steadily from 77 to 67 per cent during the period 1987 to 1997 (Figure 7.2). This decline in unpolluted channel was accompanied by an increase in instances of slight and moderate pollution. An increase in unpolluted channel (70%) was evident in the 1998–2000 period but this fell slightly again in the 2001–2003 period (69.2%). The most recent survey period highlighted a 2 percentage point increase in unpolluted channel (71.4%). It is hoped that this trend will continue into the future in order to meet the requirements of the WFD.

### River Quality 2004–2006: Regional Position

The WFD (2000/60/EC) aims to protect and enhance the status of aquatic ecosystems, thereby ensuring that there is no further deterioration in the status of any waters and that all waters achieve at least good status by 2015 (Chapter 5). Under the regulations (SI 722 of 2003) implementing the WFD, seven of the eight river basin districts (RBDs) – four national (Eastern, South Eastern, South Western, Western) and three

international districts (North Western, Shannon and Neagh Bann) – into which the island of Ireland is divided for water management purposes fall wholly or partly within the Republic of Ireland (Figure 7.3).

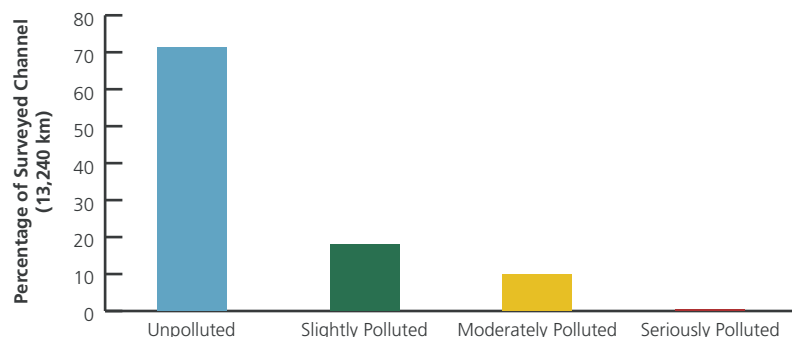
A regional analysis of river quality demonstrates that the South Western RBD has the highest proportion of unpolluted river channel (90%) while the portion of the Neagh Bann international RBD (IRBD) situated south of the border (49%) and the densely populated and industrialised Eastern RBD (52%) are the most polluted regions (Figure 7.3). The incidence of serious pollution is relatively low, ranging from 0.07% in the Western RBD to 1.30% in the Eastern RBD. Slight pollution (mainly seen as eutrophication) is most widespread in the Neagh Bann IRBD, Eastern and South Eastern RBDs. Moderate pollution (usually characterised by marked organic and severe eutrophication effects) is most widespread in the Neagh Bann IRBD and Eastern RBD. In terms of the proportion of channel in Class A, the regions may be ranked as shown in Table 7.1. The less densely populated and less developed as well as less intensively farmed regions have the highest proportions of unpolluted channel.

Recent improvements, i.e. an increase in unpolluted channel length, are

**Table 7.1 Proportion of Unpolluted River Channel (Class A) in Each Region**

	Region	Percentage
1	South Western RBD	90
2	Western RBD	84
3	North Western IRBD (South)	71
4	Shannon IRBD	67
5	South Eastern RBD	62
6	Eastern RBD	52
7	Neagh Bann IRBD (South)	49

**Figure 7.1** Quality Status of the National River Baseline Channel Monitored in 2004–2006 (Source: Clabby *et al.*, 2008)



noted in four river basin districts (Eastern by 11 percentage points, South Eastern by 4, Shannon by 4 and South Western by 1) when compared with the previous 2001–2003 period. An increase in the length of polluted channel was most notable in the Neagh Bann IRBD (6 percentage points) and in the North-Western IRBD (5 percentage points; Figure 7.3). The Eastern RBD, Shannon IRBD and Neagh Bann IRBD had the greatest percentage of seriously polluted river length across the regions (Figure 7.3).

### Causes of Pollution

While the causes of the observed pollution may not always be proven, it is clear in most cases what they are likely to have been – especially in the case of point sources of pollution such as wastewater treatment plants or obvious silage effluent discharge from a farm. In the case of more diffuse pollution a number of approaches are taken to determine the nature of the pollutant source. These include on-the-spot investigations such as walking and sampling smaller streams to pinpoint the location of pollution sources, analysis of changes over time in relation to land use, examination of

Ordnance Survey aerial photography, and the mapping and analysis of large-scale land-use patterns in relation to water quality. In cases where the total pollution load is measured at the end of a river catchment, techniques of ‘source apportionment’ are used to allocate pollutant loads to their source. Of the 2,985 sites examined, 1,974 were classified as unpolluted.

### Slight and Moderate Pollution

Of the 972 instances of slight (586) and moderate (386) pollution recorded in the 2004–2006 period, 360 are attributed to municipal (i.e. sewage, diffuse urban runoff, water works, septic tank, landfill, bridge works and other works) sources, while agriculture sources account for 309 cases (Figure 7.4). Forestry (84) and industry (45) sources are also attributed as causes for slight and moderate pollution in the streams and rivers surveyed. The ‘other’ category refers to influences such as quarrying, fish farming, land clearance, mining, lake or groundwater effects.

**Figure 7.2** Long-Term River Trends (13,240 km baseline) (Source: Clabby *et al.*, 2008)

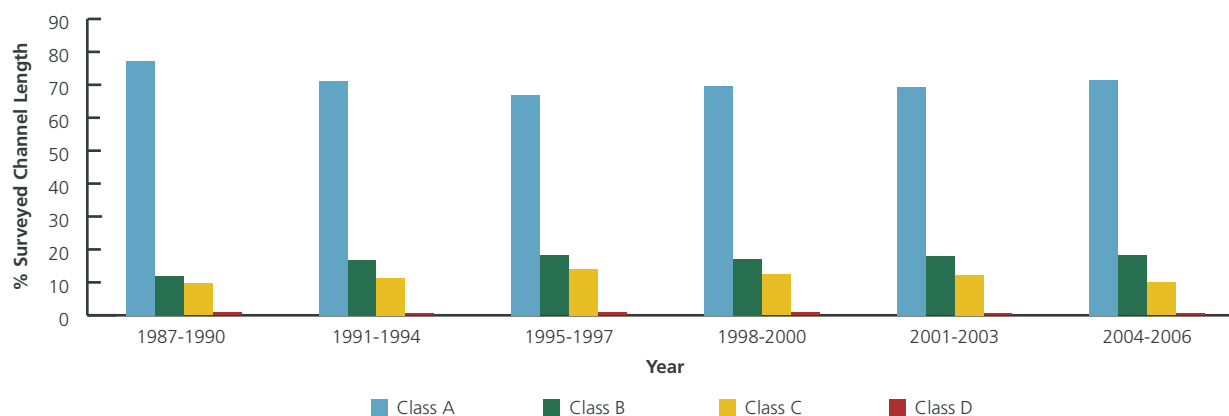
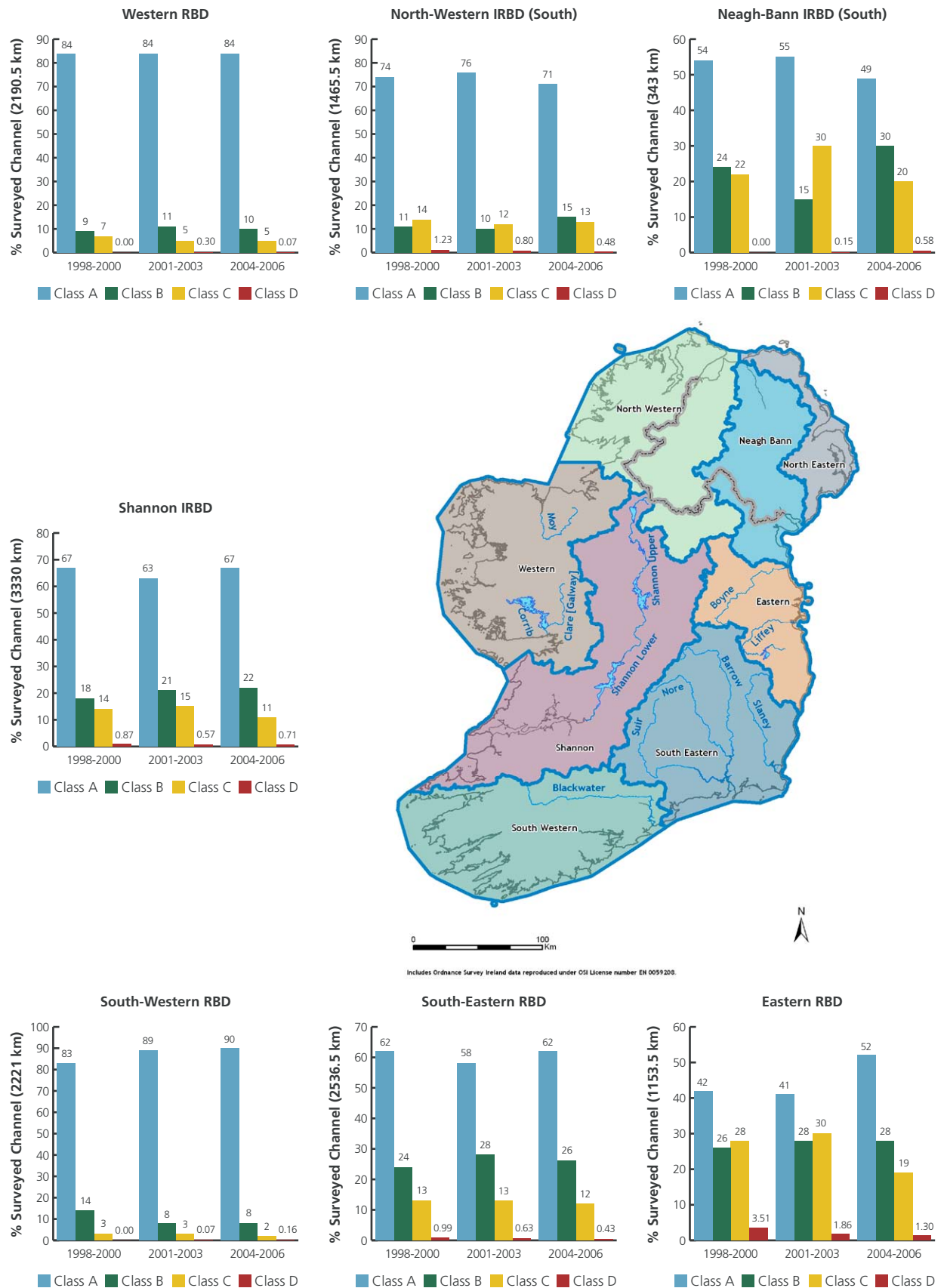
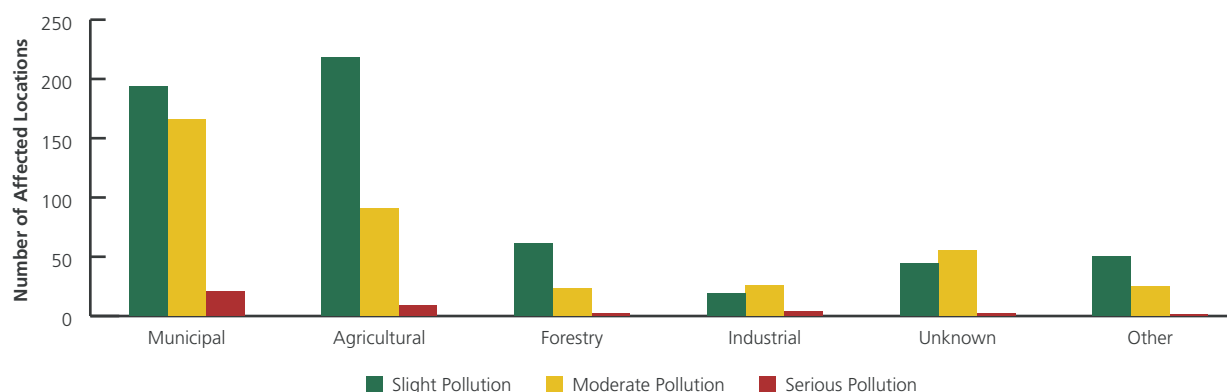




Figure 7.3 River Quality in the River Basin Districts



**Figure 7.4 Suspected Sources of River Pollution Recorded in 2004–2006** (Source: Clabby *et al.*, 2008)

### Serious Pollution

The EPA biological surveys carried out between 2004 and 2006 indicate that serious pollution affects 39 locations along 36 rivers and streams throughout the country (Table 7.2). This represents a decrease in the number of seriously polluted locations (49) encountered in the 2001–2003 period (Toner *et al.*, 2005). However, although the situation has improved, most of these locations remain significantly polluted. In order to meet the requirements of the WFD, i.e. reach and maintain a satisfactory status, the impacting pollutants must be reduced significantly or removed permanently.

Municipal (mostly sewage) discharges are suspected to account for 21 known instances of serious pollution, with agricultural activities suspected in the case of nine and industrial activities suspected in the case of four locations (Table 7.2). An improvement in status was observed at the Avoca River in 2006, removing it from the list of seriously polluted locations. This river has been affected by acid mine leachate since the 1850s. The improvement was, however, only temporary, with the 11.5 km stretch of river once again classified as seriously polluted when assessed in 2007 (EPA, unpublished data).

Most of the locations affected by serious pollution are situated on relatively small streams or in the shallower upper reaches of larger rivers, but some larger rivers continue to be seriously polluted. In particular the Triogue below Portlaoise, the Tullamore River below Tullamore, the Tully River below Kildare, the lower Camac and Tolka and the Brosna below Mullingar have been seriously polluted, continuously or intermittently, for many years. Other long-term instances of serious pollution are evident on the Maggy's Burn, Jiggy (Hind), Roosky, Bredagh and Greenhill Stream.

It is hoped that the continued installation and upgrading of sewage treatment works funded by the Department of the Environment, Heritage and Local Government's (DEHLG) and the new Waste Water Discharge (Authorisation) Regulations 2007 (SI 684 of 2007) will assist in the elimination of untreated discharges in most of these affected locations in the near future.

### Fish Kills

Mass deaths of fish – 'fish kills' – are usually a sign of serious water pollution. Occasionally disease may



**Table 7.2** Seriously Polluted River Location, Grouped by Suspected Cause and Showing the Estimated Channel Length Affected, Year Pollution First Recorded, Year of Most Recent Biological Survey and Number of Locations (Source: Clabby *et al.*, 2008)

River Name	Code	km	Location	Pollution First Noted	Year	Number of Locations
<b>Municipal</b>						
Ahavarraga Stream	24A02	1.5	d/s of Drumcolliher	1989	2005	1
Borrisoleigh Stream	16B06	1.0	Near Borrisoleigh	2006	2006	1
Bredagh	40B02	0.5	Moville Bridge	1987	2004	1
Brosna	25B09	2.5	Downstream of Mullingar	1971	2005	1
Camac	09C02	2.0	Inchicore area	1981	2005	1
Clarinbridge	29C02	1.5	Near Castle Turvin	1980	2006	1
Clodaigh (Portlaw)	16C03	0.5	Clonea Bridge	2005	2005	1
Clodaigh (Tullamore)	25C06	1.0	Just u/s Gorrage R confl	2005	2005	1
Corravaddy Burn	39C03	1.0	Br d/s Cullion Br.	2004	2004	1
Erne	36E01	*	Downstream of Belturbet	2001	2004	1
Fane	06F01	1.5	South Bridge Dunfelimy	2006	2006	1
Glory	15G01	0.5	Near Kilmaganny	1995	2004	1
Jiggy (Hind)	26J01	3.0	In Roscommon	1987	2005	1
Maggy's Burn	39M01	2.0	Just u/s Lough Fern	1973	2004	1
Tolka	09T01	3.0	Finglas area	1971	2005	1
Triogue	14T01	3.0	Downstream of Portlaoise	1971	2006	1
Tubbercurry	34T02	2.0	Near Tubbercurry	1980	2004	1
Tubbercurry Stream	34T03	0.8	Near Tubbercurry	2004	2004	1
Tullamore	25T03	6.0	Downstream of Tullamore	1971	2005	1
Tully Stream	14T02	3.0	Downstream of Kildare	1986	2006	2
Total municipal		31.5 (49.6%)				21
<b>Agriculture</b>						
Brown's Beck Brook	12B03	0.5	Donard area	2004	2004	1
Conawary (Upper)	36C11	1.5	Bridge d/s Greagh Lough Branch	2004	2004	1
Garranacool Stream	15G10	2.0	Garranacool area	2005	2005	1
Greenhill Stream	01G02	1.0	Bridge at Greenhill	1990	2004	1
Milltown (Kerry)	22M03	1.0	Bridge d/s Glens Bridge	2004	2004	1
Owenalondrig	22O01	1.5	Bridge in Foheraghmore	2004	2004	1
Ownahinchy	20O03	1.0	Bridge u/s Ownahinchy Br.	2006	2006	1
Roosky	40R01	1.0	Mullinroe Bridge	1987	2004	1
Ward	08W01	6.5	Coolatrath Bridge	2005	2005	1
Total agriculture		15.0 (23.6%)				9
<b>Industrial Discharges</b>						
Deel (Newcastlewest)	24D02	1.5	d/s of Castlemahon Bridge	1999	2005	1
Gowran	14G03	0.5	Goresbridge area	1989	2006	1
Laurencetown Stream	26L07	6.5	Near Laurencetown	1994	2006	2
Total industrial		8.5 (13.4%)				4
<b>Other Discharges</b>						
Ballymascanlan	06B02	0.5	Jonesborough area	2003	2006	1
Broadford	27B02	1.5	Scotts Bridge	2001	2005	1
Kilcullen Stream	09K02	3.5	Bridge East of Yellowbog	2005	2005	1
Roachrow	37R01	3.0	N Br. SSW Meenatea	2005	2005	2
Total other		8.5 (13.4%)				5
<b>Total</b>		<b>63.5</b>				<b>39</b>

\*Less than 0.5 km; u/s = upstream; d/s = downstream.

Note: The following rivers had seriously polluted stretches that were not used in the calculation of the percentage of seriously polluted river channel length: Greenhills Stream, Maggy Burn, Tubbercurry River and Tubbercurry Stream. These rivers are not included in the main baseline 13,240 km river channel length surveyed.



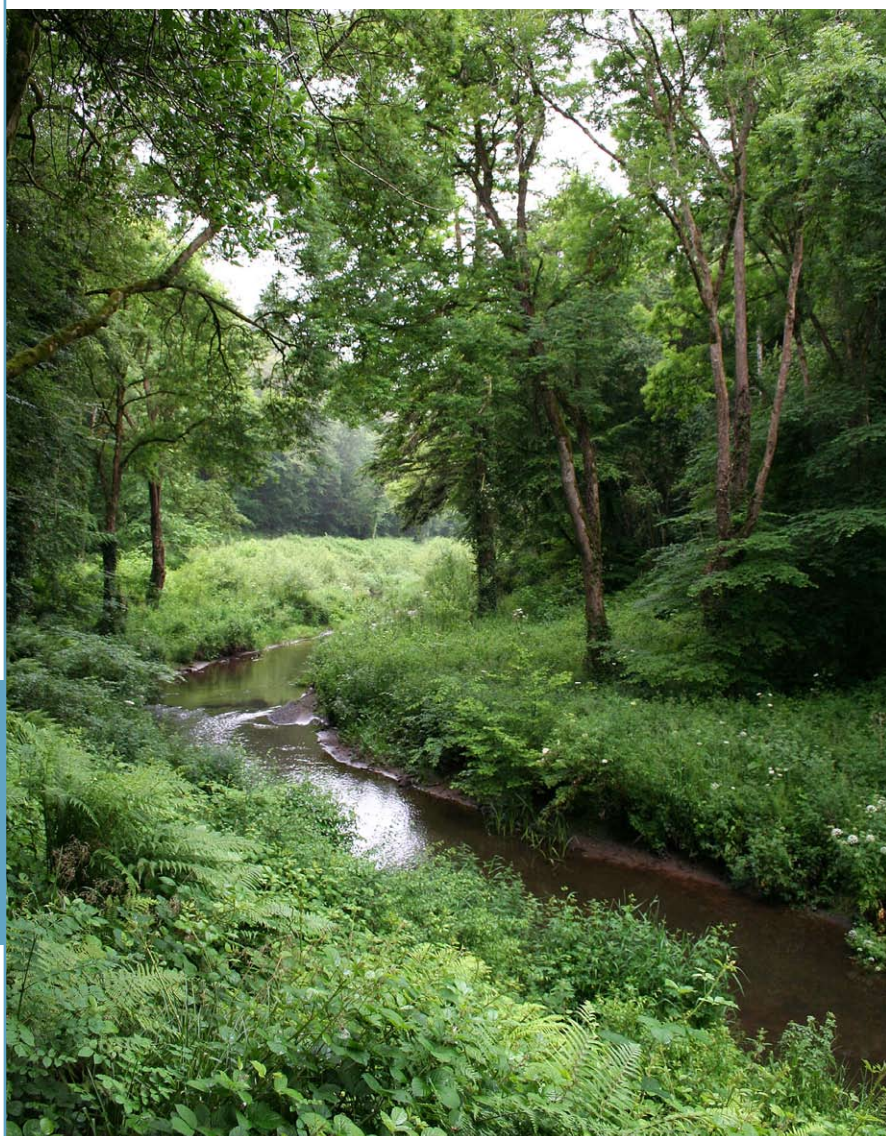
be implicated, particularly in the case of mass deaths of coarse fish in lakes. Typically, very low oxygen concentration in water is the principal cause of fish kills. Severe deoxygenation can be brought about by discharges of organic matter (e.g. industrial effluent, sewage, silage, slurry) to water or it may

occur indirectly from nutrient inputs causing excessive plant growth and deoxygenation at night. On occasion toxic chemicals such as heavy metals are to blame.

Data on fish kills in Ireland are compiled annually by the Central Fisheries Board, based on returns

from the Regional Fisheries Boards. In the period 2004–2006, 122 fish kills were reported for Irish freshwaters, most occurring in rivers but some in lakes – especially in Cavan and Monaghan lakes and particularly coarse fish deaths in Lough Oughter during the summer of 2004.

Based on investigations carried out by fisheries board environmental staff, causes of fish kills were attributed on a sectoral basis where possible (Table 7.3). Agriculture, municipal sewage and industrial discharges were the main point source causes of serious fish kills, with 23, 18 and 11 cases, respectively, clearly attributed. A substantial number of cases were attributed to 'unknown' causes or to 'eutrophication'. It is likely that many of the eutrophication cases in particular are due to widespread diffuse nutrient losses from fields or farmyards and thus may also be due to agricultural sources. Diffuse nutrient losses lead to excessive growth of filamentous algae and other green plants, which can cause night-time deoxygenation and fish kills. The heading 'Other' covers a wide variety of individual pollution events, notably several fish kills in the Avoca River due to mine wastes. This river recovers briefly allowing fish to return and then, at times of low flow or high discharge from the old mines, toxic conditions recur causing fish kills. This recovery phenomenon has also been noticed recently in the case of macroinvertebrates – the 2006 survey appeared to show a recovery to satisfactory conditions but unfortunately a subsequent survey revealed that toxic conditions had returned.

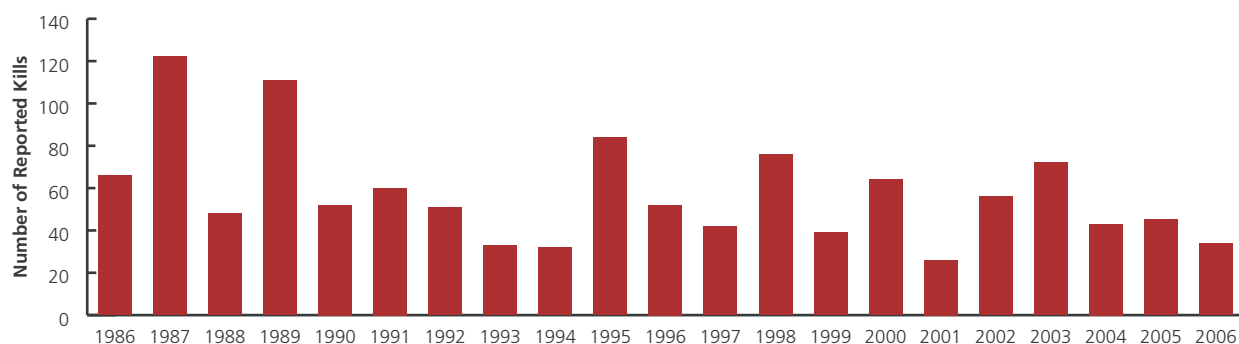


**Table 7.3 Fish Kills in Freshwaters 2004–2006**

Year	Agriculture	Industry	Municipal	Eutrophication	Other	Unknown	Total
2006	5	2	7	5	10	5	34
2005	10	7	6	7	8	7	45
2004	8	2	5	13	8	7	43
Total	23	11	18	25	26	19	122

The overall number of fish kills for 2004 to 2006, i.e. 122, is one of the lower totals for any three-year period in recent times and is approximately 20 less than recorded in 2001–2003 (Figure 7.5).

**Figure 7.5** Number of Fish Kills reported by Fisheries Boards and the Marine Institute (Source: Central Fisheries Board)



Recent trends may suggest a progressive reduction in the number of fish kills. Such apparent trends have to be taken with caution, however, as evidenced by the upsurge of fish kills recorded in 2002 and 2003 in comparison with 2001. Year-to-year climatic variation and variation in river flow rates superimposed on pollution events are also important in determining the occurrence of fish kills; this may become an increasing problem with climate change. The other caveat with regard to interpretation of fish kills as an overall indicator of water quality is that they occur only in rivers where fish are present. Fish kills will not be recorded in many of the moderately and seriously polluted river stretches because there are so few fish remaining; particularly lacking are species such as salmon and trout that are most sensitive to pollution events.

### Phosphate and Nitrate in Rivers

Figures 7.6 and 7.7 illustrate the long-term 1979–2006 annual median phosphate and nitrate concentrations in a set of representative Irish rivers. Higher concentrations are recorded for both nitrate and phosphate in eastern compared with western

rivers. This difference primarily reflects the greater pressures in terms of land use intensity and population density in the eastern part of the country.

Phosphorus and nitrogen are the key nutrients implicated in eutrophication of rivers and lakes. High concentrations result in excessive plant and algal growth and a range of adverse consequences – deoxygenation at night perhaps resulting in fish kills, clogging of spawning gravels, taste and odour problems, algal blooms in lakes and

estuaries, and generally increased costs of treatment for water supplies.

At present the only standards for nitrogen in freshwaters are those aimed at protecting drinking water. The EU maximum and guideline limits for nitrate in abstracted water for human consumption are respectively 11.30 and 5.65 mg/l N. From an ecological point of view these are extremely high values and unlikely to prevent adverse eutrophication impacts in the freshwater environment. The average nitrate concentrations for Class A





**Figure 7.6 Annual Median Nitrate Values (mg/l N) in Rivers 1979–2006 (Source: Lucey, 2007)**

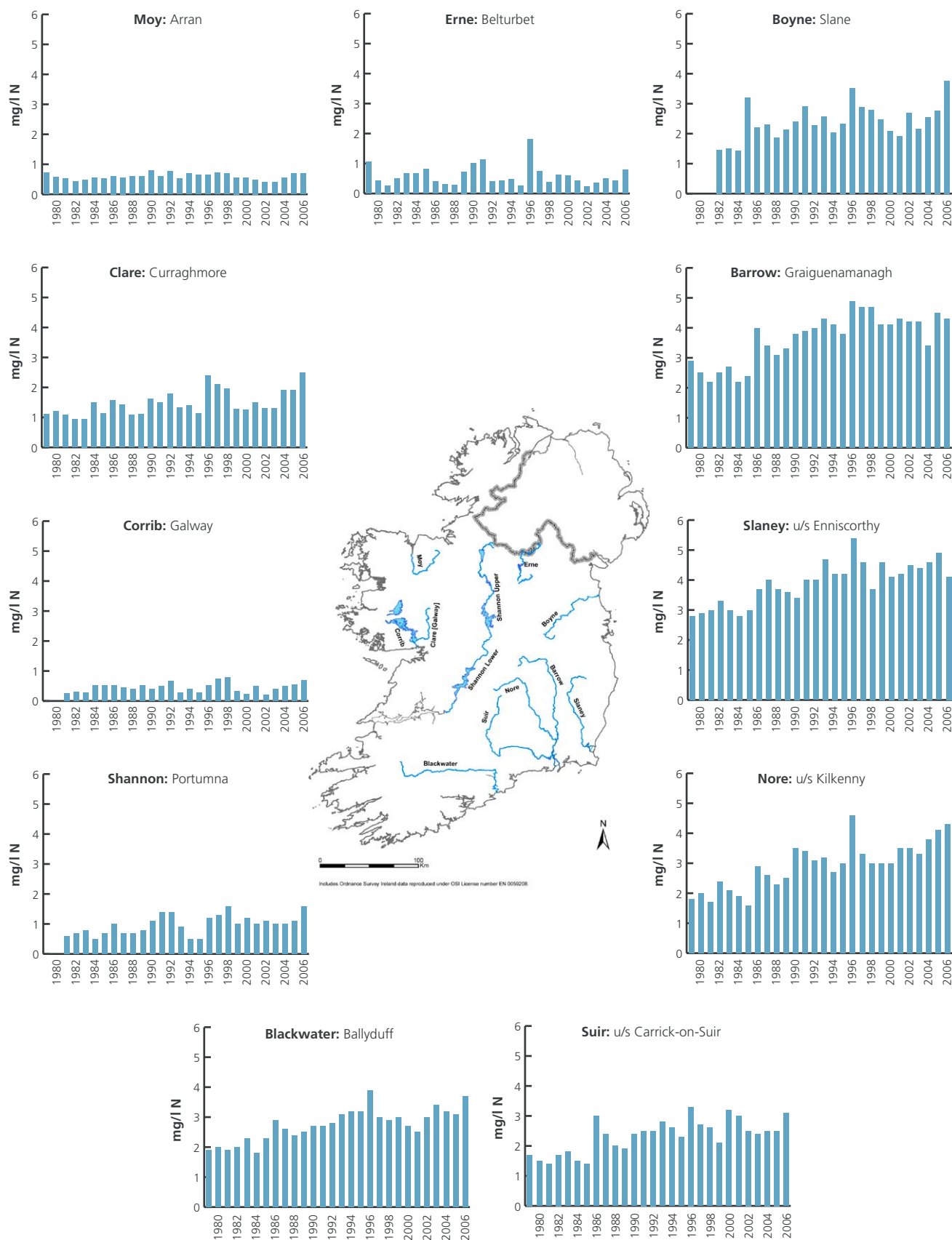


Figure 7.7 Annual Median Phosphate Values (mg/l P) in Rivers 1979–2006 (Source: Lucey, 2007)



(high status) reaches on Irish rivers are typically less than 0.9 mg/l N and good status rivers have less than 1.8 mg/l N. (The OECD open boundary system for lake classification predicts total nitrogen concentrations of 0.661 mg/l N for oligotrophic lakes and 1.875 mg/l N for eutrophic lakes.) As many rivers are strongly influenced by groundwater during low-flow summer periods it is important that surface water and groundwater standards be coherently set and provide adequate protection for the most sensitive ecological elements. Similarly, marine nitrate concentrations are crucial

as nitrogen is more important as a limiting nutrient in seawater. It is thus important to control the input of nitrogen into tidal areas in order to protect transitional and coastal waters.

Ireland is unique in having long-standing legal standards for phosphorus in rivers – set in 1998 in compliance with the requirements of the Dangerous Substances Directive. Empirical comparison of in-stream phosphate levels and biological quality has demonstrated that once median phosphate concentrations exceed 0.03 mg/l P, significant

deterioration is typically seen in Irish river ecosystems. Median phosphorus concentrations for the best quality river stretches are typically half this level, and indeed lower than rainfall concentrations (this is because natural vegetation and soils are low in phosphorus and scavenge phosphorus effectively). The statutory phosphorus regulations require that rivers with median concentrations greater than 0.03 mg/l P must achieve that target through a programme of measures to reduce phosphorus inputs. The regulations also include a no-deterioration clause similar to the approach now being taken under the WFD.

It is interesting to compare Irish rivers with data published for 24 European countries by the EEA. The median of the annual average phosphate concentrations for rivers submitted to the EEA in 2000 was greater than 0.060 mg/l P, while the corresponding statistic for over 2,400 sites on Irish rivers in the 1999–2000 period was 0.037 mg/l P. The median of the reported average European nitrate concentrations was 1.5 mg/l N and the corresponding value for Irish nitrate values was approximately 1.47 mg/l N.

### Dangerous Substances Monitoring

Due in part to the lack of a heavy chemical industry and the absence of intensive agriculture in Ireland during the 1960s, monitoring for dangerous substances was confined to occasional surveys and some screening of drinking water abstraction points. The chief targets for this screening were the 18 substances for which limits had been set under the Dangerous Substances Directive 76/464/EEC and some pesticides known to be widely used. In 2001 a further 13 substances





were specified in an Irish Regulation (SI 12 of 2001). The results of surveys showed that most of these compounds were generally either absent or present at only very low concentrations.

With the advent of the WFD in 2000, a project was undertaken to identify locally relevant pollutants to be included in the Surveillance Monitoring programme. The WFD specifies a priority list of 41 substances to be monitored, and member states must also monitor other chemicals that are discharged in significant quantities into surface waters.

A project team considered existing priority lists and selected a candidate list of 202 target substances including the 41 prioritised by the WFD, Annexes IX and X, and 161 selected on available information. A preliminary survey was carried out at 17 surface-water sites, one wastewater treatment plant, one landfill leachate and four groundwater sites. Samples were taken monthly between May 2005 and May 2006 and screened for the presence of the candidate list compounds. Six sites were added to cover specific usage of pesticides in forestry and sheep dipping. Sediment and biota samples were also analysed at these sites.

The results of the survey showed that 31 of the 41 WFD Priority Substances and 89 of the 161 chosen target compounds were detected in one or more samples, often at trace levels. The most commonly detected compounds were metals and polycyclic aromatic hydrocarbon (PAH). The levels of the locally relevant pollutants were considered, and 28 compounds were considered to be significant. These were chosen for inclusion, along with the 41 on the WFD list, in the Surveillance

Monitoring programme. This programme commenced in July 2007 and the first cycle of monitoring is due for completion in 2009.

## References

- Clabby, K.J., Bradley, C., Craig, M., Daly, D., Lucey, J., O'Boyle, S., O'Donnell, C., McDermott, G., McGarrigle, M., Tierney, D., Wilkes, R. and Bowman, J. (2008) *Water Quality in Ireland 2004–2006*. EPA, Wexford.
- Lucey, J. (2007) *Water Quality in Ireland 2006: Key Indicators of the Aquatic Environment*. EPA, Wexford.
- Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCarthaigh, M., Craig M. and Quinn, R. (2005) *Water Quality in Ireland 2001–2003*. EPA, Wexford.