CHAPTER TWO

THE WATER QUALITY OF RIVERS, STREAMS AND CANALS

INTRODUCTION

National surveys of Irish rivers have taken place on a continuous basis since 1971, when 2,900 km of river channel was surveyed. The surveys combine general chemical and biological assessments, and over time have increased to include surveys of some 13,240 km of river channel length. The baseline channel surveyed since 1987 is that depicted on the 1958 map '*Rivers and their Catchment Basins*', published by the Ordnance Survey of Ireland. This provides 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.

This chapter presents an overview of water quality in Ireland's rivers and streams for the 2004–2006 period. A total of 2,985 sampling locations on 1,151 rivers were surveyed biologically in this period. Water quality trends on a national, regional and local basis are identified by comparison with previous overviews of the position carried out since 1987 and the national position in this review is based on the biological (macroinvertebrate) surveys. Results of physico-chemical measurements of the levels of nitrate contamination and the quality of designated salmonid waters are presented. This chapter also presents information on the measurements of toxic substances in river waters and on the quality of canal waters. Since one complete survey of this channel length takes three years, it is important to note that the overview presented in these reports cannot represent the most recent position for all rivers.

Routine water quality monitoring programmes are of most value in assessing the effects of more or less continuous inputs of waste but short-term pollution events may well escape detection, particularly by routine chemical surveys which generally rely on relatively infrequent grab samples. However, effects of such once-off events on flora and fauna are usually detectable for some considerable time afterwards, so that the biological surveys are likely to detect them in many instances. Again, however, because of the current frequency of assessment (triennial), the biological survey is not expected to adequately reflect all such transient events.

The rivers surveyed biologically in the 2004-2006period are set out by Hydrometric Area in Appendix II.1. For each river, the year of the most recent survey is shown and the channel length surveyed is apportioned to four biologically-based Quality Classes. The overall condition of each Hydrometric Area is also summarised in diagrammatic form and shown alongside a similar representation of the national position for comparative purposes.

A colour-coded River Quality Map depicting biological quality at each of the 2,985 locations surveyed will accompany this report: hard copies of this map will be available from EPA Publications, EPA, Richview, Clonskeagh Road, Dublin 14. Smaller streams, which are not routinely surveyed, are shown without an identification code on this map.

WATER QUALITY ASSESSMENT

The biological river quality (Q or biotic index) classification system (Toner *et al.*, 2005; Appendix 1) is summarised below:

Q Value	Community Diversity	Quality	Water Condition*
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Much Reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very Low	Bad	Unsatisfactory

* 'Condition' refers to the likelihood of interference with beneficial or potential beneficial uses.

Intermediate indices Q1-2, 2-3, 3-4 and 4-5 are used to denote transitional conditions. The scheme mainly reflects the impacts of inputs (i.e. deoxygenation and eutrophication) of biodegradable organic wastes but toxic effects are also readily discernible and where such effects are suspected or apparent the suffix '0' is added to the biotic index (e.g. Q1/0, 2/0 or 3/0). Biotic indices are related to four Water Quality Classes (Unpolluted, Slightly Polluted, Moderately Polluted and Seriously Polluted) and to Water Framework Directive (WFD) water status as follows:

Biotic Index	Quality Status	Quality Class	WFD Status
Q5, Q4-5	Unpolluted	Class A	High
Q4	Unpolluted	Class A	Good
Q3-4	Slight Polluted	Class B	Moderate
Q3, Q2-3	Moderate	Class C	Poor
Q2, Q1-2, Q1	Serious	Class D	Bad

WFD High and Good status waters (Class A waters) are those in which problems relating to existing or potential uses are unlikely to arise and which must be maintained as such; they are, therefore, regarded as being in a 'satisfactory' condition. WFD Moderate, Poor and Bad status waters (Classes B, C and D) are to a lesser or greater extent 'unsatisfactory' in this regard and such waters must be restored to at least Good status by 2015. For example, the main characteristic of Classes B and C waters is eutrophication, which may interfere with the amenity, abstraction or fisheries uses of such waters. Eutrophication is typically found in the recovery zones below seriously or moderately organically polluted reaches or it may arise as a consequence of the run-off of nutrients from agricultural or forestry land.

Class B waters are essentially transitional between the satisfactory Class A and the unsatisfactory Classes C and D. It is considered prudent, however, that these slightly polluted waters should also be classified as unsatisfactory in the analyses set out in this report because of the potential risk to game fish populations of nocturnal dissolved oxygen (DO) depletion which may occur in such waters, particularly in times of low flow and elevated temperature.

In Class D waters excessive organic loading leads to deoxygenation and may produce 'sewage fungus' growths; as a consequence, most beneficial uses may be severely curtailed or eliminated. The principal characteristics of the four water quality classes and the relationship between these and the biotic indices (Q1 to Q5) are set out in Toner *et al*., 2005.

SAMPLING PROCEDURE

The freshwater reaches of rivers and streams are surveyed from an upper 'survey limit' to their confluences with other rivers or to their tidal limit. The survey limit is a point in the headwaters above which biological sampling is impracticable, usually because of insufficient flow. Sampling sites are typically located at five km intervals with extra stations located in some reaches to better reflect the effects of point discharges or of other known or potential pollution sources. In order to determine the channel lengths in the various water quality classes it has been necessary to interpolate conditions between the individual sampling points: this procedure has been carried out in a systematic and standardised fashion having regard to typical or expected patterns of water quality recovery in rivers affected by waste discharges. River lengths quoted in the text refer to the surveyed, freshwater reaches, exclusive of lakes.

SURVEY RESULTS: MAIN FINDINGS

River Quality: National Status

The results of the 2004-2006 biological surveys indicate that the bulk (71.4% or 9451km) of surveyed rivers/stream channel length is in a satisfactory quality condition. However, a considerable length is affected by slight or moderate pollution; some 18 per cent (2401.5 km) is classed as slightly polluted/eutrophic, a further 10 per cent (1324 km) as moderately polluted but less than one per cent (63.5 km) is currently subject to a serious degree of pollution (Figure 2.1).

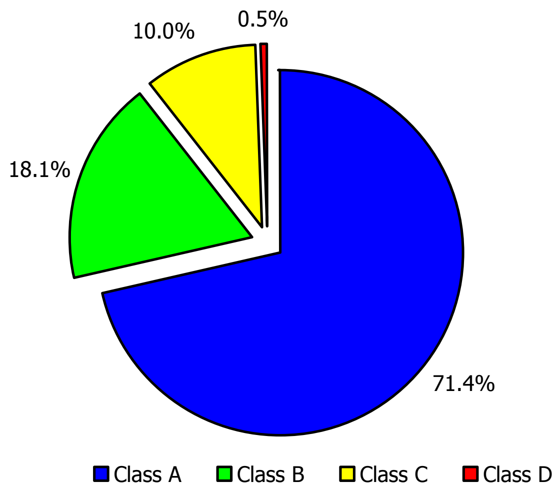


Figure 2.1 River Quality 2004-2006: Percentage channel length in each quality class

River Water Quality Trends

Baseline (13,240 km) This (13,240 km) baseline survey includes virtually all of the rivers and streams depicted on Ordnance Survey map entitled *Rivers and their Catchment Basins* (1958) and is, therefore, regarded as representative of river quality nationally for the more significant channels. Figure 2.2 summarises trends in this baseline: throughout the 1990s the proportion of channel in Class A declined by 10 percentage points (from 77% to 67%) due to the spread of slight and moderate pollution which increased by a similar percentage. Since then the three most recent surveys show that this situation appears to have improved: the proportion of channel in Class A is now of the order of 71 per cent of the total while less than one per cent of channel (63.5 km) is currently polluted at the serious level.

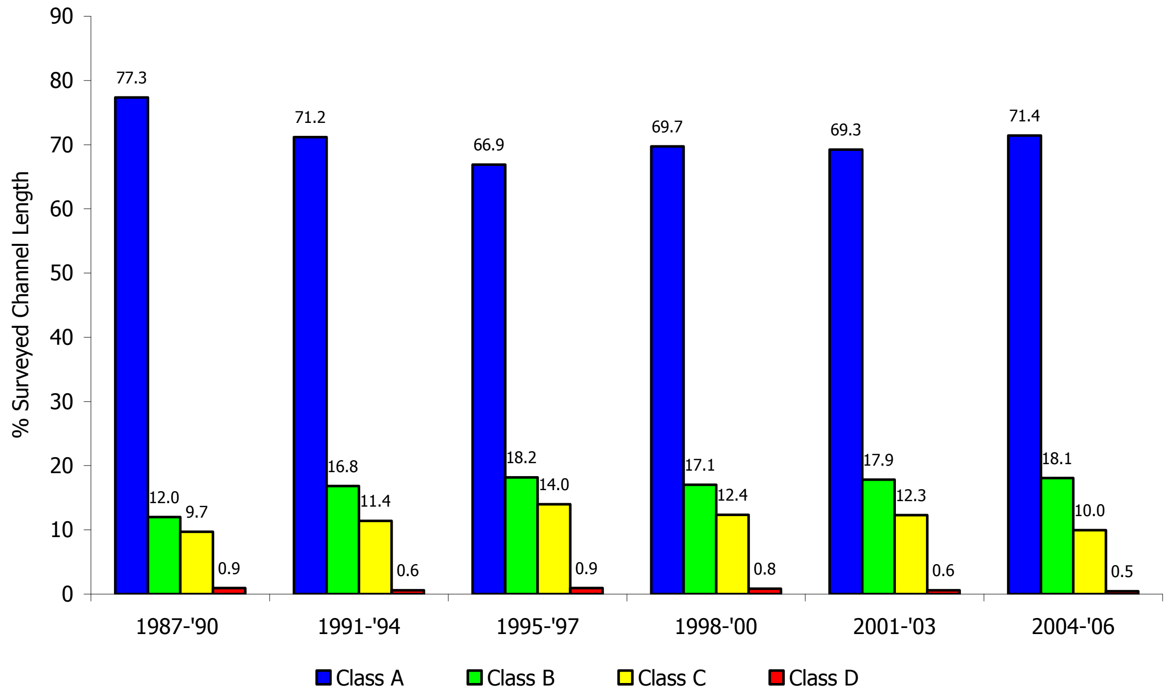


Figure 2.2 Recent Trends in the 13,240km baseline showing the percentage of surveyed channel in four biological quality classes: A Unpolluted, B Slightly Polluted, C Moderately Polluted and D Seriously Polluted. Historic data from (a) Clabby *et al.*, 1992, (b) Bowman *et al.*, 1996, (c) Lucey *et al.*, 1999, McGarrigle *et al.*, 2002 and Toner *et al.*, 2005.

River Quality: Hydrometric Area Analysis

By agreement between the hydrological agencies in the State and in Northern Ireland, the island of Ireland is divided into 40 Hydrometric Areas (HAs), each of which comprises a single large river catchment or a group of smaller catchments. Table 2.1 sets out the year(s) in which each area was surveyed (in the 2004-2006 period) and the estimated length of channel in the four

Biological Quality Classes A, B, C and D as well as national totals and percentages; these latter summary data may be taken as the 'national averages' against which each area might be compared. This analysis also shows that the cleanest waters are to be found in the more remote, less developed, less populated areas along the southern, western and north-western seaboards with the most polluted rivers and streams, generally speaking, in the east and south-east.

Hydrometric areas 21 (Dunmanus-Bantry-Kenmare), 20 (Bandon-Ilen) and 34 (Moy and Killala Bay) had the highest percentage (≥90%) of channel classified as Class A when compared to all the other hydrometric areas examined (Appendix II.1). On the east side of the country hydrometric areas 10 (Avoca - Vartry) and 12 (Slaney and Wexford Harbour) had the highest percentage (80%) of channel classified as unpolluted. In the eastern region of the country, hydrometric area 08 (Nanny-Delvin) however had the lowest percentage (18%) of Class A channel. Hydrometric areas 24 (Shannon estuary south) and 03 (Bann) had 39 and 40 per cent respectively of channel classified as Class A quality.

River Quality in the River Basin Districts

The WFD (2000/60/EC) aims at protecting and enhancing 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. Under the regulations (SI 722 of 2003) incorporating the WFD into Irish legislation, 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. These RBDs, for the most part, are based on existing Hydrometric Areas.

Figure 2.3 summarises the overall river quality situation expressed as the percentage of Class A unpolluted channel recorded in each of the seven River Basin Districts wholly or partly within the State. On the basis of the percentage of surveyed channel classified as Class A, the South-Western and Western river basin districts continue to be ranked the most unpolluted districts (Figure 2.3). As expected the less densely populated and less developed regions have the higher proportions of unpolluted channel while those in the eastern and north-eastern part of the country are most affected by water quality degradation.

Table 2.1

Analysis by Hydrometric Area (HA) of the 2004 – 2006 surveys showing year and channel length surveyed and the estimated lengths in the four biological classes. (For trend analysis see end of table).

HA No.	Hydrometric Area	Year Surveyed	Channel length (km) in class A	B	C	D	Total km
01	Foyle	2004	92.5	55.5	50.5	-	198.5
03	Bann	2004	31.0	9.5	37.5	-	78.0
06	Newry, Fane, Glyde & Dee	2006	137.0	92.5	26.0	2.0	257.5
07	Boyne	2006	217.0	205.5	56.5	0.0	479.0
08	Nanny - Delvin	2005	22.5	23.0	70.0	6.5	122.0
09	Liffey & Dublin Bay	2005	148.5	44.0	84.5	8.5	285.5
10	Avoca - Vartry	2006	216.0	48.5	5.5	-	270.0
11	Owenavorragh	2005	40.5	21.0	10.5	-	72.0
12	Slaney & Wexford Harbour	2004	359.5	77.0	11.5	0.5	448.5
13	Ballyteige - Bannow	2004	57.5	19.0	9.5	-	86.0
14	Barrow	2006	319.5	178.5	109.0	6.5	613.5
15	Nore	2004/05	254.0	201.5	61.0	2.5	519.0
16	Suir	2005/06	457.5	142.5	90.0	1.5	691.5
17	Colligan - Mahon	2004	74.0	12.5	2.0	-	88.5
18	Blackwater (Munster)	2005/06	696.0	85.0	26.5	-	807.5
19	Lee, Cork Hbr & Youghal Bay	2005	344.5	30.5	13.5	-	388.5
20	Bandon - Ilen	2006	281.0	9.0	3.0	1.0	294.0
21	Dunmanus - Bantry - Kenmare	2006	327.0	11.0	-	-	338.0
22	Laune - Maine - Dingle Bay	2004/05	352.0	34.0	5.5	2.5	394.0
23	Tralee Bay - Feale	2004/05	249.5	31.5	19.5	-	300.5
24	Shannon Estuary South	2005/06	122.0	94.5	94.5	3.0	314.0
25	Lower Shannon	2005/06	676.5	300.5	80.0	9.5	1066.5
26	Upper Shannon	2005/06	795.5	229.5	114.0	9.5	1148.5
27	Shannon Estuary North	2004/05	202.5	48.5	44.0	1.5	296.5
28	Mal Bay	2006	156.0	11.5	14.5	-	182.0
29	Galway Bay South East	2006	134.0	23.0	16.5	1.5	175.0
30	Corrib	2006	351.5	77.5	36.0	-	465.0
31	Galway Bay North	2006	79.5	11.5	-	-	91.0
32	Erriff - Clew Bay	2005/06	220.5	11.5	24.5	-	256.5
33	Blacksod - Broadhaven	2005	190.5	18.0	7.0	-	215.5
34	Moy and Killala Bay	2005/06	534.0	45.0	16.5	-	595.5
35	Sligo Bay and Drowes	2006	362.5	35.5	20.0	-	418.0
36	Erne	2004	275.5	106.5	50.5	1.5	434.0
37	Donegal Bay North	2005	175.5	13.5	22.0	3.0	214.0
38	Gweebarra - Sheephaven	2006	225.0	18.5	30.0	-	273.5
39	Lough Swilly	2004	133.0	21.0	27.5	1.0	182.5
40	Donagh - Moville	2004	87.5	4.0	12.5	1.5	105.5
Baseline : Current Status (km)			**9451.0**	**2401.5**	**1324.0**	**63.5**	**13240**
Percentages			71.4	18.1	10.0	0.5	
Baseline : Previous Status. (km)*			**9169**	**2364**	**1630.5**	**76.5**	**13240**
Percentages			69.3	17.9	12.3	0.6	
Changes since Previous Survey (km)			**282**	**37.5**	**-306.5**	**-13**	**0**

* Table 2.2 in Toner *et al*., 2005

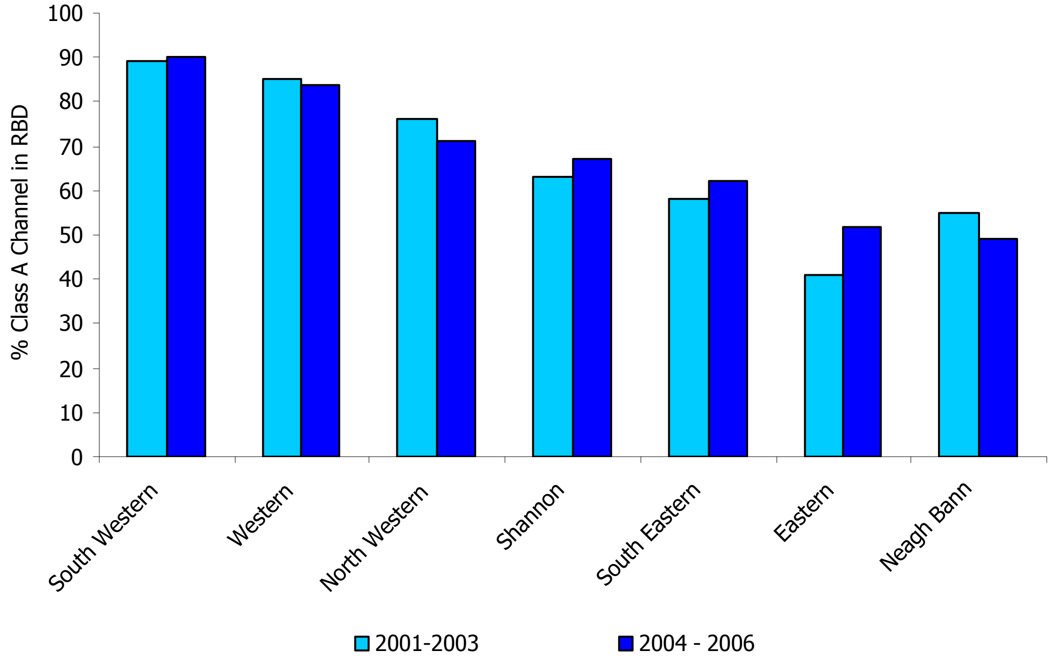


Figure 2.3 The percentage of unpolluted Class A channel in each River Basin District in the State for the 2004 – 2006 survey period compared with the figures for the previous 2001 – 2003 period (Toner *et al*., 2005).

Recent Water Quality Trends in the River Basin Districts:

South-Western RBD With 90 per cent of surveyed river channel in Class A and with results showing a continuous increase over the two previous assessment periods (Fig 2.4a), the South Western RBD is the least polluted RBD in the country. A steady decline is noted in the channel length assigned to Classes B and C. However, serious pollution was recorded on three small streams, the Ownahinchy, Owenalondrig and Milltown (Kerry) by suspected agricultural sources when recently surveyed: the total channel length affected is estimated to be 3.5 kilometres.

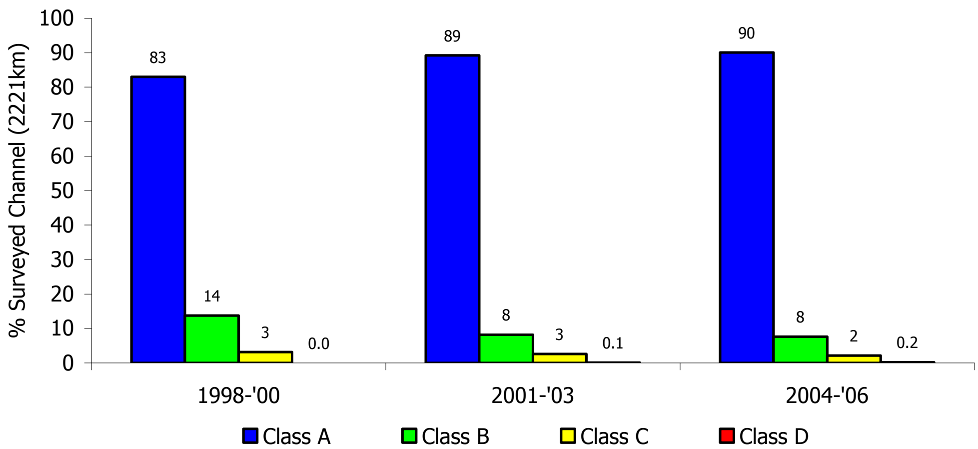


Figure 2.4a River quality in the South Western RBD compared with that recorded in the previous two survey periods.

Western RBD The bulk (84%) of surveyed channel in the Western RBD continues to be of a satisfactory standard (Class A) with all levels of pollution continuing to be well below national averages (Fig 2.4b). Serious pollution has abated in the Loughnaminoo stream below Balla but it was recorded in the Clarinbridge River.

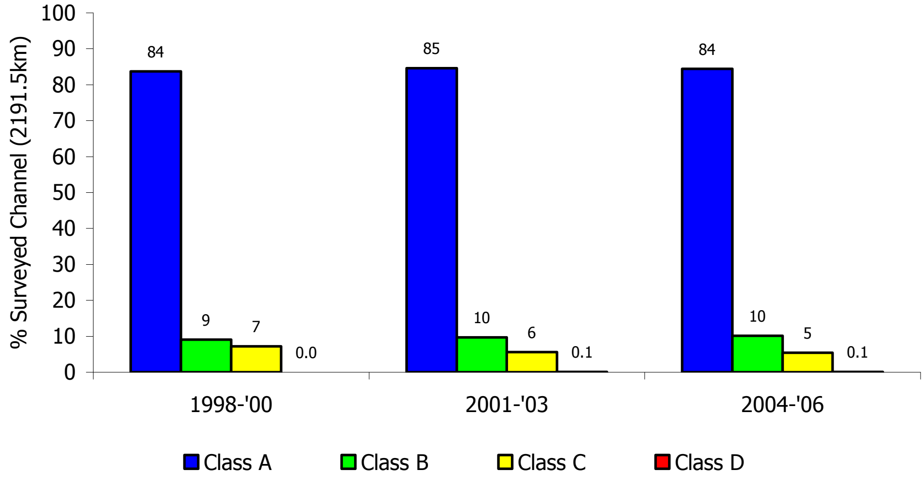


Figure 2.4b River quality in the Western RBD compared with that recorded in the previous two survey periods.

North-Western IRBD A marked reversal (5%) of the increase in the length of unpolluted river channel measured in 2001 – 2003 was noted in the North Western IRBD in the latest survey period (Fig 2.4c). This decrease was accompanied by a corresponding increase in slight pollution and a one per cent increase in moderate pollution. There was, however, a slight decrease in the amount of channel classified as seriously polluted when compared to the 2001 – 2003 period. Serious pollution was recorded in six rivers and streams in the district: Conawary Upper, Erne at Belturbet, Roechrow, Corravaddy Burn, Roosky and Bredagh.

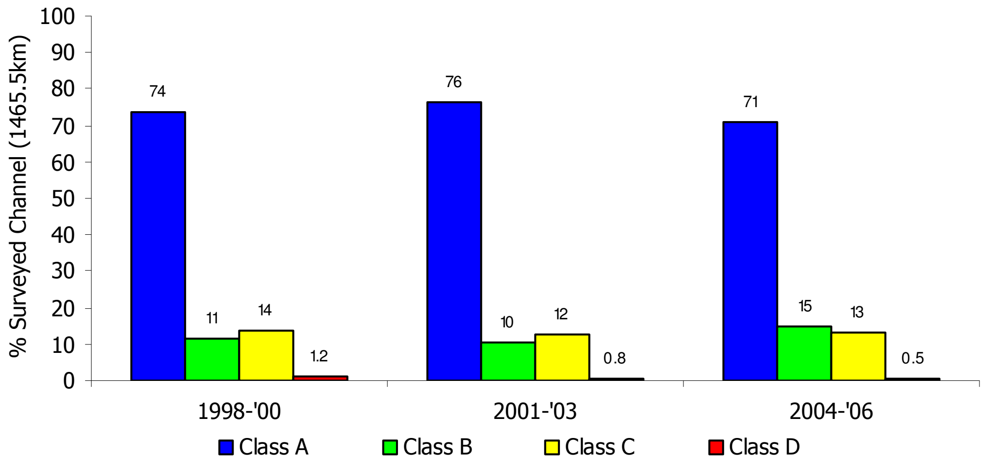


Figure 2.4c River quality in the North Western IRBD compared with that recorded in the previous two survey periods.

Shannon IRBD A substantial increase (4%) in Class A channel and a corresponding reduction in moderate pollution (Class C) was noted in the Shannon IRBD (Fig 2.4d) compared with the previous assessment period. Despite this positive development, however, the extent of water quality impairment remains slightly above the national averages for slight and serious pollution. The latter condition was recorded in eight rivers and streams in the district: Ahavarraga, Broadford, Brosna, Clodiagh (Tullamore), Deel (Newcastlewest), Jiggy (Hind), Lawrencetown Stream and Tullamore.

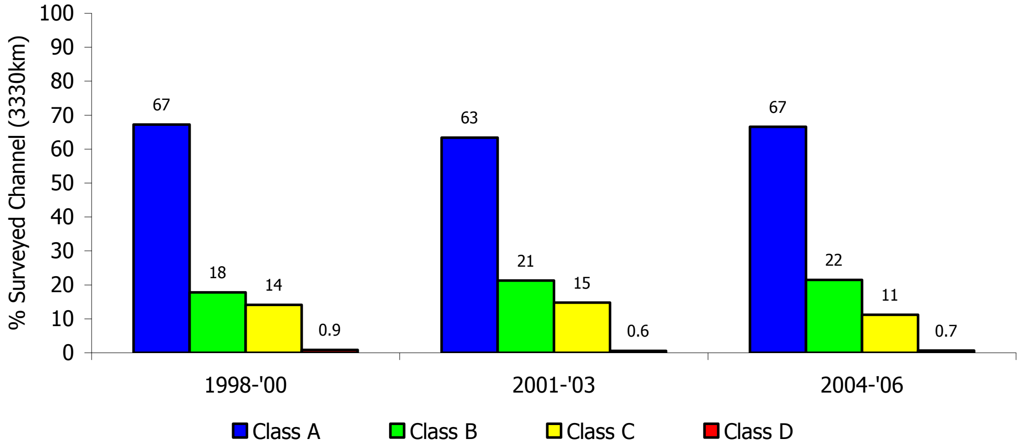


Figure 2.4d River quality in the Shannon IRBD compared with that recorded in the previous two survey periods.

South-Eastern RBD All levels of pollution decreased and a commensurate increase in the unpolluted Class A river channel length was recorded in the South-Eastern RBD in the period under review (Fig 2.4e). Slight pollution/eutrophication however continued to affect a significant length (26%) of channel. Four rivers/streams were seriously polluted when last surveyed: the Glory, Clodiagh (Portlaw), Borrisoleigh and the Garranacool Stream (King's River tributary).

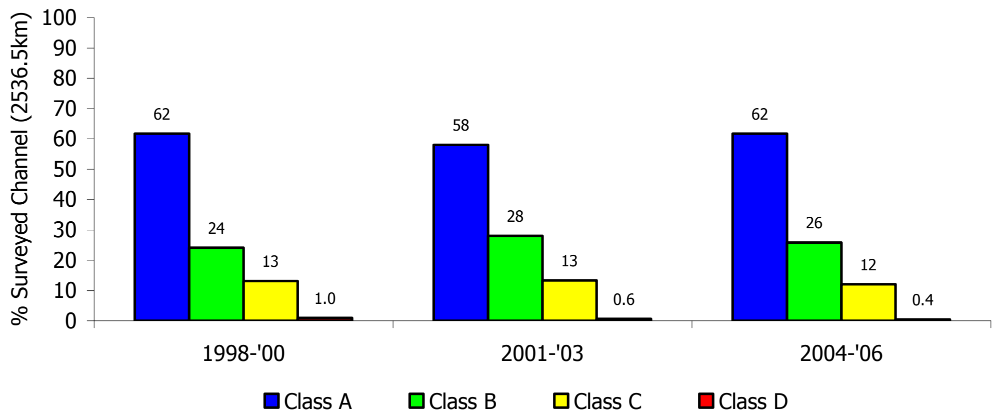


Figure 2.4e River quality in the South Eastern RBD compared with that recorded in the previous two survey periods.

Eastern RBD A very significant increase was noted in the ERBD in the percentage of river channel length in Class A compared with all other river basin district for this sampling period (Fig 2.3). Most notable is the reduction (11%) in the extent of moderate pollution (Class C) in the district (Fig 2.4f): as a consequence there was a significant (11%) increase in Class A unpolluted channel. A significant length of channel (28%) however continues to be affected by slight pollution. The length of channel affected by serious pollution decreased in this survey period but with three rivers (15 km in total) still affected: the Upper Ward (Coolatrath Bridge), the Kilcullen Stream (Yellowbog area) and the Tolka at Finglas.

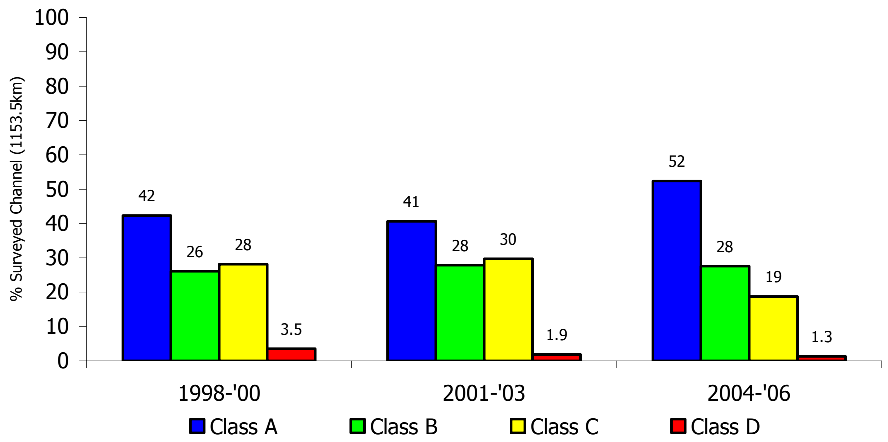


Figure 2.4f River quality in the Eastern RBD compared with that recorded in the previous two survey periods.

A notable improvement in quality was observed at the Avoca River when surveyed in late May 2006, the macroinvertebrate composition was consistent with unpolluted conditions 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).

Neagh-Bann IRBD With 49 per cent only of the surveyed river channel length of this International RBD in the State assessed as satisfactory (Class A), the IRBD performed worst in the national rankings (Fig 2.3). The most notable trend in this district is the very significant (15%) increase in the extent of slight pollution/eutrophication and six per cent decline in Class A channel (Fig 2.4g). The marked reduction in the percentage of river channel classified as Class C (10%) is however, welcome. The Ballymascanlan River was again seriously polluted at Jonesborough as was the upper west branch of the Fane River when sampled in 2006.

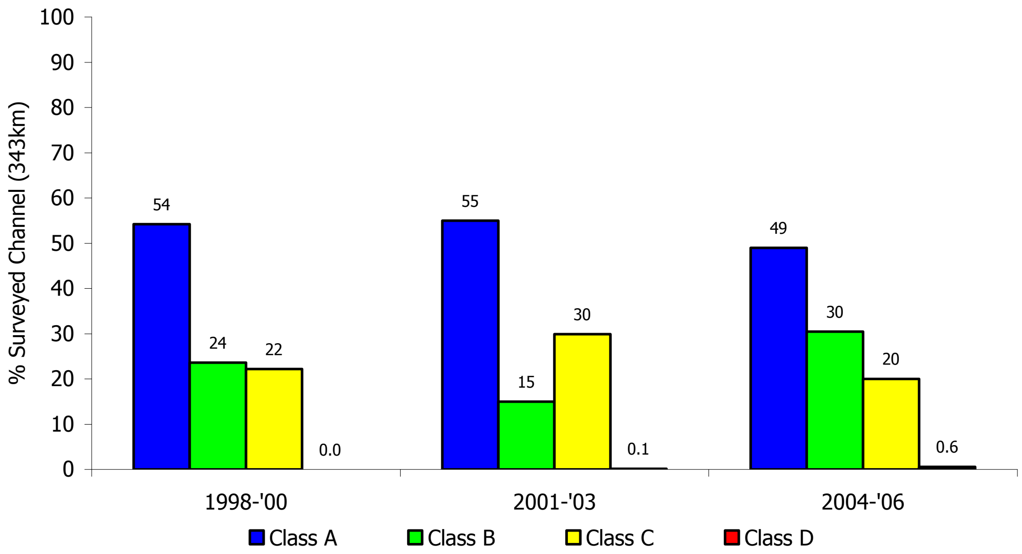


Figure 2.4g River quality in the Neagh-Bann IRBD compared with that recorded in the previous two survey periods.

POLLUTION CAUSES

General Considerations

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 discharges from a farm. In the case of more diffuse pollution a number of approaches are taken to establish 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 or a little more than 66 per cent were classified as unpolluted.

Suspected causes of all observed pollution are summarised in Figure 2.5. In the figure, the category 'Agriculture' includes the various adverse effects of organic pollution and eutrophication caused by diffuse and point sources of agricultural wastes while 'Municipal' includes sewage, waterworks effluent, on-site wastewater treatment systems and diffuse urban inputs. 'Lake Effects' indicates where rivers and streams are being enriched by the outflows from eutrophic lakes.

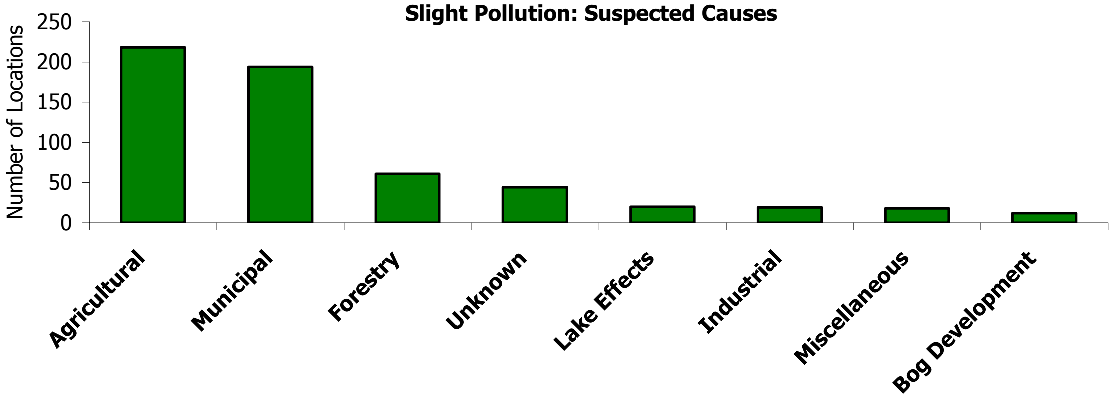
A total of 2985 locations were examined in the period 2004 – 2006, of which 1011 locations were assessed as polluted: 586 slightly, 386 moderately and 39 seriously. The two most important sources of pollution in Irish rivers are from municipal wastewaters and agricultural activities, which account for 38 and 31 per cent respectively of the number of polluted river sites recorded between the categories.

Slight pollution

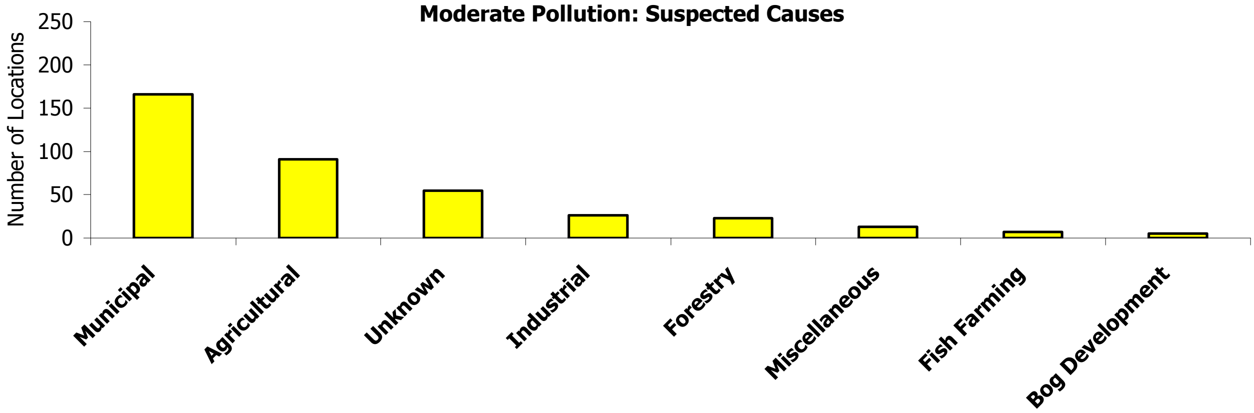
Figure 2.5 indicates that the bulk (218) of the recorded instances of slight pollution can be attributed to agriculture, with municipal sources (194 instances - mostly sewage discharges) and Forestry (61 instances) also featuring prominently. The main effect of these sources is eutrophication (i.e. greatly enhanced plant and algal growth) caused by the plant nutrients nitrogen and phosphorus. Another frequently encountered effect is siltation where the more sensitive species are much reduced by the smothering effects of inert or organic silt from the above-mentioned sources but also from such activities as quarrying, dredging, bog or forestry development and civil works. Eutrophic lake outflows can also have a marked effect on the downstream biota commonly resulting in the severe depletion or elimination of sensitive species.

Moderate Pollution

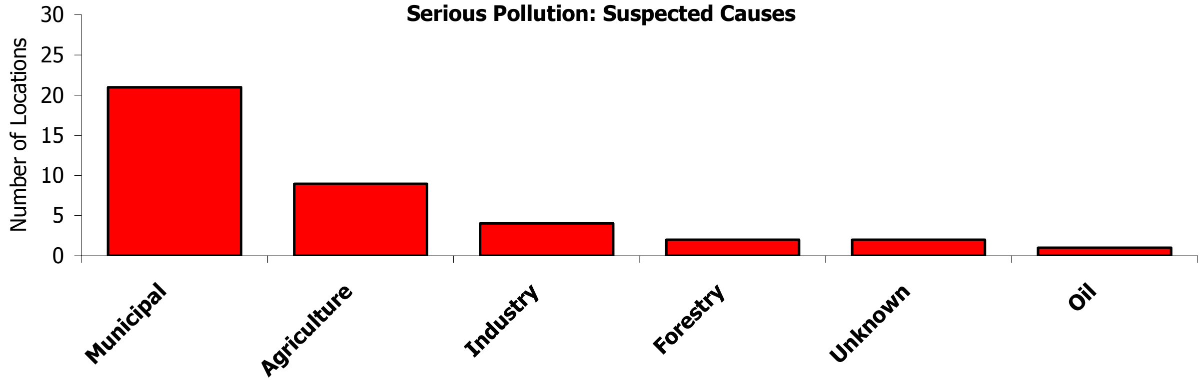
The bulk of recorded instances of moderate pollution could also be attributed to municipal and agricultural sources (166 and 91 instances respectively) and the main effects are intense eutrophication often accompanied by heavy bottom siltation. The majority of instances attributed to 'municipal' sources are locations downstream of sewage discharges from towns but there were also 25 instances attributed to diffuse urban runoff and six to water treatment plant effluent. Watering animals, farmyard runoff and inappropriate slurry spreading (or dumping) are the more commonly encountered causes of moderate pollution from agriculture. Other suspected sources include industrial, forestry, fish farming, bog development, on-site wastewater treatment systems, dredging, highly eutrophic lake outflows, quarries, landfills, civil works, thermal and oil pollution.



'Municipal' include Sewage discharges (160), Diffuse Urban (17), Water Works (8), Domestic/On-site waterwater treatment systems (6), Landfill (3). 'Miscellaneous' include Siltation-quarrying (4), Siltation-unspecified (5), Mining (2), Fish Farming (1), Groundwater (1), Land Clearance (1), Silt + Lake effects (1), Tidal effects (1), Other Unspecified (2).



'Municipal' includes Sewage discharges (129), Diffuse Urban (25), Waterworks (6), Bridge & other Works (2), Landfill (2), On-site wastewater treatment systems (2). 'Miscellaneous' includes Lake effects (4), Siltation-unspecified (4), Oil (1), Thermal (1), Groundwater (2), Mining (1).



'Municipal' includes Sewage discharges (18), Diffuse Urban (2) and Landfill (1).

Figure 2.5 The number of surveyed locations which were polluted either slightly, moderately or seriously in the period 2004 – 2006 grouped by suspected cause.

Table 2.2
Seriously polluted river locations in 2004 –2006 grouped by suspected cause

River Name	Code	St. No.	Location	1st Record* noted	This survey
			SUSPECTED CAUSE: MUNICIPAL		
Fane	06F01	0155	South Br. Dunfelimy	2006	2006
Camac	09C02	0500	Camac Close Emmet Rd	1981	2005
Tolka	09T01	1100	Violet Hill drive	1971	2005
Triogue	14T01	0200	Kyle Br	1971	2006
Tully Stream	14T02	0300	Kilberrin Br	1986	2006
Tully Stream	14T02	0390	Soomeragh Br	2003	2006
Glory	15G01	0045	0.1 km d/s Br N of Kilmaganny	1995	2004
Borrisoleigh Stream	16B06	0600	Br 0.5 km SE of Borrisoleigh	2006	2006
Clodaigh (Portlaw)	16C03	0300	Clonea Br	2005	2005
Ahavarraga Stream	24A02	0400	D/s Drumcolliher	1989	2005
Brosna	25B09	0100	Butler's Br	1971	2005
Clodaigh (Tullamore)	25C06	0220	Just u/s Gorragh R confl	2005	2005
Tullamore	25T03	0400	Br near Ballycowan Br	1971	2005
Jiggy (Hind)	26J01	0090	Br S.W. of Old Workhouse	1987	2005
Clarinbridge	29C02	0300	Br N.W. of Castle Turvin	1980	2006
Tubbercurry[1]	34T02	0050	Br 1 km W. of Tubbercurry	1980	2004
Tubbercurry Stream[1]	34T03	0500	0.1 km d/s old Railway Br	2004	2004
Erne	36E01	1410	Kilconny Belturbet (LHS)	2001	2004
Corravaddy Burn	39C03	0250	Br d/s Cullion Br.	2004	2004
Maggy's Burn[1]	39M01	0300	Just u/s Lough Fern	1973	2004
Bredagh	40B02	0400	Moville Bridge	1987	2004
			SUSPECTED CAUSE: AGRICULTURE		
Greenhill Stream[1]	01G02	0100	Br at Greenhill	1990	2004
Ward	08W01	0070	Coolatrath Br	2005	2005
Brown's Beck Brook	12B03	0200	Br WNW of Donard	2004	2004
Garranacool Stream	15G10	0060	Br SE of Garranacool	2005	2005
Ownahinchy	20O03	0400	Br u/s Ownahinchy Br	2006	2006
Milltown (Kerry)	22M03	0200	Br d/s Glens Br	2004	2004
Owenalondrig	22O01	0500	Br in Foheraghmore	2004	2004
Conawary (Upper)	36C11	0500	Br d/s Greagh Lough Branch	2004	2004
Roosky	40R01	0200	Second Bridge u/s Lough Foyle	1987	2004
			SUSPECTED CAUSE: INDUSTRIAL		
Gowran	14G03	0400	Br at Red Mill (N Channel)	1989	2006
Deel (Newcastlewest)	24D02	0600	D/s Castlemahon Br	1999	2005
Laurencetown Stream	26L07	0500	Bridge near Kylemore Bridge	2006	2006
Laurencetown Stream	26L07	0300	Br NW Ballyhoose (West Br)	1994	2006
			SUSPECTED CAUSE: OTHER		
Ballymascanlan	06B02	0100	Jonesborough Br.	2003	2006
Broadford	27B02	0500	Scotts Br.	2001	2005
Kilcullen Stream	09K02	0800	Br. E. of Yellowbog	2005	2005
Roechrow	37R01	0100	N Br SSW Meenateia	2005	2005
Roechrow	37R01	0200	Br U/S Stragar R. Confluence	2005	2005
Total No. of Locations	**39**				

***1st Record is the year in which serious pollution was first recorded at location in question**
[1] indicates non-baseline streams

Serious Pollution

A total of 39 locations were assessed as seriously polluted in the 2004-2006 period (Table 2.2). Suspected municipal (mostly sewage) discharges account for the bulk (21) of the recorded instances; most of the affected locations have been polluted for a considerable time but in some instances the deterioration is a recent phenomenon. Agriculture is suspected as seriously polluting nine locations in the period under review while industry, forestry, oil and unknown sources are suspected for the remaining instances.

Long-standing instances of serious pollution are evident in the Bredagh River below Moville (since 1987), while the Tubbercurry and Ahavarraga Stream have been seriously polluted on most occasions surveyed. The Brosna (below Mullingar) and Tullamore rivers also have a long history of heavy or serious pollution and although both had been slowly improving in the 1980s and 1990s they had reverted to a condition assessed as serious in 2002. Other recent reversions include the Tully Stream below Kildare, the Glory below Kilmaganny and the Maggy's Burn below Milford. The Roosky river which has a long history of serious pollution continues to be affected upstream of Lough Foyle.

New instances of serious municipal pollution include locations on the west branch of the Fane, Clodaigh (Portlaw) at Clonea Bridge, Clodaigh (Tullamore) River and Corravaddy Burn. New instances of serious pollution resulting from agricultural activities were recorded on the Brown's Beck Brook near Donard (Wicklow), Owenahinchy (Cork), Miltown (Kerry) and Owenalondrig (Kerry).

A total of 33 stations had recovered from serious pollution recorded in the previous 2001-2003 period (Table 2.3). The majority (21) continued to be moderately polluted, five achieved 'slight pollution' status with six achieving full recovery: these are the Gowran at Freneystown, Brogeen, Owendalulleegh, Tullinteane, Donagh and Avoca. In the case of the Donagh River the recovery is attributed to a new waste water treatment works where as in the Avoca the improvement was, only temporary, with the 11.5 km stretch of river once again classified as seriously polluted when assessed in 2007 (EPA, unpublished data).

As previously stated there has been a major reduction in the length of channel assessed as seriously polluted – from 112 km in 1998-2000 to 76 km in 2001-2003 with a further reduction noted in the 2004 - 2006 period (63.5km). Figure 2.6 shows the trend in suspected causes of serious pollution over time. A decrease in the amount of river channel classified as seriously polluted was observed in the ‘municipal’, industrial’ and ‘other’ categories of attributed causes. An increase however in the amount of river channel seriously polluted by agricultural activities was noted in the latest survey period (15 km) when compared to the 2001 to 2003 period (5.5 km).

Table 2.3

Rivers in which serious pollution has recently (2004 – 2006) abated or partially abated, also showing current status

River Name	EPA Code	Length km	Station Location	Class D in year	Class in 2004 - '06
Avoca**	10A03	11.5	Avoca Bridge	2002	A
Gowran	14G03	1.5	Br E of Freneystown	2003	A
Brogeen	18B06	1.0	Br N of Islandav	2003	A
Owendalulleegh	29O01	5.5	Ford at Tooraglassa	2003	A
Tullinteane	37T01	0.5	Just u/s Oily River confl	2002	A
Donagh	40D01	3.5	2 Stations d/s Carndonagh Bridge	2001	A
Cappanacloghy	15C06	22.0	Br E of Clooncullen	2001	B
Halfway House Stream	16H02	0.5	Br to NW of Halfway Ho	2003	B
Lee (Tralee)	23L01	*	Ahnambraher Br (RHS)	2001	B
Loobagh	24L01	1.0	North Br d/s Kilmallock	2002	B
Lough Naminoo Stream	34L04	1.0	Br 600 m d/s Samp Stat 0100	2001	B
St Johnston[1]	01S01	n/a	Second Bridge u/s Foyle River	2002	C
Nanny (Meath)	08N01	3.0	Folistown Br	2001	C
Painestown[1]	09P01	n/a	Bridge in Kill Village	2002	C
Santry	09S01	7.0	Clonshaugh Rd Br	2002	C
Aughboy (Wexford)	11A02	2.0	Br NE of Middletown Ho	2001	C
Figile	14F01	2.5	Br S of Ticknevin Br	2003	C
Slate	14S01	2.0	Quigley's Br	2003	C
Cappanacloghy	15C06	1.0	Br S of Coole	2001	C
Nore	15N01	0.5	Thomastown Br (LHS)	2001	C
Blackwater (Munster)	18B02	*	Fermoy Br (LHS)	2003	C
Bride (Lee)	19B04	0.5	Br at Crookstown RHS	2003	C
Graney (Shannon)	25G04	3.0	400 m d/s Scarriff Br	2003	C
Silvermines Stream[1]	25S10	n/a	d/s Silvermines complex	2002	C
Rhine	26R04	1.5	Br N of Cartron	2002	C
Magherarney	36M01	1.0	Magherarney Br	2001	C
Aighe	38A03	1.0	Br NNW of Cashel	2003	C
Keel Lough Stream	38K01	1.0	1.2 km u/s Crolly Bridge	2003	C
Murlin	38M03	1.0	2 Stations in the Glencolumbkile area	2003	C
Tullaghobegly	38T01	1.5	Ford 1.5 km d/s Lough Altan	2003	C
Roosky	40R01	1.0	First Bridge u/s Lough Foyle	2001	C
Totals		**66.0**	Kilometres		
		33.0	Stations		

* indicates less than 0.5km affected by the pollution
**temporarily improved however returned to serious pollution status shortly afterwards
[1]Indicates non-baseline streams (not used in calculations of percentage channel length).

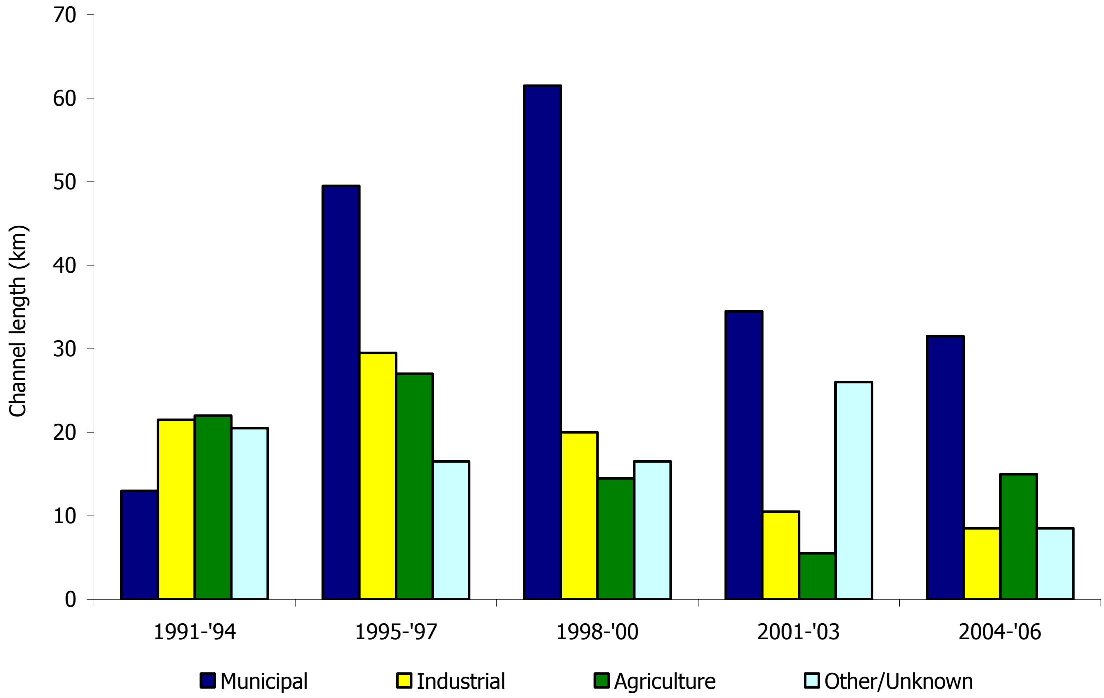


Figure 2.6 Serious pollution - Trends and suspected sources in five survey periods. Total Channel length 77, 122, 112.5, 76.5 and 63.5 km respectively.

FISH KILLS

Fish mortality in rivers is reported as “kills” if there is a strong suspicion that the death is pollution related or otherwise unnatural. Death due to natural causes, for example older salmon die naturally after spawning, are not counted as kills. The total numbers of reported fish-kills in freshwaters (rivers and lakes) in the period under review is 122 compared to 147 in the previous period (T. Champ, Central Fisheries Board (CFB) pers. comm.). A comparison with data from previous periods is given in Figure 2.7, reported kills in each period are grouped under five main headings denoting the likely causes.

Fish kills attributed to enrichment and induced deoxygenation are likely to be of anthropogenic origin, figures under these headings were proportionally re-distributed to the most obvious primary sources (agriculture, sewage and industry). On the basis of this assumption it is possible that in the period under review, agriculture was responsible for some 34 fish kills, with 28 attributed to sewage and 15 to industry.

The historic data (Figure 2.7) show a marked upsurge in fish kills between the 1970s and late 1980s/early 1990s, which was largely attributed to an eight-fold increase in kills due to agriculture. In response to this alarming situation, a public information campaign was launched by the government in the late 1980s and a campaign of vigorous enforcement was undertaken by local authorities and by the Central and Regional Fisheries Boards. These measures were primarily aimed at the agricultural sector and were very successful in combating the problem as the figures for the early years show: thus, between the 1989-91 and 1992-94 periods, the kills attributed to agriculture dropped by roughly one-third (35%) but those due to industry fell by almost twice this rate (61%) and to sewage by even more (76%).

This encouraging trend was reversed in 1995-97, however, when total reported kills increased by 49 per cent. Since then there have been further improvements with yearly totals of 43, 45 and 32 being reported for the current period. Although the situation seems to have stabilised the number of reported fish-kills remains unacceptably high and demands a renewal of radical measures to redress the situation. Notwithstanding the overall reductions in fish kills in recent years there has been a marked increase in such incidents attributed to sewage discharges since the 1998 – 2000 assessment period.

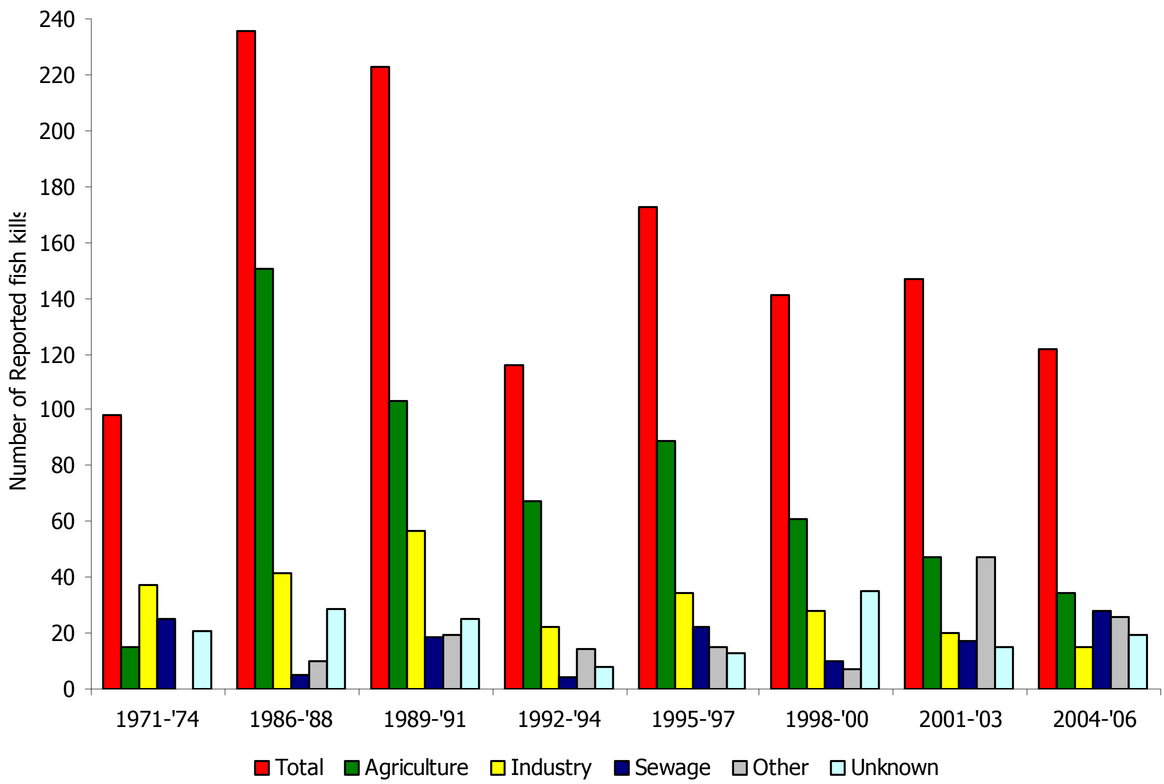


Figure 2.7 Number of reported fish kills and suspected causes for the period 2004 – 2006. The corresponding data for the six previous periods and 1971 – 1974 are shown to indicate trends.

QUALITY IN DESIGNATED SALMONID WATERS

This section presents an overview of the quality of salmonid waters monitored in the context of the European Communities (Quality of Salmonid Waters) Regulations of 1988 (Minister for the Environment, 1988). These regulations implement the Freshwater Fish Directive (CEC, 1978) and specify a range of water quality parameters to be monitored in the following designated waters:

Aherlow, Argideen, Munster Blackwater, Boyne, Bride (Waterford), Brown Flesk, Castlebar, Corrib (including Lough Corrib), Corroy, Dargle, Deel (Crossmolina), Feale, Fergus, Finn (Donegal), Glashagh (Lower), Glashagh (Upper), Glore (Mayo), Gweestion, Leannan, Lee (Cork), Lurgy, Maggy's Burn, Maine, Manulla, Moy, Mullaghanoe, Nore, Owengarve (Sligo), Slaney, Spaddagh, Swilly, Trimoge, Vartry and Yellow (Foxford).

The parameters required under the Salmonid Regulation include temperature, pH, BOD_5, Dissolved Oxygen, Suspended Solids, Total Ammonium, Non-ionised ammonia, nitrites, dissolved copper, total zinc, Phenolic compounds, petroleum hydrocarbons and total residual chlorine. A more detailed discussion of the Freshwater Fish directive is given in Clabby *et al.*, (1992).

Information pertaining to the 2004-2006 period is available for most of the specified parameters with the exceptions of phenols, petroleum hydrocarbons and residual chlorine. These parameters would normally be associated with discrete pollution events, which would be recorded separately and, generally speaking, it is unlikely that the designated waters would suffer from these pollutants. Data for suspended solids were generally not available and consequently this parameter is not dealt with here. ***The information below should not be taken, however, as indicating a definite compliance or non-compliance under the Regulations as it is based on a composite 3-year data set rather than on an annual set as would be provided by local authorities when making their official returns under the Freshwater Fish Directive.*** It is, rather, an indication of waters that are most likely to have breached the Regulations on the basis of the data supplied for the three-year period.

Table 2.4 summarises the overall situation in 2004-2006 showing those rivers that were or were not compliant for the parameters shown. Details as to the specific river locations where standard limits were exceeded are given in Appendix II.2. As indicated in Table 2.4, nine of the 34 designated rivers were likely to have been in compliance with all of the parameters for which sufficient data are available; these rivers include the Deel (Crossmolina), Glore (Mayo), Gweestion, Manulla, Moy, Owengarve (Sligo), Spaddagh, Trimoge and Yellow (Foxford).

Exceedances of prescribed limits were recorded for DO in three rivers, BOD in six, Total Ammonium in three, Un-ionised Ammonia in one, Nitrite in twenty-three, Total Zinc in two and Dissolved Copper in five rivers. The large majority (77%) of the 167 recorded exceedances were in relation to Nitrite (NO_2). Nitrite exists normally in very low concentrations (<0.03mg/l NO2) in unpolluted waters, mainly because nitrogen will tend to exist in the more reduced (ammonia) or more oxidised (nitrate) forms, therefore higher concentrations may indicate sewage pollution. BOD and total copper exceedances each accounted for 6 per cent of the total number of exceedances (Table 2.4).

Copper exceedances were higher in this period – ten in just five rivers with even fewer Total Zinc exceedances - one in the Dargle and one in the River Slaney. It should be noted that both copper and zinc have sliding threshold values under the Regulations depending on the hardness range of the water since toxicity reduces as water hardness increases. Thus, it is necessary to have accompanying hardness values in order to evaluate the true situation regarding compliance with the Regulations. In some cases it was necessary to estimate hardness values due to lack of data and this may have affected the final number of ‘exceedances’.

Table 2.4
Summary of numbers of recorded parameter exceedances in the 34 designated salmonid rivers in the period 2004 – 2006. Exceedances were not recorded in those rivers shown in bold.

River Name	DO	BOD	Suspended Solids	Total Ammonia	Un-ionised Ammonia	Nitrites	Dissolved Copper	Total Zinc
Aherlow						4		
Argideen						6		
Blackwater (Munster)						18		
Boyne						21		
Bride						7		
Brown Flesk							2	
Castlebar						1		
Corrib (incl. Lough Corrib)						1		
Corroy						1		
Dargle						2	1	1
Deel (Crossmolina)								
Feale		1				1	3	
Fergus	6	2						
Finn (Donegal)		3				5		
Glashagh (Lower)						1		
Glashagh (Upper)						1		
Glore (Mayo)								
Gweestion								
Leannan						4		
Lee (Cork)						6		
Lurgy		1		1		2		
Maggy's Burn						2		
Maine	1	2	1	1		6		
Manulla								
Moy								
Mullaghanoe						1		
Nore	2					18		
Owengarve (Sligo)								
Slaney						14	3	1
Spaddagh								
Swilly		1	1	2	1	4		
Trimoge								
Vartry						3	1	
Yellow (Foxford)								
No. of exceedances (Total 167)	**9**	**10**	**2**	**4**	**1**	**129**	**10**	**2**
% of exceedances	**5**	**6**	**1**	**2**	**1**	**77**	**6**	**1**
No. rivers breeching parameter	**3**	**6**	**2**	**3**	**1**	**23**	**5**	**2**

OXIDISED NITROGEN/NITRATE LEVELS

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.

Ireland has 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 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.

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 (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.

Agricultural fertilisers and farmyard wastes have been identified as the chief causes of nitrate enrichment of waters in many countries in Europe prompting the adoption of the Nitrates Directive by the EU. Nitrate concentrations in waters have been receiving much public notice recently in Ireland due to the implementation of the European Communities Good Agricultural Practice for the Protection of Waters Regulations (S.I. No. 788 of 2005) relating to the Nitrates Directive (CEC 1991a). Direct waste discharges, such as sewage, may also contribute significantly to such contamination. The EU Directive on urban waste water treatment (CEC, 1991b) provides for the removal of nitrogen from such waste in certain circumstances.

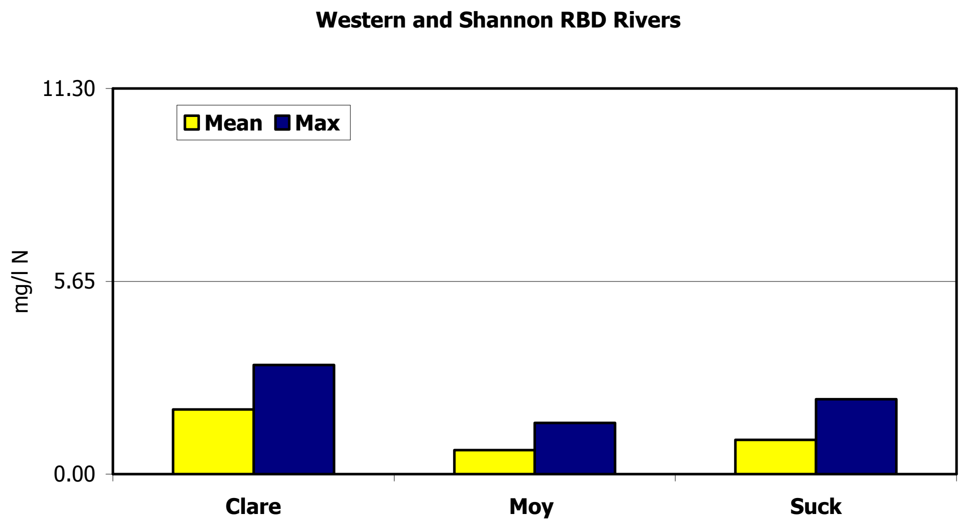
In certain areas of Ireland, e.g. the south-east, where there is a greater than average proportion of the land under tillage, the possibility of excess nitrate loadings on surface waters and groundwaters is increased. Neill (1989) has shown a positive correlation between the nitrate levels in the rivers in this area and the proportion of the land in the catchments under tillage. This correlation is due both to the relatively intense application rates of fertilisers in such areas and to the relative ease with which nitrate is leached from arable land. An assessment of the current significance of nitrate contamination in Irish surface waters is presented here (Fig. 2.8) on the basis of a comparison of the total oxidised nitrogen (TON)* levels in the larger rivers in the south-eastern with those in the western part of the country as these areas may be considered, respectively, as areas where waters are at high and low risk of contamination.

The data shown in Figure 2.8 compare the annual means and maxima recorded in the Clare, Moy and Suck in the west of the country with those in the Barrow, Nore and Suir rivers in the south-east for the period 2004 - 2006. They thus give a general nitrate overview of the levels to be expected in the larger rivers in the two areas. The figure clearly shows the contrast between the two regions with values in the south-east being significantly higher than in the Western and Shannon RBDs where maximum values are generally typical of un-impacted or just slightly impacted waters (viz. from 1 to 3 mg/l N). As noted in previous reviews and above, the higher nitrate levels in the rivers of the south-east reflect the differences in respect of land use, particularly the extent of tillage in the two areas.

In order to track nitrate trends in the south-east as representative of an area where contamination is significant, the average annual median and maximum values recorded over the period 1979-2006 in four of the larger rivers in the region are presented in Figure 2.9. In this figure, the three-year rolling averages are used in order to smooth out year to year variations. The data show that while annual average median concentrations in these rivers have not exceeded EU Guideline limit values at any time the recorded maxima have exceeded this limit on several occasion in the Barrow and Slaney and more recently in the 2004-2006 period on the River Suir. The trend that emerges is one of a gradual increase in average concentrations in each of these rivers until the 1996-1998 period when values started to fall slightly until the 1999-2001 period where an increasing trend occurs up until the 2002–2004 period. The latest trend in the 2003–2005 and 2004-2006 periods demonstrates an increasing average concentration of nitrate on all four rivers examined.

* TON is the sum of nitrate and nitrite. As nitrite is usually present in very small concentrations, the TON value can be taken as approximating the nitrate concentration. For analytical convenience measurements are usually confined to oxidised nitrogen unless specific information is required on nitrite.

In summary the most recent oxidised nitrogen data indicate that while individual breaches of the EU guideline limit have been recorded in the period under review, nitrate concentrations in Irish surface waters are generally well within the mandatory limit set for abstraction and drinking waters. The trend of increasing average median and maximum nitrate levels in the rivers of the south-east in the latest survey period is a situation that will need attention.



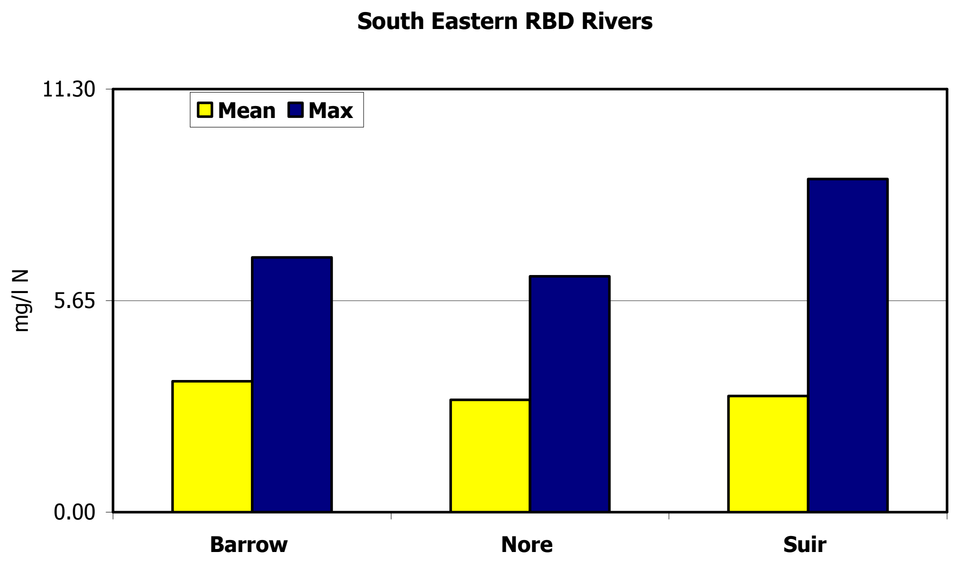


Figure 2.8 Nitrate concentrations in the larger Western/Shannon and South-Eastern RBD rivers compared. Figure shows average and maximum concentrations recorded and the number of samples analysed by EPA in the period 2004-2006. The EU maximum and guideline limits for nitrates in waters abstracted for potable supply are shown for reference. Values in unimpacted rivers seldom exceed 2 mg/l.

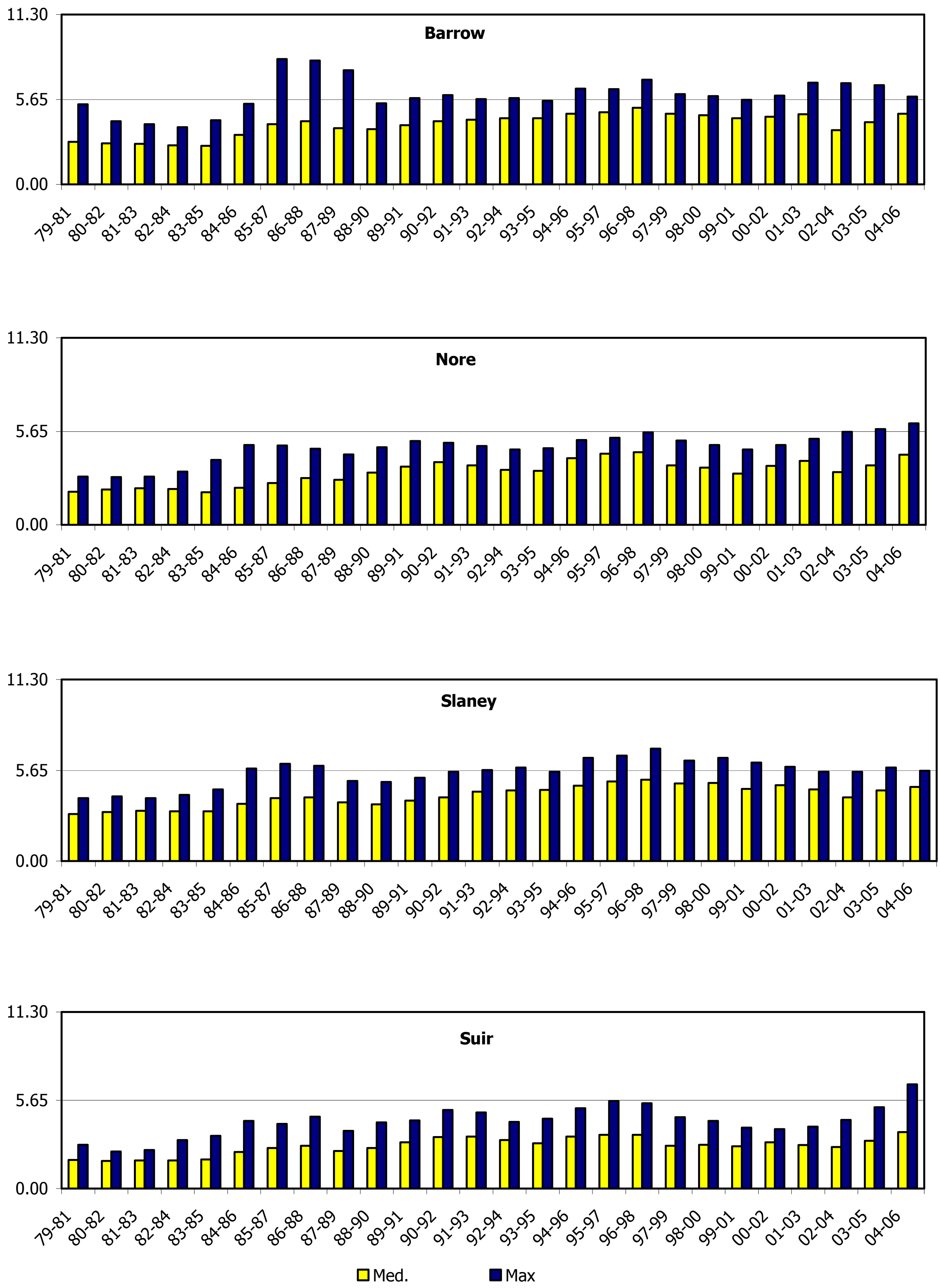


Figure 2.9 Three year rolling averages of the annual median and maximum concentrations of oxidised nitrogen in the main rivers in the south east in the period 1979 to 2006 in relation to the EU maximum (11.3mg/l N) and guideline (5.65mg/l N) limits for nitrate. Data are for the sampling stations showing the highest values for these annual statistics in each case

DANGEROUS SUBSTANCES MONITORING

Due in part to the lack of a heavy chemical industry and, until recent decades, the absence of intensive agriculture in Ireland, monitoring for dangerous substances was confined to occasional surveys and some screening of drinking water abstraction points. The chief targets for subsequent 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) (Minister for the Environment and Local Government, 2001). The results of surveys showed that most of these compounds were generally either absent or else present at very low concentrations.

To assist in the implementation of the WFD, in 2005 a project was undertaken to identify nationally relevant pollutants to be included in the WFD 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 present at significant concentrations. 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.

WATER QUALITY OF CANALS AND THEIR FEEDER STREAMS

Introduction

Canals are important amenity areas for leisure activities, such as boating and coarse fish angling, and provide a habitat for many wildlife species including aquatic plants, invertebrates, fish and birds. Conservation species such as the white-clawed crayfish (*Austropotamobius pallipes*) and the otter (*Lutra lutra*), protected Annex II species under the Habitats Directive (CEC, 1992), are also found in the canals. As habitats of national importance the Grand and Royal Canals have been designated as proposed Natural Heritage Areas (NHAs) under the Wildlife (Amendment) Act, 2000.

Waterways Ireland is responsible for the management, maintenance, development and restoration of the inland navigable waterway system throughout the island of Ireland, principally for recreational purposes. It is currently responsible for the Barrow Navigation, the Erne System, the Grand Canal, the Lower Bann Navigation, the Royal Canal, the Shannon-Erne Waterway and the Shannon Navigation. The water quality monitoring of those canals in the Republic of Ireland, for which Waterways Ireland is responsible, is carried out by the Central Fisheries Board (CFB).

The first systematic water quality survey of the major canals in the Republic of Ireland was undertaken in the 1990-1994 period (Caffrey and Allison, 1998) and sampling has been continued since then by the CFB which undertook surveys in the current period of reporting. The results, which were gleaned from reports to Waterways Ireland from CFB cover July 2003 to December 2004 (Central Fisheries Board, 2005), 2005 (Central Fisheries Board, 2006) and July 2006 to June 2007 (Nicola O'Gorman, pers. comm.). In addition an analysis of the data for the period July 2003 to June 2006, carried out by CFB, has been provided by Waterways Ireland. The following summary of water quality in canals has been taken from these reports.

Sampling Sites and Parameters

The CFB water-quality monitoring programme for Waterways Ireland covers the Royal and Grand Canals, the Barrow Navigation and the Shannon-Erne Waterway (Figure 2.10). In total 224 sites are monitored three times a year. For sampling purposes, the canals and waterways are divided into the following sections:

Royal Canal	**Number of Canal Sampling Sites**	**Number of Feeder Sampling Sites**
Royal Canal East (Mullingar to Dublin)	21	9
Royal Canal West (Mullingar to Ballybrannigan Harbour (western limit of navigation in Co Longford))	10	7

The main feeder for the Royal Canal, the Lough Owel supply, enters at Mullingar (Co. Westmeath)) and from this summit point the canal flows west to the River Shannon and east to Dublin.

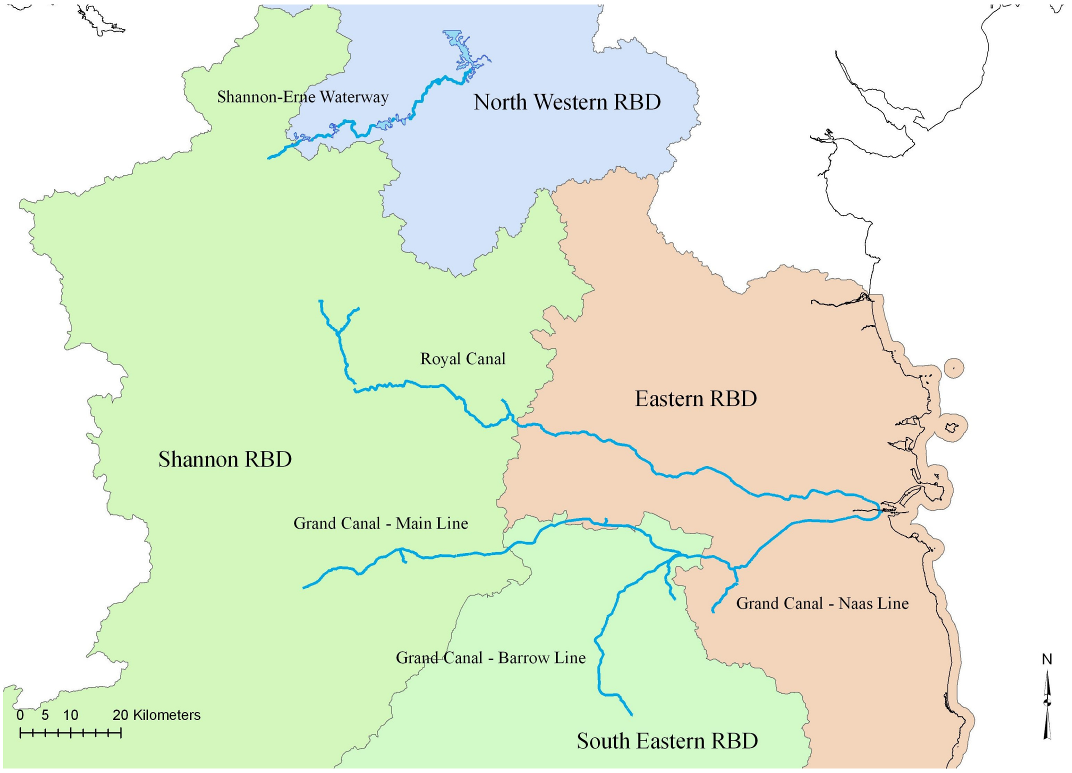


Figure 2.10 Map showing Royal Canal, Grand Canal (including Barrow and Naas lines) and Shannon – Erne waterway with River Basin Districts (RBDs) through which they traverse (Map courtesy of Waterways Ireland).

Grand Canal	**Number of Canal Sampling Sites**	**Number of Feeder Sampling Sites**
Grand Canal East (Lowtown to Dublin)	11	3
Grand Canal West (Lowtown to Shannon Harbour)	19	7
Grand Canal Barrow Line (Lowtown to Athy)	12	7
Grand Canal Naas Line	4	1

The summit point on the Grand Canal is at Lowtown (Co. Kildare), where the Milltown feeder enters, from where the canal flows west to Shannon Harbour, east to Dublin and south to Athy (Barrow Line). At Athy the Barrow Line connects with the Barrow Navigation.

Barrow Navigation	**Number of Sampling Sites**
Barrow Navigation	27
Barrow Navigation Tributaries	35

For the purposes of the Canal water quality monitoring programme, the Barrow Navigation starts at Athy and continues to St Mullins, comprising a channel length of some 65 km. A large number of feeders discharge into the Barrow Navigation, which, for present purposes are referred to as tributaries.

Shannon-Erne Waterway	**Number of Sampling Sites**
Lake	22
River	24
Canal	5

The summit point of the Shannon-Erne Waterway is Lough Scur (Co. Leitrim) from where the waterway flows east to join the River Erne, at a point downstream of Belturbet and west in a short length of canal to the River Shannon at Leitrim village.

In the sampling programme 14 parameters are measured. Table 2.5 lists the limits, for seven parameters, which have been tentatively set by the CFB for assessing canal quality. The three main parameters used in the assessment of water quality of the canals are Molybdate Reactive Phosphate (MRP), Total Phosphorus (TP) and Faecal Coliforms (FC). Phosphorus is the nutrient directly linked to productivity in the canals. MRP is a measure of the phosphorus fraction or component that is most readily available for uptake by plants. Additionally, the CFB uses the Quality of Bathing Water Regulations, 1992 (S.I. No. 155 of 1992) as a surrogate for secondary contact recreational activities (e.g. boating, angling and canoeing). This stipulates that bathing waters must conform to a standard of 1000 faecal organisms per 100 ml of water in 80 per cent or more of samples. Since 2005 chlorophyll concentrations have been measured at a number of sites along the canals as a parameter for assessing trophic status (See Table 3.2, in Chapter Three, for scheme of classification used for lakes). Figures 2.11 and 2.12 illustrate the annual mean values for six of the parameters (TP, MRP, TON, Chlorophyll, Total and Faecal Coliforms) in the Grand Canal and Royal Canal sections in the period 2004-2006.

Table 2.5

Maximum limits for parameters tentatively used by the Central Fisheries Board for assessing canal water quality

Parameter	Maximum Limit Value
Total Phosphorus (TP)	0.063 mg/l P
Molybdate Reactive Phosphate (MRP)	0.02 mg/l P
Total Oxidised Nitrogen (TON)	11.3 mg/l N
Dissolved Oxygen (DO)	>5 mg/l O2
Biochemical Oxygen Demand (BOD)	<6 mg/l O2
Total Coliforms	5000/100 ml
Faecal Coliforms	1000/100 ml

Survey Results

Royal Canal East - Mullingar to Dublin The water quality in this section was generally satisfactory with nutrient levels relatively low. However, in October 2004 elevated faecal coliform levels, below the limit set for safe recreational use, were recorded at some sites, reflecting inputs from contaminated feeders. In 2005 a discharge to an inflow at Kilcock Harbour did lead to some localised pollution but, despite investigative monitoring by CFB and Kildare County Council, the source of the discharge was not identified. Faecal Coliform bacterial levels breached the set standard in 2006, and elevated levels were also recorded in some feeder streams. Chlorophyll measurements made in 2005 and 2006 were generally indicative of mesotrophic status with the exception of February 2006 when two of the five sampling sites exhibited elevated levels (Figure 2.12).

Royal Canal West - Mullingar to Ballybrannigan Harbour (Co. Longford) The water quality in this section was generally satisfactory (Figure 2.11). Faecal coliform levels were, however, elevated at one site in October 2004 and again in February 2005 due to a discharge to an inflow at Mullingar. In 2006 water quality was of a high standard with no breaches of nutrient or coliform limit values on any sampling occasion. Chlorophyll measurements made in 2005 and 2006 were indicative of mesotrophic to oligotrophic status (Figure 2.12).

Grand Canal East - Lowtown to Dublin With a few exceptions the water quality was good in this section (Figure 2.11). In October 2005 the MRP limit value was exceeded at Baggot Street

Bridge and the TP limit was exceeded at two other sites. Two feeder streams, the Monread and the Morrell rivers, also breached the MRP standard. Although bacteriological results indicated generally satisfactory conditions overall in the 2004-2006 period, the Monread feeder was grossly polluted on a number of occasions. Chlorophyll measurements made in this reach of the canal in 2005 and 2006 were indicative of oligotrophic status (Figure 2.12).

Grand Canal West - Lowtown to Shannon Harbour While this section of the canal had low bacteriological levels throughout the period, some of its feeder sources exceeded the set limits. With the exception of an MRP breach in February 2005 all other parameters were within the set limits in that year. Elevated TP and MRP values have been recorded in this section during the period, which have been attributed to the Ballymullen and Ballylennon feeders. Chlorophyll measurements made in 2005 and 2006 were indicative of oligotrophic status (Figure 2.11 & 2.12).

Grand Canal Naas Line Generally good water quality was recorded in this section during the period despite it exhibiting the highest, though modest (less than one-third of the set limit), mean annual TON levels. Mean MRP levels were well below the limit. Chlorophyll values indicated a moderate degree of enrichment in 2005. Of the five monitoring sites two had elevated total coliform counts on a number of occasions (Figure 2.11 & 2.12).

Grand Canal Barrow Line - Lowtown to Athy A number of serious breaches of the total coliform limit were recorded in this section and attributed, for the most part, to discharges to an inflow at Athy. Mean MRP levels were generally below the limit but were elevated in February 2005 following rainfall, which increased agricultural run-off to the canal feeders. Mean faecal coliform counts breached the threshold level also on the same date in the Pluckerstown feeder (Figure 2.11 & 2.12).

Barrow Navigation Less than good water quality, in relation to coliform numbers and phosphorus levels, was recorded during monitoring of the Barrow and its tributary sites in the period. The highest TP value (0.18 mg/l P) was recorded downstream of Clogrennan Lock while a high MRP value (0.14 mg/l P) was measured near the sewage treatment plant at Graiguenamanagh. Annual mean values for total and faecal coliforms breached the threshold levels in all years over the range of sites.

Shannon-Erne Waterway This waterway is unique in that it comprises three different physical site types (canal, lake and river) so that the assessment criteria are slightly different; but with the same thresholds applying for the canal and lake sites. Physico-chemical results during the monitoring period indicated good water quality overall. Results for the canal sites revealed that the highest annual means for TP and MRP occurred in 2004 when 0.05 mg/l P and 0.013 mg/l P respectively were recorded. Mean annual TON values were low overall ranging from 0.13 mg/l N in the lake sites to 0.29 mg/l N in the river sites. Total and faecal coliform results were indicative of good water quality particularly in relation to the lake and canal sites. Chlorophyll levels recorded from the canal and lake sites indicated a mesotrophic status.

Overall Water Quality of Canals and their Feeder Streams

Water quality monitoring over the period 2004-2006 indicated generally good water quality in the Royal and Grand Canal systems and in the Shannon-Erne Waterway. Breaches of the limits used for assessment by the CFB, in relation to nutrients and Coliform bacteria, occurred in all water bodies to a greater or lesser extent during the period of reporting. The majority of breaches in the Royal and Grand Canals were attributed to a small number of feeder streams that caused localised pollution problems. The Barrow Navigation exhibited unsatisfactory water quality throughout the sampling programme, as evidenced by the high incidence of bacteriological contamination and elevated phosphorus levels.

Breaches of the set limits for water quality during the reporting period were mainly due to exceedance of phosphorus (as measured by TP and MRP) and microbiological (total and faecal coliforms) limits.

Nitrogen levels were below the limit at all sampling locations over the current monitoring programme.[*] Of the canal sections the lowest ranges in annual mean values for the period 2003-2006 were recorded in the Royal Canal, both East (0.58-1.58 mg/l N) and West (0.33-1.89 mg/l N) of the summit, while the highest were in the Grand Canal Naas Line (2.56-3.18 mg/l N). The Barrow Navigation showed a range of 3.76-5.57 mg/l N in the same period with some tributaries even breaching the relatively high limit. Analysis of results showed a seasonal pattern in nitrogen concentrations, with generally higher levels in winter months compared with the summer

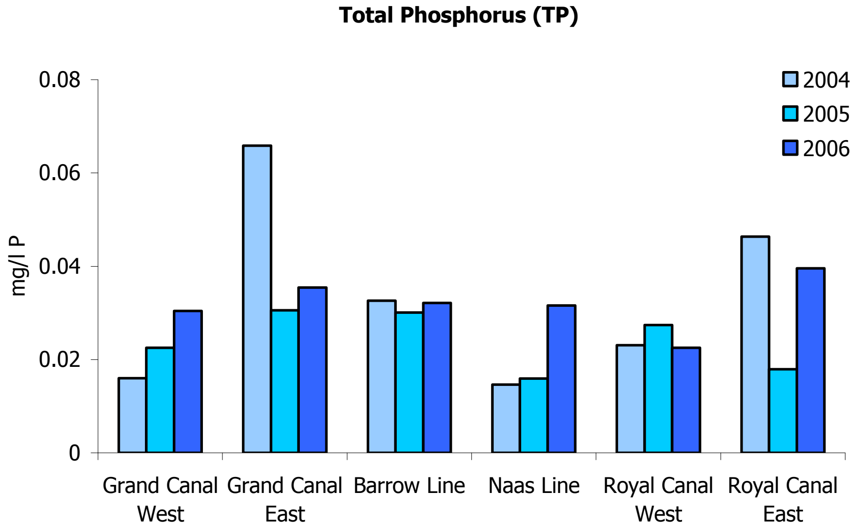
[*] The Total Oxidised Nitrogen (TON) limit tentatively used for canals would seem to be set far too high. In the absence of known ecological standards the EU maximum limit for nitrate in abstracted water for human consumption, 11.30 mg/l N, has been used. A maximum limit of 2 mg/l N has been given as an appropriate level to protect the most sensitive freshwater species (Camargo *et al.*, 2005).

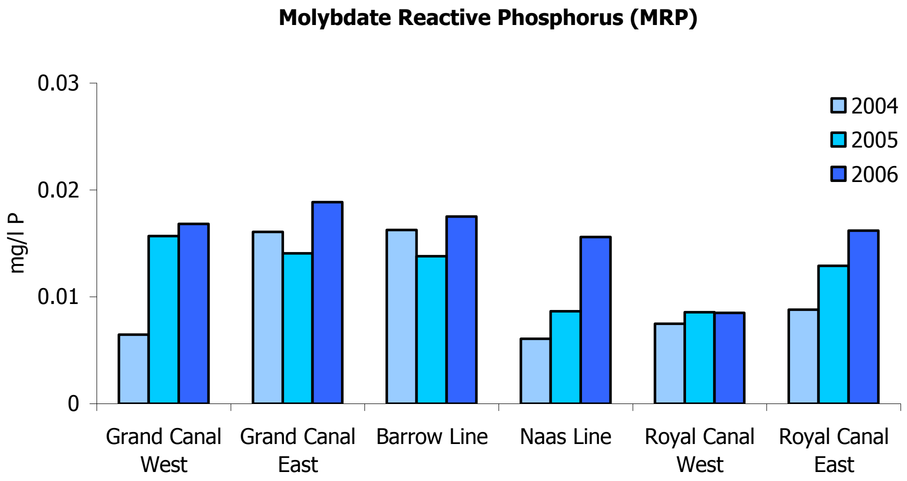
months. This reflects rainfall patterns, with increased rainfall in winter leading to greater nutrient run-off to feeder streams to canals from the surrounding land. In addition, nitrogen is removed from the water by aquatic plants during the growing season from late spring to late summer. A similar seasonal pattern was observed in relation to TP and MRP although, with the greater amount of phosphorus breaches, it was more difficult to discern.

Physico-chemical sampling of the four waterways in the 2004-2006 monitoring period showed that most sampling sites were compliant with the water quality limits used and that, with the exception of the Barrow Navigation, water quality was good overall. Chlorophyll results for the Royal and Grand Canals as well as for canal and lake sites in the Shannon-Erne Waterway indicate that these waters are oligotrophic to mesotrophic, indicating good water quality. Despite this, localised problems still exist in the Royal and Grand Canals, while the Barrow Navigation has had a poor record in terms of levels of total and faecal coliforms. It should be remembered, however, that the Barrow Navigation, unlike the canals proper, is riverine over much of its length and is thus subject to various point discharges.

For the future the CFB, on behalf of Waterways Ireland, plans to implement a monitoring programme for the canals and the Shannon-Erne Waterway that is compliant with the requirements of the WFD. The Royal and Grand Canals and sections of the Shannon-Erne Waterway have been identified as Artificial Water Bodies (AWBs) under the WFD. AWB is defined in Article 1 of the WFD as ‘a body of surface water created by human activity’. A project is currently under way to develop a classification tool for canals so that the ecological potential,• as defined by the WFD, can be assessed. This project is co-ordinated by SNIFFER (Scotland and Northern Ireland Forum for Environmental Research) and co-funded by British Waterways (BW), the Scottish Environmental Protection Agency (SEPA), the Environment Agency (EA), the EPA and Waterways Ireland. The project involves the use of appropriate biological, hydromorphological and physico-chemical quality elements (as defined by the WFD) to classify the ecological status of canals. It is envisaged that the classification tool developed by this project will be used by CFB to develop a WFD-compliant monitoring programme for the canals.

• The Water Framework Directive (WFD) allows for these water bodies to be designated as Artificial Water Bodies (AWB) and are required to achieve good ecological potential rather than ecological status. Ecological potential, means that the water body is managed to achieve the biology that can be attained given its artificial nature. Annex V of the Directive sets outs requirements for ecological potential. Good chemical status must be achieved.





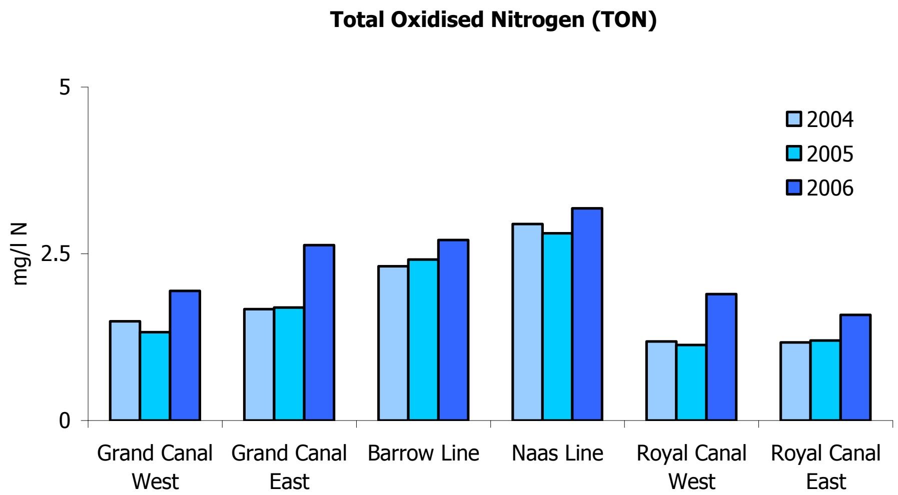


Figure 2.11 Annual mean values for three parameters (TP, MRP and TON) in the Grand Canal and Royal Canal sections in the period 2004-2006. Sampling and analysis was carried out by the Central Fisheries Board on behalf of Waterways Ireland.

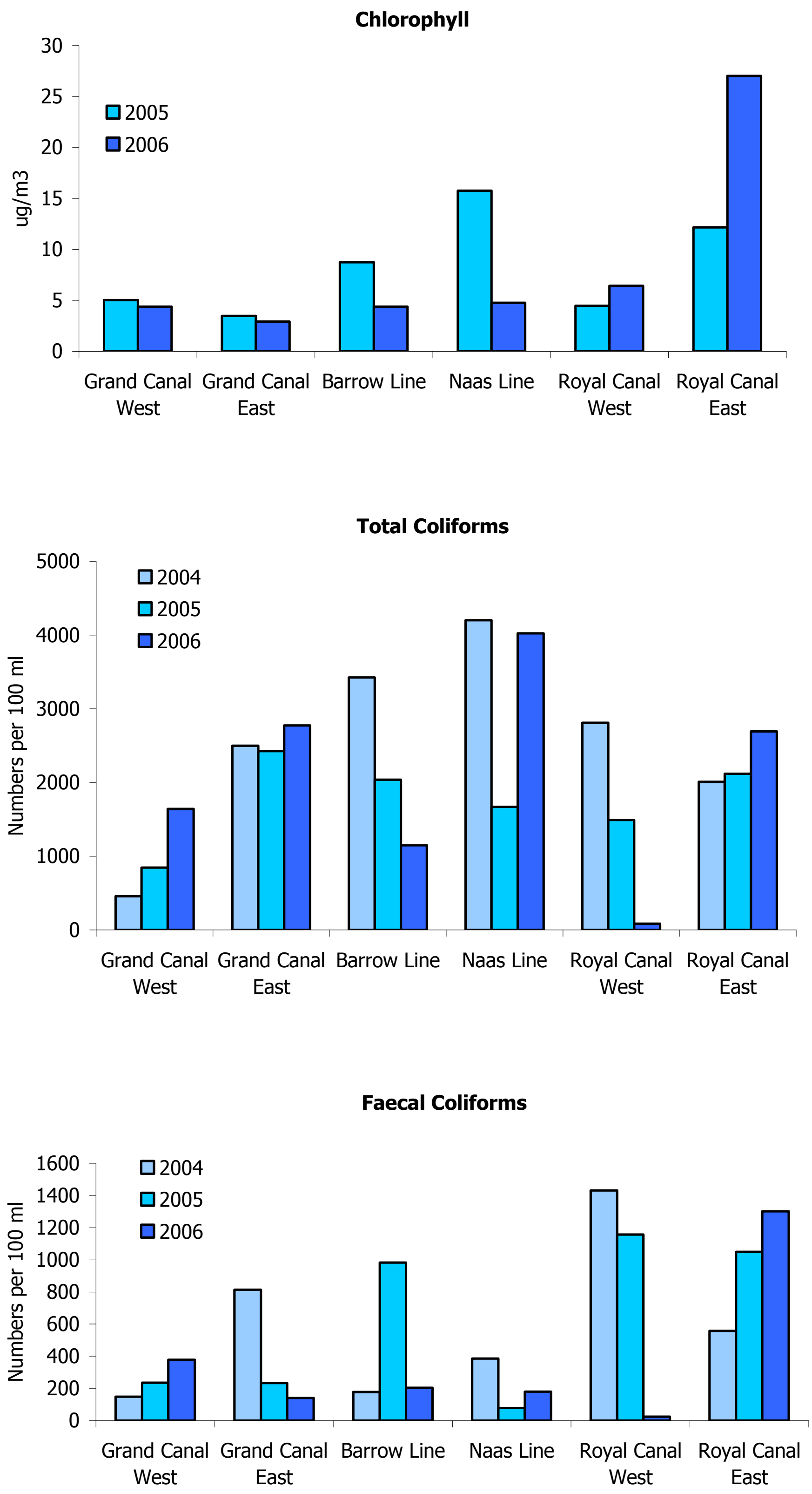


Figure 2.12 Annual mean values for three parameters (Chlorophyll, Total and Faecal Coliforms) in the Grand Canal and Royal Canal sections in the period 2004-2006. Prior to 2005 chlorophyll analysis was not carried out on samples. Sampling and analysis was carried out by the Central Fisheries Board on behalf of Waterways Ireland.

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