



# **WATER QUALITY IN IRELAND 2007-2009**

Edited by  
Martin McGarrigle, John Lucey and Micheál Ó Cinnéide

*Aquatic Environment*

*Office of Environmental Assessment*

ENVIRONMENTAL PROTECTION AGENCY  
An Ghníomhaireacht um Chaomhnú Comhshaoil  
Johnstown Castle  
Wexford  
Ireland

Telephone: +353 53 9160600  
Lo Call: 1890 33 55 99  
Fax: +353 53 9160699  
Email: [info@epa.ie](mailto:info@epa.ie)  
Web site: [www.epa.ie](http://www.epa.ie)

© **Environmental Protection Agency 2010**

Although every effort has been made to ensure the accuracy of the material contained in this publication, complete accuracy cannot be guaranteed. Neither the Environmental Protection Agency nor the author(s) accept any responsibility whatsoever for loss or damage occasioned, or claimed to have been occasioned, in part or in full as a consequence of any person acting or refraining from acting, as a result of a matter contained in this publication. All or part of this publication may be reproduced without further permission, provided the source is acknowledged.

## **WATER QUALITY IN IRELAND 2007-2009**

Published by the  
ENVIRONMENTAL PROTECTION AGENCY, IRELAND

Design by *Altemar Ltd.*  
Printed by *Brunswick Press*

ISBN: 978-1-84095-387-9

12/10/500

Price: €20 (Including CD ROM with Maps and Appendices)

This Report is dedicated to the memory of our colleague  
Michael Neill (1948-2010)



## ACKNOWLEDGEMENTS

The editors and authors wish to express their gratitude to the following organizations and individuals who provided data and information for this report: Local Authorities, the Central and Regional Fisheries Boards - now Inland Fisheries Ireland – (F. Kelly, T. Gallagher and S. Doyle) Waterways Ireland (C. McCarthy), Marine Institute (E. McGovern, E. Joyce, B. McHugh, J. Silke and L. Tyrrell), Sea Fisheries Protection Authority (B. Nolan), Irish Coast Guard (H. Barry) and Radiological Protection Institute of Ireland (L. Currivan and P. McGinnity).

The help of K. Tedd (EPA STRIVE/TCD) and C. Hickey (Geological Survey of Ireland) as well as EPA Hydrometric technicians (J. Agnew, M. Bourke, M. Browne, A. Curran, M. Kerr, B. Magennis, M. Maher, M. Morgan, J. Penny, D. Quinn, J. Rigney, J. Reilly, J. Ryan and M. Stapleton) is greatly appreciated in groundwater survey work.

The EPA regional chemists (C. Bowden, C. Concannon, R. McGinn, R. Smith and P. Webster) and their staff are thanked for supplying river physico-chemical data. Information on wastewater treatment plants in chapters 3 and 5 was kindly provided by the Office of Climate, Licensing & Resource Use (S. Wylde).

The following are acknowledged for their input to lake quality information: EPA (C. O'Loughlin, M. Neill, R. Smith, P. Webster, R. McGinn, M. Quinn, U. Cullen and J. Larkin); Central Fisheries Board (F. Kelly and J. Hennelly); Cavan County Council (C. O'Callaghan); Clare

County Council (T. Duffy and M. Lait); Cork County Council (D. Sheehan); Donegal County Council (D. Casey and G. McGinley); Dublin City Council (D. Morrissey and A. Boylan); Galway County Council (M. Ni Chionna, D. Connell, A. Dolan and C. Sullivan); Kerry County Council (D. Lenihan and I. McGloin); Leitrim County Council (E. Gibbons and A. Reynolds); Limerick County Council (C. Gleeson); Longford County Council (A. Brady and A. Skelly); Mayo County Council (M. Sweeney and H. Neary); Meath County Council (V. Collins and A. Leavy); Monaghan County Council (B. O' Flaherty and G. Kelly); Roscommon County Council (J. O'Gorman); Sligo County Council (P. Bergin); Waterford County Council (P. Carroll); Westmeath County Council (A. Marshall and M. Connolly); Wicklow County Council (T. Griffin and J. Sexton).

Dublin City Council (S. Walsh) is thanked for supplying additional data for the Liffey estuary and Dublin Bay. The EPA Hydrometric technicians as well as N. Harmey (National Parks and Wildlife Service), C. Murray and P. O'Seasain are thanked for their help with Macroalgae surveys.

Photographs were provided by MERC Consultants (B. Deegan), EPA (D. Daly, R. Little, J. Lucey, M. McGarrigle, J. Reilly and R. Wilkes), Geological Survey of Ireland (C. Hickey) CDM Ireland, Ltd (H. Moe) and Irish Coast Guard (H. Barry).

Maps in the report include Ordnance Survey Ireland (OSI) data reproduced under licence. Cartography by A. McElwain.



## FOREWORD

This report is the sixth in the series of three-year reviews of water quality in Ireland that have been undertaken by the Environmental Protection Agency (EPA) since 1995. A number of earlier reports were published by our predecessors, An Foras Forbartha, from 1970 to 1980 and the Environmental Research Unit, covering the period 1987 to 1990. Ireland is one of the few countries in Europe with such a detailed, scientifically based time series of water quality, which now spans four decades.

This report presents a review of Irish ambient water quality for the years 2007 to 2009. The aim of the report is to present a detailed overview of the main aspects of the quality of the aquatic environment in Ireland, to assist in the protection and enhancement of this key national resource. The data will provide a basis for Programmes of Measures to restore and maintain water quality.

The EPA has worked with a range of agencies to deliver a national assessment, based on the criteria and standards set out in the Water Framework Directive (2000/60/EC). The EPA published a national monitoring programme in June 2006 to meet the requirements of the WFD and the regulations implementing the Nitrates Directive (S.I. No. 788 of 2005).

The water quality data are presented in two ways: against the new ecological status criteria of the Water Framework Directive (WFD) and reporting on water quality, in the manner of previous EPA reports, so that trends can be seen.

The WFD assessment scheme for **water status**, that includes water quality, is a complex but comprehensive ecological approach, to aquatic resource management, in which the scope has been broadened to include a wide range of supporting parameters.

Thus, with many areas of aquatic systems to be covered, the report marks a transition phase towards a new, multi-agency programme.

The water quality data and other information have been generated by EPA field and laboratory based teams in the Office of Environmental Assessment, supplemented by information from

- Local authorities,
- Central and Regional Fisheries Boards (now Inland Fisheries Ireland)
- Marine Institute
- Radiological Protection Institute of Ireland
- Sea Fisheries Protection Authority
- Waterways Ireland and the Irish Coast Guard

We wish to convey sincere thanks and appreciation to our colleagues in these agencies.

The EPA looks forward to working with the Department of Environment, Heritage & Local Government and with the network of agencies to deliver the next phase of the Water Framework Directive and to meet the targets set out in the Directive for 2015 and 2021. This report makes clear that the targets are ambitious. Significant pollution remains an issue, for example in at least 20 river sites, in 25 lakes and in nine estuarine water bodies.

As previously stated by EPA, the achievement of future WFD targets will require a review of current water governance and the evolution of a regional network of agencies, based on the River Basins, in order to provide a more effective balance of national integration and local implementation.

Micheál Ó Cinnéide  
Director  
Office of Environmental Assessment





---

**TABLE OF CONTENTS**

<b>ACKNOWLEDGEMENTS.....</b>	<b>v</b>
<b>FOREWORD .....</b>	<b>vii</b>
Table of Contents .....	ix
<b>CHAPTER THREE.....</b>	<b>41</b>
<b>WATER QUALITY OF RIVERS AND CANALS .....</b>	<b>41</b>
Introduction .....	41
Irish River Water Quality and Ecological Status .....	41
River Quality: Ecological Status - Macroinvertebrates.....	41
Water Quality Trends .....	43
Other Ecological Quality Elements .....	49
River Water Bodies – Combined Ecological Status.....	56
Dangerous Substances Monitoring Programme .....	58
Metals Monitoring Overview .....	62
Water Quality and Ecological Potential of Canals and Their Feeder Streams.....	66
Causes of pollution - rivers .....	70
Conclusions.....	72
References .....	74



## CHAPTER THREE

### WATER QUALITY OF RIVERS AND CANALS

Martin McGarrigle, Catherine Bradley, Colman Concannon, Darragh Cunningham, Bryan Kennedy, John Lucey, Patricia McCreesh and Micheál MacCárthaigh

#### INTRODUCTION

This chapter is based on the results from the first three years of the Water Framework Directive (WFD) river monitoring programme (2007-2009) and provides an integrated assessment of the biological, physico-chemical and hydromorphological quality elements monitored in Irish rivers. Monitoring of water quality of Irish rivers has been undertaken since 1971 and while a new approach to defining ecological status has been introduced by the WFD it is also important to maintain continuity with previous survey results in order to assess trends over the past three to four decades. Thus, in addition to the integrated view, results are given on an individual quality element basis where necessary to provide comparisons with historical data.

During the 2007-2009 period, as in previous triennial periods, over 13,000 km of main-stem river channel was surveyed; biological assessments were made at almost 2,500 sites and assessment of the supporting physico-chemical parameters, including nitrate, phosphate, BOD and ammonia was undertaken by local authorities and the EPA at over 1,700 river sites. A core group of 180 representative surveillance monitoring sites was also sampled for a full suite of quality elements including a wide range of dangerous substances that enables 'chemical status' to be assessed in addition to ecological status.

This chapter presents national results for the biological quality elements surveyed and supporting physico-chemical elements in particular those indicators of 'organic enrichment'. Priority or dangerous substances are also reviewed. Results are also summarised at the level of individual River Basin Districts and references are given to more detailed source documents and online maps as well as reports for river by river and site by site data. In addition canal water quality is summarised and the occurrence of fish kills in the period is reported.

#### IRISH RIVER WATER QUALITY AND ECOLOGICAL STATUS

The methodology for WFD status assessment is outlined in Appendix 3.1. The rivers surveyed biologically in the current period are set out by hydrometric area in the separate 2007, 2008 and 2009 Interim Biological Survey Reports and are published online<sup>1</sup>. Appendix 3.2 summarises the results by hydrometric area. These reports provide details of assessment methods used and river by river and station by station results. The current chapter summarises the results at national and RBD level. A colour-coded River Quality Map depicting biological quality at each of the 2,487 locations surveyed accompanies this report (McGarrigle *et al.*, 2010).

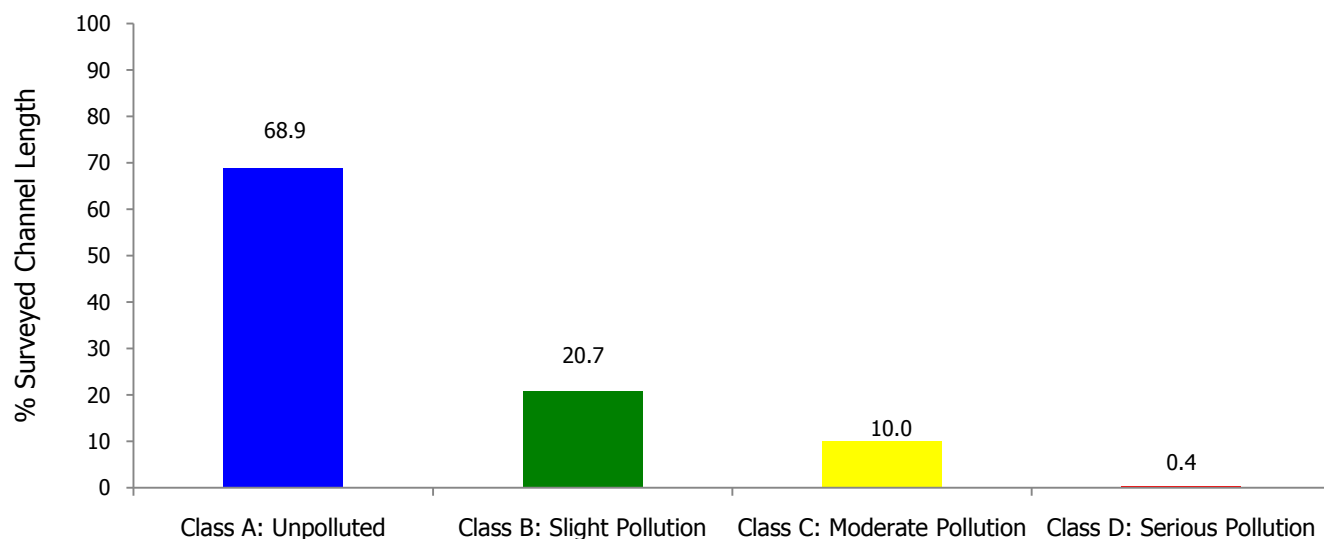
#### RIVER QUALITY: ECOLOGICAL STATUS - MACROINVERTEBRATES.

The results of the macroinvertebrate surveys of rivers provide an important input to the final definition of ecological status of rivers. The ecological status for macroinvertebrates corresponds closely to water quality defined by the long-term biological survey of rivers undertaken since 1971. The results in this section may therefore be interpreted as synonymous with historical 'water quality' while also comprising part of the so-called 'one-out-all-out' approach to defining overall ecological status in conjunction with status assessments for other quality elements. The high / good and good / moderate ecological status boundaries used for macroinvertebrates in Irish rivers have been intercalibrated with other European countries as part of the formal intercalibration exercise (European Commission, 2008). The survey of macroinvertebrate ecological status is still the most comprehensive survey of Irish rivers in that all the main-stem rivers are included accounting for over 13,000 km of river channel as in previous surveys. The results of the

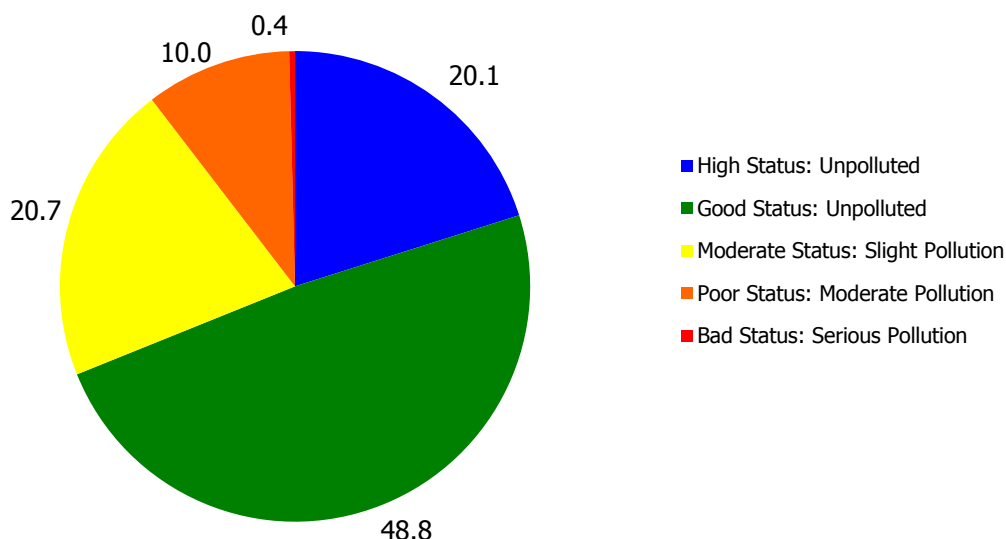
<sup>1</sup> <http://www.epa.ie/downloads/pubs/water/rivers/>

2007-2009 biological surveys show that the majority (69% or 9,086 km) of surveyed rivers and stream channel length was in unpolluted condition (Figure 3.1a). In terms of the Water Framework Directive, the intercalibrated ecological status for the macroinvertebrates allows the 9,086 km of unpolluted river channel to be subdivided further with 20 per cent (2,652 km) of the total channel surveyed at high ecological status while 49 per cent (6,434 km) was of good ecological status for

the macroinvertebrate quality element (Figure 3.1b). Almost 31 per cent of the surveyed channel was affected by slight or moderate pollution with nearly 21 per cent (2,728 km) classed as slightly polluted/ eutrophic, a further 10 per cent (1,321 km) is moderately polluted and 0.4 per cent (52.5 km) classified as seriously polluted (Figure 3.1a). This gives a uniform national picture for all important main-stem rivers based on the macroinvertebrates.



**Figure 3.1a.** River Quality 2007-2009: Percentage channel length classified into each of the four EPA biological quality classes (13,188 km).



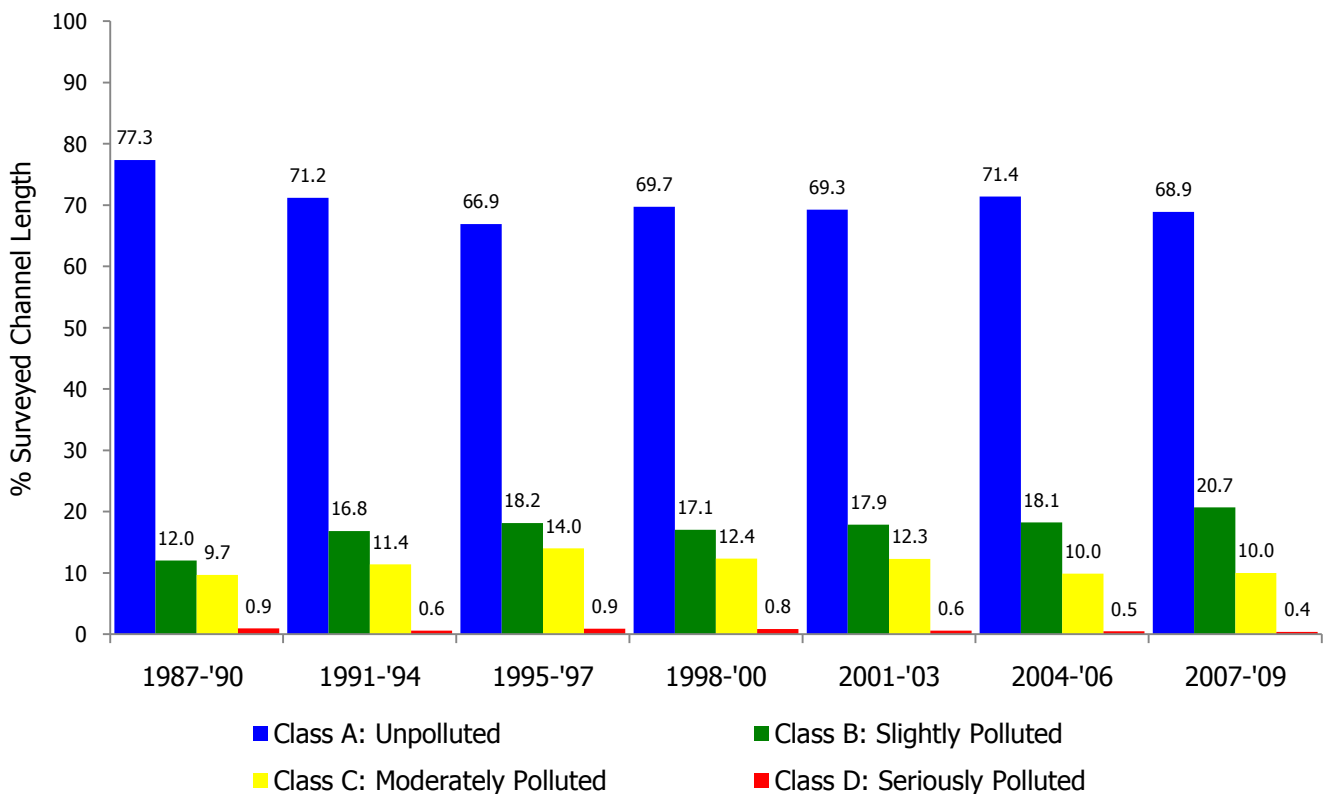
**Figure 3.1b.** River Quality/Status 2007-2009: Percentage channel length (13,188 km) with a further division of the unpolluted 68.9% of channel into 'High' status (20.1%) and 'Good' status (48.8%) corresponding to the new ecological status classes for macroinvertebrates under the WFD. This new distinction arises from the EU intercalibration exercise for macroinvertebrates – the old EPA four-category water quality breakdown, from Fig. 3.1a above, is compared with the new five-category ecological status classification for WFD purposes (the legend gives the old and new terminology side by side). The main difference is the splitting of the old 'Class A: Unpolluted' category into two new sub-categories: High and Good ecological status.

## WATER QUALITY TRENDS

### National Trends

The 13,188 km of river channel for which current status and water quality is shown above has been monitored nationally since 1987 and this allows trends over time to be assessed (Figure 3.2). During the 1990s the proportion of unpolluted channel length (Class A) declined by 10 per cent (from 77 per cent to 67 per cent) due to the spread of slight and moderate pollution which increased by a similar percentage. The proportion of unpolluted channel has remained relatively static since 2000 with only a small percentage variation. The most significant ongoing trend is the increase in slight pollution (Class B) from 12 per cent in the 1987-1990 period to over 20 per cent at present. This category corresponds to moderate ecological status and is typically, though not always, due to eutrophication caused by excess nutrients. The proportion of poor status or moderately polluted channel is

currently at 10 per cent, down from a peak of 14.0 per cent in the 1995-1997 period. This category is primarily due to organic pollution and is expected to decline as improved wastewater treatment is implemented. On a positive note the percentage of surveyed channel classified as seriously polluted has further decreased to 0.4 per cent (52.5km) compared with the previous period when 0.5 per cent (63.5 km) was seriously polluted. The length of seriously polluted channel is now half the length seen in the late 1980s and 1990s and is significantly less than that observed in the 1970s and early 1980s when several hundred kilometres of river channel were classified as seriously polluted based on similar assessment techniques. A breakdown of the causes of pollution is given later in this chapter.

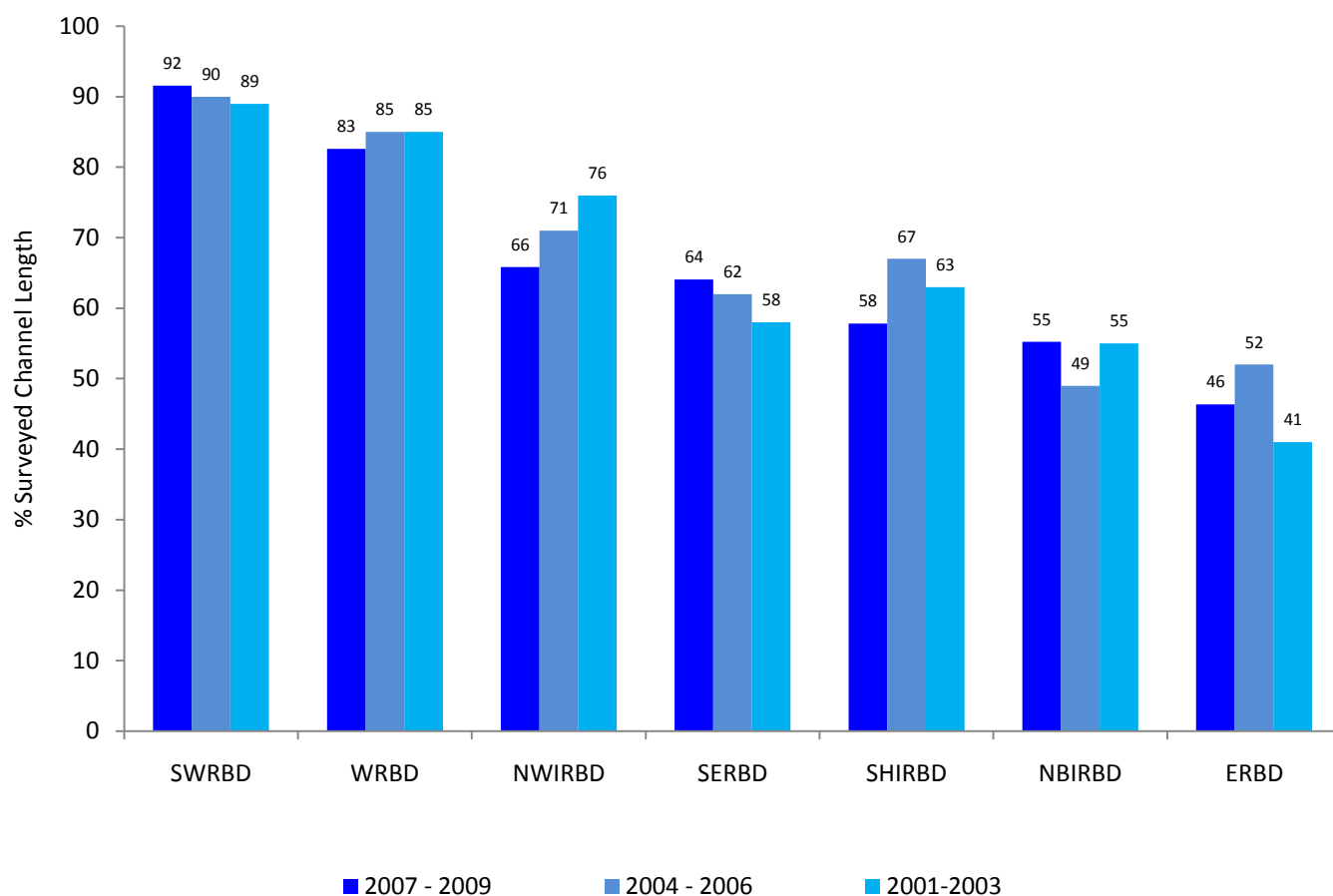


**Figure 3.2.** Recent Trends in the 13,188km baseline showing the percentage of surveyed channel in the four EPA biological quality classes. Historical data from Clabby *et al.*, 1992, Bowman *et al.*, 1996, Lucey *et al.*, 1999, McGarrigle *et al.*, 2002, Toner *et al.*, 2005 and Clabby *et al.*, 2008.

### Trends in the River Basin Districts (RBDs)

The importance of protecting high and good status waters is emphasised by the Water Framework Directive as an important aim for member states in their approach to improving water quality. Figure 3.3 summarises trends within individual RBDs for unpolluted channel (corresponding to high and good ecological status based on results for the macroinvertebrate quality element). Results are expressed as the percentage of Class A unpolluted channel recorded in each of the seven River

Basin Districts within the State over the last three survey cycles. 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 3.3). 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.



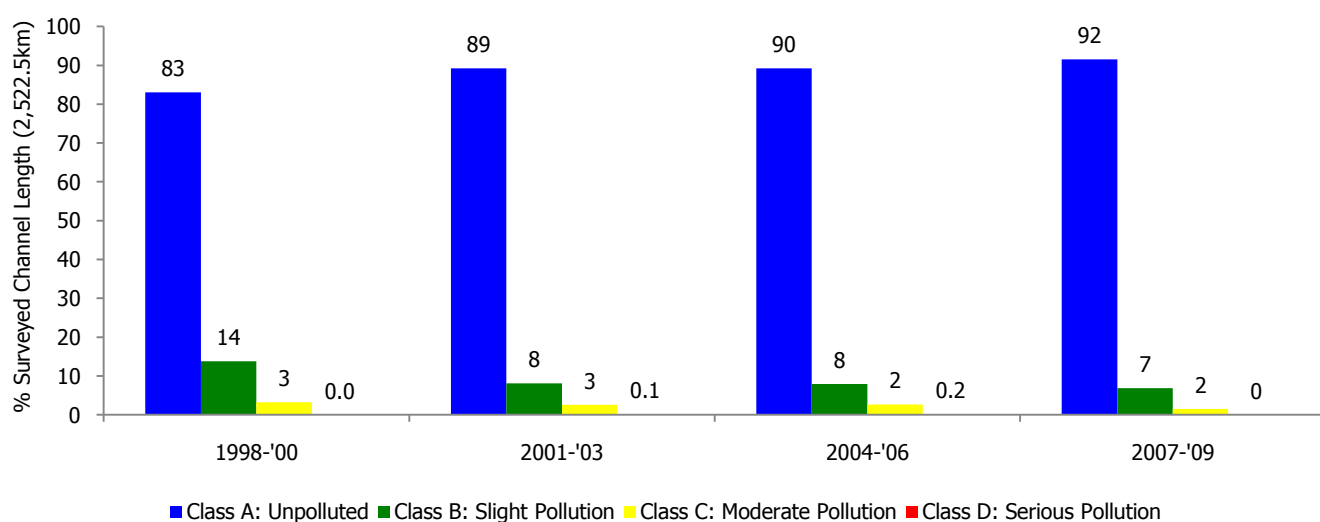
**Figure 3.3.** Trends in the percentage of unpolluted Class A (High and Good status) channel length in each River Basin District in the state for the survey periods 2007-2009, 2004-2006 and 2001-2003.

### South-Western RBD – River Water Quality Trends

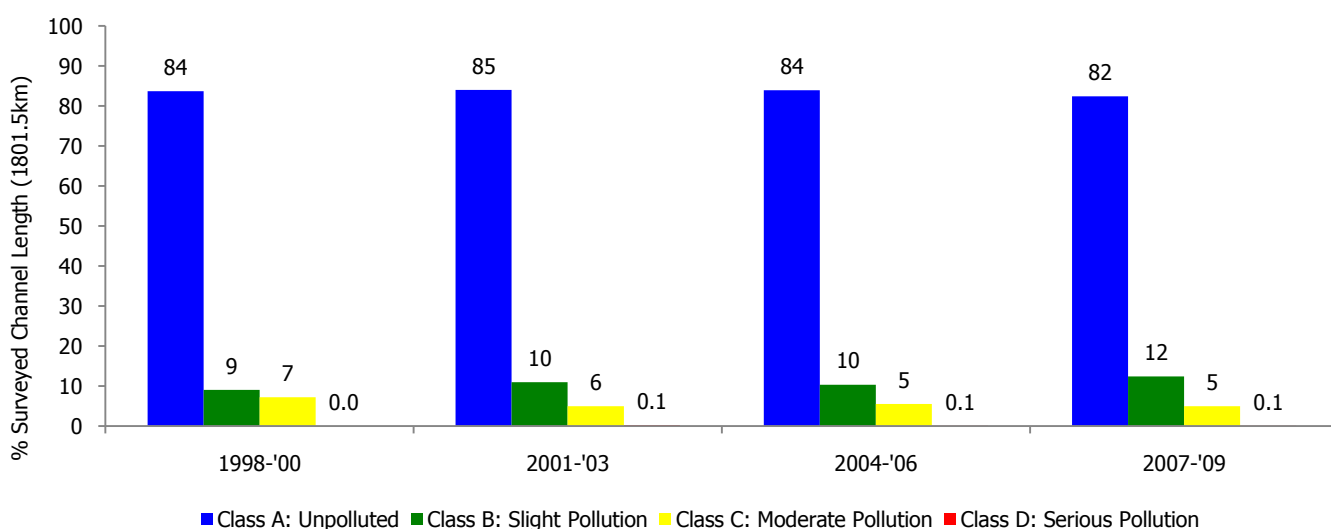
With 92 per cent of the surveyed channel classified as unpolluted, the South Western River Basin District (SWRBD) is considered the least polluted RBD in the country (Figure 3.4a). A steady decline in the proportion of channel length assigned to Classes B and C has been noted. Improvements in quality on the serious pollution in the Owenalondrig, Owenahinchy and Milltown (Kerry) are noted but further pollution abatement is required on the Milltown (Kerry). Serious pollution was, however, noted on a short stretch (<200m) of the River Lee (Tralee) in 2009.

### Western RBD – River Water Quality Trends

As in the 2004-2006 period, the majority (82 per cent) of surveyed channel was unpolluted (Figure 3.4b). The extent of unpolluted channel declined, however, with a corresponding increase in the percentage of slight pollution. Serious pollution continued on the Clarinbridge River, Tubbercurry Stream and Tubbercurry River due primarily to poorly treated municipal wastewater.



**Figure 3.4a.** Trends in River quality in the South Western RBD for the last four survey periods.



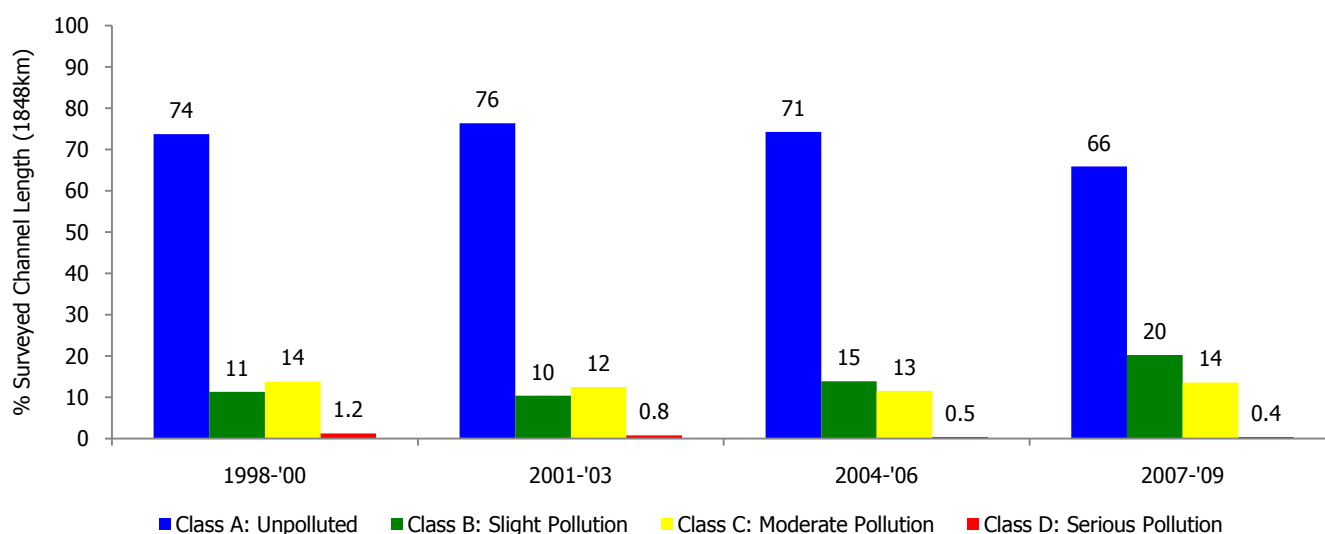
**Figure 3.4b.** Trends in River quality in the Western RBD for the last four survey periods.

### North-Western IRBD (South) – River Water Quality Trends

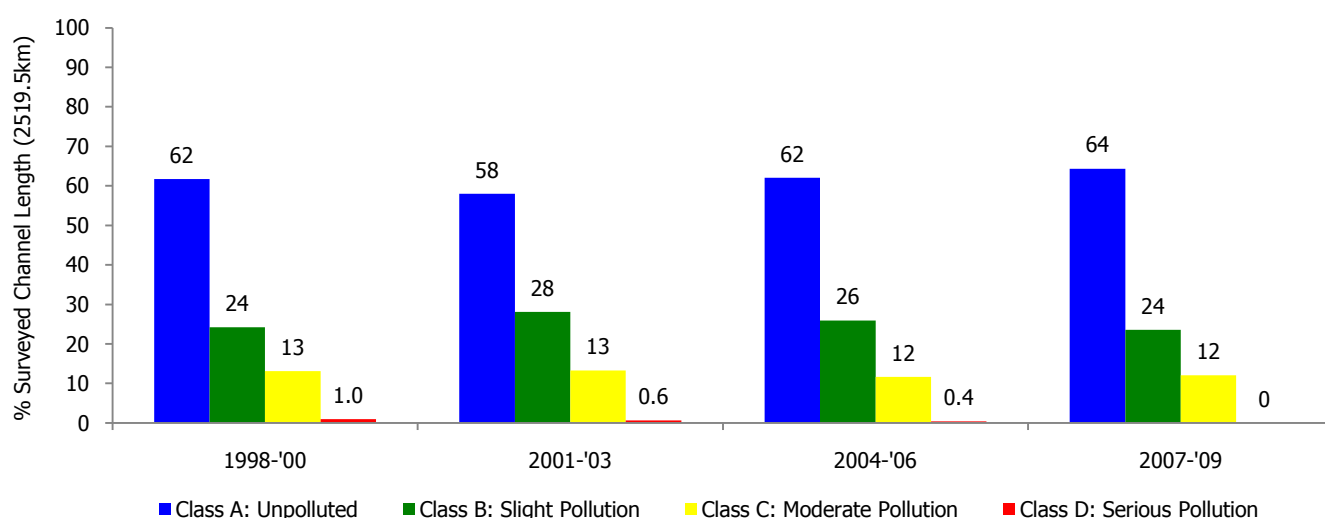
A marked decrease (5%) in the percentage of unpolluted channel length was noted in the 2007-2009 period mainly due to a decrease in Class A channel length at Hydrometric Areas 01, 36, 39 and 40 in particular (Figure 3.4c). A decrease in the length of seriously polluted channel was noted on the Conawary Upper, Corravaddy Burn, Erne, Greenhill Stream, Maggy's Burn, St. Johnston and at one of the Roechrow locations. Serious pollution however continues on the Swilly Burn, Roosky and the Roechrow while a new problem was noted on the Ballaghdoon River.

### South-Eastern RBD – River Water Quality Trends

An increase in the percentage of unpolluted channel length was again noted during the 2007-2009 survey period (Figure 3.4d) with a corresponding decrease in the percentage of slight and serious pollution. Improvements from serious pollution were noted on the Aughboy (Wexford), Borrisoleigh Stream, Clodaigh (Portlaoise), Garranacool Stream, Glory, Gowran, Mountrath, Nore, Triogue and Tully Stream during the 2007 -2009 survey period.



**Figure 3.4c.** Trends in River quality in the North Western IRBD (South) for the last four survey periods.

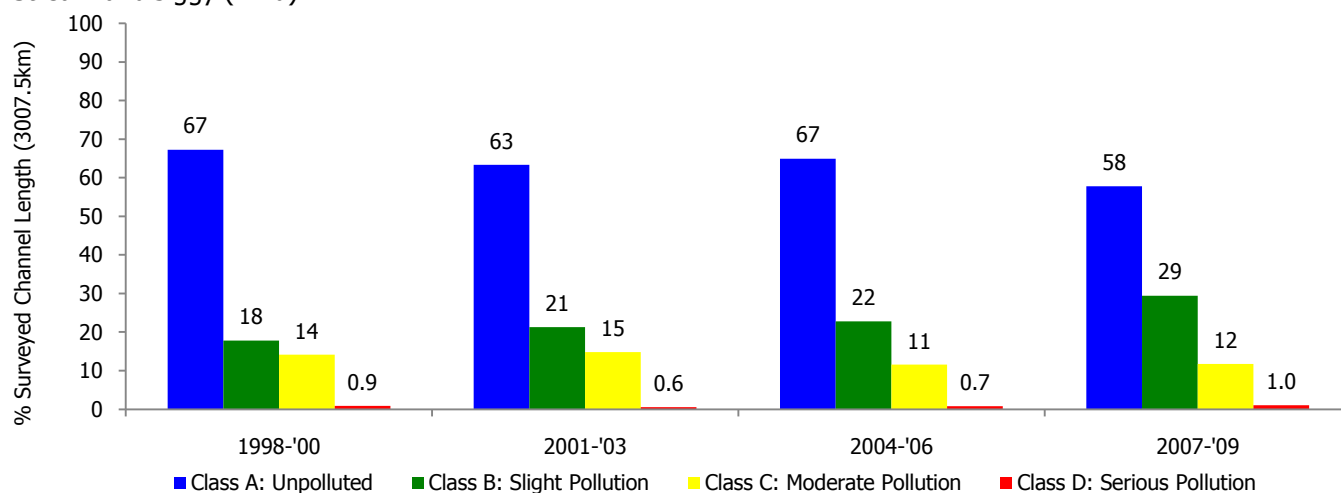


**Figure 3.4d.** Trends in River quality in the South Eastern RBD for the last four survey periods.

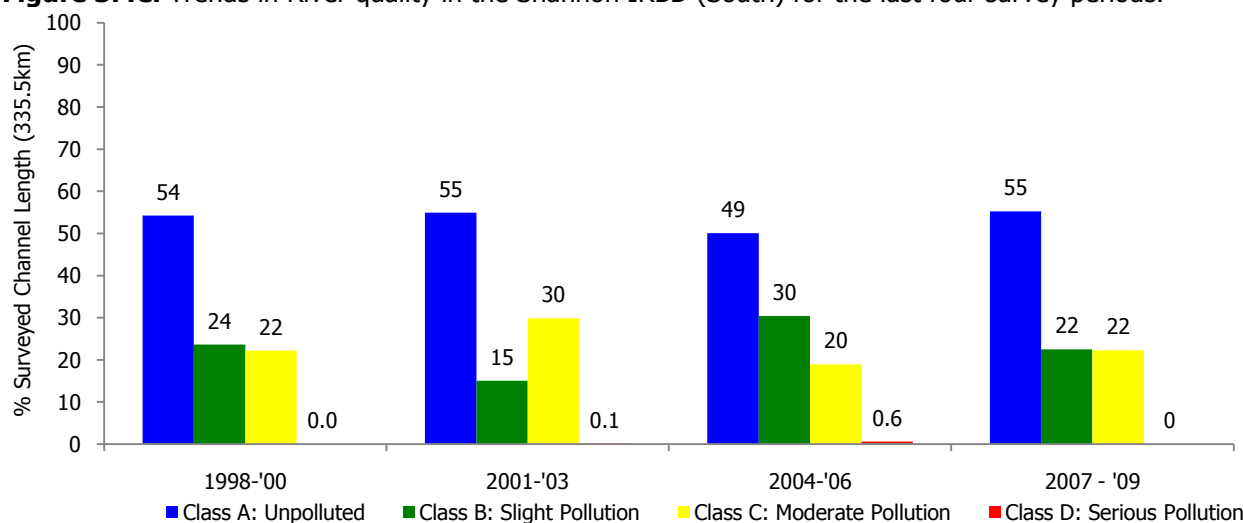


### Shannon IRBD (South) – River Water Quality Trends

A nine per cent decline in the percentage of unpolluted channel length was noted in the latest period with a corresponding increase of slight pollution noted (Figure 3.4e). Although a substantial improvement was noted in Hydrometric Area 24, the greatest decline in unpolluted channel length was noted in Hydrometric Areas 25 and 26. An overall increase in the percentage of channel length classified as seriously polluted was also noted. Improvements from serious pollution were noted on the Broadford, Clodaigh (Tullamore), Deel (Newcastlewest), Shinrone Stream, at one of the locations on the Laurencetown Stream and on the Tullamore River during the 2007-2009 period. Serious pollution continued in the Ahavarraga Stream, Arigna (Roscommon), Brosna, Gowlaunrevagh, Laurencetown Stream and Jiggy (Hind).



**Figure 3.4e.** Trends in River quality in the Shannon IRBD (South) for the last four survey periods.

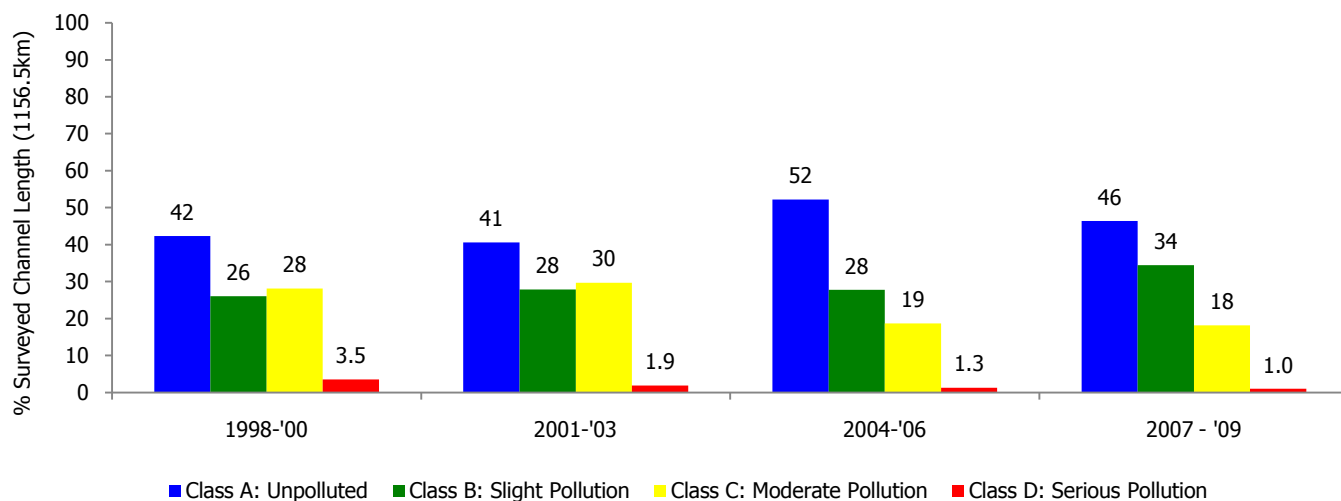


**Figure 3.4f.** Trends in River quality in the Neagh Bann IRBD (south) for the last four survey periods.

**Eastern RBD– River Water Quality Trends**

Despite the steady reduction in seriously polluted channel length the Eastern RBD had the lowest percentage of unpolluted channel length in the 2007-2009 survey period. A decrease (6%) in the percentage of surveyed unpolluted channel length with a corresponding increase in the length of slight pollution was noted (Figure 3.4g). The main decrease in unpolluted channel length was noted in Hydrometric Areas 08, 09 and 10. An

improvement from serious pollution was noted on the Camac, Dunshaughlin Stream, Kilcullen Stream as well as at two locations on the Tolka and Ward; but none of these stations have returned to satisfactory quality yet. Although temporary improvements continue to be noted on the Avoca in the early summer surveys, serious pollution was noted again by late summer in each of the three years 2007 to 2009.



**Figure 3.4g.** Trends in River quality in the Eastern RBD for the last four survey periods.

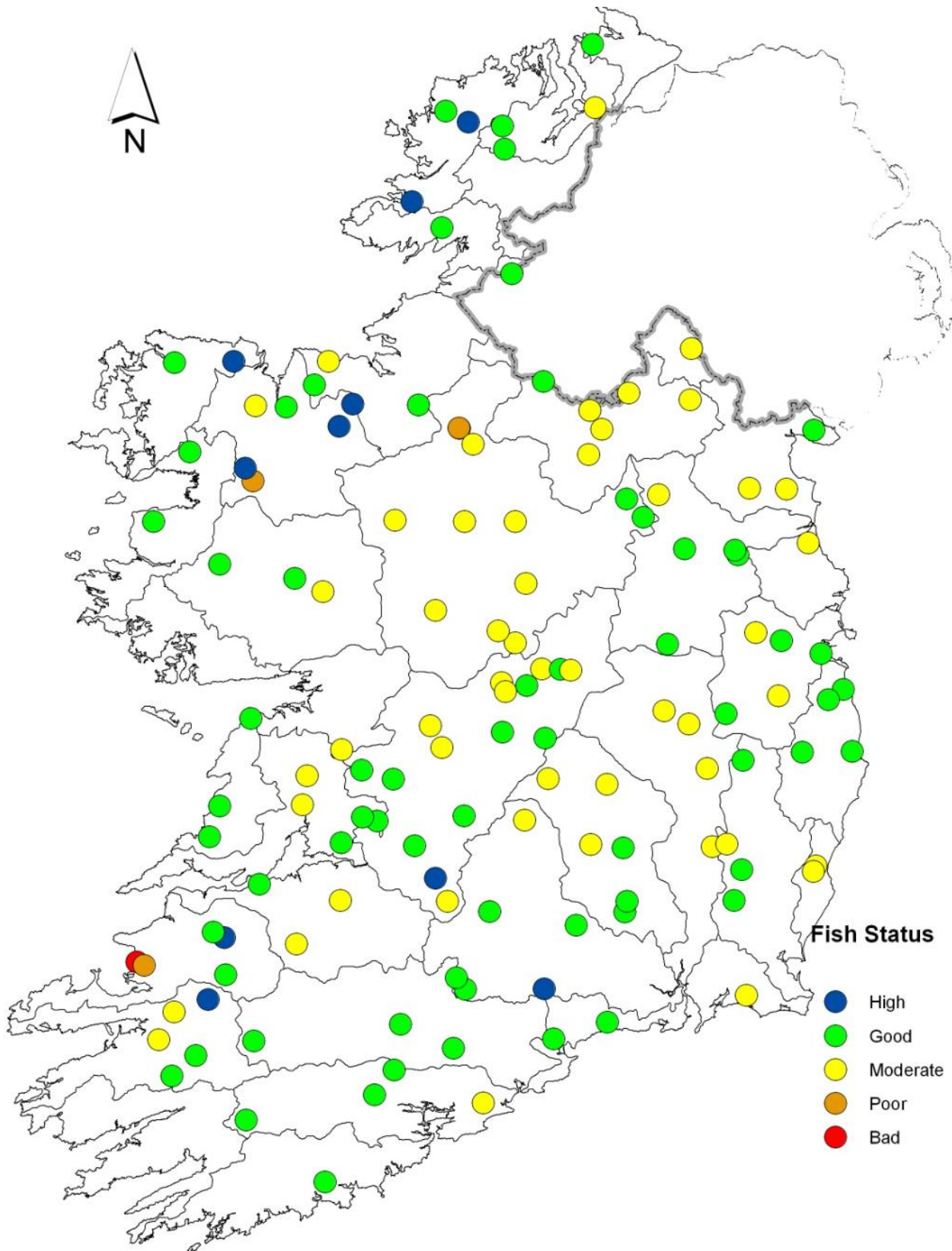


## OTHER ECOLOGICAL QUALITY ELEMENTS

### Surveillance Monitoring Fish Ecological Status Results

The Central Fisheries Board (now part of Inland Fisheries Ireland) undertook monitoring of fish, primarily at surveillance monitoring

sites. Fish populations were assessed at 132 sites during this programme in 2008 and 2009 (Figure 3.5).



**Figure 3.5.** Ecological status for the fish biological quality element in Irish rivers 2008-2009.



**Table 3.1.** Status breakdown for fish populations in each of the WFD River Basin Districts based on 132 sites surveyed in the 2008 – 2009 period.

RBD/IRBD	High	Good	Moderate	Poor	Bad	Number
East	0%	73%	27%	0%	0%	15
Neagh/Bann	0%	17%	83%	0%	0%	6
North West	15%	54%	31%	0%	0%	13
South East	4%	46%	50%	0%	0%	24
Shannon	5%	44%	44%	5%	2%	44
South West	7%	71%	21%	0%	0%	14
West	24%	47%	24%	6%	0%	17
<b>Total</b>	<b>8%</b>	<b>51%</b>	<b>39%</b>	<b>2%</b>	<b>1%</b>	<b>133</b>

The surveys suggest that some 59 per cent of sites surveyed across the country were of high or good status. Approximately 39 per cent of sites were of moderate status and a small number of sites in the Shannon IRBD were at poor or bad status. The general reference condition for Irish rivers is that rivers should have viable populations of salmonid fish such as trout and salmon. Generally sites even at moderate status still had some salmonids but with unbalanced populations. At poor and bad status salmonids are generally absent. A series of publications summarising the results of the WFD fish surveys is available from Inland Fisheries Ireland (Central and Regional Fisheries Boards, 2009; IFI, 2010).

### Fish Kills

Fish mortalities in rivers are reported as 'kills' if there is a strong suspicion that the death is pollution related or otherwise unnatural. Deaths due to natural causes, for example some salmon and lamprey die naturally after spawning, are not counted as kills. Low oxygen concentration in water is the principal cause of fish kills in Ireland. These conditions can be brought about by anthropogenic inputs of organic matter to water or may result from excessive plant growth causing deoxygenation during hours of darkness. Silt can also cause mortality or injury to fish, by clogging of gills, and siltation can smother salmonid eggs and alevins in redds (spawning gravels) or prevent fry from emerging. Data on fish kills in Ireland

are compiled annually by the Central Fisheries Board based on returns from the Regional Fisheries Boards. The total numbers of reported fish kills in freshwaters (rivers and lakes) in the period under review was 72 compared to 122 in the previous period and 147 in 2001-03 (S. Doyle and T. Champ, *pers. comm.*). A comparison with data from previous periods is given in Figure 3.6 with reported kills in each period grouped under five main headings denoting the likely causes. Table 3.2. shows the number of fish kills and their suspected or definitive causes for each year in the period 2007-09.

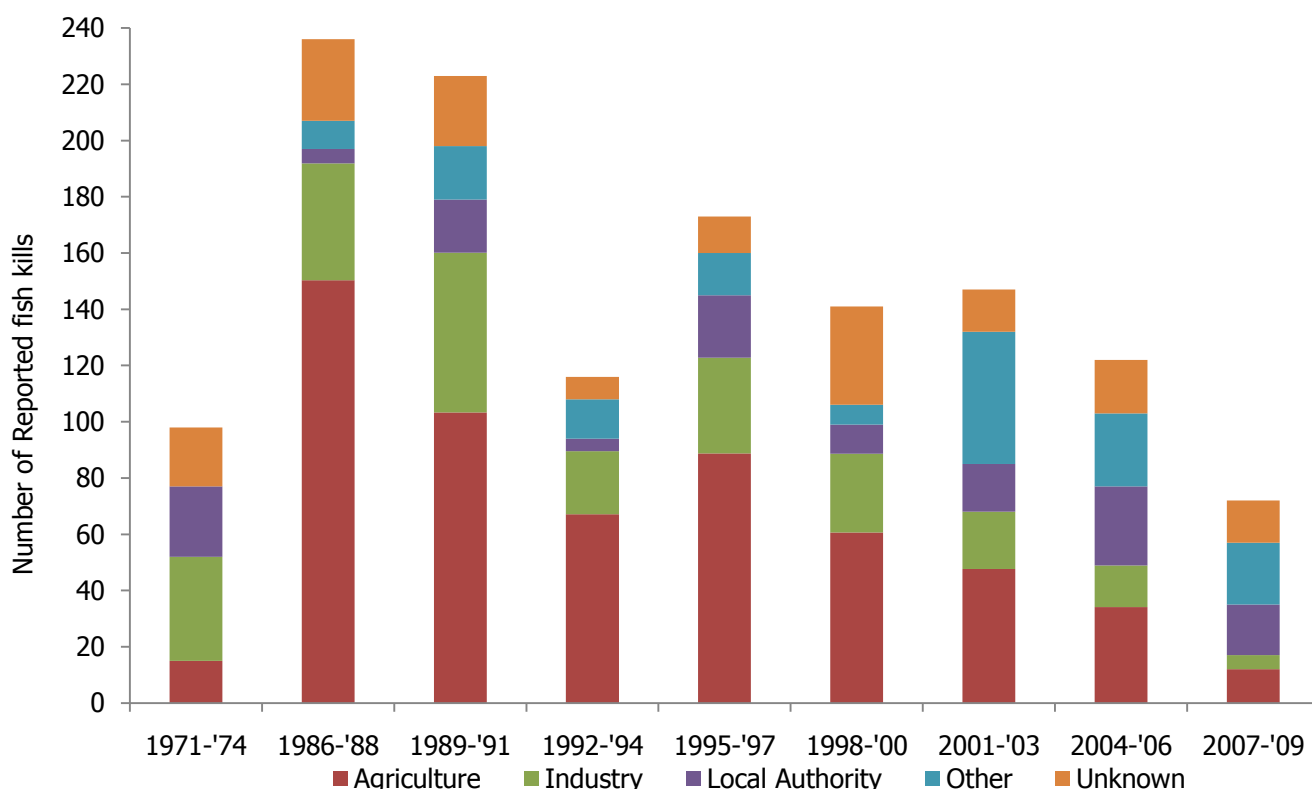
The breakdown, among the seven Regional Fisheries Board areas, of fish kills in 2007, 2008 and 2009 shows that the highest number (9) occurred in the Northern Region and the lowest number (1) was recorded in the North Western Region. There were no fish kills reported for the Western Region in 2007 nor for both the Shannon and South Western Regions in 2009. Of the 16 fish kills reported in 2009 none were attributed to agriculture or industry while two were recorded as local authority or municipal sources. The historical data (Figure 3.6) 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.

**Table 3.2.** Number of fish kills and suspected or definitive causes for each year in the period 2007-09.

	Agriculture	Industry	Local Authority	Other	Unknown	Total
2007	4	2	10	5	1	22
2008	8	3	6	10	7	34
2009	0	0	2	7	7	16
Total	12	5	18	22	15	72
Per cent	17%	7%	25%	31%	21%	

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 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 local authority, mainly from sewage

discharges, by even more (76%). That 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 2004-2006 period and 22, 34 and 16 for the current period. The trend in fish kills shows that the years 1987 and 1989 were the worst with in excess of 100 fish kills reported annually while 2007 and 2009, with less than one-fifth and one-sixth their totals respectively, had the least number.



**Figure 3.6** Number of reported fish kills and suspected causes for the period 2007-2009. The corresponding data for the seven previous three-year periods and for 1971-1974 are shown to indicate trends.

The number of such events in 2007 and 2008 show a reduction relative to 2004 and 2005 when 43 and 45 respectively were recorded while 2006 and 2008 with the same number had 34 reported. In 2009 the total number of fish kills reported was the lowest on record. It should be considered that the wet summer in that year, with concomitant higher river flows and fuller lakes, may have contributed to this state of affairs. For example, in 2009 summer rainfall was 230 per cent of normal at Johnstown Castle in Co. Wexford ([Met Éireann www.met.ie/climate/monthly\\_summaries/summer09.pdf](http://www.met.ie/climate/monthly_summaries/summer09.pdf)). However, rainfall totals were above average for all three successive summers in the reporting period and more than double the 2009 number of fish kills occurred in 2008.

#### **Aquatic Plants – diatoms**

Diatoms have well described responses to nutrients and acidification and are widely used in ecological assessment. Diatoms as indicators of the status of phytobenthos in rivers have been intercalibrated under the WFD intercalibration process and are surveyed at Irish surveillance sites. In the longer term diatoms will be combined with an assessment scheme for higher plants which is due for finalising in 2011 under the intercalibration process. The status breakdown for RBDs based on the diatoms was broadly similar to other biological elements (Table 3.3). These results are included in the final ecological status for those water bodies in which diatoms were sampled and processed.

#### **Chemical and physico-chemical elements supporting the biological elements.**

The WFD specifies chemical and physico-chemical quality elements supporting the biological elements which include the following: thermal conditions, oxygenation conditions, salinity, acidification status, nutrient conditions plus specific pollutants. The latter are dealt with separately below under the dangerous substances heading. Analysis for the general supporting physico-chemical elements was undertaken at some 1,414 river

sites (see Appendix 3.3) with a minimum average of four samples per year in the 2007-2009 period. Investigative sampling was also undertaken at a further 400 sites at varying frequencies. Surveillance monitoring was carried out 12 times per year at 180 river sites with a more detailed list of priority substances and specific pollutants measured in this programme.

For Irish rivers the main quality elements of environmental concern remain those of nutrients and oxygenation conditions. Thermal pollution, acidification and salinity issues are not as prevalent as eutrophication and organic pollution.

The WFD guidance document on ecological status assessment refers to 'organic enrichment' and this is a useful term to describe the combined organic pollution effect followed by eutrophication as organic matter is broken down and mineralised. Phosphate, nitrate, total ammonia and biochemical oxygen demand (BOD) in combination provide a useful index of this pressure. The maps shown in Figure 3.8 give concentrations for phosphate, nitrate, BOD and ammonia averaged on a hydrometric area basis. The thresholds used are those used in the European Environment Agency online maps. This allows for a direct comparison of Irish RBDs with those across Europe in terms of nutrients. Generally when Irish rivers are ranked in comparison with other EU countries for phosphate, BOD and ammonia they typically fall into the lowest 5 percentile in terms of concentration – i.e. among the lowest concentrations across Europe.

For nitrate, Irish rivers rank about mid-way in comparison with other European countries. More detailed aggregated results are available in conjunction with this report – as a statistical compendium on a river by river basis. The EPA's online mapping system, Envision ([www.maps.epa.ie](http://www.maps.epa.ie)), also allows users to obtain results on a site by site basis for rivers of interest.

**Table 3.3.** Percentage breakdown of diatom status by river basin district at the surveillance sites surveyed 2007-2008.

<b>Status</b>					
River Basin District	High	Good	Moderate	Poor	Bad
EA	8%	58%	33%	0%	0%
NB	17%	33%	33%	17%	0%
NW	10%	60%	20%	10%	0%
SE	19%	27%	54%	0%	0%
SH	25%	50%	0%	25%	0%
SW	35%	53%	12%	0%	0%
WE	33%	44%	11%	11%	0%
National	20%	46%	29%	5%	0%

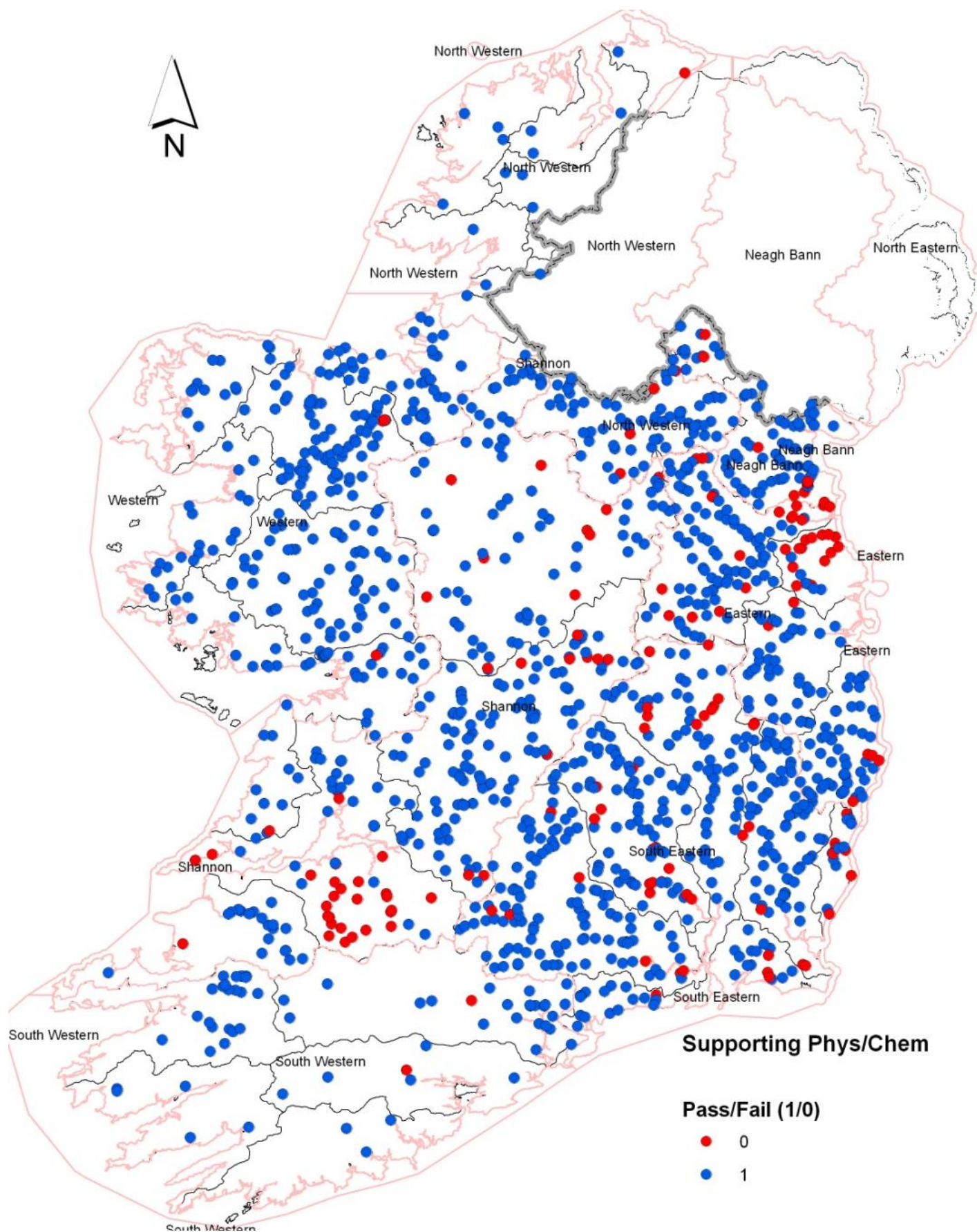
Compliance with the environmental quality standards (EQS) set out in S.I. No. 272 of 2009 is illustrated in Figure 3.7 for the combined parameters indicative of organic enrichment. This assessment then feeds into the overall ecological status of individual river water bodies on a one-out-all-out basis. In

general there is good agreement between the supporting chemistry and biological quality – and this is to be expected as the standards are to a large extent based on the relationships between biology and chemistry that have been observed over 30 years at many hundreds of Irish river sites surveyed during this period.



Aquatic macroinvertebrates such as the insects, *Perla* and *Leuctra*, shown above are routinely used to assess water quality. Some are highly sensitive to pollution while others can be very tolerant of pollution. Because they spend most of their annual life cycle in water they effectively act as 24x7 indicators of water pollution. The EPA Quality Rating System based on aquatic macroinvertebrates enables the detection of pollution events for an extended period of time after they occur.

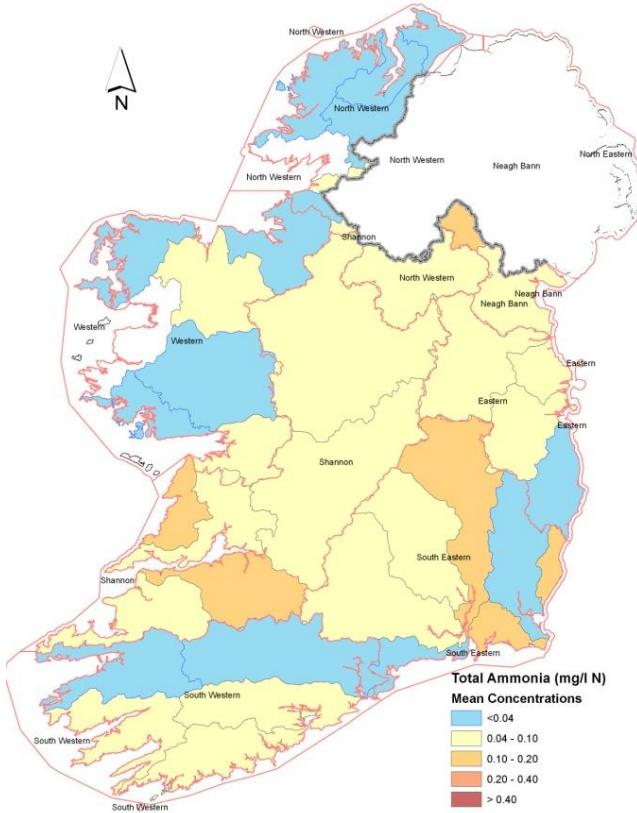




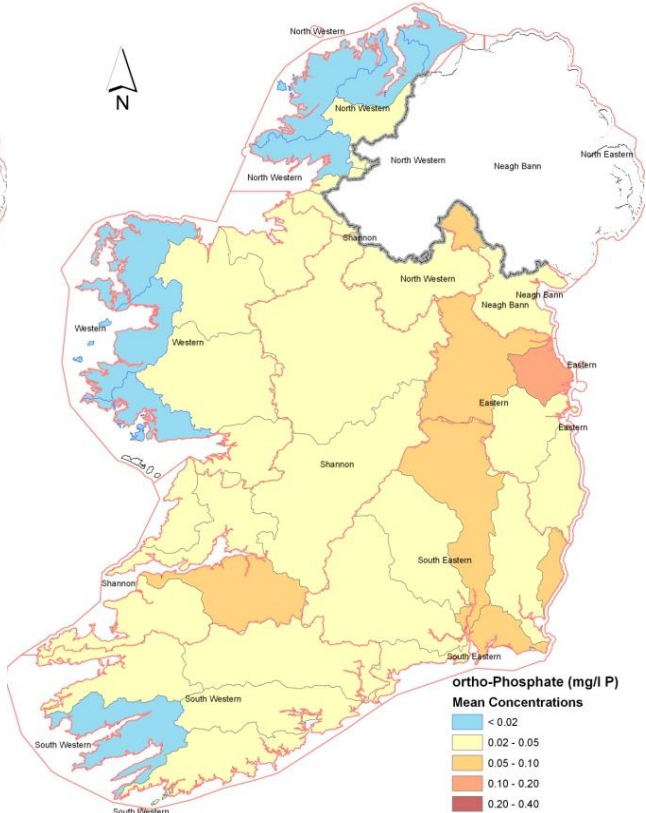
**Figure 3.7.** Combined pass/fail compliance for supporting physico-chemical quality elements indicative of organic enrichment ( $\text{PO}_4$ , BOD,  $\text{NH}_3$ ,  $\text{NO}_3$ ) at 1,414 river stations surveyed between 2007 and 2009. Red indicates less than good status for this quality element and blue indicates good or better status.



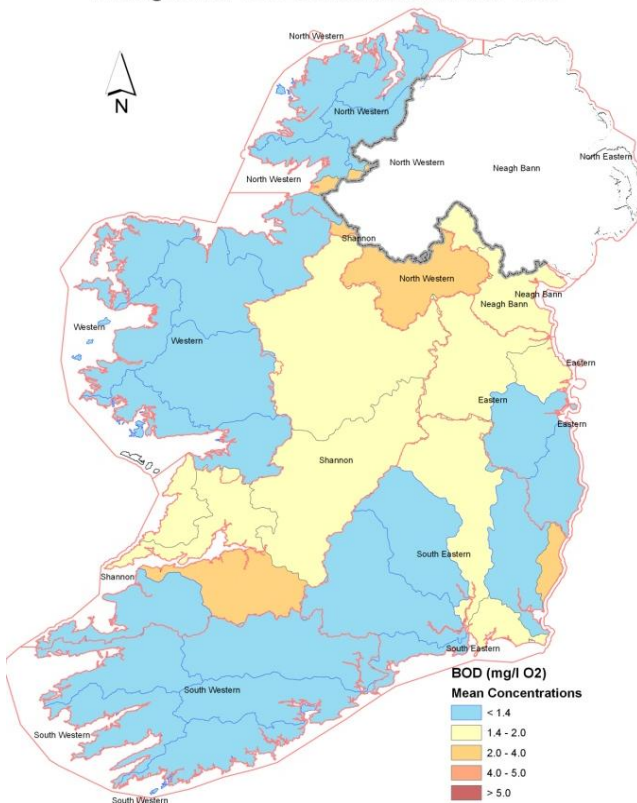
Average River Total Ammonia Concentrations 2007-2009



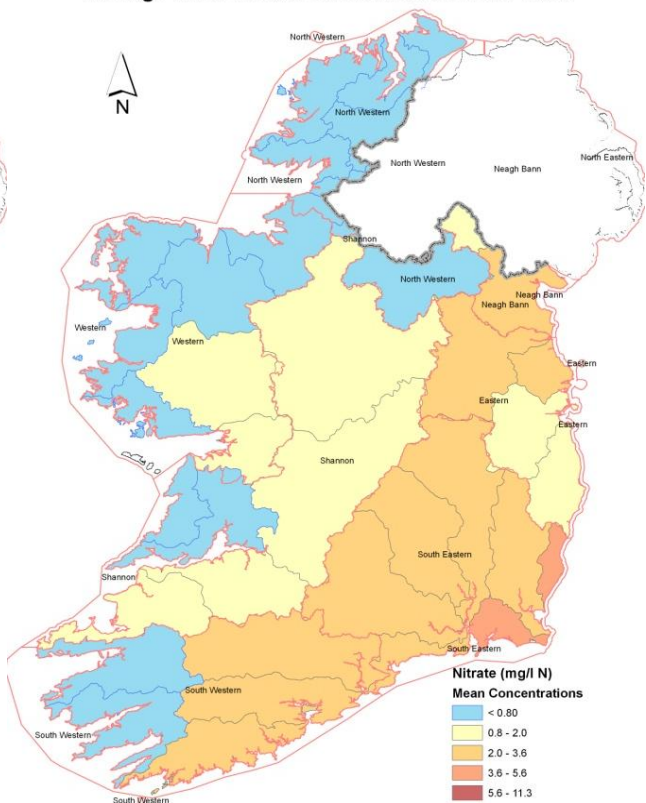
Average River ortho-Phosphate Concentrations 2007-2009



Average River BOD Concentrations 2007-2009



Average River Nitrate Concentrations 2007-2009



**Figure 3.8.** Maps showing average riverine concentration of oxygen consuming substances: ammonia and BOD, and nutrients: nitrate and phosphate. Results are averaged for all stations within hydrometric areas for the period 2007-2009 and are based on over 1,400 monitoring stations and 30,000 samples. The results are directly comparable with similar EEA-wide maps for the Wise SOE classifications: <http://www.eea.europa.eu/themes/water/interactive/water-live-maps/all-water-live-maps>

### RIVER WATER BODIES – COMBINED ECOLOGICAL STATUS

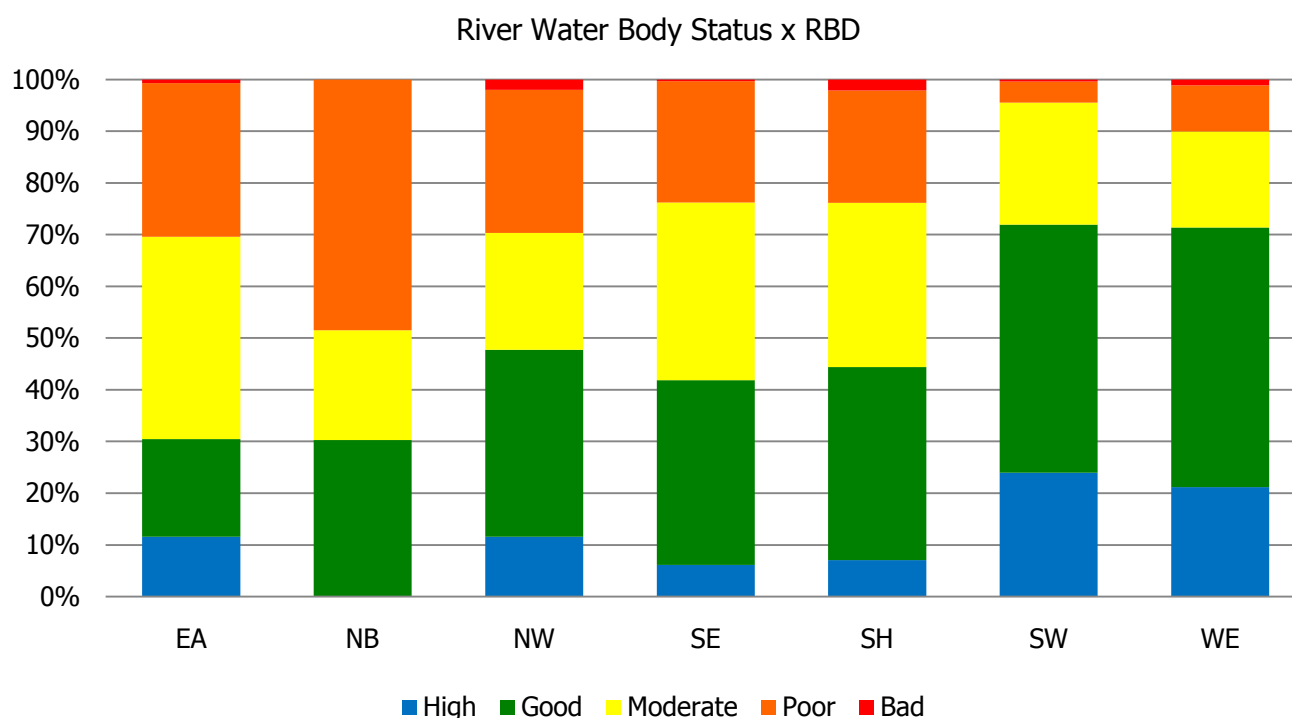
When the various biological and supporting physico-chemical quality elements are combined within individual river water bodies on a one-out-all-out basis a different picture is obtained. Table 3.4 and Figure 3.9 provide a breakdown by RBD and status for individual river water bodies.

The summary here can be compared with the water quality statistics above which were also broken down by RBD on a channel length basis. It can be seen that the overall ecological status seems lower than that based on

individual sites and quality elements. This is because the final ecological status of a water body is determined by the lowest status of the available quality elements at each site and also by the lowest status of the monitored sites within the water body – there may be more than one monitoring station within a river water body. The geographical distribution of river water bodies monitored during 2007-2009 is shown in Figure 3.10 below with colour coding for the one-out-all-out ecological status.

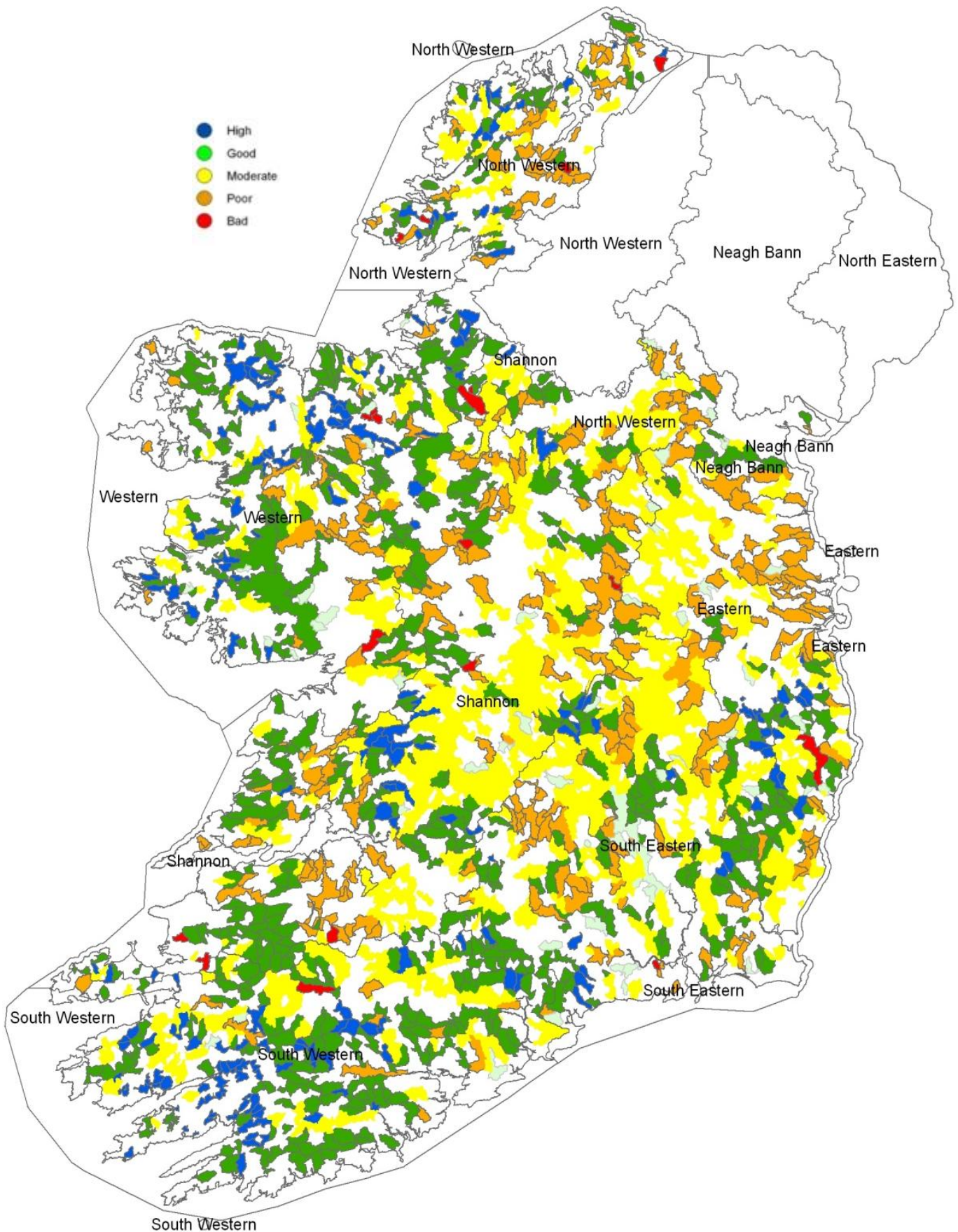
**Table 3.4.** Monitored River Water Bodies – Numbers within RBDs in each of the five ecological status categories based on one-out-all-out combination of quality elements

River Basin District	High	Good	Moderate	Poor	Bad	Totals
EA	16	26	54	41	1	138
NB	0	10	7	16	0	33
NW	23	72	45	55	4	199
SE	17	99	95	65	1	277
SH	27	142	121	83	8	381
SW	64	128	63	11	1	267
WE	57	135	50	24	3	269
National	204	612	435	295	18	1564
Percentage	13%	39%	28%	19%	1%	100%



**Figure 3.9.** Percentage breakdown of river water bodies within each RBD showing final ecological status based on lowest status for the available range of biological and physico-chemical quality elements within each water body.





**Figure 3.10.** Map showing ecological status for Irish monitored river water bodies based on lowest status by quality element and then lowest status by monitoring station within each water body. Blank areas indicate unmonitored water bodies.

## DANGEROUS SUBSTANCES MONITORING PROGRAMME

### Introduction

EPA surveillance monitoring for what are commonly known as the dangerous substances i.e. priority substances and priority hazardous substances was undertaken in 2007-2009. The programme included 33 substances or group of substances on the list of WFD Annex IX & X priority substances, including plant protection products, biocides, metals and other groups such as combustion by-products, polyaromatic hydrocarbons (PAHs), and the flame retardants polybrominated diphenyl ethers (PBDEs). Monitoring was also undertaken for the WFD Annex VIII list of 28 relevant or specific pollutants selected for Ireland in accordance with WFD criteria.

Monitoring was undertaken at each site at a frequency of 12 times per year once the programme commenced in mid 2007 (Table 3.5). The results are used to classify the water bodies by comparing them with the relevant quality standards. The results were also used to prioritise compounds for monitoring during the second WFD cycle, from 2010 to 2015.

### Environmental Quality Standards

Environmental Quality Standards (EQS) have been set by the European Commission for all of the priority pollutants (Directive 2008/105/EC) and are expressed as the annual average value (AA-EQS), for chronic exposure, and/or the maximum allowable concentrations (MAC-EQS), for acute exposure. The WFD dangerous substances along with their Irish EQS values are listed in EC Surface Water Regulations (S.I. No. 272 of 2009).

### Summary of Monitoring

All of the required Annex VIII, IX and X substances were included in the 2007-2009 monitoring programme. The levels of priority pollutants were generally very low with very few exceedances being found.

### Organic Compounds Monitoring including VOCs

#### Organics detected above MAC threshold

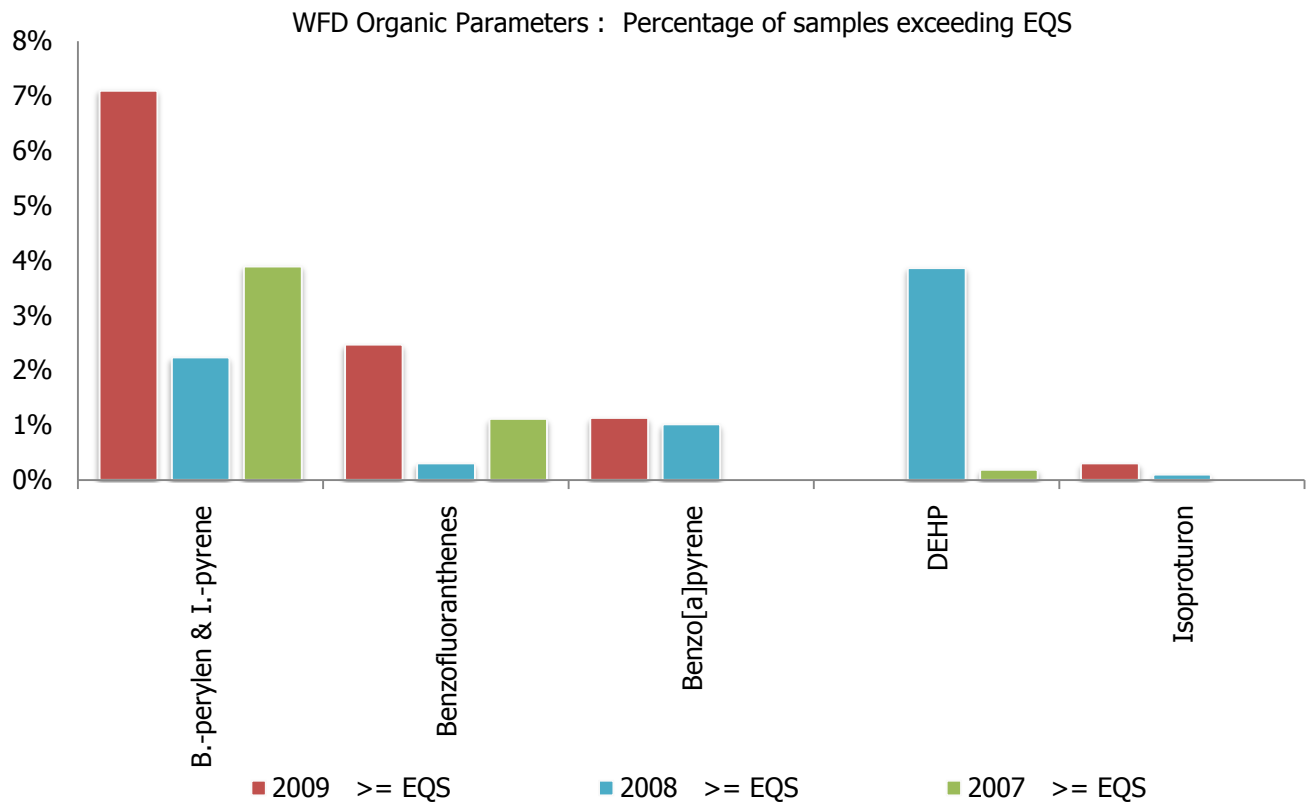
The compounds with exceedances and/or detects are shown in Figures 3.11 and 3.12 respectively, with the exception of four pesticide substances which were detected only once, chlorpyrifos-ethyl, penta chlorophenol (PCP), linuron and epoxiconazole. None of these detections were above the EQS.

Figure 3.11 indicates that there were exceedances for each of benzo[a]pyrene, di(2-ethylhexyl) phthalate (DEHP), benzofluoranthenes, isoproturon and the sum of benzo(g,h,i) perylene and indeno(1,2,3-c,d) pyrene.

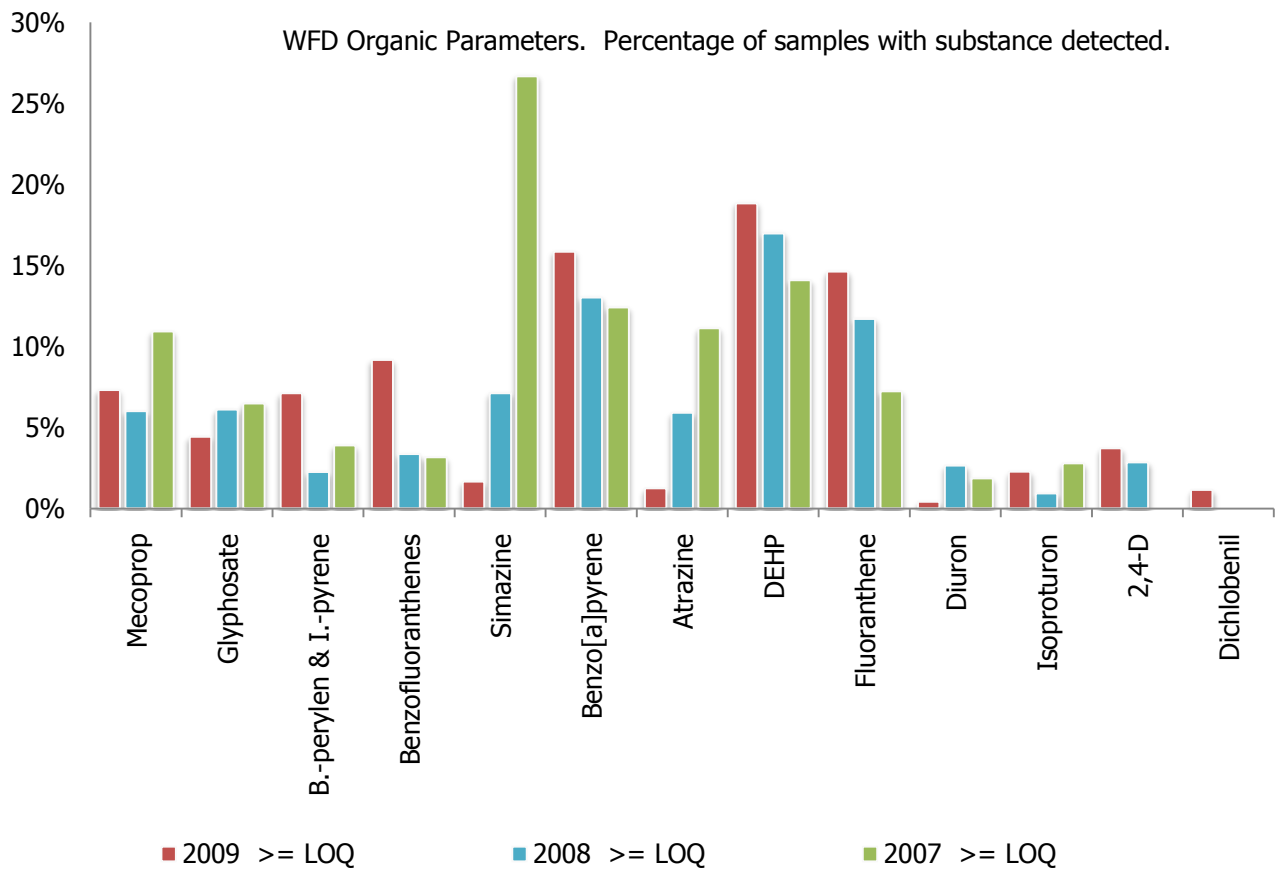
*Isoproturon* is a herbicide used against grasses and broad-leaved weeds in spring and winter cereal crops and owes its action to inhibition of photosynthesis. The very low number of exceedances of this compound (four from 2,500 samples) was confined to rivers in the eastern part of the country. *DEHP* is widely used as a plasticizer in manufacturing of articles made of PVC due to its suitable properties and low cost. Its ubiquitous nature indicates that it will inevitably be found regularly in water samples. The overall levels found were low when compared against its occurrence in a European context.

**Table 3.5.** Numbers of river and lake sites sampled with frequency and numbers of samples taken for priority substances and specific pollutant WFD monitoring.

Year	River sites	Lake sites	No of sampling visits	No of samples
2007	66	25	6	546
2008	57	25	12	984
2009	57	26	12	996
2007-2009	180	76	30	2526



**Figure 3.11.** Exceedances expressed as the percentage of samples with concentrations in excess of the relevant EQS values monitored in each of the first three years of the WFD surveillance monitoring cycle.



**Figure 3.12.** (Detects) The percentage of samples in which the substances were detected in each of the first three years of the WFD surveillance monitoring cycle. Note that the individual limits of detection and quantification vary depending on the substance. Typically the level of detection should be lower than the EQS AA or MAC.



#### *Polyaromatic Hydrocarbons (PAHs)*

The remainder of exceedances were from the PAH group, a substance category that is ubiquitous; with a number of diverse sources but are often linked to emissions to air. As PAHs have a strong affinity towards the solid phase, their occurrence in whole water samples is sometimes linked to conditions that lead to a temporary increase in the load of suspended particulate matter in the water body. No apparent geographical or seasonal pattern could be observed, indicating that instances of increased PAH concentrations in the monitored rivers and lakes do not originate from significant point sources.

The number of detects for benzo(g,h,i) perylene and indeno(1,2,3-c,d) pyrene corresponds to the number of exceedances of

their EQS, indicating the analytical method is not sufficiently sensitive for the extremely low annual average (AA)-EQS. No maximum allowable concentration (MAC) is provided for these parameters since the AA is deemed to be sufficiently protective for short term discharges. In the case of the other PAH compounds the methods are sufficiently sensitive to capture all the EQS exceedances.

In terms of actual compliance with WFD standards, it is not clear that a single exceedance of MAC at a sampling location will necessarily lead to failure of water body status. At the time of writing the issue of statistical treatment of once-off exceedances of the MAC is still subject to discussion at EU level.

#### **Box. 3.1a Persistent Chlorinated and Brominated Organic Contaminants in Irish Eels**

The occurrence of persistent chlorinated and brominated organic contaminants in the European Eel (*Anguilla anguilla*) in Irish waters has recently been investigated (McHugh *et al.*, 2010). Samples were taken from five Irish catchments (River Suir, Lough Conn, River Corrib, River Farne and Burrishoole) in October and November 2005 and confirmatory sampling also took place in Burrishoole in July 2007. The analysis looked at levels of dioxins, furans, polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs) and

chlorinated pesticides in eel muscle tissue. Elevated dioxins (especially octa-chlorinated dioxin (OCDD)) were found in eels from the Burrishoole catchment. The authors propose that this would strongly suggest point source influences at this location and further investigation is ongoing. However, with the exception of higher substituted dioxins in three samples from this one catchment, persistent organic pollutant (POP) levels in general were low in eels from Irish waters compared to those in other countries.

#### **Box. 3.1b Future Concerns in Relation to Organic Contaminants**

Future concerns include the possible impact of insecticides used for sheep dipping and control of pine weevil in forestry. Signs of toxicity revealed by reduced diversity of aquatic macroinvertebrates in some upland rivers suggest that cypermethrin and/or pesticides

such as diazinon should be analysed for in catchments thought to be at risk. Cypermethrin has recently been suggested as a new candidate priority substance and it has already been banned in some EU member states.

**Compounds detected above LOQ (level of quantification) but below MAC**

A much wider range of substances were detected at levels below the MAC. Figure 3.12 shows the frequency of substances which were detected as a percentage of the total number of samples.

Apart from the PAH group discussed above, the other main category of organic substances which were detected were pesticides and herbicides. It was particularly noteworthy that both simazine and atrazine, which have been effectively banned since 30 June 2007 as a result of their risk of leaching to ground water, show an approximately 90 % reduction in

detection frequency over the 2007-2009 period.

The widely used herbicides mecoprop and glyphosate both show an approximately 5-10% detection level for the period although no high concentrations of concern were noted.

Some other pesticides such as 2,4-D and dichlobenil were added after the commencement of the programme since they were being found occasionally in drinking water monitoring. However, WFD monitoring for these parameters have not given rise to any significant concern.

**Table 3.6.** Summary of priority metals exceeding EQS in the 2007-2009 Surveillance Monitoring Programme.

Type	Metal	Code	Name	AA-EQS	No. Samples	No. Samples Detected	Mean (µg/l)	Median (µg/l)
RW	Zinc	10A031100	Avoca	50	12	12	112	102
RW	Zinc	10G050200	Glenealo	8	12	12	62	55
LK	Zinc	EA_10_25	Tay	8	12	12	14	13
LK	Zinc	EA_10_29	Dan	8	12	12	10	9
RW	Copper	10A031100	Avoca	5	12	12	7	
RW	Copper	40B020400	Bredagh	5	6	6	6	
RW	Copper	39B020600	Burnfoot	5	6	6	5	
RW	Cadmium	10A031100	Avoca	0.08	30	28	0.32	
RW	Cadmium	10G050200	Glenealo	0.08	12	12	0.28	
RW	Cadmium	33G010100	Glenamoy	0.08	11	1	0.10	0.05
RW	Mercury	09L012350	Liffey	0.05	12	1	0.05	

## METALS MONITORING OVERVIEW

In total over 3,000 samples were analysed for metals over the period 2007-2009 at surveillance monitoring sites and additional to OSPAR and the EU Freshwater Fish Directive sites. Generally, the occurrence of environmentally significant metals in Irish waters is low with the 95<sup>th</sup> percentile for measured concentrations typically lying below relevant standards. Table 3.6 shows those metals exceeding their EQS in the 2007-2009 Surveillance Monitoring Programme. The overall results are summarised in Appendix 3.4 which includes the full suite of metals analysed for in rivers and lakes during 2007-2009. Figure 3.13 shows the distribution of metals results relative to applicable EQS and Figure 3.14 maps the results for rivers showing the majority of sites where no metals were detected contrasted against those sites listed in Table 3.6 where at least one metal exceeded the relevant EQS. Additionally, it should be noted that metal levels in the vicinity of mining sites may be significant in some locations but not all of these are included in the surveillance monitoring programme.

## Priority Hazardous Substances – Metals

### *Mercury and Cadmium*

Cadmium and Mercury are both designated as Priority Hazardous Substances in the Surface Water Regulations (S.I. No. 272 of 2009). Mercury was not detected in the vast majority of samples at the limit of detection. One sample from the Liffey at Chapelizod, had a reported result of 0.1 µg/l which exceeds the MAC-EQS for mercury (0.07 µg/l) but subsequent monitoring at this site failed to detect mercury. Of the three sites at which cadmium was detected, above the EQC, one Glenamoy at Glenamoy Bridge, was associated with a single detection (Table 3.6) Two sites, at the Avoca (at New Bridge) and Glenealo (Bridge d/s Upper Lake), consistently showed cadmium levels above the relevant AA-EQS for these sites. One sample from the Avoca (0.6 µg/l), exceeded the MAC-EQS of 0.45 µg/l for cadmium in waters with a hardness < 40 mg/l CaCO<sub>3</sub>.

## Priority Substances – Metals

### *Nickel*

The highest Nickel results were less than half the EQS of 20 µg/l.

### *Lead*

No sites were identified with an average lead concentration higher than the EQS of 7.2, although one sample from the Glenealo River had a concentration of 8.0 µg/l.

## Specific Pollutants

### *Arsenic*

Arsenic was not found at levels approaching the EQS (25 µg/l) in any of the sites monitored.

### *Chromium*

Chromium analyzed by ICP-MS cannot distinguish between Cr III and Cr VI forms. In the absence of this speciation all results were compared against the lower Cr VI limit. For the years 2007 and 2008 no exceedances of the chromium limit were observed. A number of sites showed possible low-level exceedances in 2009 (ranging from 4 – 6 µg/l). The rivers affected all had hardness levels greater than 200 mg/l CaCO<sub>3</sub> and the observed chromium may be an artefact of the measurement process, associated with the high hardness levels. These potential exceedances are currently being investigated and chromium will continue to be monitored in the interim.

### *Copper*

Copper was not found at levels approaching the higher EQS of 30 µg/l for waters with a calculated hardness > 100 mg/l CaCO<sub>3</sub>. It was however measured above or close to the lower EQS of 5 µg/l for three sites with a calculated hardness of < 100 mg/l CaCO<sub>3</sub> (Table 3.6).

### *Zinc*

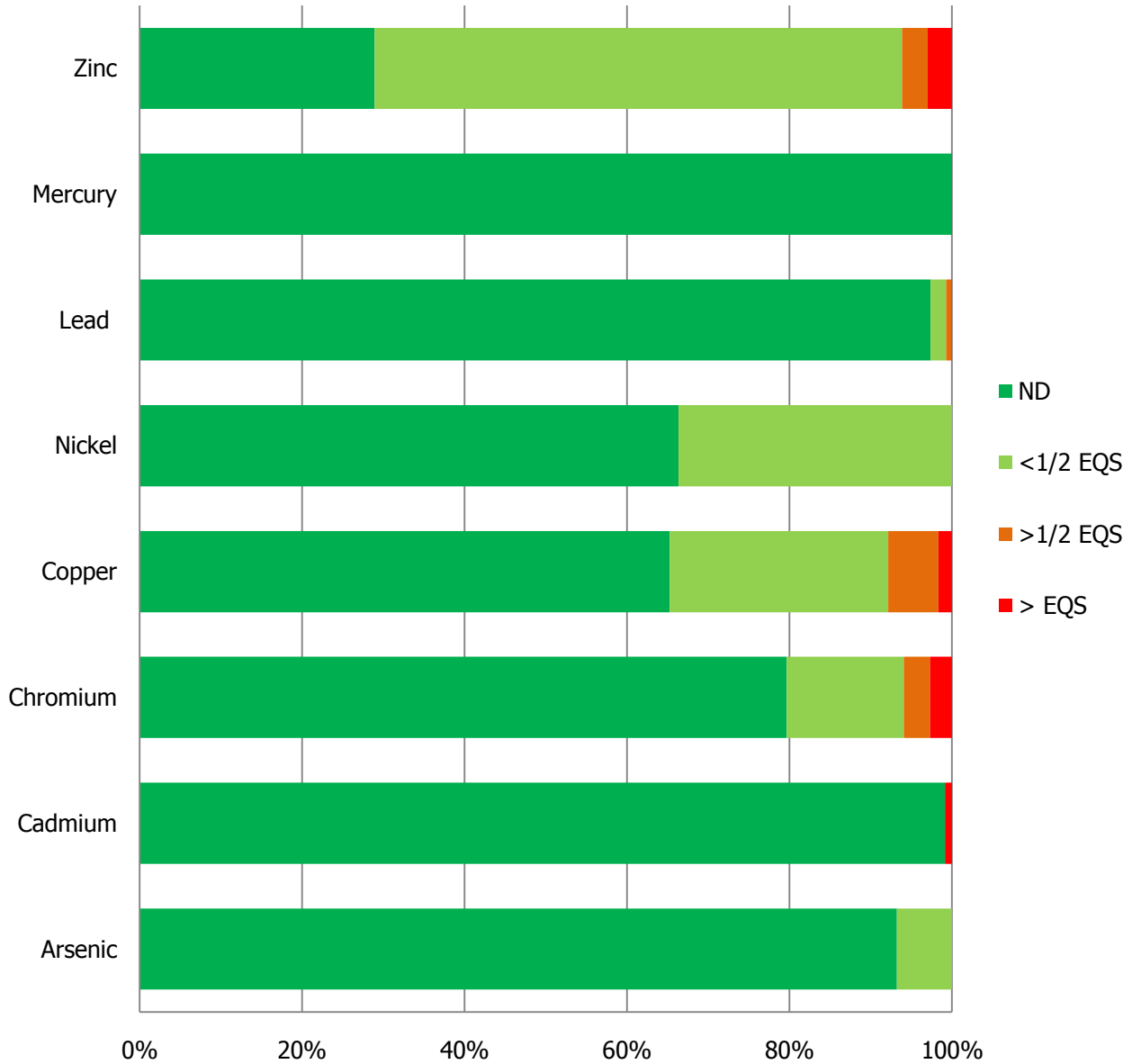
Zinc is a ubiquitous element in the environment and consequently turns up as a contaminant in samples. The median value of zinc may be a better estimate of the actual concentration than the arithmetic mean and for the results below, this approach has been adopted. There are three separate EQS values for zinc depending on water hardness – for water bodies with hardness ≤ 10 mg/l CaCO<sub>3</sub>,



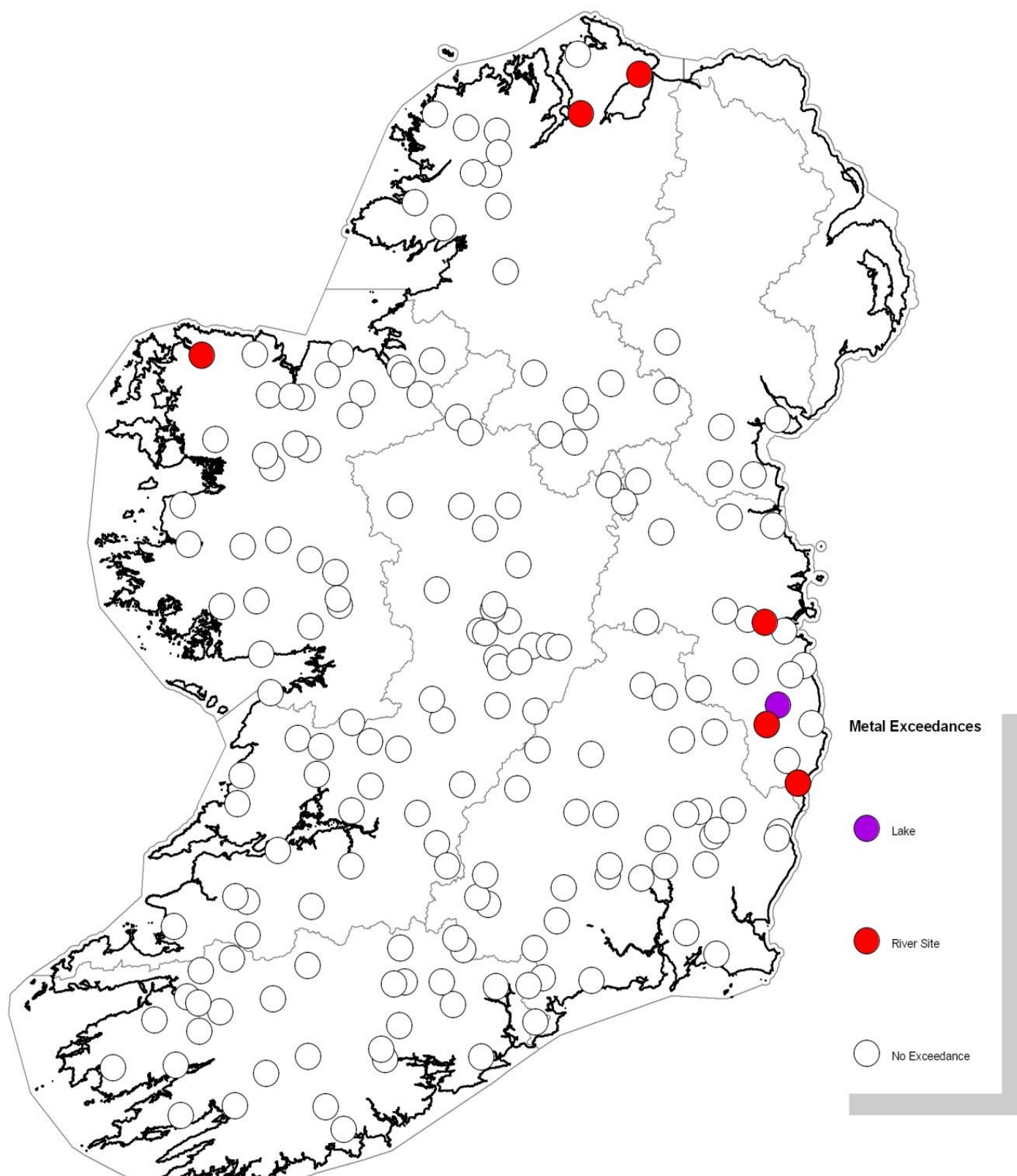
an EQS of 8 µg/l is applicable. Three stations consistently exceeded this EQS, namely Gleneao, Lough Tay and Lough Dan. For water bodies with a hardness between 10 and 100 mg/l CaCO<sub>3</sub> an EQS of 50 µg/l is applicable.

One site, Avoca – New Bridge, exceeded this EQS. For high hardness waters, > 100 mg/l CaCO<sub>3</sub>, no station approached the EQS of 100 µg/l for zinc.

Breakdown by Parameter and EQS



**Figure 3.13.** Distribution of metals results relative to applicable EQS



**Figure 3.14.** River sites sampled intensively for metals showing non-detects as open circles and locations where at least one metal pollutant prioritised under WFD monitoring exceeded its EQS in 2007-2009 shown in colour – red for river sites and purple for lakes (Lough Tay and Lough Dan in Wicklow).

### Box. 3.2 Weather and River Flows in the Period 2007-2009

During the 2007-2009 period many areas of the country experienced a wide range of climatic conditions which had impacts on water levels and corresponding flows. In particular all three summers were relatively wet with that of 2009 extremely wet. In 2007, the distribution of rainfall over the year was very uneven. The annual rainfall totals were above normal over most of Leinster, but were well below normal near southern and south-eastern coasts. The months of June, July and August 2007 were exceptionally wet, especially over the eastern half of the country, where more than twice the normal summer rainfall was recorded at some stations. In contrast, the subsequent months were very dry and 2007 had the driest autumn for more than 30 years in many places. The heaviest daily rainfalls of 2007 were associated with thunderstorms during the summer months, particularly in June and August.

In 2008, annual rainfall totals were above normal everywhere and it was the wettest year for between six and 22 years generally, but for a longer period at some western stations. The distribution of rainfall in 2008 was also very uneven; as after a relatively dry spring, there followed a spell of very wet weather between late May and mid-September. The summer period was exceptionally wet for the second year running. The summer of 2008 also brought the heaviest daily falls, leading to flooding in many parts of the country. In 2009, the annual rainfall totals were well above normal. Like the previous two years, the summer period of June to August was extremely wet, while November 2009 was the wettest November since records began at most stations and the wettest of any month on record in several places. The driest months of 2009 relative to normal were March and September (Met Éireann).

The variation in rainfall was reflected in the runoff pattern, with an increase in runoff with increased rainfall and a reduction in runoff

after rainfall ceased. In the three year period 2007-2009, the low flow at all hydrometric stations was above the long term 95 percentile flow rate. There was flooding on the East coast on 9 August and 5 September 2008, but runoff was historically high in the months of November-December 2009 in the Avoca, Bandon, Erne, Lee and Shannon Catchments, causing widespread flooding.

During low flow periods, the impact of point source discharges is enhanced in the downstream reaches below such discharges due to lower levels of dilution, this being particularly noticeable during the growing season. In contrast, the impact of diffuse discharges such as agricultural runoff from fields or farmyards, for example, will tend to be greater during wetter periods. Flood events result in wash-off and leaching of pollutants, especially from more highly fertilized soils, causing increased phosphorus concentrations in rivers during flood events. This is particularly problematic if such floods occur during the growing season as eutrophication can result. The eutrophication of Lough Leane in Killarney following a major rainfall event during the summer of 1997 is an example of this effect. The increased loading that results during flood events can deliver large quantities of nutrients to lakes and coastal waters. The exceptionally heavy rainfall brought extensive flooding during the late summer of 2009 and again during November 2009, especially in the Bandon, Erne, Lee and Shannon catchments.

The relatively high rainfall of 2008 and 2009 will have resulted in increased recharge to groundwater aquifers in many parts of the country. Increased rainfall can also result in an increased impact of pollution on shallow water in groundwater systems, rivers, canals and lakes the effects of which may, however, be attenuated by the greater dilution (See also Chapter Two and section on Fish Kills in this Chapter).

## WATER QUALITY AND ECOLOGICAL POTENTIAL OF CANALS AND THEIR FEEDER STREAMS

### Introduction

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).\*

An assessment of the water quality of Irish canals has been included in the previous four national reports on water quality covering the periods 1995-1997 (Lucey *et al.*, 1999), 1998-2000 (McGarrigle *et al.*, 2002), 2001-2003 (Toner *et al.*, 2005) and 2004-2006 (Clabby *et al.*, 2008). 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 who undertook surveys in the current period of reporting, i.e. 2007-2009. The results were gleaned from reports to Waterways Ireland (C. McCarthy, pers. comm.), from CFB, covering the monitoring periods July 2006-June 2009 (Central Fisheries Board, 2009) and July-December 2009 (Tara Gallagher, pers. comm.).

The Water Framework Directive (WFD) allows for these water bodies to be designated as Artificial Water Bodies (AWB) and they 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 out requirements for

ecological potential. Good chemical status must also be achieved. The main canal systems, the Royal and Grand Canals and sections of the Shannon-Erne Waterway have been identified as Artificial Water Bodies (AWBs) under the Water Framework Directive (WFD).\*\* For classification purposes the ecological potential can be maximum, good, moderate, poor or bad. The interim classification of ecological potential for Irish canals, based on chemical, biological and hydromorphological data, is shown in Table 3.7 (Waterways Ireland and Central Fisheries Board, 2008).

In a project, to investigate the use of two biological quality elements (macroinvertebrates and macrophytes) specified in Annex 5 of the WFD, it was found that the low diversity of macrophytes in the canal habitat in Ireland may militate against these being used successfully to establish Ecological Quality Ratios (EQRs) for status classification purposes. Therefore, it was concluded that macroinvertebrates and physico-chemistry were a better indicator of impact (Millane *et al.*, 2009). The Irish canal network poses a difficulty for such studies in that a gradient of impacted sites is not available to establish class boundaries for moderate, poor and bad ecological potential, illustrating the generally good water quality prevailing in these artificial water bodies. The parameters measured in the monitoring programme, with their limit values, are shown in Table 3.8. Since 2005 chlorophyll concentrations have been measured at a number of sites along the canals as a parameter for assessing trophic status (See Table 4.1 in Chapter Four, for scheme of classification used for lakes and canals).

\* With effect from 1 July 2010 the Central and seven Regional Fisheries Boards were incorporated into, and replaced by, Inland Fisheries Ireland (IFI) in accordance with the Inland Fisheries Act (2010).

\*\* AWB is defined in Article 1 of the WFD as 'a body of water created by human activity'. Annex V of the Directive sets out requirements for ecological potential. Good chemical status must be achieved.

**Table 3.7.** Interim Status Classification, for Water Framework Directive (WFD) purposes, of Artificial Water Bodies.

Artificial Water Body	River Basin District	Length (km)	Number of locations	Interim Status
Royal Canal Main Line East of Lough Owel (RCEEa)	Eastern	82.8	10	GEP
Royal Canal Main Line West of Lough Owel (RCWSh)	Shannon	41.7	5	<GEP*
Grand Canal Main Line East of Lowtown (GCEEa)	Eastern	41.4	6	GEP
Grand Canal Main Line East of Lowtown (GCESe)	South	4.2	1	GEP
	Eastern			
Grand Canal Main Line West of Lowtown (GCWSe)	South	25	5	GEP
	Eastern			
Grand Canal Main Line West of Lowtown (GCWEa)	Eastern	14.6	1	GEP
Grand Canal Main Line (GCWSh)	Shannon	46.5	7	GEP
Grand Canal Naas & Corbally Branch (GCNLEa)	Eastern	12.1	1	GEP
Grand Canal Milltown Feeder & Old Barrow Line (GCMFSe)	South	11.7	1	GEP**
	Eastern			
Grand Canal Barrow Line (GCBLSe)	South	46	4	GEP
	Eastern			
Shannon-Erne Waterway (SESh)	Shannon	6.3	1	GEP

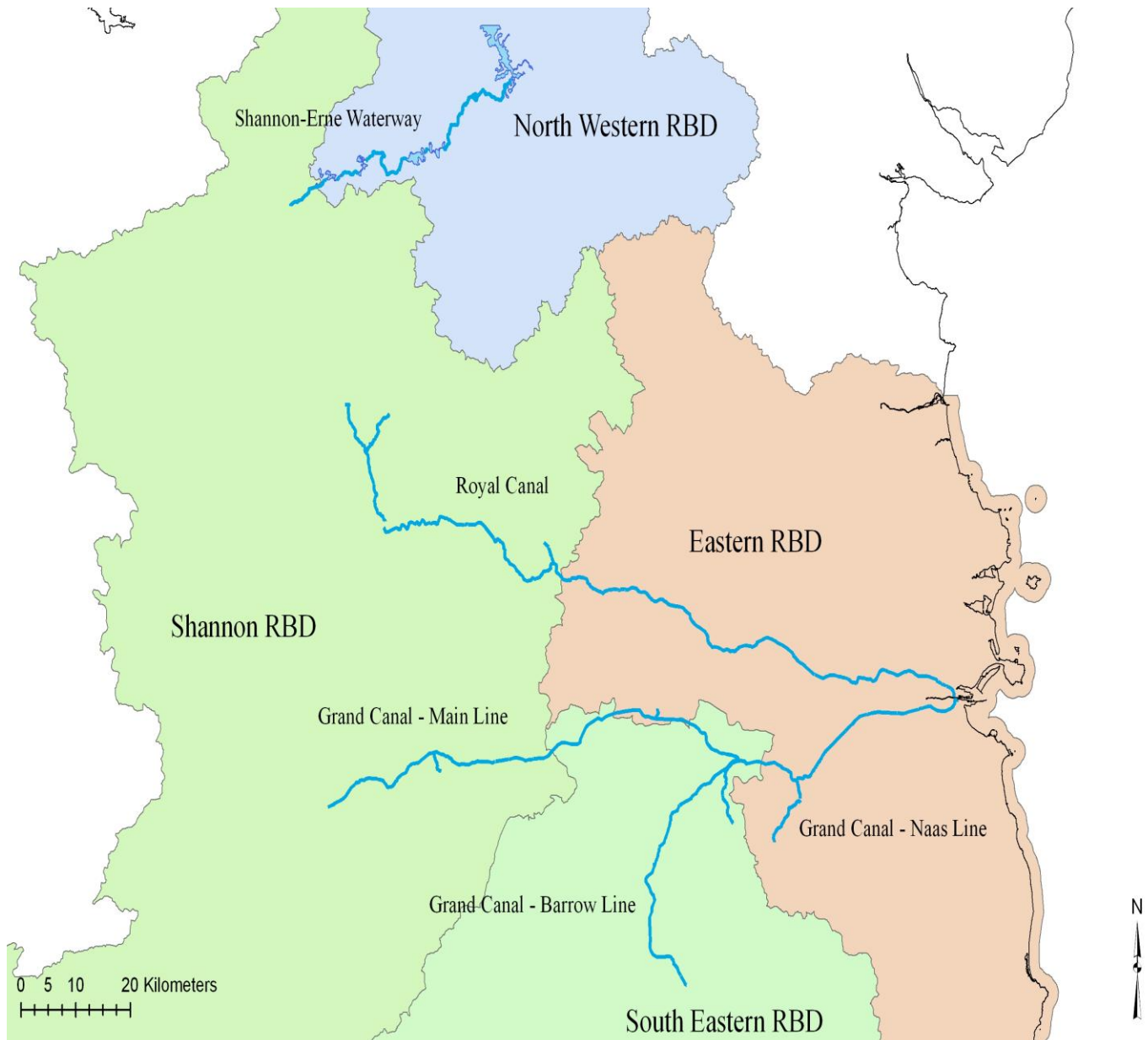
\* Canal section RCWSh under restoration so classed as less than GEP on hydromorphological element.

\*\* Sampling of the Grand Canal Milltown Feeder (GCMFSe) began in September 2009.

**Table 3.8.** Interim water quality standards for parameters measured as part of Water Framework Directive (WFD) monitoring for Artificial Water Bodies (AWBs)

Parameter	Maximum Limit
Total Phosphorus (TP)	0.063 mg/l P
Molybdate Reactive Phosphorus (MRP)	0.02 mg/l P
Soluble Reactive Phosphorus (SRP)	0.02 mg/l P
Total Oxidised Nitrogen (TON)	11.3 mg/l N
Total Ammonia	0.12 mg/l N
Dissolved Oxygen (DO)	>5.0 mg/l O <sub>2</sub>
Biochemical Oxygen Demand (BOD)	<2.5 mg/l O <sub>2</sub>
Total Coliforms (TC)	5000/100 ml
Faecal Coliforms (FC)	1000/100 ml
Chlorophyll	<25 mg/m <sup>3</sup>





**Figure 3.15.** Map showing Royal Canal, Grand Canal (including Barrow and Naas Lines) and Shannon-Erne Waterway with River Basin Districts (RBDs), in which they occur, delineated (Map courtesy of Waterways Ireland).

#### Overall Water Quality of Canals and their Feeder Streams

Monitoring of the AWBs in the Royal and Grand Canals and the Shannon-Erne Waterway for WFD purposes commenced in 2006. This has involved monitoring of the biological quality elements (macroinvertebrates and aquatic macrophytes) and physico-chemical monitoring over the period 2006-2009. To achieve compliance with the WFD, there are clear guidelines with regard to the frequency of sampling: macroinvertebrates are sampled once every three years (Spring and Autumn), macrophytes annually (Autumn) and physico-chemical samples are collected four times per annum. For the purposes of WFD monitoring,

the Royal and Grand Canals and the Shannon-Erne Waterway are divided into a number of water bodies according to the River Basin Districts (RBDs) in which they occur. Water quality monitoring was carried out in 11 AWBs (Table 3.7. and Figure 3.15.) which involved collecting water samples from a total of 42 sites.

Water quality monitoring over the period 2007-2009 indicated generally good conditions in the Royal and Grand Canal systems and in the canalized section of the Shannon-Erne Waterway. Breaches of the limits used for

assessment, 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 results for 2007 and 2008 were summarized in the most recent water quality indicators report (Lucey, 2009) so the emphasis here will be on monitoring carried out in 2009. Breaches of the criteria for water quality during the reporting period were mainly due to raised phosphorus (as measured by TP and MRP) and microbiological (total and faecal coliforms) levels. The trend in annual mean value for four parameters, total phosphorus, total oxidised nitrogen, chlorophyll and faecal coliforms is shown in Figure 3.16

#### **Grand Canal**

Water quality in the Grand Canal was generally good in 2009 when five of the eight AWBs were compliant with the criteria set for nutrients and coliform bacteria. Three of the Grand Canal main channel water bodies, GCESe, GCEEa and GCWSe, breached the criteria with the first of these, comprising the single site GCE1 (Robertstown), having raised ammonia (0.124 mg/l N) in November 2009. In August 2009 the threshold value for faecal coliforms was exceeded in GCEEa, between Sallins and Baggot Street Bridge in the city, due to high counts in the feeder streams at Hazelhatch, Ponsonby Bridge and Monread. Similarly three sites in GCWSe, between Allenwood and Daingean, had raised MRP in November 2009 which has been attributed to the Ballylennon feeder. Of all the AWBs in the monitoring programme, GCWSe experienced the highest number of breaches in nutrients over the period of reporting. The majority of breaches occurred at three sites in this water body, i.e. downstream of Rhode Bridge, downstream of Killeen Bridge and upstream of Daingean, where elevated levels of TP, MRP and ammonia were recorded on a number of occasions. Faecal coliforms were also elevated at these three sites in August 2008. The Ballylennon and Ballymullen feeder streams

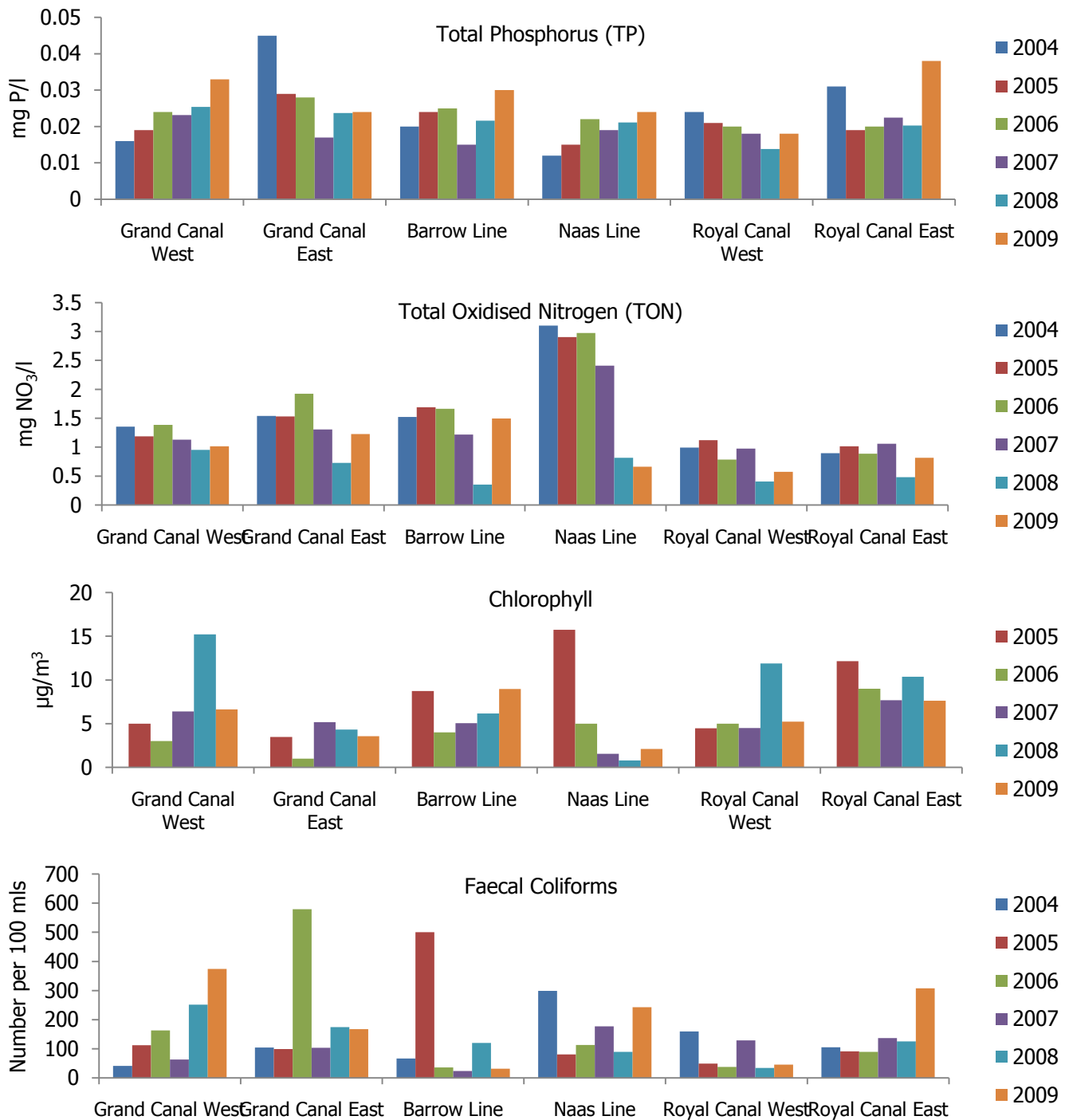
regularly breach nutrient and coliform limits and it is likely that these feeders are responsible for elevated levels in the main channel. The suspicion is that diffuse agricultural pollution may be impacting on this water body occasionally.

#### **Royal Canal**

Water quality in the Royal Canal was good during 2009 particularly in the water body which stretches from the Lough Owel feeder to Ballybrannigan Harbour (RCWSh). In the stretch between Lough Owel and Dublin (RCEEa), however, both TP and MRP threshold limits were breached in November 2009 where usually good quality is recorded. November 2009 was notable for high rainfall and consequent severe flooding (Walsh, 2010) which could account, through run-off, for the higher than normal values recorded for some parameters in canal sections.

#### **Shannon-Erne Waterway**

Water quality in the Shannon-Erne Waterway AWB (SESh) was good with nutrients and faecal coliforms below threshold limits during the July-December 2009 surveys. However, a few breaches occurred at the canal site on the Shannon-Erne Waterway over the three year period. Total Phosphorus readings were above the threshold in August 2006 (0.07mg/l), March 2007 (0.068mg/l) and August 2008 (0.07mg/l), while MRP levels were at the limit (0.02mg/l) in November 2007. Faecal coliform results were good for the most part although a high count (1434/100ml) was measured in August 2008. Water quality of the canals/AWBs remained relatively good in the period. Some locations exhibited higher than usual levels for some parameters in November 2009 when extreme rainfall was recorded (Walsh, 2010). While the very poor (i.e. wet) summers in the three consecutive years (2007-2009) of the reporting period might have, through dilution, mitigated the biological effects of pollution (See section on Fish Kills in this chapter) they would, through run-off in the short-term, have led to increases in certain parameters.



**Figure. 3.16.** Annual mean values for four parameters in the Grand Canal and Royal Canal sections in the period 2004-2009. 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.

### CAUSES OF POLLUTION - RIVERS 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 specify 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 the 2007-2009 biological survey 953 surveyed sites were of less than good ecological status due to pollution or hydromorphological pressures. Suspected causes of pollution are summarized in Figure 3.17. Of the 2515 sites surveyed in the 2007-2009 period 953 were polluted or of less than good status. These were examined in some detail to assess the primary cause of pollution in each case. Up to four different potential causes of pollution were assigned to each site and an assessment made as to the severity of each cause. The breakdown discussed here only applies to the primary cause of pollution in each case. As in previous surveys the two most important causes of pollution are agriculture and municipal wastewater discharges accounting for 47 and 39 per cent respectively of the 953 polluted sites surveyed.

### **Slight Pollution**

More than half of the cases of slight pollution (which typically corresponds to moderate ecological status under the Water Framework Directive assessments) was attributed to agriculture – primarily diffuse agricultural pollution causing eutrophication – and accounted for 297 of the 547 sites in this category. Municipal sources accounted for 178 slightly polluted sites. The majority of these latter were due to nutrient losses from municipal wastewater treatment plants, but also a wider range of urban impacts such as diffuse urban runoff, landfills, smaller onsite wastewater treatment units, engineering works, road and rail runoff and water treatment works. Siltation from building of major roads was an issue during the wet summer of 2008 in particular. Forestry and various industrial pollution sources each accounted for 4 per cent of slight pollution recorded. In this analysis the impact of eutrophic lakes has been assigned insofar as is possible to primary sources in the lake catchments. A miscellaneous group of causes accounts for another 15 sites and includes effects such as siltation and quarrying, hydromorphological impacts, lake effects where the impact on the site was unclear and one 'unknown' case where the source was not obvious. Finally two cases of aquaculture impacts and five sites where peat bog

exploitation was giving rise to nutrients losses and/or siltation.

### **Moderate Pollution**

The surveys found 386 river sites that were moderately polluted. Moderate pollution, as indicated by the EPA's macroinvertebrate survey and supporting physico-chemical results, is most likely to be classified as poor ecological status under the Water Framework Directive. Municipal wastewater treatment plants and associated urban activities were the main cause of moderate pollution, accounting for 44 per cent of instances – 170 river sites. Wastewater treatment plants accounted for approximately 84 per cent of sites within the municipal category with diffuse urban runoff, water treatment plant discharges, engineering works and landfills, making up the remainder of the municipal category. Agricultural pollution accounted for 39 per cent of the moderate pollution recorded – primarily diffuse losses including farmyard losses, siltation due to bank erosion and cattle access to streams, phosphorus loss from riparian areas and nitrate losses from tillage land. The remaining 17 per cent of sites classified as moderately polluted were impacted by a variety of pressures – industrial discharges and forestry accounting for 18 and 17 sites respectively with peat harvesting and aquaculture next, with 7 and 4 sites respectively, and finally a miscellaneous group of impacts including quarrying/siltation, groundwater, lake effects and hydromorphological issues accounting for 4 per cent of this category (16 sites).

### **Serious Pollution**

There were 27 river sites classified as seriously polluted (bad ecological status) at some point during the course of the 2007-2009 survey. Of these, seven sites improved in quality when they were re-surveyed subsequently to assess programmes of measures. This brought the final total down to 20 seriously polluted sites (Table 3.9). This represents a significant improvement on the 2004-2006 situation when 39 locations were found to be seriously polluted. Municipal wastewater treatment plants accounted for 15 of the original seriously polluted sites but seven of these improved to moderate or slightly polluted

conditions between 2007 and 2008 or from 2008 to 2009 when re-surveyed to give a final figure of nine of the seriously polluted sites being due to municipal waste discharges. There are eight wastewater treatment plants associated with the nine locations identified in Table 3.9 as being polluted by municipal sources. These wastewater treatment plants are Raphoe (Co. Donegal), Dromcollagher (Co. Limerick), Mullingar (Co. Westmeath), Clonaslee (Co. Laois), Roscommon Town (Co. Roscommon), Athenry (Co. Galway), Tubbercurry (Co. Sligo) and Merville (Co. Donegal). The Agency has granted wastewater discharge licences for Mullingar (Co. Westmeath) and Clonaslee (Co. Laois). The licences require improvement works to be carried out to the wastewater treatment plants to mitigate the impact of the discharge from the treatment plants on the receiving waters. The wastewater treatment plants at Raphoe (Co. Donegal), Dromcollagher (Co. Limerick), Roscommon Town (Co. Roscommon), Athenry (Co. Galway), Tubbercurry (Co. Sligo) and Merville (Co. Donegal) are being addressed by the Agency through the wastewater discharge licensing regime also. The Agency will ensure that appropriate mitigation measures are put in place to address the impact the discharges

from these wastewater treatment plants are having on the receiving waters.

A further three were due to agricultural discharges. Three instances were due in particular to a major landslide or bog burst caused by engineering works associated with wind farm construction affecting the Arigna and Owengar river catchments in August 2008. The remaining sites were impacted by mining, landfill, forestry and construction activities.

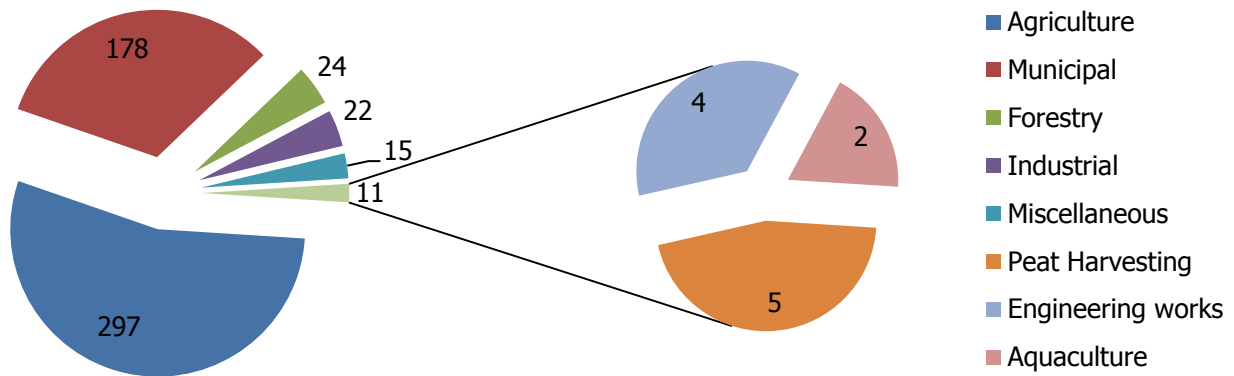
## CONCLUSIONS

The quality of Irish rivers has gone through a series of trends over the past 40 years since monitoring began. The initial decline in the extent of the most seriously polluted rivers was rapid until approximately 100 km of highly polluted channel remained. A further improvement in this was noted in the comparison between the 2004-2006 period and the 2007-2009 period under consideration in this report with a halving of the number of seriously polluted sites. The increase in eutrophication seen through the 1980s and 1990s now appears to have stabilised with year to year variation in quality probably within the normal year to year climate variation and its effect on pollutant transport into surface waters (See Box 3.2).

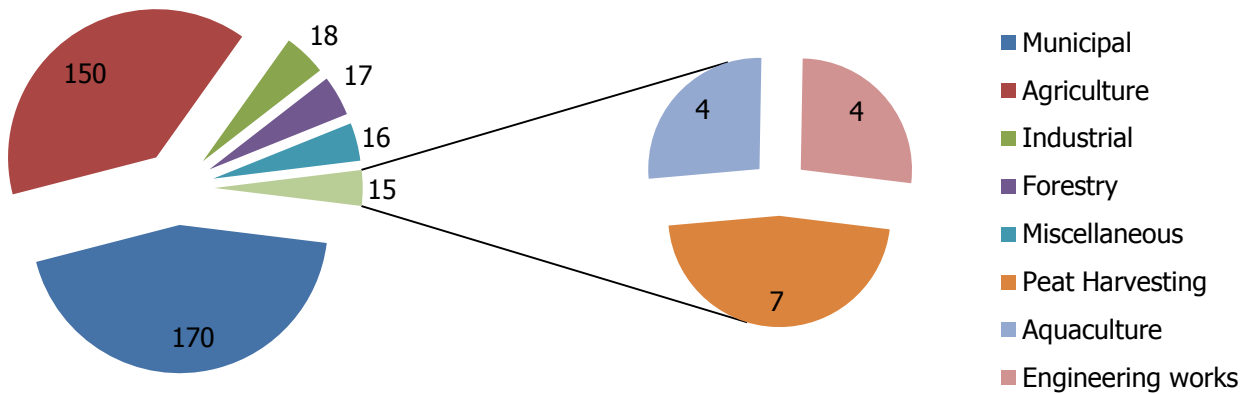
**Table 3.9.** Seriously polluted river locations 2007-2009 with suspected cause of pollution

River Name	Code	Location	Suspected Cause of Pollution
Brogeen (Cork)	18B060100	Br N of Islandav	Agriculture
Lee (Tralee)	23L010030	Ahnambraher Br (RHS)	Agriculture
Roosky (Donegal)	40R010200	Mullinroe Bridge	Agriculture
Arigna (Roscommon)	26A020100	At Altagowlan School	Engineering works
Arigna (Roscommon)	26A020300	Mount Allen Bridge	Engineering works
Gowlaunrevagh (Leitrim)	26G120050	Br S Glassalt	Engineering works
Ballaghdoe (Donegal)	37B010050	Br WNW Meenychanon	Engineering works/Forestry
Roechrow (Donegal)	37R010100	N Br SSW Meenateia	Forestry
Laurencetown (Galway)	26L070300	Br NW Ballyhoose (West Br)	Industrial
St John's (Donegal)	16S030300	Bleach Bridge	Landfill
Swilly Burn (Donegal)	01S030200	Br 1.5 km SE of Raphoe	Municipal
Ahavarraga (Limerick)	24A020400	Br 0.5 km d/s Priests Br	Municipal
Brosna (Westmeath)	25B090100	Butler's Br	Municipal
Clodiagh (Tullamore)	25C060220	Just u/s Gorrage R confl	Municipal
Jiggy (Hind) (Roscommon)	26J010090	Br WSW Ardsallagh Beg	Municipal
Clarínbridge (Galway)	29C020300	Br N Mulpit	Municipal
Tubbercurry (Sligo)	34T020050	Br 1 km W. of Tubbercurry	Municipal
Tubbercurry Stream (Sligo)	34T030400	At old railway bridge	Municipal
Bredagh (Donegal)	40B020400	Br in Merville	Municipal
Avoca (Wicklow)	10A030700	Avoca Br	Mining

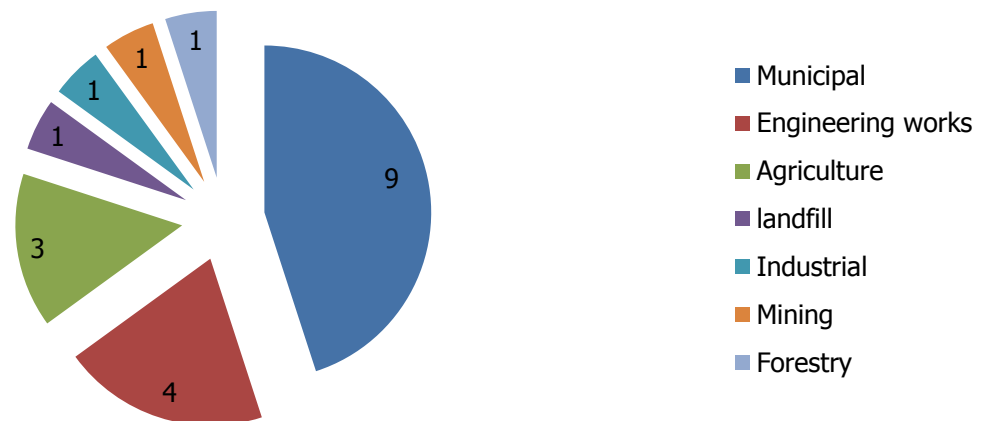
Suspected Causes of Slight Pollution - 547 Sites



Suspected Causes of Moderate Pollution - 386 Sites



Suspected Causes of Serious Pollution - 20 Sites

**Figure. 3.17.** Polluted river sites surveyed in 2007-2009 grouped by severity of pollution and by suspected cause.

## REFERENCES

- Bowman, J.J., Clabby, K.J., Lucey, J., McGarrigle, M.L. and Toner, P.F., 1996. *Water Quality in Ireland 1991-1994*. Environmental Protection Agency, Wexford.
- Caffrey, J.M. and Allison, J.P., 1998. Eutrophication in canals. In: Wilson, J.G. (ed.) *Eutrophication in Irish Waters*, 71-81. Royal Irish Academy, Dublin.
- Central and Regional Fisheries Boards, 2009. *Sampling Fish for the Water Framework Directive – Summary Report 2008*. 163pp. Central Fisheries Board, Swords, Co. Dublin, Ireland
- Central Fisheries Board, 2009. *Fisheries Development Programme for Waterways Ireland, July 2006-June 2009*. Waterways Ireland and Central Fisheries Board.
- Clabby, K.J., Bowman, J.J., Lucey, J., McGarrigle, M.L., and Toner, P.F., 1992. *Water Quality in Ireland 1987-1990*. Environmental Research Unit, Dublin.
- Clabby, K.J., Bradley, C., Craig, M., Daly, D., Lucey, J., McGarrigle, M., O'Boyle, S., Tierney, D. and Bowman, J., 2008. *Water Quality in Ireland 2004-2006*. Environmental Protection Agency, Wexford.
- European Commission, 2008. Commission Decision 2008/915/EC of 30 October 2008 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the member state monitoring system classifications as a result of the intercalibration exercise. *Official Journal of the European Communities* **L327**, 1-73.
- IFI (Inland Fisheries Ireland), 2010. *Sampling Fish for the Water Framework Directive – Summary Report 2009*. Inland Fisheries Ireland, Swords, Co. Dublin, Ireland
- Lucey, J. (Comp.), 2009. *Water Quality in Ireland 2007-2008: Key Indicators of the Aquatic Environment*. EPA, Wexford.
- Lucey, J., Bowman, J.J., Clabby, K.J., Cunningham, P., Lehane, M., MacCárthaigh, M., McGarrigle, M.L. and Toner, P.F., 1999. *Water Quality in Ireland 1995-1997*. Environmental Protection Agency, Wexford.
- McHugh, B., Poole, R., Corcoran, J., Anninou, P., Boyle, B., Joyce, E., Foley, B. and McGovern, E., 2010. The occurrence of persistent chlorinated and brominated organic contaminants in the European eel (*Anguilla anguilla*) in Irish waters. *Chemosphere*. **79**, (3), April 2010, 305-313.
- McGarrigle, M.L., Bowman, J.J., Clabby, K.J., Lucey, J., Cunningham, M., MacCárthaigh, M., Keegan, M., Cantrell, B., Lehane, M., Clenaghan, C. and Toner, P.F., 2002. *Water Quality in Ireland 1998-2000*. Environmental Protection Agency, Wexford.
- McGarrigle, M.L., Lucey, J., Bradley, C. and McCreesh, P., 2010. : *Map: Biological Survey of Rivers 2007-2009*. EPA, Wexford. Hard copies can be obtained from EPA Publications, EPA, Richview, Clonskeagh Road, Dublin 14. [www.epa.ie/whatwedo/monitoring/water/rivers](http://www.epa.ie/whatwedo/monitoring/water/rivers)
- Millane, M., Baars, J-R. and Kelly-Quinn, M., 2009. *Development of a Macrophyte and Macroinvertebrate EQR for Establishing WFD Status in Irish Canals*. Report prepared for Waterways Ireland. AQUENS Ltd., Dublin.
- Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCárthaigh, M., Craig, M. and Quinn, R., 2005. *Water Quality in Ireland 2001-2003*. Environmental Protection Agency, Wexford.
- Walsh, S., 2010. Report on Rainfall of November 2009. *Climatological Note No. 12*. Met Éireann Dublin.
- Waterways Ireland and Central Fisheries Board, 2008. *Report on the Interim Classification of Ecological Potential and Identification of Measures for Ireland's Artificial Water Bodies (AWBs)*. Waterways Ireland and Central Fisheries Board for the Surface Water Status Group.

