WATER QUALITY IN IRELAND 2007-2009

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

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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

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EXECUTIVE SUMMARY

SCOPE AND PRESENTATION OF REPORT

This report presents a review of water quality in the State for the years 2007 to 2009. It is the latest in the series of comprehensive three-year reviews of water quality in Ireland that have been undertaken by the Environmental Protection Agency (EPA) and its predecessor organizations. Since the last such report, for the 2004 to 2006 period, the Agency has published a water quality indicators report, covering the years 2007 and 2008, in order to update the situation. The purpose of the present report, however, is to give a more detailed review of all the main aspects of the quality of the aquatic environment in Ireland in order to provide guidance towards the protection and enhancement of this resource.

The report is based on measurements made at:

- 211 groundwater monitoring locations,
- almost 2,500 sites on more than 1,700 rivers and streams (representing over 13,000 km of channel length),
- 42 locations on 11 canal water bodies,
- in 222 lakes (representing almost 1,000 km2 of surface area)
- and in 89 estuarine and coastal waters.

These water quality data have been generated by EPA monitoring programmes supplemented by information provided by the local authorities, the Central and Regional Fisheries Boards, Waterways Ireland, the Marine Institute as well as from other State sources such as the Radiological Protection Institute of Ireland, the Sea Fisheries Protection Authority and the Irish Coast Guard.

The water quality information is presented largely in two ways: against the new ecological status criteria of the Water Framework Directive (WFD) and reporting on water quality, *sensu stricto*, in the manner of previous reports so that any trends can be discerned.

GROUNDWATER QUALITY

In the assessment of overall groundwater status (Chemical and Quantitative)

- **84.7 per cent of water bodies were at good status** and 15.3 per cent were at poor status.

The WFD criteria do not include microbiological parameters but

- Positive counts of faecal coliform bacteria were detected in 34.8 per cent of samples during the reporting period, representing an increased incidence.

There was a general reduction in phosphate and nitrate concentrations compared with the previous period which has been attributed to increased rainfall, reductions in inorganic fertilizer usage, improvements in organic fertilizer storage and the implementation of land-spreading restrictions.

- Just 0.3 per cent of the country was at poor status due to nitrate while 13.3 per cent of the country was at poor status due to phosphate. The nitrate concentrations remain highest in the south-east and phosphate concentrations are highest in the vulnerable Karst aquifers.

Situation in the River Basin Districts

The tabulation summarizes the status classification results for groundwater bodies in the river basin districts.

Three groundwaters were at poor status due to historic pollution from contaminated land sites while four were at poor status due to historic mining activities. Pesticides have not resulted in any groundwater bodies being classed at poor status.

While the overall picture nationally for nitrate indicates a relatively stable situation two groundwater monitoring locations, at Durrow (Laois) and Ballyheigue (Kerry), show a statistically significant upward trend.

River Basin District Summary of Groundwater Status Classification				
River Basin District	Good Status (Number)	Good Status (% Area)	Poor Status (Number)	Poor Status (% Area)
Eastern	67	89.7	8	10.3
Neagh Bann	26	95.3	2	4.7
North West	72	100.0	0	0.0
South East	146	97.8	5	2.2
Shannon	182	74.5	60	25.5
South West	77	96.8	7	3.2
Western	71	65.2	34	34.8
National	641	85.6	116	14.4

WATER QUALITY OF RIVERS

In excess of 1,550 river water bodies were directly assessed, for WFD status purposes, in the 2007-2009 period. Using the traditional Irish method of assessment the following figures would equate with the WFD categories: High 20.1 per cent; Good 48.8 per cent; Moderate 20.7 per cent; Poor 10 per cent; Bad 0.4 per cent.

For the 13,188 km of river and stream channel assessed by the EPA, for biological quality nationally and to indicate trends, the results show

- a further decrease in the length of seriously polluted channel and an un-changed moderately polluted channel but there has been a deterioration, to slightly polluted, of 2.5 per cent in unpolluted channel since the previous period.

When assessed for ecological status, according to the requirements of the Water Framework Directive (WFD), based on the various biological and supporting physico-chemical quality elements for individual river water bodies on a one-out all-out basis, a different picture emerges with

- just 52 per cent of water bodies achieving good status.

A breakdown by River Basin District and status obtained for individual river water bodies is shown in the figure below. 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. New criteria such as hydromorphology and the occurrence of invasive species are included in the assessment of ecological status as opposed to water quality in the traditional sense.

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%

High and Good Quality River Sites

It is important to protect high and good status waters and this is a basic tenet of the WFD. On the basis of the percentage of surveyed channel classified as unpolluted, in the EPA biological quality scheme of classification,

- the South-Western and Western River Basin Districts continue to be ranked the most unpolluted districts.

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.

Seriously Polluted River Sites

There were **27 river sites classified as seriously polluted** (bad ecological status) during the course of the 2007-2009 survey compared with 39 in the previous period. Of these, seven sites improved in quality when they were re-surveyed subsquently to assess effectiveness of programmes of measures. This brought the final total down to:

- 20 seriously polluted sites in 2009 which represents a significant improvement on the 2004-2006 situation.

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. The final breakdown as to cause, as of 2009, was as follows:

- eight of the seriously polluted sites were due to municipal wastewater treatment plants;
- a further three were due to agricultural discharges;
- three instances were due in particular to a major landslide or bogburst caused by engineering works associated with wind farm construction affecting the Arigna and Owengar river catchments in August 2008;
- and the remaining sites were seriously impacted by a landfill, historical mining, forestry activities and construction works.

Chemical Status

The assessment for chemical status was carried out primarily at the 180 surveillance river monitoring sites, in the period 2007-2009, for the presence of those priority substances listed in the WFD (Annex X).

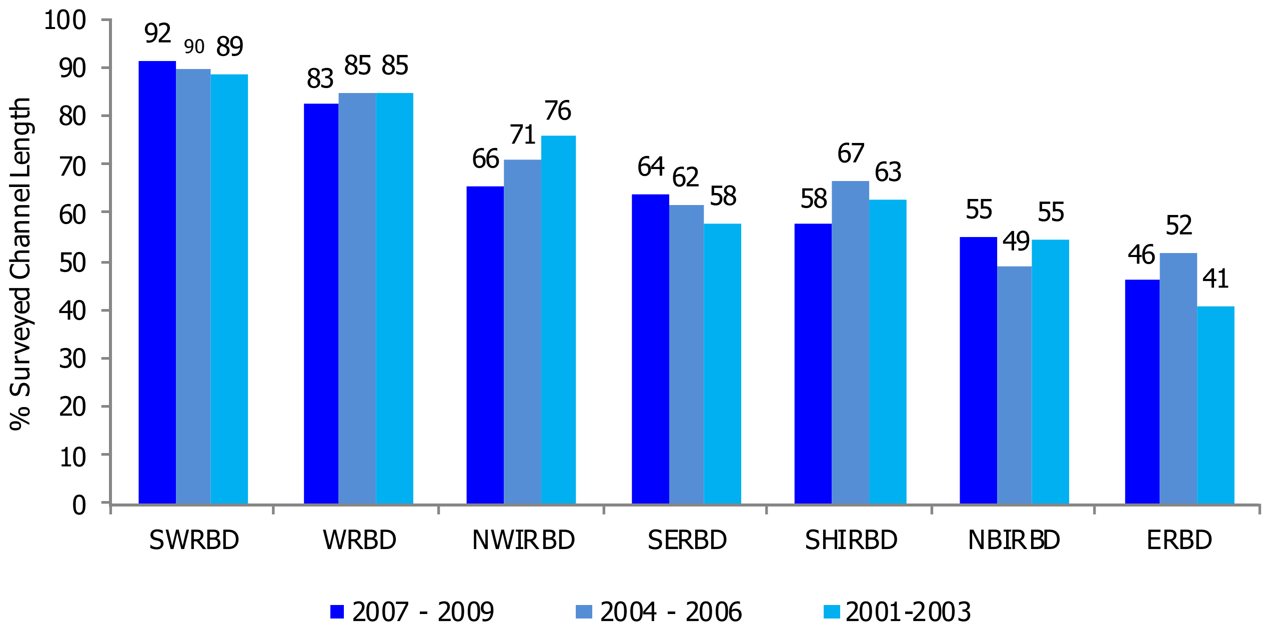
The main category of organic substances detected in the reporting period, as well as PAHs (polycyclic aromatic hydrocarbons) compounds, were pesticides.

- The widely used herbicides mecoprop and glyphosphate both showed an approximately 5 to 20 per cent detection level although no high concentrations were recorded.
- Two other herbicides simazine and atrazine, which have been effectively banned since 2007 because of their risk of leaching to groundwaters, showed an approximately 90 per cent reduction in detection frequency.

Regarding metal contamination some locations (e.g. River Avoca) in the vicinity of mining sites may be significant.

- Zinc was detected at most of the monitoring sites while both copper and chromium were recorded at many.

Generally the occurrence of environmentally significant metals in Irish waters is low.



Extent of good and high status river channel and trends over time in each of the river basin districts.

Instances of Serious Pollution in Irish Rivers (2009)

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

Fish Status

The general reference condition for Irish rivers is that they should have viable populations of salmonid fish. Monitoring of fish status, for WFD purposes, was undertaken by the Central Fisheries Board (now incorporated into Inland Fisheries Ireland) at 132 sites between 2008 and 2009. The surveys indicated that

- **59 per cent were of high or good status** while 39 per cent were moderate and a small proportion, in the large Shannon district, was either poor or bad.

Fish Kills

The total number of reported fish kills in freshwaters (rivers and lakes) in the period was 72 compared to 122 in the previous period and 147 in 2001-2003.

- The lowest number of annual fish kills, 16 which is also the lowest on record, was reported for 2009 while 22 and 34 respectively were documented in 2007 and 2008.

Although this would indicate a downward trend in such catastrophic events, summer weather conditions with higher river flows and fuller lakes particularly in 2009, may have had a mitigating effect.

WATER QUALITY OF CANALS

Monitoring of the Royal and Grand Canals as well as the Shannon-Erne Waterway, called Artificial Water Bodies (AWBs) for WFD purposes, involved assessment of biological quality elements and physico-chemical parameters at 42 sites in 11 AWBs.

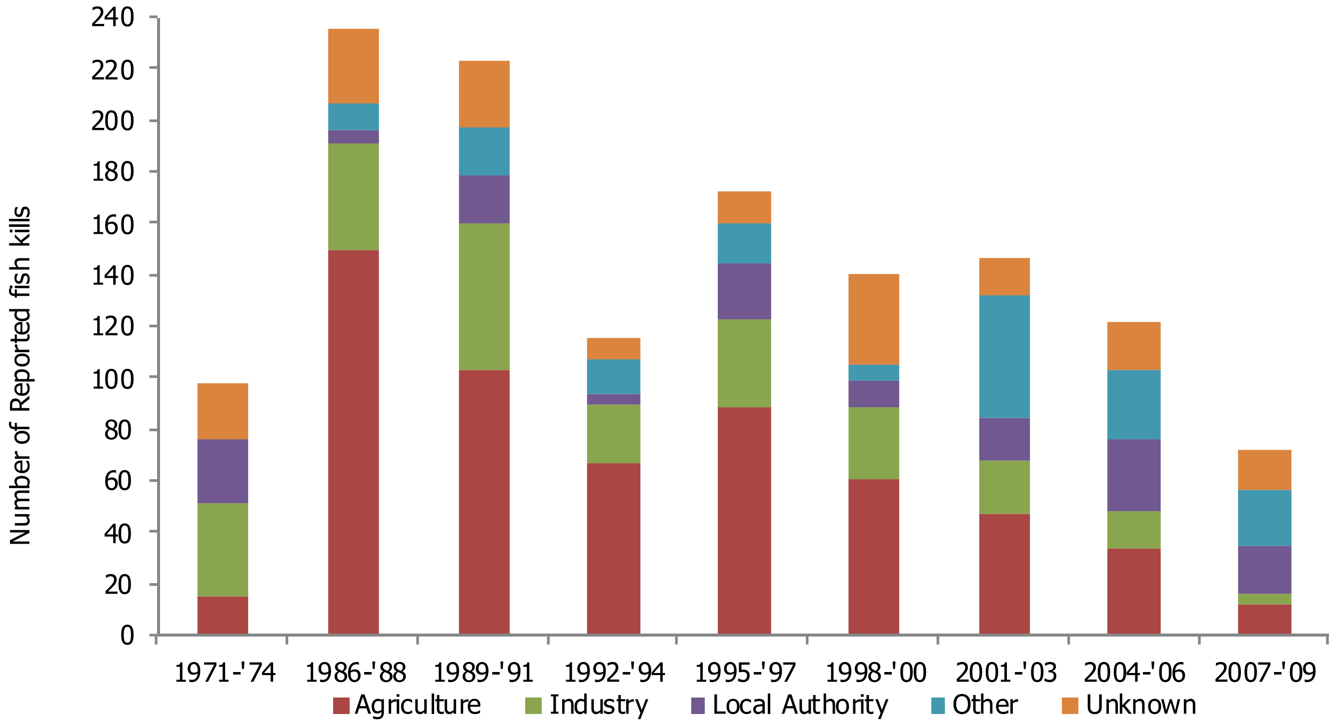
- As has been the case in previous reporting periods, generally good water quality conditions were recorded in the Royal and Grand Canals and in the canalized section of the Shannon-Erne Waterway.

Despite a small number of feeder streams leading to localized pollution problems just one AWB was less than good ecological potential (GEP) and that on hydromorphological grounds where the canal section was under reconstruction. While some locations exhibited higher than usual levels for physico-chemical parameters in November 2009, when extreme rainfall was recorded, the biological effects, through dilution, may have been mitigated.

The status breakdown, for fish classification, in the River Basin Districts was as follows:

Fish Ecological Status in Rivers

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
Total	8%	51%	39%	2%	1%	133



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.

WATER QUALITY OF LAKES

In the 2007-2009 period, 222 lakes were examined representing 988.5 km^2 of lake surface water or approximately 65 per cent of the surface area covered by lakes in the country. Using the traditional national assessment method 180 (81.1%) of these were satisfactory quality while 39 were moderately to strongly eutrophic with just three lakes, Gur, Inner and Naglack, in the most enriched state. Compared with the previous reporting period this represents a decline in satisfactory quality of more than four per cent.

- In terms of lake area 92.1 per cent was in the unenriched oligotrophic or mesotrophic categories which is similar to that (91.9%) reported for the 2004-2006 period.
- When assessed for ecological status, according to the requirements of the Water Framework Directive (WFD), **105 (47.3%) lakes were of high or good status** with the majority, 38.3 per cent, in the latter category while 92 (41.4%) were moderate, 19 poor and 6 bad.

Acid-Sensitive Waters

Monitoring continued in the 2007-2009 period of the representative acid-sensitive lakes and their feeder streams in counties Donegal (Lough Veagh), Galway (Lough Maumwee) and Wicklow (Glendalough Lake Upper).

- Physico-chemical and biological monitoring again demonstrated the absence of an impact, due to artificial acidification, in the Donegal and Galway lakes and their streams.
- The intermittent presence of acid-sensitive organism types at the sampling location on the Lugaduff River, tributary of Glendalough Lake Upper, and in the littoral fauna of the lake continue to suggest a reduction in the level of impact by artificial acidity in these waters, which were regarded as being severely degraded by artificial acidification in the past.

Situation in the River Basin Districts

The following lakes were of poor or bad status in the 2007-2009 period:

Lakes of Poor or Bad Ecological Status during 2007-2009

River Basin District	Lake	County	Status
Eastern	Drumkeery	Cavan	Poor
	Upper Lough Skeagh	Cavan	Poor
	Ramor	Cavan	Bad
Neagh Bann	Corcaghan	Monaghan	Poor
	Emy	Monaghan	Poor
	Monalty	Monaghan	Poor
	Naglack	Monaghan	Poor
	Muckno or Blayney	Monaghan	Bad
North West	Garty	Cavan	Poor
	Sillan	Cavan	Poor
	Glasshouse	Cavan	Bad
	Fern	Donegal	Poor
	Drumlona	Monaghan	Poor
	Drumore	Monaghan	Poor
	Egish	Monaghan	Bad
	Inner	Monaghan	Bad
South East	Knockaderry Reservoir	Waterford	Poor
Shannon	Dromore	Clare	Poor
	Cavetown	Roscommon	Poor
	Derg	Tipperary	Poor
	Rinn	Leitrim	Bad
South West	Ballinlough	Cork	Poor
Western	Belhavel	Leitrim	Poor
	Cross	Mayo	Poor

Regarding trends the percentage of lake area in each trophic category has remained relatively stable since 1998. There has been a small increase in the percentage area assessed as moderately eutrophic and this has been mirrored by a decline in the percentage area in the hypertrophic category. The majority of lakes had relatively similar maximum chlorophyll values compared with the previous assessment period. The notable exceptions were Loughs Gowna, Muckno and Oughter, all of which have seen a decline in maximum chlorophyll values resulting in improved status class. This is probably due to the presence of Zebra Mussel as indicated by the elevated total phosphorus (TP) values recorded. Other Zebra Mussel infested lakes such as Sheelin, Kinale and Key have also continued to 'improve'. Gortglass Lough in Co. Clare has deteriorated compared to the previous assessment period and a few lakes (Arrow, Ennell, Iniscarra and Owel) have less dramatic deteriorations not all resulting in a change of status class.

Lake Bathing Water Quality

Nine lakes are designated as freshwater bathing areas under the EU Bathing Waters Directive which specifies mandatory and guide standards for the protection of public health and the environment. Unlike in the previous period, 2004-2006, 100 per cent compliance with EU mandatory limits was not achieved in 2008 and 2009. Compliance with the more stringent EU guide values was 67 per cent (6) of areas in 2007 which declined to 44 per cent (4) in 2008 and returned to the 2007 proportion in 2009.

- Ballyallia Lake (Ennis), Keeldra (Leitrim) and Lilliput Lough Ennell (Westmeath) were consistent failures during 2007 to 2009.

ESTUARINE AND COASTAL WATER QUALITY

An assessment of 89 estuarine (or transitional) and coastal waters was undertaken in the 2007-2009 period. Of these, 9 (10.1%) were classed as eutrophic, 5 (5.6%) as potentially eutrophic, 31 (34.8%) as intermediate and 44 (49.5%) were unpolluted. In terms of surface area, 102.1 km^2 or 5.3 per cent of the total area assessed (just under 2,000 km^2) is classed as either eutrophic or potentially eutrophic.

- The results of the latest assessment would indicate an improvement in overall water quality conditions compared with previous assessments, e.g. four fewer water bodies were classed as eutrophic when compared with the 2002-2006 period, and in the case of the Liffey estuary, its unpolluted status confirmed the incremental improvement in water quality noted in previous reports.

- A total of 121 transitional and coastal water bodies were assessed between 2007 and 2009 for WFD status classification, using biological quality and physico-chemical elements. Of these, 55 were classed as either high (16%) or good (30%) ecological status with the remainder being classed as moderate or worse.

- In terms of surface area, just over **64 per cent of the total monitored area was found to be at high or good ecological status**.

The highest nitrate values were found in the Glashaboy estuary, the Upper and Lower Slaney estuary, the Owenacurra estuary and the Upper Barrow estuary.

Overall, 31 water bodies breached the winter Dissolved Inorganic Nitrogen (DIN) assessment criterion. Regarding the other important nutrient phosphate, four water bodies, Lough Mahon (Harper's Island), Lee estuary (Tralee), Castletown estuary and Tolka estuary, breached the winter criterion and four, Tolka, Deel, Broadmeadow and Rogerstown were also in breach in summer.

The vast majority of waters (99.5 % of the surface area assessed) had satisfactory oxygen conditions capable of supporting nearly all forms of aquatic life and no hypoxia or indeed anoxia was observed in any of the water bodies surveyed. Some deoxygenation, however, was observed in a small number of water bodies, with the lowest concentrations being observed in the Avoca estuary, lower Lee estuary and upper Liffey estuary.

Toxic Contaminants

The levels of contaminants in fin-fish and shellfish measured by the Marine Institute between 2007 and 2008 were generally well below the strictest standard of guidance values. A slightly elevated level of cadmium was found, however, in a mussel sample from Inner Tralee Bay in October 2007 marginally exceeding the EC maximum limit. In 2008, two oyster samples marginally exceeded the relevant value for total arsenic in Mannin Bay and Dungloe, as did another sample from Ballymacoda Bay in winter 2009. Samples of cockles from Dundalk Bay breached the guide value for nickel in 2008 and 2009. All organohalogen (PCBs and pesticides) concentrations were low with PCB levels below the guide value.

Breakdown of Ecological Status for Transitional and Coastal Waters by River Basin District

RBD	High	Good	Moderate	Poor	Total
Eastern	3 (207)	1 (3)	8 (66)	1 (0.2)	13 (276)
Neagh-Bann	~	1 (64)	4 (83)	~	5 (146)
North western	3 (778)	4 (125)	7 (295)	~	14 (1198)
South eastern	1 (5)	4 (162)	14 (124)	~	19 (291)
Shannon	1 (216)	4 (58)	10 (536)	~	15 (809)
South western	2 (201)	9 (88)	14 (360)	2 (5)	27 (654)
Western	9 (472)	13 (230)	5 (37)	1 (0.1)	28 (738)
Total	19 (1879)	36 (729)	62 (1500)	4 (5)	121 (4114)

Radioactivity

The levels of radioactive contamination present in the marine environment do not warrant any modification of the habits of people in Ireland either in respect of consumption of seafood or any other use of the amenities of the marine environment. The results of the Radiological Protection Institute of Ireland's monitoring programme show that, while the levels of artificial radioactivity in the Irish environment remain detectable, they are low and do not pose a significant risk to human health.

Quality of Shellfish and Shellfish Waters

The Sea Fisheries Protection Authority (SFPA) is the competent authority in Ireland for classifying shellfish production areas.

The 2009 classification of shellfish production areas in Ireland classified 125 production areas:

- 28 (22.4%) were classified as A (Highest Quality), 19 (15.2%) classified as 'seasonal' A and 67 (53.6%) as B classification (Intermediate Quality) while a single area in Wexford Harbour was classed as C (Low Quality).

The production areas around the coast are monitored on a weekly or monthly basis for phytoplankton and the presence of marine biotoxins. Where toxicity is detected, the production area is closed and harvesting prohibited until the danger of toxicity has passed.

- In 2007, biotoxin levels were low but in 2008, there was considerable shellfish toxicity, resulting in widespread closures of shellfish production areas.

The Marine Institute samples coastal areas including shellfish waters for chemical contaminants.

- Few significant upward or downward trends were identified for trace metals although a significant upward trend was detected for cadmium, copper and zinc at the North Bull Island (Co. Dublin) in recent years.

Where significant trends were detected for persistent organic pollutants (POPs) they were invariably downward, with 26 downward trends detected for individual PCB congeners or organochlorine pesticides and five downward trends for individual polyaromatic hydrocarbon (PAH) compounds.

Bathing Waters

Of the 122 designated seawater bathing areas monitored during the 2009 bathing season, **93 per cent complied with the minimum EU mandatory values** thus achieving sufficient water quality status. However, this represents a downward trend of compliance from 97 per cent in 2007 and 95 per cent in 2008. While some of this may be due to high summer rainfall in recent years (average numbers of wet days were between 10-20% above normal in 2008 and 2009) measures need to be taken to minimise these effects on bathing waters. Further measures including the provision of appropriate waste water treatment facilities are required if all bathing areas are to comply with EU standards.

The eight seawater bathing areas that failed to achieve sufficient water quality status were:

- Balbriggan Front Strand,
- Skerries South Beach,
- Sutton Burrow Beach (Dublin)
- Clifden Beach (Co. Galway)
- Dunmore Strand (Co. Waterford)
- Duncannon (Co. Wexford)
- Killala Ross Beach (Co. Mayo)
- Youghal Main Beach (Co. Cork).

While the overall level of bathing water quality remains relatively good, a small number of bathing areas are consistently classified as poor. Of particular concern are the bathing areas of Clifden, which failed to achieve sufficient water quality status for the past five years, and Balbriggan Front Strand, which only achieved sufficient water quality status once in the last seven years.

Oil Pollution Incidents

Responsibility for the investigation of oil pollution incidents in Ireland rests with the Irish Coast Guard (IRCG) which provides a response to marine pollution incidents or threat of pollution from ships and offshore platforms.

The IRCG received 54 pollution reports during 2007, 45 in 2008 and 53 in 2009, all of which were investigated.

- In 68 per cent of incidents reported in 2007 and 38 per cent in 2008 and 2009, oil spillage was identified as the cause.
- The majority of the reported spills during the three years were of diesel and light oils with the estimated volume of discharge less than 1,000 litres (1 tonne).
- One spill in 2009 was greater than 50,000 litres (50 tonnes) while two in 2008 were in the 1,000-50,000 litres (1-50 tonnes) volume category. There were seven reported pollution incidents in 2009 where the estimated volume of discharges was unknown. Also in 2009 there was one incident involving crude oil.
- The majority of oil discharges occurred in the smaller harbours and surrounding areas.
- The number of reported oil pollution events that beached on the shoreline was respectively two, five and six in 2007, 2008 and 2009, with the extent in all cases less than 1.6 km.
- During 2008, six incidents were reported involving oiled birds while there were no reported incidents of oiled wildlife in 2007 or 2009.

To estimate the number of incidents occurring in the open sea is difficult and always conservative as the IRCG has no dedicated aerial surveillance capacity and relies on reports from shipping and commercial air traffic for such incidents.

The largest marine pollution incident during the period occurred in 2009, south of Fastnet Rock, when an estimated 300 tonnes of fuel oil and water mixture was lost during a refuelling at sea incident. There was concern that the oil would have come ashore, but due to the prevailing weather conditions at the time, the slick trajectory was offshore and eventually dispersed.

FINDINGS AND RECOMMENDED ACTIONS

In the final chapter the key findings are reported with recommendations on how some issues might be resolved.

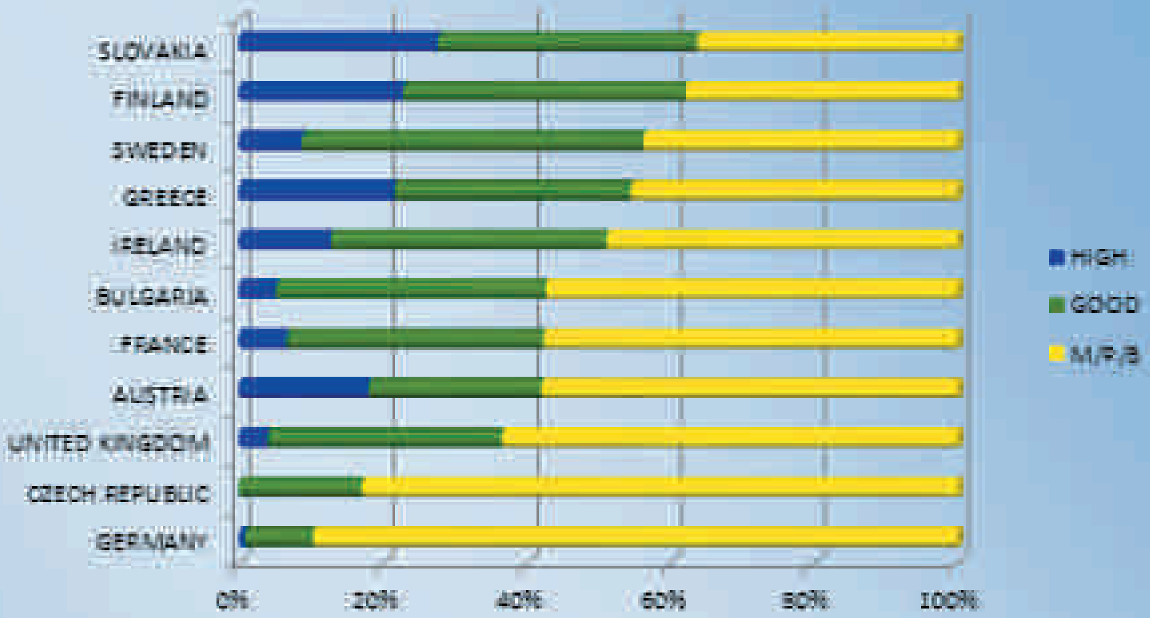
Three key issues for water quality management emerge:

- Eliminating point source serious pollution,
- Tackling diffuse pollution,
- Using Legislative support.

From the findings, it is apparent that substantial measures will be needed in order for Ireland to fully comply with the objectives of the Water Framework Directive (WFD).

A graphic has been presented (See Box) to give an indication of where Ireland's surface waters stand, compared with some other EU member states, in terms of interim classification for the Water Framework Directive (WFD).

Water Quality and Water Status



It is important to distinguish between water quality and water status as the latter can include quality as well as quantity and other attributes.

In Ireland and elsewhere in Europe water quality *per se* has traditionally been measured and assessed using either physico-chemical or biological parameters or a combination of both – typically assessing organic pollution and eutrophication from, e.g. town sewage and farm wastes or specific toxic pressures such as mining or sheep dip.

The Water Framework Directive (WFD) introduced a much broader approach to monitoring and assessment of water status for a wider range of pressures. The integrated approach includes measuring a range of biological elements, some not previously surveyed or assessed, including protected native species and adverse impacts of some invasive non-native species as well as physico-chemical parameters, specific pollutants and hydromorphology. The last mentioned elemental attribute, which relates to the form and structure of a water body, is only a determinant in classifying WFD high status.

In this report, the interim ecological status of surface water bodies has been presented alongside the more traditional water quality assessment of these waters. By their very nature the two assessments will have different outcomes as can be seen in the case of rivers where 68.9 per cent of channel length (of total >13,000 km examined) had good or better water quality while 52 per cent of water bodies (of total >1,500 examined) achieved good or high ecological status. Some 70 per cent of western rivers were good or high ecological status while just 30 per cent were so classed in the east. The ecological status of Irish surface waters compares favourably with that of other countries which have reported their status.

The graphic shows a comparison of Irish surface water bodies classified for Ecological Status with 10 other EU countries in terms of percentage of water bodies classified as High, Good and 'Less Than Good' (M/P/B) ecological status – the countries are ranked in terms of the proportion of less than good status water bodies classified (The graphic is based on the European Environment Agency's WISE map of WFD Surface Water Ecological

CHAPTER ONE

INTRODUCTION

This report gives an account of the quality of the State's surface waters and groundwaters based on survey data for the period 2007-2009 and continues a series of national reviews of water quality which commenced in 1972 (Flanagan and Toner, 1972; Flanagan, 1974; Flanagan and Toner, 1975; Lennox and Toner, 1980; WPAC, 1983; Toner *et al*., 1986; Clabby *et al*., 1992; Bowman *et al*., 1996; Lucey *et al*., 1999; McGarrigle *et al*., 2002; Toner *et al*., 2005; Clabby *et al*., 2008). More recently water quality reports have also been issued to give indications of the interim situation regarding water quality (Lucey, 2006, 2007 and 2009).

Under Section 65 of the Environmental Protection Agency Act, 1992, the EPA was required to implement national monitoring programmes for water quality to satisfy the requirements of EU and national obligations. Monitoring programmes for rivers, lakes, estuarine and coastal waters as well as groundwaters were established in 1999 which strengthened the already existing ones. Monitoring of water quality is now largely driven by the EU Water Framework Directive (EP and CEU, 2000) and the results of monitoring for the period of review are judged against the criteria therein as well as in the traditional manner of reportage. It is important that these latter assessments are continued so that any trends emerging over time can be detected although there is much convergence between the two types of assessment but with the WFD approach being more holistic. These new programmes have set out a greatly expanded range of biological, physico-chemical, morphological and chemical quality elements to be assessed. As part of the WFD implementation process the EPA was also required to identify public authorities by whom additional monitoring would be undertaken.

The main sources of data on which the report is based were from the national monitoring programmes undertaken by the EPA and local authorities supplemented by information supplied by the Marine Institute, the Central and Regional Fisheries Boards (now incorporated into Inland Fisheries Ireland), Waterways Ireland, the Sea Fisheries Protection Authority, the Irish Coast Guard and the Radiological Protection Institute of Ireland. The new monitoring programmes for the WFD were put in place in 2007 (EPA, 2006) and the classification systems and standards have been applied to the data collected in the monitoring programmes to determine the overall status of all identified waterbodies in Ireland. The WFD required the establishment of two primary monitoring programmes, known as surveillance and operational, to gather data for assessment. A third type, called investigative monitoring, which is aimed at identifying the causes of failure to achieve good environmental status and to determine the measures needed to achieve this, is also provided for in the Directive.

This report reviews the water quality status of groundwaters and surface waters in chapters Two to Five and then in a final chapter outlines measures needed to achieve compliance with WFD objectives. The timeframe to achieve the objectives set out in the WFD will pose a major challenge for those charged with protecting Ireland's aquatic resource. In relation to water quality the aims of the WFD are to maintain high status of water where it exists, prevent any deterioration in the existing status of water and achieve at least good status in accordance with the targets set out in the River Basin Management Plans by 2015.

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CHAPTER TWO
GROUNDWATER QUALITY

Matthew Craig, Anthony Mannix and Donal Daly

INTRODUCTION

Groundwater, which originates from rain that soaks into the ground, is an important natural resource in Ireland. It flows through and is stored in fractures in the bedrock and the pore spaces of sand and gravel deposits. If the geological deposit can yield enough water for a significant water supply then it is referred to as an aquifer. The physico-chemical properties of groundwater can be examined through the study of groundwater abstractions from pumped boreholes and wells, and groundwater that issues to the surface from springs, e.g. Plate 2.1.

Bedrock aquifers in Ireland have fissure permeability only, where water flow is through fissures or fractures and not through pore spaces in the rock itself; thus, any contaminants present in the groundwater undergo minimal attenuation. The sand and gravel aquifers that underlie approximately two per cent of the country are the only aquifers with intergranular permeability. Some attenuation of contaminants may occur where the aquifers are protected by the overlying soil and subsoil; therefore variation in subsoil type and thickness is important when characterising the vulnerability of groundwater to contamination.

A large proportion of the productive aquifers in Ireland are karstified limestone (e.g. Plate 2.2). Karst landscapes develop in rocks that are readily dissolved by water, e.g. limestone (composed of calcium carbonate), and typically conduit, fissure and cave systems develop underground (Geological Survey of Ireland, 2000).

GROUNDWATER QUALITY IN IRELAND

The natural quality of groundwater varies as groundwater flows from recharge areas, e.g. elevated topography, to discharge areas, e.g. springs or rivers. The groundwater chemistry may change as it passes through soils, subsoils or rocks with different mineralogy.

In Ireland, limestone bedrock and limestone dominated subsoil are common and consequently groundwater is often hard, containing high concentrations of calcium, magnesium and bicarbonate. In areas where sandstone or volcanic rocks dominate, softer water is normal. Elevated concentrations of certain ions can occur naturally and may lead to water quality problems, e.g. iron, manganese, sulphate and arsenic, and sodium and chloride in aquifers near coasts. Therefore, it is important to consider natural hydrochemical variations when interpreting the analyses from groundwater quality monitoring programmes and assessing whether groundwater is polluted.

The groundwater chemistry is also continually being modified by the influence of human activity, whether that is through changes in groundwater flow, caused by groundwater abstraction, or the introduction of anthropogenic substances. The presence of purely anthropogenic substances, e.g. hydrocarbons or pesticides, clearly indicates departure from natural conditions.

Plate 2.1. Groundwater issuing from a spring and properly constructed boreholes (inset).

Appraisal of Existing Groundwater Data

The appraisal of data focuses on monitoring points selected for the WFD Groundwater Monitoring Programme. Therefore historical data from monitoring points that are no longer in the WFD Programme are not included in the data analysis. Data are presented for the period 2007-2009, and, for comparison, historical data from 1995-2006 are presented, again only using historical data from monitoring points that have remained in the WFD Groundwater Monitoring Programme.

Groundwater Quality

The data have been gathered by the EPA and are presented for parameters that are indicators of anthropogenic pollution (Ammonium, Nitrate, Phosphate and Faecal Coliforms). Comparison is made with the appropriate WFD threshold values, standards and assessment principles for these parameters, e.g. the key phosphate threshold concentration in groundwater has been derived from the environmental quality standard for surface water receptors.

Hazardous Substances

A WFD further characterisation study on the risk to groundwater from diffuse mobile organic substances (CDM, 2008) identified groundwater bodies which were potentially at risk from pollution because of land use and the groundwater vulnerability in relation to pesticides. The EPA initiated a sampling programme for pesticides between 2007 and 2009. The data from the sampling programme confirmed that pesticide pollution of groundwater from diffuse sources was uncommon and the Drinking Water Maximum Admissible Concentration (MAC) of 0.1 µg/l for individual pesticides was exceeded in 16 of 18,722 samples (<0.1%). During 2009, the EPA initiated a sampling programme for a suite of chemical organic parameters, e.g. hydrocarbons, at all monitoring locations in the sampling programme. None of the samples for any of the parameters analysed exceeded the Drinking Water MAC at any monitoring location. Consequently, the EPA has decided to run a less intensive monitoring programme in future for both the pesticide and organics parameter suites, e.g. sampling one year in every three.

Plate 2.2. Karstified limestone outcrop in Co. Clare.

Box 2.1 Groundwater as a Source of Drinking Water

Approximately 26 per cent of the public and private drinking water supply in Ireland is provided by groundwater (Lucey, 2009). In certain counties, e.g. Roscommon, the percentage is significantly higher, with groundwater providing approximately 75 per cent of the drinking water (Lucey, 2009).

The majority of private group schemes and small supplies are reliant on groundwater and often have inadequate treatment or, in many cases, no treatment at all. This heightens the need for groundwater and source protection, pollution prevention, and the treatment of groundwater, to ensure that the quality of drinking water conforms to the requirements of the Drinking Water Regulations (S.I. 278 of 2007). Furthermore, to protect private supplies, and reduce the risk of pollution of public supplies, there needs to be adequate protection of groundwater as a resource. Also, as groundwater may ultimately discharge from an aquifer to springs, rivers, estuaries or wetlands, these may also be adversely affected if the groundwater is polluted.

The interaction between groundwater and surface water is complex and the quantification of the volume of groundwater that contributes to surface water flow and its chemical composition is often difficult to determine. Groundwater contributions to surface water flow vary; often in the more productive aquifers, e.g. karstified limestone or sand and gravel aquifers, the groundwater contribution may be as large as 80 or 90 per cent of the average surface water flow. In contrast, in the low yielding 'poorly productive' aquifers that underlie two-thirds of the country, the average deep groundwater contribution is frequently less than five per cent of the average surface water flow. However, groundwater may also flow at shallow depths where the bedrock is fractured at the 'top of the rock'. Therefore the overall groundwater contribution from these aquifers may be around 30 per cent of the average surface water flow.

Plate 2.3. Boreholes being drilled near Glencastle, Co. Mayo

Ammonium

Microbiological reduction of nitrogen-containing compounds generally results in very low background concentrations of ammonium in natural waters. Ammonium has a low mobility in soil and subsoil. Its presence in groundwater much above 0.15 mg/l N is usually indicative of a nearby source of organic pollution, such as effluent from farmyard manure, slurry and dirty water or from on-site wastewater treatment systems (such as septic tanks or similar systems), although high ammonium concentrations may be encountered naturally.

Between 2007-2009, a total of 2,698 individual monitoring samples were analysed for ammonium at 211 monitoring stations. The mean concentration results are summarised in Figure 2.4 and the monitoring locations are shown in Map 2.1.

The river water Environmental Quality Standard (EQS) of 0.065 mg/l N for Total Ammonium (as an annual mean concentration) is taken as the threshold value for groundwater. The average ammonium concentration in groundwater was below the threshold value at 81 per cent of the monitoring locations for the period 2007-2009. This equates to a ten per cent decrease in the number of monitoring locations with an average concentration less than 0.065 mg/l N over the previous assessment period (2004-2006). There has been a noticeable increase (16%) in the proportion of sites in the 0.04 to 0.065 mg/l category.

Ninety-four samples had ammonium concentrations greater than the Drinking Water MAC of 0.23 mg/l N. The majority (97%) of the monitoring locations had mean concentrations less than the MAC with mean concentrations greater than 0.23 mg/l N recorded at six of the 211 monitoring locations. Four of the six monitoring locations also tested positive for faecal coliforms, possibly indicating that a nearby organic pollution source is getting into the water supply. There has been little change in the overall proportion of sites with mean concentrations greater than the MAC value of 0.23 mg/l N between 2004-2006 and 2007-2009.

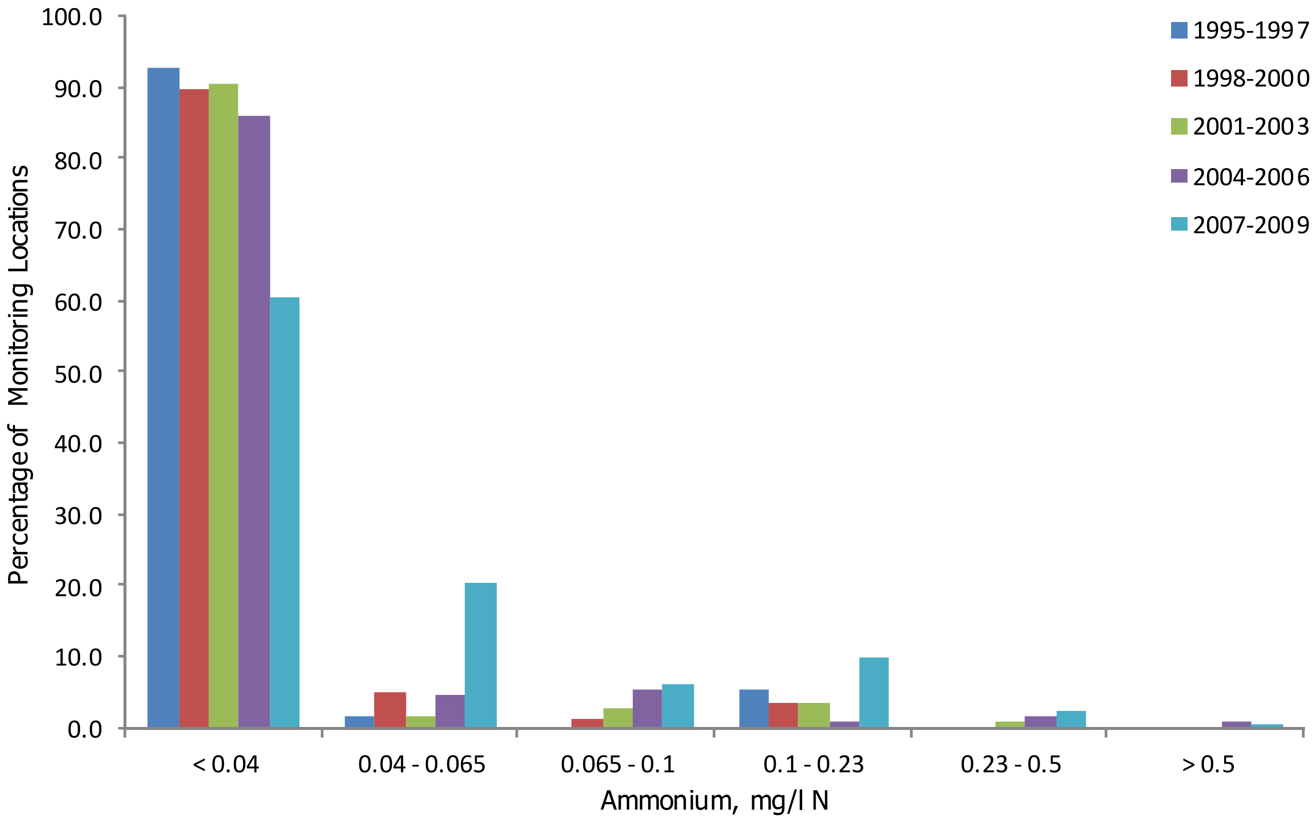
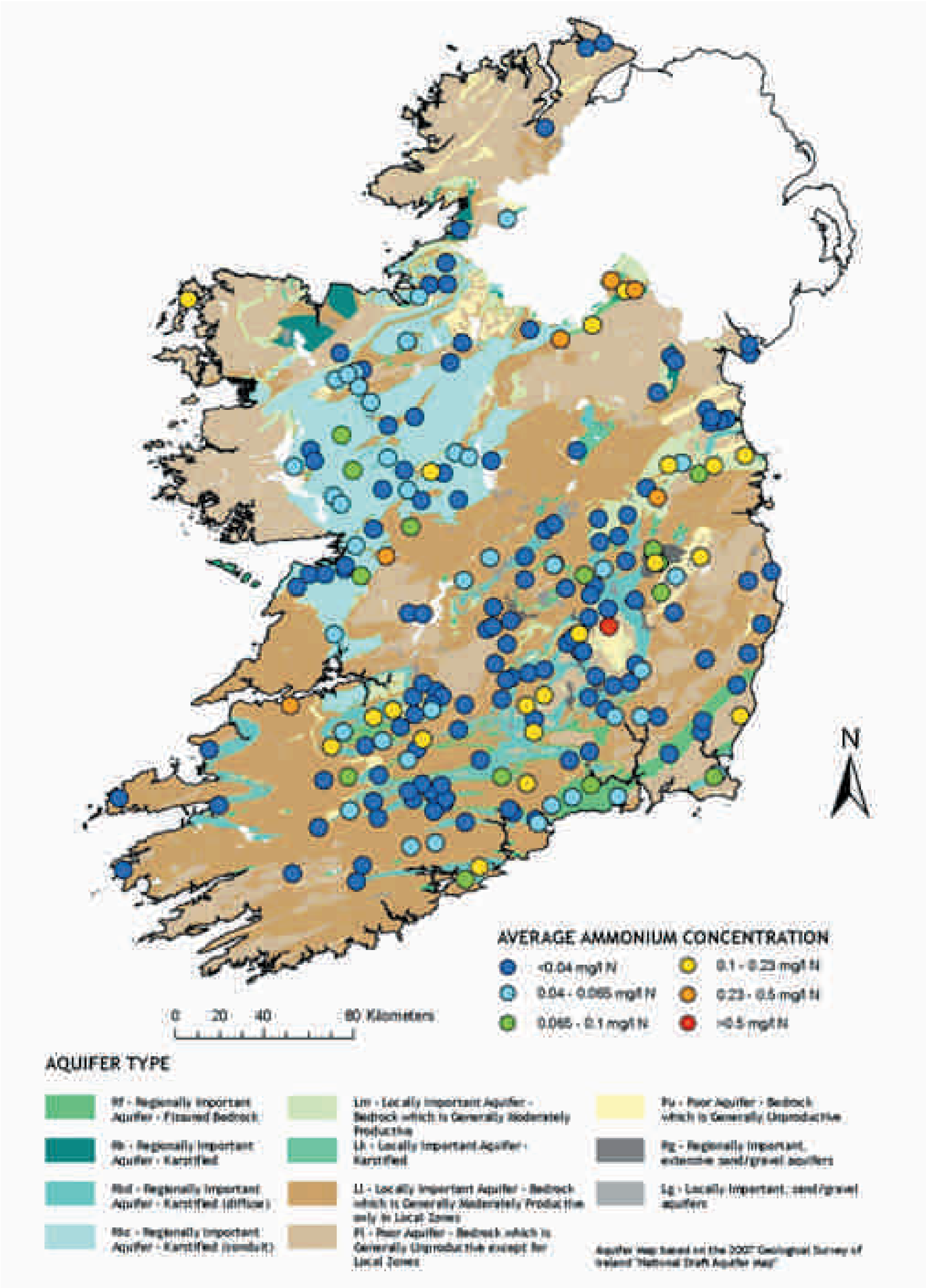


Figure 2.4. Comparison of the proportion of monitoring locations over different reporting periods with mean ammonium concentrations in the ranges indicated



Map 2.1. Mean Ammonium Concentrations in Groundwater 2007-2009 (Source: EPA, GSI)

Nitrate

Relatively low concentrations of nitrate are found naturally in groundwater and concentrations higher than 10 mg/l as NO_3 are usually indicative of anthropogenic organic or inorganic inputs. Organic sources can include organic fertiliser, e.g. slurry, or effluent from on-site wastewater treatment systems, whilst inorganic sources can include the spreading of artificial fertiliser. If a significant proportion of surface water flow is derived from groundwater, then increased nitrate concentrations in groundwater may contribute to eutrophication in surface waters, particularly in transitional and coastal waters.

Under the Drinking Water Regulations, the MAC for nitrate is 50 mg/l as NO_3. A mean concentration greater than the Threshold Value of 37.5 mg/l NO_3 is an indication of appreciable contamination, which given the dynamic nature of groundwater in Ireland, would probably result in the Drinking Water MAC being exceeded at the monitoring point at some time during the sampling period.

A total of 2,681 individual monitoring samples were analysed for nitrate at 211 monitoring locations between 2007-2009. Concentrations greater than 37.5 mg/l NO_3 were recorded in 186 individual samples, of which 50 samples exceeded the MAC of 50 mg/l NO_3. The mean concentration results are summarised in Figure 2.5 and the monitoring locations are shown in Map 2.2. At ten (4.7%) of the monitoring locations, the mean concentrations exceeded the Threshold Value of 37.5 mg/l NO_3, while at two of these locations, the mean concentration exceeded 50 mg/l NO_3. Figure 2.5 indicates that there has been a change in the overall pattern in nitrate concentration in the 2007-2009 results when compared to previous reporting periods. Prior to 2006 a slight increase in nitrate concentrations has been detected with time. The 2007-2009 data indicate an overall decrease in nitrate concentrations, with a noticeable increase in the percentage of samples with concentrations less than 10 mg/l NO_3.

Generally, the south and south-east of the country continue to have the greatest proportion of monitoring locations with elevated nitrate concentrations. Although elevated nitrate concentrations may be observed in monitoring points that are in close proximity to point source waste discharges, the intensive agricultural practices in the south and south-east are the probable cause of the elevated nitrate concentrations in groundwater.

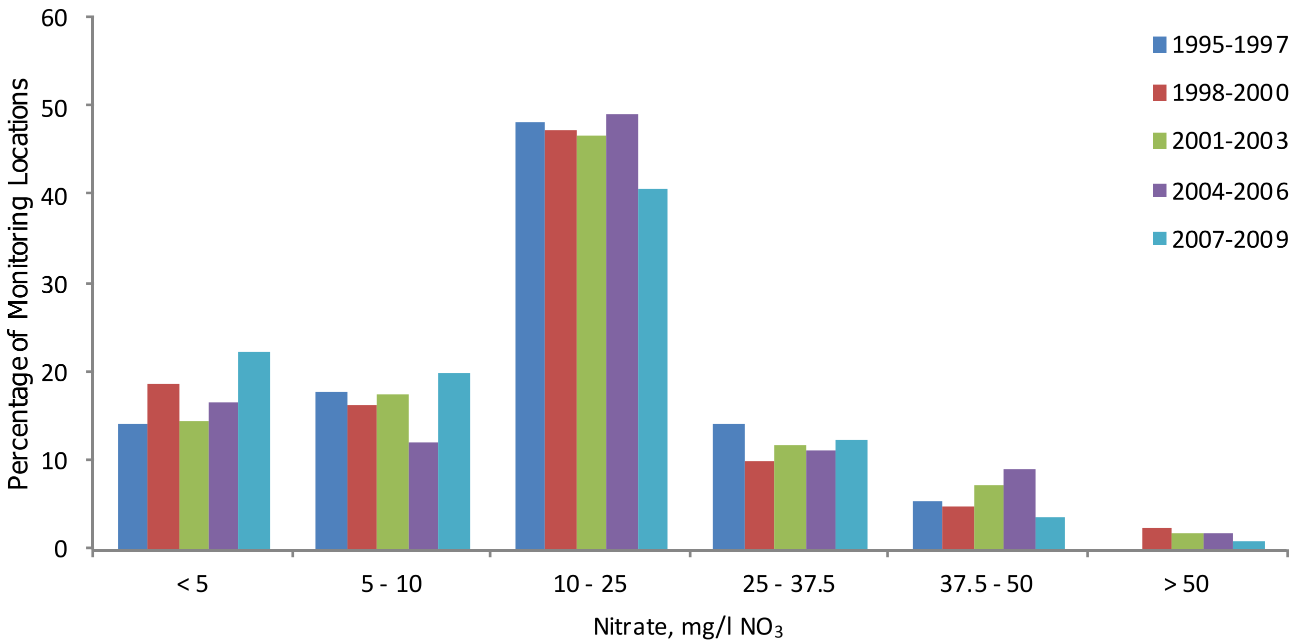
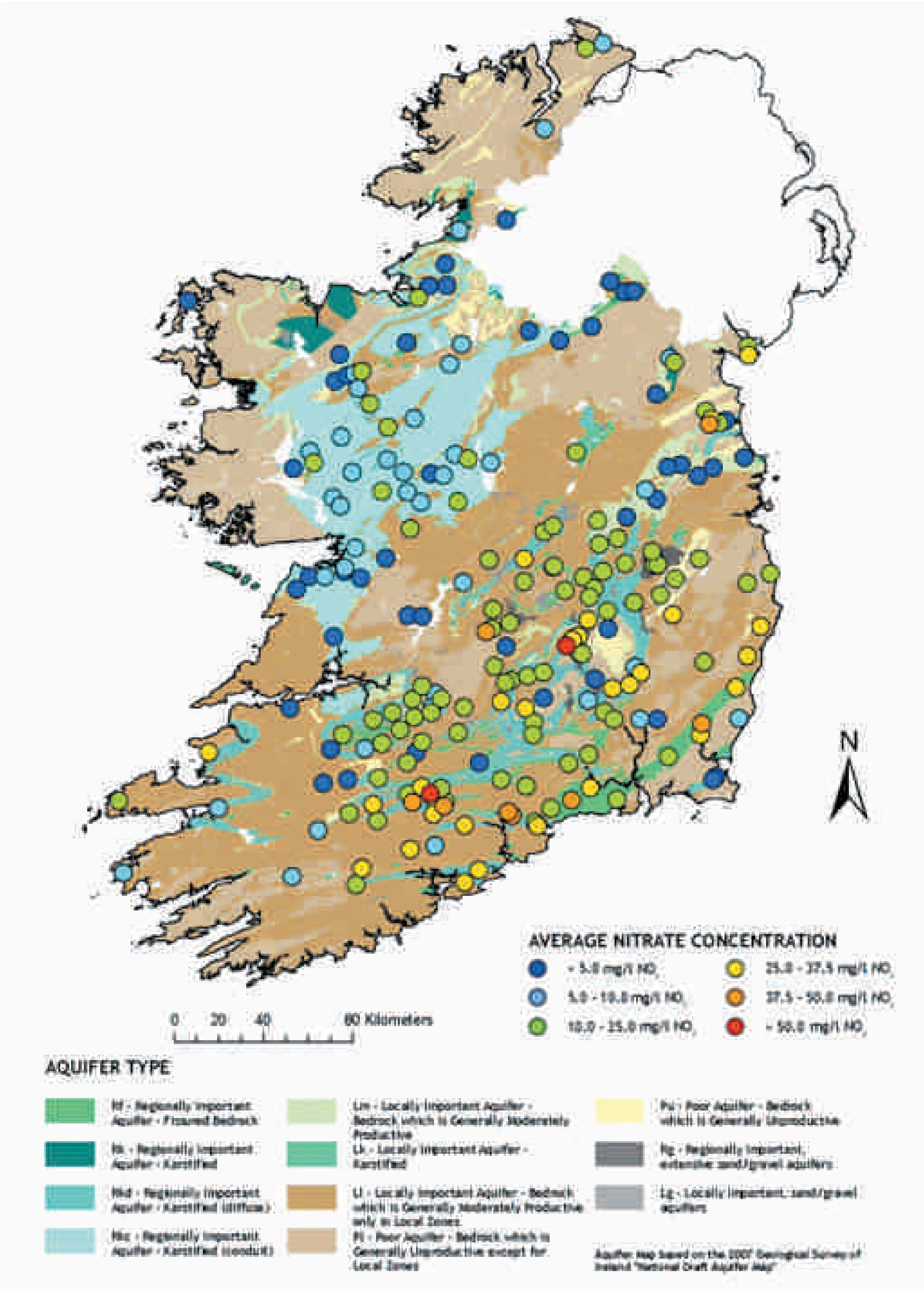


Figure 2.5. Comparison of the proportion of monitoring locations over different reporting periods with mean nitrate concentrations in the ranges indicated



Map 2.2. Mean Nitrate Concentrations in Groundwater 2007-2009 (Source: EPA, GSI)

Phosphate

Phosphate is a major source of concern for surface waters because small amounts may lead to eutrophication of lakes and rivers. Historically, phosphate was not considered to be a significant problem in groundwater because it was seldom detected above the drinking water standard. However, as observed in the WFD status assessments, in extremely vulnerable areas, where the soil and subsoil are shallow and where phosphate enters groundwater; groundwater may act as an additional nutrient enrichment pathway for receptors such as lakes, rivers and wetlands.

The river water Environmental Quality Standard (EQS) of 0.035 mg/l P for Phosphate (as an annual mean concentration) is taken as the threshold value for groundwater. Between 2007-2009, a total of 2,732 individual samples were analysed for phosphate at 211 monitoring locations. Concentrations greater than 0.035 mg/l P were recorded in 251 (9%) of the samples. The mean concentration results are summarised in Figure 2.6 and the monitoring locations are shown in Map 2.3.

In the period 2007-2009, the average phosphate concentration in groundwater exceeded this threshold value of 0.035 mg/l P at 16 monitoring locations, eight of which exceeded 0.05 mg/l P. Figure 2.6 indicates that between 1995 and 2006, there had been a gradual increase in the percentage of monitoring locations with mean phosphate concentrations less than 0.015 mg/l P. This increase was more pronounced during the period 2007-2009. There has also been a noticeable increase in monitoring locations with mean concentrations in the range 0.015 to 0.025 mg/l P. Overall, there has been a increase of approximately 27 per cent of monitoring locations with mean concentrations less than 0.035 mg/l P when compared with the previous period.

In general phosphate concentrations in groundwater are not a cause of concern in relation to its use as a drinking water supply. As referred to earlier in this chapter, there are areas of the country where groundwater contributes significantly to flows in rivers, e.g. where 80 or 90 per cent of the average surface water flow comes from groundwater. If the phosphate concentrations in groundwater are above 0.02 mg/l P in these areas; then groundwater may be significantly contributing to eutrophication in rivers and lakes.

Map 2.3 indicates that elevated phosphate concentrations have been measured in the karstified aquifers, particularly where the groundwater is vulnerable to pollution and there are shallow soils and subsoils.

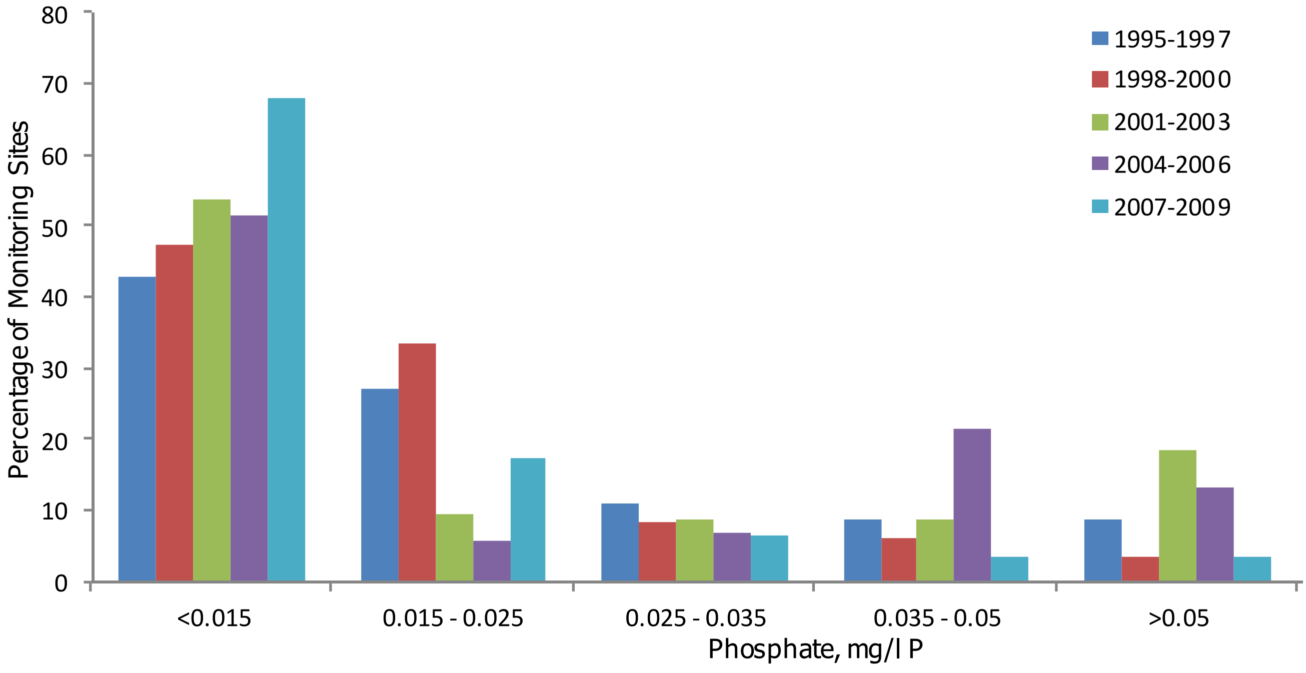
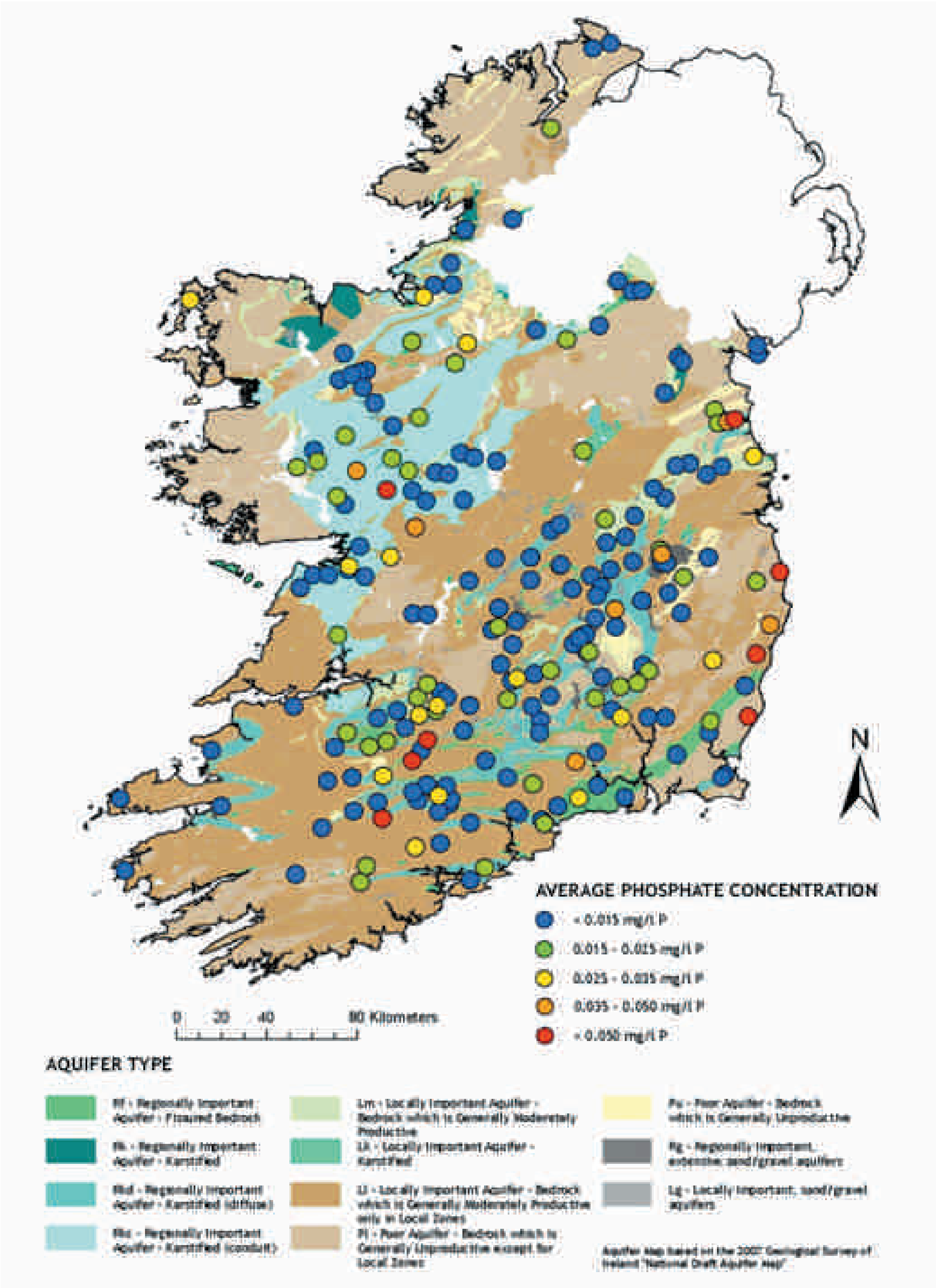


Figure 2.6. Comparison of the proportion of monitoring locations over different reporting periods with mean phosphate concentrations in the ranges indicated



Map 2.3. Mean Phosphate Concentrations in Groundwater 2007-2009 (Source: EPA,GSI)

Microbiological Contamination

Microbiological contamination arises from the entry of faecal matter to waters. The main sources of microbial pathogens are on-site wastewater treatment systems (e.g. septic tank systems), farmyard run-off, grazing animals and the land-spreading of manure or slurry. The natural environment, particularly soils and subsoils, can be effective in removing bacteria and viruses by filtration and absorption. However, not all areas are naturally well protected. Extremely vulnerable areas, including karst aquifers, fractured aquifers and areas with exposed outcrop or shallow soils, allow the rapid movement of contaminants into groundwater with minimal attenuation. While the presence of glacial till subsoils and peat will, in many instances, retard the vertical migration of microbes, preferential secondary flow paths such as cracks in clay materials can allow the filtering effect of the subsoils to be reduced or bypassed.

In practice, the presence of faecal coliform bacteria (e.g. *Escherichia coli*) in water samples is taken as an indicator of faecal contamination. The detection of *E. coli* may mean that associated pathogenic micro-organisms are present, i.e. those organisms capable of causing disease (e.g. viruses and the parasitic protozoan *Cryptosporidium*) as well as the 0157:H7 strain of the *E. coli* bacterium. It should be noted that the absence of faecal coliform bacteria in groundwater does not mean that more persistent organisms such as *Cryptosporidium* are not present.

From the perspective of human use and consumption of groundwater, the most important consideration is the absence of pathogens. Disinfection techniques, e.g. chlorination, are used to counteract this potential problem in public drinking water treatment, and 'barriers' such as filtration or ultraviolet disinfection are included in many areas susceptible to cyst forming protozoa (e.g. *Cryptosporidium*) as chlorine has limited effectiveness against these. However, the majority of private groundwater supplies do not undergo any treatment prior to use. The delineation of source protection areas around water supplies provides an area in which protective measures can be applied. The source protection area is based on the premise that 99.9 per cent of bacteria will die off within 100 days in groundwater. Therefore proper management of activities within this 100 day "time of travel" area should reduce the risk of bacteriological contamination of the water supply.

Between 2007 and 2009, a total of 2,718 samples were analysed for faecal coliforms at 211 monitoring locations. Where systems, such as chlorination, exist to treat the abstracted water, then samples were taken prior to treatment being applied. Positive faecal coliform counts were detected in 945 (34.8%) samples, 182 (6.7%) of which exceeded 100 cfu/100 ml (Figure 2.7). Positive counts were detected at 157 (74.4%) monitoring locations (Map 2.4) on one or more occasions during the reporting period. Faecal coliform counts in excess of 100 cfu/100 ml were recorded at 64 (30.3%) of the monitoring locations. Figure 2.7 indicates that there has been a decrease in the percentage of samples with zero faecal coliforms in the most recent reporting period and that there has also been an increase in the percentage of samples with >100 cfu/100ml. While the proportion of monitoring points with faecal coliform detections is high, it not only reflects the impact of human activities, but also the vulnerable nature of groundwater in some parts of the country.

The increased incidence of faecal coliform detections is largely a factor of the review and updates that were made to the national groundwater monitoring network in 2007 for WFD purposes; resulting in a network that is more representative of the hydrogeology and pressures. As a consequence, the network includes a higher proportion of monitoring locations that are vulnerable to bacteriological contamination.

Map 2.4 indicates that the groundwater monitoring locations in karst limestone areas show the greatest degree of microbiological pollution. The highest faecal coliform counts were recorded in springs. This reflects the

vulnerable nature of the more dynamic flow systems to pollution and the lack of attenuation capacity in extremely vulnerable areas with shallow soil or subsoil. Many private supplies are untreated and the sources of contamination of the groundwater quality are unknown, or are beyond the control of the owner of the supply.

Therefore, general improvements in well design, knowledge of source protection and good land use practice are essential if the risks to these supplies are to be reduced and improvements in water quality are to be seen.

The presence of a single faecal coliform in a drinking water supply is a breach of the Drinking Water Regulations (S.I. No. 278 of 2007) and as such must be regarded as a matter of serious concern and the circumstances promptly investigated. This matter has been addressed in detail in the annual reports on drinking water quality published by the EPA (e.g., Page *et al.*, 2009).

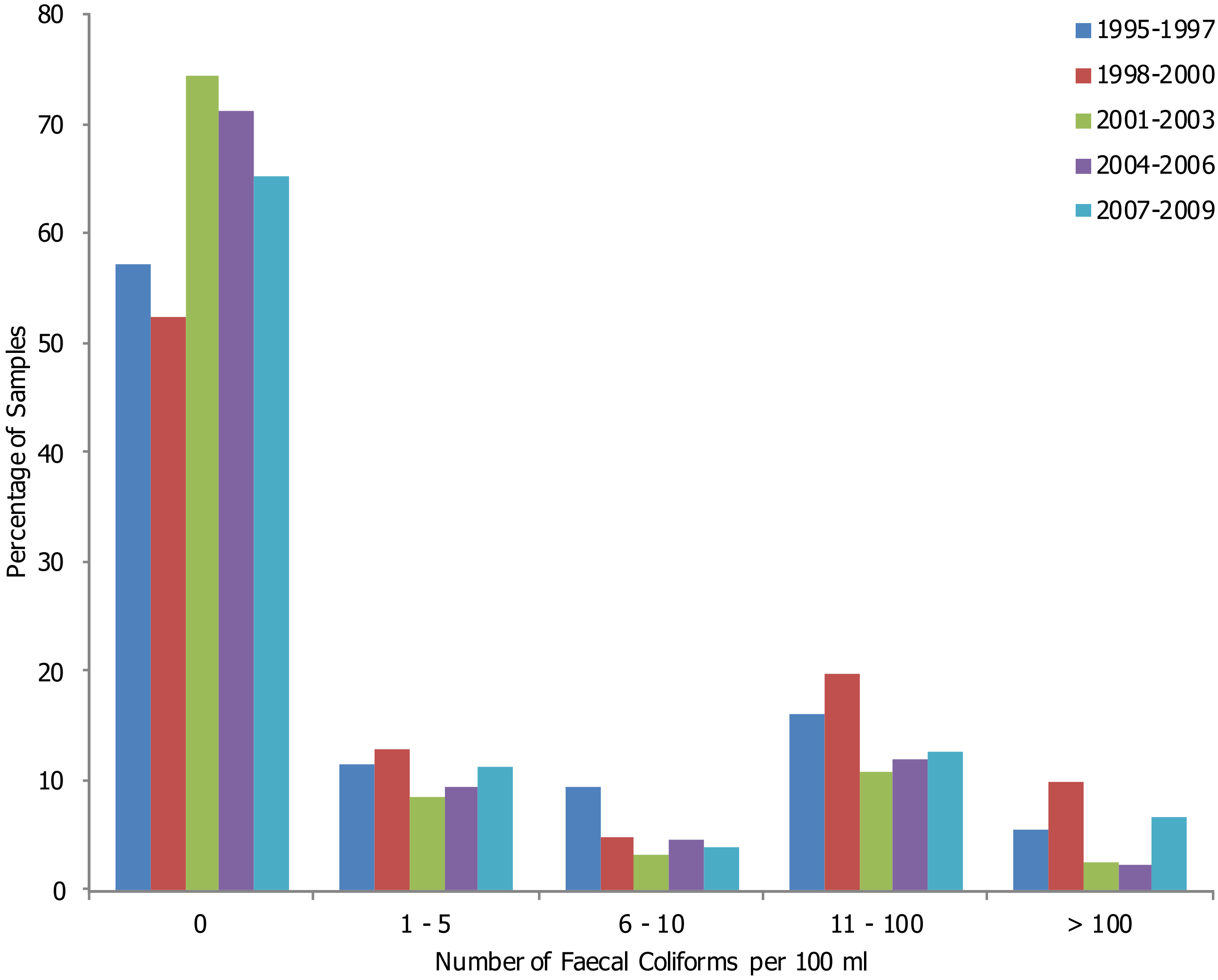
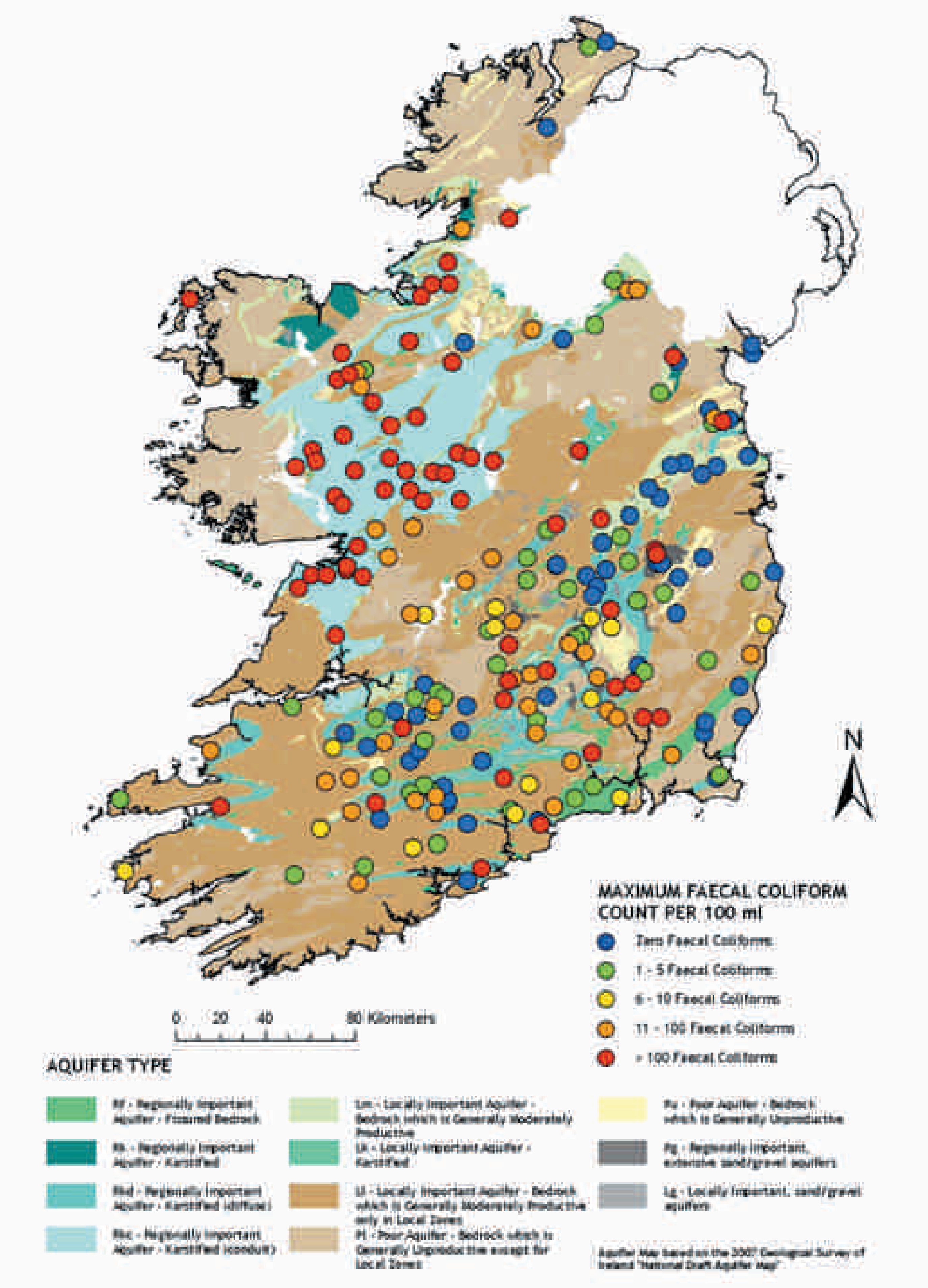


Figure 2.7. Comparison of the proportion of samples over different reporting periods with the number of faecal coliforms detected in the ranges indicated



Map 2.4. Faecal Coliform Detections in Groundwater 2007-2009 (Source: EPA, GSI)

CLASSIFICATION OF GROUNDWATER BODIES

Background

The European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. 9 of 2010) establish a new strengthened regime for the protection of groundwater in line with the requirements of the Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC). The EPA is identified as the responsible body for establishing and maintaining a list of Threshold Values (TVs) for pollutants in groundwater, assessing the chemical and quantitative status of groundwater bodies and undertaking pollutant trend and trend reversal assessments.

The Water Framework Directive (WFD) requires an integrated, holistic approach to the management and protection of water, thereby increasing the effectiveness of river basin management in Ireland. Groundwater is, therefore, at the core of the WFD. While the focus on groundwater in the past has been mainly concerned with its use for drinking water, the environmental value of groundwater, as well as its value as a water supply reservoir, has been recognised by the ecological objectives of the WFD. Groundwater plays an essential role in the hydrological cycle and is critical for maintaining river flows and surface water ecosystems such as wetlands.

In most rivers in Ireland, more than 30 per cent of the annual average flow is derived from groundwater. In low flow periods, this figure can rise to more than 90 per cent. Therefore, reductions in groundwater input, particularly in dry weather periods, or deterioration in groundwater quality may directly affect related surface water and terrestrial ecosystems. For instance, since surface waters receive inflowing groundwater, its quality will ultimately be reflected in the quality of surface waters. Therefore, the effect of human activity on groundwater quality will eventually impact on the quality of associated aquatic ecosystems and directly dependent terrestrial ecosystems if natural attenuation reactions such as biodegradation and adsorption in the subsurface are not sufficient to remove the contaminants.

In 2005, the WFD Article 5 Characterisation and Risk Assessments (WFD Working Group on Groundwater, 2005) were undertaken to identify groundwater bodies that were at risk of failing to meet the objectives of the WFD. The characterisation process involved two elements: physical characterisation and risk characterisation. Physical characterisation provided relevant information on groundwater receptors and on the geological pathways that link pressures and receptors. The risk assessment process concluded that 458 of the 757 groundwater bodies (60.5%), comprising 26.7 per cent of the area of the country, were classified as being "at risk" of failing one or more objectives of the WFD. While a large number of groundwater bodies (295) were at risk due to point source pollution, diffuse source pollution affected the greater area (24.6%).

The diffuse pressures risk assessment indicated that nutrient pressures from agricultural activities (including livestock farming, arable activities and intensive enterprises) and usage of dangerous substances, e.g. agrochemicals, are the most widespread and nationally significant anthropogenic pressure on groundwater. Nitrates were identified as being the most significant pollutant when considering groundwater as the receptor. The groundwater pathway for delivering phosphate loading to surface waters receptors was considered to be significant in some areas, such as extremely vulnerable bedrock areas. In most instances point source pressures, e.g. mines, quarries or landfills were considered unlikely to cause a significant impact on an entire groundwater body, as groundwater bodies are relatively large units (generally over fifty square kilometres). Unlike in most other European countries, groundwater abstraction was generally not considered to be a significant pressure.

The EPA's classification assessments have generally followed the procedures set out in EU Guidance Document No. 18: Guidance on Groundwater Status and Trends (EC, 2009),

UKTAG Paper 11b(i): Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Daughter Directive (UKTAG, 2008a), UKTAG Paper 11b(ii): Groundwater Quantitative Classification for the purposes of the Water Framework Directive (UKTAG, 2008b) and UKTAG Guidance on Groundwater Trend Assessments (UKTAG, 2009).

Threshold Values

Under Articles 48–52 of the Groundwater Regulations, the Agency is required to establish, and where appropriate maintain and update, a list of Threshold Values (TVs) for pollutants in groundwater. Threshold Values only have to be derived for pollutants placing a groundwater body at risk of failing to achieve a WFD objective.

Threshold Values are groundwater quality standards that are established by each Member State for the purpose of assessing the chemical status of groundwater bodies.* Threshold Values are also used when undertaking trend assessments. They can be set nationally or at a local groundwater body scale. They are triggers, such that their exceedance prompts further investigation to determine whether the conditions for good status have been met. As such, they do not represent the boundary between good and poor status. It is only if the average concentration of pollutants exceeds the Threshold Value and supporting evidence confirms the presence of an impact that compromises the achievement of WFD status objectives, that the groundwater body is classified as poor status.

When assessing monitoring data, the Threshold Value and assessment procedure must be appropriate to the receptor being considered for each status test, e.g. for an associated surface water body, a groundwater dependent terrestrial ecosystem (GWDTE) or groundwater that is used, or could be used for drinking water supply. The Threshold Values are identified in Schedule 5 of the Groundwater Regulations.

Status Assessments

Articles 33–44 of the Groundwater Regulations identify the conditions for assessing groundwater body status. The achievement of good groundwater status involves meeting this series of conditions, which are designed to satisfy the criteria defined in the WFD and the Groundwater Directive. In order to assess whether these conditions are being met, a series of tests has been prescribed for each of the quality elements defining good (chemical and quantitative) groundwater status.

Status assessments are required for all groundwater bodies identified as being at risk of failing one or more objectives of the WFD. The assessments are undertaken at the end of every six-year river basin management planning cycle and are used to generate a snap shot that shows the impacts of abstraction and pollutants on groundwater. In contrast, the risk assessments are carried out at the beginning of the six-year cycles. Whilst similar in nature, the goals of status assessments and ongoing risk assessments are different in that the risk assessments help determine the requirements for future monitoring and investigation, and help identify areas where future developments could impinge on the groundwater status objectives of the WFD. Essentially, the risk assessments are assessments of whether objectives of the WFD may not be achieved in the future, whilst status assessments consider compliance with the WFD objectives in the previous River Basin Planning cycle.

A groundwater body can be at good status, but there can still be an environmental risk, e.g. where the local impacts on groundwater quality are not substantial enough to impact on the status of the whole groundwater body. However, where a groundwater body has been classified as being at poor status, this implies that there is also a risk of failing WFD objectives in the future.

For groundwater, the overall aim is to achieve good status in all bodies of groundwater by

* Whilst the standards and conditions that are applied to environmental permits should reflect the need to meet all WFD objectives, including good chemical status, these are not Threshold Values.

2015, as well as preventing deterioration in those waters that have been classified as good. The process of classifying groundwater bodies follows logically from the characterisation and risk assessment process undertaken for Article 5 of the WFD.

Classification of groundwater bodies differs from that undertaken for surface water bodies, in that the surface water standards relate to ecological status and these standards define the classification boundaries. Groundwater status does not directly assess ecology, but the classification process takes account of the ecological needs of the relevant rivers and terrestrial ecosystems that depend on contributions from groundwater. Another key component of the groundwater classification is assessment of the impact of pollution on the uses (or potential uses) of groundwater from the groundwater body, e.g. for water supply. The groundwater body classification is based on the objectives defined in Annex V of the WFD and Annexes I – III of the Groundwater Directive.

Five chemical and four quantitative tests (Figure 2.8) have been developed to assess whether the WFD objectives are met. Each test is applied independently and the results are combined to give an overall assessment of groundwater body chemical and quantitative status. The worst-case classification from the relevant chemical status tests is reported as the overall chemical status for the groundwater body, and the worst-case classification of the quantitative tests is reported as the overall quantitative status for the groundwater body. The worst result of the chemical and quantitative assessments is reported as the overall groundwater body status.

The EPA, assisted by River Basin District Project consultants, completed the interim classification of groundwater bodies in December 2008. The classification will be finalised and reported to Europe in 2011, following a consultation process.

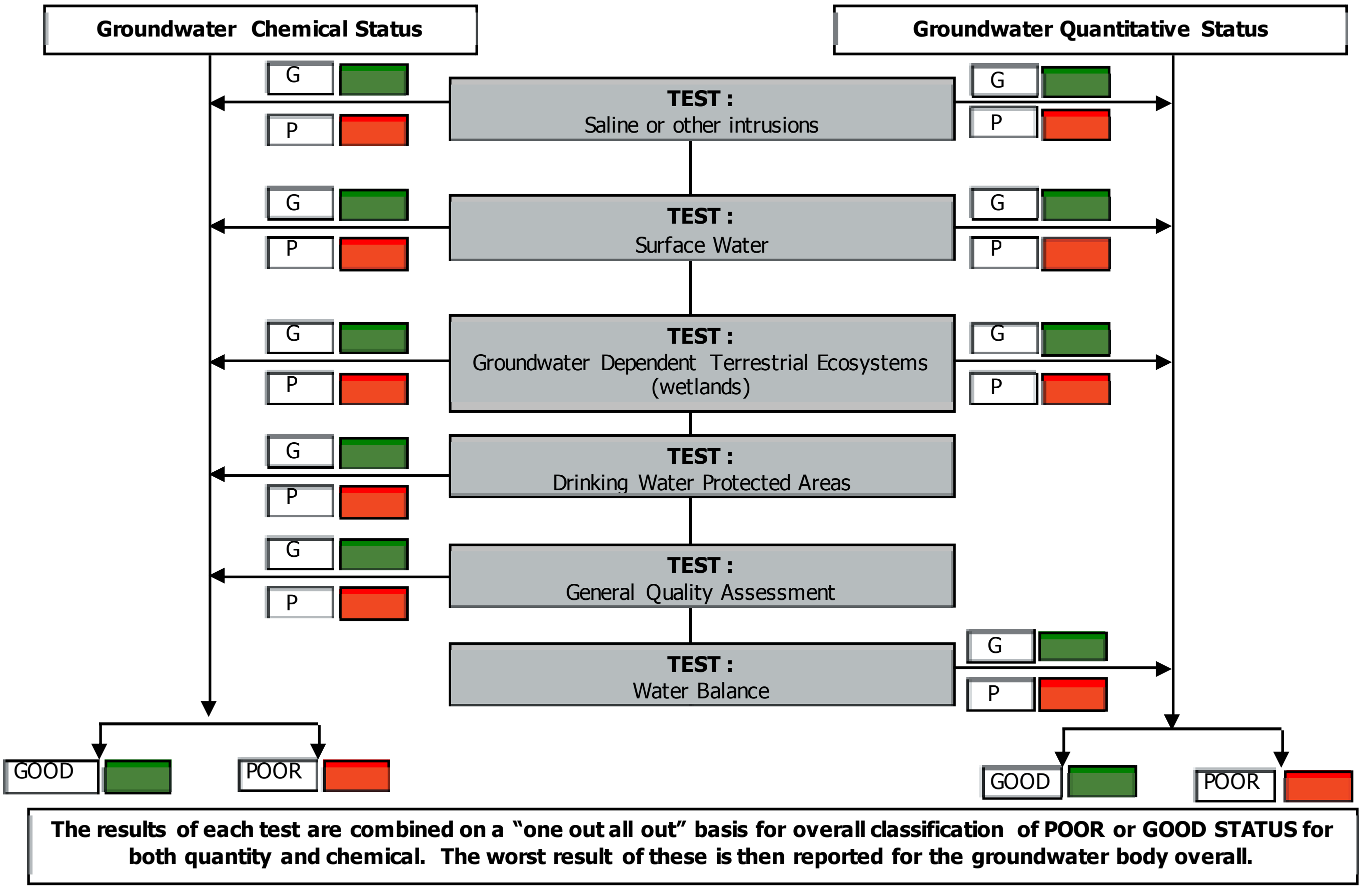


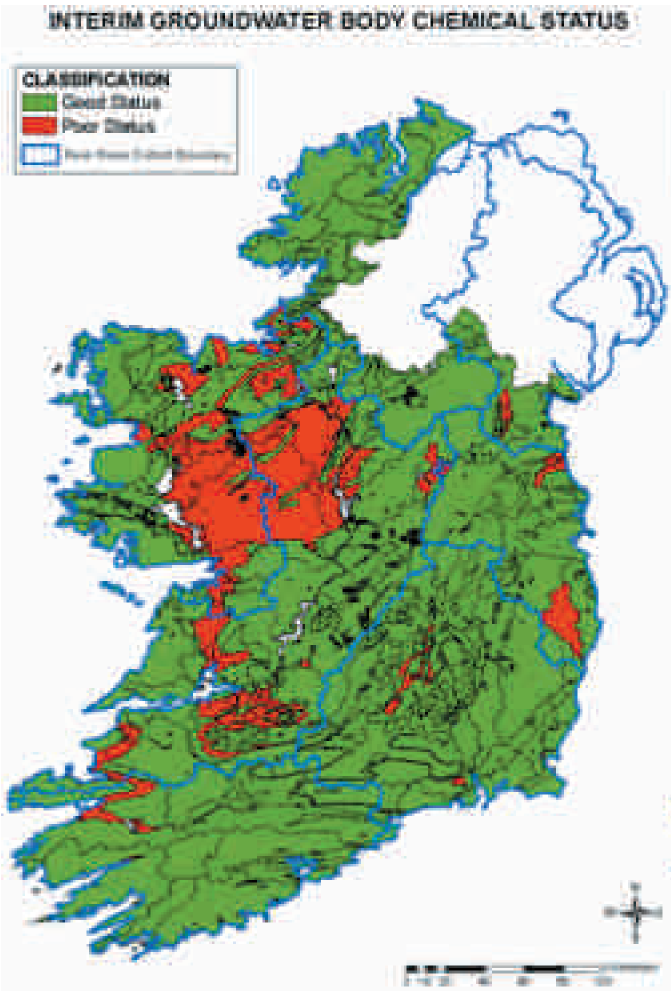
Figure 2.8. Overview of the status assessment (Classification) process (UKTAG, 2008a)

OVERALL GROUNDWATER STATUS RESULTS

For each groundwater body, the lowest classification from the five chemical tests has been reported as the overall chemical status (Map 2.5), and the lowest classification from the four quantitative tests have been reported as the overall quantitative status (Map 2.6). If either the chemical or the quantitative assessment is poor, then a "one out all out" approach is used to determine the overall classification. The summary results are given in Table 2.1. The overall results depicted in Table 2.1 show that 84.7% of the groundwater bodies are at Good Status and 15.3% (which relates to 14.4% of the total land area) are at Poor Status.

Table 2.1. Summary of interim status classification results for groundwater bodies

Status		Chemical		Quantitative		Overall	
		Number (% of total)	% area	Number (% of total)	% area	Number (% of total)	% area
GOOD		645 (85.2)	85.9	753 (99.5)	99.7	641 (84.7)	85.6
POOR		112 (14.8)	14.1	4 (0.5)	0.3	116 (15.3)	14.4
Total		757 (100)	100	757 (100)	100	757 (100)	100



Map 2.5. Interim Chemical Status of Groundwater Bodies

Map 2.6. Interim Quantitative Status of Groundwater Bodies

Box 2.2 Groundwater Monitoring

Historically, the EPA has monitored groundwater quality at a number of public and private wells and springs across the country. To meet the requirements of the Water Framework Directive (WFD), the monitoring networks were reviewed in 2007, resulting in a number of the historical monitoring points being dropped, and a number of monitoring points being added to the EPA's Groundwater Monitoring Programme. The revised groundwater monitoring programme has been developed to improve knowledge of groundwater quality, and the links between groundwater and the ecological health of associated receptors. Monitoring data provide the basis for the assessment of groundwater status for the WFD.

The location of groundwater monitoring points has been determined by assessing the requirements for achieving a network that is representative of the variations in hydrogeology and anthropogenic pressures across a groundwater body, i.e. the 'average' concentrations of pollutants from a representative network of monitoring points should reflect the 'average' concentrations for those pollutants across the whole groundwater body.

The poorly productive aquifers are generally unable to yield significant quantities of groundwater for abstraction, although high yields can be obtained at some locations, such as along fault zones. As these aquifers are generally unable to support significant yields, the contributing area to the wells is often relatively small and only reflects a small proportion of the overall groundwater body. Monitoring networks in these aquifers have been developed to focus on the higher yielding abstractions from fault zones and 60 monitoring points that have been installed at different depths in different poorly productive bedrock aquifers (Plate 2.4).

Monitoring data from selected compliance monitoring sites at IPPC (Integrated Pollution Prevention and Control) licensed activities have been utilised for the assessment of point source pressures within groundwater bodies. The compliance monitoring data may be supplemented by additional monitoring in the future, e.g. where the monitoring is deemed to be inadequate for WFD purposes or for point source pressures that are not part of the compliance monitoring network, e.g. historical waste dumps.

Plate 2.4. Water level data loggers being downloaded in a poorly productive bedrock aquifer in Co. Donegal

Assessment of Groundwater Pollution and Water Quality Trends

Background

Part VI of the Groundwater Regulations indicate that the Agency should identify significant and sustained upward trends in the concentration of pollutants in groundwater bodies or groups of bodies identified as being at risk of failing to achieve the objectives of the WFD. In groundwater bodies or groups of bodies that are not at risk of failing to achieve the objectives of the WFD, it may also be necessary to undertake trend assessments, to determine changes in natural conditions or to identify future changes due to anthropogenic activity.

Where significant and sustained upward trends are identified, Member States are required to reverse these trends through the introduction of programmes of measures (PoMs). Generally, it will take a number of years before the impact of measures is seen in groundwater systems. Therefore, upward trends need to be identified in sufficient time, so PoMs can bring about a reduction in pollution and prevent deterioration in groundwater quality, thereby reducing the chance of failing the relevant WFD objectives. Article 55 of the Regulations indicates that the starting point for trend reversal must be expressed as a percentage of the relevant groundwater quality standard or Threshold Value (TV). The start date for trend reversal is based on the significance of the trend and the risk associated with it. By default, Schedule 8 (Part B) of the Regulations indicates that the starting point for trend reversal is the date when 75 per cent of the standard or TV is likely to be exceeded, but an earlier or later starting date can be chosen to meet the environmental objectives in a cost effective manner.

Trend Assessments

Trend assessments have been undertaken for parameters that are placing groundwater bodies at risk of failing a groundwater chemical status objective, i.e. those parameters that relate to drinking water, saline intrusion, surface water or groundwater dependent wetland assessments. In the context of the WFD, a significant and sustained upward trend is a trend that is both statistically and environmentally significant, causing an increase in concentration of a pollutant, group of pollutants, or indicator of pollution in groundwater for which trend reversal would be required. Trend assessments were undertaken at 119 monitoring points. The remaining monitoring points had insufficient data to undertake the trend assessment in the first River Basin Planning cycle. Assessments were undertaken using data from 1999-2008 for Electrical Conductivity, Chloride, Sulphate, Sodium, Ammonium, Nitrate, Molybdate Reactive Phosphorus (MRP), Iron and Manganese, as these are the only parameters that are placing a groundwater body at risk, and that have sufficient data records to undertake a robust trend assessment. The general pattern for trends is shown in Table 2.2.

A small number of environmentally significant upward trends were detected for Ammonium, Chloride, Electrical Conductivity, Molybdate Reactive Phosphorus (MRP), Iron and Manganese. Natural processes and local geological conditions are thought to be the cause of the elevated concentrations for Chloride, Electrical Conductivity, Iron and Manganese. The Ammonium and MRP trends are thought to partly be a function of data gaps and a significant proportion of samples being at or below the limit of quantification, which has distorted the trends to some degree, resulting in weakened confidence in the trend.

The overall picture for nitrate trends at the monitoring points indicates a relatively stable picture nationally. Environmentally and statistically significant upward trends in nitrate concentrations are evident at Durrow, Laois (Figure 2.9) and Ballyheigue, Kerry (Figure 2.10). Average nitrate concentrations are also above the threshold value of 37.5 mg/l NO_3 at these monitoring locations.

In relation to the nitrate trends, both Durrow and Ballyheigue are Drinking Water Supplies, and therefore the groundwater bodies in which they are located are classified as being at poor

status in relation to the drinking water objectives of the WFD. As such, there is a requirement to reverse trends in these groundwater bodies. The average concentration of Nitrate at both Durrow and Ballyheigue in 2008 was greater than 75 per cent of the Nitrate Threshold Value of 37.5 mg/l NO_3. Therefore the start date for trend reversal is 2009 and programmes of measures to reverse trends should be introduced immediately.

Table 2.2. Summary of monitoring point trends for assessed parameters

Parameter	Monitoring locations with No Significant Trend	Monitoring locations with Downward Trends	Monitoring locations with Downward Trends that are Statistically Significant	Monitoring locations with Upward Trends	Monitoring locations with Upward Trends that are Statistically Significant	Monitoring locations with Upward Trends that are Statistically & Environmentally Significant
Electrical Conductivity	17 locations	69 locations	15 locations	33 locations	4 locations	1 location
Chloride	3 locations	86 locations	30 locations	30 locations	7 locations	7 locations
Ammonium	3 locations	6 locations	0 locations	110 locations	42 locations	7 locations
Nitrate	7 locations	56 locations	11 locations	56 locations	14 locations	2 locations
Molybdate Reactive Phosphorus	9 locations	42 locations	1 location	68 locations	3 locations	3 locations
Sulphate	5 locations	50 locations	13 locations	64 locations	12 locations	0 locations
Sodium	12 locations	72 locations	9 locations	35 locations	2 locations	0 locations
Manganese	3 locations	90 locations	33 locations	26 locations	3 locations	2 locations
Iron	11 locations	63 locations	12 locations	45 locations	1 location	1 location

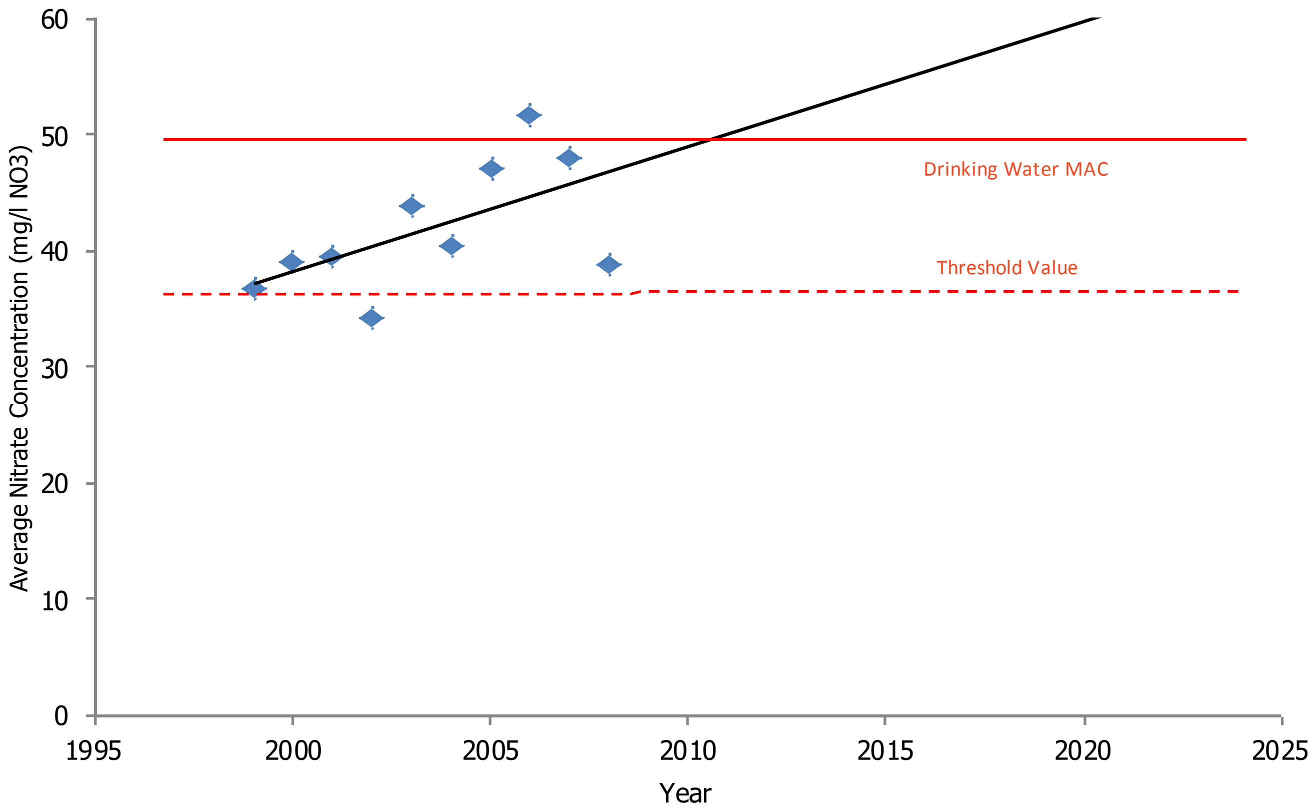


Figure 2.9. Environmentally and Statistically Significant Upward Trend for Nitrate at Durrow (Laois)

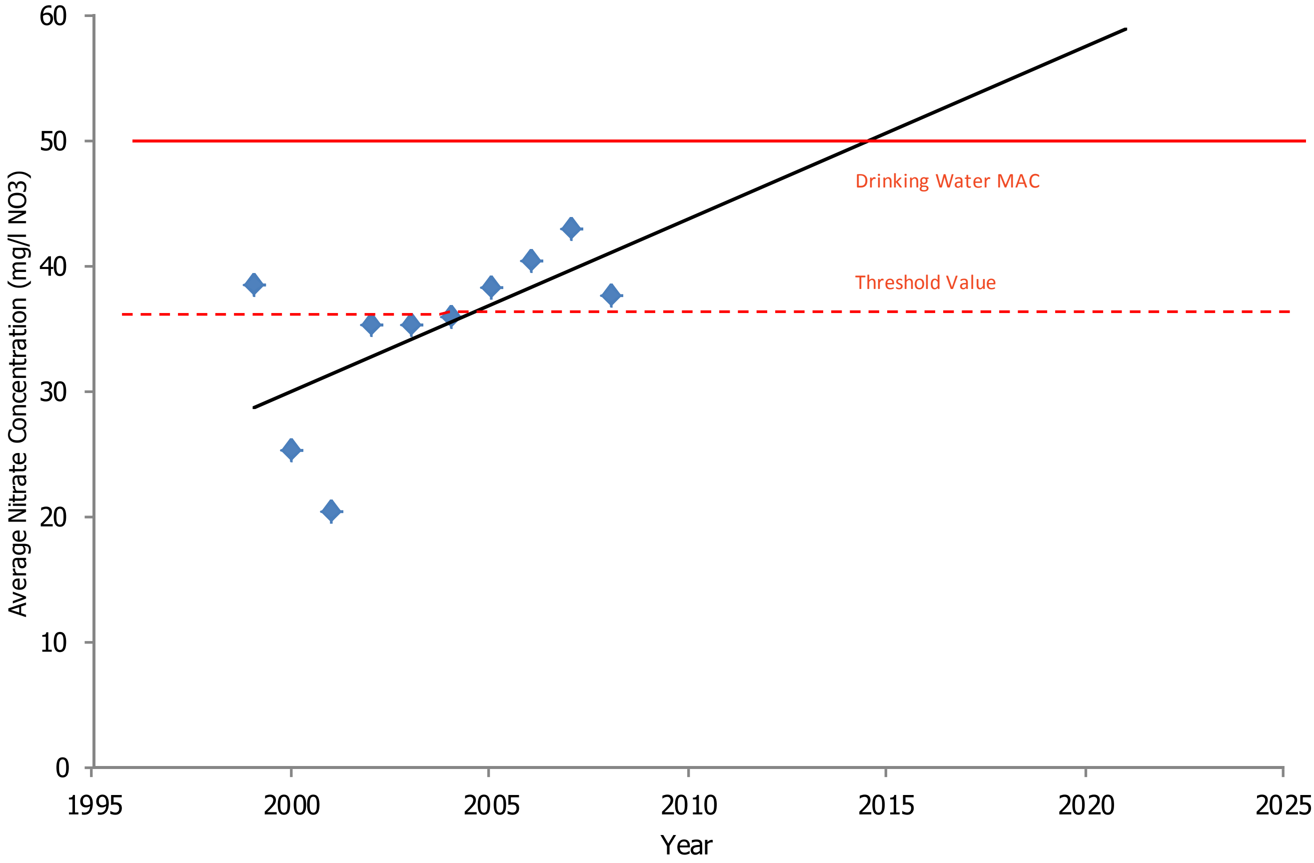


Figure 2.10. Environmentally and Statistically Significant Upward Trend for Nitrate at Ballyheigue (Kerry)

WATER FRAMEWORK DIRECTIVE SUMMARY

The interim classification of groundwater bodies has resulted in 14 per cent of the land area as being poor status which is likely to be relatively low in comparison to other EU countries. By far the greater proportion of this is caused by the input of pollutants, mainly phosphate, probably from agricultural activities, although on-site wastewater treatment systems may also be a minor source.

Environmentally and statistically significant trends were detected for nitrate at two monitoring locations, and the upward trends will require trend reversal. The average nitrate concentration already exceeds the nitrate Threshold Value, so the starting point for trend reversal is 2009, i.e. the beginning of the 2nd River Basin Planning cycle. Pesticides in groundwater have not resulted in any groundwater bodies being at poor status. Also abstraction of groundwater was not shown to be a significant issue. While the implementation of measures, which are required to return these groundwater bodies to good status, will have environmental benefits, they are also likely to have some social and economic costs.

Further characterisation, risk, status and trend assessments will be undertaken in the 2nd River Basin Planning cycle, and trend assessments will be undertaken for the first time at monitoring points where monitoring data were sufficient to undertake the assessments during the 1st River Basin Planning cycle.

The results of chemical status, quantitative status, overall status and trend assessments are reported in the River Basin Management Plans for each River Basin Management District*, and are available from the WFD Ireland "Water Matters" website (http://www.wfdireland.ie).

* See individual River Basin District websites for the reports, e.g. http://www.serbd.com for the South Eastern River Basin District.

In addition to providing the results of the status and trend assessments, the River Basin Management Plans also provide information on the role of the River Basin District in the implementation of the WFD and the key environmental issues that are pertinent to that River Basin District, e.g. water requirements and pressures. The Plans identify the key WFD objectives that are relevant to that River Basin District. These include:

- Preventing deterioration in the status of groundwater bodies;
- Restoring the status of groundwater bodies to at least Good Status;
- Reducing chemical pollution of groundwater;
- Meeting the protected area objectives in relation to groundwater.

Where they key objectives are unlikely to be fulfilled by 2015, the Plans identify alternative objectives, including extended deadlines to achieve the objective.

To achieve the key WFD objectives, a series of basic and supplementary measures are proposed in the Plans. The basic measures focus on compliance with existing legislation, e.g. the Groundwater Regulations and the *Good Agricultural Practice for Protection of Waters Regulations* (S.I. 101 of 2009). Supplemental measures will be required where environmental issues exist, but currently do not fall under the remit of existing key legislation, e.g. abstraction control regulations.

INTERPRETATION OF THE GROUNDWATER QUALITY DATA

Factors Influencing Changes in Groundwater Quality for the Period 2007-2009

A comprehensive assessment of groundwater quality data requires an understanding of the whole groundwater system, including knowledge of the pressures and the hydrogeology. Rainfall is the driving force behind the groundwater system through the recharge of water to the aquifers. Variations in rainfall patterns have the potential to impact on the dynamics of groundwater systems. This includes both the quantity of flow and the quality of the water in the aquifers.

The years 2008 and 2009 are considered to have been wet years, with the rainfall generally being higher than the 30 year average rainfall. An initial finding of an ongoing EPA funded STRIVE research project is that the rainfall during the period 2008 and 2009 has been at least 20 per cent above the 30 year average in the south-east of the country (Katie Tedd pers. comm.). Consequently, the relatively high rainfall experienced will have resulted in increased recharge to aquifers in many parts of the country.

In recent years there has been significant investment (over €2 billion) to upgrade facilities for the storage of livestock slurry and manures at a farm level. This investment is likely to have a significant beneficial impact for farm management, which in turn should be beneficial for the environment. There has also been a significant reduction in fertiliser sales over the last decade, particularly in the last five years, with nitrogen and phosphorus fertiliser sales falling by approximately 30 per cent during this time period (DAFF, 2009). In time, the improved storage and reduced application of inorganic fertiliser should bring about a reduction in nitrate and phosphate concentrations in groundwater.

At the majority of monitoring locations, the mean ammonium concentrations were below the Drinking Water MAC. Historically 85 to 90 per cent of monitoring locations had ammonium concentrations less than 0.04 mg/l N, which fell to approximately 60 per cent of locations during the 2007-2009 reporting period. There was a ten per cent increase in the number of monitoring locations with concentrations greater than 0.065 mg/l N during the 2007-2009 reporting period. Increased rainfall may have resulted in an increased impact of pollution on near surface/shallow water in groundwater systems, resulting in pollutants getting into groundwater relatively quickly, particularly in areas with extreme groundwater vulnerability. Although the nitrification of ammonium to nitrate will readily take place when favourable conditions exist, concentrations of ammonium in groundwater that are significantly above the

EQS may have an impact on the receiving surface waters. Over half of the monitoring locations with ammonium concentrations greater than 0.065 mg/l N also had positive detections of faecal coliforms, although the majority of these sites are springs or are located in areas of extreme groundwater vulnerability.

Compared with the 2004–2006 reporting period, there was an approximately 14 per cent increase in the number of monitoring locations with nitrate concentrations less than 10 mg/l NO_3. There was also a six per cent reduction in the number of monitoring locations with nitrate concentrations greater than 37.5 mg/l NO_3. The general reduction in nitrate concentrations appears to be the result of a number of factors. The recent reductions in inorganic fertiliser applications, improvements in storage for organic fertiliser and the implementation of landspreading restrictions, coupled with the above average rainfall, may have resulted in a reduction in pressures and increased the potential for dilution, thereby causing a reduction in nitrate concentrations. In particular, the dilution is likely to be more prominent in those aquifers readily capable of accepting the increased recharge, i.e. the more productive aquifers. This is verified by the monitoring data, which indicates the greatest reductions in nitrate concentrations have occurred in the karst limestones aquifers in the south-east. However, nationally, the nitrate concentrations remain highest in the south-east and south of the country.

The general reduction in phosphate concentrations evident in the 2007-2009 monitoring data is again likely to be a result of reduced inorganic fertiliser applications, improvements in storage for organic fertiliser and the implementation of landspreading restrictions, although dilution may be the most significant factor. The aquifers that are readily capable of accepting increased recharge, e.g. the karst aquifers in the west, are more likely to show the effects of dilution and it is those aquifers which have historically had relatively high concentrations of phosphate. There was an increased percentage of samples with positive detections of faecal coliforms during the reporting period. While improved storage facilities and the implementation of landspreading restrictions should result in a reduction of faecal coliform counts, the above average rainfall may have resulted in faecal coliforms by-passing the soils and subsoil and getting into groundwater before attenuation can occur. This is reflected by a large number of spring monitoring locations, e.g. in the karst limestone, that have greater than 100 cfu/100ml.

Groundwater Classification

Table 2.3 shows the status classification breakdown for each River Basin District. The status results indicate that only 0.3 per cent of the country is at poor status due to the presence of high nitrate concentrations in the vicinity of groundwater supply abstraction points (one groundwater body in each of the South Eastern and Shannon River Basin Districts). Pesticides in groundwater have not resulted in any groundwater bodies being at poor status.

In contrast, 13.3 per cent of the country is at poor status due to the presence of phosphate in groundwater. The majority of the poor status groundwater bodies in the Shannon and Western River Basin Districts are driven by the surface water classification test and the contribution of phosphate in groundwater to surface water bodies being at less than good status.

This outcome is due to two factors: firstly, to the sensitivity of surface water ecosystems to phosphate; and secondly, to the impact of groundwater input and quality on surface water ecosystems, particularly in the karstified limestone aquifers, where the groundwater flow contribution to surface water is usually more than 60 per cent of the average surface water flow and the vulnerability of the groundwater (with shallow soils and subsoils, and sinking streams) results in high average phosphate concentrations in the groundwater (typically mean phosphate concentrations in these aquifers are > 0.025 mg/l P). Ammonium concentrations in groundwater were low with regard to Drinking Water Standards and typically they are also lower

than the surface water Environmental Quality Standard. No groundwater bodies were at poor status due to faecal coliforms because they are not included as a parameter for WFD classification. Pressures from unregulated point source activities, such as historic mines, contaminated land and old dumps may have adverse impacts on groundwater in the immediate area downgradient of the pollution source, but generally this pollution does not have a significant impact at a groundwater body scale. A small number of groundwater bodies have been placed at poor status, where the pollution extent is having a significant impact at a groundwater body scale. Three groundwater bodies are at poor status due to historic pollution from contaminated land sites and four groundwater bodies are at poor status due to historic mining activities. Adherence to, and enforcement of the regulations relating to point discharges to groundwater should minimise the impacts from these sources in the future.

Table 2.3. River Basin District Summary of Status Classification results in groundwater bodies

RBD	Good Status (no. of bodies)	Good Status (% RBD Area)	Poor Status (no. of bodies)	Poor Status (% RBD Area)
Eastern	67	89.7	8	10.3
Neagh Bann	26	95.3	2	4.7
North West	72	100.0	0	0.0
South East	146	97.8	5	2.2
Shannon	182	74.5	60	25.5
South West	77	96.8	7	3.2
Western	71	65.2	34	34.8
National	641	85.6	116	14.4

Future Developments and Measures

The WFD has provided a time scale of 2015 for each Member State to reduce the anthropogenic impacts on its water bodies and restore them to good status. Each Member State must develop an approach to restore groundwater bodies to good status and protect groundwater bodies currently at good status. This approach is largely two fold, with classification providing the basis to drive measures in areas that are currently failing to achieve good status and 'prevent or limit' regulations, e.g. licensing activities, employed to prevent further deterioration. The approach will be iterative, with ongoing risk assessment helping to determine the exact nature of the problem and to examine the impacts of measures.

The delineation of areas contributing to a groundwater abstraction, in particular Source Protection Zones for water supply abstractions is critical to the success of any measures taken to reduce the anthropogenic impacts on the water supply. Once a Source Protection Zone has been delineated, it helps improve conceptual understanding of where the water that is being sampled comes from in a catchment and it provides an area in which measures can be applied. These measures will largely focus on areas that are more vulnerable to anthropogenic contaminants entering groundwater, e.g. in areas where there are shallow soils and subsoils.

The delineation of Source Protection Zones has historically been undertaken at a number of water supplies by the Geological Survey of Ireland (GSI) and to a lesser degree by academic institutions and consultants. The EPA has recently begun work delineating the zones (areas) that are contributing water to the monitoring points in the National Monitoring Programme that currently do not have Source Protection Zones delineated. It is hoped that in time, these zones of contribution will be upgraded to full Source Protection Zones for many of the monitoring points.

Due to the lack of information on trigger action values for groundwater dependent wetlands (GWDTEs), the GWDTE ecological/chemical status assessment could not be undertaken

during the 1st River Basin Planning cycle. Ongoing research in Ireland and elsewhere in Europe should yield trigger action values for a number of wetland types and the GWDTE ecological/chemical status assessment will be undertaken in the 2nd River Basin Planning cycle for these wetlands.

CONCLUSIONS

Groundwater is an important natural resource; both in terms of water supply and as a contributor to surface water receptors. Therefore, to ensure that long-term sustainable groundwater resources are achieved, groundwater resource management is required, through an assessment of anthropogenic pressures and the physical characteristics of the subsurface deposits, i.e. soil, subsoil and aquifer type.

Microbiological problems are also observed in the areas where groundwater is more vulnerable to pollution (particularly at spring monitoring locations) because they have little natural protection from organic inputs. Increased concentrations in ammonium were probably as a result of above average rainfall during the most recent reporting period and pollutants not being attenuated by the soils and subsoils. If abstraction wells are properly designed and installed, and are located in areas where the groundwater vulnerability is lower, the impacts of organic inputs should be minimal.

Although natural variations in nitrate and phosphate concentrations may influence water quality assessments, the elevated concentrations of nitrate and phosphate measured in Irish groundwater are largely anthropogenic. The intensive agricultural practices in the south-east suggest that diffuse, agricultural sources are the cause of the elevated nitrate concentrations and the vulnerable nature of the Karst Limestone aquifers in the west may explain the elevated phosphate concentrations in groundwater, and groundwater may be contributing to eutrophication in rivers and lakes in these areas.

There have been decreases in nitrate and phosphate concentrations in the period 2007-2009. The above average rainfall is likely to have been a significant contributory factor in this reduction, particularly as the concentrations have decreased most in the productive karst limestone aquifers that can readily accept the additional rainfall. However, improvement in farm storage for organic fertiliser, a reduction in inorganic fertiliser applications and the implementation of the Good Agricultural Practice Regulations are all likely to have contributed to a reduction in nitrate and phosphate concentrations in groundwater.

The presence of phosphate in groundwater is the main reason why the majority of groundwater bodies were classified as being at poor WFD status. This is largely due to the sensitivity of surface water ecosystems to phosphate and high contribution of average surface water flow coming from groundwater in certain areas, particularly the karstified limestone aquifers. Therefore, in areas where the groundwater is vulnerable to pollution, if small concentrations of phosphorus get into the groundwater, they may have an impact on surface water receptors. For the groundwater body to be at poor status, the surface water bodies must initially be at less than good status and the pressure must be diffuse, i.e. not a sewage treatment works or industrial discharge. Therefore when measures are introduced to bring the surface water body back to good status, the groundwater pathway to surface water must be considered.

Overall, there is a continued need for improved protection of groundwater, especially in the context of achieving the WFD objective of good status for all waters by 2015. In some instances it will not be feasible to meet this objective by 2015, e.g. where the concentrations of nitrate or phosphate in groundwater already exceed the Threshold Value and there is an upward trend in concentration. In these instances it may take a number of years for the measures to bring about a reduction in concentrations because the nitrate and phosphate will require time to flush through the groundwater system. If all the basic and supplemental measures are implemented, the objectives should be reached within the 2021 or 2027 extended deadlines. However, it is

likely that it will not be technically or economically feasible to achieve the objective by 2027 for a small number of water bodies, such as groundwater pollution from historic mining activities. These bodies will be candidates for less stringent objectives. In all cases, but particularly for the less stringent objective bodies, the objective of no further deterioration applies and, as a minimum, measures are required to ensure that this happens.

To meet the objectives of the WFD, an improved understanding of the interactions between groundwater and surface water receptors is required because this understanding is fundamental if further deterioration in water quality is to be prevented and sustainable water resources are going to be achieved. This understanding may help improve management of groundwater resources, and ultimately maintain the quality and yield of drinking water sources, and ensure that groundwater is not having a detrimental impact on surface water and ecological receptors in the future.

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A swallow hole at Kiltullagh Turlough, County Galway, where a stream is sinking underground into a karstified limestone aquifer

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[1]. 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

[1] 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.

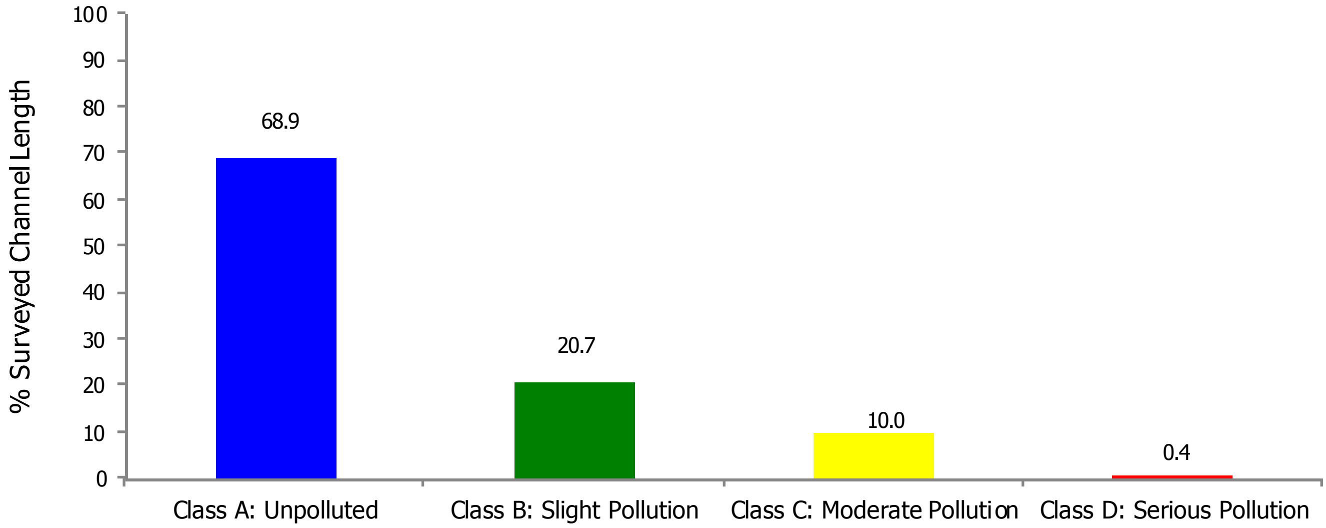

Figure 3.1a. River Quality 2007-2009: Percentage channel length classified into each of the four EPA biological quality classes (13,188 km).

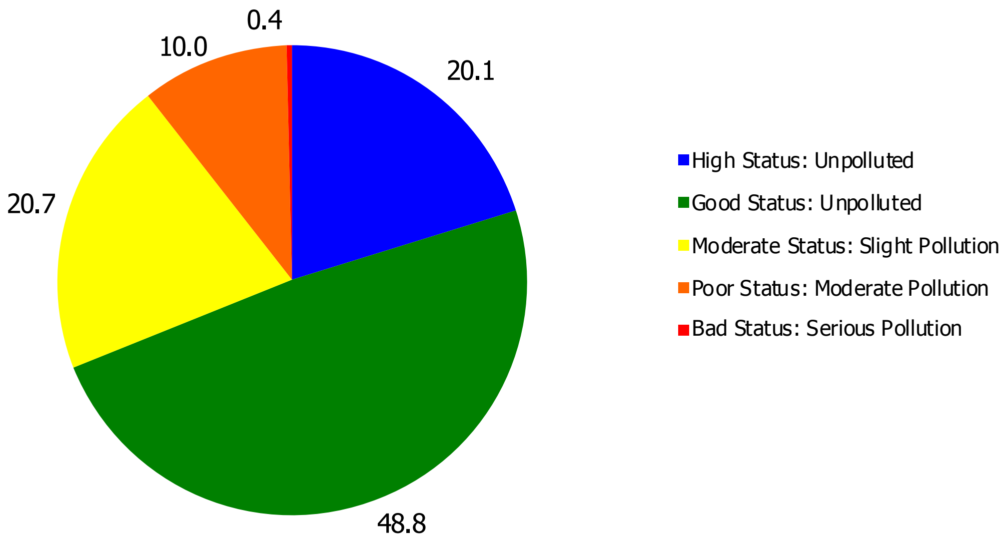

Figure 3.1b. River Quality/Status 2007-2009: Percentage channel length (13,188 km) with a further division of the unpolluted 68.9% of channel into 'High' status (20.1%) and 'Good' status (48.8%) corresponding to the new ecological status classes for macroinvertebrates under the WFD. This new distinction 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.

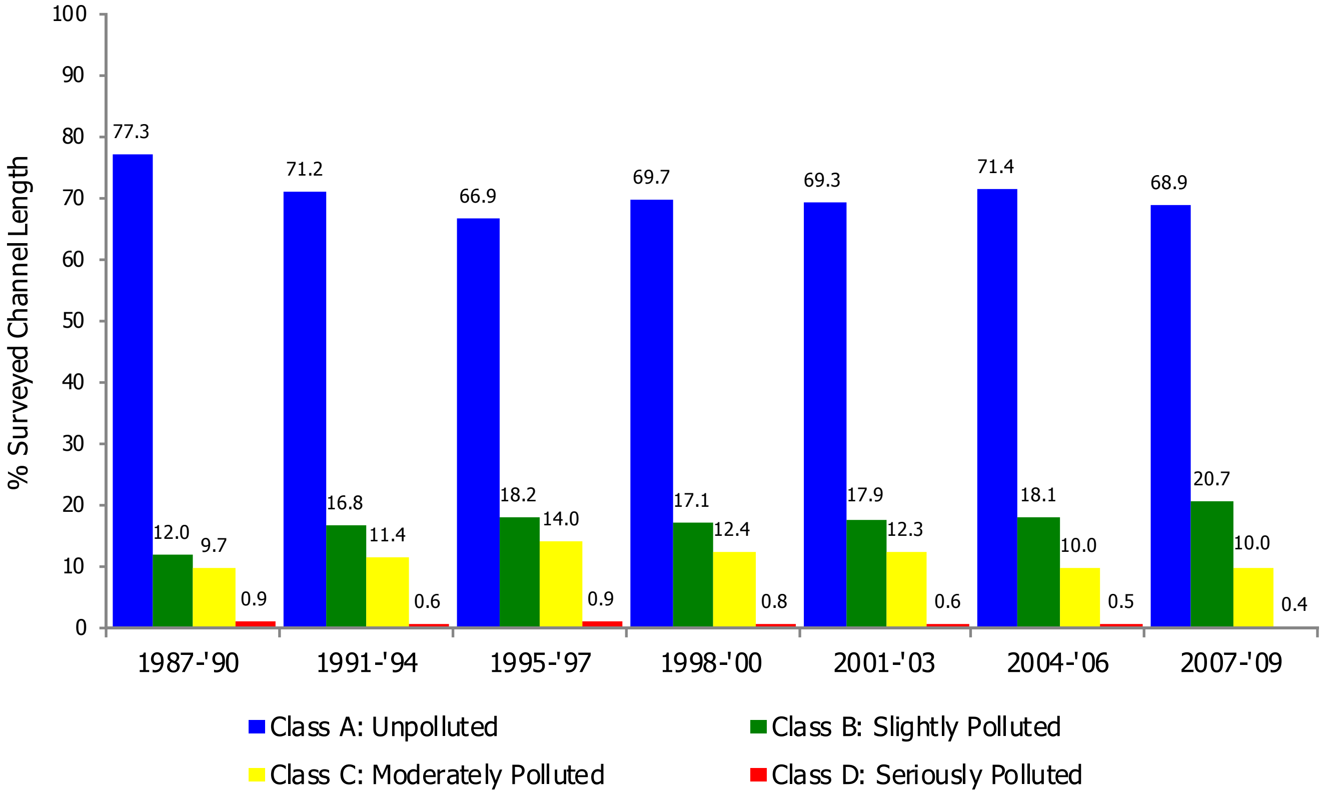

Figure 3.2. Recent Trends in the 13,188km baseline showing the percentage of surveyed channel in the four EPA biological quality classes. Historical data from Clabby *et al.*, 1992, Bowman *et al.*, 1996, Lucey *et al.*, 1999, McGarrigle *et al.*, 2002, Toner *et al.*, 2005 and Clabby *et al.*, 2008.

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.

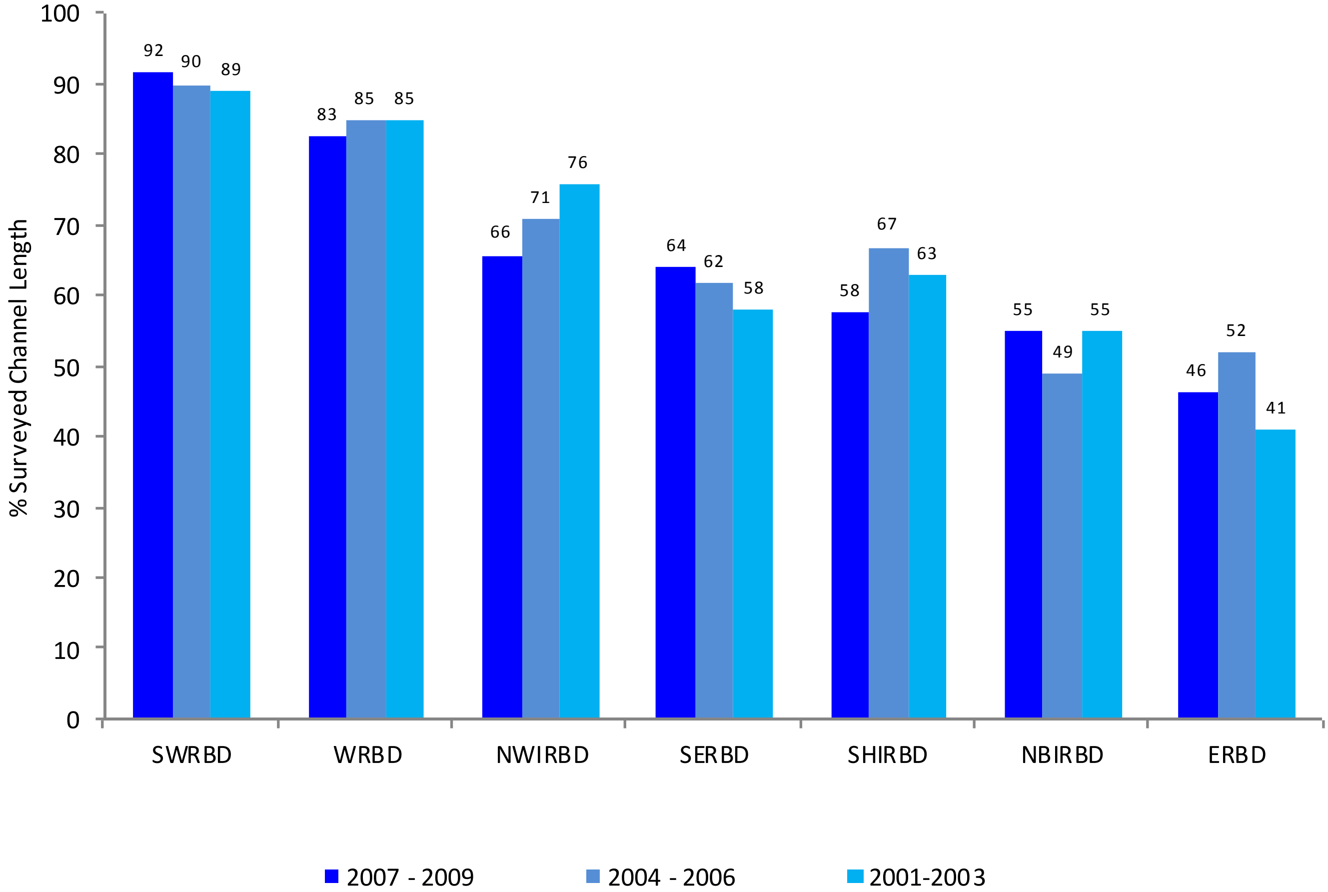

Figure 3.3. Trends in the percentage of unpolluted Class A (High and Good status) channel length in each River Basin District in the state for the survey periods 2007-2009, 2004-2006 and 2001-2003.

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.

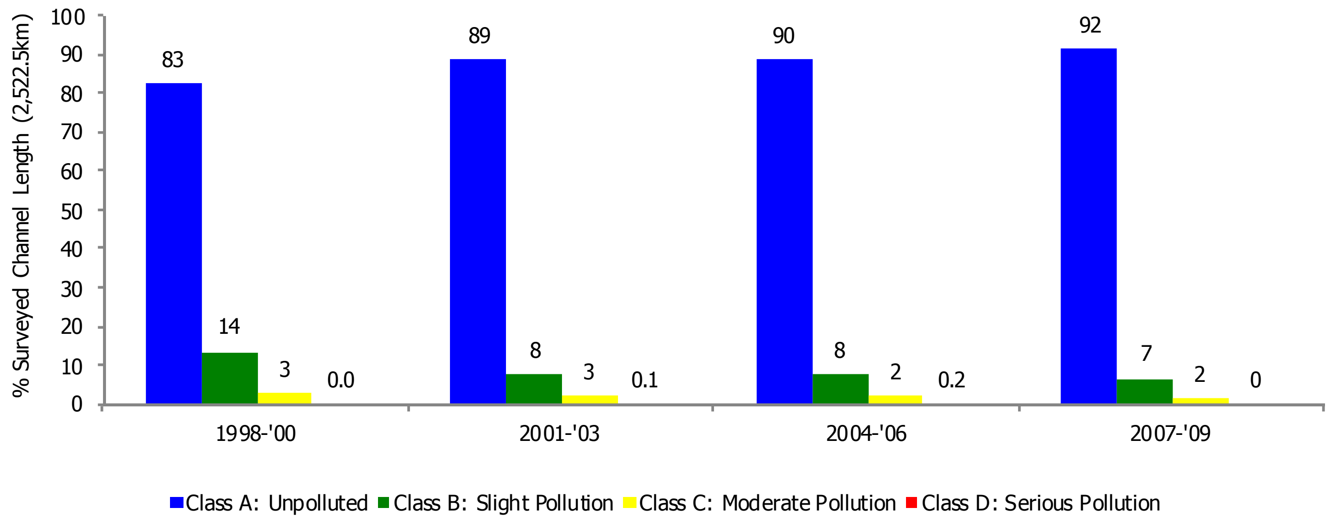

Figure 3.4a. Trends in River quality in the South Western RBD for the last four survey periods.

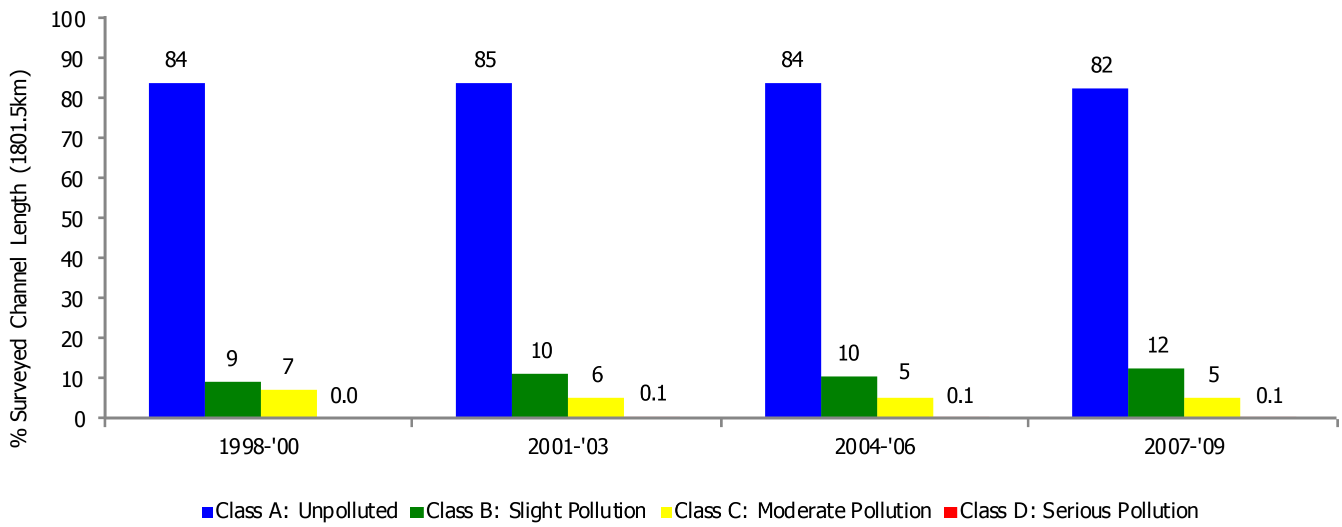

Figure 3.4b. Trends in River quality in the Western RBD for the last four survey periods.

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 Conaway 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 Ballaghdoo 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 (Portlaw), Garrancool Stream, Glory, Gowran, Mountrath, Nore, Triogue and Tully Stream during the 2007 -2009 survey period.

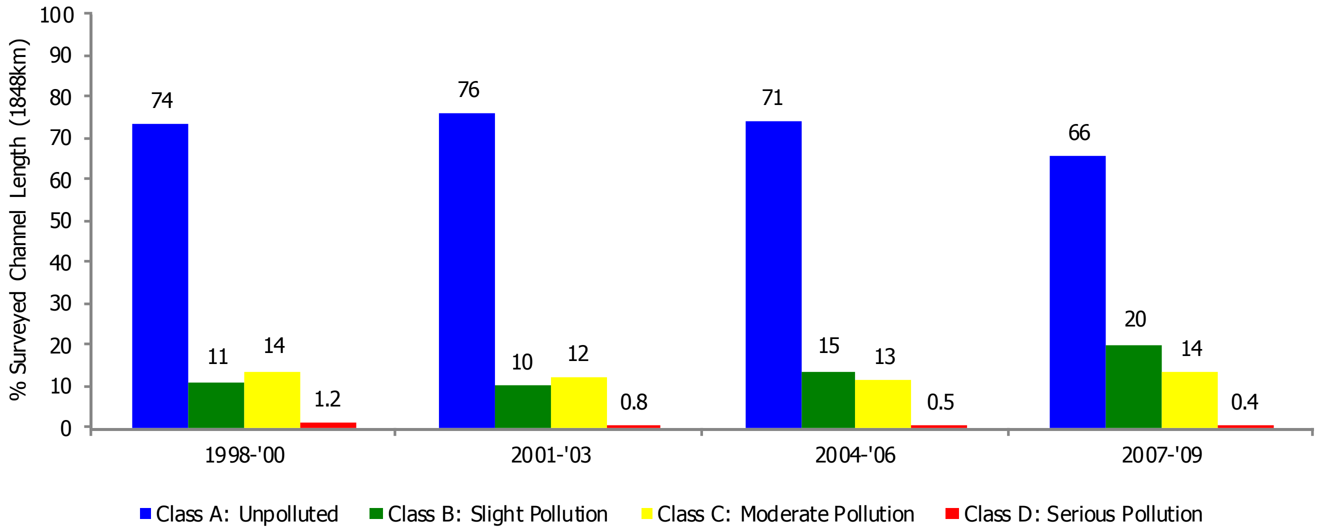

Figure 3.4c. Trends in River quality in the North Western IRBD (South) for the last four survey periods.

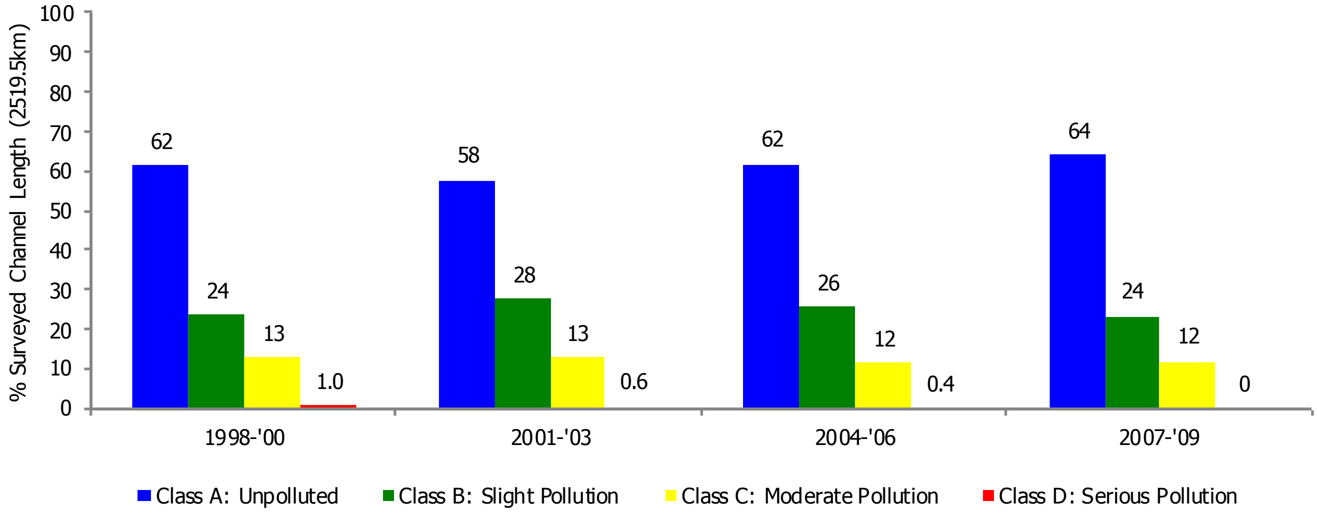

Figure 3.4d. Trends in River quality in the South Eastern RBD for the last four survey periods.

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).

Neagh-Bann IRBD (South) – River Water Quality Trends

A six per cent improvement in the length of unpolluted channel length was noted in the latest survey period with a corresponding decrease in the percentage of slight pollution and serious pollution but with a two per cent increase also of moderately polluted channel length (Figure 3.4f). Improvements from serious pollution were noted at the Fane and Ballymascanlan River locations however further pollution abatement is required in order to achieve the requirements of the Water Framework Directive.

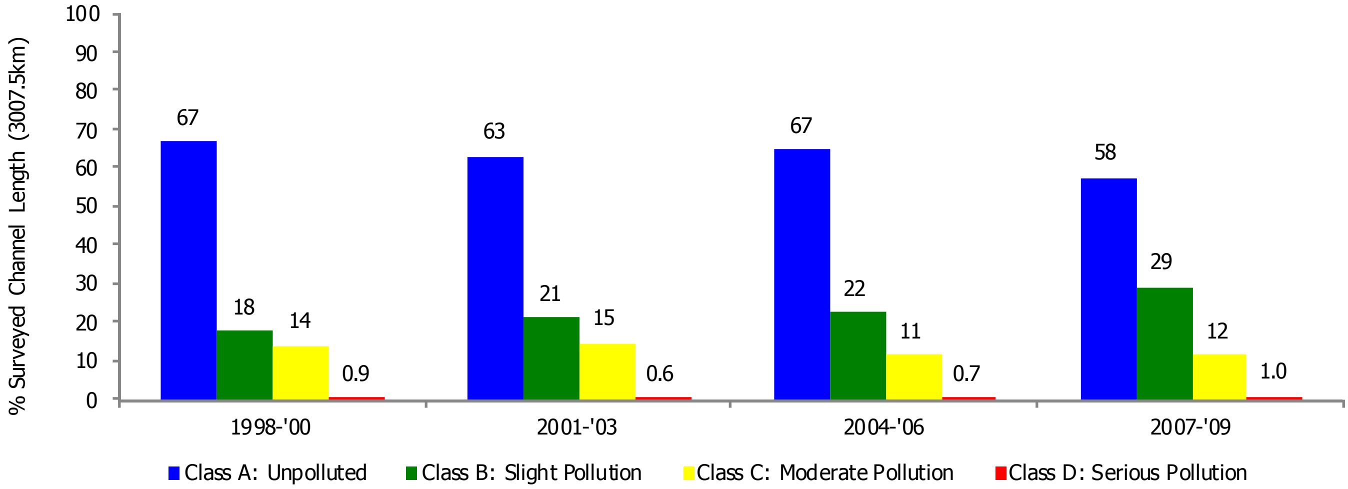

Figure 3.4e. Trends in River quality in the Shannon IRBD (South) for the last four survey periods.

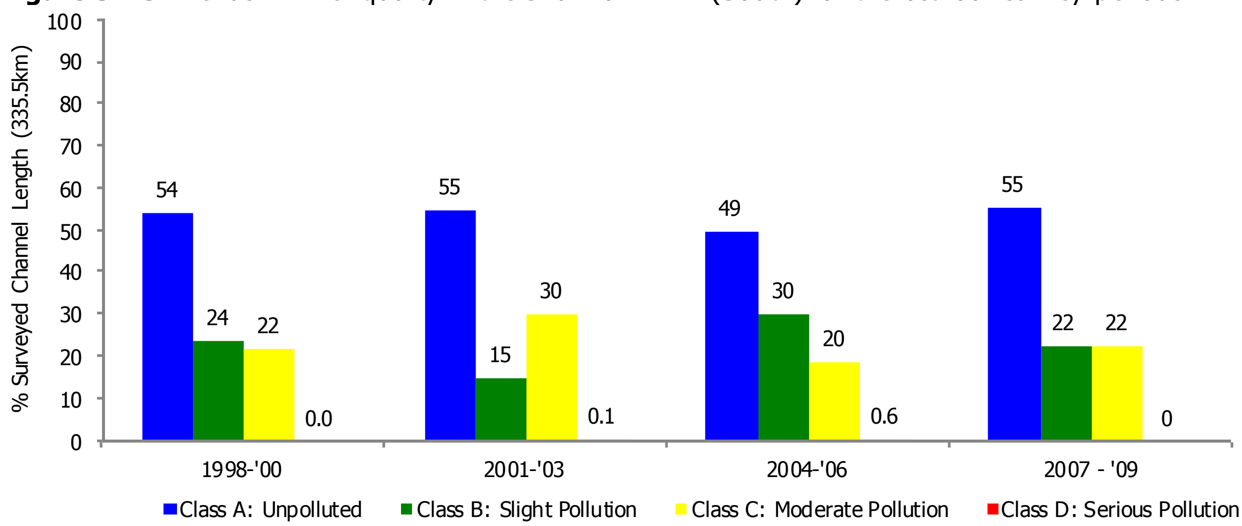

Figure 3.4f. Trends in River quality in the Neagh Bann IRBD (south) for the last four survey periods.

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.

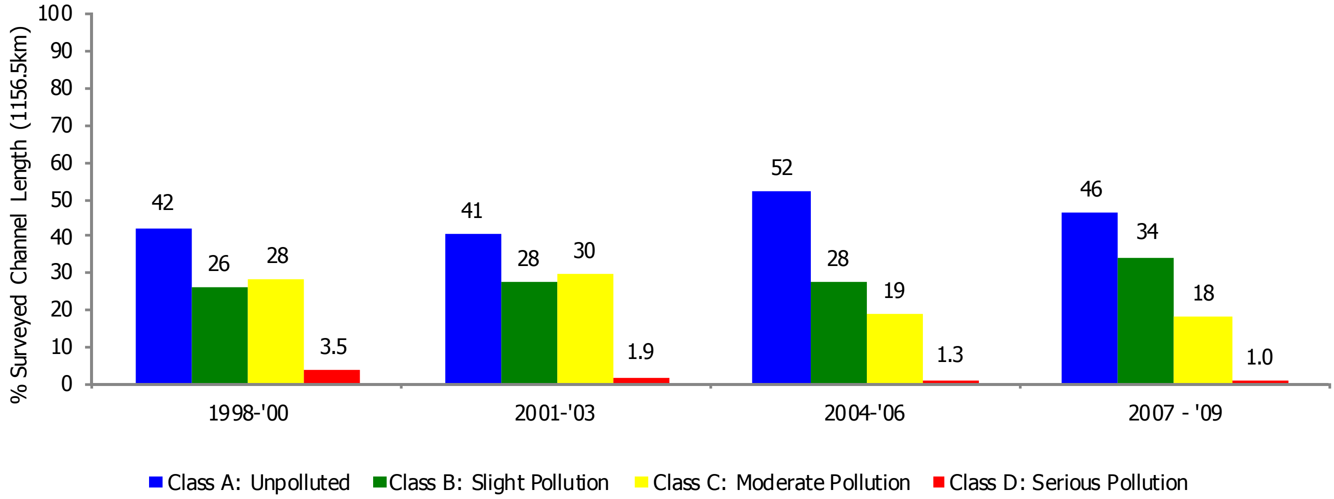

Figure 3.4g. Trends in River quality in the Eastern RBD for the last four survey periods.

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).

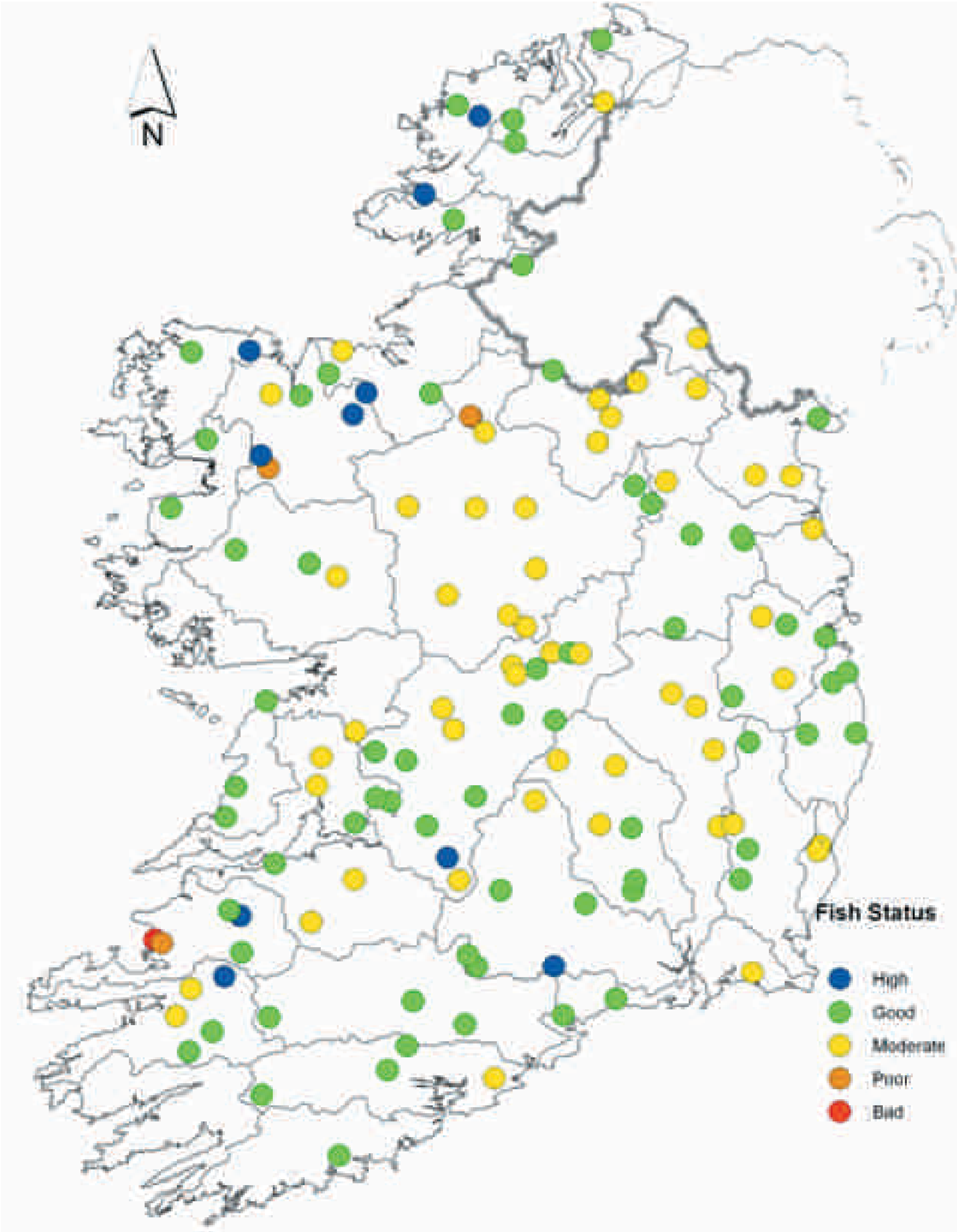

Figure 3.5. Ecological status for the fish biological quality element in Irish rivers 2008-2009.

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
Total	8%	51%	39%	2%	1%	133

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.

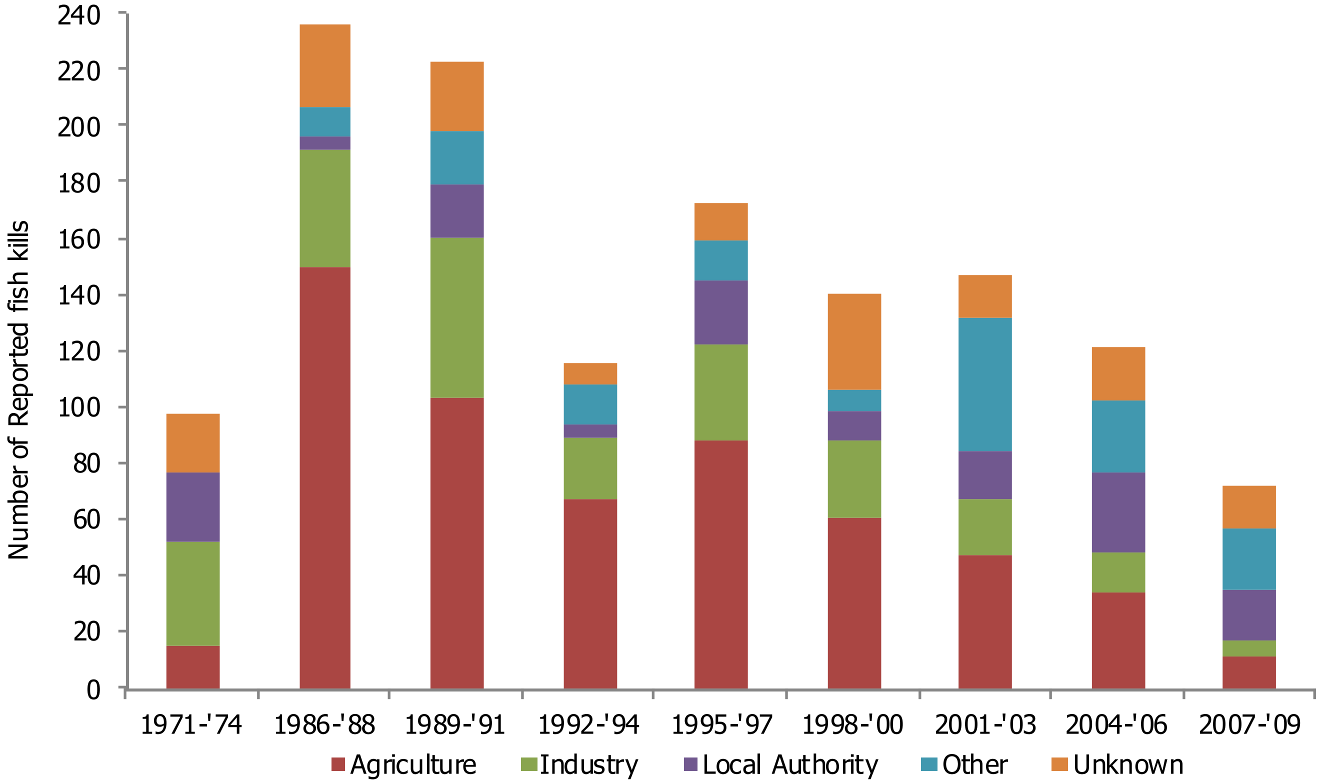

Figure 3.6 Number of reported fish kills and suspected causes for the period 2007-2009. The corresponding data for the seven previous three-year periods and for 1971-1974 are shown to indicate trends.

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_summarys/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), 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.

Status					
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.

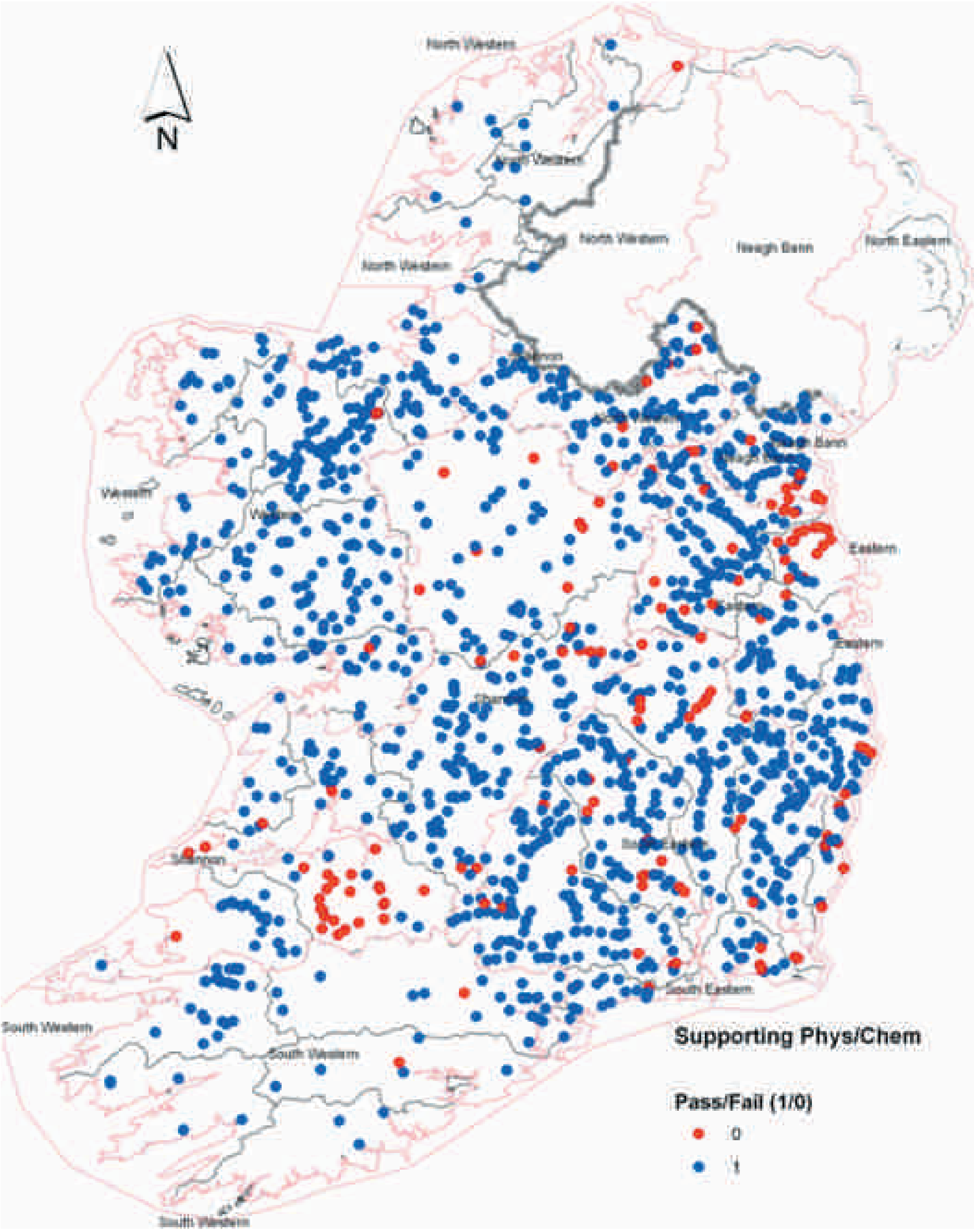

Figure 3.7. Combined pass/fail compliance for supporting physico-chemical quality elements indicative of organic enrichment (PO4, BOD, NH3, NO3) at 1,414 river stations surveyed between 2007 and 2009. Red indicates less than good status for this quality element and blue indicates good or better status.

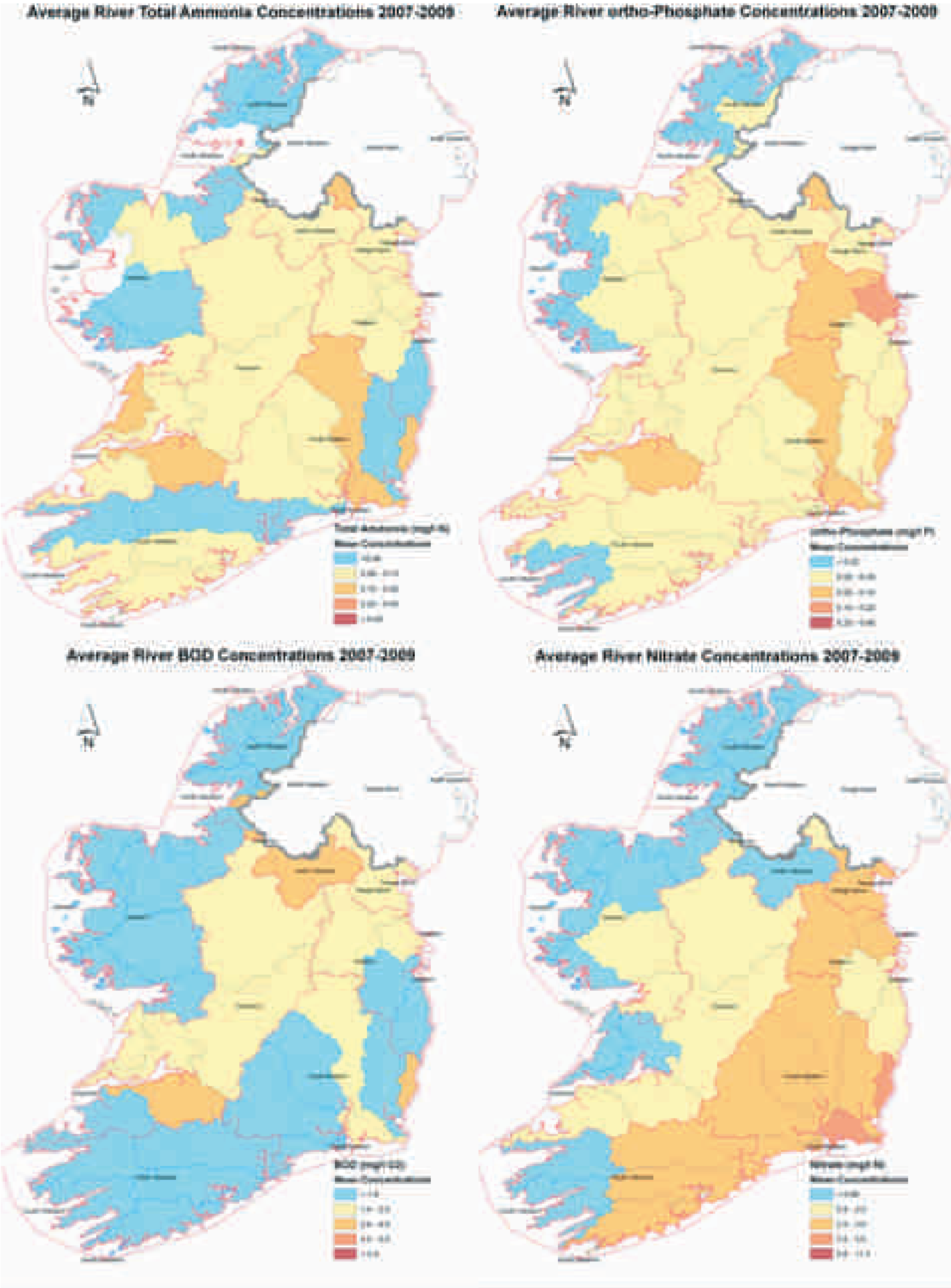

Figure 3.8. Maps showing average riverine concentration of oxygen consuming substances: ammonia and BOD, and nutrients: nitrate and phosphate. Results are averaged for all stations within hydrometric areas for the period 2007-2009 and are based on over 1,400 monitoring stations and 30,000 samples. The 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%

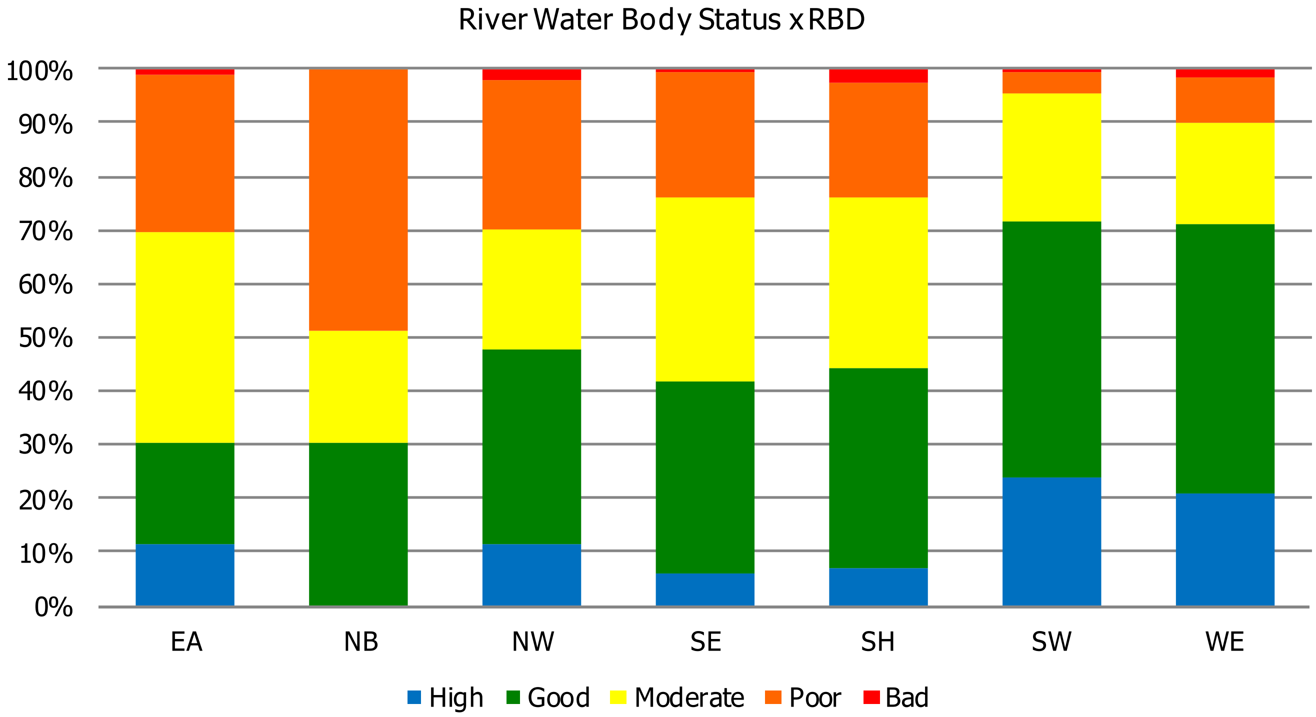

Figure 3.9. Percentage breakdown of river water bodies within each RBD showing final ecological status based on lowest status for the available range of biological and physico-chemical quality elements within each water body.

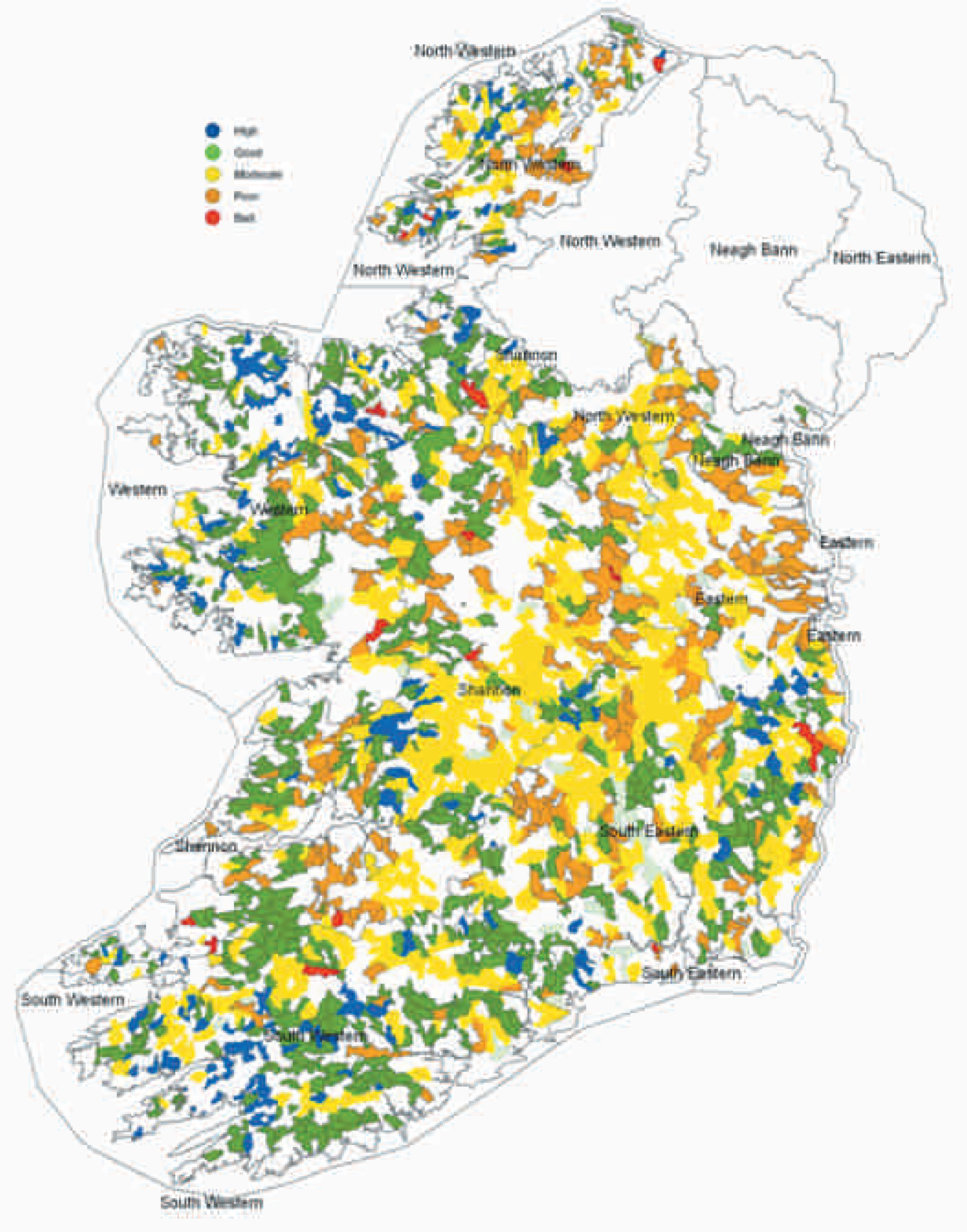

Figure 3.10. Map showing ecological status for Irish monitored river water bodies based on lowest status by quality element and then lowest status by monitoring station within each water body. Blank areas indicate unmonitored water bodies.

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

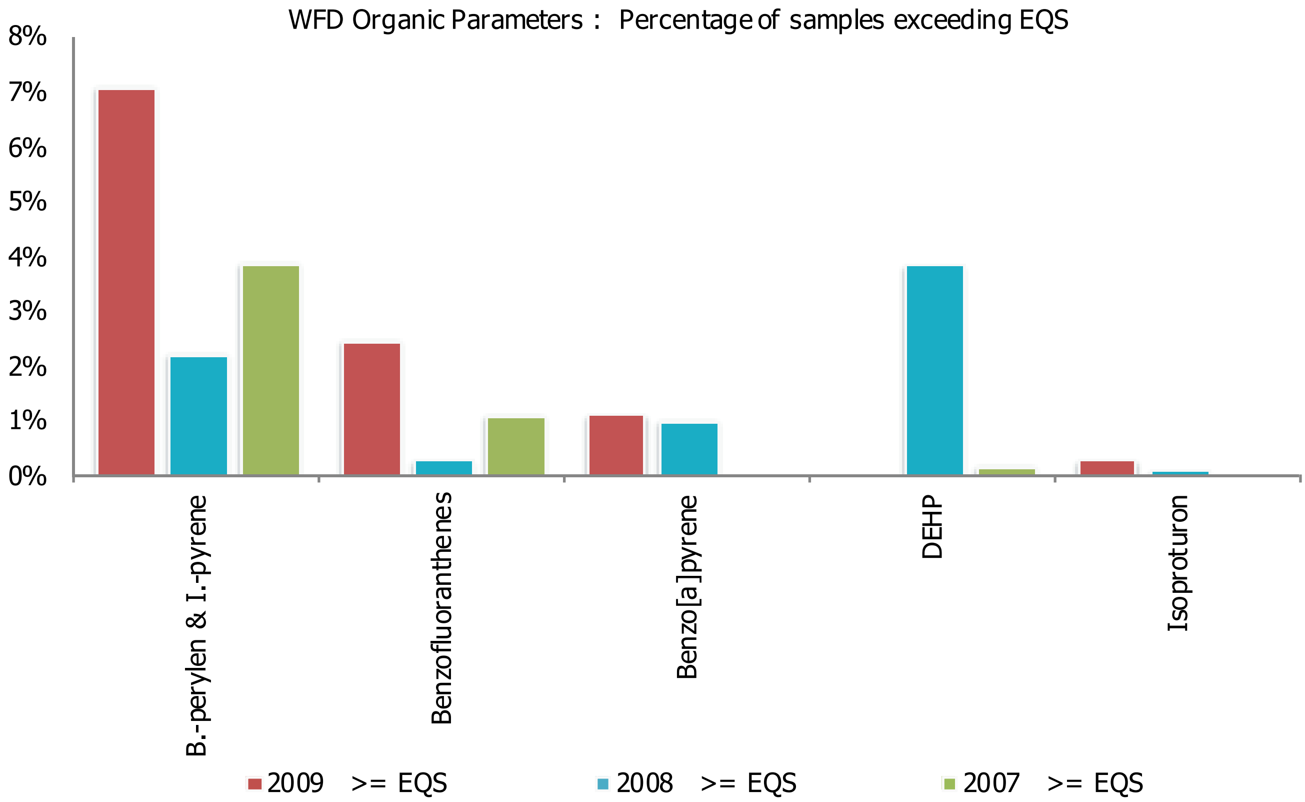

Figure 3.11. Exceedances expressed as the percentage of samples with concentrations in excess of the relevant EQS values monitored in each of the first three years of the WFD surveillance monitoring cycle.

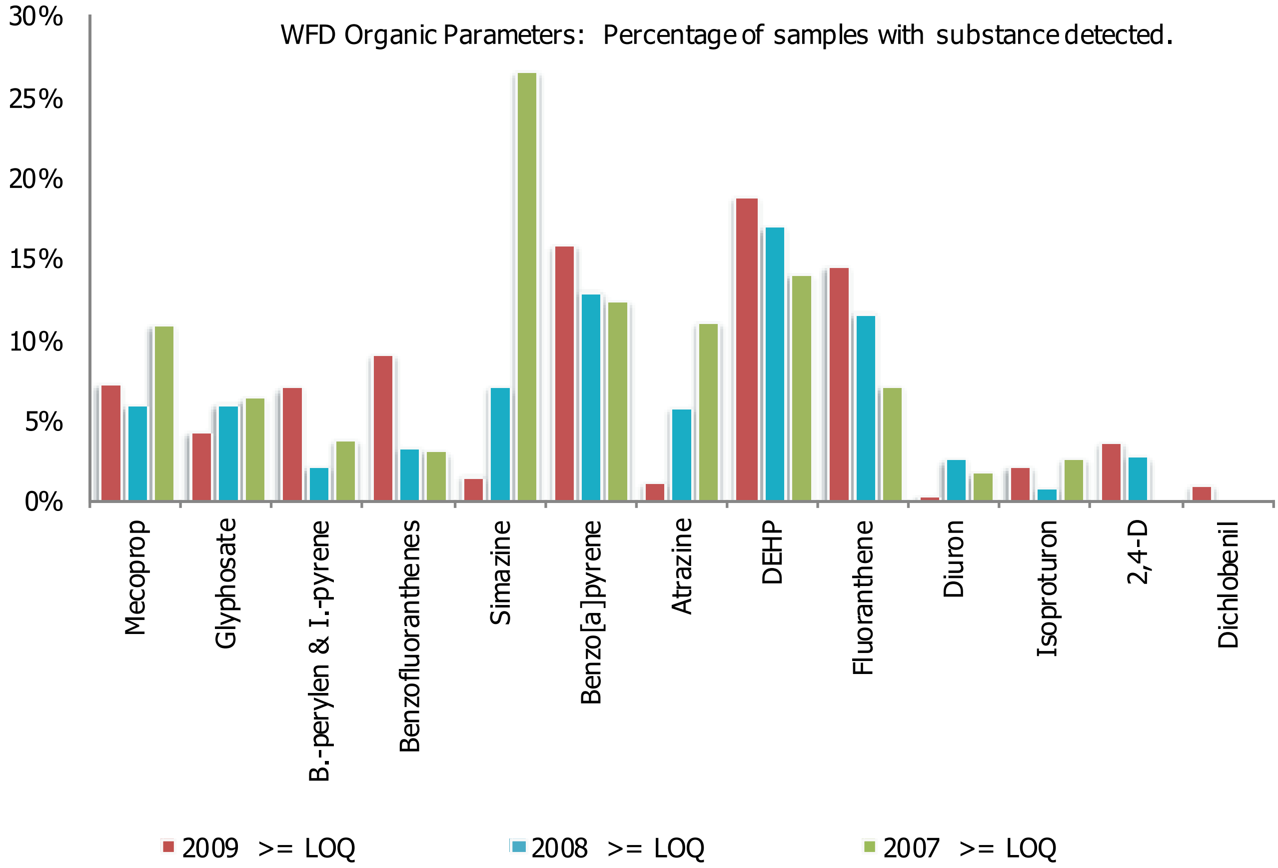

Figure 3.12. (Detects) The percentage of samples in which the substances were detected in each of the first three years of the WFD surveillance monitoring cycle. Note that the individual limits of detection and quantification vary depending on the substance. Typically the level of detection should be 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 OSPAR and the EU Freshwater Fish Directive sites. Generally, the occurrence of environmentally significant metals in Irish waters is low with the 95th 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 EQS, 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 CaCO3.

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 $CaCO_3$ 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 $CaCO_3$. 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 $CaCO_3$ (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 then 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 $CaCO_3$,

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 $CaCO_3$ an EQS of 50 µg/l is applicable. One site, Avoca – New Bridge, exceeded this EQS. For high hardness waters, > 100 mg/l $CaCO_3$, no station approached the EQS of 100 µg/l for zinc.

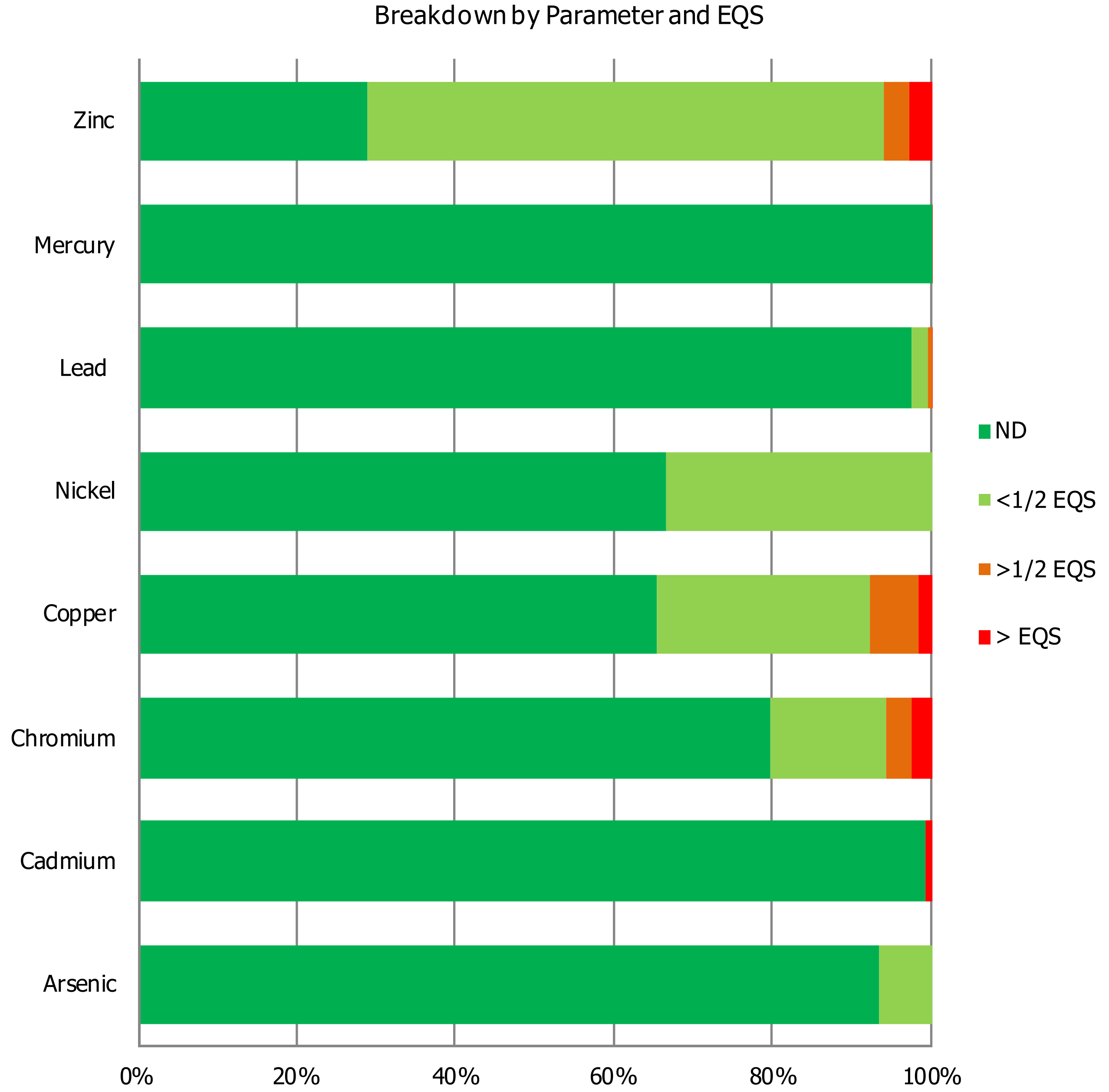

Figure 3.13. Distribution of metals results relative to applicable EQS

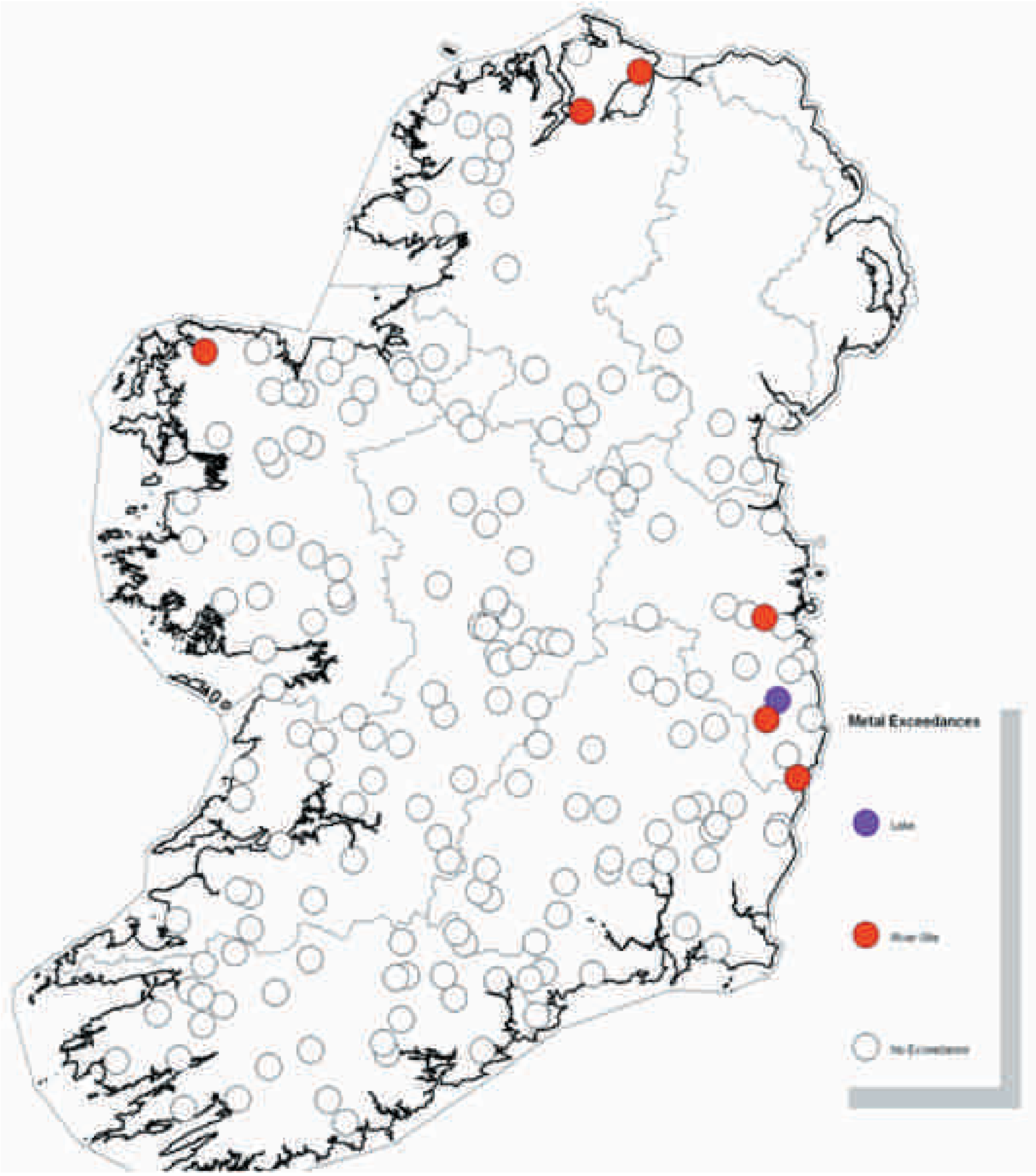

Figure 3.14. River sites sampled intensively for metals showing non-detects as open circles and locations where at least one metal pollutant prioritised under WFD monitoring exceeded its EQS in 2007-2009 shown in colour – red for river sites and purple for lakes (Lough Tay and Lough Dan in Wicklow).

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 outs 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).

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* 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 outs 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 Eastern	4.2	1	GEP
Grand Canal Main Line West of Lowtown (GCWSe)	South Eastern	25	5	GEP
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 Eastern	11.7	1	GEP**
Grand Canal Barrow Line (GCBLSe)	South Eastern	46	4	GEP
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_2
Biochemical Oxygen Demand (BOD)	<2.5 mg/l O_2
Total Coliforms (TC)	5000/100 ml
Faecal Coliforms (FC)	1000/100 ml
Chlorophyll	<25 mg/m^3

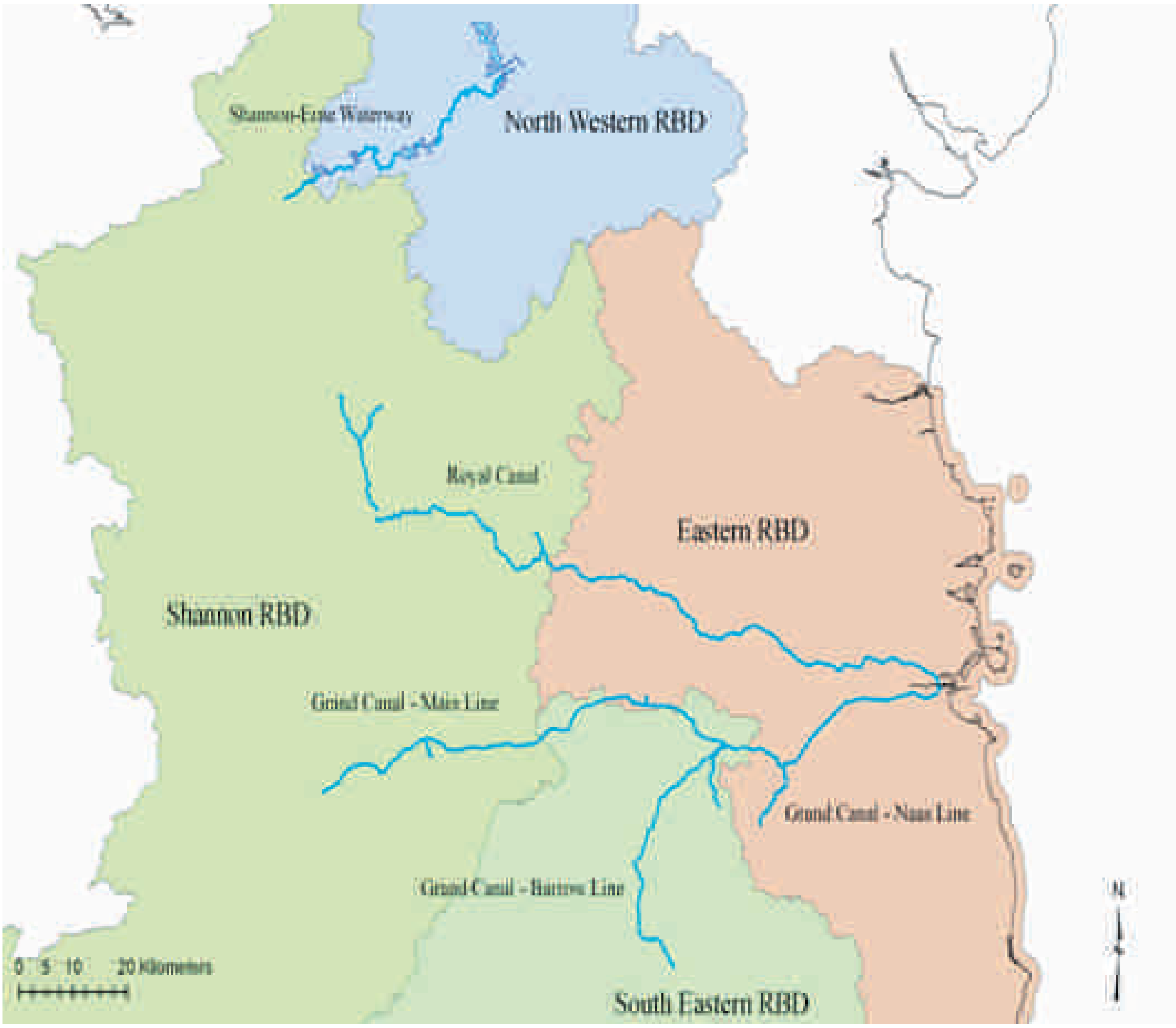


Figure 3.15. Map showing Royal Canal, Grand Canal (including Barrow and Naas Lines) and Shannon-Erne Waterway with River Basin Districts (RBDs), in which they occur, delineated (Map courtesy of Waterways Ireland).

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.

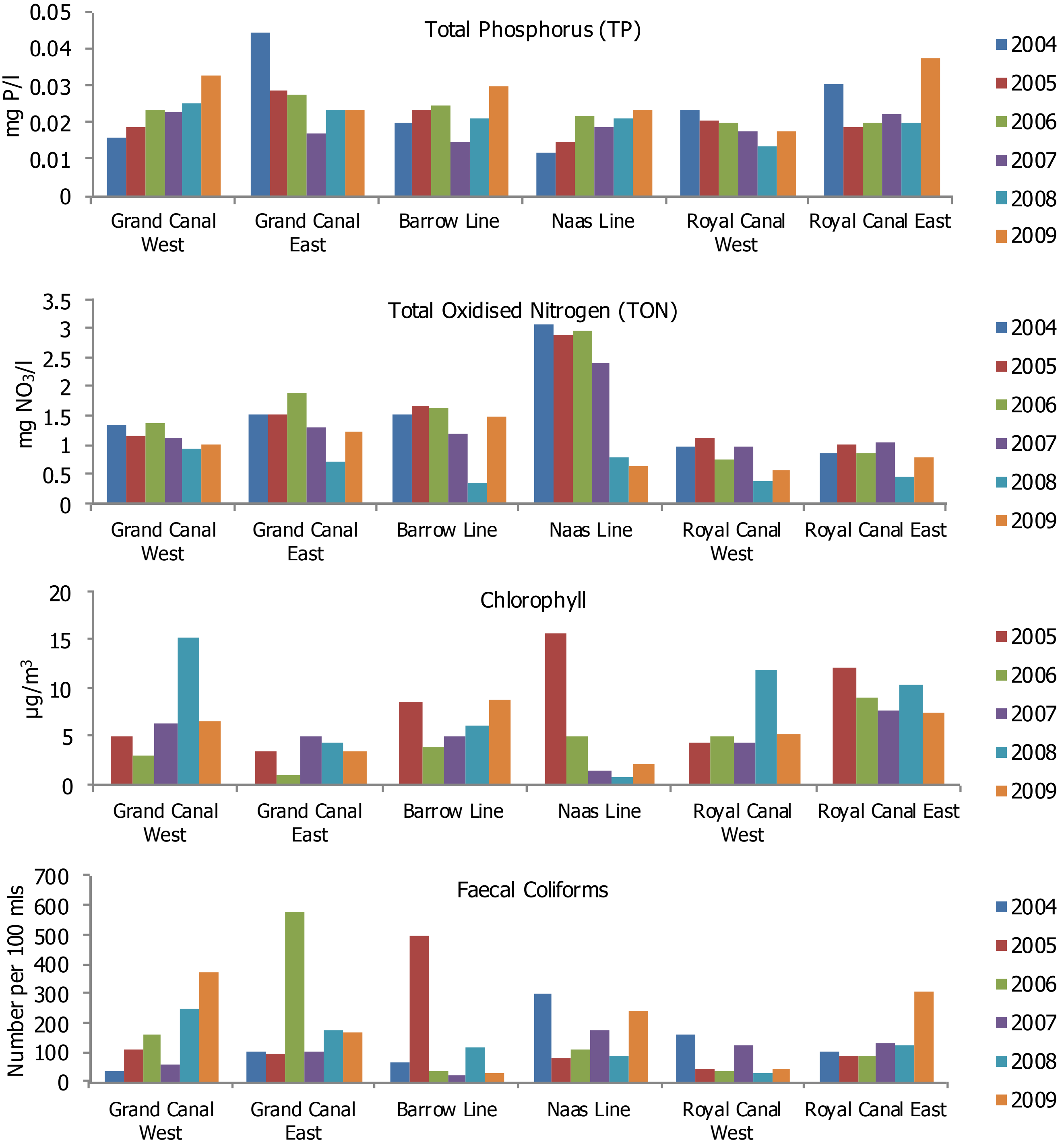


Figure. 3.16. Annual mean values for four parameters in the Grand Canal and Royal Canal sections in the period 2004-2009. Prior to 2005 chlorophyll analysis was not carried out on samples. Sampling and analysis was carried out by the Central Fisheries Board on behalf of Waterways Ireland.

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), Tubercurry (Co. Sligo) and Moville (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), Tubercurry (Co. Sligo) and Moville (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.

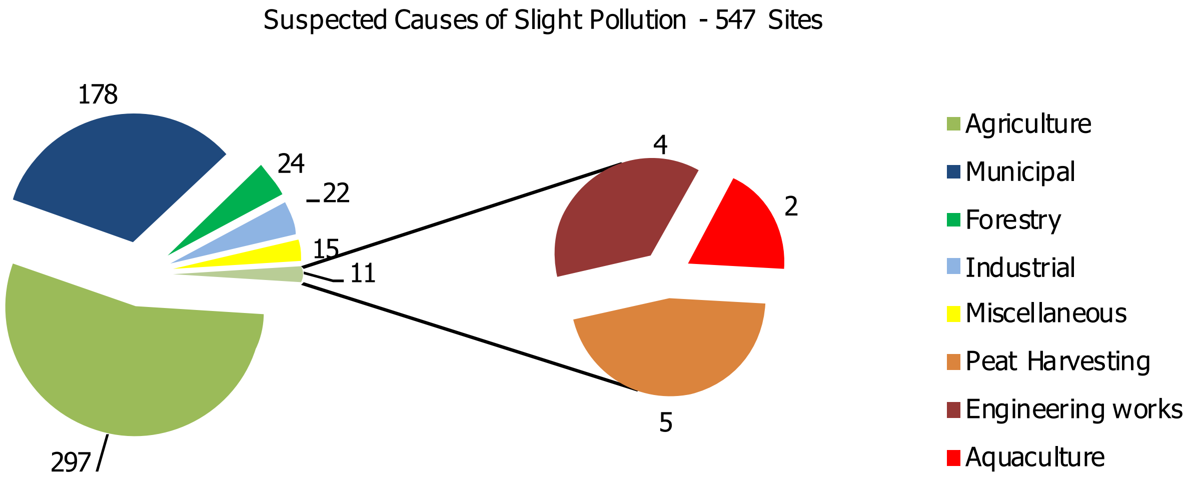
A further three were due to agricultural discharges. Three instances were due in particular to a major landslide or bog burst caused by engineering works associated with wind farm construction affecting the Arigna and Owengar river catchments in August 2008. The remaining sites were impacted by mining,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

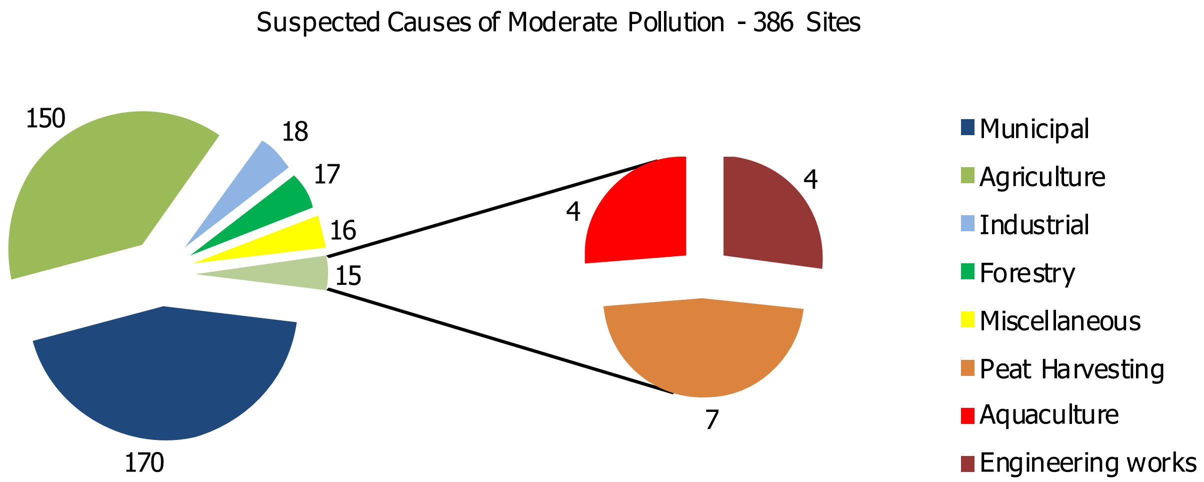
CONCLUSIONS

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
Ballaghdoo (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 Gorragh R confl	Municipal
Jiggy (Hind) (Roscommon)	26J010090	Br WSW Ardsallagh Beg	Municipal
Clarinbridge (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 Moville	Municipal
Avoca (Wicklow)	10A030700	Avoca Br	Mining





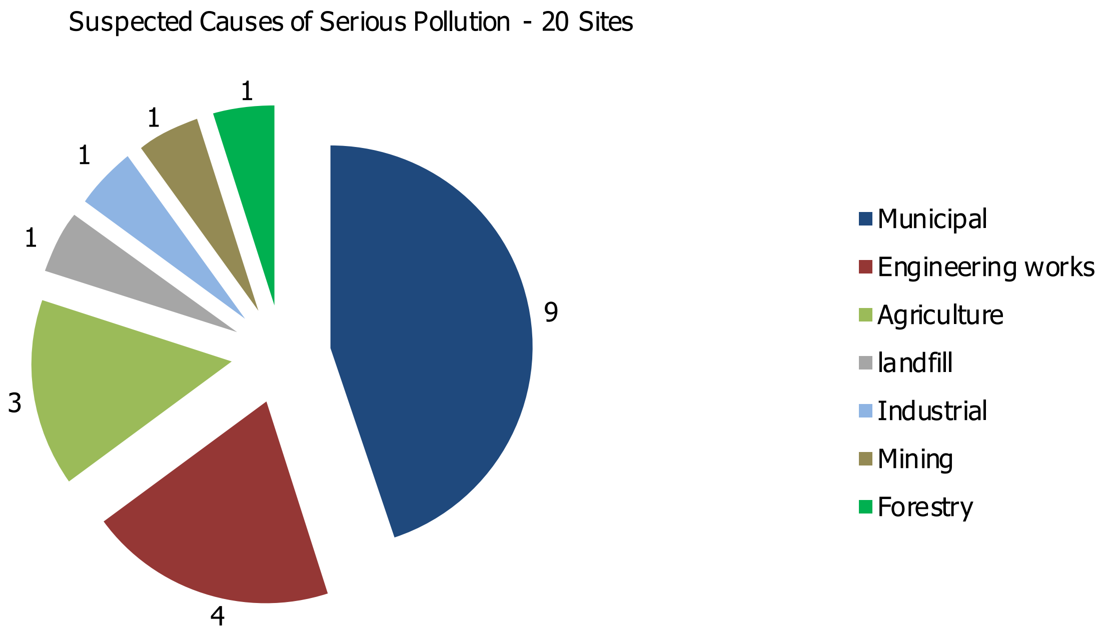


Figure. 3.17. Polluted river sites surveyed in 2007-2009 grouped by severity of pollution and by suspected cause.

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CHAPTER FOUR

WATER QUALITY OF LAKES

Deirdre Tierney, Gary Free, Bryan Kennedy, Ruth Little, Caroline Plant, Wayne Trodd and Caroline Wynne

INTRODUCTION

This chapter is based on the results from the first three years of the Water Framework Directive (WFD) lake monitoring programme (2007-2009) and provides an integrated assessment of the biological, physico-chemical and hydromorphological quality elements monitored in Irish lakes. Results are summarised at the level of individual River Basin Districts. For continuity with previous reports, the lakes are also classified, based on their trophic status, by the number and surface area in each trophic category. In all, 222 lakes were examined representing over 988 km^2 of lake surface water or approximately 65 per cent of the surface area covered by lakes in the country.

The information on these lakes was derived from investigations carried out by the EPA, Local Authorities and the Central and Regional Fisheries Boards*.

The results of the long-term monitoring on selected representative acid-sensitive lake systems are also given, as is summary information on bathing water compliance for the nine designated freshwater bathing areas.

Lake Monitoring History

The first national survey of lakes was undertaken in the mid-1970s (Flanagan and Toner, 1975). Subsequent lake monitoring and assessments have been undertaken by An Foras Forbartha, the Environmental Research Unit (ERU), the EPA, the Local Authorities and the Central Fisheries Board (Inland Fisheries Ireland). The number of lakes, the sampling frequency and the parameters measured, have varied to suit different objectives over the years. The mid-1990s saw the commencement of research into lake ecology, under a series of EPA research grants designed to prepare for the forthcoming ecological assessment of lakes which would be required under the WFD (e.g. Free *et al.,* 2007; Irvine *et al.,* 2001; McCarthy *et al.,* 2001).

In 2001 The EPA published a discussion document on the National Lake Monitoring Programme in anticipation of the monitoring needs under the WFD (Bowman and Toner, 2001). In the 2004-2006 water quality report 449 lakes were reported upon. However, as before, the number of lakes, sampling frequency and parameters measured varied among lakes.

In 2007 the WFD lake monitoring programme commenced with a more comprehensive assessment of lakes, albeit fewer in number, covering more physico-chemical and biological quality elements at specified and more consistent frequencies.

In this chapter the results of the 2007-2009 Irish WFD lake monitoring are presented. These relate mainly to the primary pressure on lakes: nutrient enrichment. In order to provide continuity with previous triennial reports, the 'traditional' trophic status assessment methods previously used for assessing lake water quality are compared with the results of the newer ecological status assessment methods developed for the Water Framework Directive. Some additional information on the long-term monitoring of lake acidification is also included.

Trophic Status Methodology

Enrichment of lakes is caused by increased inputs of nutrients, primarily phosphorus. Initially this results in increased growth of rooted plants, particularly those species tolerant of enrichment. Increased phytoplankton growth may follow (as indicated by increasing chlorophyll levels) and ultimately nuisance algal blooms may occur. As eutrophication progresses, the increasing density of algal cells in the water reduces water clarity (transparency), which in turn reduces the area colonised by submerged plants due to light exclusion. This can lead to a progressive reduction in the maximum depth at which they can grow and eventually even to their elimination. Increased plant and phytoplankton production can also

* The Central and seven Regional Fisheries Boards have been incorporated into, and replaced by, Inland Fisheries Ireland (IFI).

result in reduced oxygen levels, especially if the lake is prone to stratification.

The OECD lake classification scheme was established in 1982 (OECD, 1982). This scheme focussed primarily on total phosphorus, chlorophyll and water transparency as general indicators of enrichment. The scheme used annual average values of the aforementioned parameters to classify lakes into five primary trophic classes representing levels of eutrophication.

Traditionally, lake water quality in Ireland has been assessed using a modified version of the standard OECD scheme based on the annual maximum chlorophyll *a* concentration (see Table 4.1). The Irish scheme classified lakes into six water quality or trophic status categories using maximum levels of planktonic algae measured during the period. The broad eutrophic category of the standard OECD scheme was divided into three sub-categories and the ultra-oligotrophic category of the original OECD scheme was merged with the oligotrophic category. This modification of the OECD scheme was first implemented in 1983 and is set out in Table 4.1 together with corresponding indicators for each category related to water quality and the probability of pollution.

The highest chlorophyll *a* concentrations recorded are taken as estimates of the annual maximum values. These are based on average values per sampling occasion where there is more than one sampling site. These maximum values are used to assign a trophic status to the individual lakes. The average of the annual maxima for the period 2007-2009 has been used for the overall assessment of trophic status of each lake.

The ultimate aim of such schemes is to predict the likely ecological response of a given lake to nutrient inputs and to predict any impacts on the lake's 'beneficial uses' – e.g. water supply, angling, other leisure uses, biodiversity, ecosystem services and inherent ecological value. The modified OECD scheme has not been transferred to the WFD classification scheme; but this chapter compares the old and new systems for lake assessment.

WFD Lake Ecological Status Methodology

Under the WFD, ecological status is derived by taking the lowest status classes for a range of specified biological and physico-chemical and hydromorphological quality elements. The methods for biological and physico-chemical quality elements are dealt with below.

For lakes that are deemed to be at high status for biological and physico-chemical quality elements, hydromorphological condition must all agree. If hydromorphology is not also of high status the lake is downgraded to good status. Neither can lakes be considered to be of high status where the alien species zebra mussel (*Dreissena polymorpha*) or roach (*Rutilus rutilus*) are present. The presence of either of these species will result in a high status lake being downgraded to good status.

Status based on biological quality elements

Biological status was based on the response of the three biological quality elements; aquatic flora (macrophytes and phytobenthos), phytoplankton and fish, to the primary pressure on Irish lakes; nutrient enrichment.

Both chlorophyll and the macrophyte classification tool have been intercalibrated at EU level, while the fish assessment method is currently being intercalibrated. The intercalibration process is a legal obligation. Its aim is to ensure that ecological boundaries are harmonised between member states. The outcome should be that the different biological classification tools that have been intercalibrated will respond similarly to the same anthropogenic pressure. Therefore, if each member states applied their classification tool for the same biological element to the same waterbody, the same ecological status class would be returned. The outcome of the lake chlorophyll and macrophyte intercalibration has been published in a Commission decision and translated into national legislation making the boundaries legally binding. At the time of publication methods for fish status classification were still being intercalibrated – and thus, depending on the outcome, fish status classes may change. Additional pressures such as acidification, abstractions, barriers to fish migration, will be taken into account when suitable assessment methods become available.

Table 4.1. Modified version of the OECD scheme based on values of annual maximum chlorophyll concentration. Indications of water quality and the probability of pollution are also shown.

Classification Scheme			Category Description			
Lake Trophic Category		Annual Max. Chlorophyll mg/m^3	Algal Growth	Deoxygenation in Hypolimnion	Level of Pollution	Impairment of Use of Lake
Oligotrophic (O)		<8	Low	Low	Very low	Probably none
Mesotrophic (M)		8<25	Moderate	Moderate	Low	Very little
	Moderately (m-E)	25<35	Substantial	May be high	Significant	May be appreciable
Eutrophic:	Strongly (s-E)	35<55	High	High	Strong	Appreciable
	Highly (h-E)	55<75	High	Probably total	High	High
Hypertrophic (H)		≥75	Very High	Probably total	Very high	Very high

Status based on the chemical and physico-chemical quality elements

The supporting physico-chemical status was assigned using the Environmental Quality Standards (EQS) for total ammonia, dissolved oxygen and pH as published in S.I. 272 of 2009. In addition, interim EQS values of 10 and 25 µg/l P total phosphorus (TP) were used for the high/good and good/moderate boundary. Lake Habitat Surveys were used to assess hydromorphological pressure.

ASSESSMENT OF LAKE WATER QUALITY

Trophic Status

The details and trophic status of the lakes monitored are set out in Appendix 4.1 (on the CD accompanying this report) for each year surveyed during the review period. In all 222 lakes were examined (Over 988 km^2 in terms of lake area). The majority (180 or 81%) of the lakes examined in the period 2007-2009 were of satisfactory quality i.e. oligotrophic or mesotrophic in status (Figure 4.1). The water quality of the remaining 42 lakes was less than satisfactory. Of these, three lakes; Lough Gur, Inner and Naglack were classified as hypertrophic, i.e. the most enriched status. In terms of surface area lakes of satisfactory quality accounted for 910 km^2 (92%). A further 77 km^2 (8%) of lake area was classified as eutrophic and 1.5 km^2 (0.2%) were assigned to the hypertrophic category.

The proportion of lakes with an overall satisfactory water quality status (81.1%) in 2007-2009 is lower than in the previous 2004-2006 assessment period (85.3%). The proportion of lake surface area categorised as oligotrophic / mesotrophic (Figure 4.2) for the period 2007-2009 (92.1%) is similar to the period 20004-2006 (91.9%). A breakdown of trophic status for the 222 lakes examined in the period 2007-2009 is presented in Table 4.2.

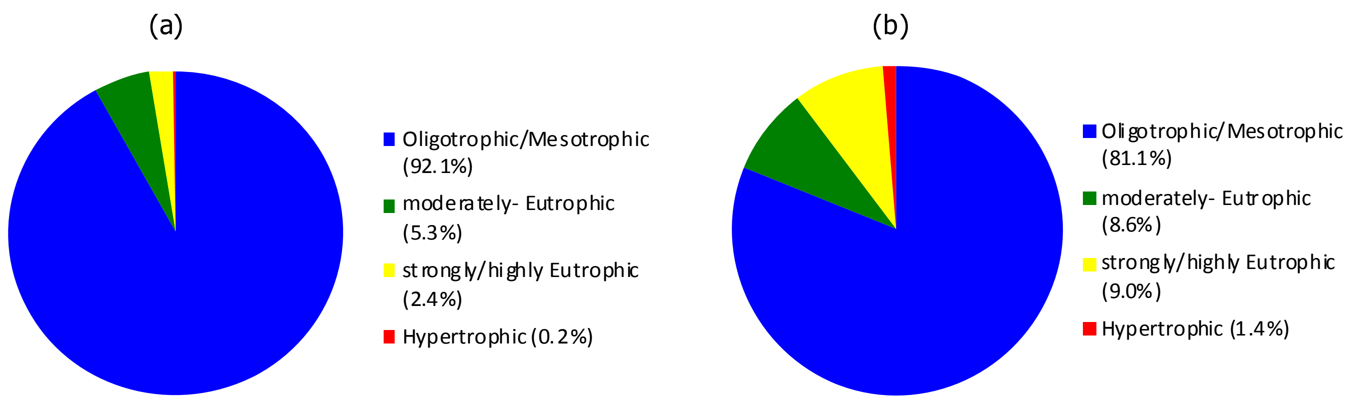


Figure 4.1. Trophic Status: (a) The percentage of lake area, and (b) percentage of lakes monitored in each trophic category.

Table 4.2. The number and percentage of lakes and the area and percentage of lake area in each trophic status for the 222 lakes examined in the period 2007-2009 is presented.

Trophic Category		Number of Lakes	% of Lakes	Surface Area km^2	% Area
Oligotrophic (O)		98	44.1	487.9	49.4
Mesotrophic (M)		82	36.9	422.1	42.7
	moderately Eutrophic (m-E)	19	8.6	52.8	5.3
Eutrophic:	strongly Eutrophic (h-E)	11	5.0	15.3	1.5
	highly Eutrophic (s-E)	9	4.1	8.8	0.9
Hypertrophic		3	1.4	1.5	0.2

Long Term trends in Water Quality based on Trophic Status

The percentage of lake area in each trophic category has remained relatively stable since 1998, based on the modified OECD scheme (Figure 4.2). There has been a small increase in the percentage area assessed as moderately eutrophic and this has been mirrored by a decline in the percentage area in the hypertrophic category.

Twenty-two lakes have been examined continuously in each review period since 1976 and a further five lakes have continuous data since 1982 (Table 4.3). Most of these lakes have relatively similar maximum chlorophyll values for the 2007-2009 period compared with the previous assessment period. The notable exceptions are Lough Gowna and L. Oughter in Cavan and L. Muckno in Monaghan, all of which have seen a decline in maximum chlorophyll values. This is believed to be due to the impact of zebra mussel populations in these lakes rather than any real improvement in trophic or ecological status, as the total phosphorus (TP) values remain elevated. Average TP values recorded for 2007-2009 for L. Gowna, Oughter and Muckno were 41, 65 and 62 µg/l, respectively. Other zebra mussel infested lakes which also showed a decline in maximum chlorophyll *a* levels include Loughs Sheelin and Kinale in Cavan and L. Key in Roscommon. The trophic status of Gortglass Lough in County Clare had deteriorated compared with the previous assessment period while most lakes remain unchanged. The majority of these lakes had attained oligotrophic or mesotrophic status, implying that for these lakes, zebra mussels have reached their maximum potential to influence chlorophyll levels.

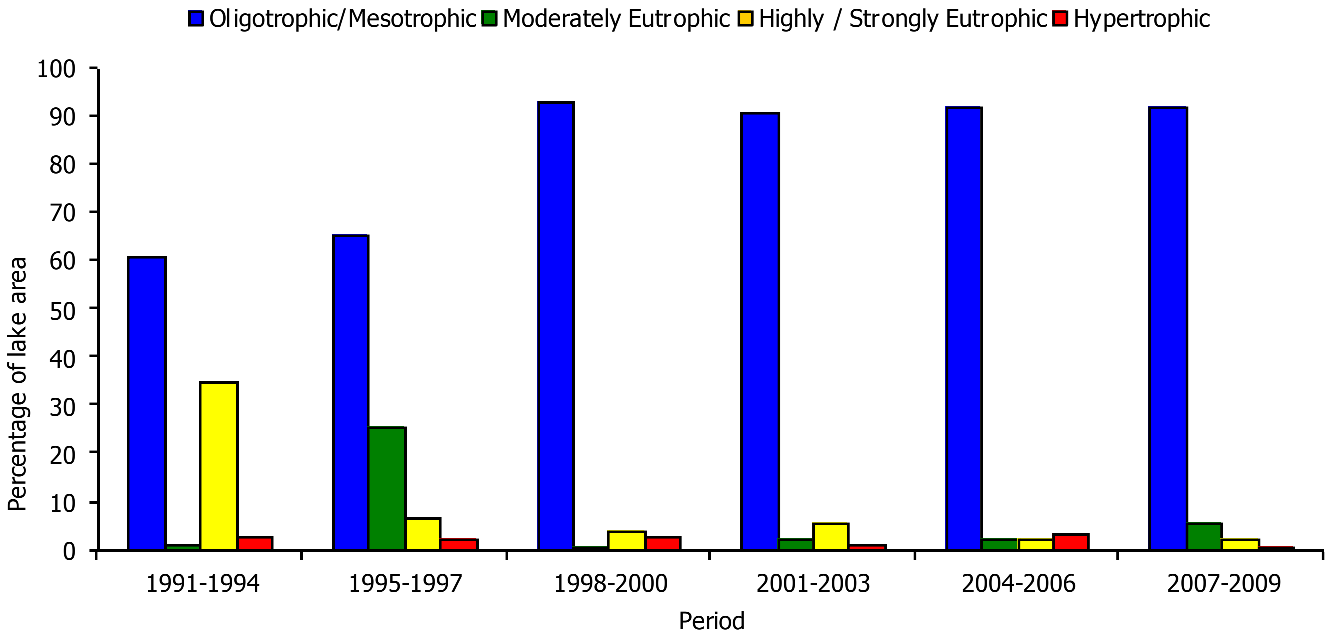


Figure 4.2. Long term trends in trophic status expressed as a percentage of total lake area examined for each of the assessment periods.

Table 4.3. Average maximum values of chlorophyll *a* (µg/l) for lakes with long term data.

		Period of Examination								
Lake	County	1976 - 1981	1982 - 1986	1987 - 1990	1991 - 1994	1995 - 1997	1998 - 2000	2001 - 2003	2004 - 2006	2007 - 2009
Arrow	Sligo	14	20	12	13	18	15	18	6	12
Carra	Mayo	9	9	9	9	10	15	7	6	6
Conn	Mayo	17	10	11	13	10	11	14	12	8
Coosan	Westmeath	5	19	-	12	13	14	16	7	7
Corrib (Lower)	Galway	28	18	10	8	11	9	8	8	8
Corrib (Upper)	Galway	11	5	9	8	11	9	13	8	7
Derg (Shannon)	N. Tipperary	14	34	41	54	27	12	10	10	10
Derravaragh	Westmeath	35	29	25	12	13	16	11	6	4
Ennell	Westmeath	47	28	19	23	16	17	21	15	17
Glendalough (Upper)	Wicklow	-	3	3	1	1	2	2	1	1
Gortglass	Clare	-	4	21	8	34	28	15	10	20
Gowna	Cavan	63	35	18	66	56	78	67	90	27
Innsicarra	Cork	34	-	61	137	43	16	29	35	40
Key	Roscommon	13	12	15	15	16	14	8	9	5
Killenure	Westmeath	16	9	-	13	11	9	6	7	5
Kinale	Cavan	40	24	24	7	6	60	33	15	9
Leane	Kerry	15	25	14	10	71	24	15	13	10
Leane (Ross Bay)	Kerry	63	57	23	17	41	30	32	25	21
Lene	Westmeath	-	5	6	7	8	8	8	14	12
Mask	Mayo	12	5	7	6	11	13	12	11	7
Maumwee	Galway	-	3	5	1	3	3	3	2	4
Muckno	Monaghan	537	54		29	24	17	48	93	65
Nahasleam (West)	Galway	-	3	3	1	2	2	3	3	3
Oughter	Cavan	11	99	68	158	132	104	86	97	34
Owel	Westmeath	290	7	8	12	11	12	11	9	11
Ramor	Westmeath	25	92	59	119	156	51	55	66	62
Ree	Longford	60	21	21	33	31	19	9	10	6
Sheelin	Cavan	-	60	37	33	48	65	44	31	26

Table 4.4. The trophic status for lakes with zebra mussel populations for the last three assessment periods (based on maximum chlorophyll) with an indication of recent changes.

		Area	Recent	Overall Trophic Status		
Lake	Location	km^2	Changes	2001-03	2004-06	2007-09
Acres	Leitrim	0.1	Improvement	s-E	h-E	M
Arrow	Roscommon	12.5	Deterioration	M	O	M
Ballykeeran	Westmeath	0.3	Deterioration	O	O	M
Boderg	Roscommon/Longford	4.3	Improvement	O	M	O
Bofin (Shannon)	Roscommon/Longford	5.1	None	O	O	O
Bunerky	Cavan	0.8	Deterioration	h-E	s-E	h-E
Conn	Mayo	50.0	Improvement	M	M	O
Coosan	Westmeath	0.8	None	M	O	O
Corrib (Upper)	Galway	85.0	None	M	M	M
Derg	Clare/Tipperary	117.5	None	M	M	M
Derravaragh	Westmeath	12.2	None	M	O	O
Derrycassan	Cavan/Leitrim	0.9	None	M	M	M
Drumlona	Monaghan	0.5	None	s-E	s-E	s-E
Forbes	Roscommon/Longford	3.4	None	O	O	O
Garadice	Leitrim	4.0	None	M	O	M
Gill	Sligo	14.3	None	M	O	O
Gowna North	Cavan	6.3	Improvement	h-E	H	m-E
Key	Roscommon/Longford	9.0	Improvement	O	M	O
Killinure	Westmeath	3.1	None	O	O	O
Kinale	Longford	2.0	None	m-E	M	M
Meelagh	Roscommon	1.2	None	O	O	O
Nablahy	Roscommon	0.78	Deterioration	M	O	M
Oughter	Cavan	13.0	Improvement	H	H	m-E
Ree	Roscommon/Longford	105.0	Improvement	M	M	O
Rinn	Leitrim	2.1	None	M	M	M
Sheelin	Cavan	17.7	None	s-E	m-E	m-E
Sillan	Cavan	1.7	Deterioration	h-E	s-E	h-E

WFD Lake Ecological Status Assessment

The first round of the WFD national lake monitoring programme assessed the ecological status of 222 lakes. The number of lakes examined in each river basin district (RBD) is presented in Table 4.5. Over half of the lakes examined (122) were located in the Western River Basin District (WRBD) and the North West River Basin District (NWRBD) reflecting the general location of lakes in Ireland. The Shannon RBD (SHRBD) had the next highest proportion of lakes at 51. The WRBD also had the greatest lake area examined (394 km^2) and 368 km^2 of lake area was examined in the SHRBD (Table 4.5).

Table 4.5. The number and surface area of monitored lakes by River Basin District for the period 2007-2009.

RBD	Number of Lakes	% of Lakes	Surface Area km^2	% Area
ERBD	16	7.2	38.8	3.9
NBRBD	5	2.3	4.4	0.4
NWRBD	61	27.5	125.7	12.7
SERBD	5	2.3	0.9	0.1
SHRBD	51	23.0	367.9	37.2
SWRBD	23	10.4	57.0	5.8
WRBD	61	27.5	394	39.8

WFD Ecological Status

In a departure from the modified OECD scheme for trophic status, lakes must now be classified using their biological quality elements and the supporting physico-chemical quality elements under the requirements of the WFD as outlined above.

National Picture: Using the new methodology, high or good status was assigned to 105 (47%) of the lakes examined (see Figure 4.3 and Table 4.6), with most of these 85 (38%) in the good status category. The majority of the remaining 117 lakes were of moderate ecological status and accounted for 53 per cent of the lakes examined. Twenty-five lakes were in either poor or bad status, most of which were located in Cavan or Monaghan. The geographical distribution of lakes in each ecological status class is illustrated in Figure 4.4.

Lakes in the high and good status categories accounted for 335 km^2 (35%) of the lake area examined (Table 4.6). A further 502 km^2 (51%) were assigned moderate status. Poor status lakes accounted for 127 km^2 (13%) of lake area examined (Table 4.6). In all, 65 per cent or 643 km^2 of lake area examined was in the moderate or worse ecological status classes (Table 4.6).

WRBD: In the WRBD 42 (69%) lakes were assigned high or good ecological status accounting for 194 km^2 (49%) of lake area monitored in the district (Figures 4.5, 4.6, 4.7 and 4.8).

(a) (b)

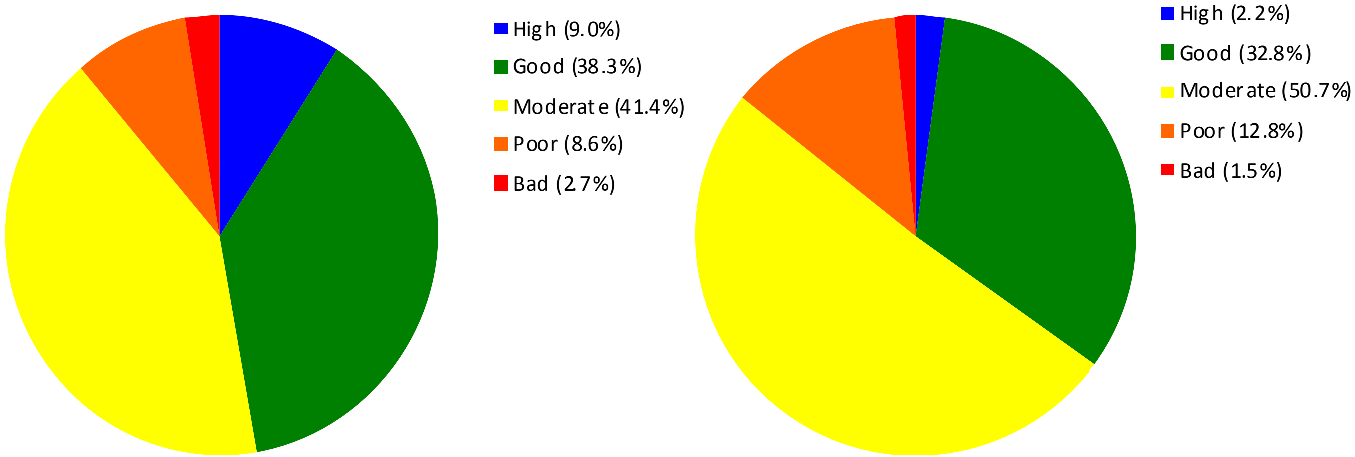


Figure 4.3 Final WFD Ecological Status: (a) percentage of lakes and (b) percentage of lake area surveyed assigned to each ecological status category.

Table 4.6. Final WFD Ecological Status: The breakdown of ecological status of the 222 lakes examined in the period 2007-2009 by number of lakes and surface area and percentage total assigned to each ecological status class.

Ecological Status	Number of Lakes	% of Lakes	Surface Area (km^2)	% Area
High	20	9.0	21.7	2.2
Good	85	38.3	323.8	32.8
High & Good	105	47.3	345.5	35.0
Moderate	92	41.4	501.6	50.7
Poor	19	8.6	126.8	12.8
Bad	6	2.7	14.6	1.5
Moderate or Worse	117	52.7	643.0	65.0


High Status
Good Status
Moderate Status
Poor Status
Bad Status

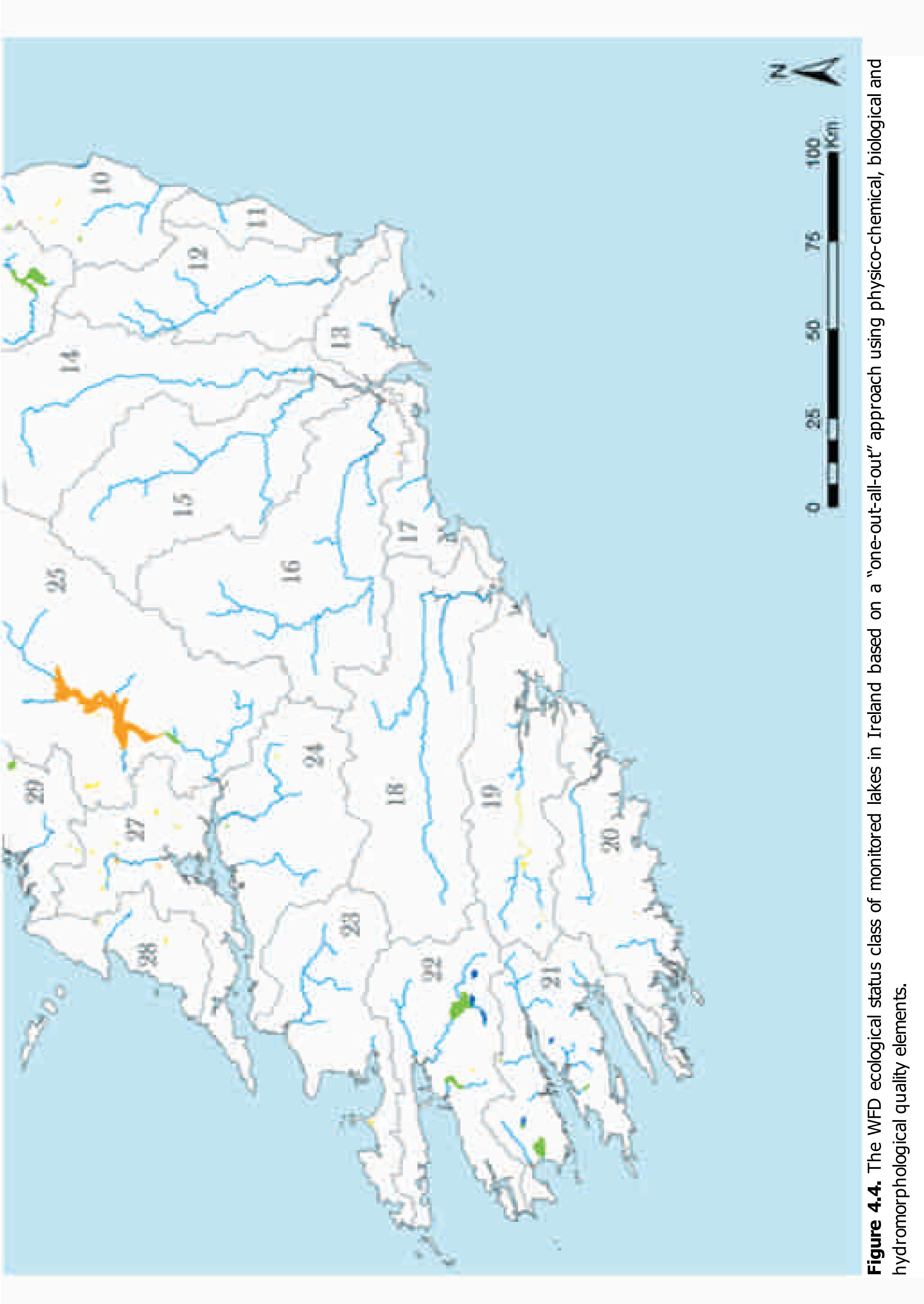


Figure 4.4. The WFD ecological status class of monitored lakes in Ireland based on a "one-out-all-out" approach using physico-chemical, biological and hydromorphological quality elements.

This reflects generally the low level pressures in this RBD but the remaining 19 lakes assigned moderate or worse ecological status accounted for over 200 km^2 (51%) of the lake area examined in the district.

NWRBD: In the NWRBD, 26 lakes (43%) were assigned high or good ecological status accounting for 27 km^2 of lake area monitored (22%) in the district (Figures. 4.5, 4.6, 4.7 and 4.8). These lakes were located in Co. Donegal in areas of low intensity agriculture, large tracts of natural vegetation and generally low levels of urbanisation. Thirty-five lakes in this RBD (57%) were assigned moderate or worse ecological status or 99 km^2 of the lake area examined (79%). The majority of these lakes were located in Cavan and Monaghan, both counties with high intensity farming but poorly draining soils.

SWRBD: The SWRBD had 14 lakes (61%) assigned to the high or good ecological status categories and nine lakes (39%) were assigned ecological status of moderate or less.

ERBD: The ERBD had no lakes of high ecological status (Figure 4.14). Nine lakes (27 km^2) were assigned good ecological status and seven lakes (12 km^2) were assigned to moderate or worse ecological status (Figures 4.5 and 4.6).

NBRBD: Lakes examined in the NBRBD were assigned either poor or bad ecological status and all of these lakes were located in County Monaghan.

SERBD: All lakes assessed in the SERBD were of moderate or poor ecological status, largely due to total phosphorus and chlorophyll possibly related to intensive agriculture. All of these latter were abstraction lakes.

Table 4.7. WFD Ecological Status: Poor and bad ecological status lakes by RBD and county.

RBD	Lake	County	Ecological Status
Eastern	Drumkeery	Cavan	Poor
	Ramor	Cavan	Bad
	Upper Lough Skeagh	Cavan	Poor
Neagh Bann	Corcaghan	Monaghan	Poor
	Emy	Monaghan	Poor
	Monalty	Monaghan	Poor
	Muckno or Blayney	Monaghan	Bad
	Naglack	Monaghan	Poor
North West	Drumlona	Monaghan	Poor
	Drumore	Monaghan	Poor
	Egish	Monaghan	Bad
	Fern	Donegal	Poor
	Garty	Cavan	Poor
	Glasshouse	Cavan	Bad
	Inner	Monaghan	Bad
	Sillan	Cavan	Poor
South East	Knockaderry Reservoir	Waterford	Poor
Shannon	Ballybeg	Clare	Poor
	Cavetown	Roscommon	Poor
	Derg SH	North Tipperary	Poor
	Dromore	Clare	Poor
	Rinn	Leitrim	Bad
	Ballinlough	Cork	Poor
West	Belhavel	Leitrim	Poor
West	Cross	Mayo	Poor

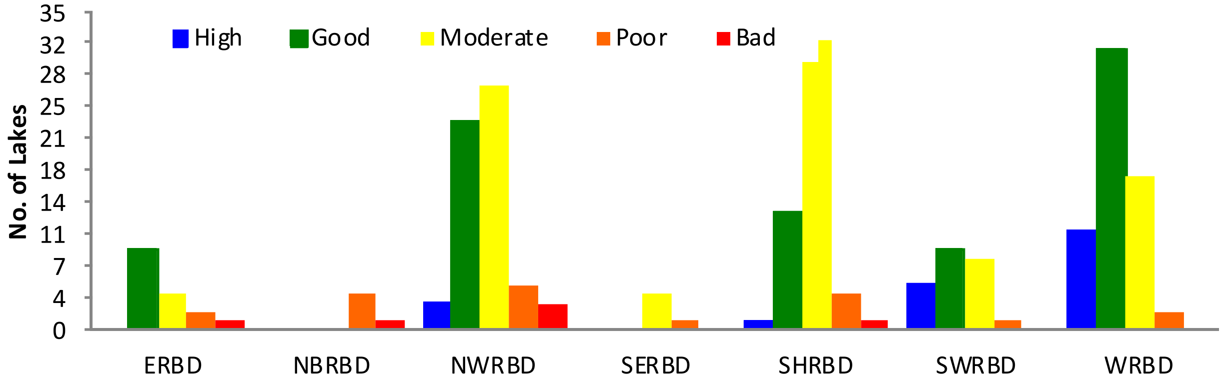


Figure 4.5. The number of lakes assigned to each ecological status class for each River Basin District

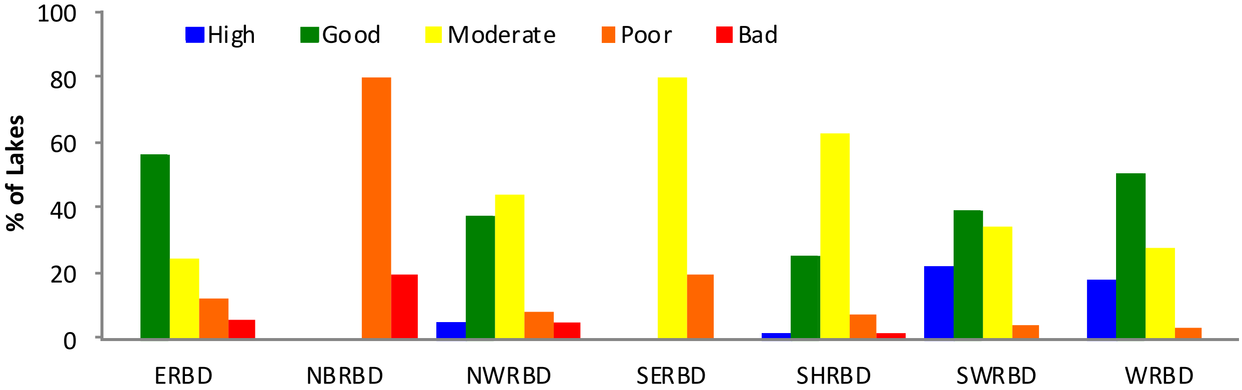


Figure 4.6. The percentage of lakes assigned to each ecological status class for each River Basin District.

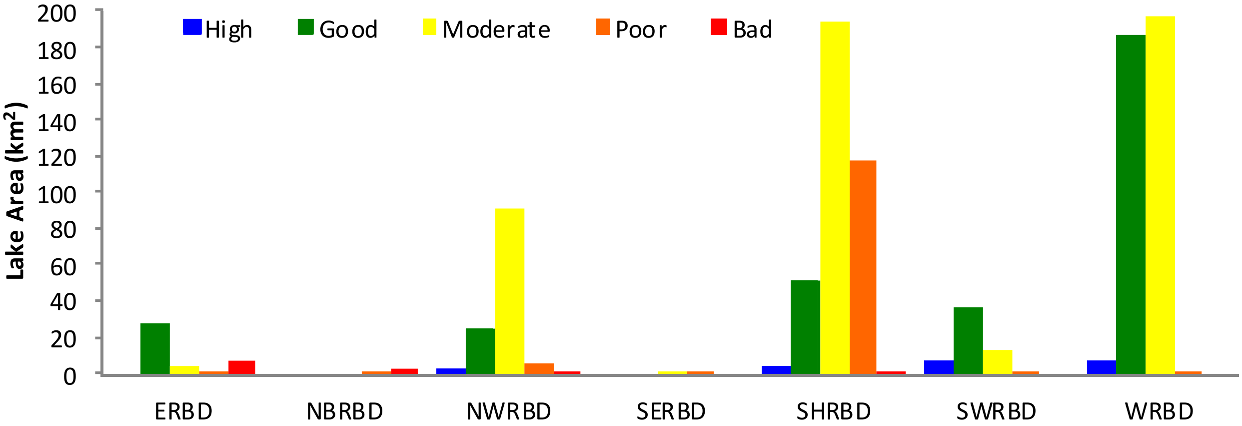


Figure 4.7. The lake area (km^2) assigned to each ecological status class for each River Basin District.

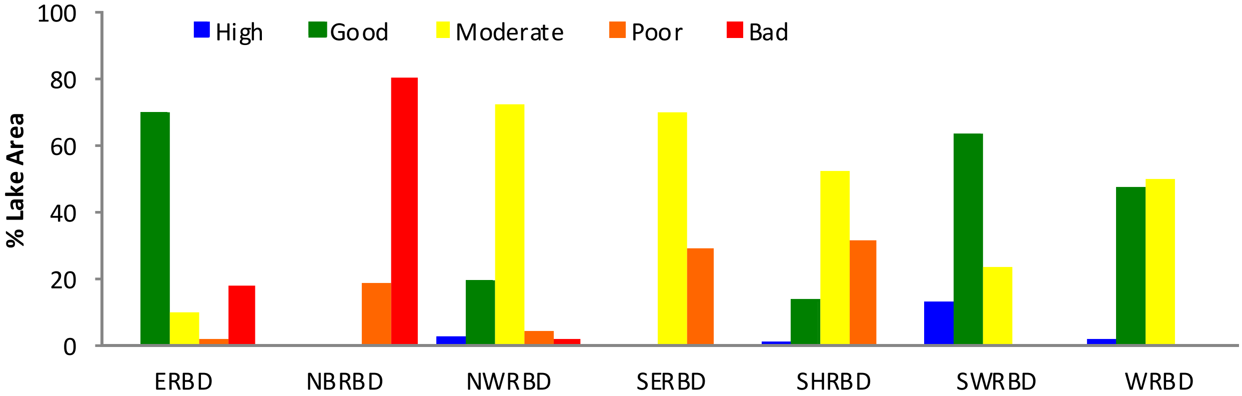


Figure 4.8. The percentage lake area assigned to each ecological status class for each River Basin District.

Seven lakes are designated as heavily modified waterbodies (HMWB). A different set of criteria apply to these lakes for assigning ecological potential rather than ecological status. Lakes for which the ecological potential assigned did not match the ecological status were reviewed in light of their modifications and the quality elements that were driving status. Two HMWBs, Pollaphuca and Lough Salt were upgraded from moderate ecological status to good ecological potential because the driving element, macrophytes, could be restricted by the modifications.

Hydromorphological pressures from abstractions or obstructions that impact one or more biological quality elements have not been considered here, nor has the pressure, acidification, with the exception of where the response was manifested in low pH values. In the future, both pressures should be included: pending the development and intercalibration of classification tools responding to such pressures.

Drivers of Ecological Status

The fact that the lowest status quality element, whether, biological, physico-chemical or hydromorphological determines the final ecological status on the so-called 'one-out-all-out' basis means that in some cases just one quality element will determine the final ecological status – possibly disagreeing with the status assigned by other quality elements. The principle is a precautionary one in the sense that most sensitive quality element should respond first to the pressures affecting the ecological status of the water body. Appendix 4.1 lists the results obtained for individual quality elements on a lake by lake basis and provides the fine detail showing the extent of agreement between the quality elements assessed. This also shows which quality element is ultimately responsible for a given lake's ecological status when there are differences between the results for different quality elements. The following summarises some of the main differences between quality elements.

High status is dependent on agreement between the physico-chemical quality elements status and biological status. The hydromorphological conditions of all high status lakes must also be assessed – and if a lake has significant hydromorphological alterations it cannot be considered to be at high status and must be downgraded to good status. In addition, any high status lake containing the alien species zebra mussel (*Dreissena polymorpha*) or roach (*Rutilus rutilus*) could not be considered to be at high status and is automatically downgraded to good status. Three lakes with high status for biological and physico-chemical quality elements were downgraded by their hydromorphology and while 54 of the monitored lakes contained populations of zebra mussel, none of them was at high ecological status and therefore no lake was downgraded on this basis. Of the 222 lakes monitored, only 20 lakes met all these criteria and could be considered at high ecological status (Appendix 4.1).

Eighty-five lakes were assigned good ecological status and for 39 of these lakes (46%) the biological and physico-chemical elements both indicated good status. The physico-chemical quality elements determined the ecological status of 21 of these lakes (25%). Good ecological status was assigned to 20 lakes (24%) based on their biological quality elements and two other lakes, designated as HMWB, were of good ecological potential.

Ninety-two lakes were assessed to be at moderate ecological status. There was agreement between the biological status and physico-chemical quality elements status for 48 of these lakes (52%). Moderate ecological status for 11 lakes (12%) was determined by their physico-chemical quality element status. Biological status determined the status of the remaining 32 lakes (35%).

The status of lakes in the poor and bad ecological classes is determined solely by the biological status as there are only three classes for the physico-chemical quality element status. All but three lakes in this status class were moderate status for the physico-chemical quality elements.

OECD Trophic Status vs WFD Ecological Status

Some 180 lakes were considered to be either of oligotrophic or mesotrophic status based on OECD classification scheme using maximum chlorophyll *a*, accounting for 910 km^2 of lake area. The chlorophyll metric used under the WFD classification is based on the average chlorophyll concentration over the 3-year period but this method also incorporates other biological and physico-chemical elements in addition to chlorophyll.

When WFD ecological status is contrasted against trophic status, 105 (59%) of the 180 oligotrophic or mesotrophic lakes were assigned either good or high ecological status; while 67 were assigned moderate ecological status (Table 4.8). Six lakes and two lakes, categorised as satisfactory under the modified OECD scheme, were assigned poor and bad ecological status, respectively. Five of these latter eight lakes were considered to be at moderate status based on physico-chemical quality element status but were less than moderate based on their biological quality elements.

Of the 67 satisfactory lakes (oligotrophic or mesotrophic lakes) 29 were assigned moderate ecological status based on both physico-chemical quality elements status and biological status. In this oligotrophic-mesotrophic group, 27 lakes were of moderate ecological status based on their biological quality elements alone but at good or high status for their physico-chemical elements, while the remaining 11 lakes were of moderate status based on their physico-chemical quality elements.

The 75 satisfactory lakes under the OECD scheme which are now assigned moderate ecological status under the WFD represent 564 km^2 of lake area examined. This results in an apparent dramatic decrease in the area of lake considered to be in a satisfactory condition based on trophic status compared with satisfactory ecological status (high or good) based on the new WFD methods.

The discrepancy between the traditional water quality assessment, the modified OECD lake quality scheme and the WFD ecological status arises as the former only considers chlorophyll levels and the latter incorporates a more holistic approach which includes a wider range of physico-chemical quality elements, additional biological elements together with more intensive monitoring.

Table 4.8. WFD Ecological Status classes compared with OECD trophic status classes for 222 lakes (2007-2009).

	Trophic Status 2007-2009						Totals:
Ecological Status	O	M	m-E	s-E	h-E	H	
High	17	3					20
Good	58	27					85
Moderate	23	44	18	4	2	1	92
Poor		6	1	6	5	1	19
Bad		2		1	2	1	6
Totals:	98	82	19	11	9	3	222

BIOLOGICAL STATUS

The status of the biological quality elements combines with physico-chemical status on a one-out-all-out basis to provide WFD ecological status as outlined above. The following provides a more detailed breakdown of biological status on a national and RBD basis and physico-chemical status is described in the subsequent section.

National: Of the 222 lakes monitored, 115 or 52 per cent were of high (20%) or good (32%) biological status (Figure 4.9) with most of these located in the WRBD. The NWRBD and the SHRBD had 12 per cent and 10 per cent of the high and good status lakes monitored nationally in their region. The remaining 107 of lakes (48%) were in moderate or worse status. The NWRBD and the SHRBD had 16 per cent and 13 per cent of these, respectively. All lakes in the NBRBD were in poor or bad biological status and all lakes in the SERBD were of moderate or poorer biological status. Figure 4.10 illustrates the national geographical distribution of lakes in each biological class.

In terms of lake area, 334 km^2 or 34 per cent of the total lake area monitored was assigned high or good biological status (Figure 4.11 & Table 4.9). The remaining 654 km^2 or 66 per cent of lake area examined was assigned moderate or worse biological status with in excess of two-thirds of this area located in the SHRBD and WRBD.

WRBD: In the WRBD 43 lakes (71%) were assigned high or good biological status (Figure 4.11) covering 194 km^2 of the monitored lake surface area (49%). There were 18 lakes (30%) of moderate biological status representing 200 km^2 (55%) of the monitored lake area there.

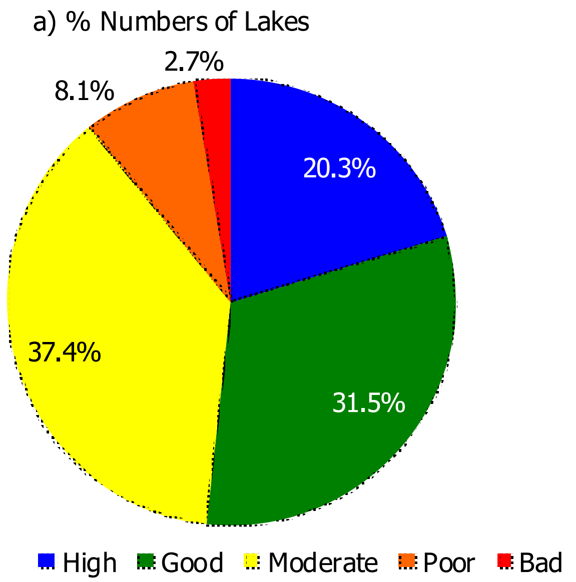
SWRBD: In the SWRBD 15 lakes (65%) were assigned high or good status amounting to 44 km^2 (77%) of monitored lake area in the district. The SWRBD had eight lakes (35%) assigned moderate biological status – just over 13 km^2 (23%) of the monitored lake area in the SWRBD.

NWRBD: High or good biological status was assigned to 26 (43%) of lakes in the NWRBD, 27 km^2 of lake area monitored. Moderate biological status was assigned to 35 lakes (57%) in the NWRBD representing 99 km^2 (79%) of lake area monitored in the district.

SHRBD: High or good biological status was assigned to 23 (45%) of lakes in the SHRBD, representing 62 km^2 of lake area monitored. There were 28 lakes at moderate biological status representing 306 km^2 (83%) of the monitored lake area in the RBD.

ERBD: Eight lakes (50%) in the ERBD were assigned high or good biological status representing 7.5 km^2 (19%) of lake area. The other half of the 16 lakes monitored in the ERBD were assigned moderate biological status representing 31 km^2 (81%) of lake area monitored.

NBRBD & SERBD: No lakes in the NBRBD and SERBD were assigned good or high biological status (See Figures 4.11-4.14).



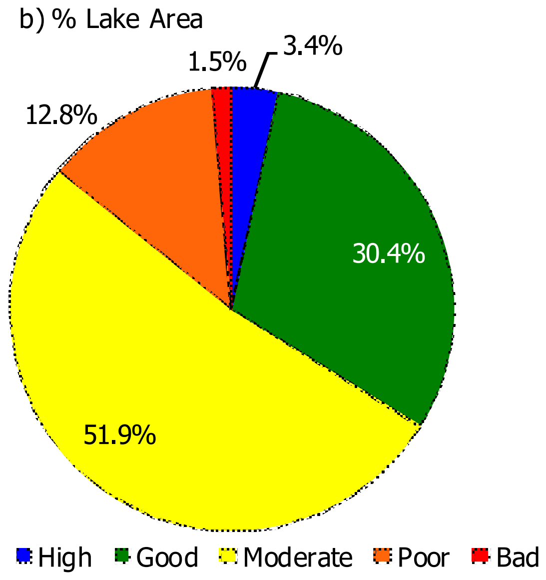


Figure 4.9. WFD Biological Status: National breakdown by a) percentage number of lakes and b) lake area assigned to each biological status category which combines with physico-chemical quality elements to yield overall ecological status.

Table 4.9 WFD Biological Status: The number, area and percentages of lakes in each biological status class for the period 2007-2009

	Number of Lakes	% of Lakes	Area	% area
High	45	20.3	33.4	3.4
Good	70	31.5	300.9	30.4
Moderate	83	37.4	512.9	51.9
Poor	18	8.1	126.7	12.8
Bad	6	2.7	14.6	1.5


High Status
Good Status
Moderate Status
Poor Status
Bad Status

Figure 4.10. WFD Biological Status: The national geographical distribution of lakes in each biological class.

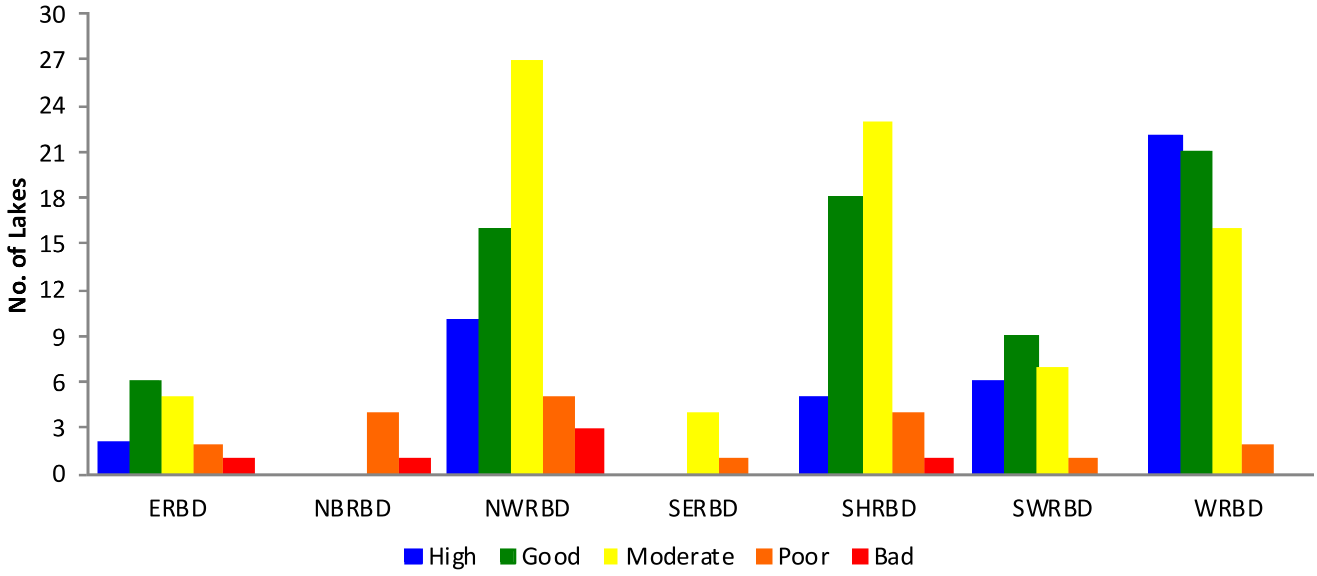


Figure 4.11. WFD Biological Status: The number of lakes assigned to each biological status class for each River Basin District.

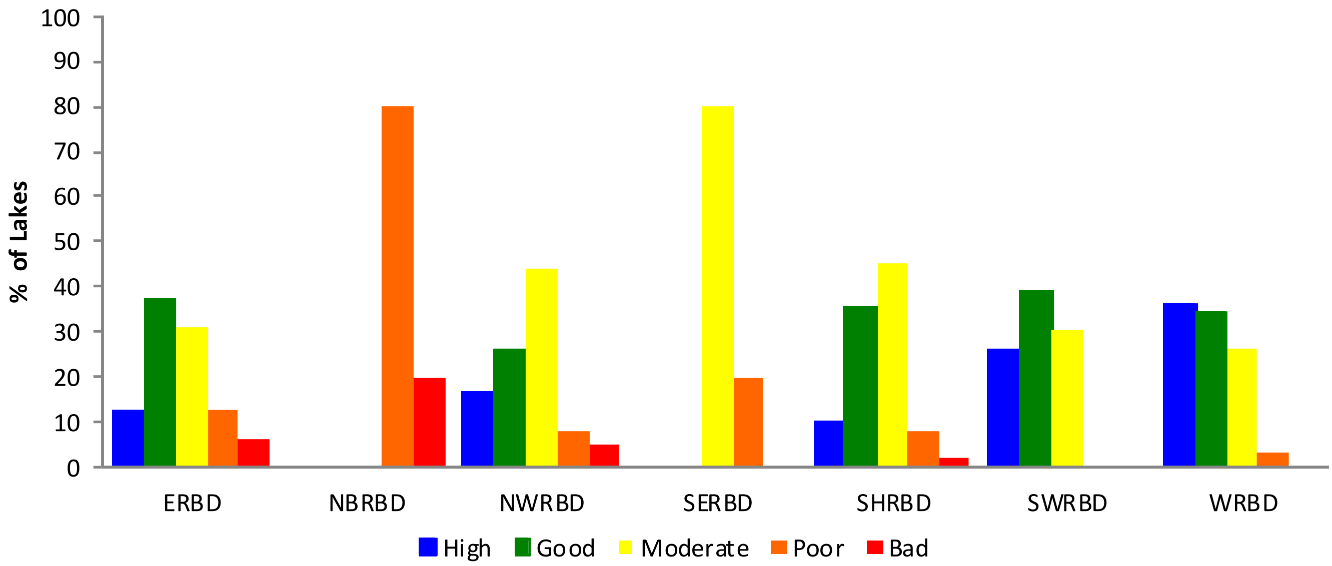
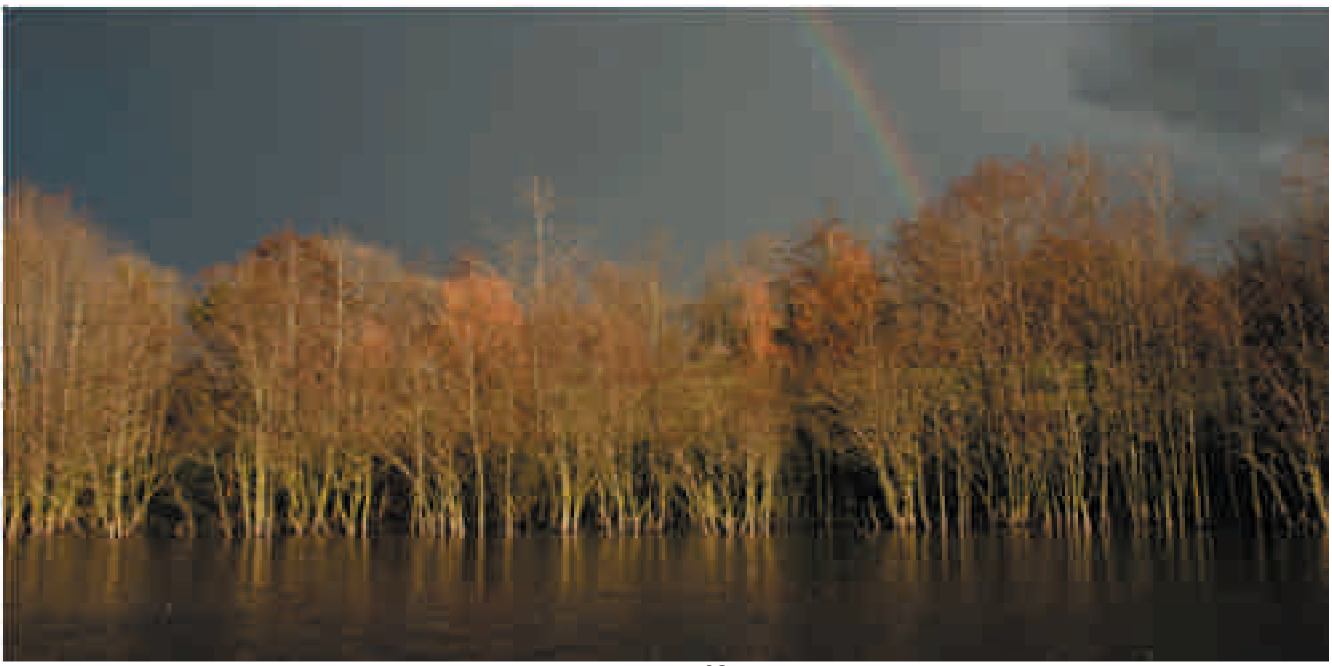


Figure 4.12. WFD Biological Status: The percentage of lakes assigned to each biological status class for each River Basin District.



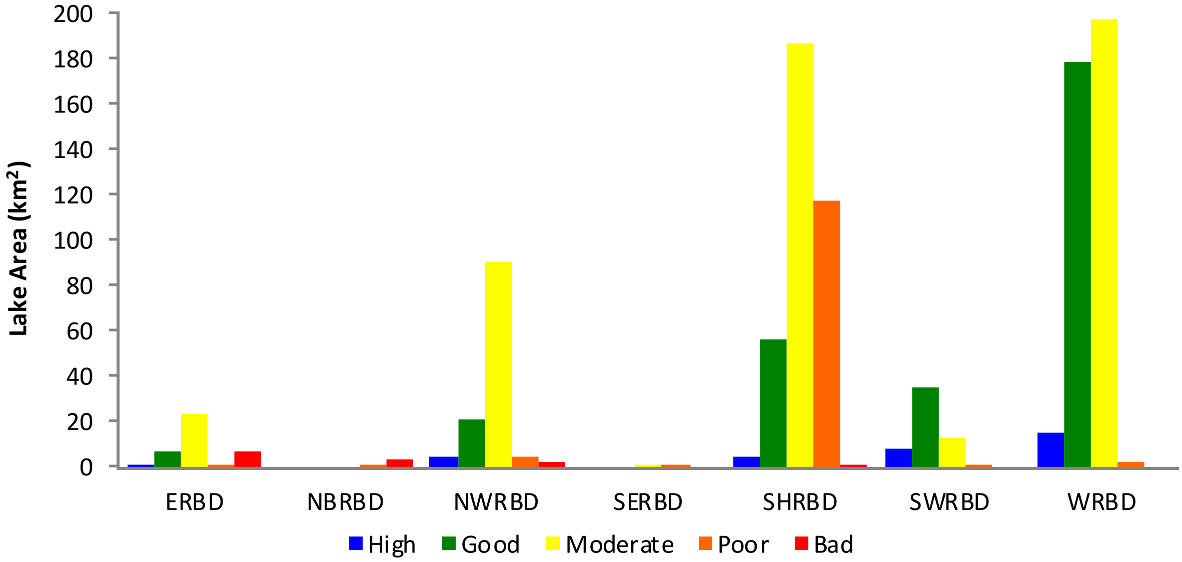


Figure 4.13. WFD Biological Status: The lake area (km^2) assigned to each biological status class for each River Basin District.

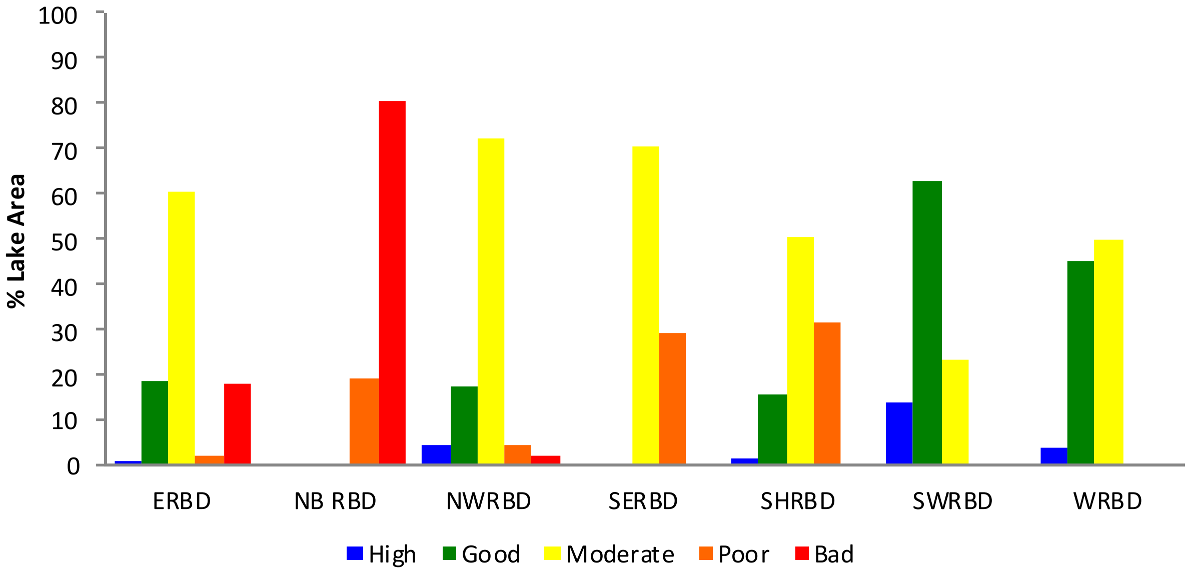


Figure 4.14. WFD Biological Status: The percentage lake area assigned to each biological status class for each River Basin District.

GENERAL PHYSICO-CHEMICAL STATUS

This section gives a breakdown of physico-chemical status, nationally and at RBD level which when combined with biological status above yields final WFD Ecological Status on a one-out-all-out basis.

National: The national geographical distribution of lakes in each of the three physico-chemical quality element status classes is mapped in Figure 4.15. Of the lakes monitored, 140 (63%) were in high or good physico-chemical quality element status (Figure 4.16). These were predominantly in the WRBD (Figure 4.15). Only 20 per cent of monitored lakes were in high physico-chemical status. The remaining 82 lakes (37%) were in moderate physico-chemical status and with over 50 per cent predominantly located in the NWRBD and SHRBD (Figure 4.15, Figure 4.17).

In terms of lake area, 851 km^2 (86%) of the total lake area monitored was in high or good physico-chemical status. Within this category good status lakes represented 57 per cent of monitored lake area. The remaining 14 per cent or 138 km^2 of monitored lake area was assigned moderate status and was predominantly located in the NWRBD and SHRBD.


High Status
Good Status
Moderate Status

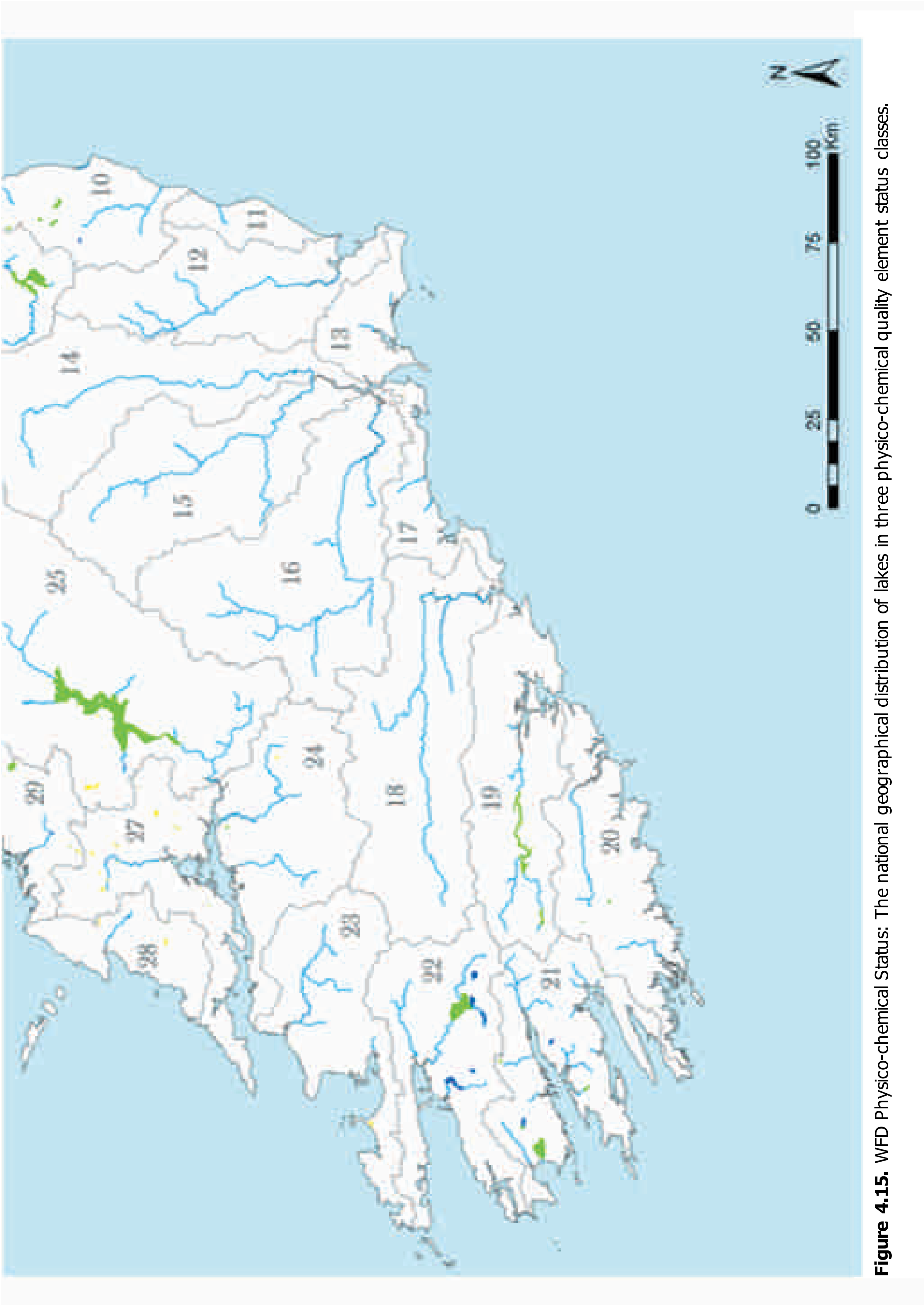


Figure 4.15. WFD Physico-chemical Status: The national geographical distribution of lakes in three physico-chemical quality element status classes.

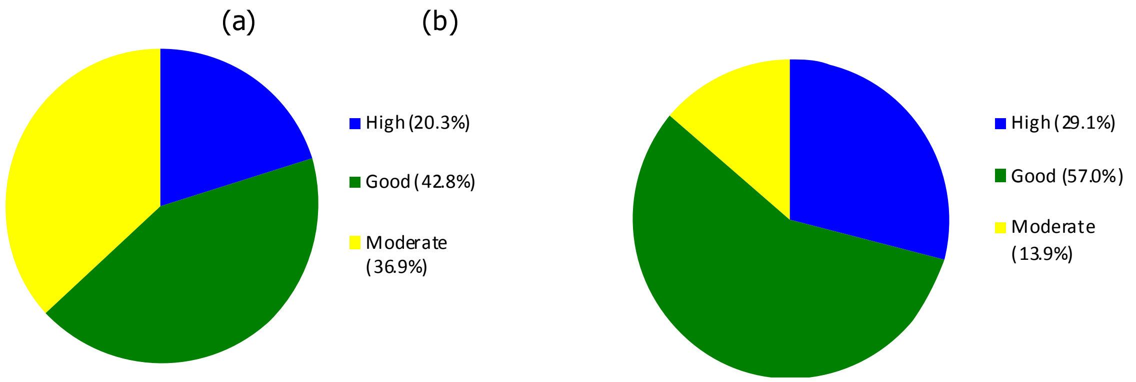


Figure 4.16. WFD Physico-chemical Status: (a) The percentage number of lakes and (b) the percentage of monitored lake area, assigned to the three physico-chemical quality element status classes.

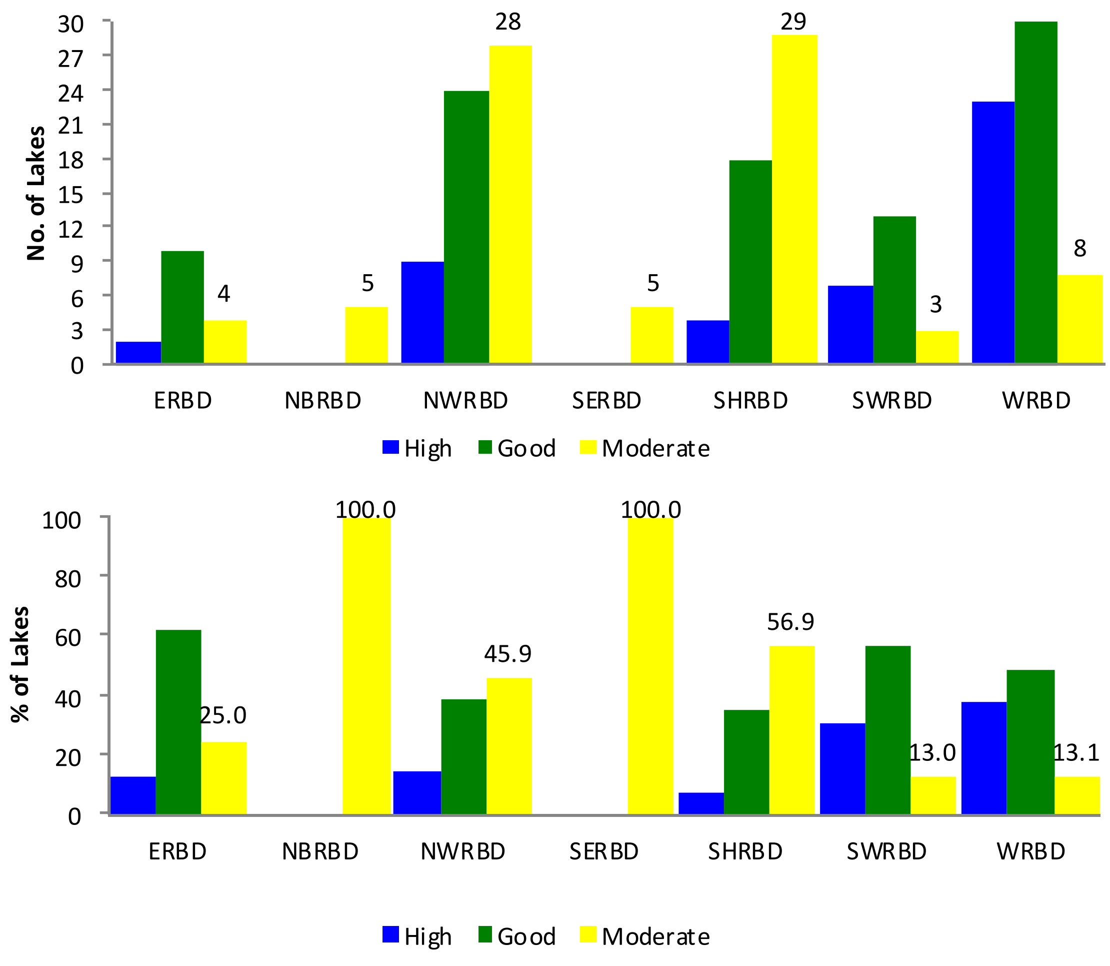


Figure 4.17. WFD Physico-chemical Status: Number (top) and percentage (bottom) of lakes assigned to the three physico-chemical quality element status classes in each RBD.

WRBD: In the WRBD high or good physico-chemical status was assigned to 53 lakes (87%) (Figure 4.17) representing 389 km^2 or almost 99 per cent of monitored lake area in the district (Figure 4.18). Moderate status was assigned to 13 per cent of lakes representing 1.3 per cent of monitored lake area in the WRBD.

SWRBD: In the SWRBD 20 lakes (87%) achieved high or good physico-chemical status, representing over 99 per cent of the 57 km^2 lake area monitored. Three lakes were assigned moderate status representing 0.6 per cent of lake area surveyed.

NWRBD: In the NWRBD high or good physico-chemical status was assigned to 33

lakes (54%), representing 42 per cent of monitored lake area in the district. The remaining 28 lakes (73 km^2) were assigned moderate physico-chemical status.

ERBD: Of the lakes monitored in the ERBD, 12 lakes (75%) were assigned high or good physico-chemical status, accounting for 78 per cent of the 39 km^2 of monitored lake area in the ERBD. Four lakes were assigned moderate physico-chemical status.

SHRBD: In SHRBD, 22 (43%) lakes representing 88% per cent of the 368 km^2 monitored lake area there were assigned high or good physico-chemical status. Moderate physico-chemical status was assigned to 29 lakes (57%) based on their physico-chemical quality elements, representing 12 per cent of lake area in the district.

NBRBD: All five lakes in the NBRBD were of moderate physico-chemical status (Figure 4.17 and 4.18).

SERBD: The five lakes monitored in the SERBD were of moderate physico-chemical status (Figure 4.17 and 4.18).

Driving Physico-chemical Parameters

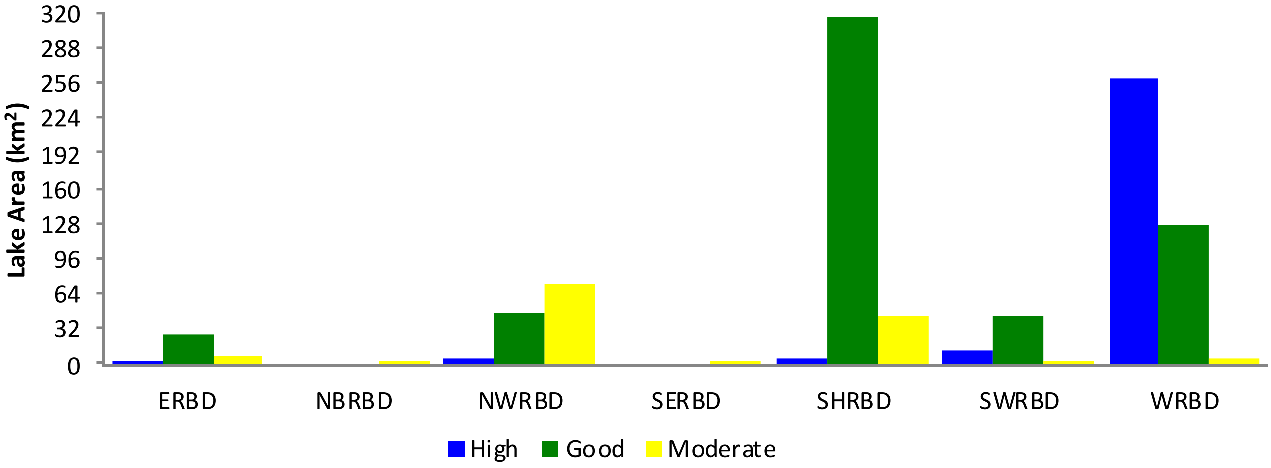
Of the 222 lakes monitored nationally, 45 lakes were assigned high physico-chemical quality element status and 95 lakes were assigned good physico-chemical status. Of these, 63 lakes were assigned good physico-chemical status based on total phosphorus (TP). Good physico-chemical status was assigned to 32 lakes based on both total ammonia and TP levels with over 50 per cent of these (20 lakes) located in the NWRBD. Only two lakes were assigned good physico-chemical status based on total ammonia alone.

Of the 82 lakes classified as being of moderate physico-chemical status, Lough Gur failed to meet the required oxygenation conditions, had an elevated pH (>9), an average TP value exceeding the interim EQS and an average ammonia exceeding the EQS for the good/moderate boundary. One lake, Summerhill, which is small and shallow, failed to meet required oxygenation conditions. Lough Cam in Kerry failed the EQS on low pH. This lake has a heavily afforested catchment and has been included on the acid lake subnet for the 2010-2015 lake monitoring programme.

The following lakes: Corcaghan, MacNean Upper and Lower, Monalty, Naglack, Upper Lough Skeagh and White Lough (Monaghan), failed to meet required oxygenation and nutrient conditions to achieve good status. Poor oxygen conditions and elevated pH levels are secondary effects of eutrophication. The remaining 72 lakes fail because of elevated nutrient conditions alone.

For the 80 lakes that failed nutrient conditions 33 failed both the interim TP and ammonia EQS values for the good/moderate boundary. These lakes were predominantly located in Leitrim, Monaghan, Cavan and Clare (NWRBD and SHRBD). Thirty-eight lakes failed to meet the interim TP EQS value for the good/moderate boundary. Over half of these lakes were located in Cavan in the NWRBD. A further nine lakes failed the ammonia EQS value for the good/moderate boundary, seven of which were located in Clare in the SHRBD.

The physico-chemical EQS standards are aimed at detecting pollution that may impact on the biological quality elements and affect overall ecological status. Elevated levels of nutrients, ammonia and phosphates are generally indicative of diffuse pollution (e.g., agriculture, forestry, septic tanks) and point source pollution (e.g., municipal or industrial wastewater treatment plants). These sources can result in depleted or elevated levels of oxygen in the water as a result of plant or phytoplankton growth and increased pH levels (>pH 9).



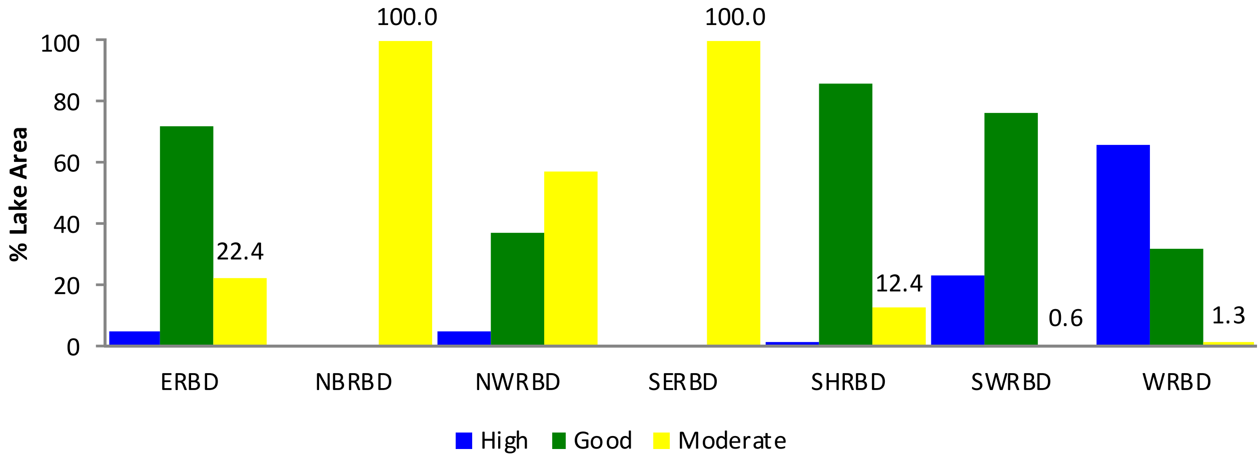


Figure 4.18. WFD Physico-chemical Status: The area (top) and percentage area of lake (bottom) examined assigned to each physico-chemical status category in each RBD.

Nitrates in Lakes

The concentration of nitrates in lakes is a key quality indicator because of its enriching effect as a nutrient and because of the potential health implication of high nitrate concentration in lake waters abstracted for potable supplies.

The EU Nitrates Directive (91/676/EEC)* requires member states to take specific measures to protect surface waters and groundwater from nitrate contamination arising from agricultural activities. The Irish Regulations implementing the Directive, and incorporating the action plan, were enacted and published as the European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2006 (S.I. No. 378 of 2006).** In addition direct waste discharges, such as sewage, may also contribute to such contamination and the EU Directive on urban wastewater treatment (91/271/EEC) provides for the removal of nitrogen from such waste in certain circumstances.

Under Regulations (S.I. No. 272 of 2009), which give effect to the measures needed to achieve the environmental objectives established by the Water Framework Directive (2000/60/EC), no criteria have, as yet, been

* The Nitrates Directive (91/676/EEC) – Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources – was adopted in 1991 and has the objective of reducing water pollution caused or induced by nitrates from agricultural sources.

** These Regulations revoke, and re-enact with amendments, the European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2005 (S.I. No. 788 of 2005). However, the European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2009 revises and replaces the previous Regulations made in 2006 and 2007.

established for nitrates in lakes or rivers. However, for reporting purposes, under the Nitrates Directive, six quality classes are included ranging from 0->50 mg NO_3/l. Nitrate, often reported as total oxidised nitrogen (TON), given very low nitrite, is measured in the lake monitoring programme and Figure 4.19 shows for 2007 to 2009 most lakes were below 2 mg/l NO_3.

Trends in Total Phosphorus

Currently, there is no formal Ecological Quality Standard (EQS) for total phosphorus. However, as it is the main nutrient driving enrichment, it is important that phosphorus is included in any assessment of lake quality.

Under the Phosphorus Regulations, the annual mean target value for TP was set at 20 µg/l. For the period 2007-2009 just over 58 per cent of lakes with monitoring data had average TP values less than 20 µg/l. Therefore, almost 42 per cent of lakes would not be compliant with the Phosphorus Regulations. Of these lakes, 34 per cent or 31 lakes had average TP values in excess of 50 µg/l (Figure 4.20). As most of the failures under the physico-chemical status assessments were due to nutrient levels this is in line with expectations. A formal EQS for phosphorus in lakes will be set in the next phase of standard setting for the WFD. It is proposed that these will take into account the sensitivity of individual lakes to phosphorus loading as well as in-lake concentration.

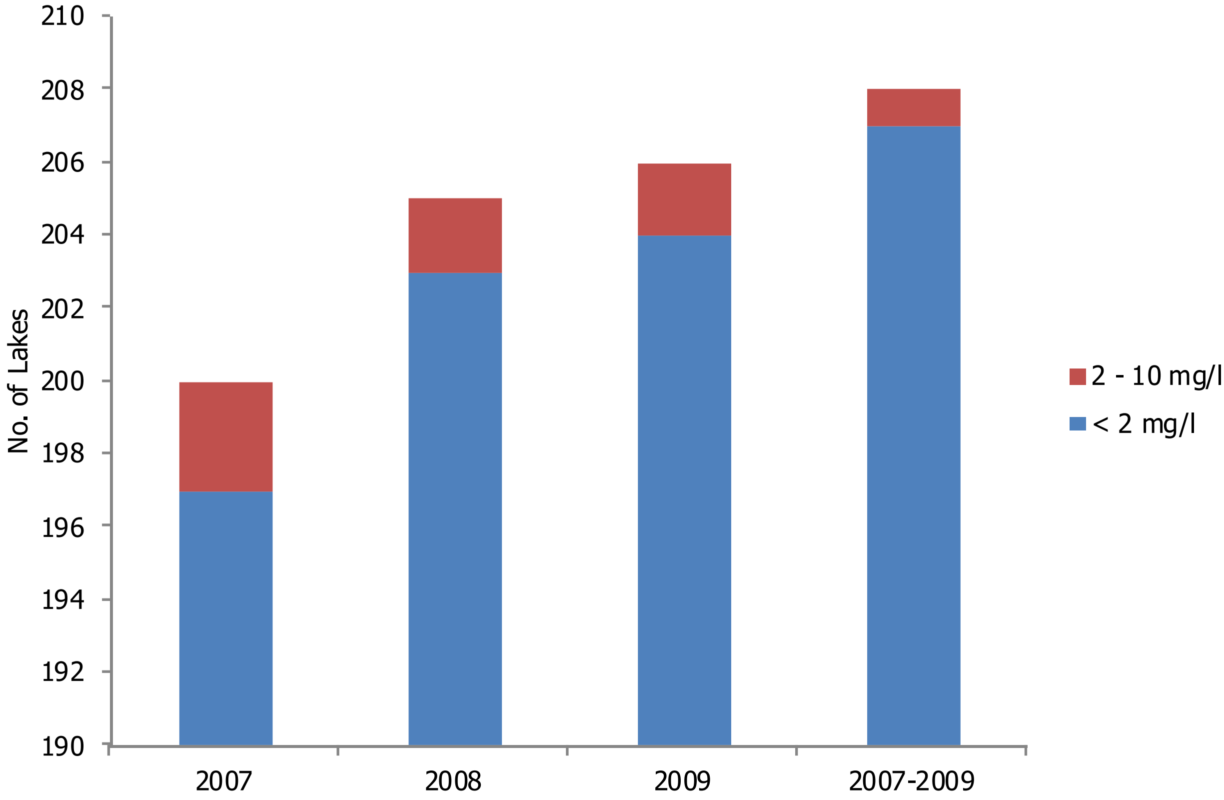


Figure 4.19. The number of lakes in each category of average total oxidised nitrogen – only one lake exceeded 2 mg/l when averaged over the 3-year period 2007-2009.

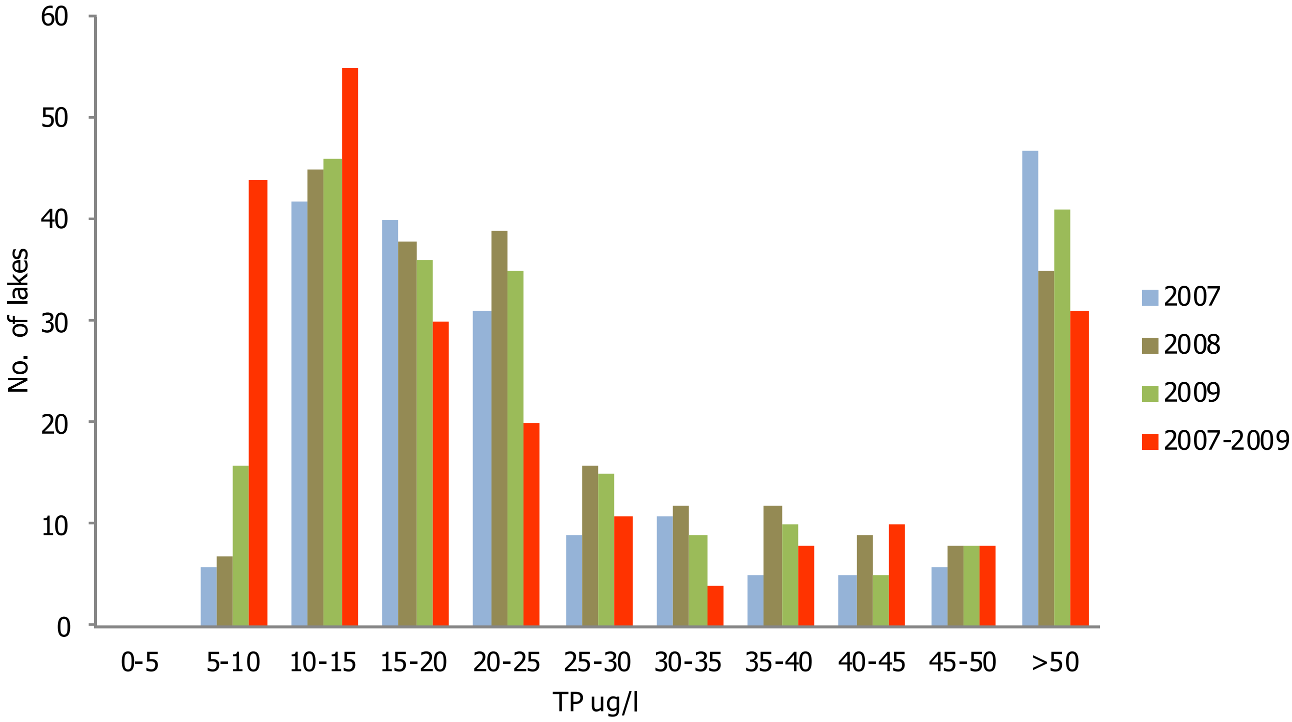


Figure 4.20. The number of lakes in each category of average total phosphorous (TP) µg/l in 2007-2009.

Acid Sensitive Waters

The principal areas in Ireland with acid sensitive water bodies are located along the western seaboard and in Co. Wicklow on the east coast. The geology in these areas is characterised by base-poor rocks such as granites and schists. Waters in these areas have a poor buffering capacity typified by their low alkalinities and are in consequence sensitive to acid inputs.

Three lakes, in Connemara, Donegal and Wicklow were selected to be the subject of a detailed investigation examining the impact of acid precipitation, in the period 1987-89 (Bowman, 1991). This investigation in the late 1980s showed that Irish waters were generally free of the impacts of anthropogenic or artificial acidification. Subsequently a longer-term monitoring programme has been carried out annually in December and April of the chemical and biological characteristics of three lakes and their inflowing streams: Loughs Veagh (Donegal), Maumwee (Galway) and Glendalough Lake Upper (Wicklow). These are regarded as representative of the larger acid-sensitive areas and this programme will continue into the 2010-2012 monitoring cycle.

The levels of acidity in the three lakes and their feeder streams were described by reference to the Raddum Index (N.I.V.A., 1987); see Table 4.10. This index is based on the sensitivity of the macroinvertebrate fauna to reduced pH and is widely used to describe the acid status of surface waters. Species are assigned an acidification score or index, in accordance with their sensitivity or tolerance to acidity. The Raddum Index scores for the three lakes systems examined in the period 2007–2009 are set out in Table 4.11. The faunal composition of the Lough Maumwee and Lough Veagh systems continue to be characterised by the presence of acid-sensitive forms, with the exception of the lake shore sampling point of the former lake.

The intermittent presence of acid-sensitive organisms at the sampling station on the Lugduff River tributary of Glendalough Lake Upper and in the littoral fauna of the lake suggest a reduction in the level of impact by artificial acidity in these waters which were regarded as severely degraded by acidity in the past.

Water samples for physico-chemical analysis were taken in conjunction with the biological

examinations on all occasions. The results of these analyses are summarised in Table 4.12. Alkalinity values were very low (<10 mg/l $CaCO_3$) at all sampling points indicating very poor buffering capacity and thus a high degree of sensitivity to acid inputs.

Little change in the acid status of these waters has been noted, however, since investigations began in 1984.

The pH values recorded at Lough Maumwee and Lough Veagh showed no evidence of inputs of artificial acidity to these systems. This assessment is supported by the relatively low concentrations of non-marine sulphate and oxidised nitrogen recorded in these systems.

Table 4.10. Raddum Index with invertebrate categories, associated acidification scores, minimum pH tolerance and inferred impact.

Category	Min. pH tolerated	Score	Inferred Acidification Impact by Presence
A	5.5-6.0	1.0	None
B	5.0-5.5	0.5	Moderate
C	4.7-5.0	0.25	Serious
D	<4.7	0	Severe

Table 4.11. The Raddum Index acidification score for Lough Maumwee, Glendalough Lake Upper and Lough Veagh and their inflowing streams during the period 2007-2009.

	2007		2008		2009	
Lough Maumwee	May	Nov	May	Dec	June	Dec
Lake shore	ns	ns	0.5	0	0.5	0
Inflow No.1	ns	1	1	1	1	1
Inflow No.2	ns	1	1	1	0.5	1
Glendalough lake Upper	May	Dec	May	Nov	May	Nov
Lake shore	0	0	1	1	0.5	1
Glenealo River	1	1	1	1	1	1
Lugduff River	0.5	1	1	0	0	1
Lough Veagh	May	Nov	May	Dec	June	Dec
Lake shore	1	ns	ns	1	ns	1
Sruthnacoille	1	ns	ns	1	1	1
Derrybeg River	1	ns	ns	1	ns	ns
Owenveagh River	1	ns	ns	1	1	1
Glenlackburn	1	ns	ns	1	1	1

ns: not sampled

Table 4.12. The minimum (Min) and median (Med) pH values and the median concentration of alkalinity (Alk), total aluminium (Tot. Al), non-marine sulphate (N-M SO4) and oxidised nitrogen (Ox-N) in Loughs Maumwee, Glendalough Upper and Veagh and their inflowing streams during the period 2007- 2009.

Location	pH Min	pH Med	Alk $CaCO_3$ mg/l	Tot. Al µg/l	N-M SO_4 mg/l	Ox-N µg/l N
Lough Maumwee						
Lake Surface	5.7	6.5	7.6	25	0.28	40
Inflow No. 1	6.0	6.3	7.0	25	0.22	100
Inflow No. 2	6.2	6.3	6.0	25	-	30
Glendalough Lake Upper						
Lake Surface	5.6	6.9	5.2	127	2.04	115
Glenealo River	5.9	6.2	4.5	112	2.92	100
Inflow No. 2	5.9	6.4	7.0	39	4.52	545
Lugduff River	5.2	5.7	2.5	217	2.20	200
Lough Veagh						
Lake Surface	5.9	6.5	6.0	77	0.27	50
Sruthnacoille River	5.7	6.1	4.5	106	-	40
Derrybeg River	5.3	6.3	2.5	93	0.28	50
Owenveagh River	6.1	6.4	7.0	68	0.37	45
Glenlackburn River	6.3	6.6	8.0	59	0.20	150
Inflow No. 5	5.6	6.3	7.0	88	-	100

BATHING WATER QUALITY IN LAKES

The EU Directive concerning the quality of bathing waters specifies mandatory and guide standards for the protection of public health and the environment (CEC, 1976). The number of designated inland bathing areas has remained at nine since 1994. Freshwater bathing areas failed to achieve 100 per cent compliance with the EU mandatory standards for the years 2008 and 2009 (EPA, 2010). This is in contrast to the previous period (2004-2006) for which 100 per cent compliance with the EU mandatory standards was achieved. The failures were at Ballyallia Lake (Ennis), Keeldra (Leitrim) and at Lilliput (Lough Ennell). Two of the three lakes recovered in 2009, the exception was Lough Ennell. Compliance of the freshwater bathing areas with the more stringent EU guide values has declined from 67 per cent in 2007 to 44 per cent in 2008 but improved again in 2009 (Figure 4.21). Ballyallia Lake, Keeldra and Lilliput consistently failed during the assessment period.

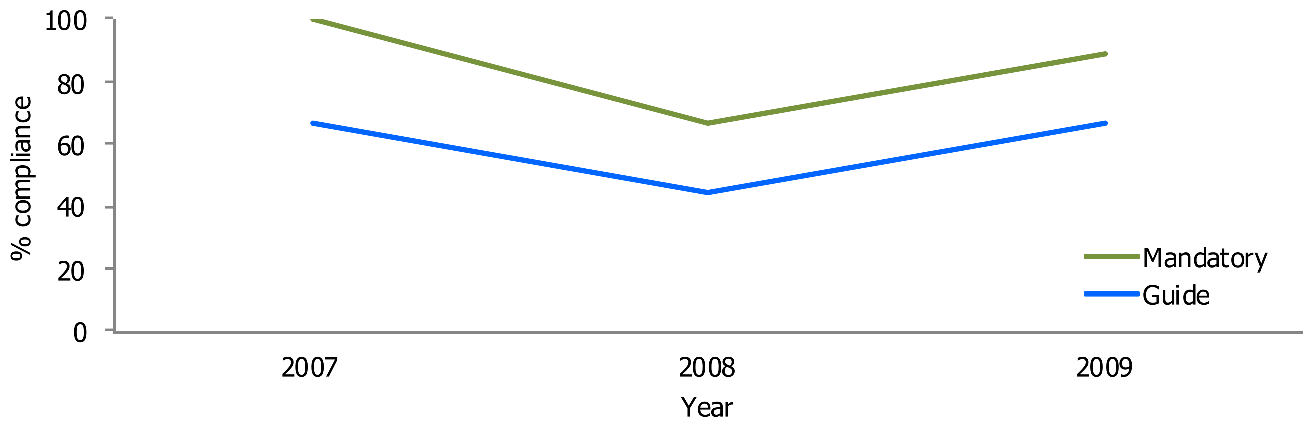


Figure 4.21. Compliance of Freshwater Bathing Areas with EU Mandatory and Guide Standards 2007 – 2009 (Source: EPA, 2008, 2009, 2010)

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CHAPTER FIVE

QUALITY OF ESTUARINE AND COASTAL WATERS

Shane O'Boyle, Robert Wilkes, Georgina McDermott and Tone Noklegaard

INTRODUCTION

Estuaries and coastal waters complete the set of water categories included in the EU Water Framework Directive. Their inclusion reflects the Directive's holistic approach to the sustainable management of water resources. The environmental status of these waters, which mark the boundary or interface between land and sea, provides an indication of how land-based human activities impact on the marine environment.

A number of pressures associated with various human activities such as urbanisation, industrialisation and intensification of agricultural practices, have the potential to impact negatively on the quality of these waters. Furthermore, stresses from external sources, such as transboundary pollution (e.g., radioactivity) and accidental, or in some cases, intentional oil spills from marine vessels, may also adversely affect their status.

This chapter presents an assessment of these different pressures and their associated impact and provides an overview of the water quality status of estuarine and coastal waters around Ireland. This assessment is based on information collected by the EPA, the Marine Institute (MI), Inland Fisheries Ireland (IFI), the Sea Fisheries Protection Authority (SFPA), the Irish Coast Guard (IRCG) and the Radiological Protection Institute of Ireland (RPII).

TROPHIC STATUS OF ESTUARINE AND COASTAL WATERS

As is the case for rivers and lakes the impact of nutrient enrichment and the process of eutrophication is also a major concern in the tidal waters environment. The direct negative effects of excessive nutrient enrichment include increases in the frequency and duration of phytoplankton blooms (sometimes of nuisance and toxin producing species) and excessive growth of attached opportunistic macroalgae. The subsequent breakdown of this organic matter can lead to oxygen deficiency which in turn can result in the displacement or mortality of marine organisms. As such the effects of over enrichment can severely disrupt the normal functioning of tidal water ecosystems.

The status of individual estuarine and coastal water bodies is assessed using the EPA's Trophic Status Assessment Scheme (TSAS). This assessment is required for the Urban Waste Water Treatment Directive and Nitrates Directive. The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state (Table 5.1). These criteria fall into three different categories which broadly capture the cause-effect relationship of the eutrophication process, namely nutrient enrichment, accelerated plant growth, and disturbance to the level of dissolved oxygen normally present;

Eutrophic water bodies are those in which criteria in each of the categories are breached, i.e. where elevated nutrient concentrations, accelerated growth of plants and undesirable water quality disturbance occur simultaneously;

Potentially Eutrophic water bodies are those in which criteria in two of the categories are breached and the third falls within 15 per cent of the relevant threshold value;

Intermediate status water bodies are those which breach one or two of the criteria;

Unpolluted water bodies are those which do not breach any of the criteria in any category.

Table 5.1. Parameters and criteria used in the Trophic Status Assessment Scheme (TSAS) for Irish estuaries, bays and nearshore coastal waters.

Category	TSAS criteria	Value from 3-year period	Threshold	Score
A: Nutrient enrichment	Nitrogen	DIN (Winter or Summer)	Salinity Corrected Threshold Value (see Appendix)	Pass/Fail
	Phosphorus	MRP (Winter or Summer)		Pass/Fail
B: Accelerated Growth	Chlorophyll	Median (Summer)		Pass/Fail
		90%ile (Summer)		Pass/Fail
	Macroalgae	WFD EQR[1] (Summer)		Pass/Fail
C: Undesirable Disturbance	Dissolved Oxygen	5%ile (Summer)		Pass/Fail
		95%ile (Summer)		Pass/Fail

[1] Ecological Quality Ratio for Good Status, derived from WFD compliant assessment method.

RESULTS FOR THE 2007-2009 TROPHIC STATUS ASSESSMENT

The outcome of the most recent trophic status assessment of estuarine and coastal waters for the period 2007-2009 is shown in Figure 5.1. Of the 89 water bodies included in the assessment, 9 (10.1%) were classed as eutrophic, 5 (5.6%) as potentially eutrophic, 31 (34.8%) as intermediate and 44 (49.5%) were unpolluted. In terms of surface area, 102.1 km^2 or 5.3 per cent of the total area assessed (just under 2,000 km^2) is classed as either eutrophic or potentially eutrophic.

The results of this assessment seem to indicate an improvement in overall water quality, with five fewer water bodies being classed as eutrophic when compared to the previous assessment. These include the Blackwater estuary (upper and lower) the Lee (Tralee) estuary, Owenacurra (Midleton) estuary and Wexford Harbour. In addition, a further five water bodies have improved from intermediate to unpolluted status and these include Kinsale Harbour, the Garavogue estuary, Sligo Harbour, McSwyne's Bay and the Lower Liffey estuary.

Improvements in the upper and lower parts of the Blackwater estuary in Co. Cork and Co. Waterford, is due to a decrease in chlorophyll levels and improved oxygen conditions. Improvements in the Lower Liffey estuary in Dublin city and in the Garavogue estuary in Sligo town, are most likely the result of upgraded levels of waste water treatment; the treatment plant in Sligo was only commissioned in 2009 but appears to have had a discernable effect on water quality in the estuary. In the case of the Liffey estuary, its unpolluted status would seem to confirm the incremental improvement in water quality noted in previous reports.

Some of the water bodies showing a decline in status include Inner Dundalk Bay, Upper Barrow estuary, Malahide Bay, Colligan (Dungarvan) estuary, Moy estuary and Ballysadare Bay and estuary. The deterioration in status in Malahide Bay and the Colligan estuary is due to the presence of green opportunistic macroalgae, which while previously observed in these areas had not been formally assessed.

A comparison of TSAS analyses and outcomes going back to the mid-1990s is shown in Table 5.2, and a summary of the physico-chemical data used in this current assessment is given in Appendix 1. The number of areas included in this assessment has increased in recent years due to the implementation of the Water Framework Directive. As such the proportion of water bodies in each status category is likely to be broadly representative of trophic conditions in Irish estuarine and coastal waters as a whole.

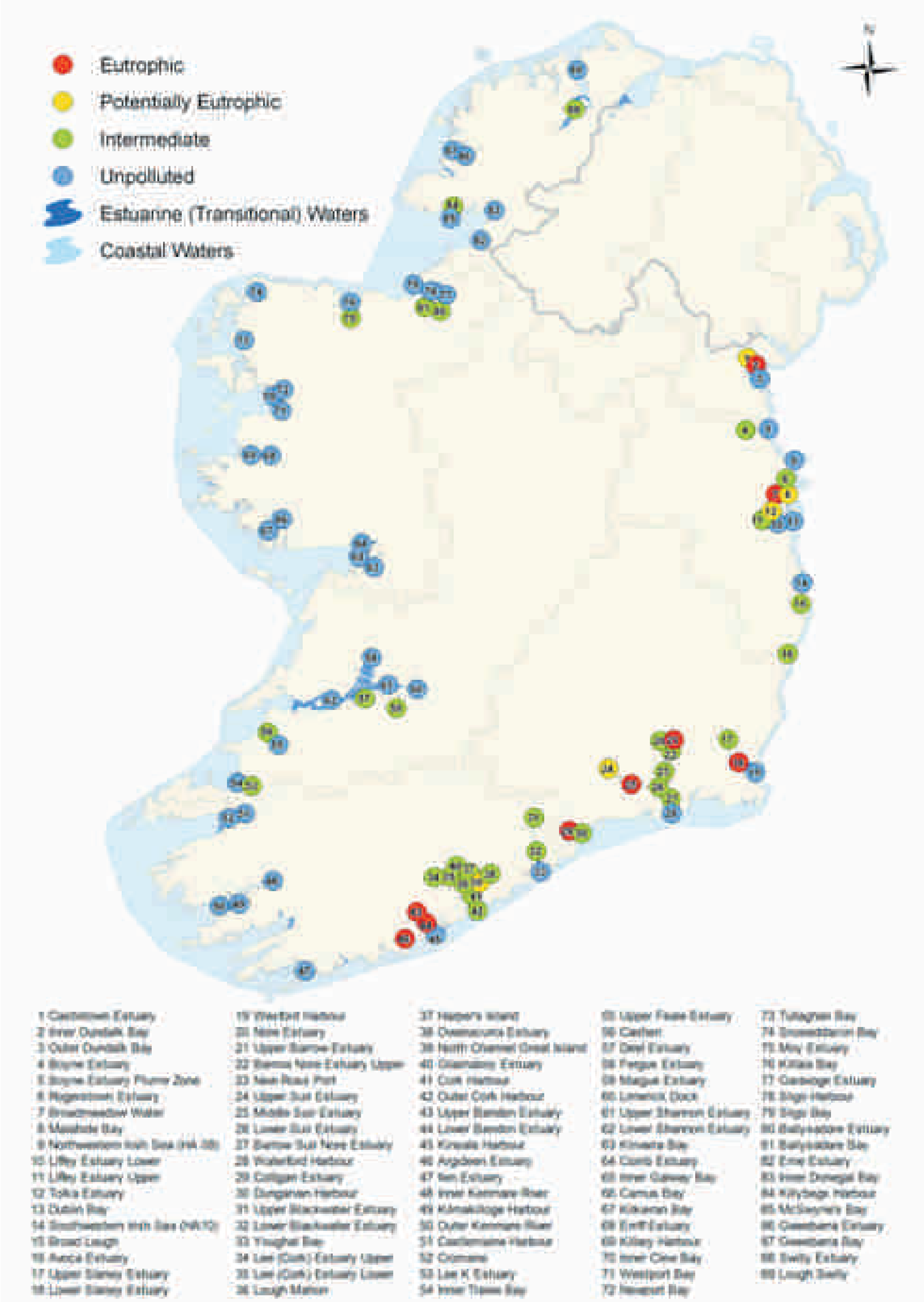

Figure 5.1. Estuarine and coastal water quality 2007-2009.

Table 5.2. Summary of TSAS analysis for the period 2007-2009, with comparative figures for the 2002 – 2006, 1999 – 2003 and 1995-1999 periods.

Water Bodies	Trophic Class	2007-2009	2002-2006	1999-2003	1995-1999
Numbers	Eutrophic	9	13	12	15
	Potentially Eutrophic	5	2	3	3
	Intermediate	31	27	28	18
	Unpolluted	44	27	26	24
	Total	89	69	69	60
Percentage	Eutrophic	10.1	18.9	17.4	25.0
	Potentially Eutrophic	5.6	2.9	4.3	5.0
	Intermediate	34.8	39.1	40.6	30.0
	Unpolluted	49.5	39.1	37.7	40.0
	Total	100	100	100	100

Nitrogen and phosphorus levels in estuarine and coastal waters

While phosphorus can limit plant growth in freshwater and estuarine systems, nitrogen is considered to be the limiting nutrient in open coastal waters not significantly influenced by freshwater run-off. The concentration of both nitrogen, as dissolved inorganic nitrogen (DIN) and phosphorus, as molybdate reactive phosphorus (MRP), is monitored in winter when levels are expected to be at their seasonal maximum due to the absence of any significant plant or algal growth. Levels of MRP are also monitored in summer to capture the potential effect of seasonal changes in river flow which in turn can result in higher phosphate concentrations in some estuaries in summer.

The highest median winter DIN values were found in the Glashaboy (Glanmire) estuary (6.3 mg/l N), the Upper and Lower Slaney estuary (5.5 and 4.3 mg/l N, respectively), the Owenacurra estuary (4.3 mg/l N) and the Upper Barrow estuary (4.9 mg/l N).

Each waterbody is assessed against salinity-related thresholds and 31 water bodies breached the winter DIN assessment criterion. The highest exceedances (greater than 100 per cent) were observed in the Glashaboy estuary (157.1%), Upper (112.1%) and Lower Slaney (119.3%) estuary and Colligan estuary (110.9%). In relation to achieving the environmental objectives established by the Water Framework Directive (WFD), three coastal areas, Cork Harbour, Outer Cork Harbour and Malahide Bay, failed to comply with the environmental quality standard (EQS) for DIN (S.I. No. 272 of 2009). Absolute concentration and exceedance values for DIN are shown in Figures 5.2a and 5.2b.

In relation to MRP concentrations, the majority (85%) of estuaries and coastal waters had MRP median winter and summer values less than 0.040 mg/l P, with half of these having levels less than 0.020 mg/l P. More water bodies had higher concentrations in summer than winter. The highest winter MRP concentrations were found in Lough Mahon (Harper's Island), Lee (Tralee) estuary, the Castletown (Dundalk) estuary, the Tolka estuary, New Ross Port, Barrow Suir Nore estuary and the Broadmeadow estuary in Co. Dublin, with values ranging from 0.049 to 0.066 mg/l P. The highest summer MRP concentrations were found in the Deel, Tolka, Nore, Broadmeadow and Upper Liffey estuaries where values ranged from 0.056 to 0.075 mg/l phosphorus.

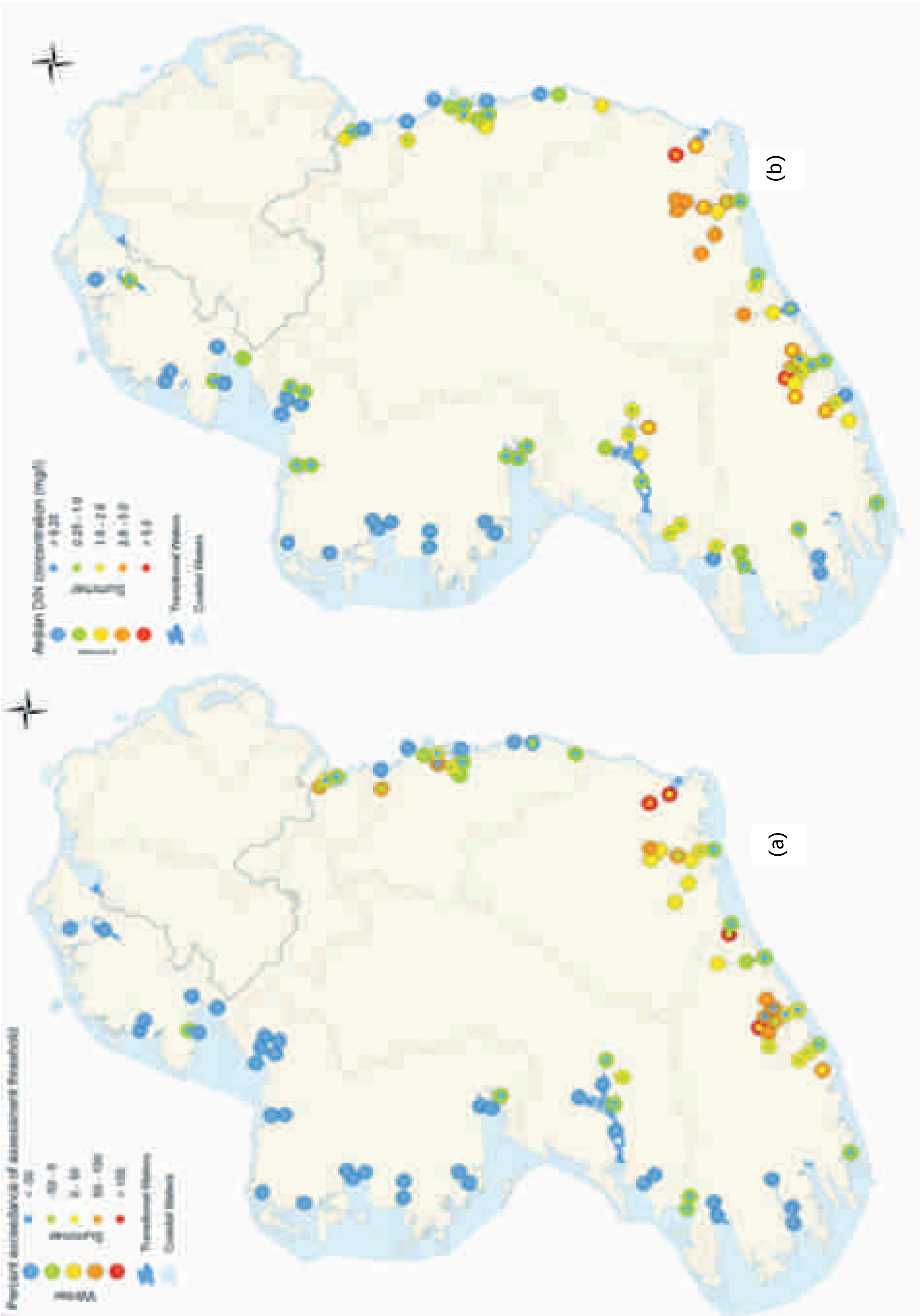

Figure 5.2. Winter and summer dissolved inorganic nitrogen (DIN) levels in estuarine and coastal waters 2007-2009, showing (a) percentage exceedance of assessment thresholds and (b) concentration.

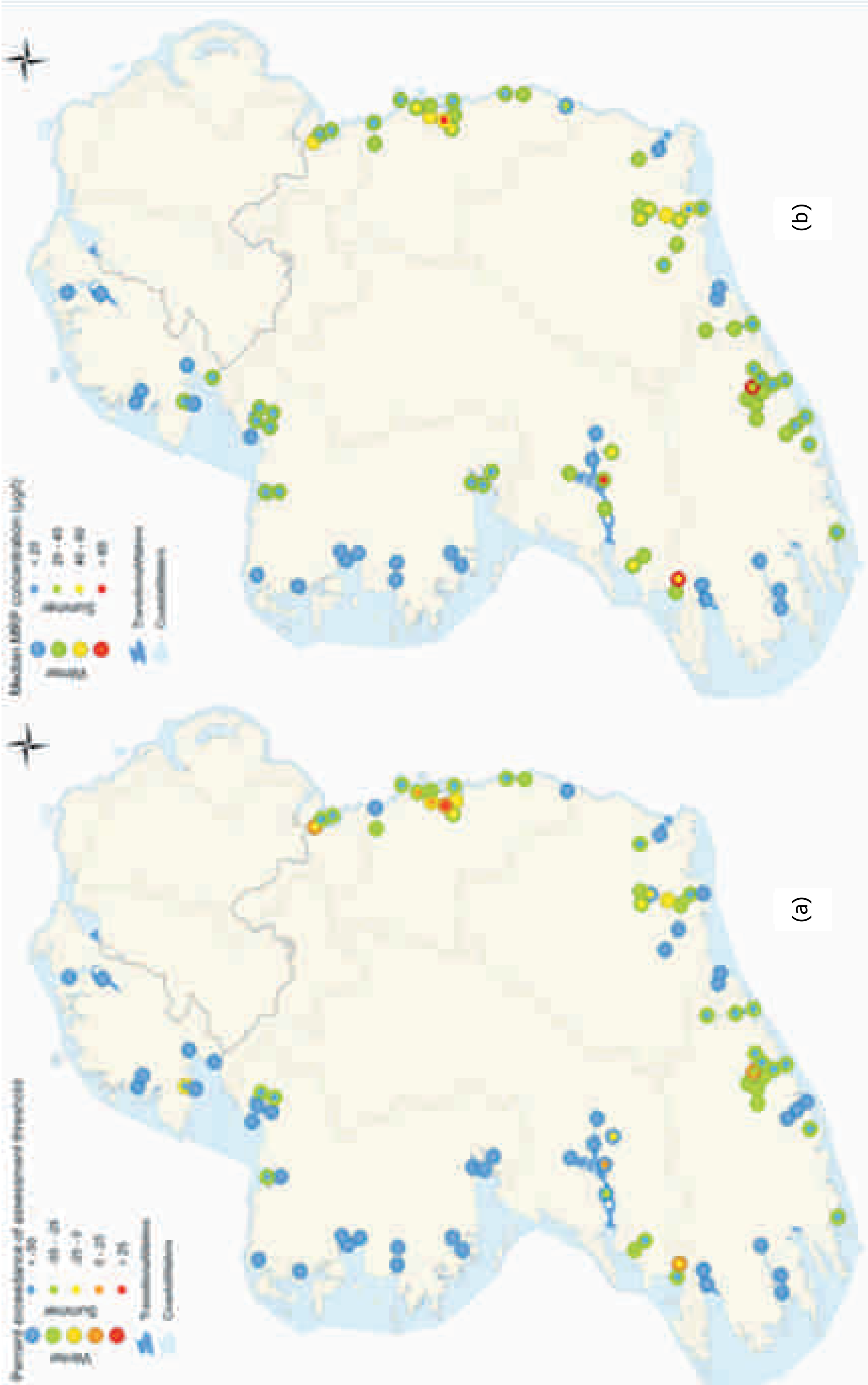

Figure 5.3. Winter and summer molybdate reactive phosphorus (MRP) levels in estuarine and coastal waters 2007-2009, showing (a) percentage exceedance of assessment thresholds and (b) concentration.

These observations are presented as concentrations and the degree of deviation from salinity-related assessment levels (see Figures 5.3a and 5.3b.). An Environmental Quality Standard (EQS) based on MRP (S.I. No. 272 of 2009) and equivalent to that used in TSAS has been established for estuarine (transitional) waters with good status being achieved if the median (summer or winter) MRP concentration is ≤0.060 mg/l (at salinity 0.0 – 17.0) and ≤0.040 mg/l (at salinity 35.0). Four water bodies, Lough Mahon (Harper's Island), Lee estuary (Tralee), Castletown estuary and Tolka estuary, breached the winter MRP criterion and therefore the EQS for MRP. The same number of estuaries (Tolka, Deel, Broadmeadow and Rogerstown) were in breach of the EQS in summer.

Before leaving this section it is worth noting that the distribution of nutrients presented here is in good general agreement with the country-wide maps of average riverine nutrient concentration presented in Chapter 3. Taken together, this information provides an excellent national picture of nutrient levels across these different water categories.

Dissolved oxygen levels and biochemical oxygen demand

When oxygen levels decline as a result of pollution they can have adverse effects on aquatic organisms including slower growth rates, impaired immune response and in severe cases mortality. When oxygen concentrations become very low, they are described as either hypoxic, when levels fall below 2 mg/l, or anoxic, when there is 'no-oxygen' present.

This assessment shows that the vast majority of waters (99.5% of the surface area assessed) had satisfactory oxygen conditions capable of supporting nearly all forms of aquatic life. Furthermore, no hypoxia or indeed anoxia was observed in any of the water bodies surveyed (Table 5.3). These findings are in good agreement with an earlier EPA study and confirm the satisfactory nature of oxygen conditions in Irish estuaries and nearshore waters (O'Boyle *et al.*, 2009). Nevertheless, deoxygenation was observed in a small number of water bodies, with the lowest concentrations being observed in the Avoca estuary, Lower Lee estuary and Upper Liffey estuary, where values fell between 3.0 – 5.2 mg/l O_2. Such levels are likely to cause some adverse effects on aquatic organisms (Vaquer-Sunyer and Duarte, 2008).

The effect of organic enrichment on oxygenation conditions, as indicated by the biochemical oxygen demand (BOD) concentration is shown in Figure 5.4, which shows that the majority of waters had acceptable levels of BOD (i.e. EQS of 95 percentile less than 4 mg/l O_2).

However, in 12 water bodies the level of oxygen demand observed indicated the presence of substantial organic enrichment, with six of these areas, Upper Bandon, Upper Swilly, Broadmeadow, Lower Bandon, Deel and Middle Suir, having BOD values ranging from 6.1-8.5 mg/l O_2.

Overall, levels of BOD appear to have declined, with the current assessment indicating a considerable improvement on the 2002-2006 assessment when nearly one-third of water bodies were in breach of the EQS.

This improvement in the level of organic enrichment is likely to be due to improved waste water treatment facilities as a result of the implementation of the EU Urban Wastewater Treatment Directive in Ireland.

Table 5.3. Proportion of water bodies in each dissolved oxygen category by number and surface area in the period 2007-2009, based on minimum (5%ile) dissolved oxygen levels.

	Anoxic	Hypoxic	Deficient	Sufficient
(mg/l)	(0 - 0.5)	(0.5 - 2.0)	(2.0 - 6.0)	(6.0-10.0)
Number (n)	0	0	5	84
(%)	0	0	5.6	94.4
Surface Area (km^2)	0	0	9.9	1922.5
(%)	0	0	0.5	99.5

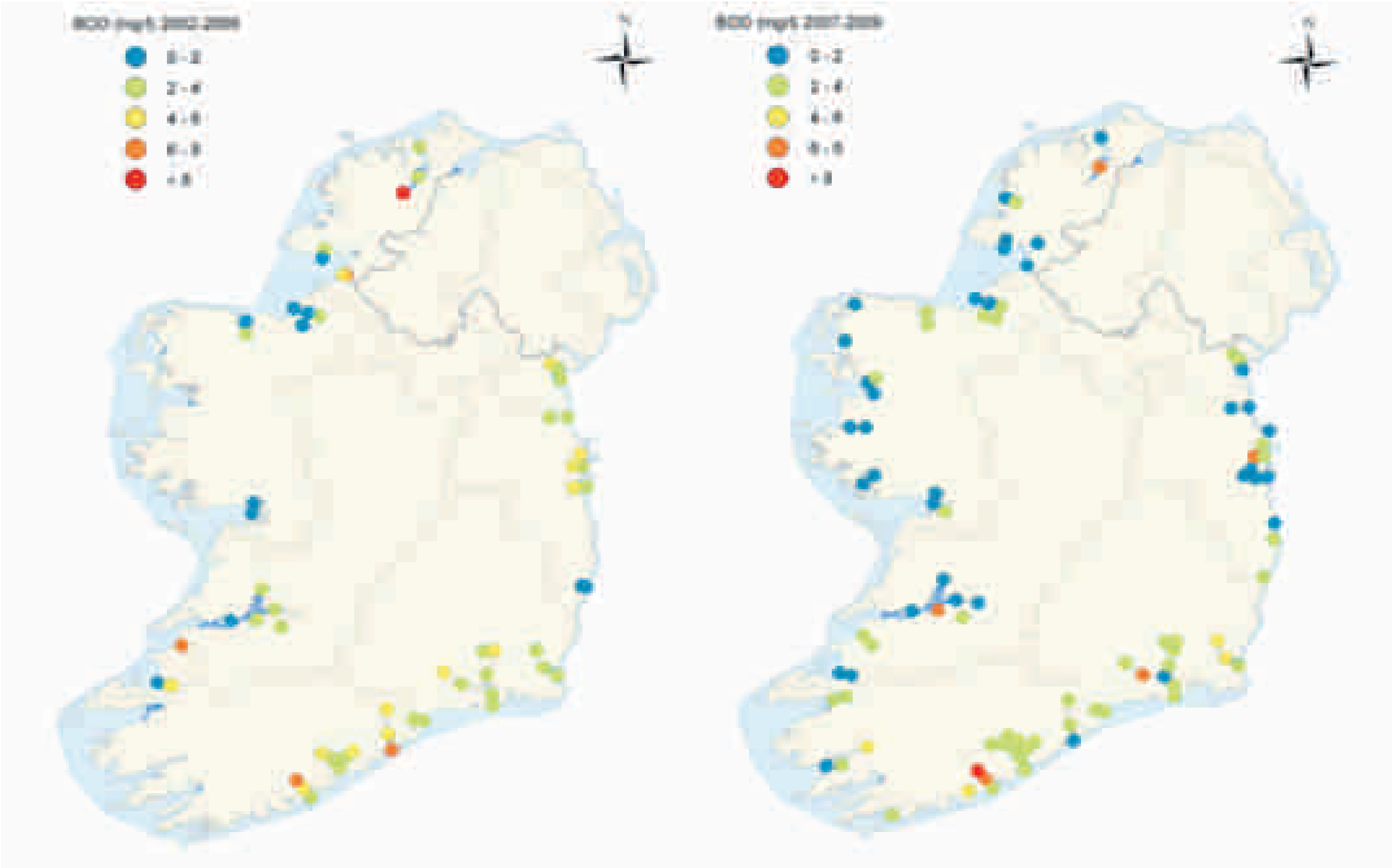

Figure 5.4. Summer biochemical oxygen demand (BOD) concentration (95 percentile) in estuarine and coastal waters in 2002-2006 and 2007-2009.

For example, between 2007 and 2008, 90 per cent of waste water arising received at least secondary treatment (EPA, 2009a). This represents a substantial improvement from the period 1998-1999, when only 26 per cent of discharges received secondary treatment, and 38 per cent of discharges received only primary treatment. A number of major wastewater treatment plants, which discharge to tidal waters, came in to operation during the period 2007-2009, including, Waterford city (Suir estuary), Sligo town (Garavogue estuary), Donegal town (Inner Donegal Bay) and Balbriggan/Skerries. The level of treatment of discharges is expected to increase further as additional treatment plants come into operation in the coming years.

At the start of 2008, however, sewage was still being discharged with either no treatment or basic treatment at 112 locations around Ireland, with the majority of these discharging directly to estuarine or coastal waters (EPA, 2009a). Although plans are in place for the provision of secondary treatment at many locations, significant towns such as Bray, (Co. Wicklow), Killybegs, (Co. Donegal), Shanganagh, (Dun Laoghaire Rathdown), Clifden (Co. Galway) and Youghal (Co. Cork) are still without this level of treatment.

The EPA is addressing the issues associated with these towns. The Agency has granted waste water discharge licences for Bray, (Co. Wicklow), Killybegs, (Co. Donegal) and Shanganagh, (Dun Laoghaire Rathdown). These licences include requirements for programmes of improvements to be implemented to ensure that a minimum of secondary treatment will be provided at these waste water treatment plants. The waste water treatment plants in Clifden (Co. Galway) and Youghal (Co. Cork) are being addressed by the Agency through the wastewater discharge licensing regime and will ensure that secondary treatment will be put in place at these plants.

ECOLOGICAL STATUS OF ESTUARINE AND COASTAL WATERS

In addition to nutrient enrichment, other pressures such as hazardous substances and morphological alterations can also impact on the quality of aquatic systems. Under the Water Framework Directive (WFD), these additional pressures, along with nutrient enrichment, must be addressed. In the Directive, biological indicators are used to assess the ecological status of transitional and coastal waters. Classification schemes have been developed that use the characteristics of different biological communities, together with information on the physico-chemical environment to define ecological status. The biological quality elements (BQEs) and physico-chemical elements currently being used for WFD status assessment are listed in Table 5.4.

Ecological status is assessed on a 'one-out-all-out' basis. Overall ecological status of a water body is based on the biological quality element or physico-chemical standard with the lowest status. For example, if all the elements in a particular water body are at or near reference conditions then the status of the water body is considered to be high. However, if any single biological quality element or chemical parameter is of lesser status then classification is based on that element. A total of 121 transitional and coastal areas were assessed by the EPA, Marine Institute and Inland Fisheries Ireland between 2007 and 2009 for WFD status classification, using the biological quality and physico-chemical elements listed in Table 5.4. Of these, 55 were classed as either high (16%) or good (30%) ecological status with the remainder being classed as moderate or worse. In terms of surface area, just over 64 per cent of the total monitored area was found to be at high or good ecological status. A detailed breakdown of these classifications for each river basin district (RBD) is shown in Table 5.5, and graphically in Figure 5.5.

A number of areas, including the mouth of the Shannon estuary and Roaring Water Bay, were classed at moderate ecological status due to the presence of a polychlorinated biphenyl (PCB) substance referred to as CB118. PCBs are manmade substances that were widely used in the manufacture of electrical equipment. While their production in Europe was banned in the 1980s, PCBs are still widespread in the environment and there are few areas where concentrations are close to zero. As such their detection does not necessarily infer recent or indeed local inputs. Indeed, where temporal trends are detected for PCBs in the Irish marine environment these are invariably downwards indicating that their presence may be due to historical diffuse inputs or atmospheric deposition. It follows, therefore, that the presence of these substances should not automatically trigger local measures, unless there is evidence that the source of contamination is local.

Table 5.4. List of parameters used to assess ecological status of Irish transitional and coastal waters.

Biological Quality Elements	
	Phytoplankton biomass (chlorophyll) in coastal and transitional waters
	Phytoplankton composition (bloom metric) in coastal waters
	Rocky shore macroalgae species multimetric in coastal waters
	Opportunistic macroalgal growths in coastal and transitional waters
	Fish in transitional water (Transitional Fish Classification Index or TFCI)
	Benthic Invertebrate fauna in coastal and transitional waters (IQI Index)
General Physico-Chemical Elements	
	Dissolved inorganic nitrogen (DIN) in coastal waters
	Molybdate reactive phosphorus (MRP) in transitional waters
	Dissolved oxygen, as per cent saturation, in transitional and coastal waters
	Biochemical oxygen demand (BOD) in transitional waters
	Specific relevant pollutants

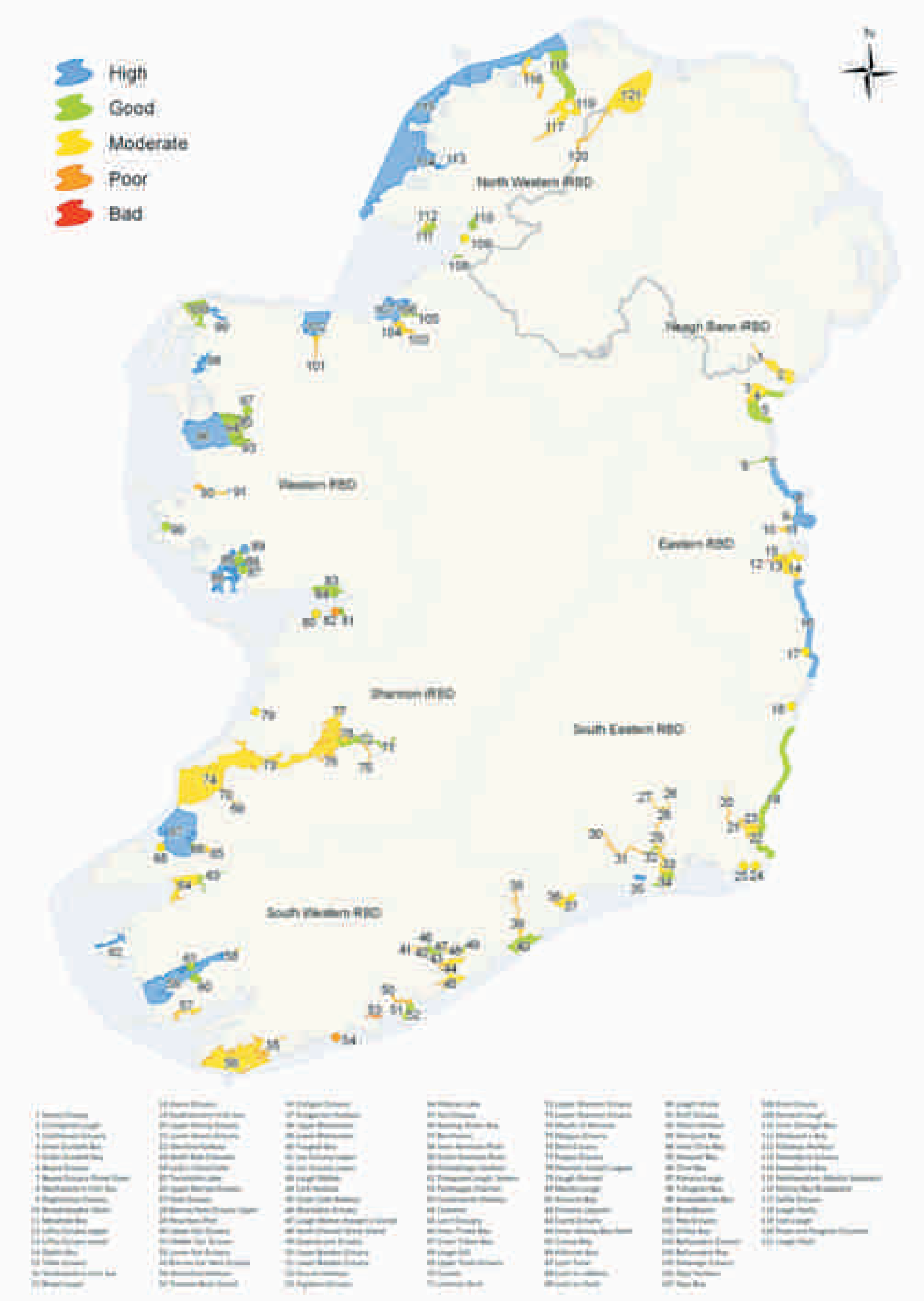

Figure 5.5. Transitional and coastal waters ecological status 2007-2009.

Table 5.5. Ecological status of monitored water bodies by number and surface area (km^2)

RBD	High	Good	Moderate	Poor	Total
Eastern	3 (207)	1 (3)	8 (66)	1 (0.2)	13 (276)
Neagh-Bann	-	1 (64)	4 (83)	-	5 (146)
North western	3 (778)	4 (125)	7 (295)	-	14 (1198)
South eastern	1 (5)	4 (162)	14 (124)	-	19 (291)
Shannon	1 (216)	4 (58)	10 (536)	-	15 (809)
South western	2 (201)	9 (88)	14 (360)	2 (5)	27 (654)
Western	9 (472)	13 (230)	5 (37)	1 (0.1)	28 (738)
Total	19 (1879)	36 (729)	62 (1500)	4 (5)	121 (4112)

Monitoring of Toxic Contaminant Levels in Estuarine and Coastal Waters

The Marine Institute monitors the levels of certain priority hazardous substances in a range of fin-fish species landed at Irish ports and also in shellfish from selected sites around the Irish coast. These are substances, such as mercury, that have been identified as being of particular concern for the marine environment and for consumers of seafood. Levels of such substances in fish and shellfish are a good indicator of contamination in the marine environment and bivalve molluscs, e.g. mussels, are widely used as sentinel organisms in marine monitoring programmes. This monitoring is part of Ireland's contribution to the Joint Assessment and Monitoring Programme (JAMP) of the OSPAR Convention.

Environmental Contaminants in Fish

In accordance with the requirements of EU legislation, the Marine Institute samples a range of fin-fish species landed at major Irish ports. Ports sampled in 2007 and 2008 included Castletownbere (Co. Cork), Dunmore East (Co. Waterford), Rossaveal (Co. Galway), Killybegs (Co. Donegal), Arklow (Co. Wicklow), and Greencastle (Co. Donegal). The fish tissue samples are tested for mercury levels and analysed for other trace metals (such as lead and cadmium) and chlorinated hydrocarbons. European Commission Regulation (EC) No. 1881/2006 as amended by Regulation 629/2008 sets maximum levels for certain contaminants, such as mercury, cadmium and lead, in fishery products (Table 5.6). Results for both years complied with the limits for mercury, cadmium and lead. There are currently no internationally agreed standards or guidelines available for other trace metals (chromium, copper, nickel, silver and zinc) and chlorinated hydrocarbons monitored in fishery products. However, the levels of these contaminants between 2007 and 2008 were well below the strictest standard of guidance value for fish tissue applied by individual contracting parties to the OSPAR Convention.

Environmental Contaminants in Shellfish

Limits for environmental contaminants in shellfish are set by the Shellfish Waters Directive (2006/113/EC) and Regulation EC No. 1881/2006, as amended by EC Regulation No. 629/2008, which lay down the maximum levels for certain contaminants in foodstuffs. The Shellfish Waters Directive sets the physical, chemical and microbiological requirements that designated shellfish waters must either comply with or endeavour to improve. This directive is implemented in Ireland by the Quality of Shellfish Waters regulation (S.I. No. 268 of 2006) which sets the guidance and imperative values for trace metals and organohalogens in shellfish flesh.

The Quality of Shellfish Waters regulation designates 14 shellfish waters sites which were amended on the 10th February 2009 by S.I. No. 55 of 2009 with 49 additional sites. These were identified as appropriate for selection as shellfish growing areas because they were aquaculture sites or wild shellfish harvesting sites that have been active in the preceding three years or the waters are in need of protection or improvement. Monitoring of seawater from the original 14 designated areas was carried out by the Marine Institute with samples collected by Bord Iascaigh Mhara (BIM) in summer and winter of 2007 and summer of 2008. One sample from Mulroy Bay (winter 2007) exceeded the imperative values for lead, nickel and zinc set in SI No. 268 of 2006.

Table 5.6. Maximum levels for mercury, cadmium and lead in fin-fish and bivalve molluscs as set by Commission Regulation (EC) No. 629/2008.

	Cadmium mg Kg^{-1} wet weight	Mercury mg Kg^{-1} wet weight	Lead mg Kg^{-1} wet weight
Muscle Meat of Fish	0.05	0. 5	0.3
Muscle meat of selected fish species	0.1	1.0	0.3
Bivalve Molluscs	1.0	0.5	1.5

Organochlorine pesticides and PCBs measured in seawater were all below the detection limits with the exception of a single α-HCH (a byproduct of Lindane) measurement in Bannow Bay in winter 2007.

The Marine Institute (MI) sampled and analysed shellfish tissue samples for nine trace metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc), which included arsenic for the first time in 2007, and organohalogens as required under the Shellfish Waters Directive. As well as harvesting sites required for the Shellfish Waters Directive, shellfish from selected other areas reflecting different pressures were also sampled to contribute to the OSPAR Convention's Coordinated Environmental Monitoring Programme (CEMP). In 2007, 2008 and 2009 the Marine Institute sampled 35, 40 and 15 locations, respectively. Furthermore, in the latter part of 2008, the MI was tasked with implementing monitoring in accordance with the expanded designations for the Shellfish Waters Directive. The Sea Fisheries Protection Authority (SFPA) collected shellfish samples (mussel, oyster, razor, clam and/or cockles), on behalf of the MI, from some 60 locations per sampling round in shellfish growing waters during November and December 2008, June to August 2009, and November/December 2009.

The results showed that levels of cadmium, lead and mercury in shellfish tissue from shellfish growing waters were generally well within EU limits for the period 2007-2009. Elevated levels of cadmium were found in Inner Tralee Bay in October 2007, where one sample of mussels marginally exceeded (1.08 mg kg^{-1}) the EC maximum limit (1.0 mg kg^{-1}) and the guide value set in S.I. No. 268 of 2006 (1.0 mg kg^{-1}) for cadmium. While the margin of exceedance was within the analytical uncertainty of the test method, similar results were found in 2006 in the same area. For the other trace metals, almost all samples complied with the guide values for metals in shellfish. In 2008, two samples of Pacific oysters marginally exceeded the relevant value for total arsenic in Mannin Bay (Co. Galway) and Dungloe, as did another sample of Pacific oyster from Ballymacoda Bay (Co. Cork) in winter 2009. Samples of cockles from Dundalk Bay breached the guide value for nickel in 2008 and 2009. However, cockles have not been part of routine monitoring and are not sampled from other locations. The high nickel concentration may be a species specific issue and does not necessarily reflect elevated levels of nickel at this location. All organohalogen (PCBs and pesticides) concentrations were low and PCB concentrations were below the guide value.

The MI also samples additional areas not designated or licensed for shellfish production/harvesting. In 2007, as in previous years, relatively high concentrations of lead (mean 32.6 mg kg^{-1}) were recorded in mussels from Paddy's Point in Cork Harbour. Concentrations measured in 2008 and 2009 were considerably lower with respective means of 1.6 and 1.1 mg kg^{-1}. The MI reports the biomonitoring data to the International Council for the Exploration of the Sea (ICES) in compliance with the OSPAR CEMP. An assessment of temporal trends carried out by OSPAR in 2008, including data up to 2007, indicated that relatively few significant trends could be discerned for Irish waters (OSPAR, 2009). Few significant upward or downward trends were identified for trace metals although a significant upward trend was detected for cadmium, copper and zinc at the North Bull Island (Co. Dublin) in recent years. Where significant trends were detected for persistent organic pollutants (POPs) they were

invariably downward, with 26 downward trends detected for individual PCB congeners or organochlorine pesticides and five downward trends for individual polyaromatic hydrocarbon (PAH) compounds. Although a global environmental legacy associated with these POPs will remain for years to come, it is expected that downward trends will continue due to measures taken to control or eliminate environmental inputs.

Quality of Shellfish Growing Waters

The Irish molluscan shellfish industry (i.e. mussels, clams, scallops and other molluscan shellfish) is estimated to be worth some €50 million annually. These filter-feeding shellfish can accumulate microorganisms when grown in sewage-contaminated water and if eaten raw, or lightly cooked, can present a public health risk for consumers.

In order to ensure the quality of shellfish for human consumption, controls are placed on the waters used for shellfish cultivation and harvesting. Since January 2006, the controls are driven by EC Hygiene Regulations 'laying down specific rules for food of animal origin' (Nos. 852/853/854 of 2004). The Sea Fisheries Protection Authority (SFPA), established in January 2007, is the competent authority in Ireland for classifying shellfish production areas.

A shellfish sanitation monitoring programme, based on a number of parameters including microbiological criteria and levels of *Escherichia coli* (*E. coli*), for classifying shellfish growing waters has been in operation in Ireland since 1985. The scheme of classification has three categories, in addition to a prohibited one, and the criteria for the classification of shellfish harvesting areas are shown in Table 5.7.

In 2008 a new code of practice on microbiological monitoring was implemented in which three years' data were used, prior to which classifications were determined every six months based on the previous year's data. The 2009 classification of shellfish production areas in Ireland classified 125 production areas: 28 (22.4%) were classified as A, 19 (15.2%) classified as 'seasonal' A and 67 (53.6%) as B classification while a single area in Wexford Harbour was classed as C. The code of practice allows for seasonal classification to be given in areas where the data shows a clear seasonal trend in *E. coli* levels over the three-year period (www.sfpa.ie).

Occurrence of Shellfish Biotoxins

A small number of phytoplankton species that occur in Irish waters naturally produce compounds known as biotoxins that can accumulate in filter feeding organisms such as shellfish. The consumption of contaminated shellfish flesh can cause serious human illness including nausea, vomiting, stomach pain, diarrhoea and in some cases neurological damage.

In Ireland the occurrence of shellfish contamination is variable from year to year, with most of the resultant closures of production areas being attributed to *Dinophysis* species, the causative organism of Diarrhetic Shellfish Poisoning (DSP). However, other toxin-producing species, such as *Pseudo-nitzschia* causing Amnesic Shellfish Poisoning (ASP), *Alexandrium* – Paralytic Shellfish Poisoning (PSP) and *Azadinium* species – Azaspiracid Shellfish Poisoning (AZP) are also problematic. The shellfish production areas around the coast of Ireland are monitored on a weekly or monthly basis for phytoplankton and the presence of marine biotoxins. Where biotoxins are detected the production area is closed and harvesting prohibited until the danger of toxicity has passed.

Such closures are essential to protect human health and the reputation of the Irish shellfish industry. Closures of shellfish-growing areas as a result of biotoxin contamination are common in the summer and autumn when toxin-producing algae are present.

In 2007 toxicity levels were low, with unusually low levels of DSP toxin through the summer, however there was an occurrence of Azaspiracid (AZP) contamination in late summer. Overall the number of site closures due to toxin presence above the regulatory limit was much lower than 2005 and 2006

which were characterized by prolonged closures due to the presence of DSP and AZP toxins. In 2008, there was considerable shellfish toxicity, resulting in widespread closures of shellfish production areas. These closures were mainly caused, as in 2005 and 2006, by the presence of DSP and AZP toxins. While the closure of shellfish production areas can cause an economic impact, there is little evidence to suggest that the occurrence of these species or toxicity events, is related to anthropogenic nutrient enrichment. A number of studies suggest that many of these species originate offshore and are advected inshore by the wind (Raine *et al.*, 1993, Raine and McMahon, 1998).

Quality of Bathing Waters

The legislation governing the quality of bathing waters for the 2009 season is set out in the Quality of Bathing Waters Regulations (S.I. 155 of 1992) and amendments, which transposed the EU Directive (76/160/EEC) concerning the quality of bathing water.

A new Directive on bathing water (Directive 2006/7/EC) came into force on 24 March 2006 and will repeal the existing 1976 Quality of Bathing Waters Directive with effect from 31 December 2014. The 2006 Directive establishes a new classification system for bathing water quality based on four classifications 'poor', 'sufficient', 'good' and 'excellent', and generally requires that a classification of sufficient be achieved by 2015 for all bathing waters.

Table 5.7. Classification scheme for shellfish production areas under EC Regulations (No. 854/ 2004; No. 853/2005; No. 2073/2005)

Classification	*E. coli* per 100g of live bivalve mollusc flesh and intra-valvular fluid[1]	Treatment Required
Class A	<230	None
Class B	<4,600	Purification, relaying in Class A or cooking by an approved method
Class C	<46,000	Relaying for a long period (2 months) to meet Class A or B requirements/or heat treatment by an approved method
Prohibited	>46,000	Harvesting not permitted

[1] Five-tube, three dilution Most Probable Number (MPN) test

Box 5.1 The biological source of Azaspiracid (AZP) toxin

Up until recently there was a great deal of speculation regarding the phytoplanktonic source of AZP toxin, which together with DSP toxin, accounts for the majority of toxin-related closures. Earlier investigations indicated that the source of the toxin was a dinoflagellate from the heterotrophic genus *Protoperidinium* (James *et al.*, 2003). However, a number of doubts remained that this organism was in fact the source. The trophic nature of *Protoperidinium* suggested that there was a possibility that the source of the toxin could have been another organism that *Protoperidinium* was feeding on. Furthermore, there was poor correlation with the presence of this species and toxicity in shellfish. The source of AZP was finally discovered by a group of German scientists during a research cruise in the southern North Sea in early summer 2007. The source turned out to be a small photosynthetic thecate dinoflagellate (*Azadinium spinosum*), which was found at stations which had high AZP toxin concentrations. The same species has now been isolated in Irish waters from survey work carried out in 2009. Experiments on the culturing, toxin content, uptake kinetics and depuration are underway in the Marine Institute and partner laboratories under a project (ASTOX II) funded by the Irish Government and the European Union.

Transitional measures are in place in Ireland until the new Bathing Water Quality Regulations 2008 (SI No. 79 of 2008) are fully implemented and these relate the new classification system to current EU guide and mandatory standards specified in the 1976 Quality of Bathing Waters Directive (76/160/EEC). The 'good' classification is related to compliance with guide and mandatory values, the 'sufficient' classification is related to compliance with the mandatory values only, whereas the 'poor' classification is non-compliance with mandatory values. Bathing areas are not classified as 'excellent' in this interim period as the 1976 Directive does not have bathing water standards that equate to this classification.

A total of 131 designated bathing areas were monitored by local authorities during the 2009 bathing season, of which 122 are seawater and nine are freshwater lakes (See also Chapter Four).

The five microbiological and physico-chemical parameters currently considered for EU compliance purposes are:

- Total coliforms
- Faecal coliforms
- Mineral oils
- Surface active substances
- Phenols.

The new Directive on bathing water (Directive 2006/7/EC) establishes tighter microbiological standards for two new parameters, Intestinal enterococci and *Escherichia coli*. From the 2011 bathing season onwards, these two robust microbiological parameters will be monitored and used to classify bathing waters.

Local authorities are required to ensure that when any bathing water sample fails the EU mandatory values, the public are made aware of this fact by means of information notices posted at the bathing area.

Local authorities are required to take the necessary measures to ensure that the standards are complied with and are required to report the results of sampling to the EPA at the end of each bathing season.

Online Bathing Water System-Splash

In July 2009, the EPA launched a new online map-based website "*Splash*" (bathingwater.ie) that provides the public with bathing water quality information for the 131 designated bathing areas around Ireland. The website provides the latest bathing water sampling results for each bathing area during the bathing season and their compliance status with EU bathing water quality standards. It also provides information about the compliance history of these bathing areas from 2003 onwards.

Overview of compliance

In 2009, the quality of Ireland's bathing waters remained high with 93 per cent of seawater bathing areas complying with the minimum EU mandatory values and achieving sufficient water quality status (EPA, 2009b, see Figure 5.6). However, this represents a downward trend of compliance from 97 per cent in 2007 and 95 per cent in 2008 (Table 5.8). While some of this may be due to high summer rainfall in recent years (average numbers of wet days were between 10-20% above normal in 2008 and 2009 (www.met.ie)), measures need to be taken to minimise these effects on bathing waters. Further measures including the provision of appropriate waste water treatment facilities are required if all bathing areas are to comply with EU standards.

The eight seawater bathing areas that failed to achieve sufficient water quality status are as follows: Balbriggan Front Strand, Skerries South Beach, Sutton Burrow Beach (Dublin, Fingal), Clifden Beach (Co. Galway), Dunmore Strand, Dunmore East (Co. Waterford), Duncannon (Co. Wexford), Killala Ross Beach (Co. Mayo), Youghal Main Beach (Co. Cork).

While the overall level of bathing water quality remains relatively good, a small number of bathing areas are consistently classified as poor. Of particular concern are the bathing areas of Clifden, which failed to achieve sufficient water quality status for the past five years, and Balbriggan Front Strand, which only achieved sufficient water quality status once in the last seven years.

Table 5.8. Seawater Bathing Water Quality Status from 2007 to 2009

Year	2007	2008	2009
Number of bathing areas	122	122	122
Number of bathing areas achieving sufficient water quality	118	116	114
Percentage of bathing waters of sufficient water quality	97%	95%	93%
Number of bathing areas achieving good water quality	99	98	102
Percentage of bathing waters of good water quality	81%	80%	84%

Box 5.2 The Blue Flag Scheme

The Blue Flag Scheme is a voluntary scheme to identify high quality bathing water areas, administered in Ireland by An Taisce and at European level by the Foundation for Environmental Education in Europe (FEEE). To receive a blue flag, a bathing site, in addition to maintaining a high standard of water quality, must meet specified objectives with regard to the provision of safety services and facilities, environmental management of the beach area and environmental education.

The EPA has co-operated with An Taisce to check that all water quality results obtained by both organisations each bathing season are comparable.

The analysis of bathing water in respect of the Bathing Waters Directive is separate from, although complementary to, the European Blue Flag Scheme. The EPA also participates in the National Blue Flag Jury, which assists in the initial assessment of the Irish applicants for the Blue Flag Award. The award is based on the performance and standards achieved during the previous bathing season. In 2007, 2008 and 2009, respectively, 80, 78 and 75 blue flags were awarded to Irish beaches. The decline in 2009 was due to heavy rainfall putting increased pressure on waste water treatment plants which had knock-on effects on the water quality at bathing areas.

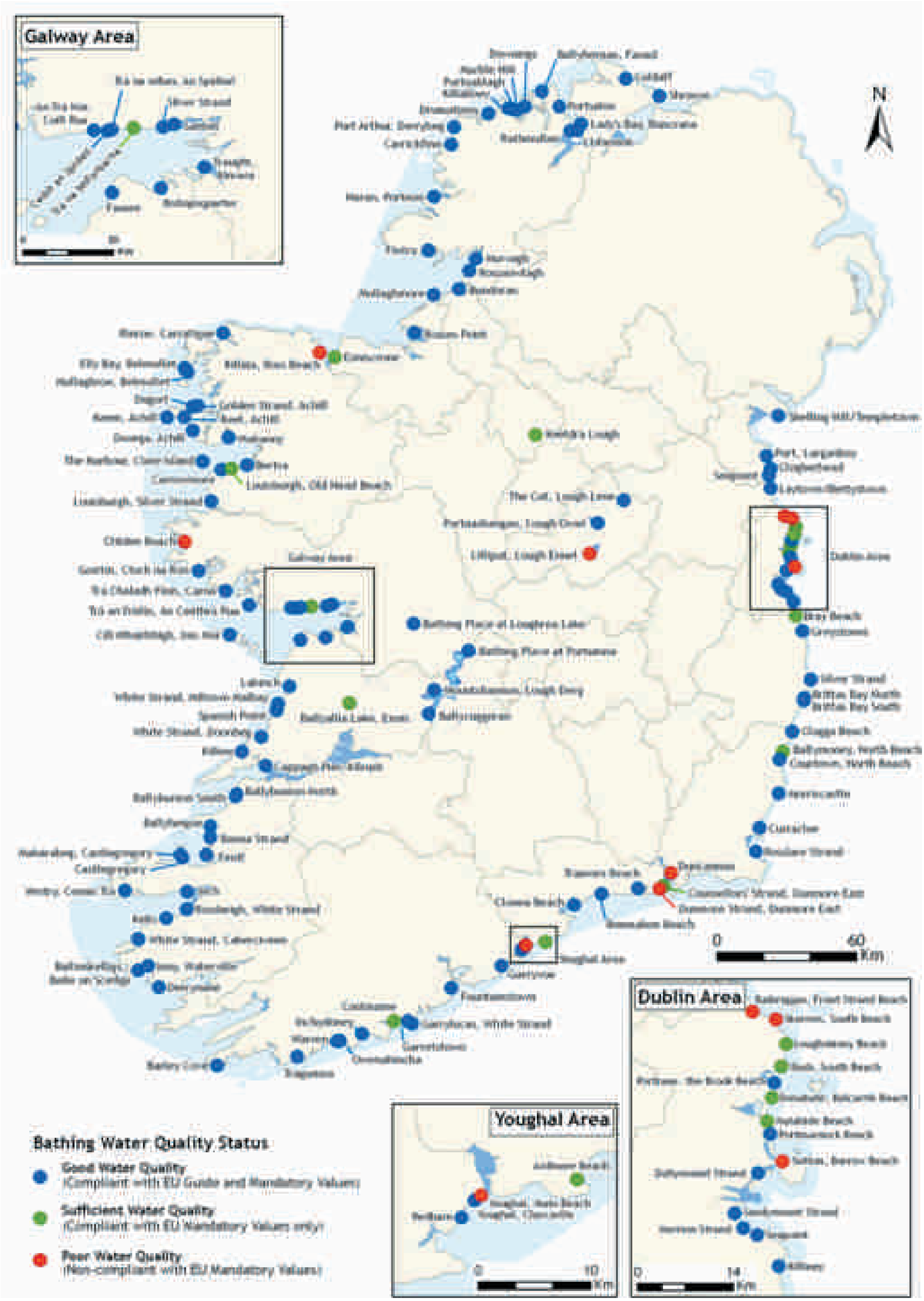

Figure 5.6. Bathing water quality 2009

RADIOACTIVITY MONITORING OF MARINE WATERS

Radioactivity monitoring of the Irish marine environment is carried out by the Radiological Protection Institute of Ireland (RPII). The primary focus of its marine monitoring programme is to assess the radiation doses to the Irish population arising from discharges from the Sellafield reprocessing plant and to assess the geographic and temporal distribution of artificial radionuclides in the marine environment. Samples of a wide range of fish and shellfish species are collected from commercial landings at major Irish fishing ports and aquaculture areas. Seawater and seaweed are analysed from coastal sites while seawater and sediment samples are taken at offshore sites in the western Irish Sea using the Marine Institute's research vessel *Celtic Voyager*. In collaboration with the Northern Ireland Environment Agency (NIEA), seawater samples from the north and north-east coast have also been collected. The most recent report on marine monitoring covers the year 2009 (McGinnity *et al.*, 2010, www.rpii.ie).

While discharges from Sellafield into the Irish Sea have been falling since the 1980s, discharges of the radionuclide technetium-99 increased sharply in the mid-1990s due to changes in waste treatment at the plant. Discharges of this radionuclide peaked in 1995 and reduced substantially after 2004 following the introduction of new waste treatment at the plant. These reductions in discharges have led to reductions in technetium-99 activity concentrations in seafood landed at Irish ports and in the Irish marine environment. By 2008, levels of technetium in the Irish marine environment had effectively fallen back to those observed in the early 1990s.

In 2008, the RPII commissioned a survey into the habits of people living along the north-east coast of Ireland. The aim of this survey was to identify the most important pathways by which people are exposed to ionising radiation as a result of discharges of radioactive materials into the Irish Sea. The survey collected quantitative information on fish consumption, beach occupancy and other potential exposure routes to allow realistic dose assessments to be made (CEFAS, 2008). Prior to this, the RPII reported doses on the basis of two hypothetical or notional seafood consumers referred to as the 'typical' consumer and 'heavy' consumer. Fish and shellfish consumption rates were estimated from habits surveys undertaken in other countries and from national average consumption figures. The typical consumer was intended to represent the dose received by an average seafood consumer while the heavy consumer represents a conservative estimate of the dose to a high-rate consumer.

The 2008 survey identified two critical consumer groups: Group A were a group of commercial fishermen who consume large amounts of fish and crustaceans (mainly prawns and crabs); Group B, were commercial oyster and mussel farmers who consume large amounts of molluscs. In 2009, the estimated annual committed effective doses to members of these two groups were 0.24µSv (micro sievert) and 0.44µSv, respectively.

These doses are small in comparison with the dose received (32 µSv) by the notional typical consumer due to the presence of a naturally-occurring radionuclide, polonium-210, in seafood. They may also be compared with the average annual dose to a person in Ireland from all sources of radioactivity of 3950 µSv. Furthermore, the annual committed effective dose to the notional typical seafood consumer has decreased steadily (Figure 5.7.), reflecting the overall reduction in Sellafield discharges since the 1980s.

The levels of radioactive contamination present in the marine environment do not warrant any modification of the habits of people in Ireland, either in respect of consumption of seafood or any other use of the amenities of the marine environment. The results of the RPII monitoring programme show that, while the levels of artificial radioactivity in the Irish environment remain detectable, they are low and do not pose a significant risk to human health.

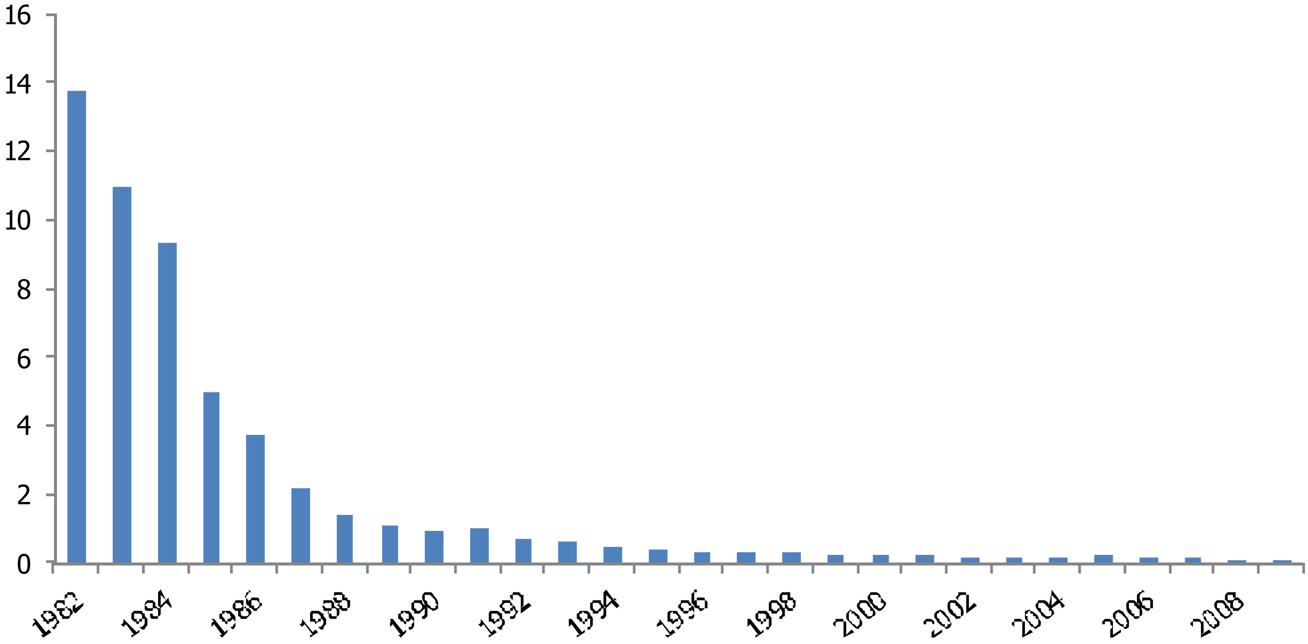

Figure 5.7. Committed effective radiation dose (µSv) to the typical seafood consumer.

OIL POLLUTION INCIDENTS

Responsibility for the investigation of oil pollution incidents in Ireland rests with the Irish Coast Guard (IRCG). The IRCG provides a response to marine pollution incidents or threat of pollution from ships and offshore platforms within the Irish Exclusive Economic Zone (EEZ) which covers an area (approx. 200,000 km^2) stretching to 200 miles off the west coast and to the median line between Ireland and the UK. The EEZ is an ecologically sensitive area with a wide variety of fauna and flora and supports an active leisure industry, with a large number of blue flag beaches, as well as commerce, including fisheries, marine transport and natural resources.

The major maritime incidents causing, or with a potential to cause, oil pollution that occurred in 2007-2009 are summarised in Table 5.9. The largest marine pollution incident during this time occurred in 2009, south of Fastnet Rock, when an estimated 300 tonnes of fuel oil and water mixture was lost during a refuelling at sea incident. The European Maritime Safety Agency (EMSA), as a result of a satellite image, first reported the oil slick south of Fastnet on the 14th February 2009. This was then confirmed by an aerial surveillance carried out by an Air Corps Casa maritime patrol aircraft, an oil pollution surveillance aircraft from the UK, an Irish Coast Guard helicopter and a Royal Navy vessel in the area. The oil slick was eventually traced back to the Russian Aircraft Carrier the Admiral Kuznetsov. The IRCG issued a large-scale response with assistance from local authorities, the Marine Institute, Air Corps, and private contractors, EMSA and the UK Maritime and Coastguard Agency (MCA). There was concern that the oil would have come ashore, but due to the prevailing weather conditions at the time, the slick trajectory was offshore and eventually dispersed.

The IRCG received 54 pollution reports during 2007, 45 in 2008 and 53 in 2009, all of which were investigated. In 68 per cent of incidents reported in 2007 and 38 per cent in 2008 and 2009, oil spillage was identified as the cause. Diesel and gas oil spills were the most frequently identified and made up roughly 58, 22 and 28 per cent of the overall total in 2007, 2008 and 2009 respectively.

Plate 5.1. Oil slick south off the Fastnet Rock in February 2009

The overall geographical pattern for oil discharges indicated that the majority of discharges occurred in the smaller harbours and surrounding areas. In 2007 and 2008 some 29 per cent of incidents were reported in the open sea while in 2009 this number was 13 per cent. The estimated number of incidents occurring in the open sea is by its nature a conservative one as the IRCG has no dedicated aerial surveillance capacity and relies on reports from shipping and commercial air traffic for such incidents. There was a rise in the reported incidents concerning offshore oil or gas installations (0 in 2007, 3 in 2008 and 4 in 2009). Although these were of a very minor nature it reflects on the readiness of the offshore oil and gas industry to cooperate with the Irish Authorities in combating potential pollution events.

The majority of the reported spills during the three years were of diesel and light oils with the estimated volume of discharge less than 1,000 litres (1 tonne). However one spill in 2009 was greater than 50,000 litres (50 tonnes) while two in 2008 were in the 1,000-50,000 litres (1-50 tonnes) volume category. There were seven reported pollution incidents in 2009 where the estimated volume of discharges was unknown. Also in 2009 there was one incident involving crude oil. The number of reported oil pollution events that beached on the shoreline was respectively two, five and six in 2007, 2008 and 2009, with the extent in all cases less than 1.6 km. During 2008, six incidents were reported involving oiled birds while there were no reported incidents of oiled wildlife in 2007 or 2009. It should be pointed out, however, that while these figures indicate little or no oiling of marine wildlife in Irish waters, they are based on rather limited information contained in reports sent to the Coastguard (H. Barry, pers comm.).

The total number of incidents reported by category of pollution in the Irish EEZ from 2007 to 2009 was:

	Mineral Oil	Garbage	Sewage	Chemicals	Other	Total
2007	43	-	2	2	7	54
2008	29	-	-	-	16	45
2009	24	-	-	-	29	53

The distribution of received reports of pollution in 2007, 2008 and 2009 by marine environmental zone within the EEZ was:

	Open Sea	Tidal River/ Estuary	Bay/Nearshore Water	Beach/Shore	Port Harbour	Total
2007	16	7	13	3	15	54
2008	13	5	6	8	13	45
2009	7	4	14	10	18	53

The breakdown of pollution sources in the three years was as follows:

	Unknown	Shore	Fishing Vessel	Oil Tanker	Cargo Vessel	Offshore Oil/Gas Installation	Pleasure Craft	Wreck	Dredger
2007	30	5	12	-	2	-	5	-	-
2008	16	5	13	1	3	3	2	1	1
2009	17	6	15	-	4	4	7	-	-

Table 5.9. Summary reports of larger maritime incidents involving the Irish Coast Guard (IRCG) during 2007-2009 in reverse chronological order (Source: H. Barry, IRCG). (NM = nautical mile)

Location	Date	Vessel	Incident	Outcome
Howth	1/08/2009	Two trawlers	Two trawlers sunk at their moorings with a resultant diesel spill.	Tier 2 response over 3 days including Bank holiday weekend. Harbour cleaned with assistance of IRCG staff and equipment and the IRCG local contractor.
50 NM S Fasnet	14/02/2009	Russian Aircraft Carrier Admiral Kuznetsov	300 tonne fuel oil lost during RAS operations	Large scale response with assistance from local authorities, Marine Institute, Air Corps, private contractors, EMSA and UK MCA. Slick trajectory was offshore and eventually dispersed.
30 m outside Killybegs Harbour Limit	4/11/2008	FV Shaun Shaun	Sunk with 1,000 l diesel, 200 l hydraulic oil and 50 l luboil on board.	Diesel observed breaking up on cliffs and at sea as weather deteriorated.
180 NM west of Loop Head	21/08/2008	FV Veni	Sunk with 123 tonnes of diesel on board.	Surveillance carried by the IRCG helicopter R115 and by Air Corps Casa 253. It reported 30 m x 30 m slick the following day breaking up in rough seas. Slick left to break up with weather action.
31 NM from Loop Head	10/07/2008	FV Koaxi	Sunk with 50,000 l diesel and 1,500 l luboil on board.	Surveillance by the IRCG helicopter R115. Slick observed to be breaking up with the weather.
53 NM W Loop Head	10/02/2008	Unknown	EMSA reported a slick which was identified by R115 9 NM x 6 NM.	AIS backtrack identified two vessels transiting that area earlier. UK and Netherlands authorities requested to inspect both vessels at next port. Netherlands inspected fishing vessel and had nothing untoward to report.
13 NM SE Ballycotton	12/09/2007	FV Jess A Dan	Sunk	5 gallons of luboil and 1500 l of diesel on board.
Mine Head	11/01/2007	FV Honeydew II	Sunk	Estimated 5,000 l diesel on board
South Coast	10/01/2007	FV Pere Charles	Sunk	Estimated 12,000 to 15,000 l diesel on board

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CHAPTER SIX

KEY FINDINGS AND RECOMMENDED ACTIONS

It is apparent from the foregoing chapters on water quality in groundwaters and surface waters that substantial measures will be needed in order for Ireland to comply with the objectives of the Water Framework Directive (WFD). The WFD stipulates that, as well as operational and surveillance monitoring, investigative monitoring should be implemented to establish causes of failure of water bodies to reach or maintain good status. This chapter highlights some of the main issues covered in the report and discusses some of the main remedies available under the WFD programme of measures. The principal findings and recommendations are set out below. The status of water bodies in each of the main categories is summarised (Tables 6.1, 6.2, 6.4 and 6.5) with target dates for achieving the objectives of the WFD shown also for rivers and lakes (Tables 6.3 and 6.4).

For water quality management three key issues are discussed below:

- Serious pollution and point sources
- Tackling diffuse pollution
- Using legislative support

GROUNDWATER: PRINCIPAL FINDINGS AND RECOMMENDATIONS

Organic Pollution

- Indicators of microbiological contamination give some cause for concern.
- Increased ammonium concentrations were noted possibly due to increased rainfall in the period.

Recommendations

- Vulnerable sources require special protection. Design and location of abstraction wells is essential to protect against organic inputs.

Elevated Nutrients

- Elevated N and P noted in some groundwaters are anthropogenic.
- Decreases in groundwater nitrate and phosphate generally were seen over 2007-2009.
- Aquifers at Durrow in Co. Laois and Ballyheigue in Co. Kerry, show a statistically significant upward trend for nitrate.
- Phosphate in groundwater is the main reason for downgrading groundwater status.

Recommendations

- Programmes of measures to reduce nitrogen and phosphorus concentrations in groundwater are required. An understanding of pathways and surface/groundwater interactions is essential.

Protection from Diffuse Impacts

- Poor status groundwater is related to diffuse impacts on surface water bodies.
- Improved protection of groundwater is required.
- Basic and supplemental measures can achieve good status by 2021 or 2027 for most.
- An improved understanding of the interactions between groundwater and surface water receptors is required.

Recommendations

- Measures to control diffuse pollution are required - in most cases for nutrients and organic pollutants but protection against mine contamination and chemical contaminants are important in some groundwater bodies.

Table 6.1. Summary of interim status classification results for groundwater bodies

Status	Chemical		Quantitative		Overall	
	Number (% of total)	% area	Number (% of total)	% area	Number (% of total)	% area
Good	645 (85.2)	85.9	753 (99.5)	99.7	641 (84.7)	85.6
Poor	112 (14.8)	14.1	4 (0.5)	0.3	116 (15.3)	14.4
Total	757 (100)	100	757 (100)	100	757 (100)	100

RIVERS AND CANALS: PRINCIPAL FINDINGS AND RECOMMENDATIONS

Overall Trends

- River Water quality monitoring shows 70% of channel unpolluted and 30% impaired to a greater or lesser extent in 2007-2009.
- In the 2007-2009 period 48% of river water bodies monitored nationally were at less than good ecological status.
- Most River Basin Districts target 100% good status by 2021 and ranging from 30% to 84% of rivers water bodies achieving target good or high status by 2015.
- Serious pollution was recorded at 20 river sites – 0.4% of channel length and down from 39 sites in 2004-2006. Fish kills were much reduced.

Recommendations

- The sources of pollution or degradation in status are well understood in most cases and measures are available to improve quality. Programmes of measures to tackle individual pollution sources must be seen to work with regular reports on progress by RBDs required.
- Maintaining existing high and good status waters has to be an important goal of WFD programmes of measures.

Causes of Pollution

- Approximately half of the polluted sites monitored are due to diffuse pollution sources.
- Point source discharges also account for a significant proportion of observed pollution.

Recommendations

- In cases of diffuse pollution where sources are not immediately obvious, investigative monitoring is required especially in regard to eliminating bad practices.
- Ongoing investment in treatment plants and their operation and maintenance is required.

Priority Substances

- Dangerous substances were monitored at surveillance sites - low levels were found generally. A decline in simazine and atrazine was noted.
- A potential issue with cypermethrin and possibly diazinon has been flagged for attention.

Recommendations

- The 2007 ban on simazine and atrazine appears to be successful but ongoing monitoring is required to confirm this.
- Urgent investigations are needed to confirm the causes of the problems noted. Cypermethrin is a candidate priority substance and additional controls may be required.

Canals

- Canals generally remained in good condition apart from cases where polluted feeder streams led to pollution.

Recommendations

- Control of pollution in the feeder sources is a priority for maintaining the quality of the canals.

Table 6.2. Monitored River Water Bodies – Numbers within River Basin Districts in each of the five WFD ecological status classes.

RBD	High	Good	Moderate	Poor	Bad	Totals
Eastern	16	26	54	41	1	138
Neagh Bann	0	10	7	16	0	33
North West	23	72	45	55	4	199
South East	17	99	95	65	1	277
Shannon	27	142	121	83	8	381
South West	64	128	63	11	1	267
Western	57	135	50	24	3	269
National	204	612	435	295	18	1564
Percentage	13%	39%	28%	19%	1%	100%

Table 6.3. Percentage of river water bodies within individual river basin districts planned to achieve at least good status by 2015, 2021 or 2027.

RBD	2009	2015	2021	2027
Eastern	40	~40	80	100
Neagh Bann	22	27	99	99
North West	54	71	99	99.9
South East	47	60	100	100
Shannon	42	61	99	99
South West	67	84	99.7	100
Western	66	74	99.9	100

LAKES: PRINCIPAL FINDINGS AND RECOMMENDATIONS

General Survey Results – water quality and ecological status

- Water Quality of Lakes – 81% had satisfactory water quality accounting for 92% of total monitored lake area.
- There were 9% of lakes in the moderately-Eutrophic class and 10% in the strongly eutrophic or hypertrophic class.
- Ecological status of lakes – 105 (47%) lakes were of high or good ecological status, 92 (41%) were of moderate status, 19 (9%) poor and 6 (3%) were in bad ecological status.
- The 20 high and 85 good ecological status lakes were noted.
- Surveys showed that 117 lakes were of moderate or poorer ecological status.
- Three hypertrophic lakes were identified: Gur (Limerick), Naglack and Inner (Monaghan).

Recommendations

- Reduction in nutrient loading to lakes is the key to reversing the current trend of increasing eutrophication.
- Catchment programmes aimed at lake specific nutrient reductions are required. Target nutrient loadings should be judged taking individual lake bathymetry and turnover time into account and relating to nutrient loadings at the lake's reference conditions.

Lake Eutrophication

- Eutrophication remains the principal problem and diffuse nutrient sources are mainly responsible.
- Source apportionment is required to identify the key sources of nutrients entering lakes.

Recommendations

- Monitoring of inflowing rivers and groundwater sources and understanding of nutrient pathways is required to assist in pinpointing measures.

Acid Sensitive Lake Survey

- The EPA's Acid Sensitive Lakes survey show lakes to be relatively free of acidification problems.

Recommendations

- Improvements have been noted but measures such as benign forestry plantation management continue to be critically important in such acid sensitive areas.

Table 6.4. Ecological status of monitored lakes by number and surface area (km^2) with target dates for achieving the objectives of the WFD also shown.

Ecological Status	No. of Lakes	% of Lakes	Surface Area (km^2)	%
High	20	9	22.6	2
Good	85	38	311.4	32
Moderate	92	41	513.1	52
Poor	19	9	126.8	13
Bad	6	3	14.6	1
Totals	222		988.5	

(Ecological Status of Surveyed Lakes)

No. of Lakes	Date for Achieving Status Target
19 High Status	2009 - Protect
59 Good Status	2009 - Protect
56 Moderate or worse	2015
48 Moderate or worse	2021

ESTUARINE AND COASTAL WATERS: PRINCIPAL FINDINGS AND RECOMMENDATIONS

General Survey Results

- The estuarine and coastal water survey covered 89 water bodies of some 2000 km^2.
- Of the above 9 (10%) were classed as eutrophic, 5 (6%) as potentially eutrophic, 31 (35%) as intermediate and 44 (50%) were unpolluted.
- The surface area classified as eutrophic amounted to 5% of the total survey area.

Recommendations

- Resources are required to continue the extensive national WFD monitoring programme now being undertaken.
- Nutrient loading from the land and direct marine discharges are the main sources of problems. Integrated catchment management tackling river pollution and shoreline groundwater discharges as well as marine outfalls is required.

Trends in Quality and Ecological Status

- An improvement with five fewer water bodies classed as eutrophic (compared to 2004-2006) – Blackwater estuary (upper and lower), Lee (Tralee) estuary, Owenacurra estuary and Wexford Harbour.
- Five water bodies improved from intermediate to unpolluted status: Kinsale Harbour, the Garavogue estuary, Sligo Harbour, McSwyne's Bay and the Lower Liffey estuary.
- A decline in status occurred in: Inner Dundalk Bay, Upper Barrow estuary, Malahide Bay, Colligan estuary, Moy estuary and Ballysadare Bay and estuary. The deterioration in status in Malahide Bay and the Colligan estuary was due to the presence of green opportunistic macroalgae.
- Of 121 transitional and coastal areas assessed for WFD status classification, 55 were classed as high (16%) or good (30%) ecological status and the remainder classed as moderate or worse. Just over 64 per cent of the total monitored surface area was found to be at high or good ecological status.

Recommendations

- Improvements due to effective programmes of measures taking effect in marine waters must be maintained up to 2015 and beyond.
- A continued high standard of operation is required for the new wastewater treatment plants, which have produced improvements in estuarine waters.
- River basin management plans should introduce measures to reduce the occurrence of opportunistic macroalgal blooms. This will first of all require identification of the source of nutrients fuelling these blooms.
- Maintaining existing high and good ecological status must be seen as an important goal of WFD programmes of measures.

Nitrates and Phosphates

- The highest dissolved inorganic nitrogen (DIN) found in the Glashaboy, Upper and Lower Slaney, Owenacurra and Upper Barrow estuaries.
- Cork Harbour, Outer Cork Harbour and Malahide Bay failed to comply with the WFD EQS values for DIN.
- Phosphates: 85% of estuaries and coastal waters had median winter and summer values less than 0.040 mg/l P and half less than 0.020 mg/l P.
- Four water bodies, Lough Mahon (Harper's Island), Lee estuary (Tralee), Castletown estuary and Tolka estuary, breached the winter phosphate EQS.

Recommendations

- The programmes of measures set out in river basin management plans must recognise that controls on both nitrogen and phosphorus from rivers and other sources are needed for the effective long-term management of eutrophication in estuarine and coastal waters. To meet future WFD and OSPAR eutrophication-related objectives, a quantitative estimate of 'distance to target' is needed. This estimate will provide a basis for assessing the effectiveness of nutrient reduction measures.

Toxic Contaminants in the Marine Environment

- The levels of contaminants in fin-fish and shellfish were generally below the strictest standard of guidance values. A few elevated concentrations in shellfish were found.
- All organohalogen (PCBs and pesticides) concentrations were low.

Recommendations

- Continued vigilance is required and ongoing monitoring of shellfish and finfish is essential.

Bathing Waters

- A downward trend of compliance was noted - 93 per cent of the 122 designated seawater bathing areas were compliant in 2009.
- Eight seawater bathing areas failed to achieve sufficient water quality status: Balbriggan Front Strand, Skerries South Beach, Sutton Burrow Beach (Dublin, Fingal), Clifden Beach (Co. Galway), Dunmore Strand, Dunmore East (Co. Waterford), Duncannon (Co. Wexford), Killala Ross Beach (Co. Mayo) and Youghal Main Beach (Co. Cork).
- A small number of bathing areas are consistently classified as poor, notably – Clifden and Balbriggan Front Strand.

Recommendations

- Some of the decline may be due to high summer rainfall in recent years and specific measures need to be taken to minimise these effects on bathing waters.
- Further measures including the provision of appropriate waste water treatment facilities are required if all bathing areas are to comply with EU standards.

Table 6.5. Ecological status of monitored transitional and coastal water bodies by number and surface area (km^2)

RBD	High	Good	Moderate	Poor	Total
Eastern	3 (207)	1 (3)	8 (66)	1 (0.2)	13 (276)
Neagh Bann	-	1 (64)	4 (83)	-	5 (146)
North West	3 (778)	4 (125)	7 (295)	-	14 (1198)
South East	1 (5)	4 (162)	14 (124)	-	19 (291)
Shannon	1 (216)	4 (58)	10 (536)	-	15 (809)
South West	2 (201)	9 (88)	14 (360)	2 (5)	27 (654)
Western	9 (472)	13 (230)	5 (37)	1 (0.1)	28 (738)
Total	19 (1879)	36 (729)	62 (1500)	4 (5)	121 (4114)

Key Issues for Irish Water Quality – Serious Pollution and Point Sources

An important immediate task facing water quality managers in the river basin districts and local authorities is to eliminate the serious pollution where it exists. In the case of groundwaters, 112 aquifers or 14 per cent by area was found to be of poor status. Less than half of one per cent of the surveyed river channel was seriously polluted – 20 sites are listed. Three lakes were classified as hypertrophic and a further 9 per cent of the 222 lakes surveyed were strongly eutrophic. In the case of estuaries and coastal waters 5.3 per cent of the area surveyed was classified as eutrophic. Together these represent the more significant water quality problems affecting Irish water bodies.

In some cases these are also linked across water categories – rivers affecting lakes or estuaries, for example, or groundwaters feeding into surface waters.

A number of the more notable problem areas will require infrastructural investment in new wastewater treatment plants, for example, if recovery in water quality is to be seen. Such measures have been shown to dramatically improve water quality in the past. Figure 6.1 shows the improvements in treatment levels achieved over the past 20 years. The success of eliminating serious pollution at many river locations has come about with the added involvement of the EPA's Office of Environmental Enforcement and cooperation of the local authorities in investigative monitoring and implementing programmes of measures.

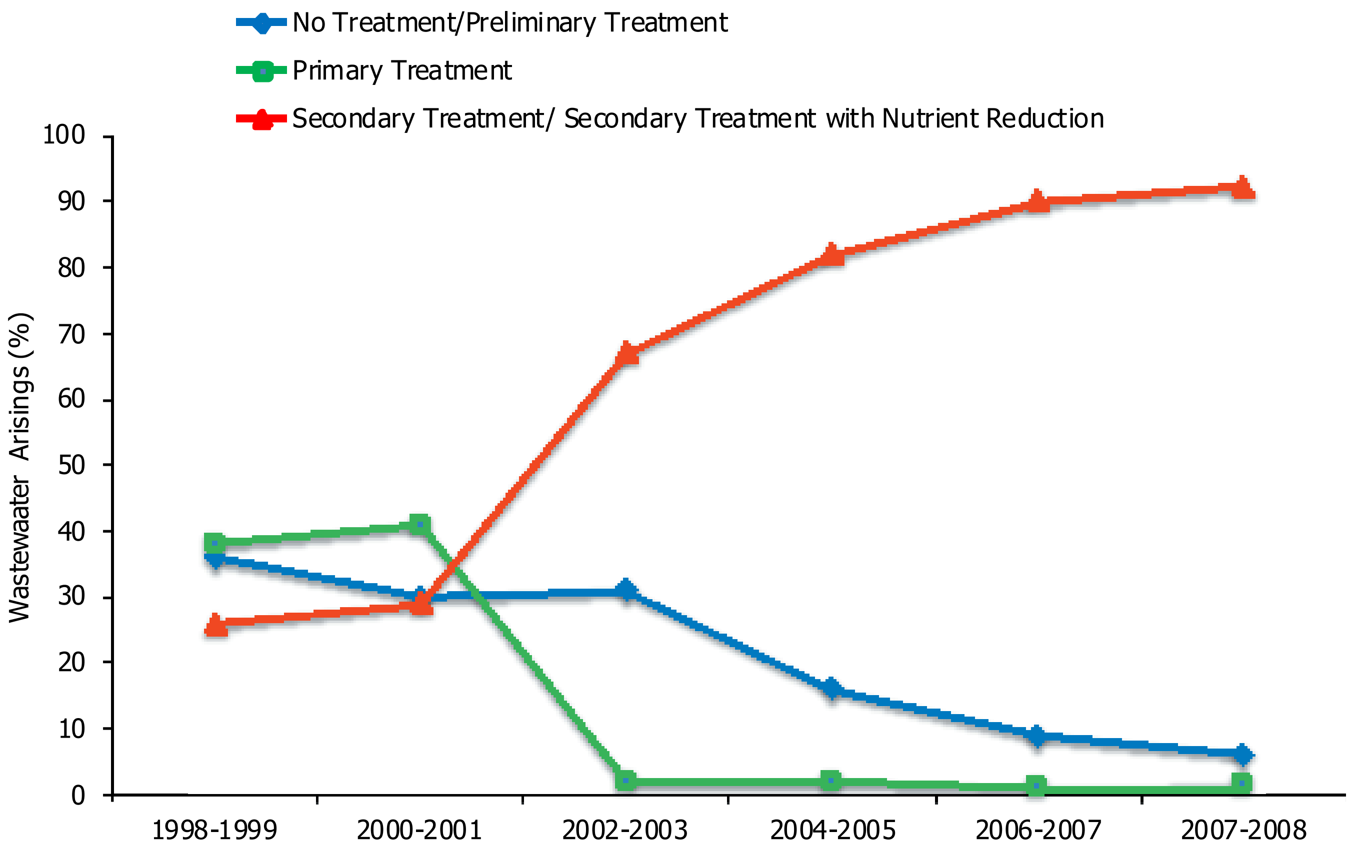

Figure 6.1. Trends in the degree of treatment applied to urban wastewater discharges in Ireland. (From EPA's Environment in Focus: www.epa.ie/environmentinfocus/water/)

Box 6.1 Reducing Diffuse Phosphorus Losses

A large STRIDE-funded programme 'Eutrophication from Agricultural Sources' has demonstrated that, in general, the higher soil phosphorus level – the greater the runoff loss to water in heavy rainfall or when flooding of soils occurs. The outcome of this research programme together with detailed agronomic calculations has given rise to reductions in soil phosphorus burdens – in particular where soils were over-fertilised to the extent that crops no longer showed a response to additional phosphorus additions. Fertiliser recommendations for phosphate are now significantly lower than they were a decade ago – but much still remains to be done.

The outputs of the research programme can assist catchment managers in assessing risks and in pinpointing 'hotspots' within catchments where excessive phosphorus losses are most likely to occur. It is important to alert catchment managers that the outputs from this important research programme are available to assist them in day to day management decisions. The reports on Eutrophication from Agricultural Sources research programme are available on the EPA website (http://www.epa.ie/ downloads/pubs/research/water/). It should also assist in the design of larger national programmes aimed at reducing diffuse phosphorus loss – e.g. in agri-environmental programmes, forestry mitigation measures and revisions of GAP measures.

Key Issues – Diffuse Pollution and Investigative Monitoring

Tackling diffuse pollution where the precise source is not clearly identifiable is a difficult, but high priority task. The main-stem river monitoring programmes reported upon here have shown that some 30 per cent of Irish river channel is still polluted to a greater or less extent. Approximately half of the monitoring points found to be polluted were due to known point sources; but the remaining sites were impacted by diffuse sources that are less easily identified, be they agricultural, forestry, peat harvesting or other causes.

Some examples of serious pollution or bad ecological status are due to one-off events such as the landslides in August 2008 that wiped out the fauna and flora of a number of rivers. Precautions to prevent future occurrences must be put in place.

Investigative monitoring is, therefore, an essential support for the WFD programmes of measures, which are required to bring about improvements in ecological status by the year 2015, 2021 or 2027. Local authorities within RBDs will have to tackle river sub-catchments that appear to be suffering from diffuse pollution (i.e. no obvious point sources in the catchment) on a site by site basis. Priority must be given to those catchments located immediately upstream of main-stem WFD operational monitoring sites in order to find the source or sources of the diffuse pollution problems.

Catchment management teams in the local authorities and river basin districts now have a range of new GIS tools, aerial photography, land cover and soil maps together with digital terrain maps for delineating upstream catchments and their characteristics in some detail. These new tools can help in pinning down the most likely cause of pollution. Such resources are combined with detailed databases listing all the known point source discharges such as wastewater treatment plants and IPPC industrial discharges and smaller industry licensed by local authorities. The large investment in providing extensive data infrastructure for the river basin districts has given a significant boost to catchment managers' ability to find the source of pollution whether diffuse or point source. On the ground, investigative monitoring techniques such as the Small Stream Risk Score (SSRS) method, are also now in use by many local authorities. This can help to focus in on the precise sources of pollution and in improving the effectiveness and accuracy of the various programmes of measures for dealing with individual problems in catchments.

Other issues such as high nitrates causing eutrophication in estuarine waters may prove more intractable. It is to be hoped that the GAP Regulations and associated catchment research programme can point the way to improved methods for reducing nutrient losses. Integration across water categories – groundwater – rivers, lakes, estuaries is important in understanding pollutant pathways.

In general it is hoped that the kind of integrated catchment analysis briefly described above and in Box 6.1 can lead to some further improvements in water quality over the next three years especially. It is hoped to report significant improvements in the 2015 River Basin Management Plans.

Key Issues – Legislative Support

The licensing of municipal wastewater plants by the EPA should help significantly in improving the quality of surface waters. Such licences now take cognisance of the new WFD standards issues by the Department of Environment, Heritage and Local Government (S.I. No. 272 of 2009). These regulations include environmental quality standards for both high and good ecological status in order to help protect high status as well as restore less than good status to either good or high status as appropriate. The nutrient and oxygen conditions standards set as environmental quality standards in these regulations are ecologically realistic as licensing targets and thus, will help to ensure, first, that existing high status can be maintained where it exists – by demanding suitably strict licence conditions. Second, in cases where less than good status exists due to existing underperforming discharges the target of achieving good status through the licensing process will bring about improvements. Such improvements may require additional investment but typically once the necessary works are completed the improvement in downstream river quality, relative to the situation upstream of the discharge point, will be seen quite quickly.

A wide range of other legislative instruments and supports are available to catchment managers (see Table 6.6). In many cases, however, it is the enthusiasm and vigilance of local authority staff working in the River Basin District that will ultimately bring about the necessary improvements in water quality. Bad practice pinpointed by investigative monitoring as causing pollution in a river or lake can often be quickly stopped by means of a discussion with the offending party (often ignorance of the impact is an issue and once the problem is explained it can be easily and cheaply corrected without further recourse). A more serious warning note may be necessary in some cases or a formal Section 12 Notice issued under the Water Pollution Acts.

Inspections carried out under the Good Agricultural Practice (GAP) Regulations and cross-compliance legislation are also valuable instruments in ensuring that codes of good practice are adhered to. Farms caught in cross-compliance breaches risk losing part or all of their single farm payment. The GAP Regulations should ultimately reduce diffuse pollution losses by means of nutrient management planning and ensuring that bad practice is less likely to occur. At the level of individual WFD water management units, manageable lists of sites, where monitoring has discovered problems, must be drawn up and prioritised for attention as indicated above for diffuse pollution.

Ultimately governance is the key issue. It is important to ensure that legislation is implemented and breaches of regulations enforced where necessary. The RBDs are tasked with achieving the WFD targets of good or high status within the designated timescales: 2015, 2021 or 2027. The EPA will endeavour to assist and encourage the local authorities in their responsibilities as lead authorities or as shared RBD authorities.

The River Basin Management Plans produced by the RBDs in 2010 can be viewed at: www.wfdireland.ie/documents.html

Table 6.6. Main Irish legislation relevant to achieving goals of Water Framework Directive

Primary Legislation or Directive	National Legislation	Regulation or other requirement
Water Framework Directive (2000/60/EC)	Water Policy Regulations	S.I. 722 of 2003 as amended
	Surface Waters Environmental Objectives Regulations	S.I. 272 of 2009
	Groundwater Environmental Objectives Regulations	S.I. 9 of 2010
Water Pollution Acts	Licences issued by local authorities	Section 4 and Section 16
EPA Acts	IPPC Licences issued by EPA	
	The Waste Water Discharge (Authorisation) Regulations	S.I. 684 of 2007
	Waste Management Regulations 2008	Certificates of Authorisation
The Water Services Act (No. 30 of 2007)	strategic planning in relation to water services provision	Water Services Strategic Plans
Bathing Waters Directive (2006/7/EC)	The Bathing Water Quality Regulations	S.I. 79 of 2008
WFD and Habitats Directive	The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations	S.I. 296 of 2009
The Shellfish Waters Directive – 2006/113/EC	The Quality of Shellfish Waters Regulations 2006	S.I. 268 of 2006, S.I. 55 of 2009 and S.I. 464 of 2009 – 64 shellfish waters now designated
EU Nitrates Directive	The Good Agricultural Practice for Protection of Waters Regulations	S.I. 101 of 2009
Urban Wastewater Directive	Amendments to Urban Waste Water Treatment Regulations 2001	S.I. 48 of 2010 – 43 sites designated
Planning and Development (Amendment) Act 2010	Regulation of Quarries	
	Integration of water management with planning policies	
	Section 28 guidance to planning authorities	
	Removal of exemption status for infill of wetlands carried out under the Land Reclamation Act	
Waste Management Acts	The waste management (certification of historic unlicensed waste disposal and recovery activity) Regulations 2008	S.I. 524 of 2008, Certificates of Authorisation.

Table 6.6. (contd.) Main Irish legislation relevant to achieving goals of Water Framework Directive.

Primary Legislation or Directive	National Legislation	Regulation or other requirement
Extractive Industries Waste Directive (2006/21/EC).	Inventory and risk assessment survey completed 2010.	
Directive 2009/128/EC (establishing a framework for Community action to achieve the sustainable use of pesticides)	National Action Plan for the sustainable use of pesticides to be completed by Dec 2012	
Water Framework Directive	Priority Substances Review Jan 2011	A number of substances are under investigation (including cypermethrin)
Fisheries (Amendment) Act, 1997.	Licensing of finfish aquaculture	Control of substances used and monitoring requirements.
Directive 2006/11/EC	The European Communities (Control of Dangerous Substances in Aquaculture) Regulations 2008)	S.I. 466 of 2008
	The European Communities (Control Of Dangerous Substances From Offshore Installations) Regulations 2009	S.I. 358 of 2009
Local Government (Planning and Development) (Amendment) Regulations, 2001	Planning threshold for peat extraction reduced from 50 to 10 hectares and threshold for mandatory EIA from 50 to 30 hectares.	

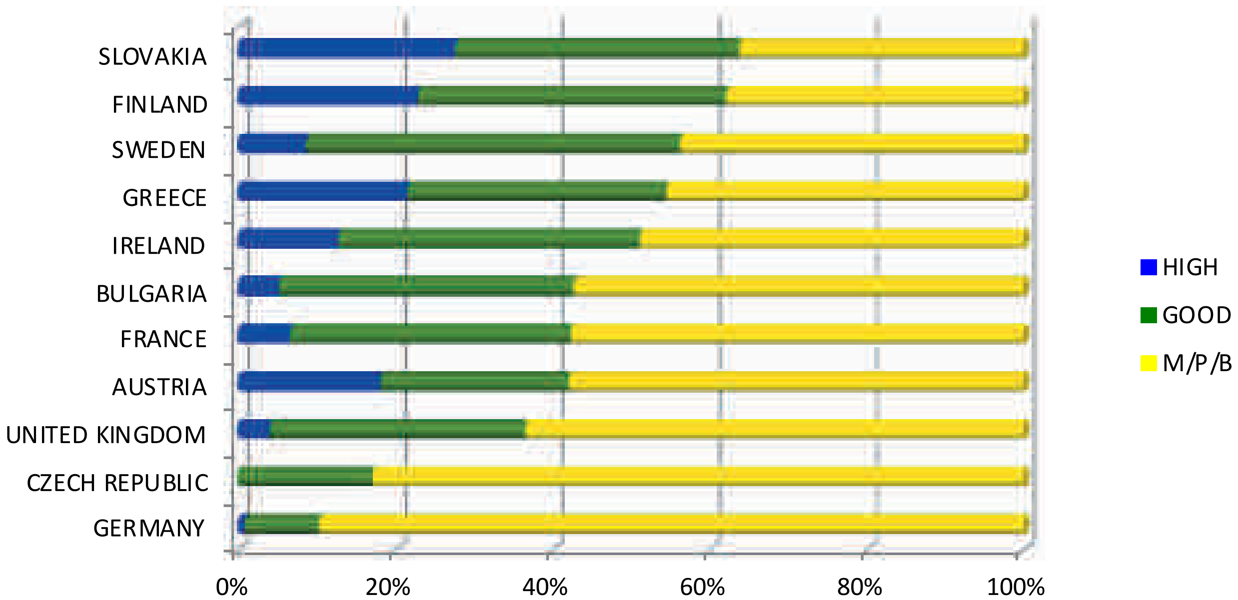

Figure 6.2. A comparison of Irish surface water bodies classified for Ecological Status with 10 other EU countries in terms of percentage of water bodies classified as High, Good and 'Less Than Good' (M/P/B) ecological status – the countries are ranked in terms of the proportion of less than good status water bodies classified (The graphic is based on the European Environment Agency's WISE map of WFD Surface Water Ecological Status and EPA data).

In conclusion it is relevant to compare Irish progress to date under the Water Framework Directive to other countries. Figure 6.2 compares the ecological status of Irish surface waters with 10 other EU countries. Ireland ranks about mid way in this initial comparison with just over 50% of surface waters reaching the WFD goals of at least good ecological status. Other more detailed international benchmarks for water chemistry such as nitrate and phosphate are also available from the EEA and these help to put Irish progress on the implementation of the WFD into a European context. As more countries finalise their surface water status maps, and the intercalibration of ecological methods is completed across Europe, these comparisons will be extended and should become more meaningful, especially for assessing progress towards achieving the aims of the Water Framework Directive.