Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Water Quality in Ireland 2010 - 2012

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

Regulation: *We implement effective regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*

Knowledge: *We provide high quality, targeted and timely environmental data, information and assessment to inform decision making at all levels.*

Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

Our Responsibilities

Licensing

We regulate the following activities so that they do not endanger human health or harm the environment:

- waste facilities *(e.g. landfills, incinerators, waste transfer stations)*;
- large scale industrial activities *(e.g. pharmaceutical, cement manufacturing, power plants)*;
- intensive agriculture *(e.g. pigs, poultry)*;
- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
- sources of ionising radiation *(e.g. x-ray and radiotherapy equipment, industrial sources);*
- large petrol storage facilities;
- waste water discharges;
- dumping at sea activities.

National Environmental Enforcement

- Conducting an annual programme of audits and inspections of EPA licensed facilities.
- Overseeing local authorities' environmental protection responsibilities.
- Supervising the supply of drinking water by public water suppliers.
- Working with local authorities and other agencies to tackle environmental crime by co-ordinating a national enforcement network, targeting offenders and overseeing remediation.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Prosecuting those who flout environmental law and damage the environment.

Water Management

- Monitoring and reporting on the quality of rivers, lakes, transitional and coastal waters of Ireland and groundwaters; measuring water levels and river flows.
- National coordination and oversight of the Water Framework Directive.
- Monitoring and reporting on Bathing Water Quality.

Monitoring, Analysing and Reporting on the Environment

- Monitoring air quality and implementing the EU Clean Air for Europe (CAFÉ) Directive.
- Independent reporting to inform decision making by national and local government *(e.g. periodic reporting on the State of Ireland's Environment and Indicator Reports)*.

Regulating Ireland's Greenhouse Gas Emissions

- Preparing Ireland's greenhouse gas inventories and projections.
- Implementing the Emissions Trading Directive, for over 100 of the largest producers of carbon dioxide in Ireland.

Environmental Research and Development

- Funding environmental research to identify pressures, inform policy and provide solutions in the areas of climate, water and sustainability.

Strategic Environmental Assessment

- Assessing the impact of proposed plans and programmes on the Irish environment *(e.g. major development plans)*.

Radiological Protection

- Monitoring radiation levels, assessing exposure of people in Ireland to ionising radiation.
- Assisting in developing national plans for emergencies arising from nuclear accidents.
- Monitoring developments abroad relating to nuclear installations and radiological safety.
- Providing, or overseeing the provision of, specialist radiation protection services.

Guidance, Accessible Information and Education

- Providing advice and guidance to industry and the public on environmental and radiological protection topics.
- Providing timely and easily accessible environmental information to encourage public participation in environmental decision-making *(e.g. My Local Environment, Radon Maps)*.
- Advising Government on matters relating to radiological safety and emergency response.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

Awareness Raising and Behavioural Change

- Generating greater environmental awareness and influencing positive behavioural change by supporting businesses, communities and householders to become more resource efficient.
- Promoting radon testing in homes and workplaces and encouraging remediation where necessary.

Management and structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Climate, Licensing and Resource Use
- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Radiological Protection
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

WATER QUALITY IN IRELAND 2010-2012

Prepared for the Environmental Protection Agency

by

Aquatic Environment

Office of Environmental Assessment

Edited by:

Colin Byrne and Andy Fanning

Authors: Bradley, C., Byrne, C., Craig, M., Free, G., Gallagher, T.[1], Kennedy, B., Little, R., Lucey, J., Mannix, A., McCreesh, P., McDermott, G., McGarrigle, M., Ní Longphuirt, S., O'Boyle, S., Plant, C., Tierney, D., Trodd, W., Webster, P., Wilkes, R. and Wynne, C.

ENVIRONMENTAL PROTECTION AGENCY

An Ghníomhaireacht um Chaomhnú Comhshaoil

PO Box 3000, Johnstown Castle, Co.Wexford, Ireland

Telephone: +353 53 916 0600 Fax: +353 53 916 0699

Email: info@epa.ie Website: www.epa.ie

1 Inland Fisheries Ireland. 3044 Lake Drive, Dublin 24, Ireland

DISCLAIMER

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

WATER QUALITY IN IRELAND 2010-2012

Published by the

ENVIRONMENTAL PROTECTION AGENCY, IRELAND

Design by Yellowstone

Printed by Essentra

Published by the Environmental Protection Agency, Ireland

PRINTED ON RECYCLED PAPER

ISBN: 978-1-84095-602-3

PRICE €20

Acknowledgements

The editors and authors wish to express their gratitude to the following organisations that provided data and information for this report: Inland Fisheries Ireland, Irish Coast Guard, Local Authorities, Marine Institute, National Parks and Wildlife Service, Northern Ireland Environment Agency, Sea Fisheries Protection Authority and Waterways Ireland.

The help of the EPA regional chemists, EPA Laboratory and Hydrometric technicians, skippers and other field assistants in undertaking the monitoring programme and analytical work is greatly appreciated. The advice and assistance of colleagues in the Informatics Unit and Water Framework Directive Integration & Coordination Unit are also gratefully acknowledged.

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

Photographs courtesy of Colin Byrne (EPA), Deirdre Tierney (EPA) and Aine O'Connor (NPWS).

Table of Contents

Any queries relating to this report or its content should be directed to:

Dr. Colin Byrne,
Manager (Ecological Monitoring & Assessment Unit),
Aquatic Environment,
Office of Environmental Assessment,
Environmental Protection Agency,
McCumiskey House, Richview,
Clonskeagh, Dublin 14.
Tel: 00 353 (0) 1-2680220
E-mail: co.byrne@epa.ie

Key findings

Water Quality	◢ 53% of rivers, 43% of lakes, 45% of transitional waters, 93% of coastal waters and 99% of groundwater were satisfactory at good or high status. ◢ Rivers monitored, using the biological Q value scheme, were in high or good condition along 73% of the monitored river channels. This was up 4% from the last monitoring period, and includes an overall increase in high status sites. ◢ There was a 5% reduction in satisfactory quality lakes (10 lakes). This requires further investigation to fully understand the reasons for the reduction. ◢ Serious pollution of rivers reduced to 17 km from 53 km since last reporting period. ◢ Reported fish kills declined to an all-time low of 70 recorded between 2010 and 2012. ◢ Water quality in canals remains very high at over 90% satisfactory. ◢ Quantitative issues resulting from over-abstraction of groundwater are minimal (99% of groundwater bodies at good status) ◢ The south and south-east of the country continue to have the greatest proportion of groundwater and rivers with nitrogen concentrations over 10 mg/l NO_3. ◢ While there was a decrease in detections of faecal coliforms in groundwater from 61% in 2008 to 51% in 2012, these levels highlight a risk for drinking water in areas where there is inadequate treatment. ◢ Approximately 35% of the designated shellfish areas were non-compliant with the guide value for *Escherichia coli*. ◢ The level of compliance with Environmental Quality Standards for hazardous substances was very high across all waters.
Key Pressures and Eutrophication	◢ Eutrophication, which is caused by nutrient enrichment, remains the most significant issue for surface waters. ◢ Levels of nitrogen and phosphorus in groundwater and rivers have been mostly decreasing (52-74% of sites for N and 69% for P) or stable (21-41% of sites for N and 24% for P) since 2007, which is a welcome development. Riverine inputs to transitional waters and coastal waters have also shown declines. ◢ The two most important suspected causes of pollution in rivers are agriculture and municipal sources, accounting for 53% and 34% of cases respectively. ◢ Nutrient inputs to rivers, particularly from the agriculture sector, have seen 18.7% and 37.7% reductions in nitrogen and phosphorus sources, respectively. ◢ Anticipated increases in pressures due to human population growth and agricultural output will need to be carefully managed to build on these positive trends.

Distance to target	◢ 47% of rivers, 57% of lakes, 55% of transitional waters and 7% of coastal waters require improvement to satisfactory condition. ◢ The target of 13.6% improvement in ecological status for surface waters from the 2009 baseline by 2015 included in the first cycle river basin management plans is unlikely to be achieved. ◢ The contamination of groundwater with faecal coliforms in 51% of samples highlights the significant challenge to protect both public and private drinking sources. ◢ 35% of designated shellfish waters with elevated faecal contamination may require additional measures to achieve the quality objectives.
Strengthened science and reporting	◢ Many new ecological monitoring tools have been developed and others are under development. These tools will be essential to managing the aquatic environment. However, further work is needed to understand the link between the new tools and environmental pressures affecting them, including hydromorphological and water abstraction pressures. ◢ Fish assessments downgraded the ecological status in 18% and 27% of surveillance rivers and lakes, respectively. Further investigation is needed to understand the reasons for this. ◢ Targeted assessment of environmental pressures, including physical habitat modifications and barriers to fish migration, needs to be undertaken to determine their ecological impacts. ◢ The EPA is reviewing its reporting outputs on the aquatic environment. The EPA is committed to improving the frequency of reporting, as well as developing key indicators so as to support catchment management activities, and will publish results for the period 2013-2015 in 2016.

EXECUTIVE SUMMARY

This report presents a review of water quality in the State for the years 2010 to 2012. It is the most recent 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 organisations. The purpose of the report is to give a detailed review of all the main issues related to the quality of the aquatic environment in Ireland, in order to provide guidance towards the protection and enhancement of this valuable resource, and the preparation of second cycle river basin management plans under the Water Framework Directive (2000/60/EC).

The report is based on monitoring carried out at:

- 336 groundwater monitoring sites (covering approximately 69,000 km^2)
- 3,051 river monitoring sites (covering approximately 13,300 km of river channel length)
- 42 canal monitoring sites (covering approximately 332 km of channel)
- 213 lakes (covering approximately 955 km^2 of lake surface area)
- 9 heavily modified water bodies (covering approximately 37 km^2)
- 193 transitional water bodies (covering approximately 844 km^2), and
- 101 coastal water bodies (covering over 13,000 km^2).

These water quality datasets have been generated by the EPA, local authorities, Inland Fisheries Ireland, Waterways Ireland, the Marine Institute, as well as from other State agencies, such as the Sea Fisheries Protection Authority and the Irish Coast Guard.

The initial focus of the report is on the status of waters as defined under the Water Framework Directive[2]. However, the report also contains more in-depth analysis of the underlying environmental indicators that determine status, including their trends. These environmental indicators are particularly important for identifying the causes of environmental impacts and for guiding the appropriate management measures for the restoration and protection of waters. The environmental indicators of the quality of Ireland's aquatic environment reported include; ecological assessments, nutrient levels and trends, reported fish kills, the quality of shellfish waters, faecal contamination of groundwater, levels of radioactivity in marine waters, oil pollution incidents in marine waters, and the presence and levels of toxic substances in the aquatic environment.

2 All water status results are available via the EPA Geoportal at: http://gis.epa.ie

Key findings and trends

While the quality of Irish groundwater and surface waters are among the best in Europe[3], there are many impacts that need to be addressed to bring all waters up to a satisfactory level and to protect waters already in good condition. The water status assessment for 2010-2012 shows that 48% of rivers, 57% of lakes, 55% of estuaries and 4% coastal waters (by area) assessed were impacted (see **Table 1** and **Figure 1**). Only 1% of groundwater bodies are at poor chemical status due to elevated phosphorus levels or due to historical contamination from mining activities and industrial development. Elevated nutrient concentrations continue to be the most widespread water quality problem in Ireland arising primarily from human activities, such as agriculture and wastewater discharges to water from human settlements, including towns, villages and rural houses. The level of pollution from hazardous substances is low.

Status of Irish waters (2010-2012)	High	Good	Moderate	Poor	Bad
Groundwater (% area) (interim status)	n/a	99	n/a	1	n/a
Rivers (% water bodies)	11.8	41	28.6	17.9	0.7
Lakes (% water bodies)	11	32	33	15	9
Transitional (% area) *	3.6	41.1	43.4	11.4	0.5
Coastal (% area) *	63.4	30	4.4	<0.01	0.0

* - unassigned waterbodies not included.

Table 1. Summary of WFD water status for groundwater (chemical status) and surface waters (ecological status) during 2010-2012.

Groundwater

1% of groundwater bodies (11) in Ireland were classified as at poor chemical status. This was an improvement from 13.6% of the groundwater bodies in Ireland classified as being at poor chemical status in the last assessment, and was due to declines in phosphate levels since the first cycle of WFD river basin management planning. Of the 11 groundwater bodies at poor chemical status, three were at poor chemical status due to phosphate contribution to rivers. The remaining eight groundwater bodies were at poor chemical status because of historical contamination from mining activities and industrial development. Two out of 336 groundwater bodies were at poor quantitative status due to impacts of water abstractions on a groundwater-dependent terrestrial ecosystem, both of which are located in the South-Eastern River Basin District.

The average nitrate concentration in groundwater was below the threshold value of 37.5 mg/l NO_3 at 96% of the monitoring locations for the period 2007-2012. The south and south-east regions of the country continue to have the greatest proportion of monitoring locations with elevated nitrate concentrations. The average phosphate concentration in groundwater was below the threshold value 0.035 mg/l P at 93% of the monitoring locations during the period 2007-2012. Downward trends in nitrate concentrations were evident at 74% of groundwater monitoring locations, with a further 21% having stable levels. There has been a gradual decrease in phosphate concentrations across the WFD groundwater monitoring network, with 70% of sites having average phosphate concentrations less than 0.015 mg/l P in 2012 compared

3 http://www.eea.europa.eu/themes/water

to 40% in 1995-1997. Certain locations have been identified as having upward trends in nitrate and phosphorus that could, if they continue, lead to failure to meet WFD objectives. Further assessment of these areas is required to understand what is causing the trend.

There was a decrease in samples with positive detections of faecal coliforms during the reporting period (from a maximum of 61% in 2008 to 51% in 2012). Groundwater sources for both public and private drinking water need to be protected, in order to reduce the risk of illness from the consumption of contaminated water, particularly from spring sources.

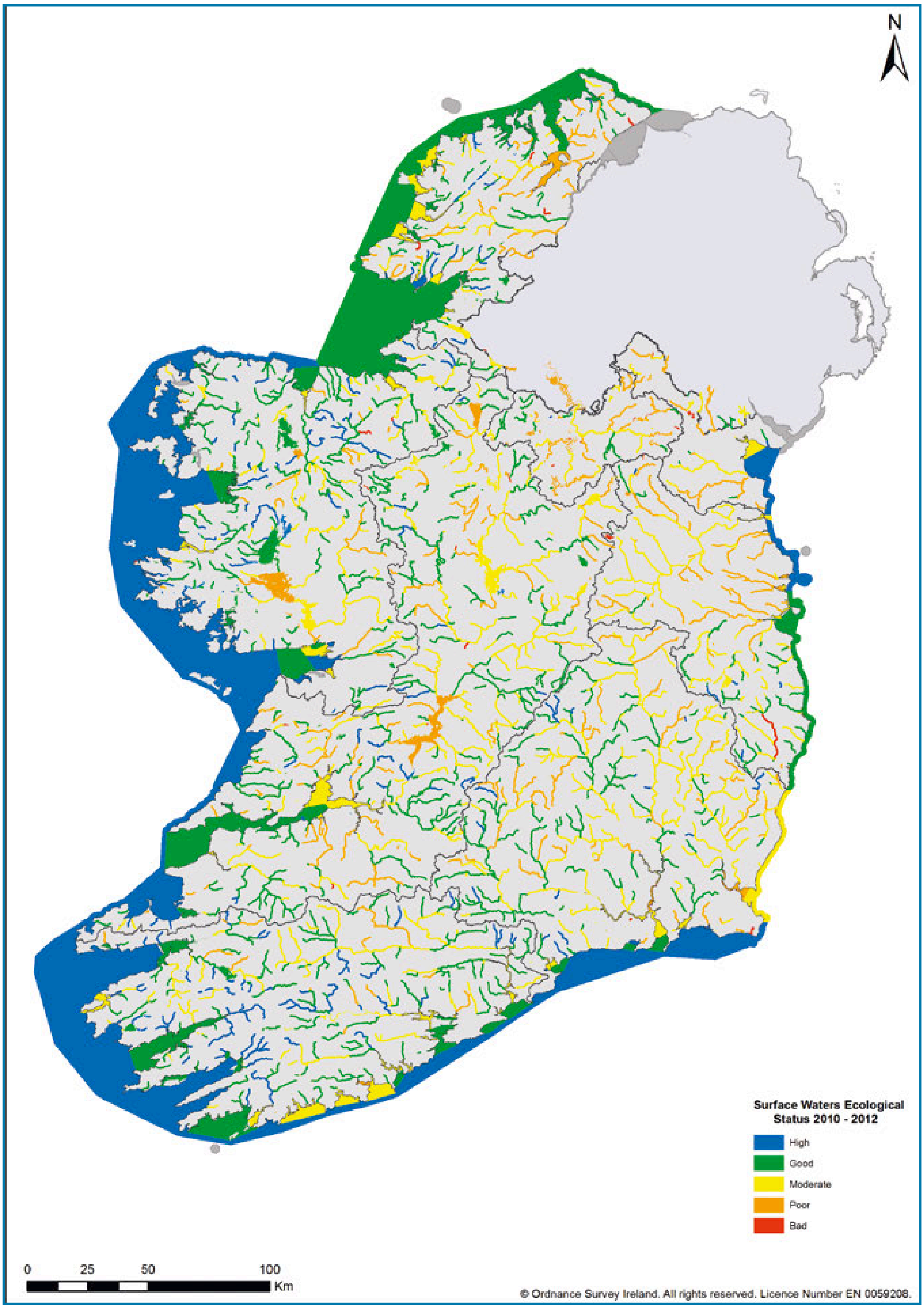


Figure 1. Surface water ecological status for rivers, lakes, transitional and coastal waters (2010-2012).

Rivers and canals

Fifty three percent of monitored river water bodies (858) were at satisfactory ecological status, up 1% since the previous period.

Of 13,300 kilometres of river channel length monitored using the biological Q value scheme, water quality was in high or good condition along 73% of the monitored river channels. This was up 4% from the last monitoring period and includes an overall increase in high status sites. Serious pollution resulting from urban wastewater and industrial pollution was reduced to 17 km of river channel length. This was down from 53 km in 2007-2009.

The two most important suspected causes of river pollution are agriculture and municipal sources, accounting for 53% and 34% of cases, respectively.

Trends in nitrogen indicate that concentrations in rivers were generally reducing (52% of sites assessed) or stable (41% of sites assessed). The greatest reductions were in the intensive agriculture areas in the South-East and Midlands. Trends in phosphorus concentrations in rivers were stable in most parts of the country (69% of sites assessed), including areas where they were historically low. 24% of sites assessed showed decreasing concentrations.

There has been a further decline in the number of fish kills to 70 reported in freshwaters (rivers and lakes) compared to 72 in the previous period (2007-2009). This is the lowest recorded to date, from a high of 235 in the 1980s.

In relation to hazardous substances, the level of compliance with Environmental Quality Standards for specific pollutants[4] was high, with the main issue being naturally-occurring metals in known, mineral-rich mining areas. In general, the level of compliance with the Environmental Quality Standards (EQSs) for priority and priority hazardous substances was very high. Polyaromatic hydrocarbons (PAHs) and mercury did show widespread exceedances of the EQS. However, these have been identified at EU level as ubiquitous persistent, bio-accumulative and toxic substances (uPBTs) which occur widely in the environment on a global scale, due principally to atmospheric deposition. uPBTs can be found for decades in the aquatic environment at levels posing a significant risk, even if extensive measures to reduce or eliminate emissions of such substances have already been taken. Some are also capable of long-range transport and are largely ubiquitous in the environment. Therefore, non-compliant results do not infer specific issues local to a water body or indeed river basin district.

The Grand and Royal Canals achieved good ecological potential. The canalised section of the Shannon-Erne Waterway was compliant with all water quality standards. However, the ecology of the canal was compromised by the hydromorphology of the canal (box-shaped profile), which makes it unsuitable for macrophyte and macroinvertebrate communities to develop.

Lakes

Two hundred and thirteen lakes, representing 955 km^2 of lake surface area, were monitored for the WFD in the period 2010-2012. Overall, 91 lakes (43% of lakes monitored) were assigned high or good status, comprising 295 km^2 by area. One hundred and twenty two lakes (57%) were moderate or worse in status (660 km^2 of lake area monitored).

One hundred and twelve lakes (53% of lakes monitored), accounting for 505 km^2 of lake surface area, did not change status. Fifty three lakes (221 km^2 of lake area) declined in status, while 33 lakes (134 km^2 of lake area) improved in status. Overall, the changes in status translate into a 5% reduction (10 lakes) in the high or good status categories, and a corresponding increase in the moderate or worse status category compared to 2007-2009. The changes in status are generally as a result of changes in phosphorus concentrations. Other factors, such as abstraction

4 Specific Pollutants are defined as substances that can have a harmful effect on biological quality, and which may be identified by Member States as being discharged to water in "significant quantities"

pressure, habitat limitations and the presence of alien species, may be impacting on status in some lakes. Fish status was the factor determining overall ecological status in 10 of 13 lakes that were classified as at poor or bad status, where biology was the sole status determinant. The issues require further investigation.

The Invasive Alien Species (IAS) zebra mussel was recorded in 70 of the monitored lakes and one heavily-modified lake water body compared to 50 known lake populations in the 2007-2009 period, suggesting that the zebra mussel continues to spread despite public awareness and biosecurity campaigns. Roach, an invasive fish species, was recorded in 36 of the 75 lakes monitored for fish in 2010-2012.

Six of the nine monitored lake heavily-modified water bodies (HMWBs) were at maximum or good ecological potential.

The levels of hazardous substances (specific pollutants, priority substances and priority hazardous substances) monitored in over 70 lakes remains low with few exceedances. Biota samples of trout and perch were analysed for mercury in 22 lakes. All samples exceeded the EQS. However, it should be noted that the concentrations were well below standards for fishery products[5], and therefore do not pose a risk to human health. Like PAHs, mercury has been identified as a ubiquitous persistent, bioaccumulative and toxic substance (uPBT) under Directive 2013/39/EU (see Section on Rivers and canals above).

Transitional and coastal waters

36.3% of transitional waters were at high or good ecological status, accounting for 44.7% of the total area assessed (377 km^2). A number of water bodies, mainly in the south-east and south of the country, continue to display symptoms of nutrient enrichment and have been classed as eutrophic.

67.4% of coastal waters were at high or good ecological status, accounting for 93% of the total area assessed (approximately 12,471 km^2).

Downward trends in nutrient loads to the marine environment were evident, with significant reductions in nutrient inputs from rivers. This downward trend is apparent in the reduction in nutrient sources, particularly from the agriculture sector, which has seen an 18.7% and 37.7% reduction in nitrogen and phosphorus sources, respectively.

Nearly two-thirds (65.1%) of the designated shellfish areas monitored over the four-year period were compliant with the guide value for *Escherichia coli*. Of the non-compliant areas, the worst performing were Bannow Bay, Bantry, Dunmanus Inner, Kinsale, Tralee Bay, and Wexford Harbour Inner, where more than 50% of the samples exceeded the guide value. It is likely that additional measures may be required to achieve the quality objectives for shellfish waters in these areas.

The majority of transitional and coastal waters were at good chemical status. There were a few exceedances of biota standards for mercury in mussel samples. However, mercury has been identified as a ubiquitous persistent, bioaccumulative and toxic substance (uPBT) under Directive 2013/39/EU (see Section on Rivers and canals above).

In general, the levels of radioactive contamination present in the Irish marine environment are low. Radioactive substances from the nuclear reprocessing plant at Sellafield in England continue to be discharged to the Irish Sea, though exposure to these substances is not considered to pose a significant health risk to the Irish public.

5 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

Key pressures

While there has been some modest improvement in the quality of Ireland's waters over the period between 2010 and 2012, there is a significant challenge to meet the requirements of the Water Framework Directive. For example, the figures for 2010-2012 indicate that the target of 13.6% improvement in surface water ecological status by 2015, set in the first cycle of river basin management planning, is unlikely to be achieved.

Eutrophication from nutrient enrichment continues to be the main issue facing Irish waters. The trends in both nitrogen and phosphorus are currently positive, with levels of nitrogen and phosphorus in groundwater and rivers mostly decreasing (52-74% of sites for N and 69% for P) or stable (21-41% of sites for N and 24% for P) since 2007. Nutrient inputs from rivers to marine waters, particularly from the agriculture sector, have seen 18.7% and 37.7% reductions in nitrogen and phosphorus sources respectively.

The two most important suspected causes of pollution of rivers are agriculture and municipal sources, accounting for 53% and 34% of cases respectively. Future pressures include the planned expansion in the agricultural sector and increased nutrient loadings to waters from municipal wastewater discharges due to population growth and other factors. These pressures may threaten the modest improvements seen to date, and if not managed correctly, are likely to impact negatively on the progress made in recent years. Continued investment and resources will be needed to improve the operation and standards of municipal wastewater infrastructure, as well as tackling diffuse pollution arising from agriculture.

The results from some ecological status assessments (e.g. macrophytes and fish) indicate that ecosystems may be responding to environmental pressures other than nutrient enrichment. For example, fish assessments downgraded the ecological status in 18% and 27% of surveillance rivers and lakes respectively. The factors concerned require further investigation to confirm the cause of the unsatisfactory ratings before management measures are considered and implemented.

Distance to target

47% of rivers (waterbodies), 57% of lakes (waterbodies), 55% of transitional waters (area) and 7% of coastal waters (area) require improvement to achieve satisfactory condition. This will require significant additional targeted action to achieve the objectives set out in the Water Framework Directive. In addition to achieving ecological health of aquatic ecosystems, focus will be required on ensuring that the public health requirements are also met. The contamination of groundwater with faecal coliforms in 51% of samples highlights the significant challenge still facing the country to protect both public and private drinking sources. When taken together with the 35% of designated shellfish waters with elevated faecal contamination, it is clear that additional measures may be required to ensure that Ireland's waters are both healthy and safe.

Strengthening science

Over 10 new ecological monitoring tools have been developed in recent years for the purpose of assessing impacts from a variety of environmental pressures, and others are under development. These tools will be essential to managing the aquatic environment but further work is needed to understand the link between the new tools and environmental pressures. One of the key findings from the assessments undertaken in this reporting period was the impact of fish status on ecological status. Fish assessments downgraded the ecological status in 18% and 27% of surveillance rivers and lakes, respectively. The reasons why are not always clear and need to be investigated further. Targeted monitoring and assessment of environmental pressures, including physical habitat modifications, barriers to fish migration, and water abstraction/impoundments, needs to be undertaken to determine their ecological impacts. An assessment of available environmental information and a review of available scientific evidence, both nationally and internationally, will help to improve the Agency's understanding of these pressures and their ecological impacts.

This report notes the loss of status in relation to a number of lakes. Given the modest positive improvement in nutrient trends, and overall water status in all other water categories, further work is required to determine the cause of this trend before management measures are implemented.

The improvement in the trophic status of estuarine waters in recent years is due to the reduction in nutrient inputs. However, a number of estuaries, mainly in the south-east and south of the country, continue to display symptoms of nutrient enrichment and have been classed as eutrophic. The relative sensitivity of these waters to elevated nutrients will need to be assessed to ensure that the right measures are put in place to improve their status.

As the review of priority substances and priority hazardous substances happens at EU level, the presence and level of these substances in Irish waters needs to be investigated. Pharmaceuticals in waters are an emerging environmental issue in Europe, and national consideration of their presence and magnitude in the Irish environment will be needed in the near future. Monitoring to date has detected a number of pesticides, including methylchlorophenoxypropionic acid (Mecoprop), 2-methyl-4-chlorophenoxyacetic acid (MCPA) and 2,4-dichlorophenoxyacetic acid (2 4-D), at low levels in a significant number of rivers (26%-56%). A comprehensive review of the data and other evidence relating to these substances is required, to determine if it will be necessary to consider regulating some of them during the next river basin planning cycle.

1. INTRODUCTION AND BACKGROUND

This report provides an account of the quality of the State's groundwater and surface waters based on survey data for the period 2010-2012. It compares results against earlier assessments. The report 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 and McGarrigle, et al., 2010). With the introduction of the Water Framework Directive (WFD) and the development of river basin management plans (RBMPs), the focus of these reports has changed since 2010 (Water Quality in Ireland 2007-2009) to address the status of waters in Ireland in the context of the WFD.

Under Section 65 of the Environmental Protection Agency Act, 1992, the EPA is 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 groundwater, were established in 1999, which strengthened the pre-existing ones. However, the national environmental water quality monitoring programme is now largely driven by the EU Water Framework Directive (2000/60/EC).

The initial focus of the report is on the status of waters as defined under the Water Framework Directive. However, the report also contains more in-depth analysis of the underlying environmental indicators that determine status, including their trends. These environmental indicators are particularly important for identifying the causes of environmental impacts and for guiding the appropriate management measures for the restoration and protection of waters. The environmental indicators of the quality of Ireland's aquatic environment reported include; nutrient levels and trends, reported fish kills, the quality of shellfish waters, faecal contamination of groundwater, levels of radioactivity in marine waters, oil pollution incidents in marine waters, and the presence and levels of toxic substances in the aquatic environment.

The aims of the Water Framework Directive are to maintain high and good status waters where they exist, prevent any deterioration in the existing status of waters, and achieve at least good status, in accordance with the environmental objectives set out in RBMPs.

The purpose of monitoring waters in the river basin management process

The Water Framework Directive requires an integrated and holistic approach to the management and protection of both groundwater and surface waters, through the river basin management planning process. The catchment is the most appropriate management unit for applying this approach and requires consideration of the connectivity between groundwater and surface waters. In most rivers in Ireland, more than 30% of the annual average flow is derived from groundwater. In low flow periods, this figure can rise to more than 90%. 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 contributions from groundwater, its quality will ultimately be reflected in the quality of surface waters.

Environmental monitoring plays a critical role in the cyclical river basin planning process. It initially helps to inform the assessment of environmental risk within the characterisation process (Figure 1-1). The risk assessment is then used to refine the monitoring programme so as to confirm whether or not environmental impacts are occurring, or are likely to occur, as a result of the risks identified. Monitoring is also used to detect negative environmental trends, monitor the effectiveness of management measures put in place as part of the programmes of measures, and identify emerging environmental issues.

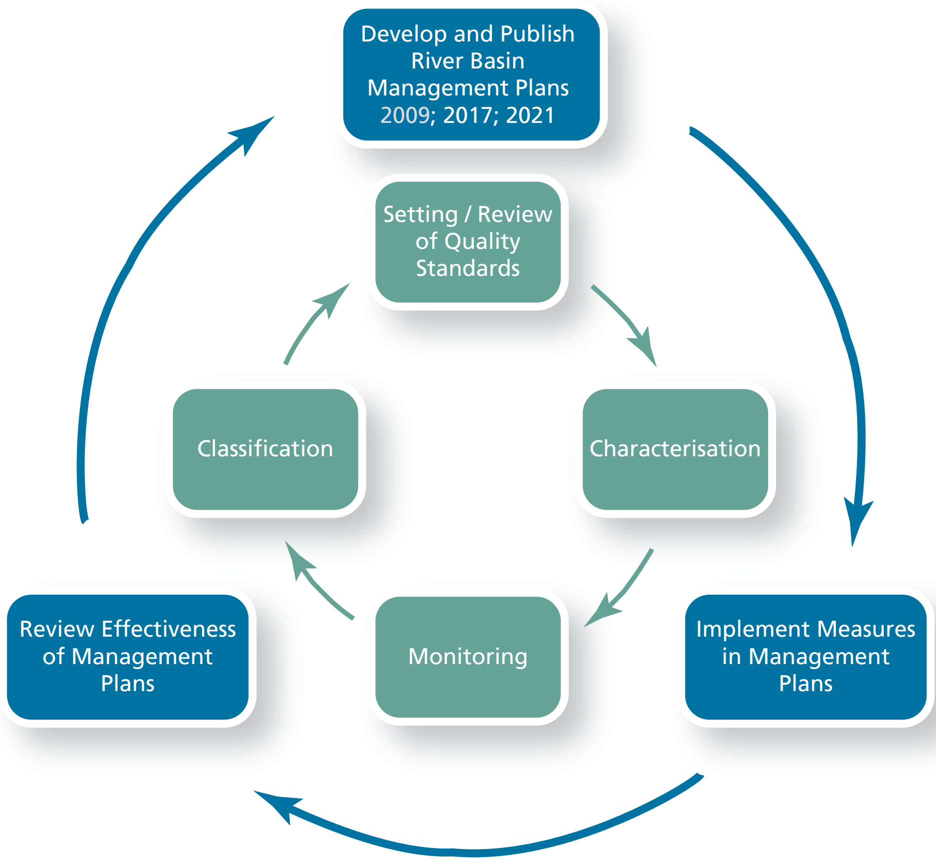


Figure 1-1. The Water Framework Directive Planning Cycles.

Monitoring networks

A comprehensive and representative environmental water quality monitoring programme has been designed and implemented in Ireland (EPA, 2006) to support the implementation of the first river basin planning cycle (**Figure 1-2**). The groundwater network consists of 336 monitoring sites. The river network consists of 3,051 monitoring sites. The lakes network consists of 213 lakes. The transitional waters network consists of 193 monitored water bodies and the coastal waters network consists of 101 monitored water bodies. While the Agency has overall responsibility for the design and management of the monitoring programme, responsibility for certain elements has been assigned by the Agency to a number of public bodies, including local authorities, Inland Fisheries Ireland, the National Parks and Wildlife Service, Waterways Ireland and the Marine Institute. The programme is currently undergoing a review for the purpose of optimising it for use in the second river basin planning cycle.

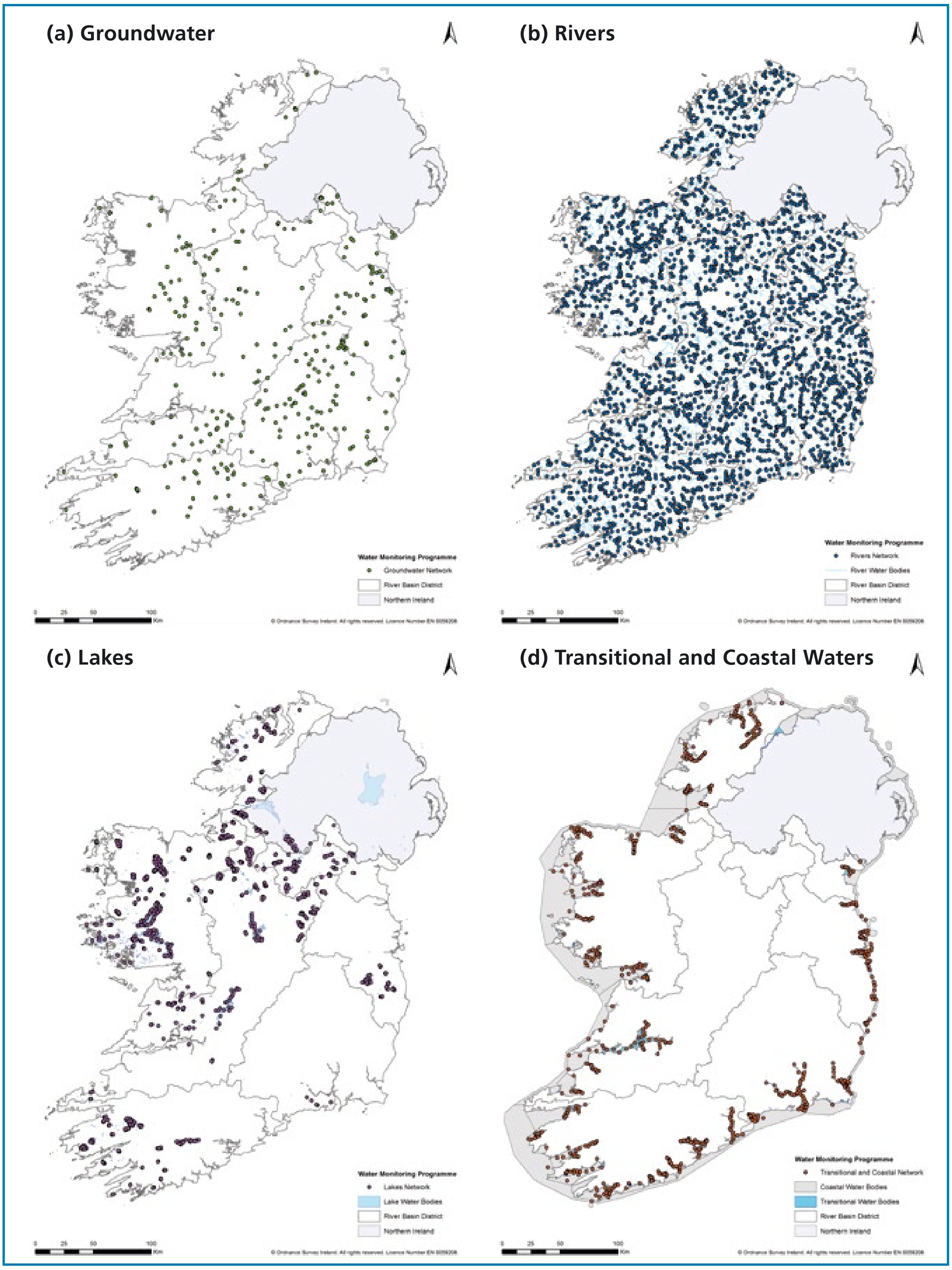


Figure 1-2. The extent of the national environmental water quality monitoring programme for (a) groundwater, (b) rivers, (c) lakes and (d) transitional and coastal waters (2007-2015).

Classification of water status

The WFD classification schemes provide the basis for describing the state of the aquatic environment, and for assessing the effectiveness of the programmes of measures in achieving the environmental objectives established through the river basin management planning process. Many of the monitoring tools used to classify status are new, and some may be revised as a result of improved understanding from their practical application and through further research.

WFD classification for groundwater consists of quantitative status and groundwater chemical status. Each is assigned as either good or poor status. Five chemical and four quantitative tests (**Figure 1-3**) have been developed to assess whether the WFD objectives are met. 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.

Tests for assessing chemical status of groundwater include; looking for evidence of saline or other intrusions, exceedances of a range of quality standards and thresholds that would result in failure to achieve the environmental objectives of associated surface waters, groundwater-dependent terrestrial ecosystems, or drinking water protected areas. It also involves looking for evidence of deteriorating trends in quality. Tests for assessing quantitative status of groundwater focus on the over-abstraction of groundwater and include; looking for evidence of saline or other intrusions due to change in groundwater levels, impacts on the environmental objectives of associated surface waters and groundwater-dependent terrestrial ecosystems due to alterations in groundwater levels, and assessing water balances to determine whether the available groundwater resource is exceeded by the long-term annual average rate of abstraction. Full details of status tests are available on the Agency's website[6].

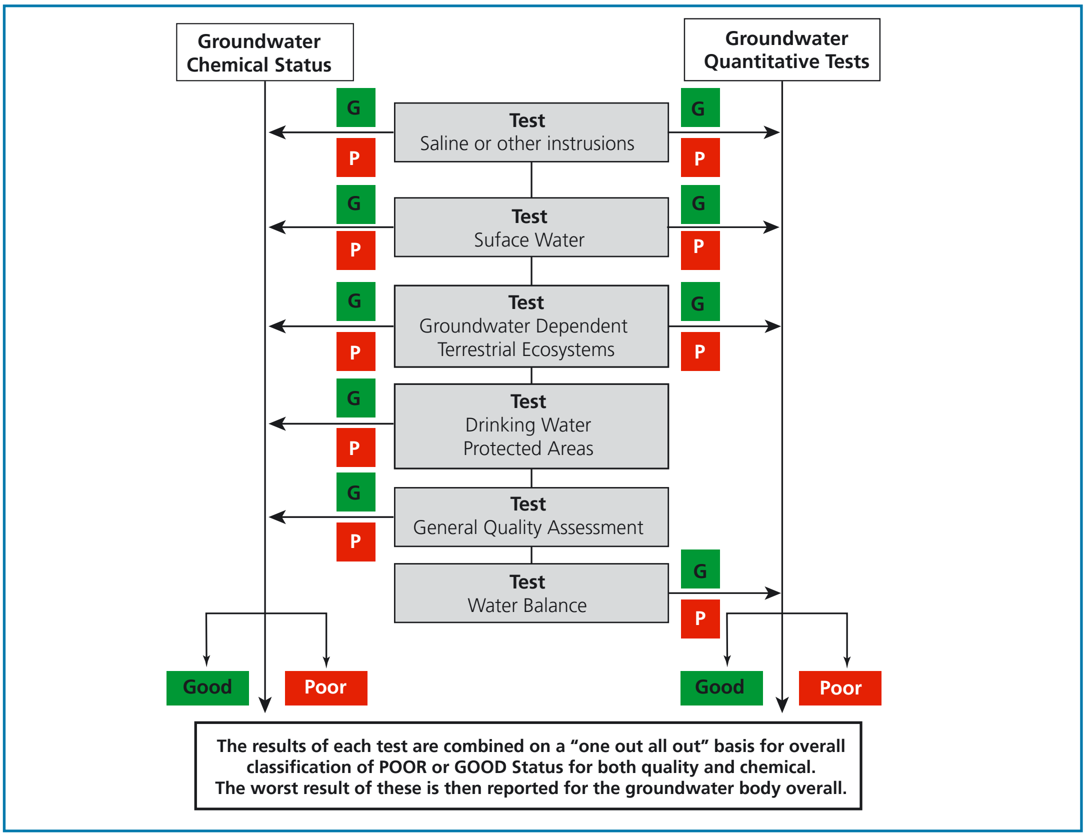


Figure 1-3. Overview of the status assessment (Classification) process (Craig & Daly, 2010 after UKTAG, 2008a).

6 http://www.epa.ie/pubs/reports/water/ground/groundwaterthresholdvaluesandassessmentofchemicalandquantitativestatus.html

WFD classification for surface water consists of ecological status and chemical status classification. These classification systems vary across rivers, lakes, transitional waters, and coastal waters. Heavily-modified and artificial surface water bodies are assessed in relation to their ecological potential, as their ecological communities do not correspond to natural ecosystems and, therefore, need to be considered separately.

The quality elements relevant in assessing ecological status and ecological potential for surface waters are:

- Biological quality elements (covering algae, plants, fish and invertebrates);
- General physico-chemical quality elements;
- Environmental Quality Standards (EQSs) for specific pollutants (i.e. synthetic and non-synthetic pollutants); and
- Hydromorphological quality elements.

Surface water bodies are assigned to one of five ecological status classes (high, good, moderate, poor or bad) or one of five ecological potential classes (maximum, good, moderate, poor or bad). The status assigned is determined by the poorest classed quality element. (This is also termed the 'one-out-all-out' principle, as applies under the WFD).

Figure 1-4 illustrates the manner in which the various quality elements for surface waters are used to define final ecological status.

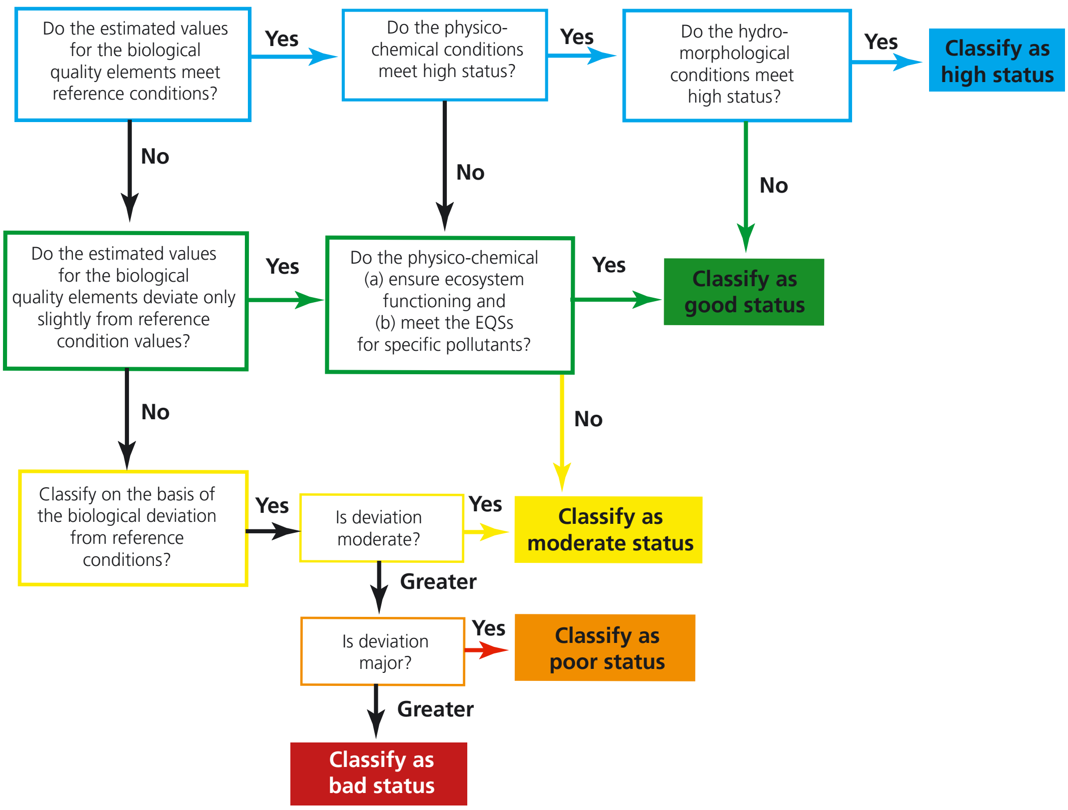


Figure 1-4. The role of different quality elements in the assessment of ecological status.

The quality elements relevant in assessing surface water chemical status are those priority and priority hazardous substances identified in Directive 2008/105/EC (subsequently amended by Directive 2013/39/EU). Water bodies are classified as either at good chemical status or poor chemical status, depending on whether or not they achieve the prescribed environmental water quality standards.

Full details of the methods used to classify groundwater status and surface water status are available to download from the Agency's website[7].

The sources of data on which the report is based were from the national monitoring programmes undertaken by the EPA, local authorities, Marine Institute, Inland Fisheries Ireland, Waterways Ireland, the Sea Fisheries Protection Authority and the Irish Coast Guard. The WFD monitoring programme has been developing, with the majority of the programme in place since 2007, with some additional aspects added in 2011, specifically in relation to the coastal waters monitoring programme.

Future reporting on water quality

There have been a number of important developments that will potentially change the context for future reporting on water quality in Ireland. These include:

1. The governance arrangements for implementing the river basin planning process have been recently changed through legislation (SI 350 of 2014). Under the legislation, the Agency has a significantly enhanced role in supporting the preparation of river basin management plans and their associated programmes of measures.
2. The existing seven River Basin Districts are to be reconfigured into three RBDs. The existing four national RBDs and the Shannon International RBD are to be merged into one national RBD for administrative and reporting reasons. The North Western and Neagh Bann International RBDs will remain.
3. River water bodies have been significantly revised so that the monitoring network is now more representative for the purpose of assessing the status of rivers. The original 4,565 water bodies have been reconfigured into approximately 3,200 water bodies (see Box 1).
4. Additional biological monitoring tools are being developed. Once finalised, they will be applied to the monitoring programme.
5. Future reporting on water quality will also need to take a more integrated assessment approach at catchment level, taking account of connectivity between groundwater, rivers, canals, lakes, transitional, and coastal waters, so as to better understand the cause of water pollution and to make informed decisions on the most appropriate management measures to implement.

7 http://www.epa.ie/pubs/reports/water/waterqua/Final_Status_Report_20110621.pdf
http://www.epa.ie/pubs/reports/water/ground/groundwaterthresholdvaluesandassessmentofchemicaland-quantitativestatus.html

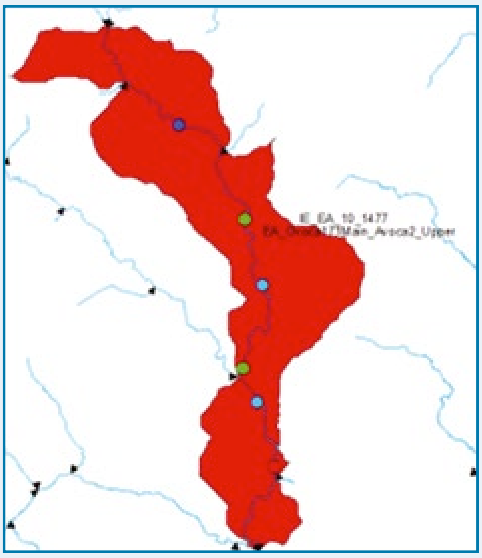
Box 1. Revisions to river water body delineation

During the first River Basin Management Plan cycle, as the WFD status was being generated, it became apparent that the link between water bodies and WFD status was not optimum: long stretches of river channels were being identified as poor status when the actual affected part was quite short. An example of this was the Avoca river water body (see map below). The catchment for the water body is the red area in the map below. It can be seen that there were a number of 'High' status (Blue) and 'Good' status (Green) sites along the length of the river with the only 'Bad' status (Red) site being the furthest station downstream. As the One-Out-All-Out (OOAO) rule applied, the whole river water body was classified as having 'Bad' status, which was inaccurate.

Despite a substantial national monitoring programme (MP) being in place, not all river water bodies had an associated monitoring station. As a consequence of this, only 1,618 river water bodies out of a potential 4,565 had a WFD Status from the reporting period of 2007-2009 assigned to them.

As mentioned above, the method of creating the current river water bodies was based on stream order. The 1st order streams and some 2nd order streams were removed from the river water bodies dataset due to their catchment size being <10km^2. The river network consists of 74,000 km of channel, of which circa 38,000 km are 1st order streams. This is a substantial length of channel that is not being reported on.

As a result of these issues, the method of delineating water bodies was changed. As the WFD monitoring programme (MP) is designed to track known pressures, it was decided that new river water bodies would be defined by the location of a MP station, i.e. a new river water body would be the length of river, including tributaries between one MP station and the next MP station or the source, whichever was applicable. This method resulted in the majority of water bodies having a one-to-one relationship with a monitoring station. This optimisation should assist in applying environmental objectives and setting practical management measures more effectively for river water bodies.



Note: The Avoca River Water Body Length is 26.5 km (69 km^2 catchment area).

2. GROUNDWATER

Authors: Anthony Mannix, Matthew Craig.

- 1.5% of groundwater bodies in Ireland were classified as being at poor chemical status based on the best information available. This was an improvement from 13.6% of the groundwater bodies in Ireland classified as being at poor chemical status in the first cycle of WFD river basin management planning.
- 11 groundwater bodies were at poor chemical status with three at poor chemical status due to phosphate contribution to rivers that were at less than good status in 2011.
- 8 groundwater bodies were at poor chemical status because of historical contamination from mining activities and industrial development.
- 2 groundwater bodies were at poor quantitative status nationally, both of which are located in the South Eastern River Basin District. The status assigned was due to impacts to a groundwater dependent terrestrial ecosystem (GWDTE).
- The average nitrate concentration in groundwater was below the threshold value of 37.5 mg/l NO_3 at 96% of the monitoring locations for the period 2007-2012. The south and south-east regions of the country continue to have the greatest proportion of monitoring locations with elevated nitrate concentrations.
- The average phosphate concentration in groundwater was below the threshold value 0.035 mg/l P at 93% of the monitoring locations during the period 2007-2012.
- Downward trends in nitrate concentrations were evident at 74% of groundwater monitoring locations, with a further 21% with stable levels.
- There has been a gradual decrease in phosphate concentrations across the WFD groundwater monitoring network, with 70% of sites having average phosphate concentrations less than 0.015 mg/l P in 2012 compared to 40% in 1995-1997.
- Certain locations have been identified as having upward trends in nitrate and phosphorus that could, if they continue, lead to failure to meet WFD objectives. Further analysis of these areas is required.
- There was a slight decrease in samples with positive detections of faecal coliforms during the reporting period. Groundwater sources for both public and private drinking water need to be protected to reduce the risk of illness from the consumption of contaminated water, particularly from spring sources.

Introduction

Groundwater originates as rainfall, or snow melt, that soaks through the soil to the underlying subsoil and bedrock. Groundwater flows from the upper reaches of catchments through interconnected spaces or fractures in the subsoil or bedrock to the streams, rivers, lakes or estuaries lower down in the valley. During periods when there is little or no rain, almost all the water flowing in the streams and rivers originates from groundwater. If the underlying gravel subsoil deposits and bedrock can yield enough water for a significant water supply, they are referred to as aquifers. A large proportion of the productive aquifers in Ireland are karstified limestone bedrock. 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[8]). Some attenuation of contaminants

8 Geological Survey of Ireland, 2000. The Karst of Ireland, GSI, Dublin.

may occur in the soil and subsoil that overlie the aquifer, consequently variation in subsoil and thickness play a critical role when characterising the vulnerability of groundwater to contamination.

The natural quality of groundwater varies as groundwater flows from recharge areas to springs or rivers. The groundwater chemistry may change as it passes through soils, sub-soils or bedrock with different mineralogy. In Ireland, limestone bedrock and limestone-dominated sub-soil are common, and consequently groundwater is often referred to as being “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 drinking 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 from human activities.

The quality of groundwater in Ireland is very good relative to other countries in Europe, based on the proportion of groundwater bodies at poor chemical status (EEA, 2013[9]). In the 2013 water quality indicator report covering the period 2004-2009, the European Environment Agency (EEA) indicates that excessive levels of nitrate are the most frequent cause of poor groundwater status across Europe. The EEA identifies agriculture as the main cause of the elevated nitrate concentrations. Pesticides and a range of other chemicals, such as heavy metals, also contribute to poor groundwater status in some areas of Europe.

Assessment of groundwater status (2007-2012)

The assessment of groundwater chemical and quantitative status in Ireland is based on representative monitoring points selected specifically for the Water Framework Directive (WFD) groundwater monitoring programme.

The European Communities Environmental Objectives (Groundwater) Regulations, 2010 define the criteria for groundwater body classification. 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 show the impacts of abstraction and pollutants on groundwater at the time of assessment. The groundwater bodies range in size from <1 km^2 to 1,884 km^2 which may be a consequence of the physical setting or the specific management objective. While the water body may be at good status, there can still be localised environmental risks, e.g. where the local pollution impacts on groundwater quality which is not substantial enough to impact on the status of the whole groundwater body.

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.

Five chemical and four quantitative tests have been developed to assess whether the WFD objectives are met. 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.

9 European Environment Agency (2013) Chemical Status Indicators for water across Europe http://www.eea.europa.eu/data-and-maps/indicators/wfd-indicator-chemical-status/assessment

Tests for assessing chemical status of groundwater include; looking for evidence of saline or other intrusions, exceedances of a range of quality standards and thresholds that would result in failure to achieve the environmental objectives of associated surface waters, groundwater-dependent terrestrial ecosystems, or drinking water protected areas. It also involves looking for evidence of deteriorating trends in quality. Tests for assessing quantitative status of groundwater focus on over-abstraction of groundwater and include; looking for evidence of saline or other intrusions due to change in groundwater levels, impacts on the environmental objectives of associated surface waters and groundwater-dependent terrestrial ecosystems due to alterations in groundwater levels, and assessing water balances to determine whether the available groundwater resource is exceeded by the long-term annual average rate of abstraction. Full details of status tests are available on the Agency's website[10].

A groundwater status update was carried out in December 2014 for a number of the main status sub-tests that caused groundwater bodies to be at "Poor Status", both quantitative and chemical, from the first River Basin Management Plan cycle. Further updates will be made to groundwater body status in 2015 following the completion of a groundwater body boundary review (physical characterisation) and further risk characterisation. EPA WFD groundwater quality data from 2007 to 2012 have generally been used where an update has been carried out, with trends based on data from 2000 to 2012, where available. Where the status update has not been carried out in 2014, the results of the status reported in 2011, based on EPA WFD groundwater quality data from 2003 to 2008, have been taken forward.

Installation of a monitoring well in Galway.

10 http://www.epa.ie/pubs/reports/water/ground/groundwaterthresholdvaluesandassessmentofchemicaland-quantitativestatus.html

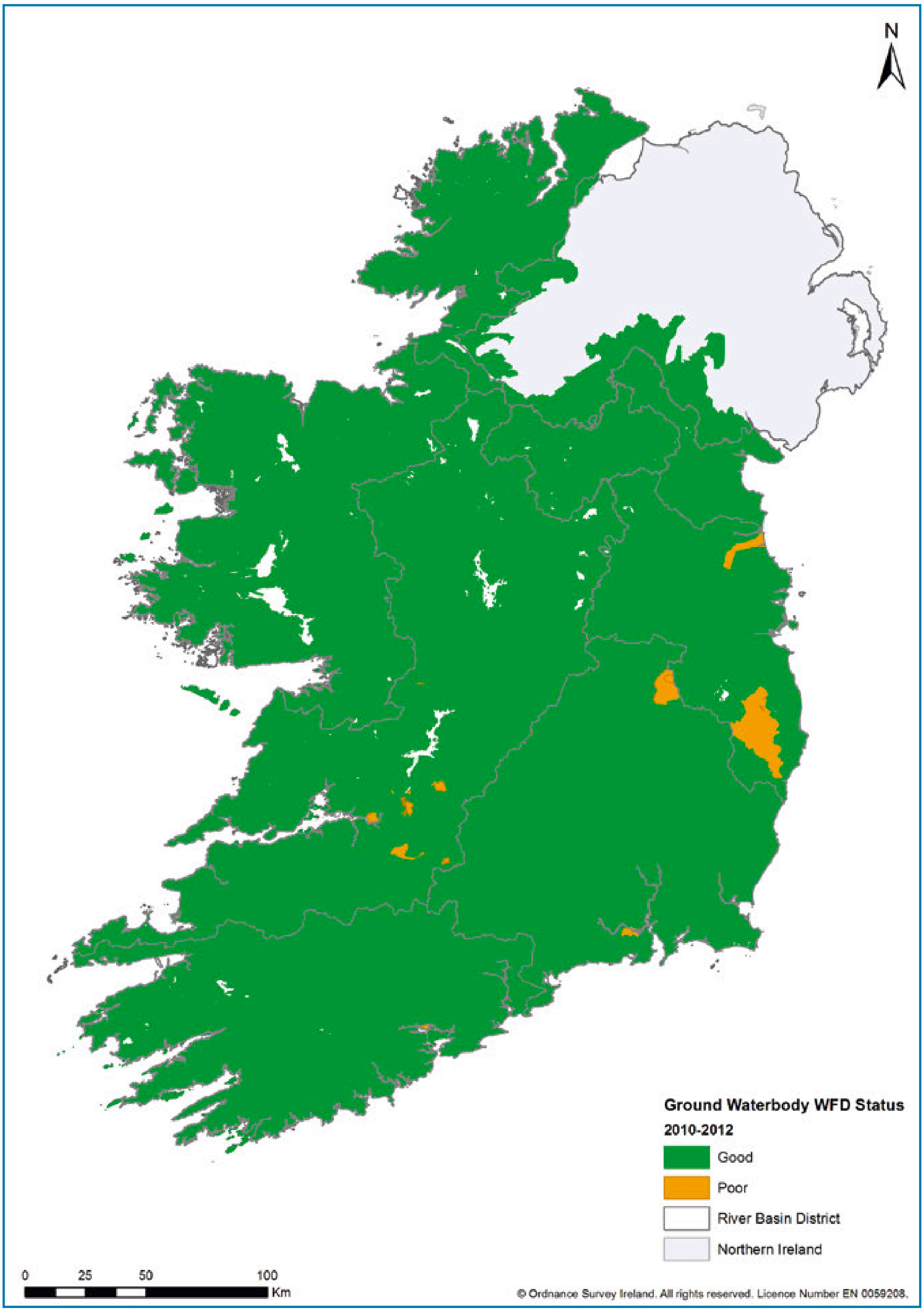


Figure 2-1. Status of groundwater bodies from December 2014 update.

The December 2014 status update (quantitative and chemical) has resulted in 1.7% of groundwater bodies being classified as poor status compared with 14% in 2011 (See **Figure 2-1** for the location of these poor status bodies). Of these, poor chemical status was assigned to eleven groundwater bodies in Ireland (1.5%) compared with 103 groundwater bodies (13.6%) in 2011 (see **Table 2-1** for a breakdown by River Basin District). In 2011, the majority of the poor status groundwater bodies in the Shannon and Western River Basin Districts were driven by the surface water classification test and the contribution of phosphate in groundwater to surface water bodies impacted by nutrient enrichment. The December 2014 update identifies that three groundwater bodies are at poor chemical status for phosphate contribution to rivers that were at less than good status because of diffuse and small point-source pressures.

Pressures from point-source activities, such as historic mines, contaminated land, and old dumps, may have adverse impacts on groundwater in the immediate area down gradient of the pollution source, but generally this pollution does not have a significant impact at a groundwater body scale. Eight groundwater bodies remain designated as being at poor chemical status because of widespread historical contamination from mining activities and industrial development, i.e. where the pollution extent is having a significant impact at a groundwater body scale. Four of these groundwater bodies are at poor status due to historic pollution from contaminated land sites, and the other four are at poor status due to historic mining activities.

Therefore, the major change in groundwater bodies from poor to good status is in those groundwater bodies that had been failing due to phosphate contribution to surface waters. This has resulted from the gradual reductions in phosphate concentrations seen nationally in recent years, which is discussed later in this chapter and presented in **Figures 2-10** and **2-11**.

Chemical status	Good		Poor	
River Basin District	**Water bodies (No.)**	**Area km²**	**Water bodies (No.)**	**Area km²**
Eastern	73	5,789	2	477
South-Eastern	149	12,869	2	24
South-Western	83	11,284	1	6
Shannon	236	17,503	6	97
Western	104	11,732	0	0
North-Western	72	7,421	0	0
Neagh Bann	28	1,805	0	0
National Total	**745 (99%)**	**68,403 (99%)**	**11 (1%)**	**604 (1%)**

Table 2-1. Groundwater chemical status.

The December 2014 status update has resulted in two groundwater bodies in Ireland being classified as at poor quantitative status (<1%) compared with three groundwater bodies in 2011 (See **Table 2-2** for a breakdown by River Basin District). This quantitative status update required the use of site-specific information, to determine whether significant abstraction pressures continued and resulted in a reduction of the number of groundwater bodies at poor status from three to two. This was related to the cessation of over-pumping of groundwater at a quarry.

Quantitative status	Good		Poor	
RBD	Water bodies (No.)	Area km²	Water bodies (No.)	Area km²
Eastern	75	6,266	0	0
South-Eastern	149	12,784	2	109
South-Western	84	11,290	0	0
Shannon	242	17,600	0	0
Western	104	11,732	0	0
North-Western	72	7,421	0	0
Neagh Bann	28	1,805	0	0
National Total	**754 (99%)**	**68,898 (99%)**	**2 (1%)**	**109 (1%)**

Table 2-2. Groundwater quantitative status.

There has been an overall improvement from 14% of the groundwater bodies in Ireland classified as being at poor status for the first WFD River Basin Management Plan (RBMP) (EPA, 2011[11]). **Table 2-3** below summarises the differences between the groundwater body status in December 2014 and that in 2011.

Groundwater Test	December 2014 Comment	May 2011 Summary		December 2014 Summary	
		Good Status	Poor Status	Good Status	Poor Status
Overall Chemical Status	Chemical Status was updated for the main "Poor Status" driver during the 1st cycle (Surface Water Test), with further updates to be made following risk characterisation in 2015.	653	103	745	11
Overall Quantitative Status	Quantitative Status was updated for the main "Poor Status" driver during the 1st cycle (Water Balance Test), with further updates to be made following risk characterisation in 2015.	753	3	754	2

Table 2-3. Summary of December 2014 status update results with summary of 2011 results for comparison.

The assessment of groundwater status does not include consideration of contamination by faecal matter. However, as will be described later in this chapter, the presence of faecal coliforms in groundwater is a widespread issue in vulnerable karst areas.

11 EPA (2011) Ecological Status and Chemical Status of Surface Waters and Chemical and Quantitative Status of Groundwaters. Prepared in fulfilment of Articles 24 and 25 of SI 272 of 2009 http://www.epa.ie/pubs/reports/water/waterqua/waterframeworkstatusupdate.html

Assessment of groundwater quality parameters

The Agency has gathered and presented data for parameters that are indicators of anthropogenic pollution (ammonium, nitrate, phosphate and faecal coliforms). Comparison is made with the appropriate WFD threshold values and standards for these parameters.

Ammonium

Microbiological reduction of nitrogen-containing compounds generally results in very low background concentrations of ammonium in unpolluted waters. Ammonium has a low mobility in soil and sub-soil. Its presence in groundwater 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 domestic wastewater treatment systems (such as septic tanks or similar systems).

Figures 2-2 and **2-3** summarise the mean ammonium concentration during the period 1995-2012 and 2007-2012 respectively for the 205 monitoring locations displayed in **Figure 2-4**.

The average ammonium concentration in groundwater was below the threshold value 0.065 mg/l N at 87% of the monitoring locations during the period 2007-2012. Of the 26 monitoring locations with average concentrations greater than 0.065 mg/l N, 10 had average concentrations greater than 0.15 mg/l N. Of these monitoring locations with elevated ammonium concentrations, in general, deep groundwater flow contribution is expected, and there is greater potential for natural reducing redox conditions and elevated ammonium concentration.

As reported in the 2007-2009 Water Quality in Ireland report (EPA, 2010) and highlighted in **Figure 2-2**, there was a significant increase in ammonium concentrations in the period 2007-2009, which has been attributed to rainfall being significantly above the long-term average during this 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.

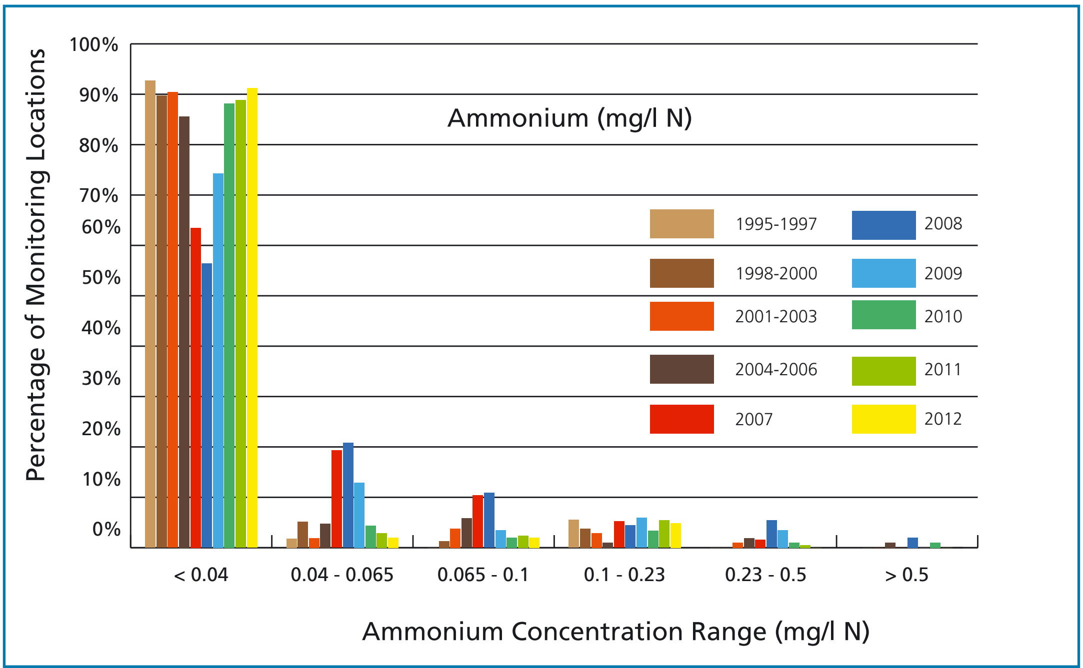


Figure 2-2. Comparison of the proportion of monitoring locations nationally over different reporting periods with mean ammonium concentrations in the ranges indicated.

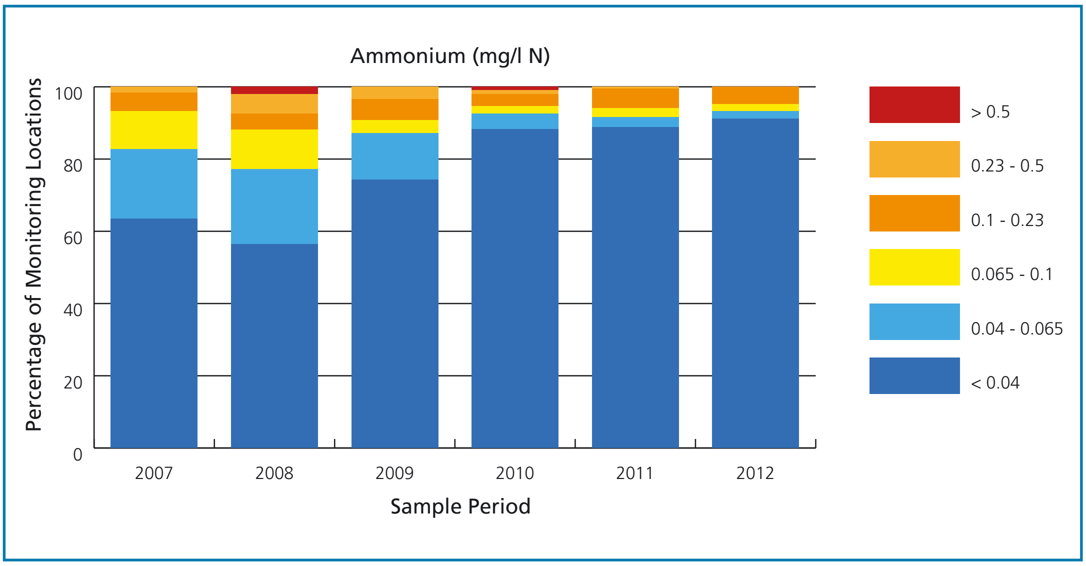


Figure 2-3. Comparison of the mean groundwater ammonium concentrations from 2007-2012 based on the national network.

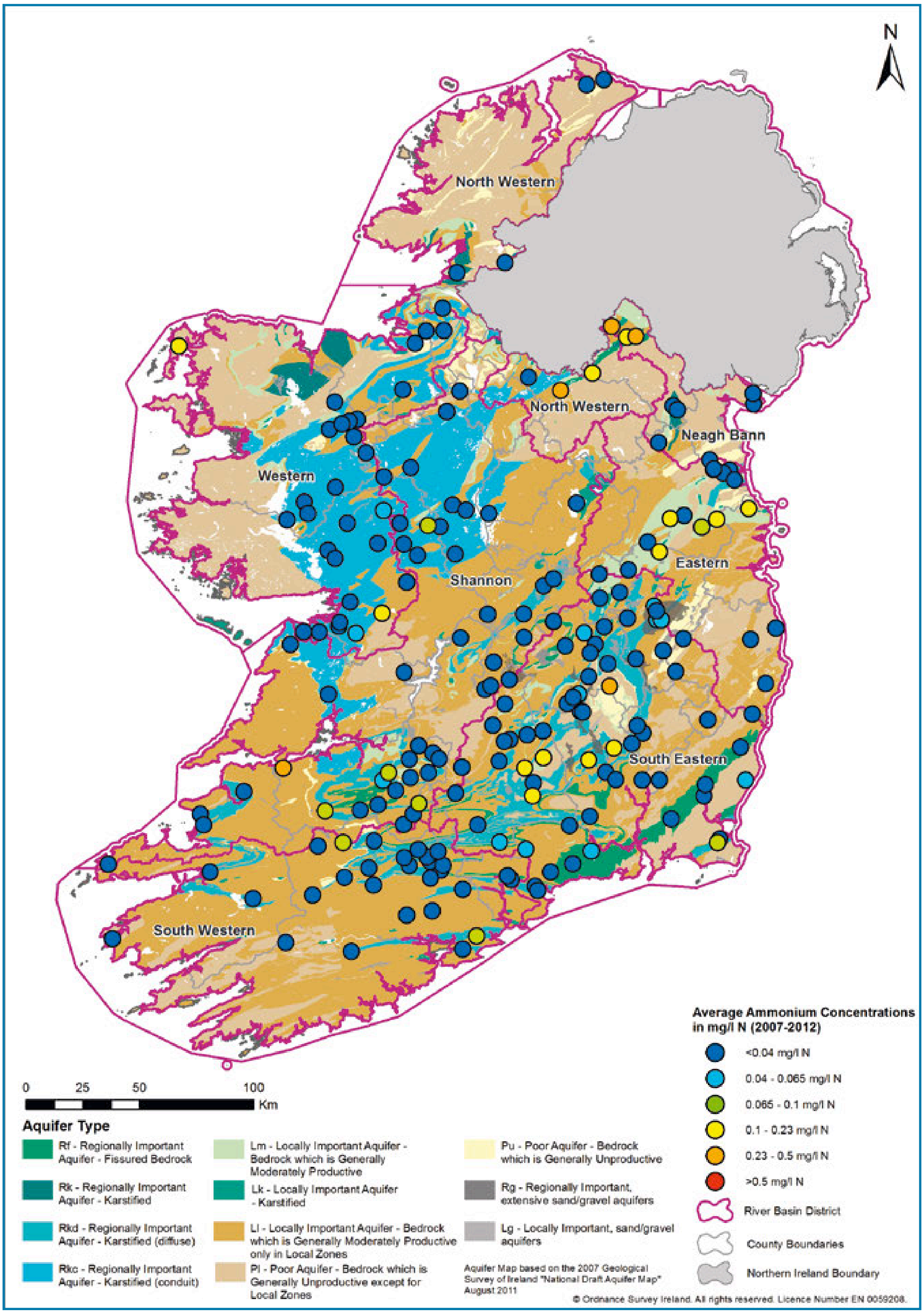


Figure 2-4. Mean ammonium concentration in groundwater 2007-2012 based on the national network. (Source: EPA, GSI)

Nitrate

Relatively low concentrations of nitrate are found naturally in groundwater, and concentrations higher than 10 mg/l of NO_3 are usually indicative of anthropogenic organic or inorganic inputs. Organic sources can include organic fertiliser, e.g. slurry, or effluent from domestic 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 impacts in downstream transitional and coastal waters.

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 Maximum Allowable Concentration (MAC) of 50 mg/l NO_3 being exceeded at the monitoring point at some time during the sampling period.

Figures 2-5 and **2-7** summarise the mean nitrate concentration during the period 1995-2012 and 2007-2012 respectively for the 205 monitoring locations displayed in **Figure 2-6**.

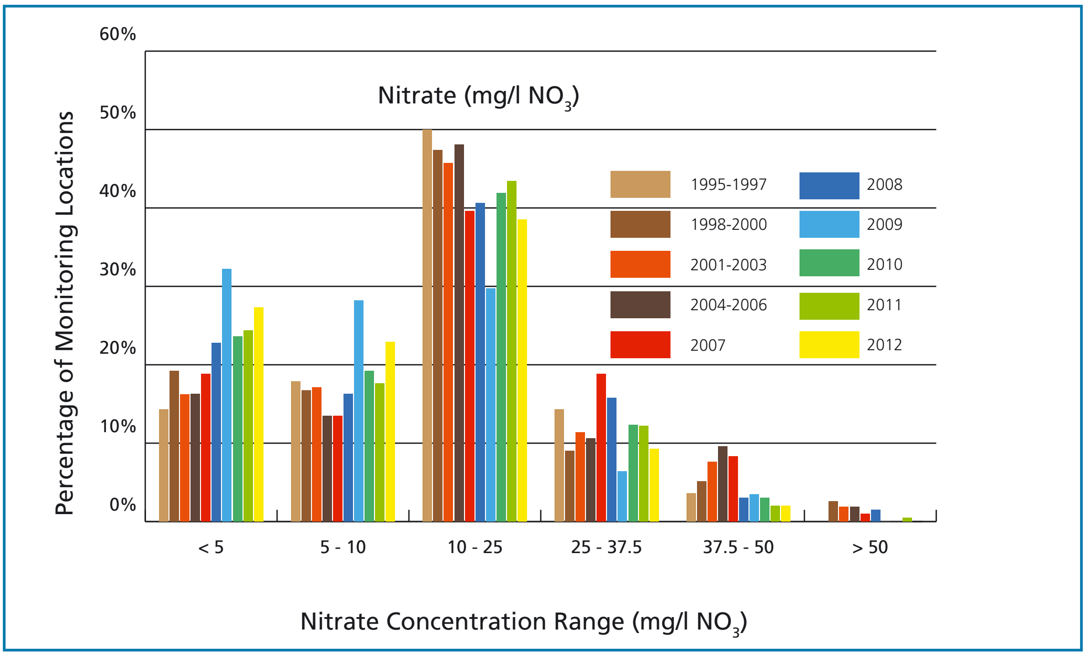


Figure 2-5. Comparison of the proportion of monitoring locations nationally over different reporting periods with mean nitrate concentrations in the ranges indicated.

The average nitrate concentration in groundwater was below the threshold value of 37.5 mg/l NO_3 at 96% of the monitoring locations for the period 2007-2012. All eight monitoring locations with average concentrations greater than 37.5 mg/l NO_3 are water supplies, and had samples with concentrations greater than the Maximum Allowable Concentration (MAC) of 50 mg/l NO_3 that is required under the Drinking Water Regulations (S.I. No. 122 of 2014[12]). One of these water supplies (Glanworth PWS (Tobermore), Co. Cork) had an average concentration greater than the drinking water standard of 50 mg/l NO_3. In situations like this, the EPA investigates and takes appropriate action, such as notifying the water services authority, to ensure that the water being supplied to the public (post-treatment) is meeting the appropriate Drinking Water Standard. In most instances, blending water from different sources or other treatment mechanisms is used by water service authorities to ensure that the water supplied to the public does not exceed the Drinking Water Standard.

12 European Union (Drinking Water) Regulations 2014 www.irishstatutebook.ie/pdf/2014/en.si.2014.0122.pdf

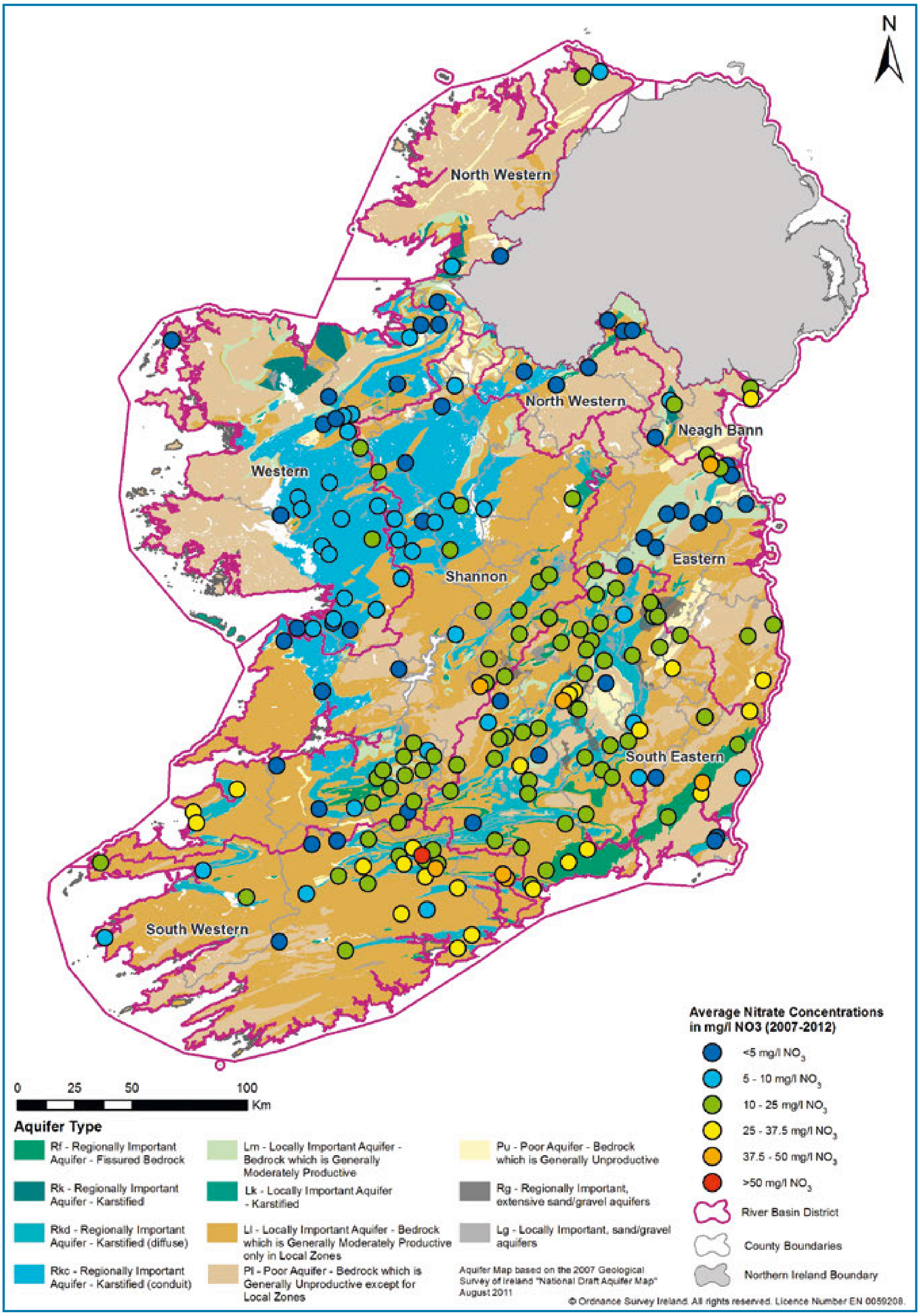


Figure 2-6. Mean nitrate concentrations in groundwater 2007-2012 based on the national network. (Source: EPA, GSI)

Figure 2-7 illustrates that there has been a gradual reduction in mean nitrate concentrations over the 2007-2012 reporting period, with the reductions in 2009 largely being attributed to the increase in annual rainfall, which Met Éireann indicate (Met Éireann, 2009[13]) was between 12% -

13 Met Éireann (2009), Year Summary 2009, December 2009 http://www.met.ie/climate/MonthlyWeather/clim-2009-ann.pdf

55% higher than the long-term average during that year. The reduction in nitrate concentration was particularly evident in the karstified aquifers in the south-east of the country. This is thought to have been caused by a combination of the above-average rainfall causing dilution, and the saturated ground conditions being unsuitable for landspreading of organic fertiliser.

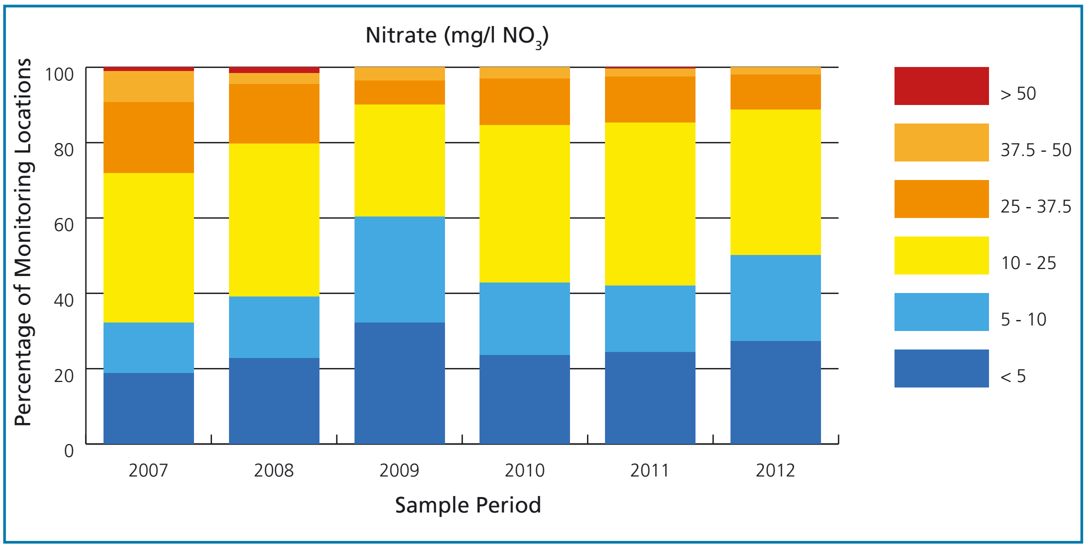


Figure 2-7. Comparison of the mean nitrate concentrations in groundwater from 2007-2012 based on the national network.

Figure 2-6 illustrates that the south and south-east regions of the country continue to have the greatest proportion of monitoring locations with elevated nitrate concentrations. Figures 2-8 and 2-9 show the breakdown of nitrate concentrations from 2007-2012 for the south-eastern and southern regions respectively. As is the case nationally, a gradual reduction in mean nitrate concentrations over the period is evident in both regions, but Figure 2-8 highlights the impact that the above-average rainfall in 2009 had on nitrate concentrations in the south-east. By contrast, a similar drop in nitrate concentrations is not seen in the southern region, although rainfall in 2009 was also well above the long-term average.

It is not possible to provide definitive reasons for the regional differences in 2009 without detailed analysis of the fertiliser applications for these regions. A possible explanation could be differences in land use between the regions, with the south-east region having a higher proportion of arable farming than the southern region. Another explanation could be differences in hydrogeology, with monitoring locations in the south-east having a higher proportion of regionally important karstified aquifers than those in the southern region. The latter is a more plausible explanation because the regionally important karstified aquifers offer greater potential for groundwater flow, and therefore greater potential for dilution.

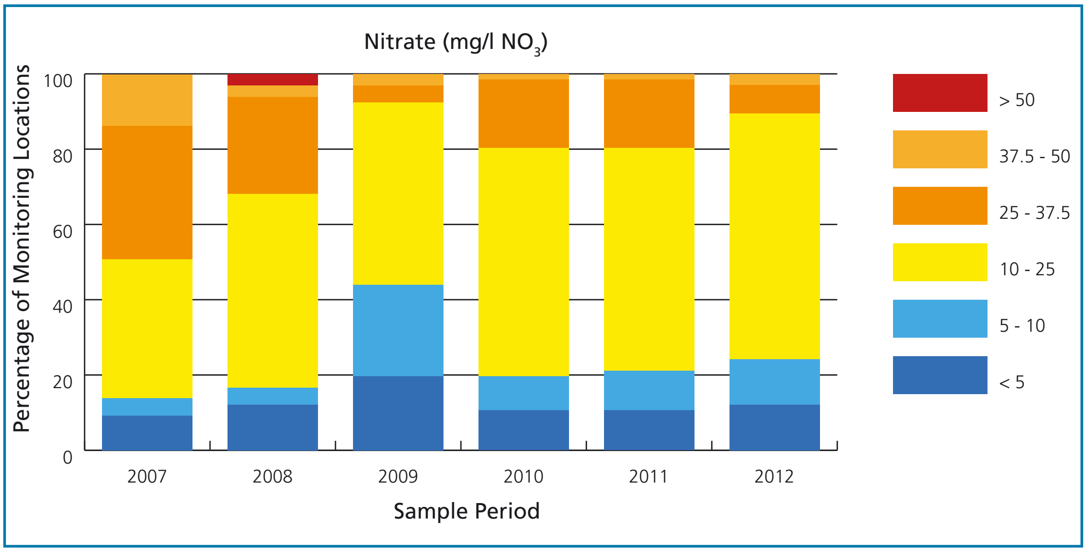


Figure 2-8. Comparison of the mean groundwater nitrate concentrations in the south-east region from 2007-2012.

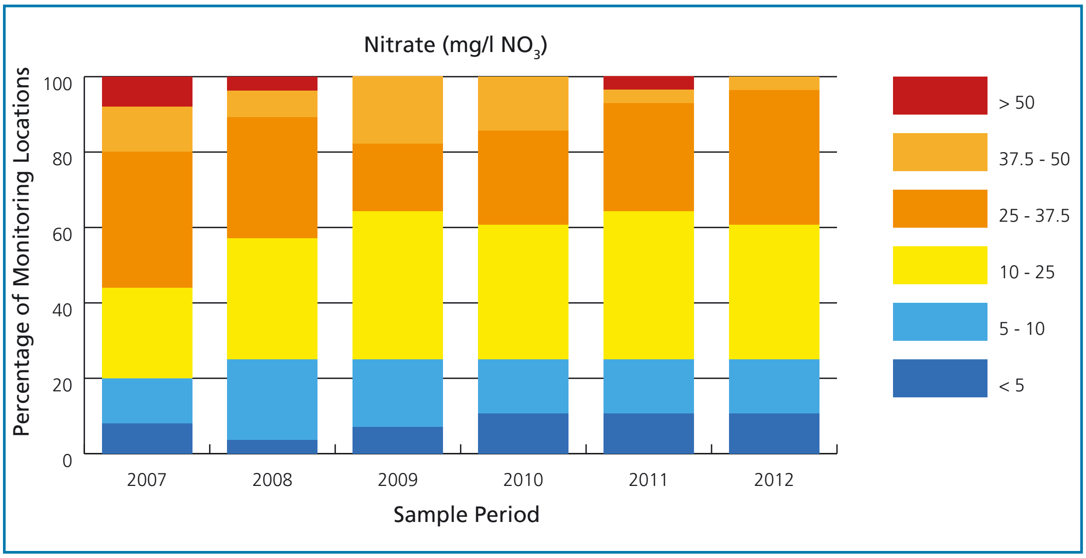


Figure 2-9. Comparison of the mean groundwater nitrate concentrations in the southern region from 2007-2012.

Phosphate

Phosphate is a major source of concern for surface waters because small amounts may lead to eutrophication of rivers, lakes and wetlands. Transport of phosphorus to surface water directly via piped wastewater effluent discharges or by near surface pathways, ditches and drains, particularly in areas with heavy soils, are understood to be the dominant mechanism for phosphorus loss. However, where phosphorus can enter groundwater, particularly those areas with shallow soils or bedrock exposed at the surface, groundwater may act as an additional nutrient enrichment pathway for surface water receptors further downstream.

The proportion of river flow coming from groundwater varies depending on the hydrogeology, with higher groundwater contributions seen from the regionally important aquifers, particularly the karst limestone aquifers. The catchments areas of rivers and lakes that are dominated by shallow soils and outcropping bedrock or free draining soils and sub-soils generally also have higher groundwater contributions. There are areas of the country, particularly the more productive regionally important karst aquifers, where 80% to 90% of the average surface water flow comes from groundwater. Consequently, if the phosphate concentrations in groundwater are elevated in areas where the groundwater contribution is high, then groundwater may be contributing significantly to eutrophication in rivers and lakes.

Figures 2-10 and **2-11** summarise the mean phosphate concentration during the period 1995-2012 and 2007-2012 respectively for the 205 monitoring locations displayed in **Figure 2-12**.

The average phosphate concentration in groundwater was below the threshold value 0.035 mg/l P at 93% of the monitoring locations during the period 2007-2012. Of the 14 monitoring locations with average concentrations greater than 0.035 mg/l P, four had average concentrations greater than 0.05 mg/l P.

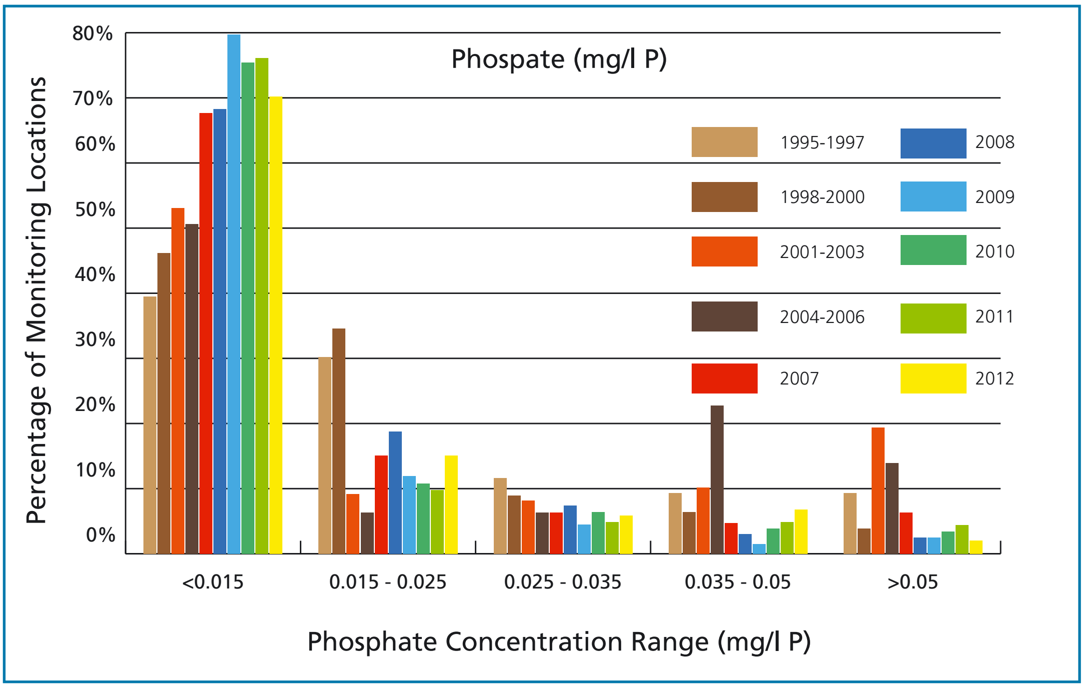


Figure 2-10. Comparison of the proportion of monitoring locations nationally over different reporting periods with mean phosphate concentrations in the ranges indicated.

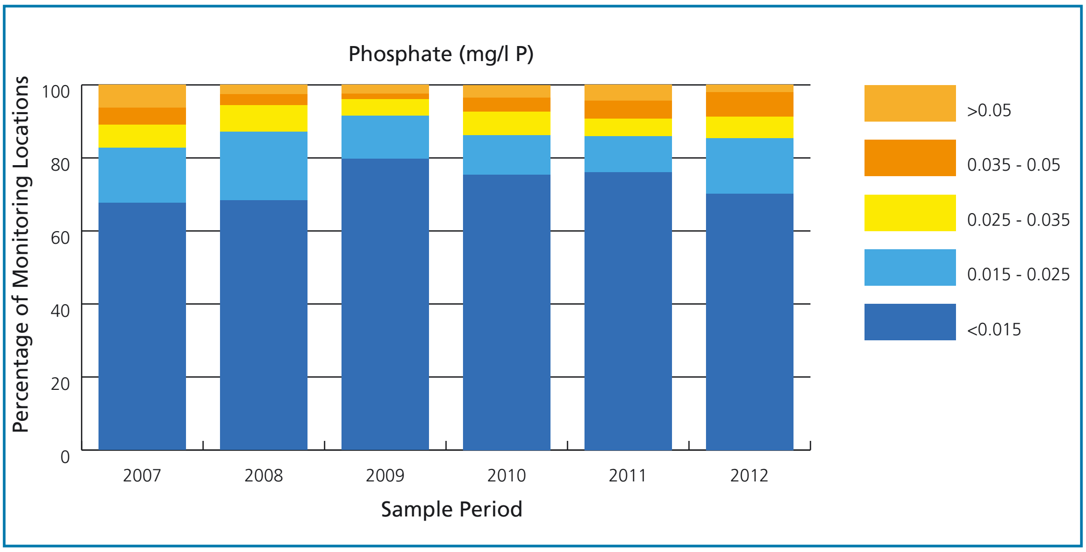


Figure 2-11. Comparison of the mean phosphate concentrations in groundwater from 2007-2012 based on the national network.

Figures 2-10 and **2-11** illustrate that nationally there has been a gradual decline in phosphate concentrations in groundwater. The WFD chemical status update in December 2014 determined that three groundwater bodies in counties Limerick and Louth were at poor status due to phosphate contributions from groundwater to rivers at less than good status (see **Figure 2-1**). This is compared to 95 water bodies at poor status due to groundwater phosphate contribution to rivers at less than good status, when assessed in 2011. In karstified limestone aquifers, it is estimated that groundwater contributes approximately 75% of the flow in the river. Therefore, although approximately 91% of groundwater monitoring locations nationally have average phosphate concentrations below the river environmental quality standard of 0.035 mg/l P, there is still potential for groundwater in certain areas to contribute a significant proportion of the phosphate load. This can be of significance at times of low flow, particularly during the summer period, when the combination of elevated nutrient levels, higher water temperatures, and the subsequent accelerated growth of aquatic algae and higher plant life can give rise to eutrophication. Consequently, any measures to improve the water quality in the river need to consider all potential pathways, including groundwater, that deliver phosphate to the river. The portions of the groundwater bodies that are within the catchment areas of the impacted rivers should be prioritised for investigation rather than the groundwater bodies as a whole. Within these areas, action should be focused where losses of phosphorus to groundwater are actually contributing to the water quality problems.

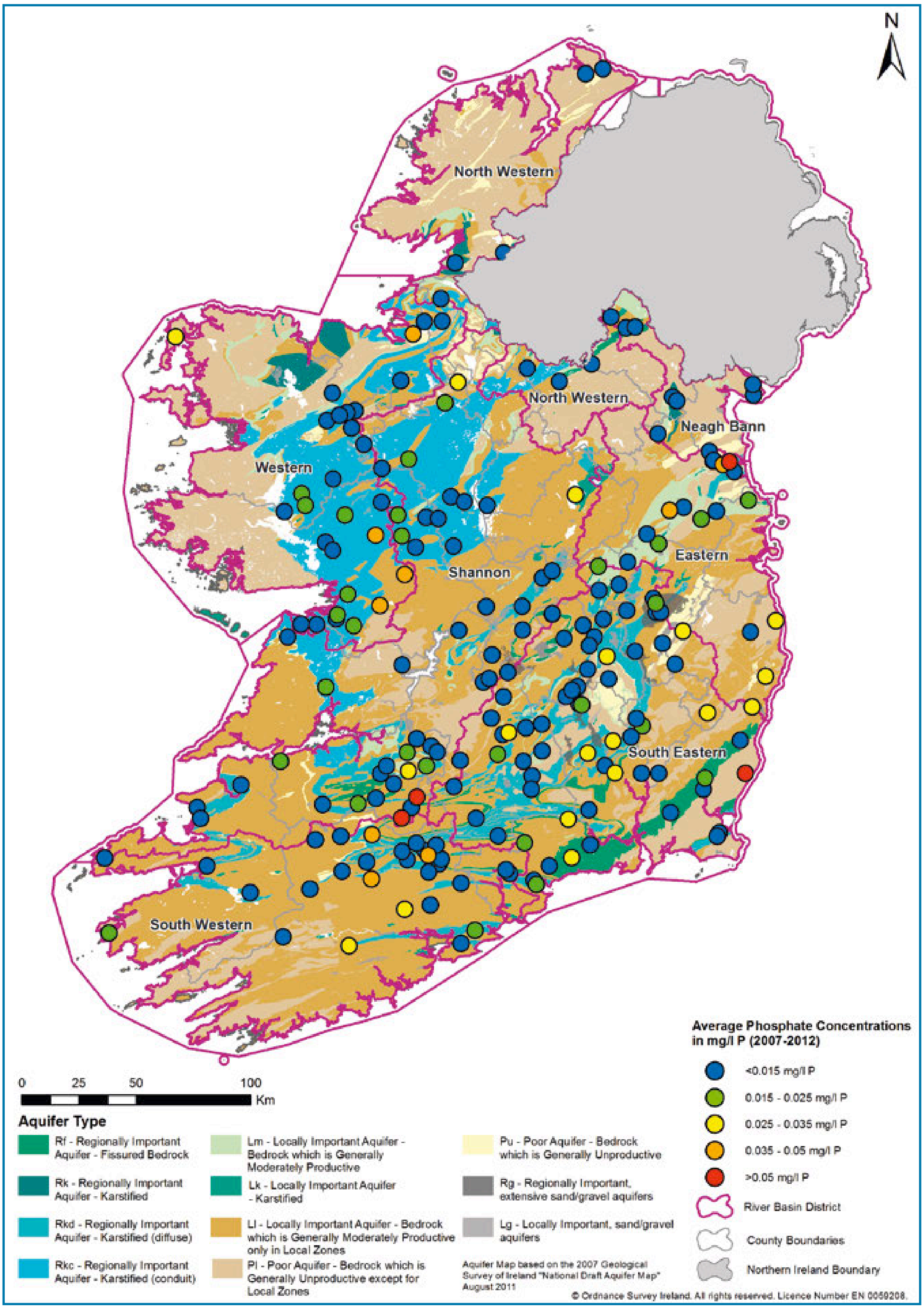


Figure 2-12. Mean phosphate concentrations in groundwater 2007-2012 based on the national network (Source: EPA, GSI).

Microbiological contamination

Microbiological contamination arises from the entry of faecal matter to waters. The main sources of microbial pathogens are domestic 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 sub-soils, 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 clayey sub-soils 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 sub-soils 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 also present, i.e. those organisms capable of causing disease (e.g. viruses and the parasitic protozoan *Cryptosporidium*). However, it should be noted that the absence of faecal coliform bacteria in groundwater does not mean that more persistent organisms, such as *Cryptosporidium,* are absent.

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 for removal', such as filtration or ultraviolet disinfection, are included in many areas susceptible to contamination by cyst-forming protozoa (e.g. *Cryptosporidium*), as chlorine has limited effectiveness. However, the majority of private groundwater supplies do not undergo any treatment prior to use which makes them particularly vulnerable. The delineation of source protection areas around water supplies can provide a means of targeting protective measures towards those land areas which pose the greatest risk to water supplies. The source protection area is based on the premise that 99.9% of bacteria will die off within 100 days in groundwater. Therefore, proper management of activities within this 100 day "time of travel" area could reduce the risk of bacteriological contamination of the water supply.

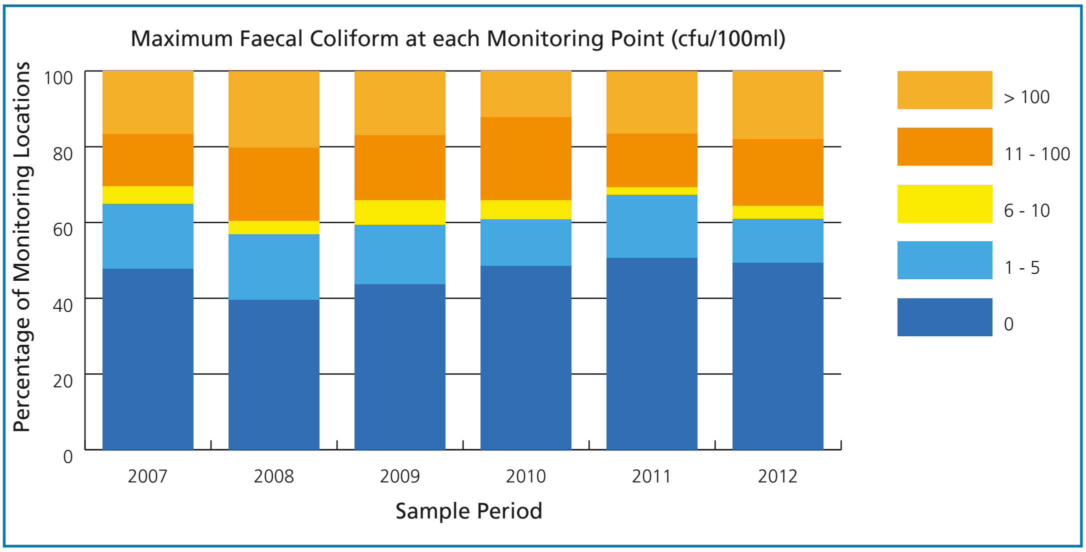


Figure 2-13. Comparison of the maximum number of faecal coliforms detected at monitoring locations from 2007-2012.

Figure 2-13 summarises the maximum number of faecal coliforms detected during the period 2007-2012 for the 205 monitoring locations. **Figure 2-14** shows the maximum number of faecal coliforms detected in 2012 at these monitoring locations. In 2012, positive counts were detected at 104 (51%) monitoring locations, with faecal coliform counts in excess of 100 cfu[14]/100 ml recorded in at least one sample at 42 (20%) of the monitoring locations. The drinking water standard (parametric value) for *E.coli* is 0 cfu/100 ml (EPA, 2013). **Figure 2-14** 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.

The presence of faecal coliforms in groundwater reflects the natural vulnerability of groundwater to contamination in some areas. Groundwater in areas with shallow soils, outcropping bedrock, or karst features, such as swallow holes, is more vulnerable to contamination than groundwater in those areas that are naturally protected by deep, heavy soils and sub-soils. **Figure 2-13** and **Figure 2-14** are a reflection of the vulnerability of groundwater, rather than necessarily being a true reflection of water quality. Nevertheless, the figures demonstrate that adequate levels of treatment and appropriate water supply catchment management strategies are required to ensure that the water supplied is safe to drink.

Whilst the majority of public water supplies and many group scheme supplies have appropriate levels of disinfection, this may not be adequate for certain viruses and parasitic protozoan, and therefore a dual approach of treatment and catchment management is needed. Catchment management also serves the purpose of protecting the water for private water supplies because these supplies may not have appropriate levels of treatment, and the sources of contamination may be 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.

14 Monitored as colony forming units (cfu)

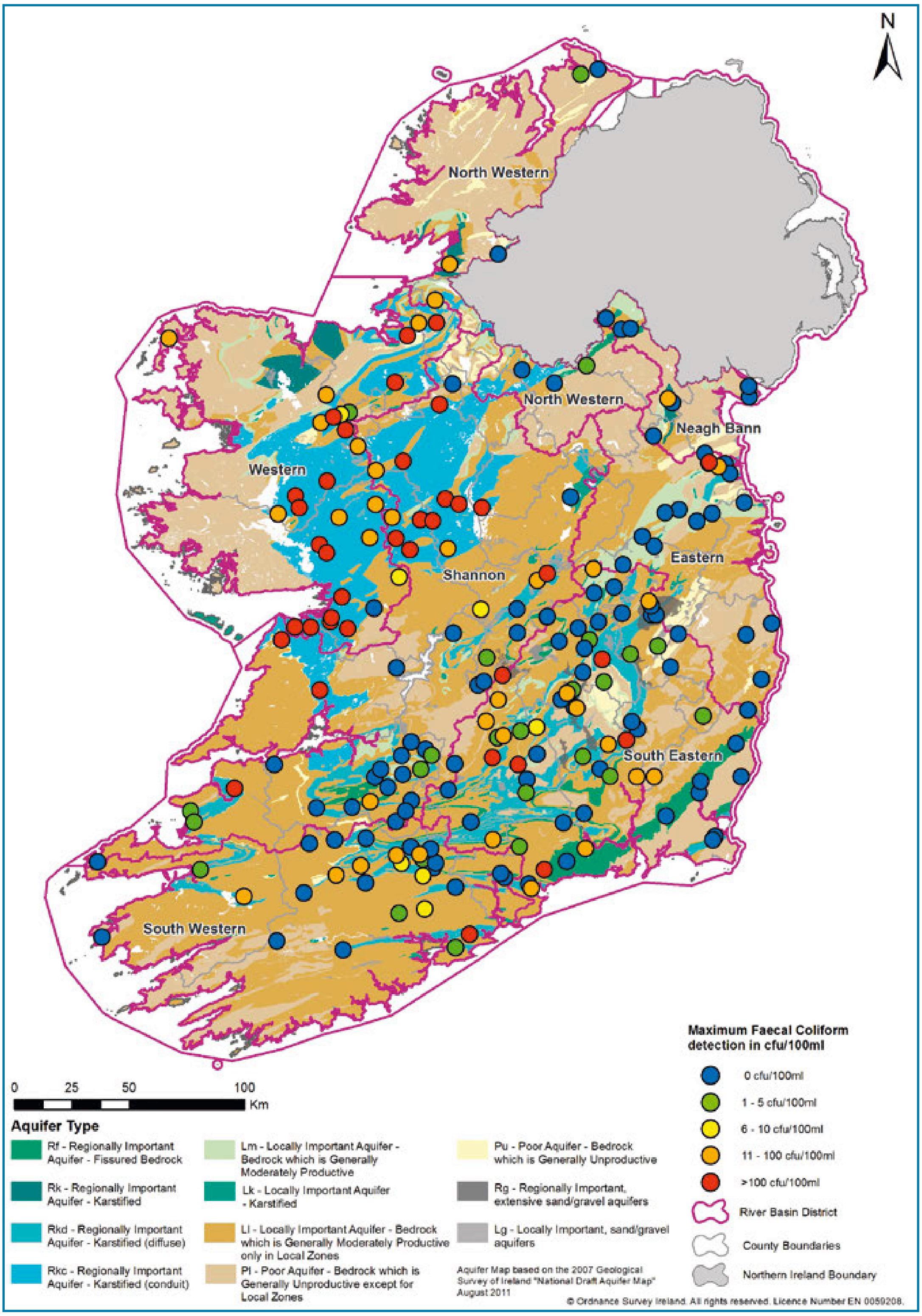


Figure 2-14. Maximum faecal coliform detections in groundwater in 2012. (Source: EPA, GSI)

Hazardous substances

Previous assessments of hazardous substances in Groundwater (EPA, 2010) have indicated that hazardous substances in groundwater are not considered to be a widespread national water quality issue. However, it is recognised that historical contamination from a small number of mining and industrial activities has resulted in significant localised groundwater pollution.

Analyses for pesticides in groundwater, as part of a series of national monitoring, have indicated that these do not contribute to a groundwater body scale issue, though local scale issues may exist. Consequently, in response to these findings, there has been a reduction in pesticide monitoring frequency.

The Surface Water Regulations (S.I. 272 of 2009) and Groundwater Regulations (S.I. 9 of 2010) introduced water quality requirements that triggered a review of existing industrial and waste licence conditions. These reviews have been the primary mechanism for addressing the water quality issues associated with these activities, and pollution issues will be addressed through licence conditions. The EPA has published guidance for licensees for dealing with such pollution (Guidelines for reporting compliance with the Groundwater Regulations). Studies and on-going monitoring are being undertaken by the Department of Communications, Energy and Natural Resources and the EPA at the sites of historical mines in Avoca, Silvermines and Tynagh, with the aim of minimising the impact of pollution at these locations.

Groundwater quality trends

The identification of statistically significant upward trends and the use of trends to demonstrate trend reversal are formal assessment requirements of the WFD for groundwater. In addition, the use of trend assessments is a key component in WFD groundwater risk characterisation, with trends used to predict where there is a risk of future deterioration in groundwater status. This is intended to enable the implementation of pre-emptive measures to minimise this risk.

Trend assessments were undertaken during the first WFD planning cycle and reported in the 2007-2009 EPA Water Quality in Ireland report (EPA, 2010[15]), indicating a relatively stable or slightly improving picture nationally with regard to groundwater quality trends. However, at the time of that report, trend assessments could not be undertaken for all sites due to data records being too short for trend assessments, and there was lower confidence in some of the detected upward trends because of the proportion of values in the data record that were below the limit of quantification. These trend assessments were produced to satisfy the reporting requirements of the Nitrates Directive (EPA, 2012[16]). This assessment indicated environmentally and statistically significant upward trends in nitrate concentrations at Redcross in Co. Wicklow and Fethard (Laffansbridge) in South Tipperary, as presented later in this chapter. These upward trends will require reversal.

Nitrate trend assessments

Of the eight monitoring locations with average nitrate concentrations greater than 37.5 mg/l NO_3 in the period 2007-2012, only one, Ballyhane, Co. Waterford, is predicted to have a nitrate concentration greater than 37.5 mg/l NO_3 by 2021. **Figure 2-15** shows the trend assessment for Ballyhane, where there is a statistically significant downward trend in nitrate concentration. However, due to high initial concentrations in groundwater, it is predicted that the trendline through the annual average concentrations will not drop below 37.5 mg/l NO_3 before 2021.

15 EPA (2010) Water Quality in Ireland 2007-2009, http://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2007-2009.html

16 EPA (2012) Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources ((1/676/EEC), Article 10 Report for the Period 2008-2011

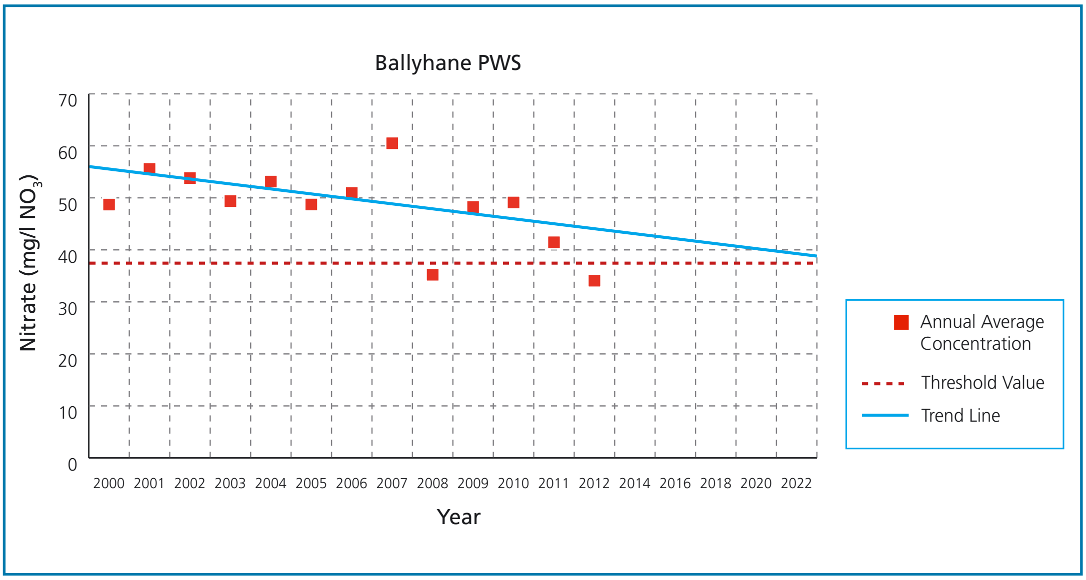


Figure 2-15. Nitrate trend assessment for Ballyhane Water Supply, Co. Waterford.

A report to the European Commission on the Nitrates Directive implementation in Ireland (EPA, 2012) indicates that downward trends in nitrate concentrations are evident at 74% of groundwater monitoring locations, with a further 21% showing stable trends. Upward trends were reported for 11 monitoring locations, two of which were considered to be environmentally significant. The nitrate trends for these monitoring locations at Fethard (Laffansbridge) Public Water Supply (PWS) in South Co. Tipperary and Redcross PWS in Co. Wicklow are shown in **Figures 2-16** and **2-17** respectively. Although the average nitrate concentration at these locations was below 37.5 mg/l NO_3 in 2007-2012, the concentration is predicted to increase above 37.5 mg/l NO_3 at these locations by 2021. Consequently, further investigation into the reasons for the elevated concentrations and measures to address these issues will be needed to ensure the threshold value is not breached.

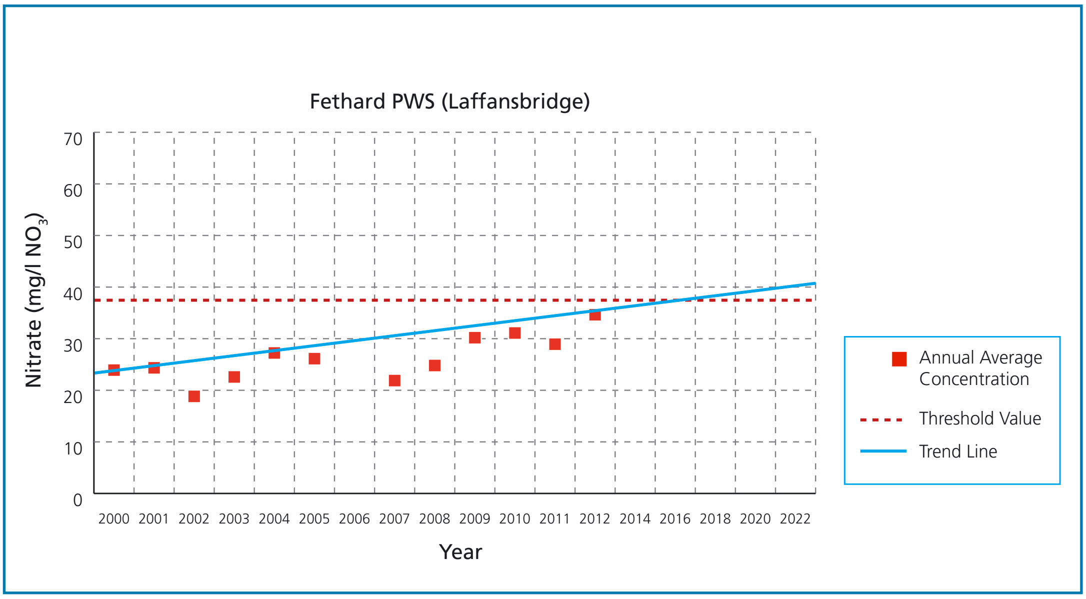


Figure 2-16. Nitrate trend assessment for Fethard (Laffansbridge) Water Supply, South Co. Tipperary.

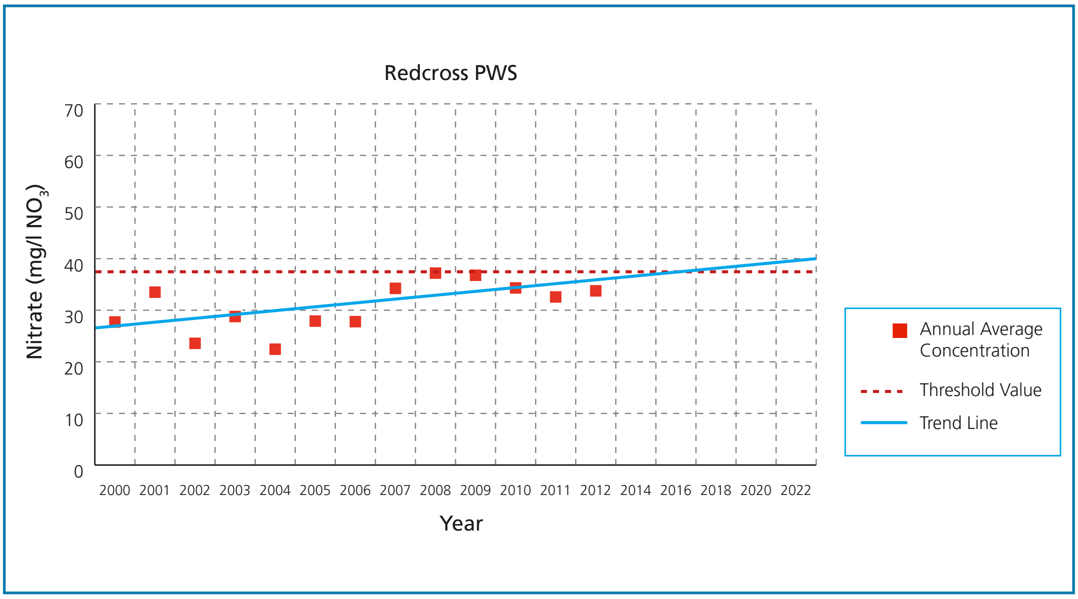


Figure 2-17. Nitrate trend assessment for Redcross Water Supply, Co. Wicklow.

Although statistically significant upward trends were not identified for Cappoquin PWS, Co. Waterford (**Figure 2-18**) and Ballyogarty PWS, Co. Waterford, there is a risk that the concentration in 2021 may exceed 37.5 mg/l NO_3. Therefore, further investigation and measures may also be required to ensure the threshold value is not breached at these locations.

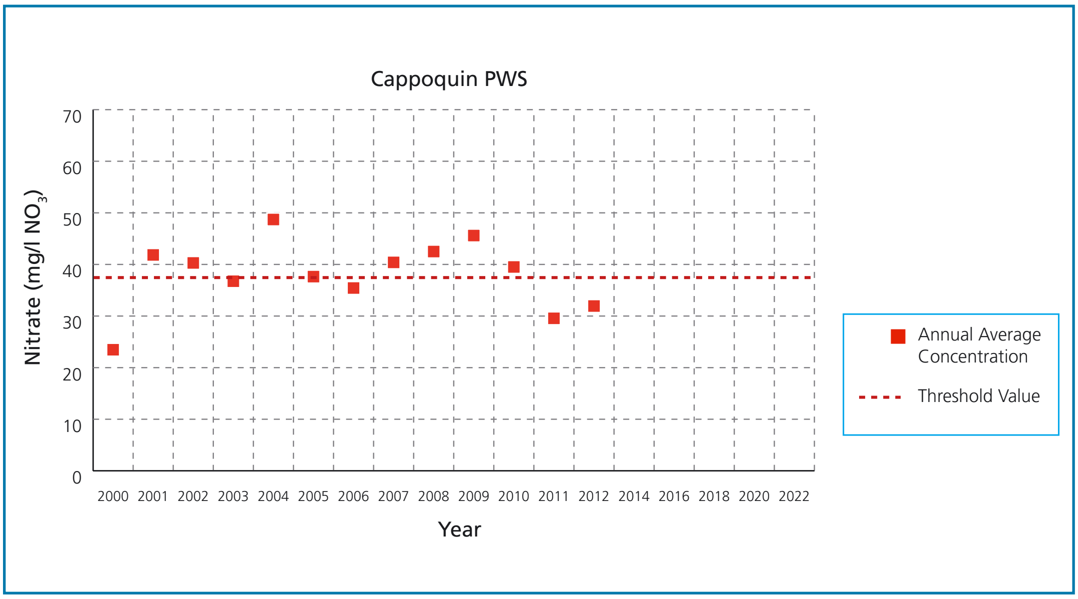


Figure 2-18. Nitrate trend assessment for Cappoquin Water Supply, Co. Waterford.

The only environmentally and statistically significant upward trends that were reported during the first WFD planning cycle were for nitrate at Durrow PWS, Co. Laois and Ballyheigue PWS, Co. Kerry. In 2009, the average nitrate concentration at these water supplies was greater than the threshold value of 37.5 mg/l NO_3, and there were statistically significant upward trends that predicted the average concentration would exceed 50 mg/l NO_3 by 2015 at both locations. The EPA conducted further investigations, including the assessment and development of a source protection zone for Ballyheigue (the Geological Survey of Ireland had already developed one for Durrow). In both cases, the primary pressure was agriculture; a mixture of tillage and dairy farming at Durrow, and primarily dairy farming at Ballyheigue. Both water supplies abstract from karstified limestone aquifers, with a high proportion of free draining soils and sub-soils in the catchment.

Figures 2-19 and **2-20** indicate that there have been marked decreases in nitrate concentrations at these water supplies since 2008. Whilst the drop in concentration during 2008 and 2009 can partly be explained by the above-average rainfall in the country, the subsequent concentrations have not returned to their pre-2008 levels, and the 2012 average concentrations were below the threshold value of 37.5 mg/l NO_3. This would imply that other factors, such as improved farm management practices, e.g. increased slurry storage infrastructure, reduced fertiliser applications, better farm management practices, and tightened regulatory controls, may have contributed to the water quality improvements.

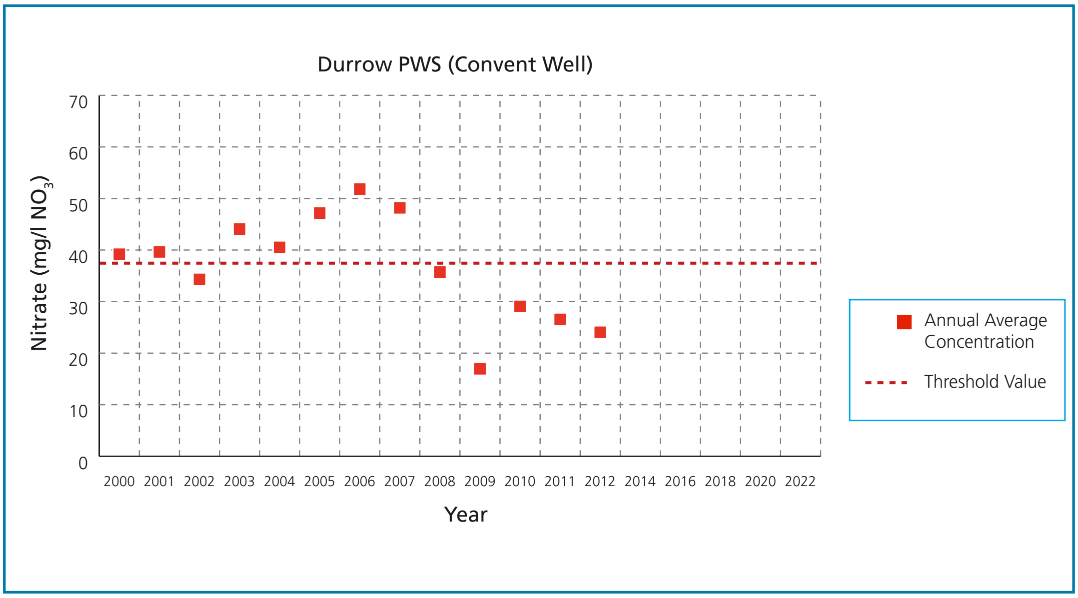


Figure 2-19. Nitrate trend assessment for Durrow Water Supply, Co. Laois.

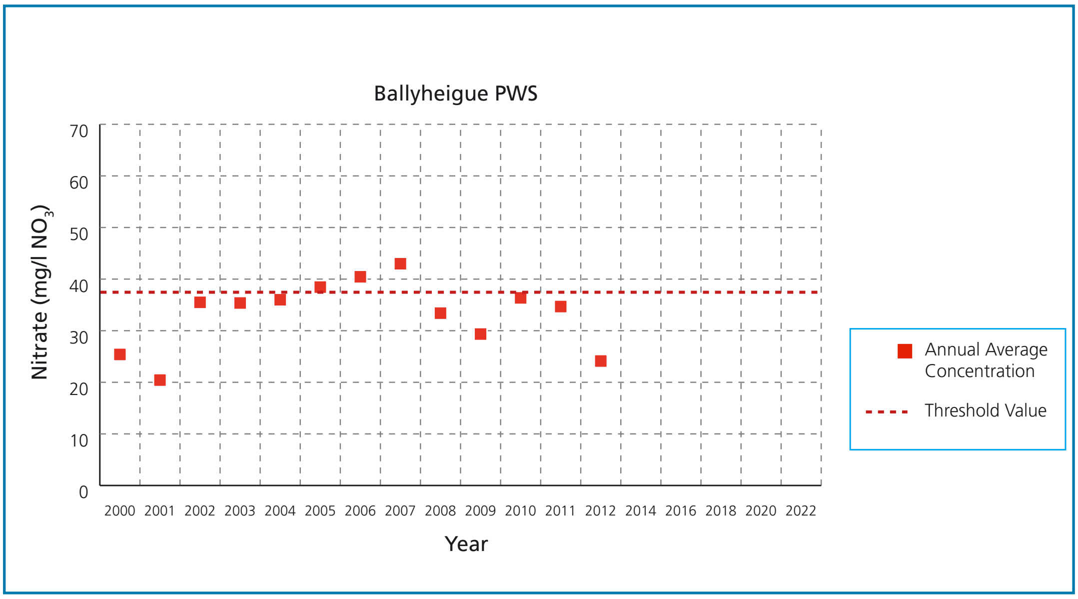


Figure 2-20. Nitrate trend assessment for Ballyheigue Water Supply, Co. Kerry.

Phosphate trend assessments

Nationally, there has been a gradual decline in phosphate concentrations in groundwater but this is not generally evident as statistically significant trends at individual monitoring points. Seven of the fourteen monitoring locations with average concentrations greater than 0.035 mg/l P during 2007-2012 had sufficient data records to undertake trend analysis. Of these, Mid-Galway, Co. Galway, New Inn (BH 1), Co. Galway, and Tobernalt, Co. Sligo (**Figure 2-21**) had statistically significant downward trends in concentrations. The trends at the remaining locations were relatively stable.

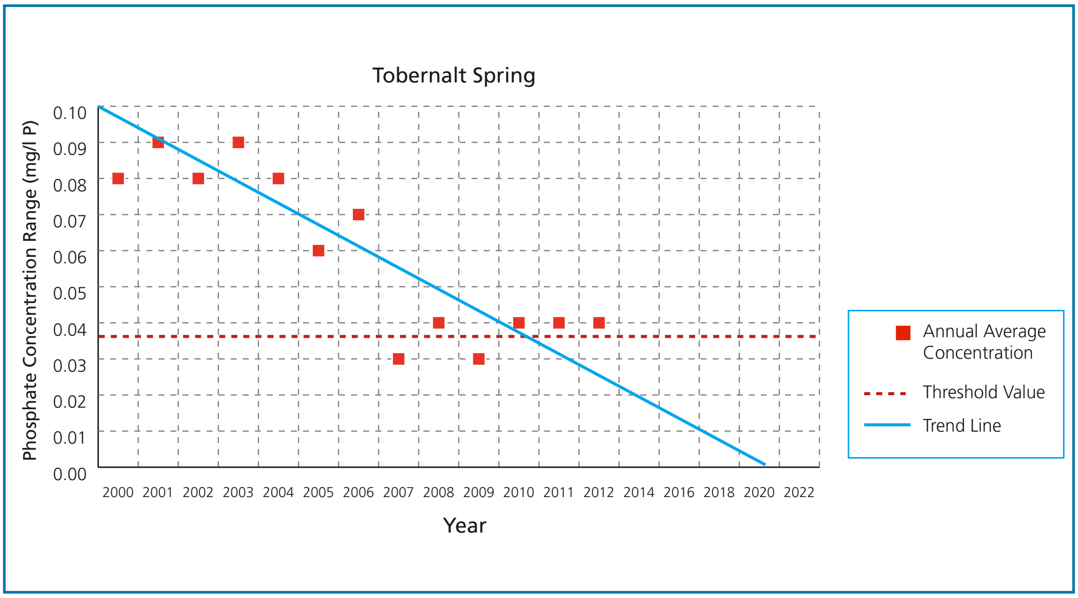


Figure 2-21. Phosphate trend assessment for Tobernalt Spring, Co. Sligo.

Where average concentrations were lower than 0.035 mg/l P in 2007-2012, statistically significant upward trends that would result in the concentration exceeding 0.035 mg/l P in 2021 were only detected at one monitoring location, Thurles Water Supply (Creamery Well), North Co. Tipperary (**Figure 2-22**). The presence of a significant upward trend means that the groundwater body will be investigated further in the risk characterisation process.

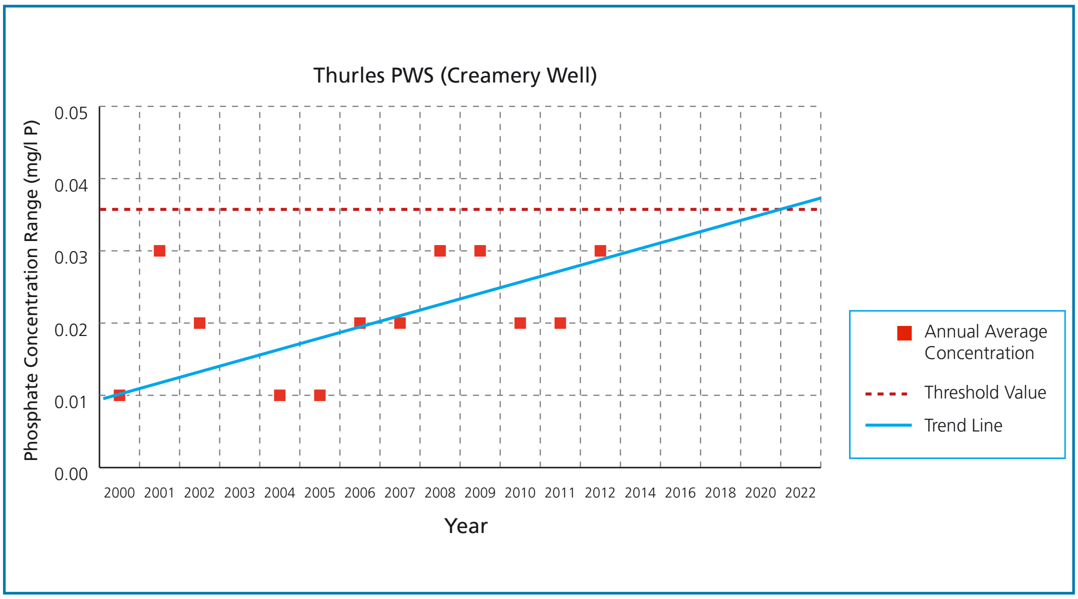


Figure 2-22. Phosphate trend assessment for Thurles Water Supply, North Co. Tipperary.

Conclusions

Groundwater is an important natural resource, both in terms of water supply and as a contributor to surface water receptors. A comprehensive assessment of groundwater quality requires an understanding of the whole groundwater system. 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 both the quantity of flow and the quality of the water in the aquifers. To prioritise measures to protect groundwater knowledge of the anthropogenic pressures, the hydrogeological characteristics of catchments (including the physical characteristics of the sub-surface deposits, i.e. soil, sub-soil and aquifer type) and groundwater quality data are required. It is through development of the understanding of the overall groundwater system that progress towards sustainable management of the groundwater resource can be achieved.

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. In some instances, it will not be feasible to meet this objective by the end of 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 at the end of this RBMP cycle. In these instances, it may take a number of years for the measures to bring about a reduction in concentrations because it will take time for pollutants to be attenuated or flushed through the system. If the appropriate measures are implemented, the objectives should be achievable. However, it is likely that it will not be technically or economically feasible to achieve good chemical status by 2027 for a small number of water bodies, such as groundwater pollution from historic mining activities. These bodies may 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.

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

There has been a general pattern of decreasing nitrate concentrations towards less than 10 mg/l NO_3 across WFD groundwater monitoring locations within the national network. 50% of sites had average nitrate concentrations less than 10 mg/l NO_3 in 2012 compared to 32% in 1995-1997. The number of monitoring locations with nitrate concentrations greater than 37.5 mg/l NO_3 reduced to only 2% of monitoring locations in 2012, with no locations having a concentration greater than 50 mg/l NO_3 in 2012. The general reduction in nitrate concentrations appears to be the result of a number of factors. Nationally, nitrate concentrations remain highest in the south-east and south of the country. There has also been a gradual decrease in phosphate concentrations across the WFD groundwater monitoring network in recent years, as 70% of sites had average phosphate concentrations less than 0.015 mg/l P in 2012 compared to 40% in 1995-1997. The reductions in inorganic fertiliser applications over the last decade, improvements in storage for organic fertiliser, and the implementation of Good Agricultural Practice Regulations, including landspreading restrictions, may have resulted in a reduction in pressures, thereby contributing to a reduction in nitrate and phosphate concentrations in groundwater. Following a slight increase in fertiliser sales in 2010-2012, the usage of inorganic nutrients should be monitored in relation to the potential for reversing the trend of increasing groundwater quality.

The reduction of phosphate concentration in groundwater has also been reflected in the 2010-2012 update to groundwater body status, where the number of groundwater bodies previously classified at poor status due to the groundwater contribution of phosphate to surface waters has significantly decreased. However, the contribution of phosphate from groundwater to associated ecosystems is still a risk because these ecosystems have limited capacity for additional phosphate. 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. When measures are introduced to improve surface water bodies, the groundwater pathway to surface water must be considered.

At all of the WFD groundwater monitoring locations, the mean ammonium concentrations were below the Drinking Water Maximum Allowable Concentration (MAC). The proportion of monitoring locations with ammonium concentrations less than 0.04 mg/l N has continued to increase, to approximately 91% of locations during in 2012. Approximately 7% of monitoring locations had average concentrations greater than the Environmental Quality Standard of 0.065 mg/l N in 2012. 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.

Microbiological contamination problems are 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. However, abstraction wells can be properly designed, installed and located in areas where the groundwater vulnerability is lower, and an adequate approach to water testing and treatment applied to reduce the potential for health impacts. There was a slight decrease in samples with positive detections of faecal coliforms during the reporting period. While improved storage facilities and the implementation of landspreading restrictions should help to reduce faecal coliform counts, faecal coliforms can, in places, by-pass the soils and sub-soil and get 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 faecal coliform counts greater than 100 cfu/100ml.

Recommendations and follow-up actions

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 the 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.

A groundwater status update was carried out in December 2014 for a number of the main status sub-tests that caused groundwater bodies to be at "Poor Status", both quantitative and qualitative, from the 1st River Basin Management Plan (RBMP) cycle. This update was based on data gathered up to the end of 2012. Work on further risk characterisation, in particular point source characterisation (e.g. contaminated land), characterisation of groundwater-dependent terrestrial ecosystems, and a groundwater body boundary review (physical characterisation), will be carried out during 2015. There will be a further update to status for the 2017 RBMP, taking account of this updated information for all risk assessments. These will drive future measures and action. For groundwater, this will include addressing groundwater bodies at risk of failing the WFD status objectives, for example relating to point source issues, or those groundwater bodies failing their water quality trends objective and requiring trend reversal. The improved understanding obtained through the characterisation process will also be used in a review of the groundwater WFD monitoring programme.

3. RIVERS AND CANALS

Authors: Catherine Bradley, Peter Webster, John Lucey, Martin McGarrigle, Patricia McCreesh, & Tara Gallagher (Inland Fisheries Ireland).

- 53% of monitored river water bodies (858) were at satisfactory ecological status, up 1% since the previous period.
- Of 13,300 kilometres of river channel length monitored using the biological Q value scheme, water quality was in high or good condition along 73% of the monitored river channels. This was up 4% from the last monitoring period and includes an overall increase in high status sites. Serious pollution resulting from urban wastewater and industrial pollution was reduced to 17 km of river channel length. This was down from 53 km in 2009.
- The two most important suspected causes of pollution are agriculture and municipal sources, accounting for 53% and 34% of cases respectively.
- Trends in nitrogen indicate that concentrations in rivers were generally reducing (52% of sites assessed) or stable (41% of sites assessed). The greatest reductions were in the intensive agriculture areas in the South-East and Midlands.
- Trends in phosphorus concentrations in rivers were stable in most parts of the country (69% of sites assessed). 24% of sites assessed showed decreasing concentrations.
- Fish kills were at an all-time low, with 70 recorded between 2010 and 2012 compared to 72 in the previous period, and 235 in the 1980s when it was at its highest.
- The level of compliance with Environmental Quality Standards for specific pollutants (hazardous substances) was high, with the main issue being naturally-occurring metals in known, mineral-rich mining areas.
- In general, the level of compliance with the Environmental Quality Standards (EQS) for priority and priority hazardous substances was very high. Polyaromatic hydrocarbons (PAHs) did show widespread exceedances of the EQS. However, these have been identified at EU level as ubiquitous persistent, bio-accumulative and toxic substances (uPBTs) which occur widely in the environment on a global scale, due principally to atmospheric deposition.
- The Grand and Royal Canals achieved good ecological potential. The canalised section of the Shannon-Erne Waterway was compliant with all water quality standards. However, the ecology of the canal was compromised by the hydromorphology of the canal (box-shaped profile) which makes it unsuitable for macrophyte and macroinvertebrate communities to develop. Therefore, they scored poorly.

Introduction

This chapter is based on the results from the second three-year survey of the WFD river monitoring programme (2010-2012). It also contains some minor revision of the results for the 2007-2009 period, following improvements in the assessment methods. Nationally, the adjustments in status for 2007-2009 were; High (13% to 12%) and Good (39% to 40%), with no change in other categories.

Under the Water Framework Directive requirements, the lowest scoring quality element determines the site's ecological status and the lowest scoring site determines the overall ecological status of a river water body. A river water body can have more than one monitoring site within its boundary. All operational and surveillance biological monitoring sites are examined and scored on their aquatic macroinvertebrate community.

Monitoring of water quality of Irish rivers has been undertaken since 1971, and while WFD Status is now the main mechanism for tracking environmental change, this report also assesses trends over the past three to four decades based on the parameters in use over that period.

During the 2010-2012 period, biological assessments were made at over 2,800 sites, and assessment of the supporting physico-chemical parameters, including nitrate, phosphate, BOD and ammonia, was undertaken at over 1,280 river sites. 180 representative surveillance monitoring sites were also sampled for a full suite of quality elements, including dangerous substances.

The chapter presents results at national and at individual River Basin District level. It also contains a summary of fish kill incidents recorded by Inland Fisheries Ireland (IFI), as well as an account of suspected causes of pollution compiled by the Agency. An assessment of canal water quality monitoring results compiled by IFI, on behalf of Waterways Ireland, is also presented.

Water Framework Directive ecological status

Under the WFD, water bodies are classified into five quality classes using a combination of biological quality elements, such as the macroinvertebrate fauna, macrophyte flora, fish communities, the supporting general physico-chemical conditions, and hydromorphology.

A total of 3,051 monitoring sites were used for ecological status assessments representing 1,624 river water bodies. **Figure 3-1** provides a breakdown of the ecological status nationally for the 2007-2009 and 2010-2012 periods. In the 2010-2012 period, 53% (858) of monitored river water bodies were classified as being at high or good ecological status, with 47% (766) classified at less than good ecological status.

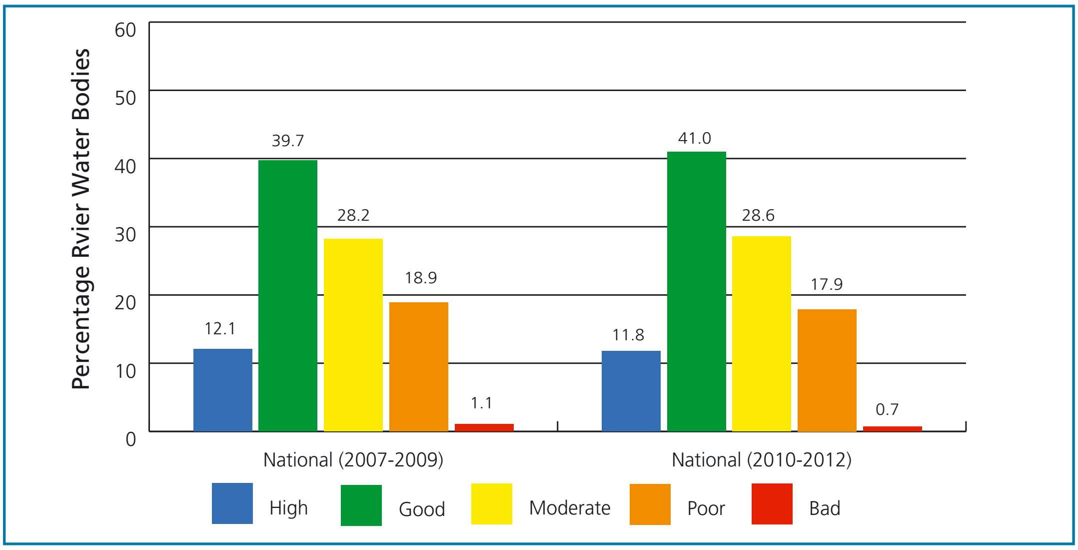


Figure 3-1. Comparison of Ecological Status between the two survey periods (2007-2009 (n= 1,573) and 2010-2012 (n=1,624)).

Table 3-1 provides a breakdown of the ecological status by river basin district (RBD) for the survey period. The less-densely populated South-Western and Western River Basin Districts continue to be ranked as the least polluted districts (**Table 3-1**). The more-densely populated and economically-developed east and north-east parts of the country are most affected by water quality degradation (**Figure 3-2**).

River Basin District	Number of Water bodies	High	Good	Moderate	Poor	Bad	Total
South-Western	278	71	132	62	13	0	278
		26%	47%	22%	5%	0%	100%
Western	276	52	139	62	21	2	276
		19%	50%	22%	8%	0.7%	100%
North-Western	213	21	72	45	71	4	213
		10%	34%	21%	33%	1.9%	100%
Shannon	393	25	176	108	81	3	393
		7%	45%	27%	21%	0.8%	100%
South-Eastern	285	17	103	117	47	1	285
		6%	36%	41%	16%	0.4%	100%
Eastern	144	5	37	58	43	1	144
		3%	26%	40%	30%	0.7%	100%
Neagh Bann	35	1	7	12	15	0	35
		3%	20%	34%	43%	0%	100%
National	**1,624**	**192**	**666**	**464**	**291**	**11**	**1,624**
		11.8%	**41.0%**	**28.6%**	**17.9%**	**0.7%**	**100%**

Table 3-1. Breakdown of the monitored river water bodies by ecological status categories at River Basin District (2010-2012).

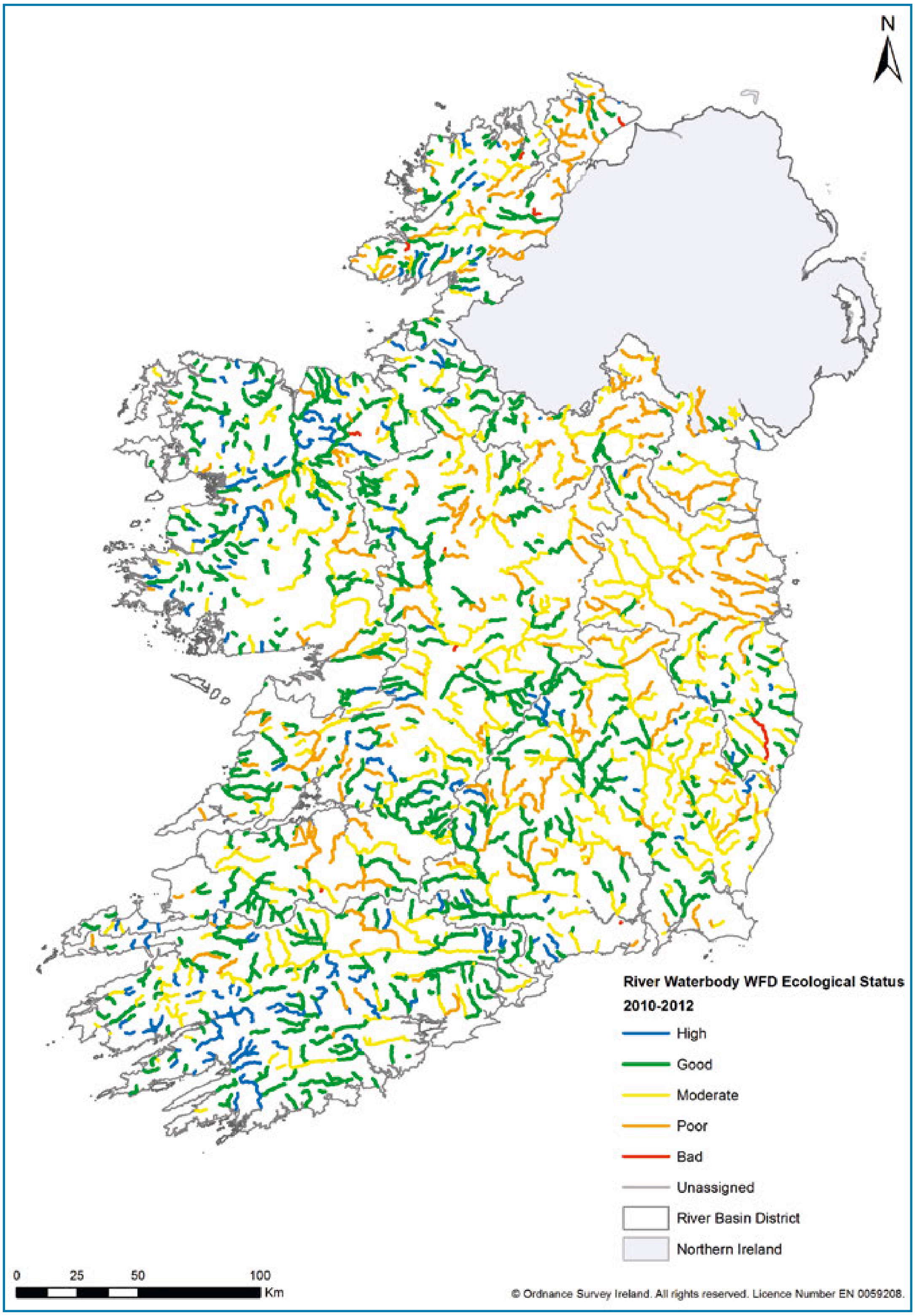
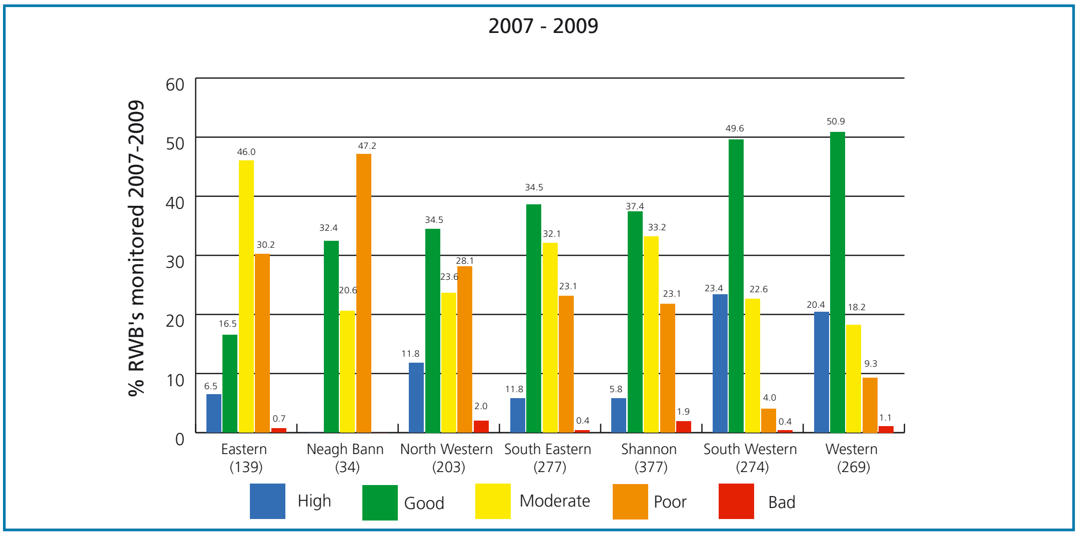


Figure 3-2. Map of ecological status for monitored river water bodies (n = 1,624) based on the lowest status by quality element and the lowest status by monitoring station within each water body.

Trends at River Basin District level

The percentage breakdown of the number of monitored river water bodies within each of the five ecological classes by RBD is shown in **Figure 3-3**. There were improvements in the percentage of the number of satisfactory river water bodies (i.e. high or good ecological status) in the Eastern RBD and Shannon RBD, while the South-Western RBD remained stable. A decline in the percentage number of satisfactory river water bodies was observed in the Neagh Bann and North-Western International RBDs, and in the South-Eastern and Western RBDs (**Figure 3-3**). However, the percentage of river water bodies classified at poor ecological status decreased in the Neagh Bann IRBD and the South-Eastern RBD, with a corresponding increase in river water bodies defined at moderate ecological status. There have been declines and improvements noted in all RBDs during the current survey period.



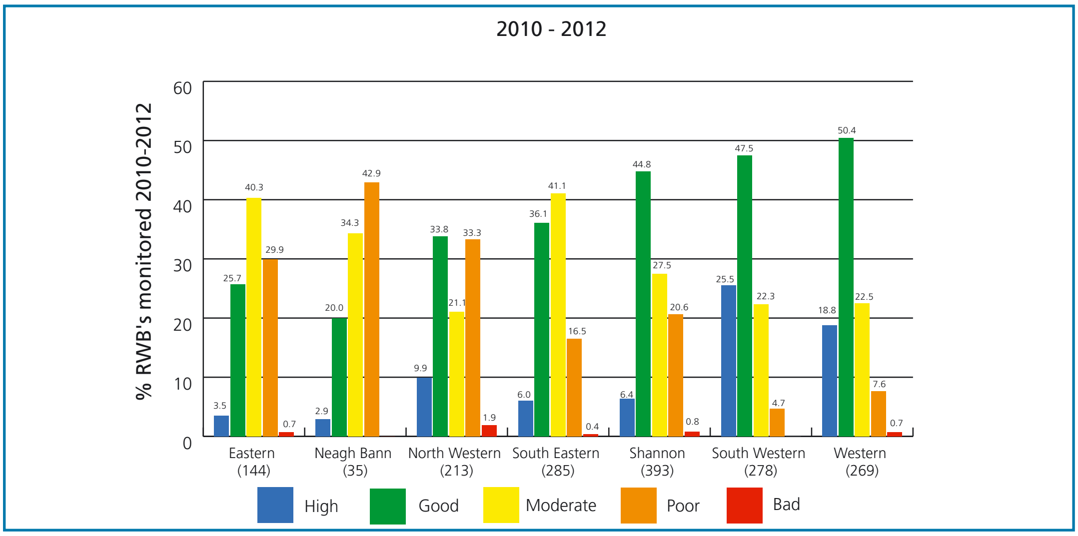


Figure 3-3. The percentage breakdown of the monitored river water bodies within each RBD, showing the final ecological status based on the lowest status for the available range of biological and physico-chemical quality elements within each water body between the two survey periods 2007-2009 and 2010-2012.

Table 3-2 illustrates the changes in river water body status between the two survey periods at the river basin district and national level. At the national level, 1,051 monitored river water bodies maintained their status. 579 river water bodies maintained a satisfactory status, while a total of 472 river water bodies remained at unsatisfactory status with no further declines. A total of 268 monitored river water bodies improved on their reported ecological status between the two survey periods. Satisfactory improvements, i.e. reached at least good status, were evident at 150 of the river water bodies. Improvements were also evident at 74 river water bodies but not to good status. Although 57 river water bodies declined from high ecological status, a further 44 river water bodies improved from good to high ecological status in their latest assessment.

Number of River Water Bodies	Eastern	Neagh Bann	North-Western	South-Eastern	Shannon	South-Western	Western	National
Status Maintained	90	22	135	164	244	206	190	1,051
Maintained Satisfactory	18	6	62	74	121	153	145	579
Remained Unsatisfactory	72	16	73	90	123	53	45	472
Status Improved	25	4	25	61	83	37	33	268
Satisfactory to High	1	0	3	5	10	18	7	44
Unsatisfactory to Satisfactory	15	2	15	32	50	17	19	150
Improved still Unsatisfactory	9	2	7	24	23	2	7	74
Status Declined	22	7	37	48	48	31	41	234
Loss of High to Good	6	0	5	2	8	12	10	43
Satisfactory to Unsatisfactory	7	5	20	39	25	17	26	139
Unsatisfactory (further decline)	9	2	12	7	15	2	5	52
Overall Gains/ Losses	3	-3	-12	13	35	6	-8	34
Total No. monitored	**144**	**35**	**213**	**285**	**393**	**278**	**276**	**1624**

Table 3-2. Comparison of the changes in river water body status between the 2007-2009 and 2010-2012 survey periods at the RBD and national level.

The ecological status of 234 monitored river water bodies declined between the 2007-2009 and 2010-2012 survey periods, 139 of these water bodies declined to unsatisfactory ecological status. There was a total loss of 57 high status water bodies, the majority declining to good status (43). However, 14 of these river water bodies declined to unsatisfactory status. Further declines were also observed at 52 water bodies, which were already deemed unsatisfactory in the 2007-2009 survey. A total of 71 river water bodies monitored in the 2010-2012 period were not surveyed in the 2007-2009 period, therefore no comparison was possible between the two periods.

Trends were also examined at the river basin district level. The number of river water bodies that improved in status class ranged from four in the Neagh Bann IRBD to 83 in the Shannon IRBD. All river basin districts, except the Neagh Bann IRBD, lost high status water bodies. The number of river water bodies that declined in status ranged from seven in the Neagh Bann IRBD to 48 in the Shannon IRBD and South-Eastern RBD. In comparing the overall improvements and declines, the greatest number of general improvements was evident in the Shannon IRBD and South-Eastern RBDs (**Table 3-2**).

Quality elements determining ecological status

Depending on the purpose of monitoring (whether for surveillance or operational purposes), different combinations of quality elements are monitored to determine ecological status. In the case of monitored water bodies, the ecological status assessment includes an assessment of macroinvertebrate fauna (EPA Q value scores) and supporting general physico-chemical (GPC) quality elements, where available. All quality elements are assessed in the surveillance network, including fish communities and hydromorphology. Where water bodies overlap with designated Freshwater Pearl Mussel sites, additional environmental water quality objectives are taken into account when assessed by the National Parks and Wildlife Service. There are currently 65 river water bodies in 27 designated areas containing Freshwater Pearl Mussel populations.

The quality element with the greatest impact on determining the overall ecological status is the macroinvertebrate fauna (**Figure 3-4**). Macroinvertebrates, on their own or in combination with other elements, are responsible for determining 92% of the monitored river water bodies' status. However, this is not entirely representative, as not all quality elements are monitored at all sites in the entire monitoring programme.

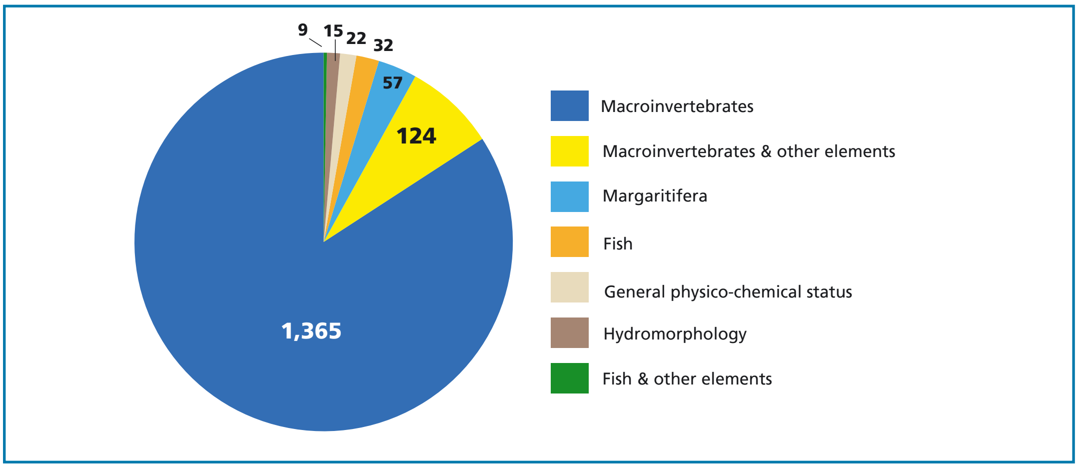


Figure 3-4. The number of river water bodies (n=1,624) status determined by the various quality elements examined in the 2010-2012 status assessment.

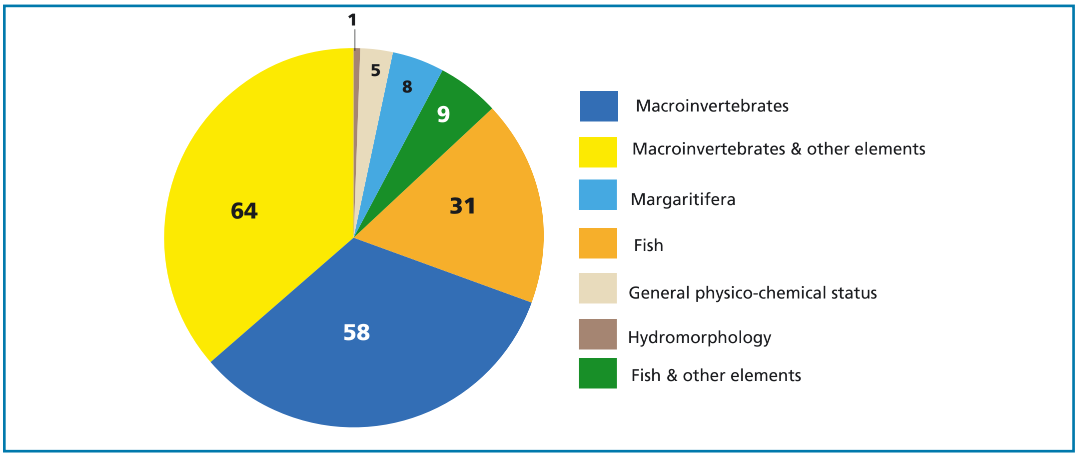


Figure 3-5. The number of surveillance river water bodies (n=176) status determined by the various quality elements examined in the 2010-2012 status assessment.

A more representative picture is provided by the surveillance network. The surveillance network has all the available monitoring tools applied and can highlight which element or combinations of elements are mainly determining ecological status when the full range of available classification tools are applied. In examining the 176 surveillance river water bodies, macroinvertebrates, either on their own or in combination with other elements, determine 69% of the river water bodies' status (**Figure 3-5**). The fish quality element also drives the status of a significant number of the surveillance river water bodies (23% alone or in combination with other elements). Additional biological quality elements, including the aquatic flora or plant community, are surveyed at the surveillance monitoring network of sites. While plant quality elements, including the diatoms, macroalgae, and macrophyte communities, are monitored in the surveillance network, classification metrics for these are currently undergoing further development. An assessment method is also being developed to assess the ecological impacts of acidification. These assessment methods will be included in future assessments.

River water quality: Biological pollution assessment

The macroinvertebrate monitoring and assessment method (Q-values), used on Irish rivers, is the most sensitive ecological assessment method available for detecting organic pollution and nutrient enrichment impacts on Irish rivers. The method has been intercalibrated with the monitoring tools from other European countries (European Commission, 2013). Status for the macroinvertebrates quality element corresponds closely to water quality defined by the Q-value surveys of rivers undertaken since 1971. The Q-values, therefore, provide a good historical record of 'water quality' since 1987. All the main-stem rivers are assessed for Q values, accounting for over 13,000 km of river channel length, as in previous surveys. The results of the 2010-2012 macroinvertebrate surveys show that 72.9% (9,689 km) surveyed rivers and stream channel length was in satisfactory or unpolluted condition (**Figure 3-6**). In terms of the Water Framework Directive, the 9,689 km of satisfactory river channel is subdivided into 22% (2,964 km) of the total channel surveyed at high, while 51% (6,725 km) was good for this quality element (**Figure 3-6**). The unsatisfactory 27% (3,641 km) of the surveyed channel is subdivided into 17.5% (2,316 km) slightly polluted/ eutrophic, 9.6% (1,277 km) moderately polluted, and 0.1% (17 km) classified as seriously polluted. The annual macroinvertebrate Q value river reports are summarised by Hydrometric area online[17] . A colour-coded River Quality Map, depicting biological quality at each of the 2,761 locations surveyed in the 2010-2012 period, accompanies this report.

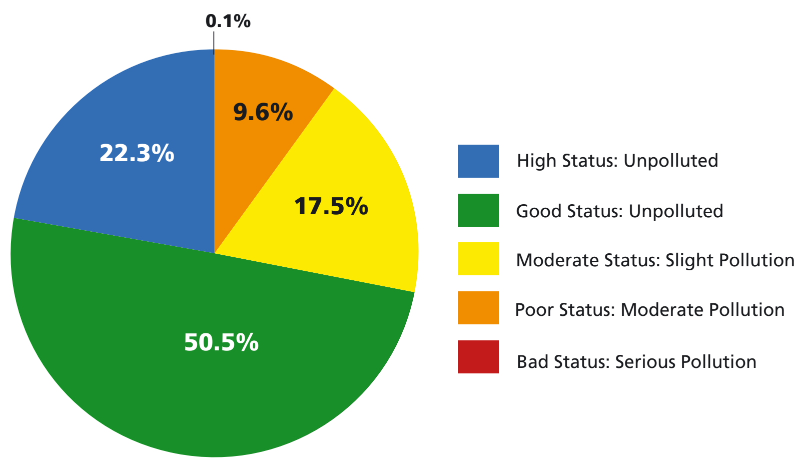


Figure 3-6. River quality 2010-2012: Percentage channel length monitored in each of the five WFD ecological status classes for macroinvertebrates (13,300 km).

17 http://www.epa.ie/QValue/webusers/

Water quality trends

Long-term national trends (1987-2012)

Thirteen thousand three hundred km of river channel has been monitored nationally since 1987 on a three-year cycle (**Figure 3-7**). During the 1990s, the proportion of unpolluted channel length (Class A) declined by 10% (from 77% to 67%) due to the spread of slight and moderate pollution. A welcome improvement has been seen in the latest survey, with the proportion of unpolluted channel increasing by 4% from 69% to 73%, the highest figure seen since before the 1991–1994 survey. The proportion of unpolluted channel length has seen an increase in both the high status (from 20% to 22%) and good status (from 49% to 51%) classes (**Figure 3-8**). The most significant trend was the decrease in slight pollution from 21% (2007–2009) to 18% (2010–2012). 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 9.6%, down from a peak of 12.4% in the 1998-2000 period.

A further welcome development is the continued decrease in the percentage of surveyed channel classified as seriously polluted, down to 0.1% (17 km) from 0.4% (53 km). This 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.

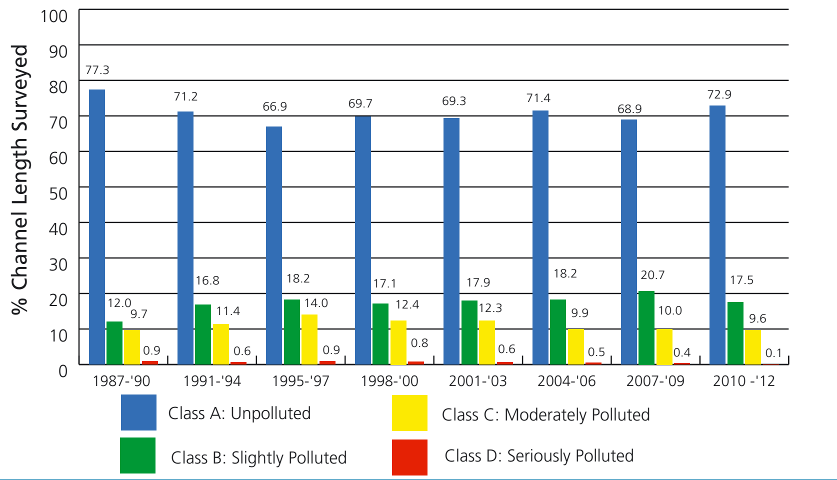


Figure 3-7. Trends in the 13,300 km baseline showing the percentage of surveyed channel nationally in the four EPA biological quality classes.

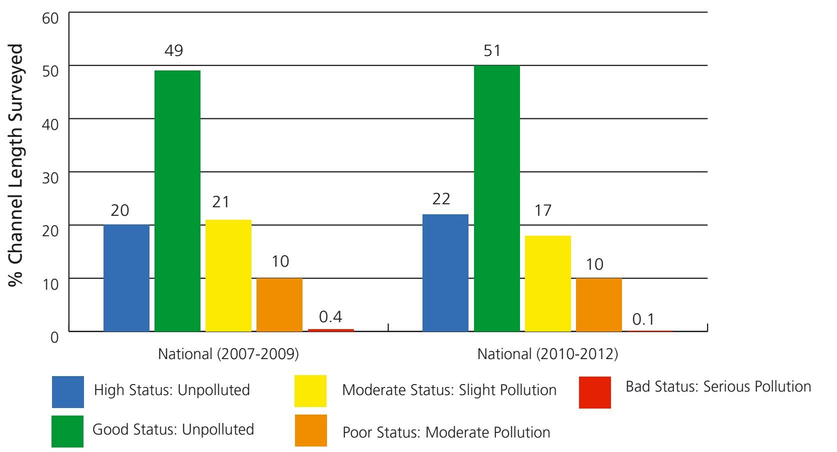


Figure 3-8. Recent trends in the 13,300 km baseline showing the percentage of surveyed channel nationally in the five WFD biological quality classes.

River water quality trends in the River Basin Districts (RBDs)

South-Western RBD

The South-Western River Basin District (SWRBD) remains the least polluted RBD in the country (**Figure 3-9**), with 93% of surveyed channel classified as unpolluted. The proportion of high status channel surveyed increased from 37% (832 km) to 41% (926 km), while the proportion of moderate status channel continues to decrease from 6% (143 km) to 5% (120 km). An unwelcome increase in poor status channel length, however, was noted.

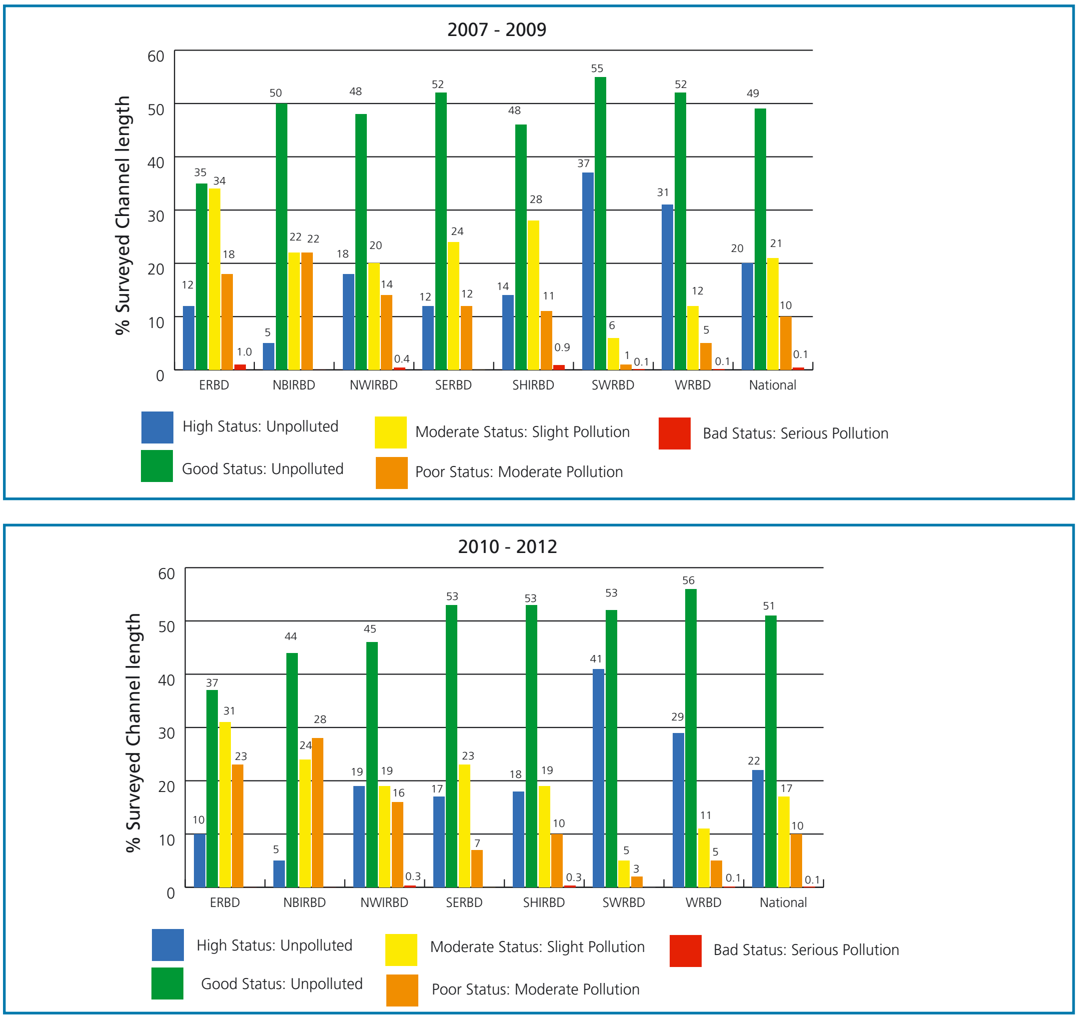


Figure 3-9. Trends in river quality based on the macroinvertebrate quality element as percentage surveyed channel length within each RBD between the two survey periods 2007-2009 and 2010-2012.

Western RBD

A significant proportion (84%) of surveyed channel was once again unpolluted in the Western RBD, however, there was a decline noted in the proportion of high status channel length. A welcome increase was observed in the extent of unpolluted channel, with a corresponding decrease in moderate status channel length (**Figure 3-9**). Serious pollution continues on the Tubbercurry Stream and Tubbercurry River due primarily to poorly treated wastewaters.

North-Western IRBD (South)

The proportion of channel classified as unpolluted in the North-Western International River Basin District (NWIRBD) declined from 66% to 65% (**Figure 3-9**). The percentage of high status channel increased from 18% to 19% of channel surveyed, while the good status channel declined from 48% to 46%. A corresponding increase in the length of poor status channel was noted (from 254 km (2007–2009) to 290 km (2010–2012)) in the Erne, Donegal Bay, Gweebarra and Swilly catchments (hydrometric areas 36, 37, 38 and 39).

Serious pollution continued on the Swilly Burn, Maggy's Burn and Bredagh rivers in the current survey and was also newly noted on the Aighe River in 2012.

South-Eastern RBD

A significant improvement in the proportion of unpolluted channel from 64% to 70% of surveyed channel) was noted in the South-Eastern RBD (**Figure 3-9**). The proportion of high status channel increased from 12% to 17% of channel surveyed, while the good status channel length increased from 52% to 53%, with a corresponding reduction in poor status. The main improvements were in the Barrow, Nore and Suir rivers (hydrometric areas 14, 15 and 16).

Shannon IRBD (South)

A welcome improvement in the length of unpolluted channel from 60% (1,982 km) to 71% (2,362 km) was noted in the Shannon International River Basin District (SHIRBD) (**Figure 3-9**). Serious pollution, however, continues on the Ahavarraga Stream, Jiggy (Hind) and Laurencetown stream. Suspected causes include industrial and municipal wastewater discharges (see **Table 3-8**).

Neagh Bann IRBD (South)

An unwelcome decline in the length of unpolluted channel from 55% to 49% was noted in the Neagh Bann in the latest survey (**Figure 3-9**). The main decline was seen in hydrometric area 06 which covers the Fane, Glyde and Dee rivers. The length of good status channel declined from 50% to 44%, while the moderate and poor status channel increased in length.

Eastern RBD

The Eastern River Basin District (ERBD) continues to have the lowest percentage of unpolluted channel length (46%) (**Figure 3-9**). The ERBD is the most highly urbanised and industrialised region of the country. A loss of high status channel and increase in poor status channel was most notable in the Boyne and Liffey (hydrometric areas 07 and 09), while an increase in high and good status channel was noted in Avoca and Vartry catchment (hydrometric area 10). The Avoca river, although showing signs of some improvement for the macroinvertebrate community, continues to exhibit toxic poor status due to acid mine drainage.

High Status Trends

High ecological quality at river sites is an indicator of largely undisturbed conditions and reflects natural background status or only minor distortion from anthropogenic influences. Sites of high ecological quality are important for supporting healthy populations of aquatic species, like the freshwater pearl mussel and juvenile salmon, which are sensitive to disturbances, such as nutrient enrichment or siltation. The presence of high status stretches along a river system can contribute significantly to the overall species diversity and enables recolonisation of sensitive species to recovering river stretches.

The percentage number of high quality sites had almost halved in the 22 years between 1987 and 2012. In each survey period the decline continued, from 29.6% of the total sampled in the 1987-1990 period to 16.4% in 2007-2009 (**Figure 3-10**). However, a welcome increase in the numbers of high status sites in the latest survey (18.3%) will hopefully continue. The number of sites assigned Q5 high status reference condition continues to decline in the latest survey

(38 sites (2007-2009) to 27 (2010-2012)). **Figure 3-11** shows the distribution of 507 high status sites across the country. The Water Framework Directive requires Member States to protect and maintain high status water bodies, therefore targeted investigative monitoring and programmes of measures will be vital in halting the loss of, and subsequent restoring of, high status rivers.

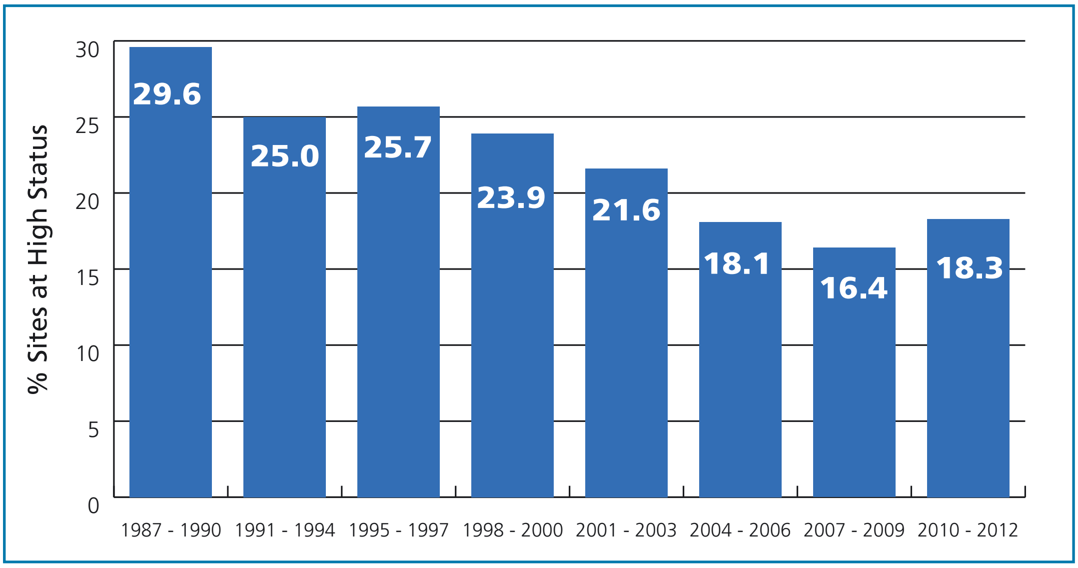


Figure 3-10. Long-term trends in the percentage number of high ecological quality (macroinvertebrate) river sites (1987 – 2012).

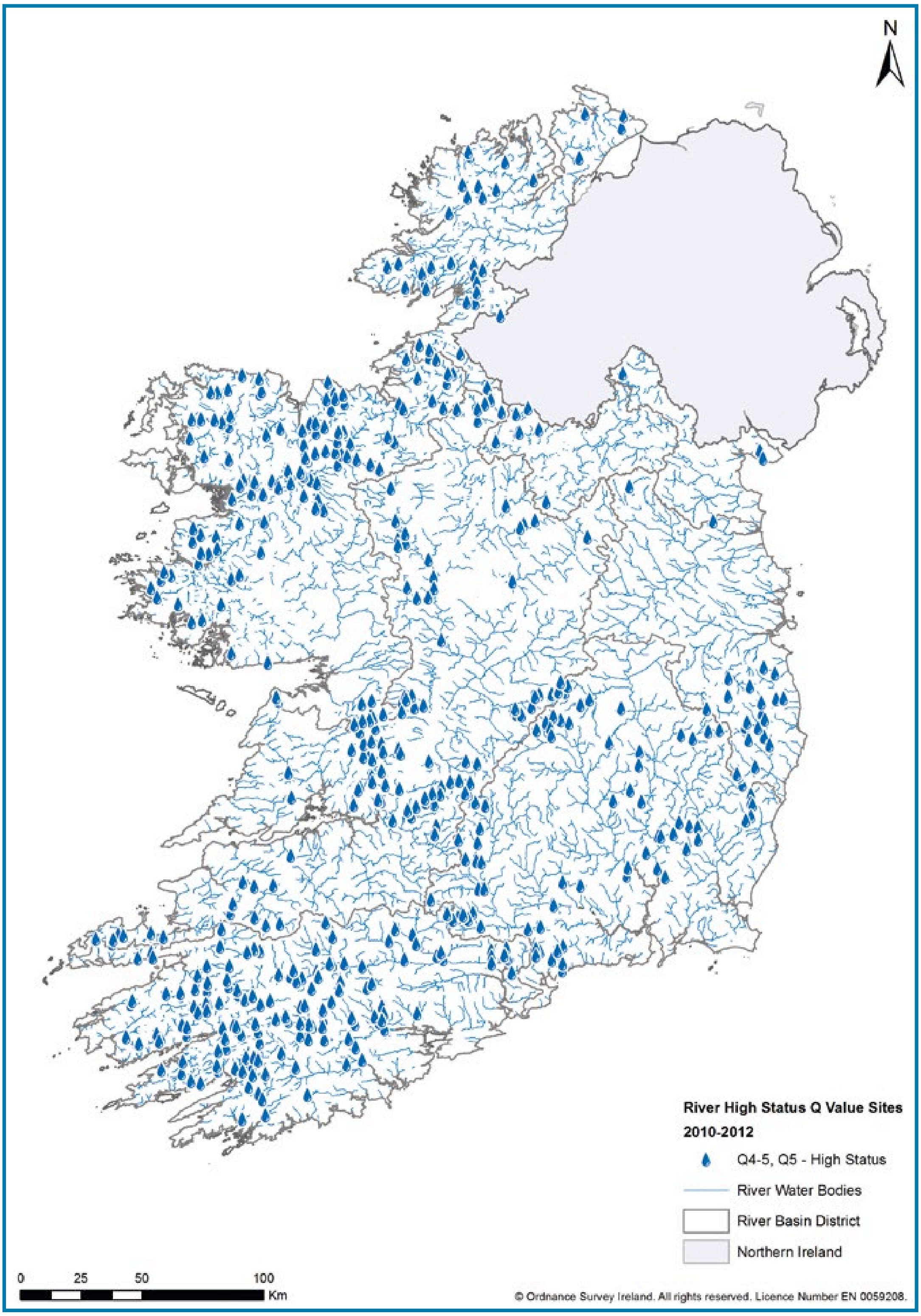


Figure 3-11. Map showing the location of the 507 high status Q value (Q4-5, Q5) sites across the country.

Other ecological quality elements: Fish

Surveillance monitoring of fish ecological status results

Inland Fisheries Ireland undertook monitoring of fish at 172 surveillance monitoring sites, as part of the WFD monitoring programme over the 2008–2012 survey period (**Figure 3-12**).

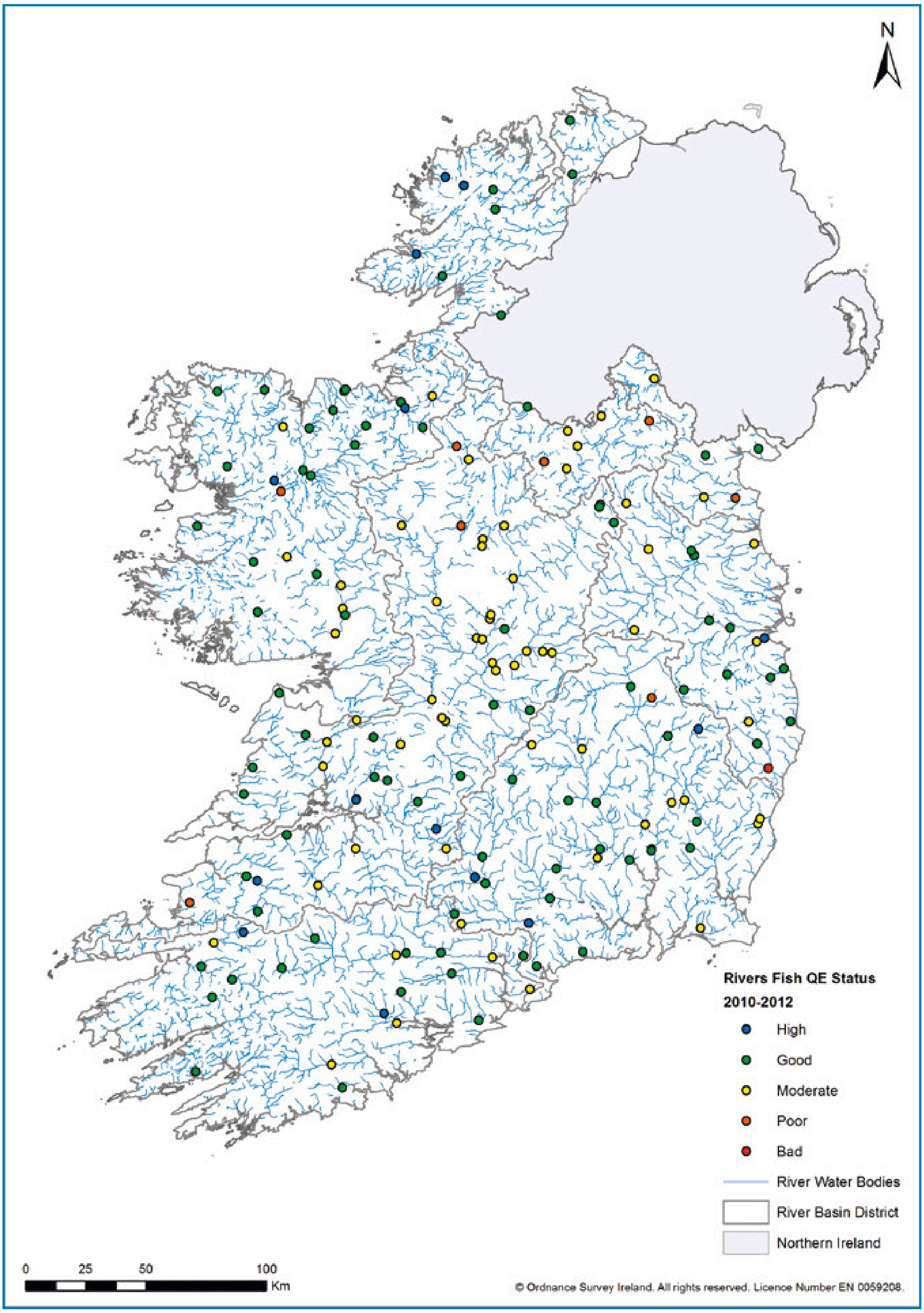


Figure 3-12. Ecological status of fish biological quality element in Irish rivers 2008–2012.

The survey results indicate that 59% of sites surveyed across the country were of high or good status (**Table 3-3**). 36% of sites surveyed were at moderate status, while 5% of sites indicated poor, and 1% of sites were classified at bad status. The fish status results were the element determining 18% (31) of the monitored surveillance river water bodies ecological status. Future investigative work will be needed to examine the causes of these declines where the other elements are not showing a similar pattern.

River Basin District	High	Good	Moderate	Poor	Bad	Total
Neagh Bann	0%	40%	40%	20%	0%	5
North-Western	19%	44%	25%	13%	0%	16
Eastern	6%	56%	33%	0%	6%	18
Shannon	8%	35%	52%	6%	0%	52
South-Eastern	10%	55%	32%	3%	0%	31
South-Western	9%	64%	27%	0%	0%	22
Western	7%	64%	25%	4%	0%	28
Total	**9%**	**50%**	**36%**	**5%**	**1%**	**172**

Table 3-3. Status results for fish populations in each of the WFD river basin districts based on 172 surveillance sites surveyed in the 2008-2012 period.

Fish kills

Data on fish kills are compiled annually by Inland Fisheries Ireland (IFI) since its establishment in 2010, with the Central Fisheries Board having previously recorded these based on returns from the Regional Fisheries Boards. Fish mortalities in rivers are only reported as 'kills' if there is a strong suspicion that the deaths are pollution-related or otherwise unnatural. The total number of reported fish kills in freshwaters (rivers and lakes) between 2010 and 2012 (**Figure 3-13**) was the lowest ever recorded (70 compared to 72 in the previous period). The wet summers in both 2009 and 2012, resulting in higher summer river flows and fuller lakes, may have reduced stresses on fish populations caused by low water levels which normally occur during the summer period.

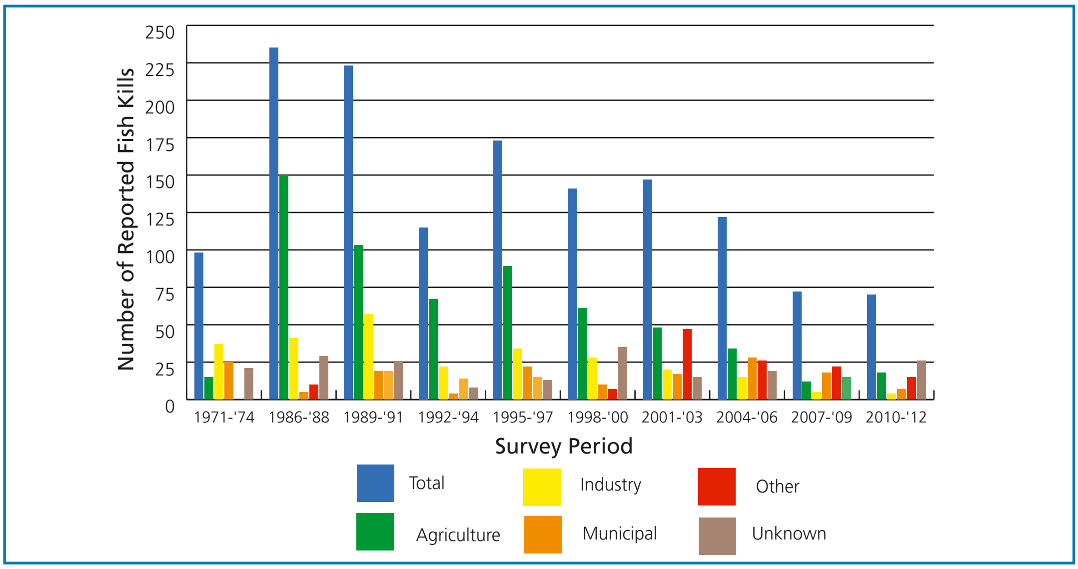


Figure 3-13. Number of reported fish kills and suspected causes since 1971.

The breakdown, of fish kills in 2010-2012 across the seven River Basin Districts (RBDs) (**Table 3.4**) shows that the highest number (20) occurred in the combined Eastern RBD and Neagh Bann IRBD, and the lowest number (7) in the North Western IRBD. Where the source of the kill was identified, agriculture accounted for the greatest number (18).

River Basin District	Agriculture	Industry	Municipal	Other	Unknown	Total	%
Eastern/Neagh Bann	1	1	1	6	11	20	28.6
North-Western	2	1	1	0	3	7	10.0
Western	1	0	3	2	3	9	12.9
Shannon	5	0	1	2	1	9	12.9
South-Eastern	5	0	0	3	4	12	17.1
South-Western	4	2	0	3	4	13	18.6
Total	**18**	**4**	**6**	**16**	**26**	**70**	**100**

Table 3-4. Number of fish kills in RBDs and suspected or confirmed causes in the period 2010-2012.

Chemical and physico-chemical elements supporting the ecological status of rivers

WFD monitoring incorporates an assessment of the general physico-chemical water quality conditions and compliance with standards for a range of toxic substances (called specific pollutants) which are necessary to support the achievement of good ecological status in rivers. In the period 2010-2012, the river surveillance sites were monitored on a monthly basis for a range of physico-chemical parameters, with metals and specific organic pollutants measured at a differing range of stations each year. The quality of waters was assessed against the Environmental Quality Standards (EQS) set in legislation. The monitoring programme covering 2010-2012 was reviewed following an extensive survey in 2006 which sought to determine the presence / absence of a large number of potential pollutants, as well as the findings of monitoring during 2007-2009. This led to a number of non-detected parameters being removed from the programme and being replaced by additional parameters of concerns, such as pesticide residues.

Surveillance sites were selected to identify changes due to anthropogenic or climatic pressures rather than being targeted to risk sites, but there is also an extensive network of operational sites covering both biological and physico-chemical monitoring where there may be specific identifiable pressures. Similar suites of analyses are reported for operational monitoring stations, with the exception of metals and organics. Approximately 1,373 operational and surveillance river sites chemical data representing 566 rivers and streams across the country were examined in the 2010-2012 period.

Nutrients (phosphorus/nitrogen)

The principal concerns for Irish rivers remain the impact of eutrophication (due to nutrient enrichment) and oxidation conditions. Increases in biochemical oxygen demand (BOD) as a consequence of organic loadings to rivers are also a concern in some areas. The following charts and maps (Figures 3-15 to 3-22) show the average concentrations for these parameters, both for the WFD surveillance stations and for all reported sites with at least five years of continuous data – approximately 1,460 stations. In general, a comparison of the nutrient concentrations in Irish rivers against those of mainland Europe shows that Irish rivers typically fall into the lower range in terms of nutrient levels (EEA, 2012)[18].

Some marked reductions, particularly in nitrate concentrations, have been observed over the period 2007–2012. Nitrogen is retained less by soils, and changes in nutrient application rates may have a more pivotal role than in the case of phosphorus, where it tends to be retained by soils for many years. Examining trends shows that the greatest reductions in nutrients appear to be in the tillage and intensive agriculture areas in the South-East and Midlands.

Phosphorus							Total Oxidised Nitrogen					
µg/l P	s↓	w↓	‹–›	w↑	s↑		**mg/l N**	s↓	w↓	‹–›	w↑	s↑
<10		4	20				**<0.2**	-	1	18	6	1
10 - 20	3	5	43	1			**0.21 - 0.5**	4	8	12	2	-
20 - 35	3	10	41	6	1		**0.51 - 1**	7	14	11	1	-
36 - 50	1	2	7	4	1		**1.01 - 2**	16	10	12	-	-
51 - 75	3	3	4	4			**2.01 - 5**	15	13	17	2	-
76 - 100	-	-	4	-	1		**5.01 - 10**	3	1	1	-	-
>100	1	1	1	-	1							
Total	11	25	120	15	4		**Total**	44	47	71	11	1

Table 3-5. Trends in phosphorus and nitrogen concentration over time (2007-2012) for the WFD surveillance sites.

Overall, adequate data were available for orthophosphate and TON during 2007-2012 for 175 surveillance river sites for the purpose of assessing trends. Data was examined to identify if a trend existed and the magnitude of that trend. The trends were assessed in terms of strength (strong / weak) and direction (increasing / stable / decreasing) (**Table 3-5** and **Figure 3-14**).

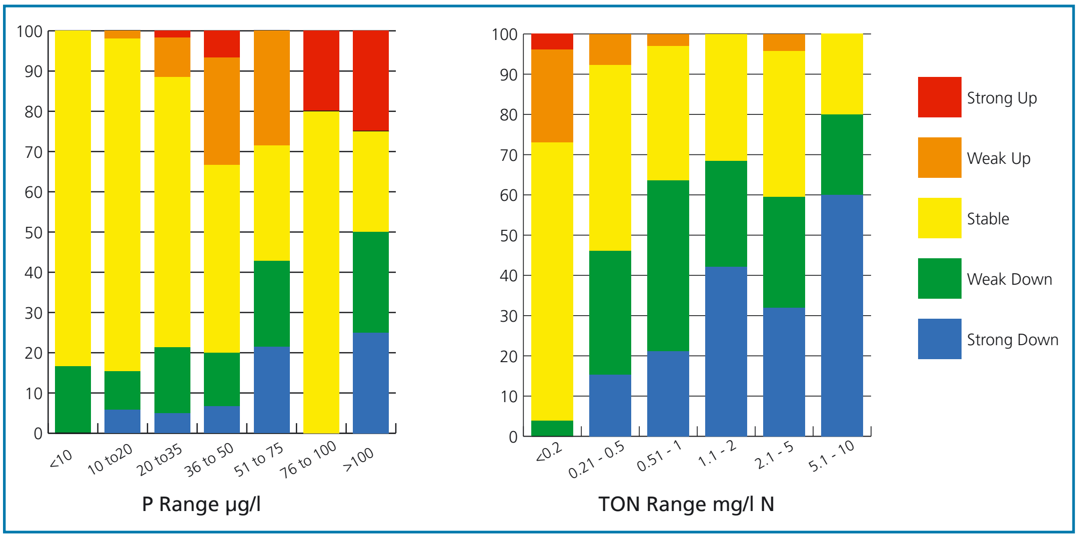


Figure 3-14. Orthophosphate (phosphorus) trends and total oxidised nitrogen (TON) trends for 175 WFD surveillance sites (2007 -2012).

18 http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-3

In the case of phosphorus, the greatest improvements have been observed in rivers where, in general, phosphate values are in the region of the good – moderate boundary between 20 – 75 µg/l P. These represent almost 50% of all of the surveillance sites. Improvements were observed in 22 (24.4%) of 90 stations in this range. Overall, 120 stations (68.6%) showed no obvious trends, while 19 (10.9%) showed an increasing trend, though in four (2.3%) of these the trend was deemed to be of environmental significance. The greatest improvements were observed in the Liffey and Avoca Vartry catchment (hydrometric area 9 and 10 (Wicklow / Kildare) and Shannon (Roscommon / Offaly / Longford / Westmeath).

The most significant reductions in total oxidised nitrogen (Nitrate + Nitrite) are evident in much of the mid-east and south-eastern counties, where nitrogen loadings have long been associated with inputs from intensive livestock and tillage farming. The Lee valley in Co. Cork (hydrometric area 19) is the only area in this group not to have witnessed any meaningful reduction. Similar patterns were noted in groundwater.

Nutrient trends by hydrometric area and by concentration range are shown below in **Figures 3-15** and **Figures 3-16** for the surveillance stations.

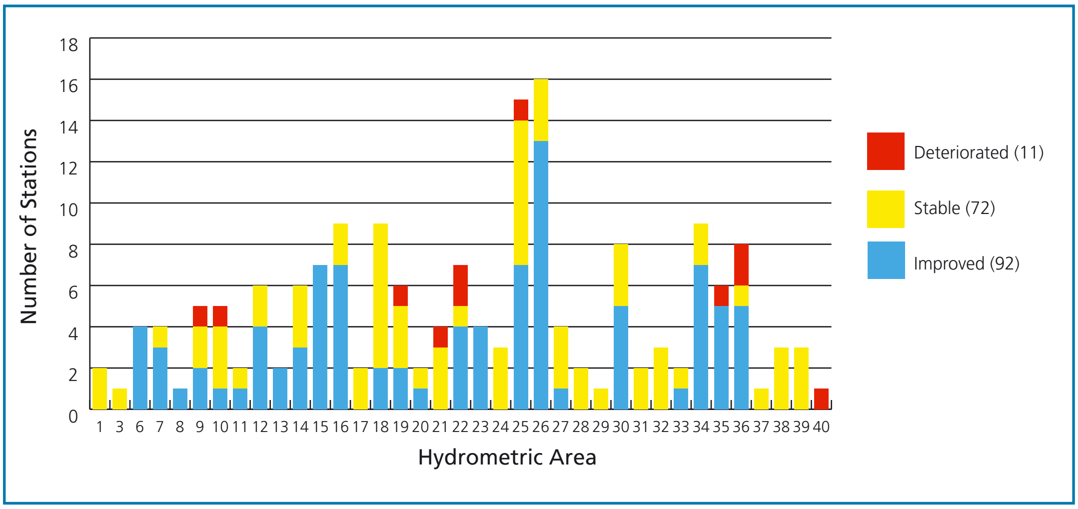


Figure 3-15. Total oxidised nitrogen (TON) changes between 2007 and 2012 for the WFD surveillance sites by hydrometric area.

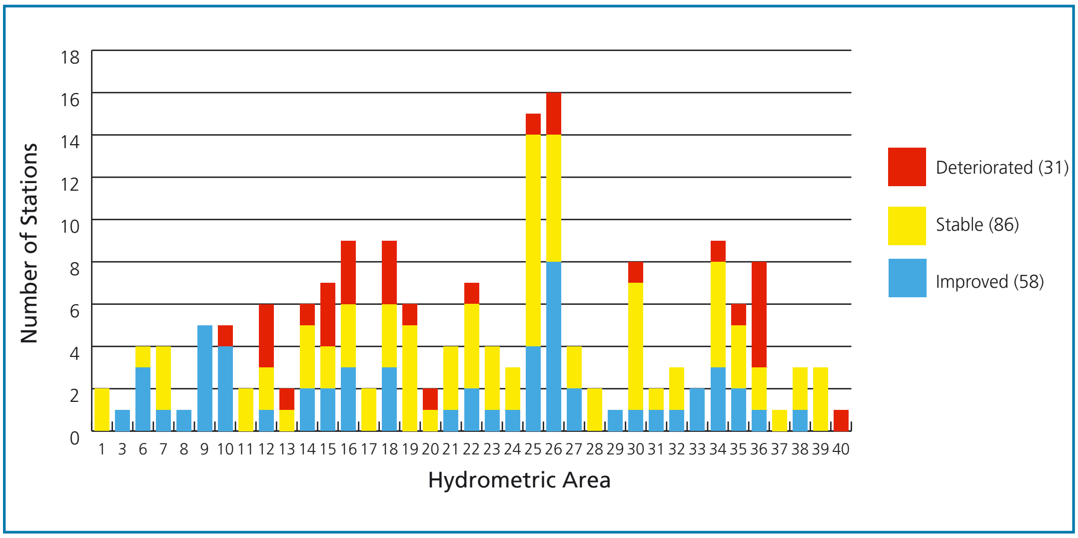


Figure 3-16. Orthophosphate changes between 2007 and 2012 for the WFD surveillance sites.

Figure 3-17 maps the national orthophosphate trends 2007–2012 by hydrometric area for all operational and surveillance monitoring sites available, while the second map shows the average river orthophosphate concentrations (mg/l P) 2010-2012 available for operational and surveillance monitoring sites.

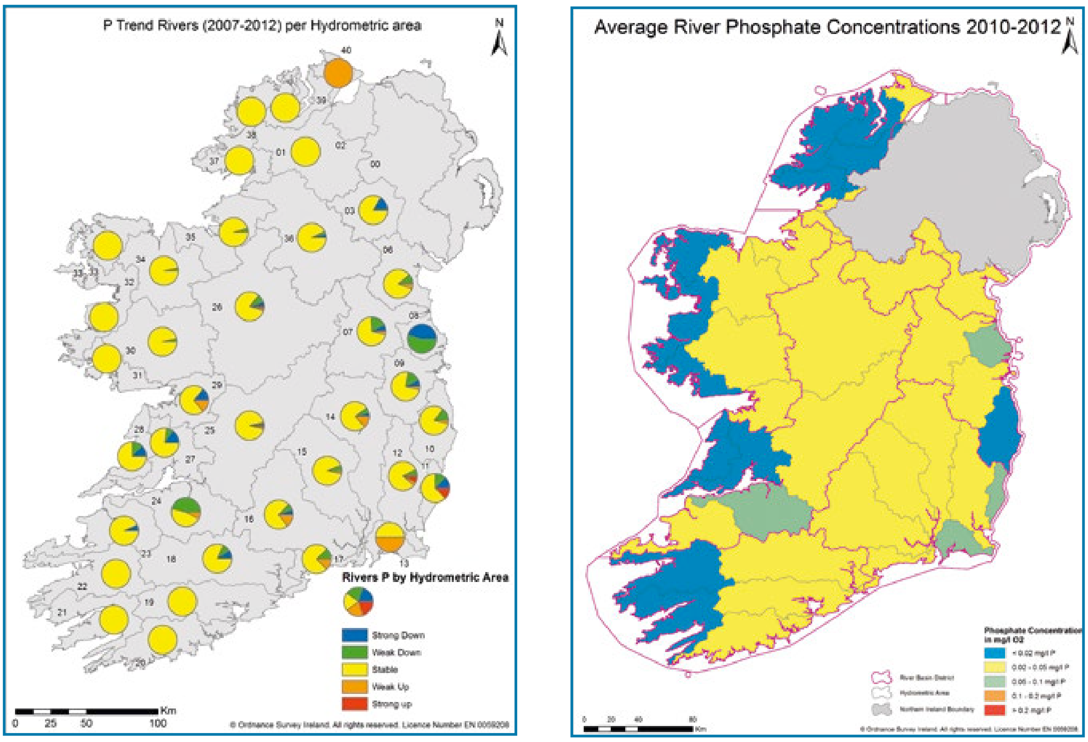


Figure 3-17. Map showing orthophosphate trends 2007–2012 by Hydrometric area for all operational and surveillance monitoring sites available. For those hydrometric areas bordering Northern Ireland, data reflects rivers in the Republic of Ireland only and map showing average river orthophosphate concentrations (mg/l P) 2010-2012 available for operational and surveillance monitoring sites.

In the case of total oxidised nitrogen (TON), there is a much more widespread pattern of reducing nitrogen concentrations across almost all areas (**Figures 3-15**). 124 of the 175 stations (70.9%) exhibit averaged TON concentrations of <2 mg/L N. 92 monitoring stations (52.6%) showed a decreasing trend, with 45 (25.7%) showing a marked reducing trend though, in many cases, this now appears to be beginning to stabilise, suggesting that future reductions may be less marked.

Figure 3-18 maps the total oxidised nitrogen (TON) trends across 175 WFD surveillance stations (2006-2012), the total oxidised nitrogen (TON) trends by hydrometric area for all operational and surveillance monitoring stations in the Republic of Ireland, and the average river nitrate concentrations (mg/l N) 2010-2012 for all available operational and surveillance sites.

Laboratory analysis for nutrients

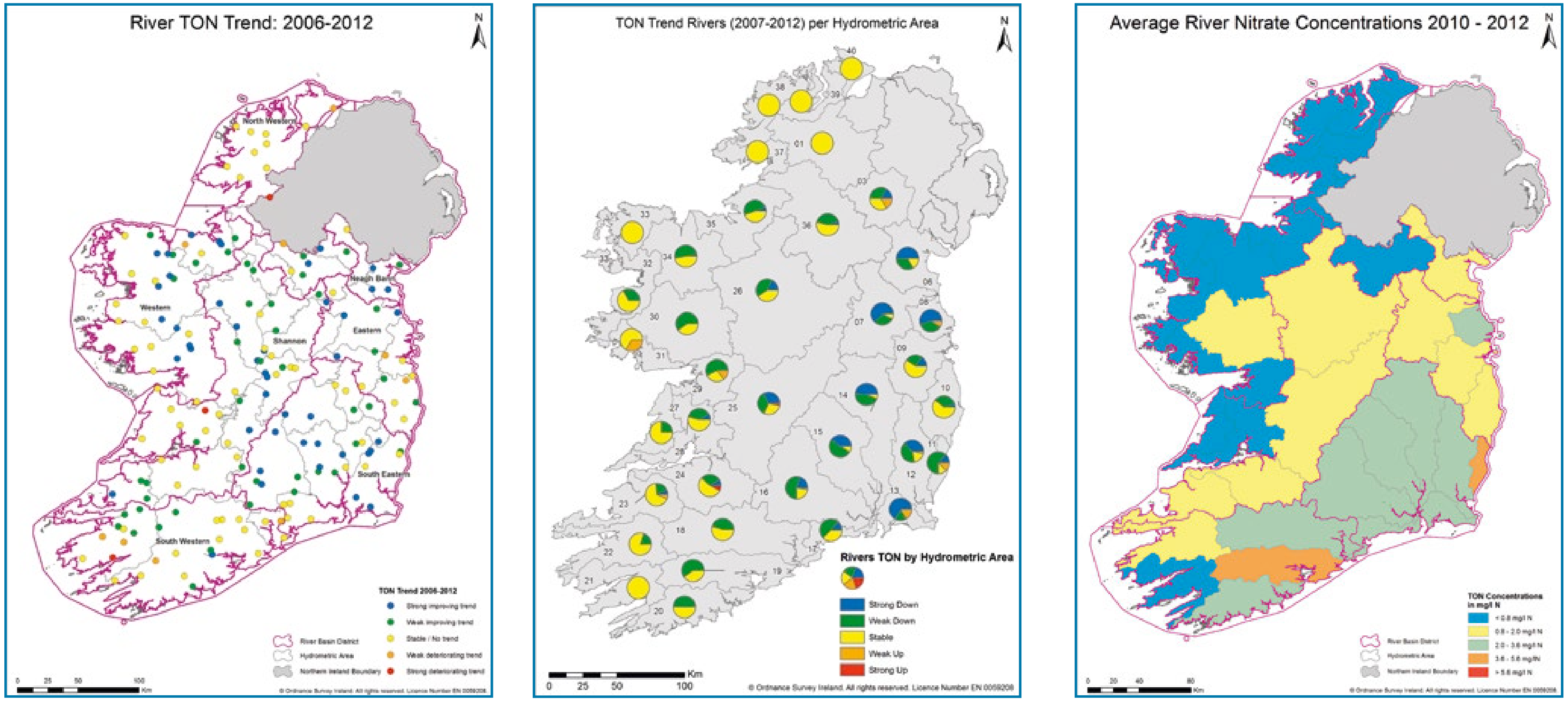


Figure 3-18. Maps showing total oxidised nitrogen (TON) trends across 175 WFD surveillance stations (2006-2012), the total oxidised nitrogen (TON) trends by hydrometric area for all operational and surveillance monitoring stations in the Republic of Ireland, and the average river nitrate concentrations (mg/l N) 2010-2012 for all available operational and surveillance sites.

Organic enrichment parameters

There appear to be improvements in average Biological Oxygen Demand (BOD) concentrations in Counties Limerick, Clare, Monaghan, and in the lower Shannon, however, many river BOD values are close to the reporting limits for laboratories and overall averages can be influenced by improvements in the performance of reporting laboratories (**Figure 3-19**).

Ammonia reductions have been observed in Counties Limerick, Clare, Kilkenny, Laois, Wicklow and Monaghan (**Figure 3-20**).

It is a similar picture for phosphorus, with improvements predominantly in the greater Dublin area and in County Meath (**Figure 3-17**).

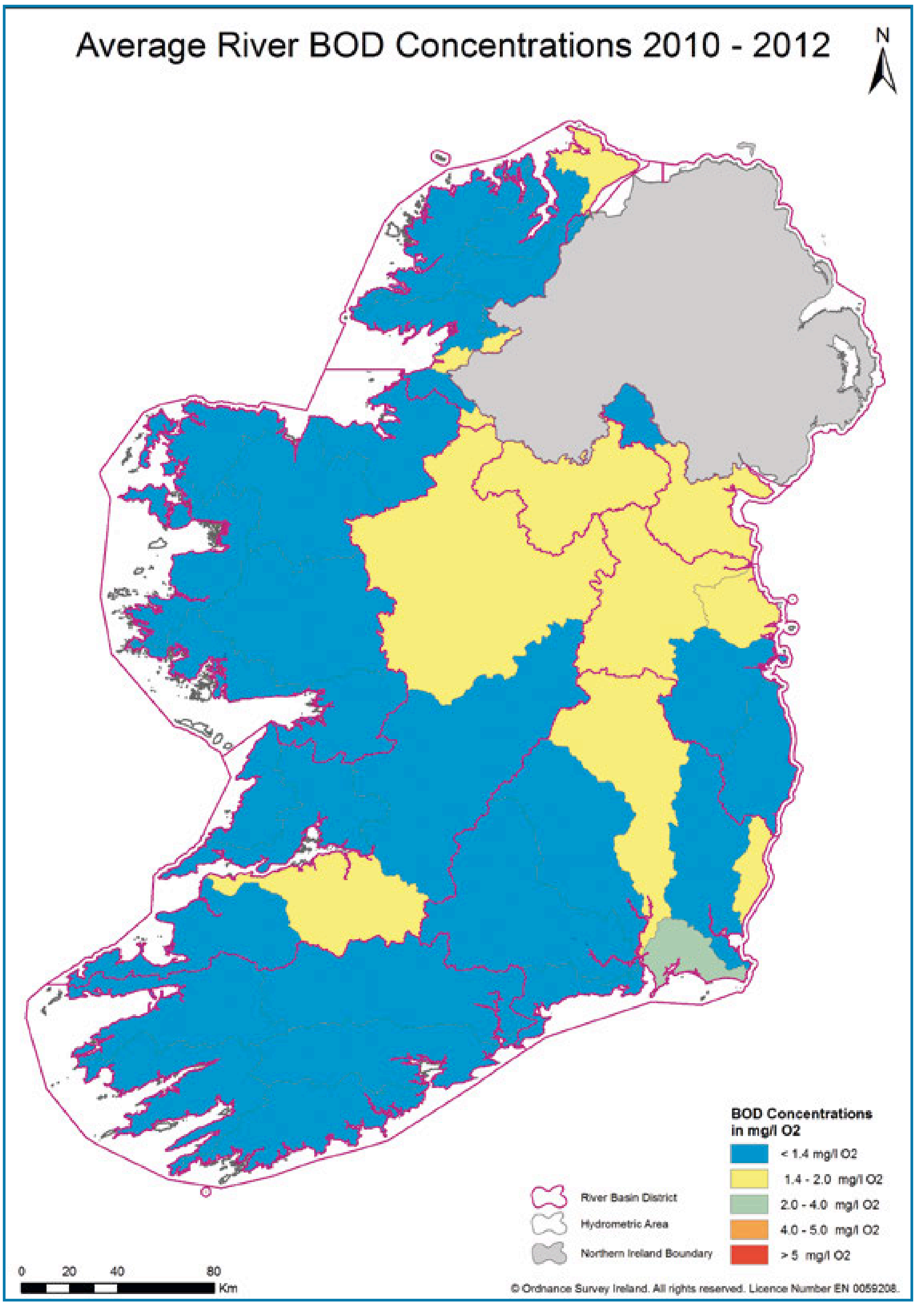


Figure 3-19. Map showing average river Biochemical Oxygen Demand (BOD) concentrations (mg/l O2) 2010-2012 available for operational and surveillance monitoring sites.

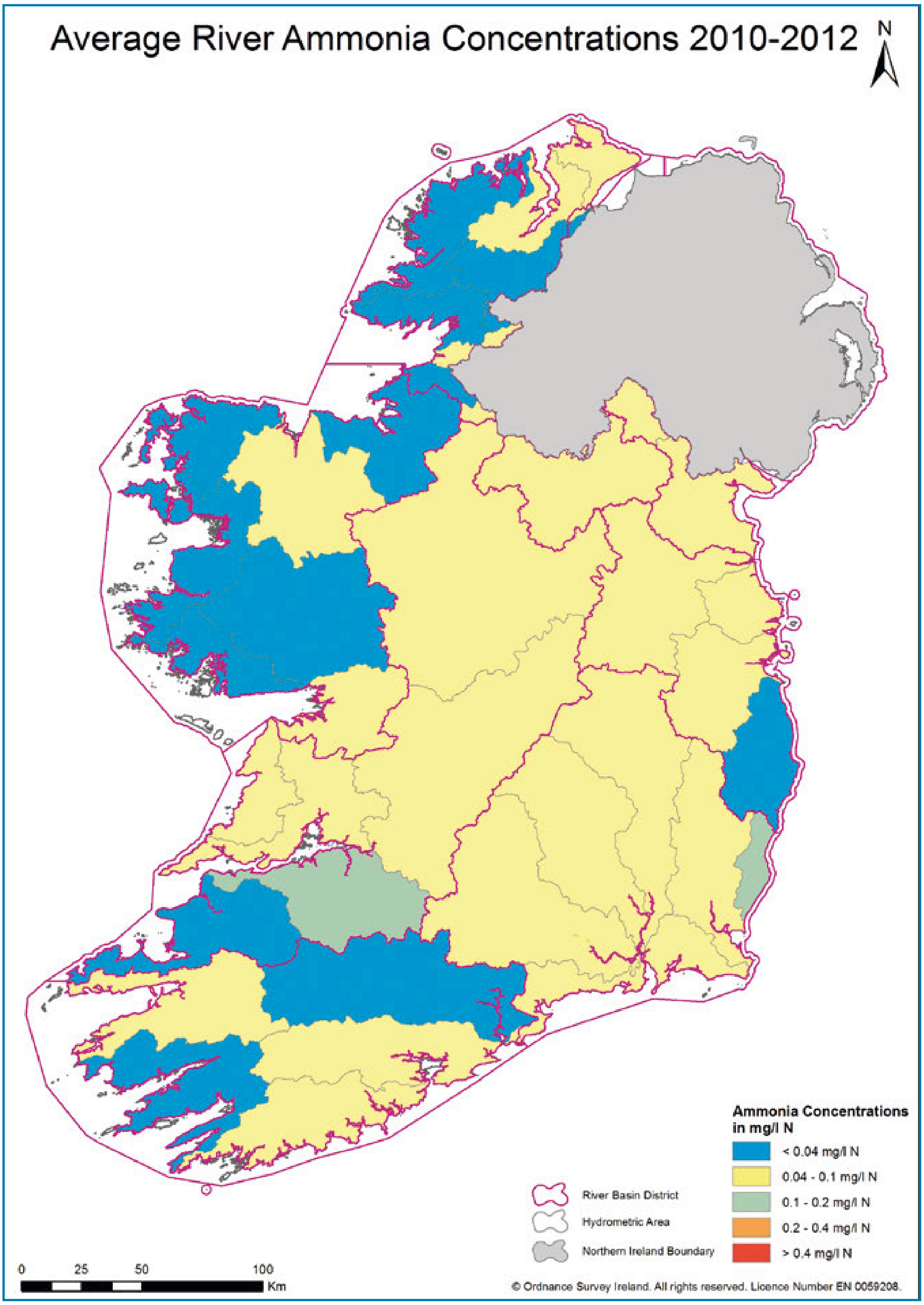


Figure 3-20. Map showing average river ammonia concentrations (mg/l N) 2010-2012 available for operational and surveillance monitoring sites.

Specific pollutants

The Water Framework Directive requires that Member States identify specific pollutants and set standards for them. specific pollutants are toxic substances that are discharged in significant quantities into the water environment. The selection of substances for subsequent EQS development and inclusion in the national monitoring programme commenced in 2006 with a screening programme for 161 substances at 23 sites across the country, including major rivers, lakes, and coastal waters, which were selected based on potential risk. Based on this screening programme, the 16 specific pollutants were prioritised for standard development. These included a range of commonly-used pesticides, plant protection products, metals, organic solvents and cyanide. National Environmental Quality Standards (EQSs) have been established for 16 specific pollutants in law. Table 3-6 outlines the results of the specific pollutants monitored in Irish rivers over the 2007-2012 period.

Substance	Period of monitoring	Number of river sites monitored	Number of river sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of river sites exceeding the Maximum Allowable Concentration (MAC)
Arsenic	2007-2009	322	0	0	NA
	2010-2012	194	0	0	NA
Chromium III [5]	2007-2009	326	17	15	6
	2010-2012	203	10	10	0
Chromium VI	2007-2009	Not	-	-	-
	2010-2012	nm	-	-	-
Copper[2]	2007-2009	507	36[4]	36[4]	NA
	2010-2012	439	5	5	NA
Cyanide	2007-2009	194	0	0	NA
	2010-2012	37	0	0	NA
Diazinon	2007-2009	nm	-	-	-
	2010-2012	19	0[3]	0	0
Dimethoate	2007-2009	nm	-	-	-
	2010-2012	19	0	0	0
Fluoride	2007-2009	316	1	0	0
	2010-2012	133	0	0	0
Glyphosate	2007-2009	180	0	0	0
	2010-2012	79	1	0	1
Linuron	2007-2009	114	0	0	0
	2010-2012	78	0	0	0
Mancozeb	2007-2009	nm	Measured in 2006 as part of Dithiocarbamates suite – no detects found		
	2010-2012	nm	-	-	-

Substance	Period of monitoring	Number of river sites monitored	Number of river sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of river sites exceeding the Maximum Allowable Concentration (MAC)
Monochlorobenzene	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Phenol	2007-2009	nm	Measured in 2006 – no significant detection rate observed		
	2010-2012	nm			
Toluene	2007-2009	226	0	0	NA
	2010-2012	68	0	0	NA
Xylenes	2007-2009	105	0	0	0
	2010-2012	nm	-	-	-
Zinc[2]	2007-2009	506	16	16	NA
	2010-2012	443	15	15	NA

Table 3-6. Specific pollutants monitored in rivers in the period 2007-2012.

Notes:

1. NA = No MAC value applicable.
2. Nm = Not monitored.
3. For cadmium, copper, and zinc multiple EQS criteria apply related to water hardness.
4. Limits of detection for this parameter are above the EQS threshold.
5. Multiple detection limits reported during this time period, with several exceeding the EQS threshold.
6. Chromium was measured as total chromium. No data available for Hexavalent Cr.

Overall, the level of compliances with EQSs for specific pollutants is high (**Table 3.6**). The analytical Limit of Detection for Diazinon is above the EQS. Of the 18 rivers where analysis was targeted, only two values were above the Limit of Detection.

Metals

Concentrations of metals in Irish rivers tend to be relatively low and come principally from geological weathering, via inputs from urban or industrial wastewater treatment plants, and from mining discharges. The main areas where metals are frequently found at elevated concentrations are in the traditional mineral mining areas - most notably in Wicklow and Tipperary. The Avoca, Drish, Rossestown and Yellow / Kilmastulla rivers accounted for a largest proportion of the chromium and zinc exceedances of the AA-EQS values (**Table 3-6**).

Information of the spatial distribution of metals in soils can be found in the Soil Geochemical Atlas of Ireland[19] published by Teagasc. For most metals, annual average EQS (AA-EQS) values apply but for some, e.g. chromium, maximum allowable concentration (MAC) values also apply. The AA-EQS values for copper and zinc are based on water hardness, with multiple values applying. The lowest threshold concentrations are associated with naturally soft waters. Few Irish rivers have carbonate hardness of below 10 mg/l of $CaCO_3$, however, a few in the north-west and in the far south-west would be very close to this value. Around 30% of monitored rivers are in the 10-100 mg/l hardness range.

Chromium

The analytical methods commonly used for metals analysis do not differentiate between the more common trivalent chromium (Cr III) and the more hazardous hexavalent species (Cr VI). Of the 2,532 results covering 138 rivers, there were 20 monitoring stations (12 rivers) which failed to meet the AA-EQS. Of these, 10 stations (four rivers) were significantly above the EQS, with the remainder being just above the EQS or where averaged values were based on fewer than four samples. There were no MAC exceedances.

Copper

Copper can be found in most areas at generally low concentrations and was detected in almost two-thirds of samples. As well as being due to geological sources, it is a common component of wastewater discharges coming from both industrial sources and from domestic plumbing. Copper exceedances consisted mainly of exceedances of the annual average of 5 µg/l set for waters with hardness of less than 100 mg/l of $CaCO_3$. This situation applies to almost one-third of all Irish rivers. Few surveillance stations indicated any issues. Of the 5,400 results covering 215 rivers, there were five monitoring stations (four rivers) which exceeded EQS values. The average Cu concentration for all samples was ca. 2.8 µg/l. Four rivers, the Avoca and Dargle in the Eastern RBD, and the Fergus and Yellow / Kilmastulla in the Shannon IRBD, are in mining areas.

Zinc

Like copper, zinc occurs naturally and is found virtually everywhere. It too is a common plumbing metal and the sources are generally the same. Its presence is also linked to areas rich in lead ore.

Of the 7,199 results, covering 443 monitoring stations (237 rivers), there were 15 exceedances of EQS values. Exceedances of the annual average EQS of 50µg/l EQS were observed in the Avoca and Glenealo in the ERBD, and in the Brown Flesk and the Owveg in the South-Western RBD. Exceedances of the annual average of 100µg/l for harder waters were observed in the Garryard Stream and Kilmastulla river in the Shannon region, together with the Drish and Rossestown in the South-Eastern RBD. When the influence of the high mining area samples is removed, the median Zinc concentration is approximately 5µg/l and is comparable to the average concentration from the 171 WFD surveillance monitoring stations.

Pesticides for which there are currently no Environmental Quality Standards

There are currently around 350 "active substances" approved for use in Ireland, of which many are plant protection products or biocides. For the period 2010-2012, monitoring was targeted more specifically toward those substances for which detects had been observed. Monitoring was carried out across 70 representative rivers. Some of these substances may be proposed for future designation as specific pollutants, if considered to be discharged in significant quantities.

19 http://erc.epa.ie/safer/iso19115/display?isoID=105

Pesticide	No. of samples	% detect	No (%) of rivers where detected
2, 4-D	910	2.5%	18 (25.7%)
2 6-Dichlorobenzamide	316	2.2%	7 (10%)
AMPA	870	0.2%	1 (1.4%)
Chlorpyriphos	151	0%	0%
Clopyralid	11	0%	0%
Dichlobenil	587	0.7%	4 (5.7%)
Dichlorprop	11	0%	0%
Epoxiconazole	131	0%	0%
Malathion	149	1.3%	2 (2.8%)
MCPA	910	7.9%	29 (41.4%)
MCPB	5	0%	0%
Mecoprop	879	10.9%	40 (56%)
Triclopyr	10	0%	0%

Table 3-7. Pesticides for which there are currently no Environmental Quality Standards.

2-methyl-4-chlorophenoxyacetic acid (MCPA) is most often used to assist in the management of reeds / rushes and was detected at 41% of rivers monitored. 56% of rivers (96 results) were reported at or above the limit of detection for methylchlorophenoxypropionic acid (Mecoprop), however of these, only 15 (1.7%) samples showed notably elevated concentrations (**Table 3-7**). Overall, some pesticide residues were detected in 60 (85.7%) of the 70 rivers monitored during the assessment period. In general, it would seem that pesticides do not appear to be a particular problem in Ireland. However, concern has been expressed over the increased use of substances, such as MCPA for weed control, and the possible impacts of substances, such as Cypermethrin, in areas of high water quality (Q4-5, Q5). They are among several additional substances that are included for further studies in a STRIVE research project currently underway. Cypermethrin has now been added to the revised list of priority substances in Directive 2013/39/EU and will require measures, where necessary, to achieve the relevant EQSs.

Chemical status of rivers (priority and priority hazardous substances)

Environmental Quality Standards (EQSs) have been set at European level in Directive 2008/105/EC for 22 priority substances and a number of other pollutants, as well as 13 priority hazardous substances. Values are generally set as annual averages and /or maximum allowable concentrations. These standards are used to determine the chemical status of rivers. Compliance with relevant standards results in waters being classified as at good chemical status. Non-compliance results in waters being classified as being at poor chemical status. These substances have been identified as posing a significant risk to surface waters at EU level, and the objective of designating substances is to put specific measures in place for the progressive reduction of discharges, emissions and losses of priority substances, and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances.

Each year, approximately one-third of all of the surveillance sites are monitored monthly for these pollutants. A summary of monitoring results is presented in Appendix 1. Apart from ubiquitous persistent, bio-accumulative and toxic substances (uPBTs) (see below), the level of compliance with the EQSs for priority and priority hazardous substances is very high. Of the pesticides monitored, only Isoproturon exceeded the annual average EQS in the River Nanny

(Eastern River Basin District) due to the influence of one very high result (4.2μg/l) in October 2011. It is widely used for controlling the growth of broad-leaved weeds and grasses, in both spring and winter seasons.

Both atrazine and simazine have been banned since 2007. However, some rare occurrences have been detected at low levels, below EQS. Clearly, some old stocks may still be in use. Di(2-ethylhexyl)- phthalate (DEHP) is a widely-used plasticiser, and traces were found in 92 of 114 rivers (81.5%), however, no values were found above the EQS of 1.3μg/l.

Cadmium

Environmental Quality Standard values for cadmium present an analytical challenge, as the limits of detection (LOD) of current laboratory techniques are insufficiently sensitive to determine, with certainty, whether breaches of the EQS values have occurred. Of the 2,706 results covering 204 river stations, there were 19 stations which apparently exceeded the AA-EQS, with five of these exceeding the respective MAC threshold. Of these, eleven can be deemed to exceed the relevant EQS. Rivers where EQS exceedances were recorded included the Avoca and Glenealo in the Eastern River Basin District, the Drish, Glengalla, and Rossestown in the South-Eastern River Basin District, and the Garryard Stream and Yellow/Kimastulla rivers in the Shannon district due to natural geological anomalies. These are also all in known mining areas.

Nickel

Nickel is a commonly-occurring element in nature, though its presence in soils is generally much lower than, for example, copper and zinc. It is quite prominent in soils in Counties Wicklow and Meath, and in some parts of Limerick. The EQS is set at 20μg/l, and of the 5,115 results covering 358 stations (219 rivers), only two rivers, the Rossestown and Drish, showed any EQS exceedances.

Lead

There are several areas in Ireland with comparatively high and naturally-occurring lead concentrations, mostly in the east of the country. In 2010-2012, of the 2,705 samples covering 203 stations (138 rivers), 26 stations exceeded the AA-EQS of 7.2 μg/l, however of these, only 13 stations (five rivers), notably the Drish, Rossestown and Tay in the south-eastern RBD, the Garryard Stream, Kilmastulla, Newport (Tipperary), and Yellow/Kilmastulla in the Shannon region, exceeded the EQS with any degree of certainty. In all of the other cases, annual averages were generally just above the EQS or were based on relatively few samples.

Ubiquitous persistent, bio-accumulative and toxic substances

Brominated diphenylethers, mercury, polyaromatic hydrocarbons (PAHs) and tributyl tin (TBT) have been identified as ubiquitous persistent, bio-accumulative, and toxic substances (PBTs) under Directive 2013/39/EU. These, and other substances that behave like PBTs, can often be found for decades in the aquatic environment at levels posing a significant risk, even if extensive measures to reduce or eliminate emissions of such substances have already been taken. Some are also capable of long-range transport and are largely ubiquitous in the environment. Therefore, non-compliant results do not infer specific issues local to a water body or indeed river basin district.

Freshwater fish (trout and perch) were sampled and analysed for mercury in 22 lakes but not in rivers. Results for all fish samples showed concentrations exceeding the EQS of 20μg/kg, ranging from 38-388 μg/kg. These concentrations are consistent with other studies across Europe, indicating the widespread distribution and persistence of this element. However, it should be noted that the concentrations were well below standards for fishery products[20] and therefore, do not pose a risk to human health. Airborne deposition of mercury from fossil fuel combustion is widely regarded as the principal source. Similarly, mussel samples from marine waters showed exceedance of the biota standard in some places.

PAHs are a group of ring-structured organic compounds that are commonly associated with the combustion of fossil fuels. They are also present in run-off from roads. They have a strong affinity to solids and may be present from both fuel spillages or bound to particulate material, such as tyre residues. They present an undesirable parameter in waters even at very low concentrations due to their build-up in the aquatic food chain. During the period 2010-2012, the presence of one or more of the five substances comprising this grouping was found in 65 of the 79 stations surveyed (82.3%). Of the 4,245 results from 68 rivers, the detection rate was 14.9%. Two additional compounds, anthracene and fluoranthene, are also measured in this family of substances. Anthracene, fluoranthene and benzo-a-pyrene all have individual EQS values, with no exceedances of the AA-EQS or MAC observed. There are two sets of grouped parameters where the EQS is set as the sum of both components. These are (benzo(b) flouranthene / benzo(k)fluoranthene) with an AA-EQS of 0.03µg/l. There were 17 detects, however, no exceedances of the EQS were observed. The second grouping is for the pair (benzo(b)flouranthene / benzo(k)fluoranthene). The EQS for this pairing is just 0.002 µg/l, and these were detected in 56 of the 79 stations monitored, with the AA-EQS being exceeded at 40 stations, with eight cases where the results were significantly above the EQS. The average value across all 68 rivers was just over twice the AA-EQS at 0.0045µg/l. It is important to recognise that this EQS of 0.002µg/l is extremely low. The standard allowed in drinking water (for total PAHs) is five times higher at 0.01µg/l. Calculations based on measurements of PAHs in ambient rainfall would indicate that the typical background concentrations in our rivers appear to be arising most likely from airborne deposition.

Applying the drinking water standard for the grouped parameter Σ (benzo(b)flouranthene / benzo(k)fluoranthene) would result in exceedances occurring at seven stations. These were noted in the Eastern RBD on the River Barrow at Monasterevin, Greese river and Tully stream, in the Shannon region on the Clodiagh (Tullamore), in the South-Western RBD on the Womanagh and Blackwater (Munster) at Killavullen Bridge, and in the Western RBD on the Kilcrow River in Galway.

Other trace organic compounds

The WFD monitoring programme also examines the presence of a range of compounds known as volatile organic compounds (VOCs). These include common solvents such as trichloroethylenes (used in dry cleaning processes), chloroform and dichloromethane (common industrial solvents), benzene and hexachlorobutadiene (from road run-off), as well as a wide range of other halogenated compounds. In total over the three-year period, 33,122 measurements were made covering 57 substances. There were no breaches of EQS values for any of these substances. Only 228 measurements detected these substances. Of these, 67 detects were for chloroform which is a common by-product of drinking water disinfection processes. Pentachlorophenol was found on two occasions in the Laune and Maine rivers in Co. Kerry. Both occurrences appear to be isolated events. Studies were also undertaken to determine concentrations of hexachlorobenzene (HCB) and hexachlorobutadiene (HCBD) in freshwater fish in lakes. None of the samples analysed showed exceedances of EQS standards for either HCB or HCBD.

20 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

Causes of water pollution

While the causes of observed pollution, as determined by using the biological macroinvertebrate Q-Value assessments, may not always be proven, it is often clear what the likely causes are. Causes, such as discharges from municipal wastewater treatment plants or silage effluent discharges from farms, are usually obvious. In the case of more diffuse pollution, a number of approaches are taken to specify the nature of the pollutant source. These include on-site investigations, such as catchment walks and sampling smaller streams, to pinpoint the location of pollution sources. In addition, examining available information on changing land use over time and ordnance survey aerial photography can be helpful in investigating causes of water pollution.

Using the WFD macroinvertebrate classification, a total of 562 sites were classified at moderate status, 398 were deemed to be at poor status, while 10 sites were at bad status.

Suspected causes of pollution recorded nationally at 840 of these monitored sites are summarised in **Figure 3-21**. The polluted sites were examined in some detail to assess the likely main cause of pollution in each case. Where more than one cause was suspected, these were recorded. The breakdown discussed in this report only applies to the main suspected cause of pollution recorded in each case. As in previous surveys, the two most important suspected causes of pollution are agriculture and municipal wastewater discharges, accounting for 53% and 34% respectively of the polluted sites examined.

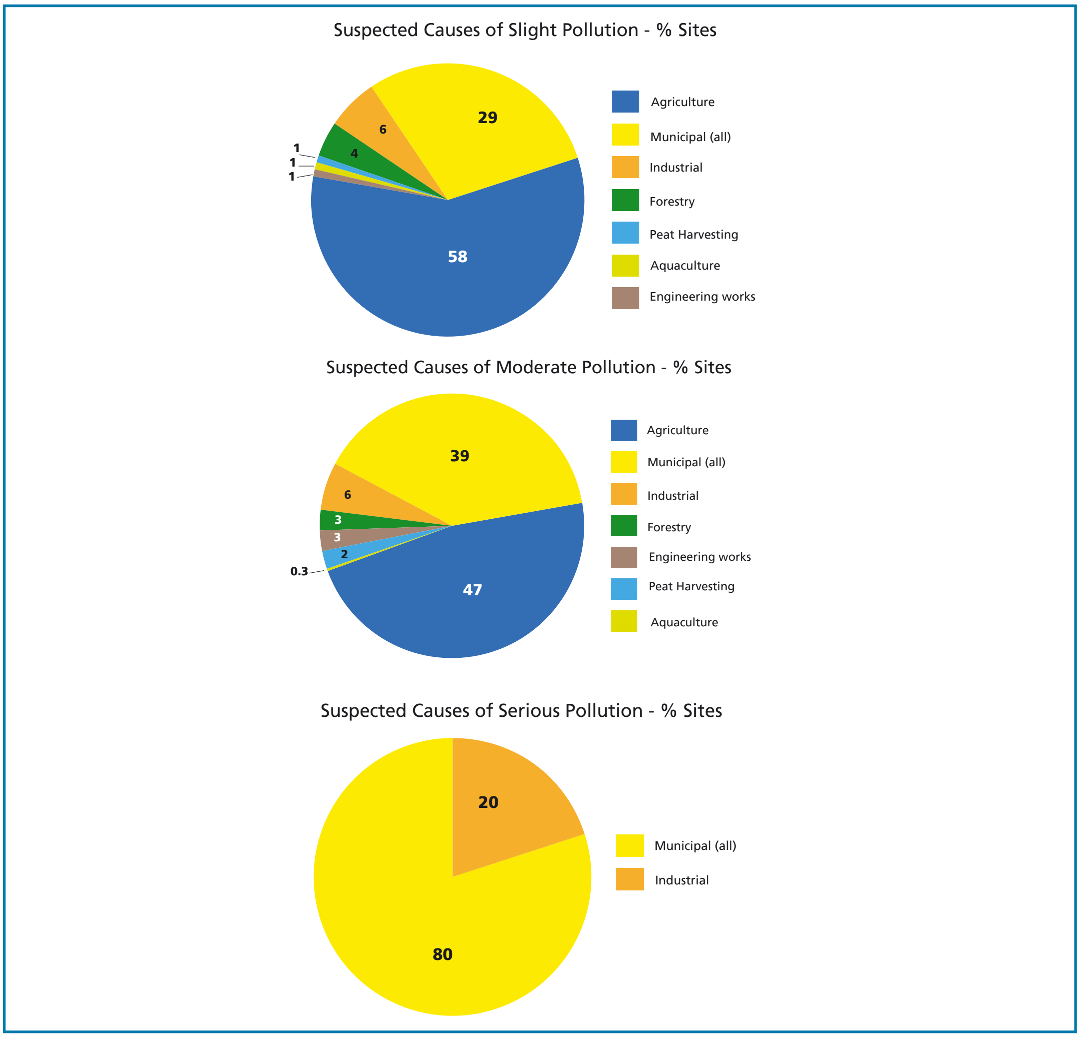


Figure 3-21. Percentage of polluted river sites surveyed in 2010-2012 grouped by severity of pollution (slight, moderate and serious) and suspected cause where assigned.

Slight pollution

Agriculture, primarily diffuse agricultural pollution causing eutrophication, was the main suspected cause of pollution assigned to over half of the cases of slight pollution (**Figure 3-21**). Slight pollution corresponds to moderate ecological status under the Water Framework Directive assessments. Municipal sources accounted for 28% of the sites in this category. The majority of these cases were due to suspected nutrient losses from municipal wastewater treatment plants but also a wider range of urban impacts, such as diffuse urban run-off, landfills and water treatment works. Industrial and forestry pollution sources accounted for 6% and 4% respectively of the cases of slight pollution examined. The main effect of these sources is eutrophication, i.e. greatly enhanced plant and algal growth caused by the plant nutrients phosphorus and nitrogen. Siltation is also another impact frequently encountered with slight pollution. Sensitive species, including the Freshwater Pearl Mussel and fish, can be affected by the smothering effects of inert or organic silt from sources mentioned above but also from engineering works, such as dredging, civil works and peat harvesting.

Moderate pollution

Moderate pollution, as indicated by the EPA's macroinvertebrate survey, is most likely to be classified as poor ecological status under the Water Framework Directive. The majority of instances of moderate pollution could also be attributed to agricultural sources and municipal sources (47% and 39% respectively) (**Figure 3-21**). The main effect from this pollution is intense eutrophication. In agriculture, primarily diffuse losses, including farm yard losses, siltation due to bank erosion, cattle access to streams, and losses from tillage land, were suspected. Municipal discharges from wastewater treatment plants were the main suspected case in the municipal category, with landfills and diffuse urban run-off also suspected. Suspected industrial sources of pollution accounted for 6%, while engineering and forestry impacts were each attributed to 3% recorded at sites examined.

Serious pollution

The extent of serious pollution has been reduced significantly in recent years due to increased enforcement[21]. There were 13 river sites classified as seriously polluted (bad ecological status) at some point during the 2010–2012 survey. Of these, four sites were newly classified as seriously polluted. Three of these sites improved in quality when resurveyed to assess the programme of measures applied to implement remediation. A total of 11 sites improved on their 2007-2009 serious pollution classification when surveyed in 2010–2012, leaving a total of 10 sites currently classified as seriously polluted (**Table 3-8**), representing 0.1% (16.9 km) of the total channel length surveyed. This represents a further significant improvement on the 2007–2009 survey when 19 locations (0.4% of channel length surveyed) were deemed seriously polluted.

21 Focus on urban waste water treatment in 2013. Environmental Protection Agency (2013)

River Name	Code	Location	County	Channel length (km)
Industrial				
Laurencetown Stream	26L070300	Br NW Ballyhoose (West Br)	Galway	3.9
Aighe	38A030150	Br NNW of Cashel	Donegal	1
Municipal				
Swilly Burn	01S030200	Br 1.5 km SE of Raphoe S Magheraha	Donegal	1.5
St John's	16S030300	Bleach Bridge	Waterford	Not available
Ahavarraga Stream	24A020400	Br 0.5 km d/s Priests Br	Limerick	2.5
Jiggy (Hind)	26J010090	Br WSW Ardsallagh Beg	Roscommon	3
Tubbercurry	34T020050	Br 1 km W. of Tubbercurry	Sligo	2.5
Tubbercurry Stream	34T030400	At old railway bridge	Sligo	Not available
Maggy's Burn	39M010300	Br Just u/s Lough Fern	Donegal	2
Bredagh	40B020400	Br in Moville	Donegal	0.5
Total (km)				**16.9**

Table 3-8. Serious pollution river locations 2010 – 2012.

Of the fourteen sites which improved, three have returned to good status, one has improved to moderate status, and the remaining 10 sites have improved to poor status. Municipal wastewater treatment plants are the suspected cause of pollution for eight of the current seriously polluted sites, while industrial discharges are suspected of causing pollution at the remaining two locations (**Table 3-8**).

Water quality and ecological potential of canals and their feeder streams

Canals are designated as Artificial Water Bodies (AWBs) under the WFD. Canals are required to achieve good ecological potential rather than good ecological status which pertains to natural water bodies. For classification purposes, the ecological potential can be maximum, good, moderate, poor or bad.

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. Inland Fisheries Ireland (IFI) operates a fisheries development programme for Waterways Ireland in the Republic of Ireland. As part of this programme, IFI carries out water quality monitoring of the canals for the purposes of the Water Framework Directive (WFD). The waterways covered include the Grand Canal, Royal Canal and the canalised section of the Shannon-Erne Waterway.

The canals traverse the Eastern, South-Eastern and Shannon River Basin Districts (RBDs) and are divided into 11 Artificial Water Bodies (AWBs) for the WFD canal monitoring programme. In the current assessment period (2010-2012), a recently-developed system for assessing the ecological potential of UK and Irish Canals was used to classify canals in Ireland. In total, 332 km of channel was monitored, with 42 surveillance monitoring sites assessed for biology, physico-chemistry and hydromorphology. Biological assessment was undertaken by surveying for macroinvertebrates and macrophytes. Supporting physico-chemistry data was obtained from a sub-set of routinely monitored parameters, including total phosphorus, soluble reactive phosphorus, total oxidised nitrogen, ammonia, BOD, and coliforms. The integration of the biological, physico-chemical and hydromorphological quality elements was used to classify the overall ecological potential of the canal water bodies. Chemical status was not assessed, as the monitoring of priority or dangerous substances is only considered when deemed to be discharging into canals from natural water bodies.

Biological quality elements

Assessment of the canals using macroinvertebrates indicates generally good biological conditions in the Royal and Grand Canals, with 43% of sites classified at maximum, and 45% achieving good potential (Figure 3-22). Four sites on the main channel of the Grand Canal were at moderate ecological potential, including two sites in Kildare (Sallins and Ticknevin) and two in Offaly (west of Daingean and Tullamore). The canalised section of the Shannon-Erne Waterway was classified as poor, when assessed using the macroinvertebrate quality element.

Results were similarly positive for the Royal and Grand Canals in terms of macrophyte assessment, with 34% of sites at maximum potential and 64% of sites classified as good (Figure 3-22). A number of sites in both canals had to be downgraded from maximum to good due to the presence of the invasive aquatic plant Nuttall's Pondweed. The Shannon-Erne Waterway was classified at moderate potential in terms of the macrophyte quality element.

Physico-chemical and hydromorphological quality elements

The majority of sites were compliant with the water quality standards throughout 2010-2012, with 90% of sites achieving good ecological potential (Figure 3-22). Three sites experienced high BOD readings on a number of occasions and were classified as moderate. These include a site on the Grand Canal at Hazelhatch, Co. Dublin, a site on the Barrow Line of the Grand Canal at Athy, and a site on the Royal Canal at Castleknock in Dublin. Exceedances of ammonia and total phosphorus occurred at a Grand Canal site located west of Daingean, Co. Offaly, also resulting in a moderate classification. When assessed for hydromorphology, all Royal and Grand Canal sites were at maximum ecological potential, while the Shannon-Erne Waterway was classified as less than good.

The surveillance monitoring programme on the canals involved the routine sampling of a number of feeder streams. These feeders can be a source of nutrient and organic enrichment to the main channels and, depending on their location, are subject to point source pollution from municipal wastewater infrastructure or diffuse pollution from agricultural run-off. Any impacts from the feeder streams in 2010-2012 tended to be minor and localised, and did not affect overall water quality in the canal water bodies. However, a fish kill on the 27th level of the Barrow Line in Athy in December 2010 was attributable to pollution from a surface water drain discharging directly to the canal. High levels of *E. coli*, an indicator of faecal contamination, occurred on a number of occasions in the Grand Canal Basin in Dublin and in a surface water drain discharging to the Royal Canal at Kilcock, Co. Kildare.

Combined ecological potential

When the biological, physico-chemical and hydromorphological quality elements were combined, all water bodies in the Grand and Royal Canals achieved good ecological potential in the 2010-2012 period (Table 3-9). The canalised section of the Shannon-Erne Waterway had a poor classification in terms of macroinvertebrates and, applying the one-out-all-out rule, was classified as poor overall. While this water body was compliant with the water quality standards for the period, the biological potential is compromised by the hydromorphology of the canal. Its box-shaped profile and resultant poor aquatic flora means that it cannot achieve good ecological potential when assessed using the macrophyte and macroinvertebrate quality elements.

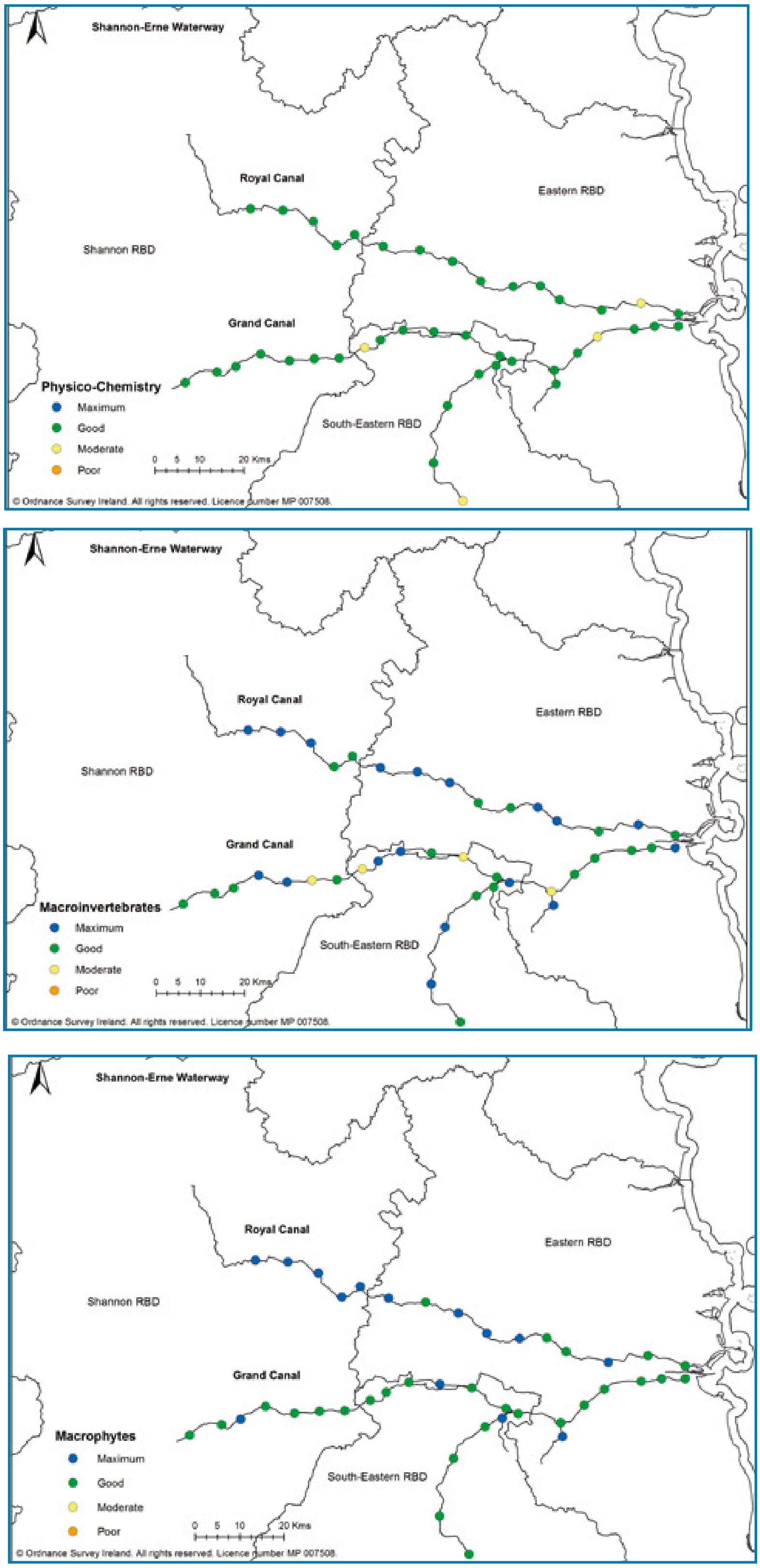


Figure 3-22. Maps of canal sites monitored for the Water Framework Directive (WFD) showing the ecological potential class based on the physico-chemical, macroinvertebrate and macrophyte quality elements.

River Basin District	Artificial Water Body (AWB)	Combined Ecological Potential
	ROYAL CANAL	
Eastern	Royal Canal Main Line	Good
Shannon	Royal Canal Main Line West of Lough Owel	Good
	GRAND CANAL	
Eastern	Grand Canal Main Line East of Lowtown	Good
South-Eastern	Grand Canal Main Line East of Lowtown	Good
South-Eastern	Grand Canal Main Line West of Lowtown	Good
Eastern	Grand Canal Main Line West of Lowtown	Good
Shannon	Grand Canal Main Line	Good
Eastern	Grand Canal Naas & Corbally Branch	Good
	BARROW LINE	
South Eastern	Grand Canal Milltown Feeder & Old Barrow Line	Good
South Eastern	Grand Canal Barrow Line	Good
	SHANNON-ERNE	
Shannon	Shannon-Erne Waterway	Poor

Table 3-9. Status classification of Artificial Water Bodies (AWBs) in 2010-2012.

Conclusions

- The proportion of river channel deemed to be in satisfactory condition has improved in the current period. 73% of river channel is at high or good macroinvertebrate status, this represents a 4% improvement on the previous survey.
- In WFD terms, 53% of monitored river water bodies (by number) are at satisfactory ecological status, however, Ireland still faces a considerable challenge, with 47% of these river water bodies currently failing to meet the WFD objectives of reaching good ecological status.
- The number of high status sites and corresponding percentage of high status channel length increased by almost 2% in the 2010-2012 survey period.
- The number of seriously polluted sites has further decreased to a current low of 10 sites.
- There has been a further decline in the number of fish kills reported in freshwaters (rivers and lakes) in the period under review (2010-2012), the lowest recorded to date.
- The principal concerns for Irish rivers remain the impact of eutrophication (due to nutrient enrichment) and oxidation conditions.
- A total of 840 monitored river sites were examined for suspected sources of pollution in the current survey. The two most important suspected sources of pollution are agriculture and municipal wastewater discharges.
- Trends in total oxidised nitrogen (TON), however, are indicating that concentrations in rivers are showing some degree of reduction (52% of sites assessed) or are stable (41% of sites assessed). The greatest reductions in nutrients appear to be in the tillage and intensive agriculture areas in the South-East and Midlands.

- Trends in phosphorus concentrations in rivers are stable in most parts of the country (69% of sites assessed). The average orthophosphate concentrations are less than the good EQS (i.e. <0.02 mg/l P) threshold for approximately two-thirds of the rivers examined, and therefore it is more difficult to demonstrate any significant trend between years examined due to seasonal variations. The greatest improvements have been observed in rivers where, in general, P values are in the good – moderate boundary (24% of sites assessed).
- Overall, the level of compliances with Environmental Quality Standards for specific pollutants is high in Irish rivers. The main issue is from metals in known, mineral-rich mining areas.
- Apart from ubiquitous PBTs, the level of compliances with the Environmental Quality Standards for priority and priority hazardous substances is very high.
- All water bodies in the Grand and Royal Canals achieved good ecological potential in the 2010-2012 period. The canalised section of the Shannon-Erne Waterway had a poor classification. While this water body was compliant with the water quality standards for the period, the biological potential was compromised by the hydromorphology of the canal.

Recommendations / follow-up actions

- The adoption and implementation of river basin management plans are beginning to show positive results, however, the pace of improvement is slow. Continued integrated catchment management planning and targeting of programmes of measures can only continue to influence the pace of change.
- River water bodies have been significantly revised so that the monitoring network will, in future, be more representative for the purpose of assessing the status of rivers. The original 4,565 water bodies have been reconfigured into approximately 3,200 water bodies. Therefore, the basis for the reporting of water status in future will change to some degree.
- The Water Framework Directive requires ecological status to be defined using all biological elements, namely the macroinvertebrates, plants and fish at surveillance sites. The status classification schemes for macrophytes and phytobenthos are currently undergoing further development and testing. These assessment methods could also be used at operational monitoring sites where they are deemed to be the most sensitive assessment method for the pressure being assessed. Once finalised and tested at the European level in the Intercalibration process, they will be adopted for use in Irish rivers. The Fish Classification Scheme 2 (FCS2) was intercalibrated at European level and adopted for use in assessing the fish populations of Irish rivers for WFD reporting. The survey results have shown some mismatch with the other biological elements and will need to be examined further to understand whether pressures other than enrichment may be causing the response, e.g. hydromorphological pressures such as barriers to access, etc.

4. LAKES

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

- 213 lakes representing 955 km^2 of lake surface area were monitored for the WFD in the period 2010-2012.
- 112 lakes (53% of lakes monitored) or 505 km^2 (54% of lake area monitored) of lake surface area did not change status. This implies no change in pressures in these lake catchments.
- 53 lakes or 221 km^2 of lake area declined in status. 33 lakes or 134 km^2 of lake area improved in status. The changes in status are generally a result of changes in phosphorus concentrations. For a small number of lakes, other factors such as abstraction pressure, habitat limitations, the presence of alien species and fish population dynamics, may be impacting on status and require further investigation.
- Overall, the changes in status translate into a 5% reduction (10 lakes) in the high or good status categories and a corresponding increase in the moderate or worse status category compared to 2007-2009. Overall, 91 lakes (43% of lakes monitored) were assigned high or good status and comprised 295 km^2. One hundred and twenty two lakes (57%) were moderate or worse in status (660 km^2 of lake area monitored).
- Fish status was the factor determining overall ecological status in 10 of 13 lakes that were classified as at poor or bad status, where biology was the sole status determinant. The reason for this requires further investigation.
- 6 of the 9 monitored heavily-modified water bodies were at maximum or good ecological potential.
- The levels of specific pollutants, priority substances and priority hazardous substances monitored in over 70 lakes remain low with few exceedances. Samples of trout and perch were analysed for mercury in 22 lakes. All samples exceeded the EQS. However, like PAHs, mercury has been identified as a ubiquitous persistent, bioaccumulative and toxic substance (uPBTs) under Directive 2013/39/EU. uPBTs occur widely in the environment on a global scale, due principally to atmospheric deposition.
- The Invasive Alien Species (IAS) zebra mussel was recorded in 70 of the monitored lakes and one heavily-modified water body compared to 50 known lake populations in the 2007-2009 period, suggesting that the zebra mussel continues to spread despite public awareness and biosecurity campaigns.
- Roach, an invasive fish species, was recorded in 36 of the 75 lakes monitored in 2010-2012.

Introduction

There are more than 12,000 lakes in Ireland, the majority of which are located along the western seaboard but substantial numbers are also located in the north-west, south-west and midlands. The WFD deals with lakes with an area greater than 50 hectares, and those acting as sources of drinking water or within protected sites[22]. Based on these criteria, approximately 856 lakes have been identified as Water Framework Directive (WFD) lakes. Of these, 213 representative lakes have been included in the national monitoring plan.

This chapter presents the monitoring results from the second three years (2010-2012) of the Water Framework Directive (WFD) lake monitoring programme cycle (2007-2012), and provides an integrated assessment of the biological, physico-chemical and hydromorphological quality elements monitored in Irish lakes. The assessment relates mainly to the primary pressure on lakes, which is eutrophication resulting from nutrient enrichment. Hydromorphological

22 Protected under habitats and birds Directives (92/43/EEC and 79/409/EEC) or nutrient sensitive waters under the UWWT Directive (91/271/EEC)

condition, acidification and alien species are also included but to a more limited extent in the monitoring programme. The information on these lakes was derived from monitoring carried out by the EPA, Local Authorities, Inland Fisheries Ireland and the Northern Ireland Environment Agency. The status assessments are summarised at the national and river basin district level.

A number of improvements to the classification tools have taken place since the publication of the 2007-2009 status report, and the 2007-2009 status has been updated to take account of these improvements. This is the baseline against which objectives were set and progress is measured. These changes included an improved version of the Fish in Lakes classification tool, the phytobenthos tool, and phytoplankton classification tool, which have been intercalibrated at EU level[23]. Lake typologies were also updated with the best available data. The general physico-chemical parameter datasets have also undergone a review that has resulted in a more reliable and improved dataset than previously used. All these changes have been incorporated into the 2007-2009 lake status update.

Fifteen lakes were removed from the programme in 2010 due mostly to problems of access. Three water bodies were turloughs and were therefore removed. Fourteen lakes have been added, partly to replace those removed. The majority of those added were lakes that were deemed to be at risk from hydromorphological pressure as a result of water fluctuations arising from abstraction for drinking water.

WFD ecological status methodology

Ecological status is derived by taking the lowest status classes for the relevant biological and physico-chemical quality elements. For lakes that are deemed to be at high status for biological and physico-chemical quality elements, hydromorphological condition must be taken into consideration, and if found wanting, the lake is downgraded to good status. Further details on status setting can be sourced from the Agency's website.[24]

Status based on biological quality elements

Biological status for surveillance lakes included three biological quality elements; aquatic flora (macrophytes and phytobenthos); phytoplankton and fish.

Monitoring macrophyte communities in a lake

23 Commission Decision, 2013/480/EU

24 http://www.epa.ie/reports/water/waterqua/Final_Status_Report_20110621.pdf

Status based on physico-chemical quality elements

General physico-chemical status was assigned using the Environmental Quality Standard (EQS) for total ammonium, dissolved oxygen and pH, as published in SI 272 of 2009. In addition, boundary values of 10 and 25 µg/l P total phosphorus (TP), representing the high/good and good/moderate boundary, were also used.

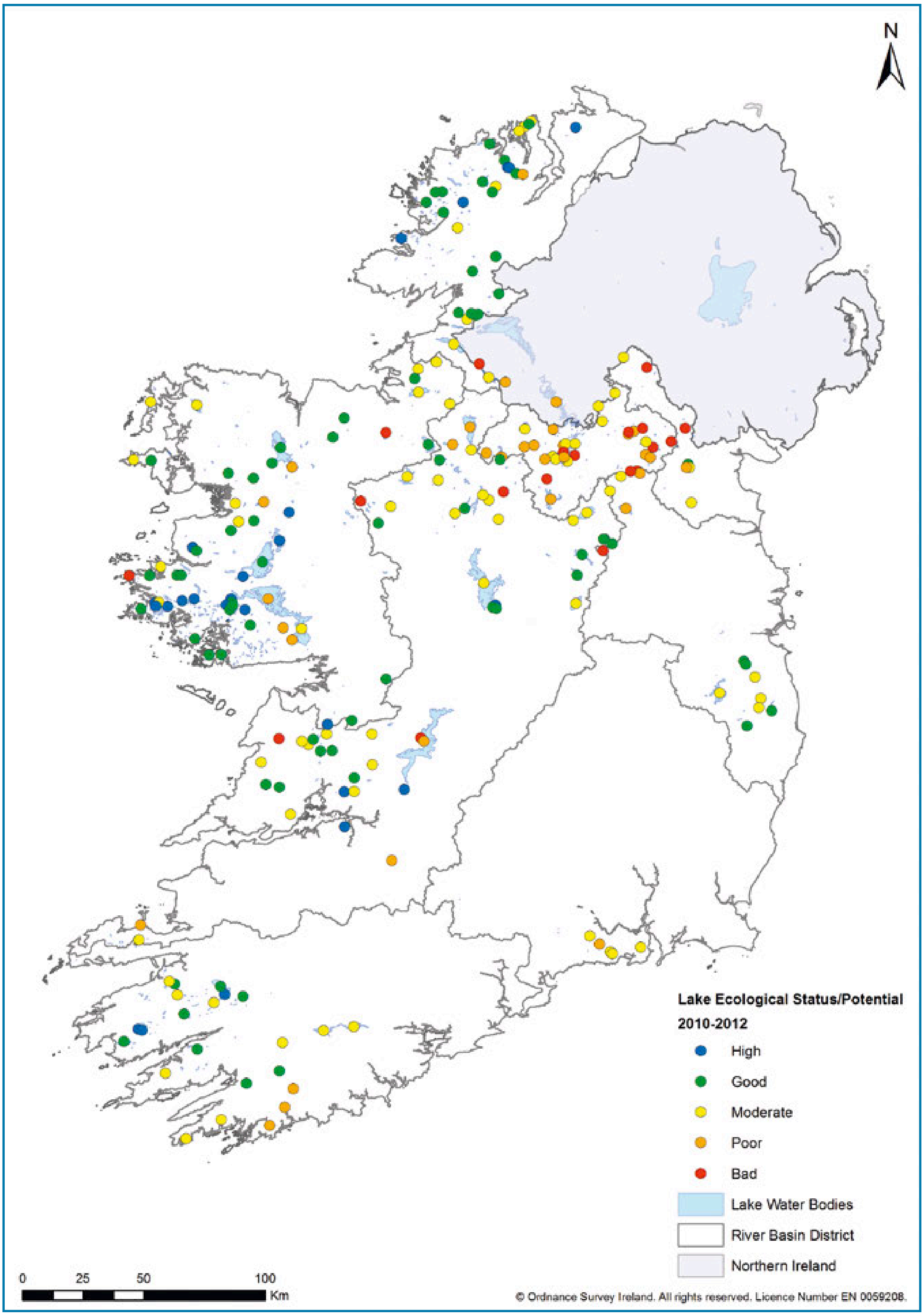


Figure 4-1 Lake ecological status/potential for 2010-2012.

2010-2012 ecological status

National Picture: The distribution of monitored lakes and their ecological status/potential are presented in **Figure 4-1.** High or good status was assigned to 91 (43%) of the lakes examined (see **Figure 4-2** and Appendix 2), with most lakes (68 lakes or 32%) in the good status category. The remaining 122 lakes were of moderate or worse ecological status, and accounted for 57% of the lakes examined. The 2010-2012 ecological status assessment results are mapped on the EPA ENVISION website and are available to download from the EPA geoportal[25].

Lakes in the high and good status categories accounted for 295 km² (31%) of the lake area examined (**Table 4-1**). A further 287 km² (30%) of lake area assessed was assigned moderate status. The 33 poor status lakes accounted for 354 km² (37%) of lake area examined, and the 19 bad status lakes accounted for 19 km² (2%) of lake area examined. In all, 69% or 660 km² of lake area examined was in the moderate or worse ecological status classes.

Western River Basin District: In the WRBD, 39 (67%) of the 58 lakes monitored were assigned high or good ecological status (**Figures 4-3**, **4-4**, Appendix 2), accounting for 192 km² (48%) of lake area monitored in the district. These were predominantly in counties Galway and Mayo, areas of low populations and farming intensity; Lough Bunny in Clare; and four lakes in Sligo. The Sligo lakes were Easky, Killsellagh and Talt, which are upland lakes in catchments with few people, low intensity farming and some forestry, and Lough Arrow, a large lake draining an upland area, and all are used as drinking water sources.

Nineteen lakes were assigned moderate or worse ecological status, including some very large lakes; Corrib Lower, Corrib Upper, and Lough Cullin. The lake area examined in the district assigned moderate or worse ecological status was 209 km² (52%).

North-Western International River Basin District: In the NWRBD, 21 lakes (33%) were assigned high or good ecological status, accounting for 25 km² (20%) of lake area monitored in the district (**Figure 4-3** and **Figure 4-4**). These lakes were located in Co. Donegal in areas of low intensity agriculture, large tracts of natural vegetation and generally low levels of urbanisation. Forty-three lakes in this RBD (67%) were assigned moderate or worse ecological status, or 100 km² (80%) of the lake area examined. The majority of these lakes were located in Cavan and Monaghan, both counties with high intensity farming with poorly draining soils.

South-Western River Basin District: The SWRBD had 11 lakes (52%) assigned to the high or good ecological status categories, accounting for 37 km² (79%) of lake area monitored in the district (**Figure 4-3** and **Figure 4-4**).These lakes were primarily in Kerry, in hydrometric areas 21 and 22, which are mountainous areas with low intensity agriculture, large tracts of natural vegetation and generally low population levels.

Ten lakes (48%) were assigned an ecological status of moderate or less, accounting for the remaining 11 km² (21%) of lake area monitored. These were located primarily in hydrometric area 20, an area of intensive agriculture, relatively dense populations, with relatively high numbers of urban wastewater treatment plants and septic tanks.

Eastern River Basin District: The ERBD continues to have no lakes of high ecological status on the monitoring programme (**Figure 4-3** and **Figure 4-4**). Three lakes (1 km²), located in Meath (two lakes) and Wicklow (one lake) were assigned good ecological status. Nine lakes (15 km²), predominantly in Cavan (five lakes), were assigned to moderate or worse ecological status, and include lakes with a history of enrichment, such as Drumkeery and Ramor.

Neagh Bann International River Basin District: One lake, Spring, was of good status in the NBRBD, accounting for 2% of the total area monitored. It is an abstraction lake with apparently one inflow from a smaller lake with no river network. It is likely to be mostly fed by groundwater[26] being on karst with springs in or around the vicinity, which is reflected in its

25 http://gis.epa.ie/

26 Jean Wilson, *pers. comm.* CombiNed Earth ObservationN and GEoChemical Tracing (CONNECT) for Groundwater

name. The remaining six lakes were of moderate or worse ecological status, and accounted for 98% (<5 km^2) of the total area monitored. Some of these lakes, such as Monalty, Muckno and Naglack, have a history of enrichment.

South-East River Basin District: The SERBD has very few lakes and therefore, the least number of lakes monitored. There are five lakes monitored which are <1 km^2. This is due to the lack of large lakes, with most lakes effectively being ponds as a result of the last glacial period (Mitchell and Ryan, 1986). Similar to the previous reporting period, all five lakes assessed in the SERBD were of moderate or poor ecological status, largely due to total phosphorus and chlorophyll, possibly related to nutrient inputs from intensive agriculture in their catchment areas.

Shannon International River Basin District: Sixteen lakes (35%) or 38 km^2 (11% of the lake area monitored in the district) were assigned good status (**Figure 4-3** and **Figure 4-4**). These were predominantly in Clare and Westmeath, and included such lakes as Cullaun, Inchicronan, Derravaragh and Owel. The remaining 30 lakes (65%) were assigned moderate or worse status, and accounted for 89% of lake area surveyed (321 km^2) which included some very large lakes, such as Allen, Ree and Derg on the Shannon, with a third of the lakes located in County Clare.

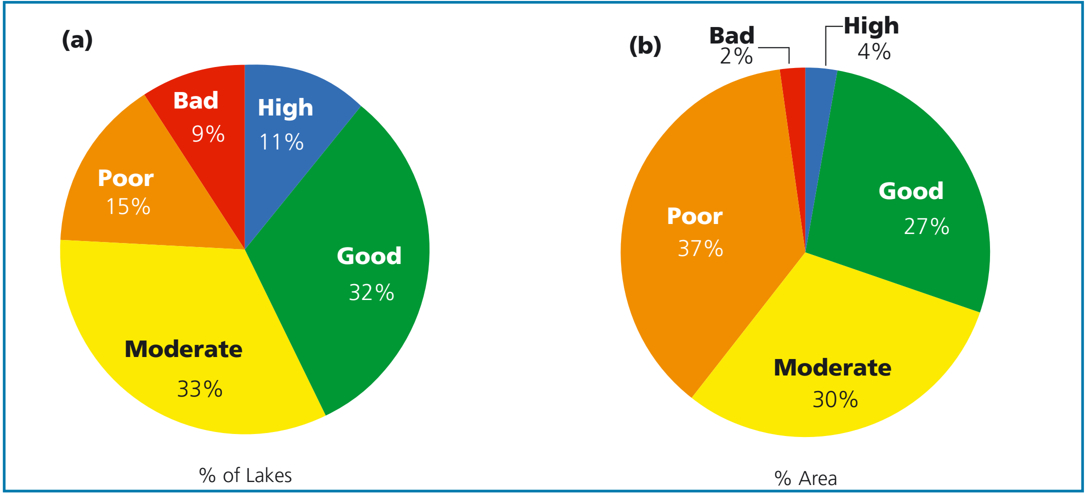


Figure 4-2. 2010-2012 WFD ecological status (nationally): (a) percentage of lakes and (b) percentage of lake area surveyed assigned to each ecological status category.

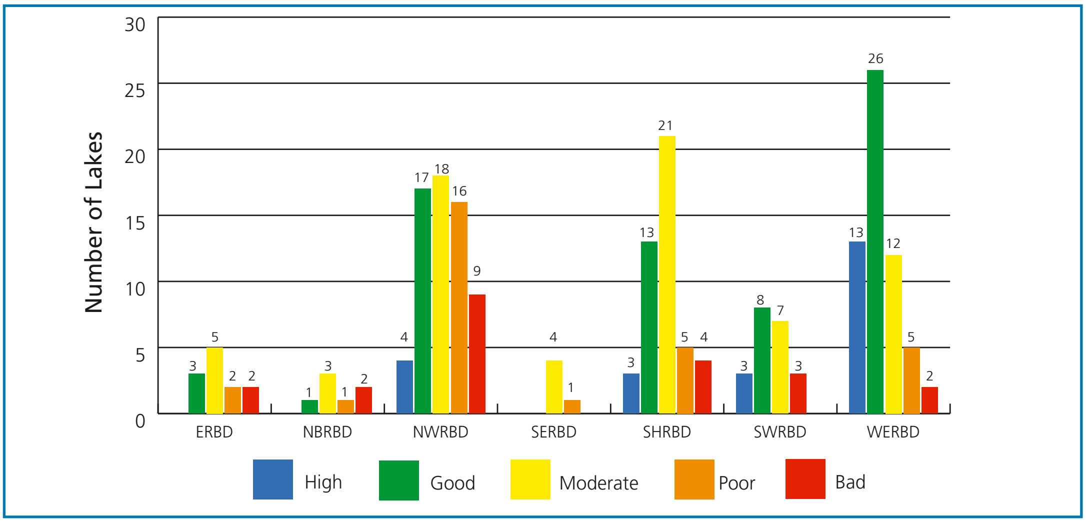


Figure 4-3. The number of lakes assigned to each ecological status class in each River Basin District for 2010-2012.

Detection and Evaluation in Ireland, a research project funded under STRIVE.

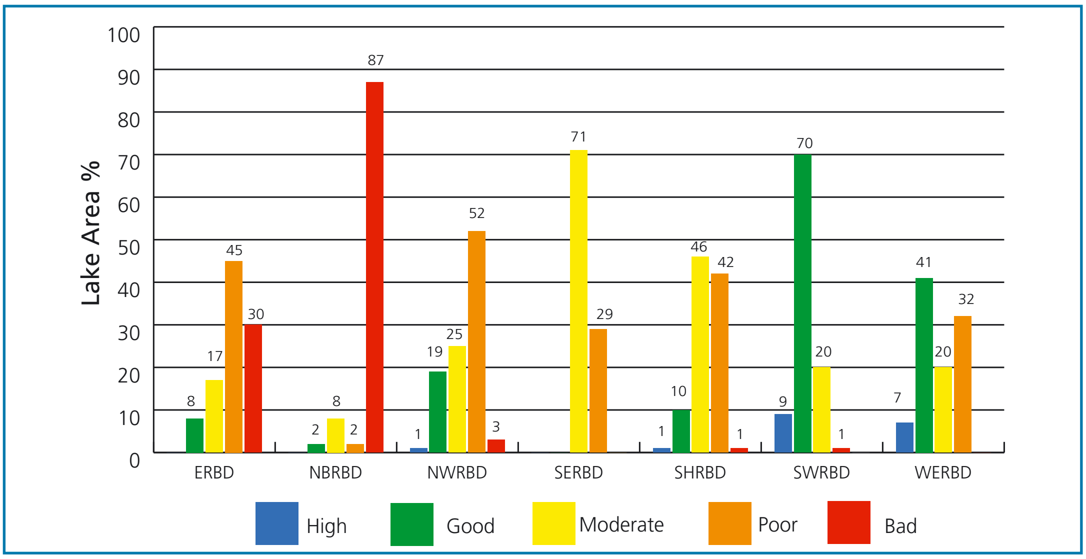


Figure 4-4. The percentage of lake area assigned to each ecological status class in each River Basin District for 2010-2012.

Update of 2007-2009 ecological status of lakes

National Picture: Results for the previous monitoring cycle (2007-2009) have also being revised following improvements in the assessment methods. The revisions resulted in minor adjustments to the overall figures. Nationally, the adjustments in status categories for the period 2007-2009 were: high (9% to 13%), good (38% to 35%), moderate (41% to 35%), poor (9% to 10%) and bad (3% to 7%). The revised results for 2007-2009 are also available on the Agency's geoportal[27]. High or good status was assigned to 101 (48%) of the lakes examined (**Figure 4-5, Table 4.1**), with most lakes (74 lakes or 35%) in the good status category. The remaining 111 lakes were of moderate or worse ecological status, and accounted for 52% of the lakes examined. Lakes in the high and good status categories accounted for 420 km^2 (45%) of the lake area examined (**Figure 4-5, Table 4.1**). A further 285 km^2 (30%) of lake area assessed was assigned moderate status. The 22 poor status lakes accounted for 189 km^2 (20%) of lake area examined, and the 14 bad status lakes accounted for 52 km^2 (5%) of lake area examined. In all, 55% or 526 km^2 of lake area examined was in the moderate or worse ecological status classes (**Figure 4-5, Table 4-1**).

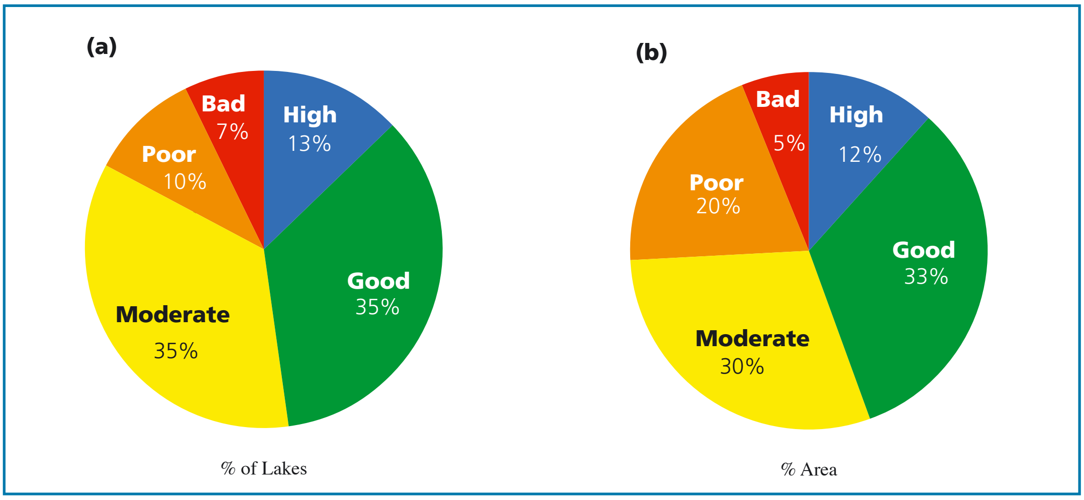


Figure 4-5. Updated 2007-2009 WFD ecological status: (a) percentage of lakes and (b) percentage of lake area surveyed assigned to each ecological status category.

27 http://gis.epa.ie/

Comparison of reporting periods

There was a decline of 5% in the high/good status category for 2010-2012 (91 lakes, 43%) compared to the period 2007-2009 (101 lakes, 48%). High status lakes declined from 27 lakes to 23 lakes (**Table 4-1**, **Figure 4-6**), and good status lakes declined in number from 74 to 68. The number of lakes in the moderate or worse category increased to 122 lakes (57%) compared to the previous reporting period, where 111 lakes were less than good (52%). The number of lakes in the moderate status category decreased from 75 to 70 lakes. There was a significant increase in the number of lakes in the poor and bad status categories. Thirty-three lakes were poor status in 2010-2012, compared to 22 lakes in 2007-2009. Nineteen lakes were bad status in 2010-2012, compared to 14 lakes in 2007-2009.

While the lake area assigned to moderate status was similar in both reporting periods, there was a decline in the lake area assigned to high status from 111 km^2 to 38 km^2, good status from 309 km^2 to 257 km^2, and bad status from 52 km^2 to 19 km^2. There was an increase in lake area assigned to poor status from 189 km^2 to 354 km^2 in 2010-2012.

Of the 33 lakes assigned poor status in 2010-2012, 10 were previously assigned poor status and accounted for 132 km^2. Therefore, 222 km^2 of lake area assigned poor status in 2010-2012 was a result of lakes changing in status. Two lakes, Corrib Upper and Drumlaheen, both previously good status, were assigned to poor status in 2010-2012. Corrib Upper (115 km^2) accounted for the majority (52%) of the increase in lake area assigned poor status and the decline in lake area previously in good status. The poor status in Corrib is due to fish status classification and is not reflected by the other biological elements or the general physico-chemical elements. Sixteen lakes that were previously moderate, accounted for 64 km^2 (29%) of lake area in poor status in 2010-2012. Five lakes improved in status from the last period.

While 13 km^2 of lake area in high status was attributable to the same 11 lakes in both periods, 94 km^2 of lake area in high status in 2007-2009 (13 lakes) was classified good or lower (one lake, Caragh) in 2010-2012. Three lakes, Mask, Caragh and Guitane, accounted for 90% (85 km^2) of the reduction. Three lakes were removed from the programme, accounting for 4 km^2. The 11 lakes that improved in 2010-2012 were considerably smaller, representing 22 km^2 in lake area. There was one new lake, Greenan, which is 2 km^2 in lake area.

	2007-2009				2010-2012			
Ecological Status	**Number of Lakes**	**% of Lakes**	**Surface Area (km^2)**	**% Area**	**Number of Lakes**	**% of Lakes**	**Surface Area (km^2)**	**% Area**
High	27	13	111	12	23	11	38	4
Good	74	35	309	33	68	32	257	27
Moderate	75	35	285	30	70	33	287	30
Poor	22	10	189	20	33	15	354	37
Bad	14	7	52	5	19	9	19	2
Total	**212**		**946**		**213**		**955**	

Table 4-1. The breakdown of ecological status for the periods 2007-2009 and 2010-2012 by numbers of lakes, surface area and the percentage total of each assigned to each ecological status class.

Fourteen lakes were new to the programme. These were assigned high (one lake), good (four lakes), moderate (four lakes) poor (one lake) and bad (four lakes) status. Both biological and general physico-chemical status were in agreement for 10 of these lakes, with general physico-chemical status determined the ecological status for two lakes. Two of the lakes were assigned bad ecological status due to fish, in contrast to other elements which were at good or better in status. The reasons for the bad fish status will need to be investigated further.

One hundred and ninety-eight lakes were common to both reporting periods (**Table 4-2**). Of these, 112 lakes (53% of lakes monitored) or 505 km^2 (54%) of monitored lake surface did not change status. These were distributed across the status classes as follows: high (11 lakes), good (42 lakes); moderate (42 lakes); poor (10 lakes) and bad (seven lakes) status.

Thirty-three lakes or 134 km^2 of lake area improved in status. These were previously assigned good (10 lakes), moderate (11 lakes), poor (five lakes) and bad status (seven lakes). These lakes comprise 21 lakes for which both the 2010-2012 biological and general physico-chemical status agreed, thus indicating that the ecological status is a good reflection of conditions.

Fifty-three lakes or 221 km^2 of lake area declined in status (**Table 4-2**). These were previously good (17 lakes), moderate (18 lakes) and high (13 lakes) status lakes, with the remainder (five lakes) poor status lakes that were assigned to bad status. The category of quality element, biological and /or general physico-chemical, determining lower status assignments are presented in **Table 4-3**. Twenty-three lakes had good agreement between their 2010-2012 biological status and physico-chemical status. This would seem to indicate that these lakes are in decline.

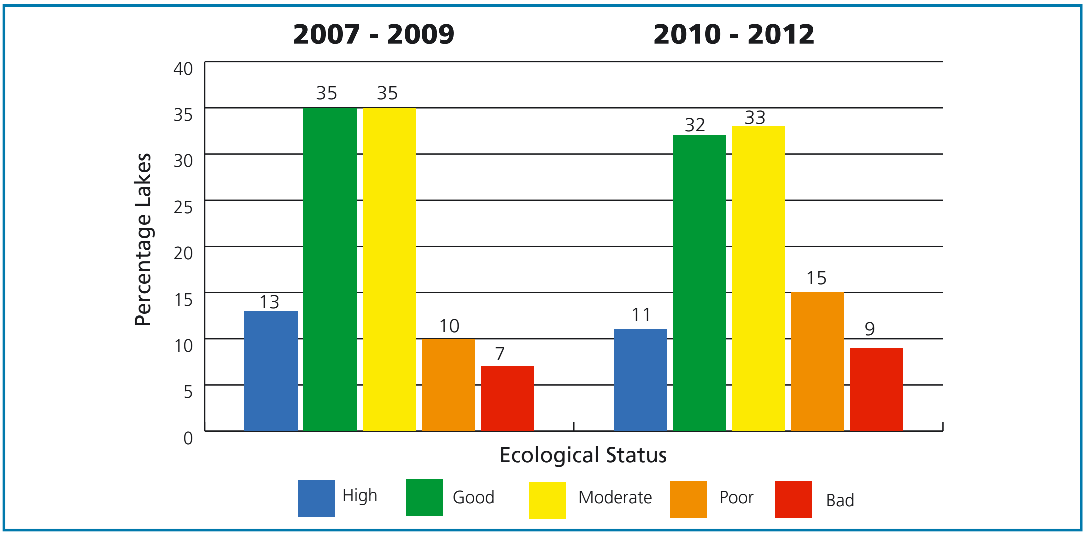


Figure 4-6. Comparison of ecological status between the two survey periods (2007-2009 and 2010-2012).

2007-2009	Number of Lakes			Surface Area (km^2)		
Ecological Status	**Dis-improved**	**No change**	**Improved**	**Dis-improved**	**No change**	**Improved**
High	13	11	0	94	13	0
Good	17	42	10	137	148	21
Moderate	18	42	11	65	203	16
Poor	5	10	5	4	132	53
Bad	0	7	7	0	8	44
Total	**53**	**112**	**33**	**221**	**505**	**134**
Grand Total			**198**			**940**

Table 4-2. A summary of the number of lakes and lakes area remaining the same (0 class change) or changing (improving – plus class or declining –minus class) ecological class between 2007-2009 and 2010-2012.

Lough Guitane was assigned good status in 2010-2012 because of hydromorphology, which was not assessed in the previous period. This is an abstraction lake and, as such, is subjected to water level fluctuations and has soft engineering bank protection structures, both of which result in less than high hydromorphological condition. The lower status class is therefore not caused by increased enrichment.

The set of nine lakes that declined in status as result of lower status in both biological and general physico-chemical are a cause for concern because, in all likelihood, these lakes are experiencing increased enrichment pressure. Increased levels of chlorophyll and total phosphorus were evident for six of the nine lakes (Abisdealy, Acurry, Ballinlough (CK), Beaghcauneen, Drumlaheen and Tully). Macrophyte and phytobenthos status declined to good status in Lough Caragh and it failed for specific pollutants (lowering its general physico-chemical status from high to moderate). The three-year average of total phosphorus increased in Lough Lickeen by 0.05 ug/L. This resulted in an assignment of moderate general physico-chemical status. This does not suggest increased pressure from enrichment. However, fish status declined from good to bad, but was not supported by the other elements and would warrant further investigation.

	class change			
Category	**-3**	**-2**	**-1**	**Grand Total**
Biological	1	3	37	**41**
Biological, general physico-chemical		2	7	**9**
General physico-chemical			2	**2**
Hydromorphology			1	**1**
Grand Total	**1**	**5**	**47**	**53**

Table 4-3. The categories responsible for the assignment of lakes to a lower status classes.

All lakes at less than good status are considered to be at risk of failing their environmental objectives and require more in-depth analyses and exploration of the data before more definitive conclusions can be drawn and actions advised. In addition, conclusions are confounded by the absence of data for some years, the presence of the alien invasive species zebra mussel, significant water abstractions, and other unknown factors.

Determinants of ecological status in 2010-2012

The fact that the lowest status quality element, whether biological physico-chemical or hydromorphological, determines the final ecological status on the 'one-out-all-out' (OOAO) rule, means that, in some cases, one quality element may determine the final ecological status.

A summary of the main determinants of the 2010-2012 ecological status is presented in **Table 4-4**. 54% of lakes (116 lakes) had good agreement between biological status and general physico-chemical status. Macrophytes and/or phytoplankton, alone or with other biological elements, and nutrients status based on total phosphorus determined the ecological status for 104 of the 116 lakes. Ecological status for nine of the remaining lakes was determined by fish and nutrients. This provided a high degree of confidence in the status outcome for these lakes.

Category	No. of Lakes
Hydromorphology	4
General physico- chemical	12
Biological Quality Elements	81
Biological Quality Elements & general physico- chemical	116
Grand Total	**213**

Table 4-4. A summary of the main determinants of the 2010-2012 ecological status.

An assessment of hydromorphological condition was responsible for the downgrade of four otherwise high status lakes; Doo Lough, Guitane, Nahasleam, and Pollacappul. There was no evidence that these four lakes were impacted by enrichment.

General physico-chemical status determined the ecological status of 12 lakes (<6%). The general physico-chemical quality elements responsible are detailed in **Table 4-5**. The general physico-chemical status was no more than one class lower compared to the biological status in all cases, except Lough Shannagh. Shannagh, in Donegal, was moderate due to elevated pH but otherwise it would be in good status for enrichment pressures. Two lakes, Caragh in Kerry and Dan in Wicklow, were moderate as a result of specific pollutants (Zinc); otherwise these lakes are in good status. Nutrient status based on total phosphorus was the main quality element determining status for the remaining lakes; four lakes were assigned moderate status and five lakes were assigned good status. Four of the good status lakes were 1 ug/L or less above the high/good boundary of 10 ug/L TP and were effectively on the high/good boundary. Measures to reduce nutrients inputs would ensure these lakes are at high status. The remaining five lakes would warrant closer inspection to establish if the general physico-chemical status is in decline, which is not reflected yet in the biological elements.

Biological status determined the ecological status for 81 lakes (38%), see **Table 4-4**. One element alone was responsible in 67 lakes (macrophytes - 36 lakes, fish - 20 lakes and phytoplankton - 11 lakes). A combination of two or more biological elements determined the status for the remaining 14 lakes.

General physico-chemical element	Good	Moderate
pH		1
Nutrients – total phosphorus	5	4
Specific pollutants (zinc)		3
	5	**7**

Table 4-5. A summary of the general physico-chemical parameters determining the 2010-2012 ecological status.

For 60 of the 81 lakes, there was only one class difference between the biological and general physico-chemical status. Further investigation of the data may show that for many of these lakes the difference in status may not be substantial.

Twenty-one lakes were assigned a biological status two or more classes worse than their general physico-chemical status. For nine of these lakes, another biological quality element was no more than one class better in status. For the remaining 12 lakes, there was a very clear divergence in status between the determining element and the high or good status of the other biological elements. Nine of these lakes were assigned poor or bad ecological status based on macrophytes (two lakes) or fish (seven lakes), and their general physico-chemical status was at least good if not high status. Three of the lakes were assigned moderate status based on macrophytes (two lakes) or fish (one lake), and their general physico-chemical status was high status. This suggests that for these 12 lakes other factors, such as abstraction pressure, habitat limitations, and population dynamics, are influencing the main determinant of ecological status other than enrichment. This warrants exploration to correctly prescribe for the programme of measures.

In summary, 54% or 116 lakes biological status and general physico-chemical status agreed. A general physical parameter determined the ecological status of 12 lakes (<6%) and five of these lakes warrant further exploration. Biological status determined the ecological status of 81 lakes (38%), with macrophytes, fish and phytoplankton the primary determining elements, but only 21 lakes had a two or more class difference between biological and physico-chemical status. Within this group, 12 lakes would warrant further exploration because the determining element was two or more classes worse than all other elements and parameters considered. This suggests there may be another factor influencing the main determinant of ecological status other than enrichment.

Specific pollutants

Specific pollutants status is based on Environmental Quality Standards (EQSs) for annual average and maximum allowable concentrations listed in SI 272 of 2009. An exceedance results in a lake being deemed to be of moderate status or lower.

Substance	Period of monitoring	Number of lakes monitored	Number of confirmed exceedance of EQS (AA or MAC)	Exceedance of Annual Average (AA) EQS	Exceedance of Maximum Allowable Concentration (MAC)
Arsenic	2007-2009	74	0	0	NA[1]
	2010-2012	34	0	0	0
Chromium III	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Chromium IV[2]	2007-2009	nm	-	-	-
	2010-2012	nm	-	-	-
Copper	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Cyanide	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Diazinon3	2007-2009	nm	-	-	-
	2010-2012	19	0	0	0
Dimethoate	2007-2009	nm	-	-	-
	2010-2012	19	0	0	0
Fluoride	2007-2009	68	0	0	NA
	2010-2012	28	0	0	NA
Glyphosate	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Linuron	2007-2009	49	0	0	0
	2010-2012	34	0	0	0
Mancozeb[3,4]	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Monochlorobenzene	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Phenol[5]	2007-2009	nm	-	-	-
	2010-2012	nm	-	-	-
Toluene	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA

Substance	Period of monitoring	Number of lakes monitored	Number of confirmed exceedance of EQS (AA or MAC)	Exceedance of Annual Average (AA) EQS	Exceedance of Maximum Allowable Concentration (MAC)
Xylenes	2007-2009	75	0	0	NA
	2010-2012	34	0	0	NA
Zinc	2007-2009	74	2	2	NA
	2010-2012	34	1	1	NA

Notes:

1. NA = No MAC value applicable.
2. Chromium was measured as Total Chromium. No data available for Hexavalent Cr.
3. Limits of Detection for this parameter are above the EQS threshold.
4. Measured in 2006 as part of Dithiocarbamates suite – no detects found.
5. Measured in 2006 – no significant detection rate observed.

Table 4-6. Specific pollutants in lakes for 2007-2009 and 2010-2012. Several parameters not detected in the 2007-2009 monitoring were removed from the subsequent monitoring programme: nm = not measured.

The EPA commenced its monitoring programme for specific pollutants in 2006 with a screening programme, followed by an intensive period of monitoring that covered all surveillance monitoring lakes between 2007-2009. This led to the refinement of the programme, excluding some substances that were not detected from subsequent rounds of monitoring.

Monitoring of the surveillance monitoring lakes for specific pollutants is now carried out on a monthly basis for one year out of a six-year cycle. For the reporting period 2010-2012, a total of 34 lakes were monitored (**Table 4-6**).

High status lakes

Of the 213 lakes monitored, 23 lakes met all the criteria necessary to be assigned high ecological status (see EPA Geoportal). The high status lakes were distributed among the Shannon, North-Western, South-Western and Western River Basin Districts in the counties of Donegal (four lakes), Kerry (three lakes), Limerick (one lake), Clare (two lakes), Galway (eight lakes), Mayo (four lakes) and Westmeath (one lake). Eleven of the lakes were high status in the previous reporting period (**Table 4-7**). One lake was new to the programme. Ten lakes were previously good status lakes but improvements in fish (three lakes), macrophytes (two lakes), total phosphorus (four lakes) and chlorophyll and total phosphorus (one lake) resulted in a high status assignment. One lake was previously moderate in status but total phosphorus improved.

In the previous reporting period, 27 lakes were assigned high status, of which 24 lakes were monitored in 2010-2012. These lakes were distributed among the Shannon, North-Western, South-Western and Western River Basin Districts, the majority in the counties of Donegal (five lakes), Kerry (five lakes), and Galway (eight lakes).

Three lakes were dropped from the programme one to access issues and the remaining two are turloughs. One lake, Guitane, was assigned to a lower status class in the current period due to hydromorphological condition failing to meet high status. Hydromorphological condition was not assessed previously, and the lake failed to achieve high status due to soft engineering bank features and water level control. Biological status failed to reach high status in this reporting period at nine lakes. The biological elements resulting in the decline were: phytoplankton (four lakes), fish in Lough Veagh and Easky, and macrophytes in Mask and Talt. The three elements, macrophytes (previously on verge of the high/good boundary), phytobenthos (not monitored previously), and chlorophyll (three-year average doubled, 3.5 ug/l to 6 ug/l), failed to achieve high status at one lake, Anure. Nutrients in Inchiquin (Kerry) were assigned good status. In Moher (Mayo), both biological (macrophytes) and general physical chemical status declined (total phosphorus increased from 10ug/l to 13.6 ug/l). In most cases, the element/s determining the status was approaching the high/good boundary in the previous reporting period. Lough Caragh failed due to specific pollutants (zinc).

LAKE	RBD	2007-2009 Ecological Status	2010-2012 Ecological Status	Elements less than high status
Ballynahinch Lake	Western	Good	High	Macrophytes
Barra	North-Western	Good	High	Macrophytes, fish
Bleach	Shannon	Good	High	Nutrients-total phosphorus
Bunny	Western	Good	High	Fish
Carra	Western	Good	High	Fish
Kiltooris	North-Western	Good	High	Fish
Nambrackmore	Western	Good	High	Nutrients-total phosphorus
Namona	South-Western	Good	High	Chlorophyll, Nutrients-total phosphorus
Shindilla	Western	Good	High	Nutrients-total phosphorus
Washpool	Western	Good	High	Nutrients-total phosphorus
Rosroe	Shannon	Moderate	High	Nutrients-total phosphorus
Mask Upper	Western	N\A	High	N\A
Bofin	Western	High	High	
Cloonaghlin	South-Western	High	High	
Derryclare	Western	High	High	
Enask	Western	High	High	
Fad	North-Western	High	High	
Fadda	Western	High	High	
Glencullin	Western	High	High	
Greenan	North-Western	High	High	
Killinure	Shannon	High	High	
Maumwee	Western	High	High	
Muckross	South-Western	High	High	
Caragh	South-Western	High	Moderate	Specific pollutants (zinc)
Agannive	North-Western	High	N\A	N\A
Funshinagh	Shannon	High	N\A	N\A
Nambrackkeagh	Western	High	N\A	N\A
Anaserd	Western	High	Good	Chlorophyll
Anillaun	Western	High	Good	Chlorophyll
Anure	North-Western	High	Good	Macrophytes, phytobenthos, phytoplankton

LAKE	RBD	2007-2009 Ecological Status	2010-2012 Ecological Status	Elements less than high status
Coosan	Shannon	High	Good	Chlorophyll
Cullaun	Shannon	High	Good	Phytoplankton
Easky	Western	High	Good	Fish
Guitane	South-Western	High	Good	Hydromorphology
Inchiquin	South-Western	High	Good	Nutrients - total phosphorus
Mask	Western	High	Good	Macrophytes
Moher	Western	High	Good	Macrophytes, Nutrients - total phosphorus
Talt	Western	High	Good	Macrophytes
Veagh	North-Western	High	Good	Fish

Table 4-7. The list of high status lakes in both reporting periods and the elements responsible for being less than high status.

Invasive alien species in Irish lakes

Previously, the presence of zebra mussels or roach was taken into account for the purposes of setting ecological status where a lake is assigned high status based on the normal assessment of status. Both the zebra mussel and roach, among others, are currently listed in Ecoregion 17 as Invasive Alien Species having a significant negative impact. The approach for alien species is currently under review. Alien species are noted but not used in the assessment on this occasion.

Zebra mussel was recorded in 69 of the monitored lakes and one heavily-modified water body compared to 54 known lake populations in the 2007-2009 period, with 50 lakes in common. Some are new known records, such as Atrain and Farnharn Lough. Both are new lakes to the programme and others were simply missed in 2007-2009 when recording was under-developed. The majority of the 18 additional known populations are in the Shannon region (nine lakes) but every region, with the exception of the South-East and the South-West, recorded a new population. The evidence suggests that zebra mussel continues to spread despite public information and biosecurity campaigns.

The presence of zebra mussels can affect many facets of lake ecology depending on population size, length and stage of colonisation, of which little has been quantified for most of these lakes. Predation by zebra mussels on the phytoplankton community can affect composition and reduce production, resulting in reduced chlorophyll levels. This, in turn, can result in increased light transparency promoting increased plant colonisation particularly in enriched lakes. Therefore, many elements, such as chlorophyll, transparency, invertebrates, and plants used to quantify status, can be affected and may be presenting a better status than would be the case if zebra mussels were absent.

Roach were recorded in 36 of the 75 lakes monitored in 2010-2012 compared to 35 recordings for the 2007-2009 period. One lake was not surveyed until 2010-2012. Fish are predominantly monitored in surveillance lakes for WFD purposes but Inland Fisheries Ireland does survey other lakes, including some operational lakes. Details of these surveys can be sourced from the IFI website.

Protected areas

Many lakes are included in the Water Framework Directive lakes monitoring programme because they qualify as a protected area for one of the following reasons; they are a designated bathing water, they are a significant drinking water source, they are part of a Natura 2000 site, they have a qualifying interest under the Habitats Directive, or they are designated as nutrient sensitive areas under the Urban Wastewater Treatment Directive (**Table 4-8**). All lakes with a protected area interest must be on the register for protected areas, require monitoring in their own right, and must meet their objectives.

Protected Area	Nos. nationally	Nos. on monitoring programme
Bathing Water	7 lakes, 9 bathing waters	6 lakes, 8 bathing waters
Nutrient Sensitive	7 lakes	7 lakes
Drinking Water Source	Not quantified	96 lakes (incl. 7 Reservoirs)
Natura 2000 sites	Not quantified	115

Table 4-8. Details of the respective protected areas interests on lakes, their numbers nationally and on the monitoring programme.

Under the provisions of the WFD, the protected areas' objectives and requirements must be considered when setting environmental objectives, prescribing the programme of measures and compiling the river basin management plans.

Identified pressures on Irish lakes

Diffuse pollution is considered to be the most significant risk to lake ecological status. The main source of enrichment for the vast majority of lakes is from agricultural activities, septic tanks and other activities carried out in the catchment. There are limited pressures from point source activities, such as urban wastewater treatment facilities, IPPC licensing and Section 4 facilities. Water abstractions and morphological alterations have also been identified as posing a risk to the ecological status of lakes. Risk assessments for lakes are currently underway and will be updated by the end of 2015.

Important factors that need to be considered when assessing the risks of pollution to lakes include; the pressures immediately surrounding a lake, the pollutant load contribution to the lake from inflowing rivers, and groundwater where groundwater contributes a significant volume to the lake. Technical work is ongoing to improve the information available on these factors, so as to improve future risk assessments.

Heavily-modified water bodies (HMWB)

Sixteen lake water bodies, predominantly reservoirs, were designated nationally as heavily-modified water bodies (South Western River Basin District Project, 2008). Nine of these water bodies are on the lake monitoring programme (**Table 4-9**). As macrophytes were considered to be negatively affected by the physical modifications to these water bodies, an adjusted assessment was applied to the macrophyte classification tool. The designation and assessment methodology will be reviewed for the second river basin cycle.

Lake Name	Use	Measures-based Classification	Ecological Potential	Final Potential Assignment
Glenasmole Reservoir Lower (Dublin)	Drinking water supply	GEP	Moderate	Moderate
Glenasmole Upper (Dublin)	Drinking water supply	GEP	Good	Good
Pollaphuca Reservoir (Wicklow)	Drinking water supply	GEP	Moderate	Moderate
Vartry Reservoir Lower (Wicklow)	Drinking water supply	GEP	Moderate	Good
Inniscarra Reservoir (Cork)	Drinking water supply, Power Generation	MEP	Moderate	Moderate
Carrigdrohid Reservoir (Cork)	Power Generation	MEP	Moderate	Moderate
Doo (Clare)	Drinking water supply	MEP	Moderate	Good
Derg pHMWB (Clare)	Power Generation	MEP	Good	Good
Salt (Donegal)	Drinking water supply	GEP	Good	Maximum

DW = Drinking water supply, PG= Power generation, M=moderate, G=Good

Table 4-9. The list of HMWB, their use, measures-based classification, ecological potential based on monitored data, and the final assignment.

The nine heavily-modified water bodies comprised 37 km². Six reservoirs (67%) or 7 km² were at maximum or good ecological potential (**Table 4-10**), and the remaining were assessed as being moderate or worse in ecological potential (30 km²). While the number of water bodies at maximum or good ecological potential is comparable to the period 2007–2009 (six reservoirs), the area has declined from 31 km² to 6 km², with a concurrent increase in area assigned moderate or worse ecological potential. This is because Pollaphuca Reservoir, which accounts for 54% of the area monitored, declined in potential from good to moderate as a result of exceeding the maximum pH. Both of the Cork Reservoirs are now moderate in potential, with the decline of Carrigdrohid to moderate potential due to increasing chlorophyll and total phosphorus.

	2007-2009				2010-2012			
Ecological Potential	Number of Water bodies	% of Water bodies	Surface Area (km²)	% Area	Number of Water bodies	% of Water bodies	Surface Area (km²)	% Area
Maximum					1	11	<1	1
Good	7	78	31	83	5	56	7	18
Moderate	2	22	6	17	3	33	30	81
Total	**9**		**37**		**9**		**37**	

Table 4-10. The breakdown of ecological potential for the period 2007-2009 and 2010-2012 by numbers of reservoirs, surface area, and the percentage total assigned to each ecological potential class.

Chemical status

Priority substances

The WFD requires compliance with the Environmental Quality Standards established for priority substances. Appendix 3 lists the priority substances required to be monitored under legislation and the number of lakes monitored for both reporting periods 2007-2009 and 2010-2012. Of the 25 priority substances, evidence of exceedances of an Annual Average (AA) or a Maximum Allowable Concentration (MAC) was not found for any of the lakes.

Priority hazardous substances

The WFD requires compliance with the Environmental Quality Standards established for priority hazardous substances, as well as the cessation or phasing out of emissions, discharges and losses to waters. This is owing to concern about their toxicity, persistence or tendency to bioaccumulate. Of the 13 priority substances listed in Appendix 3, exceedances were found for cadmium and polyaromatic hydrocarbons (PAHs). Cadmium exceeded the EQS for Lough Muckno in 2010. Exceedance was caused by one uncharacteristic high value but there were detectable concentrations on other sampling occasions, making it more prudent to fail the lake.

The majority of surface water failures were caused by the ubiquitous poly aromatic hydrocarbons (PAHs), which are a group of ring-structured organic compounds that are commonly associated with the combustion of fossil fuels, such as oil or coal, or from forest and heathland fires. They are also present in run-off from roads. They have a strong affinity to solids and may be present from both fuel spills and bound to particulate material, such as tyre residues. They present an undesirable parameter in waters even at very low concentrations due to their build up in the aquatic food chain. They are among a group of substances known as "PBTs" i.e. persistent, bio-accumulative and toxic. Two lakes failed for benzo(a)pyrene; Lough an tSeisigh in 2009 and Lough Kindrum in 2010. Concentrations exceeded the limit of detection on only one occasion in Kindrum but on a total of four occasions in Lough an tSeisigh in 2009 and 2012. The sum of the parameters benzo(b)flouranthene and benzo(k)fluoranthene have an AA-EQS of 0.03μg/l. This was exceeded for Lough Kindrum in 2012, with values being above the limit of detection on three occasions.

The second grouping of PAHs, the sum of the sum of benzo(g,h,i)perylene and indeno(1,2,3-cd) pyrene, recorded the highest level of exceedances of 44% of monitored sites (15 lakes) in the reporting period 2010-2012. Recorded exceedances were lower in the period 2007-2009 but this was an artefact of the less sensitive methodology used. This group of PAHs is one of the most common causes of failure of EQSs across Europe, with up to 60% of river samples failing to meet standards (Kodeš *et al.*, 2013). Recent EPA-funded research in Ireland has shown the ubiquitous nature of PAHs, being present in even upland headwater lake catchments not subject to direct industrial emissions (Scott *et al.*, 2012).

Priority hazardous substances in biota

Environmental Quality Standards for priority hazardous substances (PHSs) have also been published for concentrations in biota (SI 327, 2012). Analysis was carried out by the Marine Institute on brown trout and perch collected from 21 lakes by Inland Fisheries Ireland. Samples were examined for the presence of mercury, hexachlorobenzene (HCB) and hexachlorobutadiene (HCBD) (Appendix 3). Results for the mercury analysis showed concentrations exceeding the EQS of 20 μg/kg at all sites ranging from 38-388 μg/kg. These concentrations and failure rates are consistent with other studies across Europe (Collins *et al.*, 2011). It should be noted that the concentrations were well below standards for fishery products[28] and therefore, do not pose a risk to human health. Airborne deposition of mercury from fossil fuel combustion is widely regarded as the source. No exceedances of HCB and HCBD were observed.

Conclusions

Two hundred and thirteen lakes, representing 955 km^2 of lake surface, were monitored for the WFD in the period 2010-2012. Fifteen lakes (7%), accounting for 15 km^2 (2%) of the lake area examined, were new to the programme and were assigned high (one lake), good (four lakes), moderate (five lakes) and bad (four lakes) status. One hundred and ninety-eight lakes (93% of lakes monitored), representing 940 km^2 (98% of lake area monitored), were common to both reporting periods. Of these, 112 lakes (53% of lakes monitored) or 505 km^2 (54% of lake area monitored) of lake surface did not change status. Fifty-three lakes or 221 km^2 of lake area declined in status. Thirty-three lakes or 134 km^2 of lake area improved in status. Overall, 91 lakes (43% of lakes monitored) were assigned high or good status and comprised 295 km^2, and 122 lakes (57%) were moderate or worse in status or 660 km^2 of lake area monitored. This represents a 5% reduction (10 lakes) in the high or good status categories and a corresponding increase in the moderate or worse status category compared to 2007-2009.

For 2010-2012, 54% of lakes (116 lakes) had good agreement between biological status and general physico-chemical status, suggesting a high degree of confidence in the status assignment. There was only one class difference between the biological and general physico-chemical for status in 60 lakes. This provides a good degree of confidence in the status assignment. General physico-chemical status determined the 2010-2012 ecological status of 12 lakes (<6%), which is comparatively low. Twenty-one lakes were assigned a biological status two or more classes lower than their general physico-chemical status based largely on macrophytes or fish. Nine of these lakes had other biological element within one class of the status determining element. There is little confidence in status assignment for the remaining 12 lakes with respect to enrichment. It is considered that other factors, such as abstraction pressure, habitat limitations, and population dynamics, are influencing the elements determining status in these lakes. There may be instances where the fish or macrophyte monitoring tools should be used with caution or are inappropriate.

Nine heavily-modified water bodies, predominantly reservoirs, are on the lake monitoring programme and comprised 37 km^2. Six reservoirs (67%) or 7 km^2 were at maximum or good ecological potential, and the remaining were assessed as being moderate or worse (30 km^2).

The levels of specific pollutants, priority substances and priority hazardous substances monitored in over 70 lakes were generally below prescribed standards. There were some naturally elevated levels of zinc due to geological anomalies in a small number of lakes. There were no confirmed exceedances of any priority substances. Of the priority hazardous substances, one lake failed for cadmium and only PAHs and mercury in biota showed widespread exceedance of the EQS in the lakes monitored. This was to be expected as both substances are ubiquitous, persistent, bio-accumulative, and toxic substances. They can be found for decades in the aquatic environment at levels posing a significant risk, even if extensive measures to reduce or eliminate emissions of such substances have already been taken. Some are also capable of long-range transport and are largely ubiquitous in the environment. Therefore, non-compliant results do not infer specific issues local to a water body or indeed river basin district.

28 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

Recommendations

The current monitoring programme consists of 213 representative lakes. However, there are approximately 600 lakes that are not monitored. A methodology for grouping and extrapolating status is being developed and implemented through an ongoing STRIVE funded project called *'Predicting ecological status of unmonitored lakes based on relationships between status, hydrogeomorphological and landuse characteristics'*. The outcome of this project will be available by the end of 2015.

A number of areas require further development, some of which are underway, including:

- Investigation of the factors influencing the unsatisfactory ratings for fish and macrophytes in some lakes
- Development of biological tools which are sensitive to hydromorphological pressures
- While face value assessment using the one-out-all-out rule is useful for a general and broad understanding of the national picture of lake water quality and for reporting, it has its limitations. A weight of evidence approach both for status assessment and for prioritising programmes of measures may be appropriate.

5. TRANSITIONAL AND COASTAL WATERS

Authors: Shane O'Boyle, Robert Wilkes, Georgina McDermott and Sorcha Ní Longphuirt

- 36.3% of transitional waters were at high or good ecological status, accounting for 44.7% of the total area assessed (approximately 377 km^2). A number of water bodies, mainly in the south-east and south of the country, continue to display symptoms of nutrient enrichment, and have been classed as eutrophic.
- 67.4% of coastal waters were at high or good ecological status, accounting for 93% of the total area assessed (approximately 12,471 km^2). Downward trends in nutrient loads to the marine environment are now evident, with significant reductions in riverine nutrient inputs. This downward trend is apparent in the reduction in nutrient sources, particularly from the agriculture sector, which has seen an 18.7% and 37.7% reduction in nitrogen and phosphorus sources respectively.
- Nearly two-thirds (65.1%) of the designated shellfish areas monitored over the four-year period were compliant with the guide value for *Escherichia coli.* Of the non-compliant areas, the worst performing were Bannow Bay, Bantry, Dunmanus Inner, Kinsale, Tralee Bay, and Wexford Harbour Inner, where more than 50% of the samples exceeded the guide value. It is likely that additional measures may be required to achieve the quality objectives for shellfish waters in these areas.
- The majority of transitional and coastal waters were at good chemical status. There were a few exceedances of biota standards for mercury in mussel samples. However, mercury has been identified as a ubiquitous persistent, bioaccumulative and toxic substance (uPBT) under Directive 2013/39/EU. uPBTs occur widely in the environment on a global scale, due principally to atmospheric deposition.
- Radioactive substances from the nuclear reprocessing plant at Sellafield in England continue to be discharged to the Irish Sea, though exposure to these substances is not considered to pose a significant health risk to the Irish public.

Introduction

In Ireland, transitional and coastal waters represent a spatial area of over 14,000 km^2 (transitional; 844 km^2, coastal; 13,325 km^2) and represent a wide variety of types, such as lagoons, estuaries, large coastal bays and exposed coastal stretches. These waters are positioned at the interface between land and sea and, as such, are exposed to a wide range of human pressures. These pressures can include discharges from industrial and municipal wastewater treatment plants, inputs from diffuse agricultural sources, morphological alterations associated with harbour and port activities, and accidental or, in some cases, intentional discharges from marine vessels. In this chapter, the authors present the surface water status of these waters based on the analysis of chemical and biological data collected mainly between 2010 and 2012. This analysis will provide the basis for the identification of new environmental objectives and an assessment of whether existing environmental objectives are being met. In addition to status assessment, this chapter will provide information on trends in nutrient inputs, which together with the status assessment, provides further insight into the effectiveness of existing measures. The chapter also provides information on the condition of water-related protected areas (i.e. bathing waters, shellfish waters and nutrient sensitive areas) and on other issues, such as radioactivity in the marine environment and oil pollution events, which have the potential to impact on the environmental quality of these waters.

In Ireland, the picture for transitional waters assessed during the first river basin cycle 2007-2009 was comparable to that in Europe, with 66% of Irish transitional waters at moderate or worse ecological status. For coastal waters, the situation was considerably better, with only one-third (33%) of these waters classified as moderate or worse (McGarrigle *et al*, 2010). The key environmental objectives for Irish transitional and coastal waters are to restore those waters which are at less than good ecological status and to protect those waters which are at high or good ecological status. The achievement of these objectives will depend on the successful implementation of measures targeted at mitigating the environmental pressures which are threatening or have already impacted the current status of these waters.

Surface water status

In assessing the status of individual water bodies (the basic management unit under the WFD), the Directive requires Member States to assess both ecological and chemical status. Chemical status is assessed by compliance with environmental standards for chemicals that are listed in the WFD (Annex X) and the Environmental Quality Standards (EQS) Directive (2008/105/EC). These priority substances include metals, pesticides, and various industrial chemicals. The ecological status of surface waters is based on the assessment of specified biological quality elements, as well as supporting hydromorphological, chemical (specific pollutants), and physico-chemical elements.

The assessment of surface water status is based on the analysis of data collected in the national WFD monitoring programme for transitional and coastal waters. 40% of transitional and coastal water bodies (85 transitional and 43 coastal) were selected as being representative of status for these surface water categories. These were subsequently monitored and extrapolated to provide a comprehensive national overview of status within each of Ireland's seven river basin districts, which in total comprise 305 individual transitional and coastal water bodies.

Ecological status

Ecological status is assessed using a number of specified biological quality elements, such as phytoplankton, benthic invertebrates, macroalgae, angiosperms (seagrass and saltmarsh), and fish (in transitional waters only). These elements are responsive to a variety of environmental pressures, including nutrient and organic enrichment, hydromorphological alteration, and chemical pollution. A number of physico-chemical parameters, such as dissolved oxygen, inorganic nitrogen, phosphorus, and a number of specific pollutants, are also used in the assessment. Ecological status is classified into five categories based on the degree of deviation away from the reference condition for each of these individual elements. The five categories are high, good, moderate, poor and bad, which corresponds to a minor, slight, moderate, major and severe deviation from undisturbed conditions. The details of the WFD ecological status assessment methodology is available online[29].

Ecological status is assessed on a 'one-out-all-out' basis, with the status of a water body being based on the biological quality element or physico-chemical standard with the lowest status. For example, if all the elements in a 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.

29 http://www.epa.ie/pubs/reports/water/waterqua/Final_Status_Report_20110621.pdf

Monitoring opportunistic macroalgae in Dublin Bay

In this assessment, 294 individual water bodies, including 193 transitional and 101 coastal, were assessed based on information collected by the EPA, Marine Institute and Inland Fisheries Ireland between 2010 and 2012. Some of the biological assessments were based on data that extended back to 2007, to include those elements which require six years of the WFD cycle for their assessment. Of the transitional waters assessed, over one-third (36%) were found to be at good or high ecological status, with just under a half (48%) at moderate or worse ecological status. By area, the picture is better, with 45% of the area of transitional waters being classified as being of good or high ecological status. The remaining water bodies (16%) were unassigned due to insufficient information. This unassigned category contains a large number of very small water bodies, mostly lagoons, which only represent a surface area of 0.7 km^2, or 0.1% of the total area assessed. A number of water bodies (15) were classed as poor, and two water bodies were classed as bad, indicating, respectively, a severe and major deviation away from undisturbed conditions. The picture for coastal waters is considerably different, with 67% of waters at good or high ecological status and 22% at moderate status. Rincarna Pools, a small coastal lagoon, was the only coastal water body to be classed at poor ecological status. In terms of surface area, 93.6% or 12, 470 km^2 of coastal waters, are at high or good ecological status.

The breakdown for each water category is shown in **Figure 5-1** and the breakdown of water bodies in each of the classification categories for each river basin district is given in Appendices 4 and 5. **Table 5.1** lists the poor and bad status transitional water bodies, together with the element resulting in this status. Of the 17 water bodies assessed as poor or bad status, 11 are lagoons. The assessment of lagoons is still considered with low confidence, as the assessment tools for lagoons are still new and require further refinement. Nevertheless, the status of these lagoons is likely to be less than good. Further information on the physico-chemical or biological element resulting in less than good status is given in the sections below.

The location of all the transitional and coastal water bodies, together with their ecological classification, is shown in **Figure 5-2**, and can be accessed electronically via the EPA Geoportal site[30]. In addition to the 294 water bodies mentioned above, eleven areas, mainly ports (e.g. Foynes Harbour, Rosslare Harbour, and Cork Harbour) have been designated as heavily-modified

30 http://gis.epa.ie/

water bodies (HMWBs). Seven of these areas were classed at moderate ecological potential (MEP), and four at good ecological potential (GEP), during the first river basin management cycle, based on a mitigation measures and status based classification scheme. The issue of HMWB designation will need to be revisited in the next set of river basin management plans. The approach to designation should be reviewed in light of the greater availability of biological monitoring data, and existing GEP classifications will also need to be reviewed to confirm the situation with regard to mitigation measures and the status of biological elements most sensitive to hydromorphological pressures.

In the following sections, further detail is provided on the physico-chemical and biological elements that were used in the classification of ecological status reported in this chapter.

It was not possible to make a direct comparison between this current assessment of ecological status and the previous assessment undertaken in 2007-2009, as the monitoring of these waters during the earlier period was not fully implemented at that time.

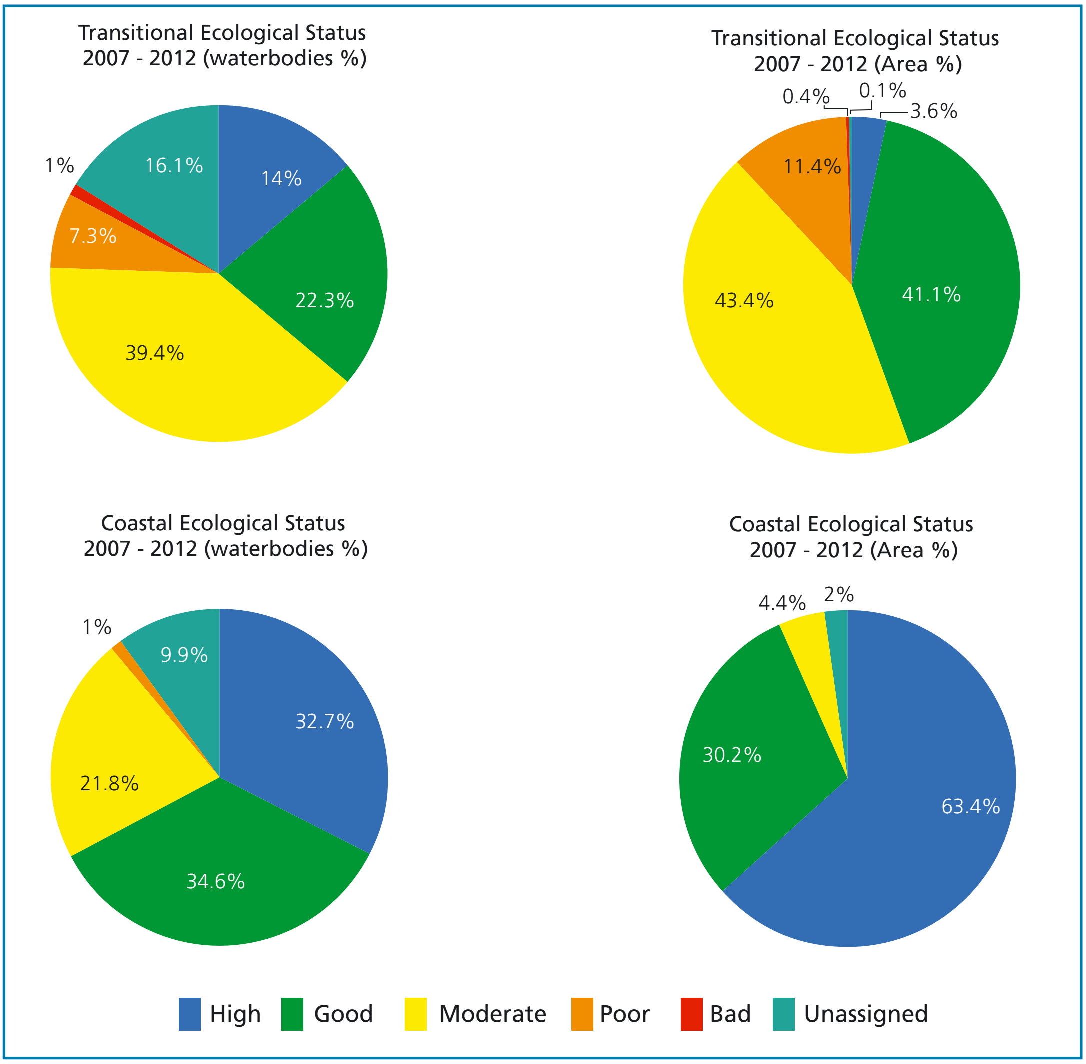


Figure 5-1. Ecological status of transitional and coastal (TraC) waters 2007-2012 (Percentage of water bodies and surface area in each status class).

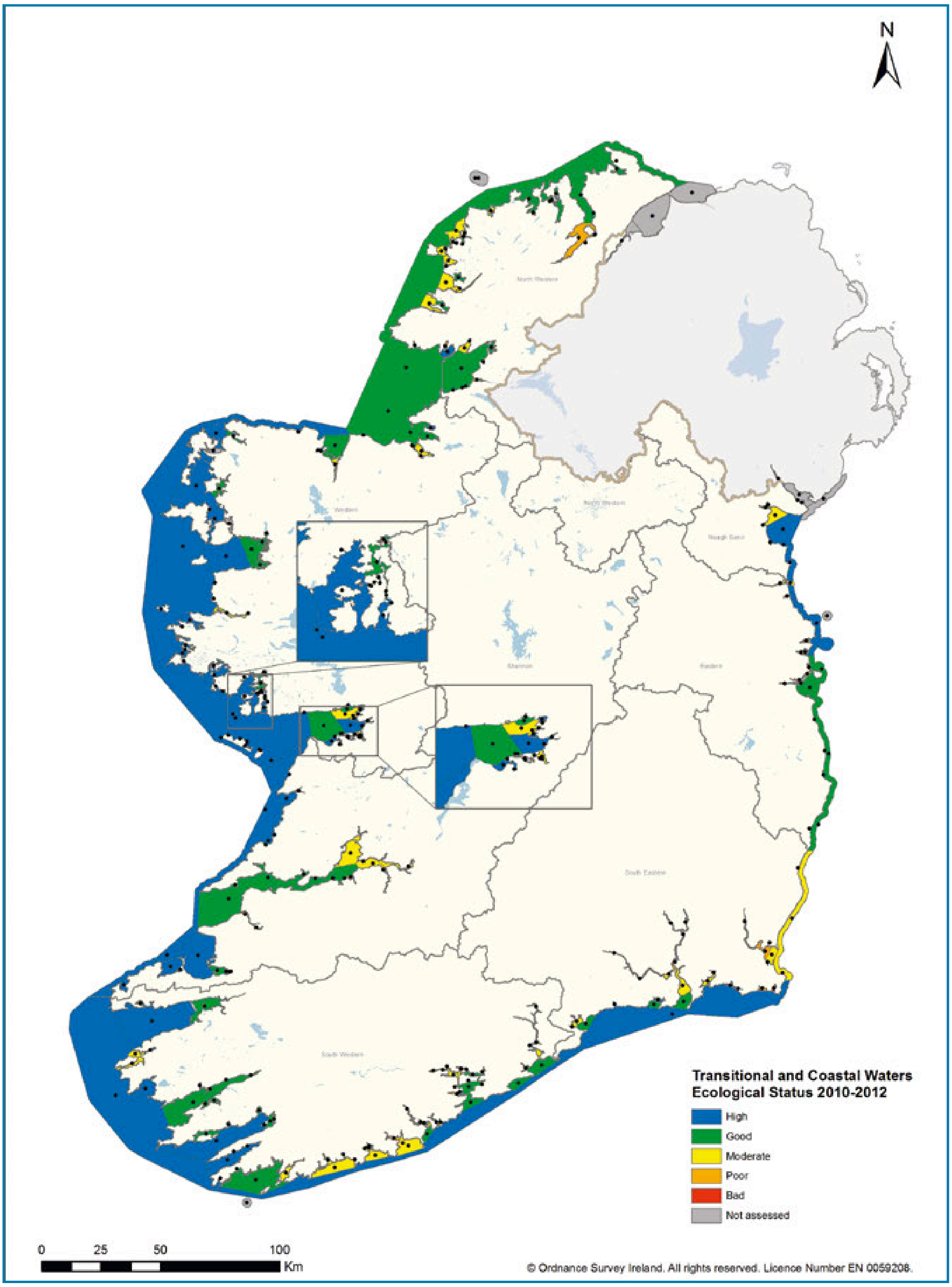


Figure 5-2. Ecological status of transitional and coastal waters around Ireland.

Quality elements determining ecological status

In transitional waters, fish, phytoplankton and marine plants are the elements most often responsible for a moderate or worse classification, whereas elements such as nutrients (MRP), dissolved oxygen (DO,) and biochemical oxygen demand (BOD) are less significant. In coastal waters, benthic invertebrates and dissolved oxygen are responsible for the greatest number of moderate or worse classifications. A breakdown for each individual water body is provided online and the element determining the status of less than good water bodies is shown in Figure 5-3, while further detail on the elements causing poor or bad status is shown in Table 5-1.

Water body	RBD	Ecological Status	Biological Element Responsible
Rogerstown Estuary	Eastern	Poor	Opportunistic macroalgae, angiosperms
Broadmeadow Water	Eastern	Poor	Marine plants, phytoplankton bloom frequency and biomass
Durnesh Lough	North-Western	Poor	Fish
Swilly Estuary	North-Western	Poor	Phytoplankton bloom frequency and biomass
Inch Lough	North-Western	Poor	Fish and phytoplankton biomass
North Slob Channels	South-Eastern	Poor	Phytoplankton bloom frequency and biomass
Lower Slaney Estuary	South-Eastern	Poor	Phytoplankton bloom frequency and biomass
Lady's Island Lake	South-Eastern	Bad	Marine plants, fish, phytoplankton biomass
Tacumshin Lake	South-Eastern	Poor	Fish and phytoplankton biomass
New Ross Port	South-Eastern	Poor	Benthos
Shannon Airport Lagoon	Shannon	Poor	Phytoplankton biomass
Lough Donnell	Shannon	Poor	Phytoplankton biomass
Glashaboy Estuary	South-Western	Poor	Fish
Argideen Estuary	South-Western	Poor	Opportunistic macroalgae
Kilkeran Lake	South-Western	Poor	Marine plants, fish, phytoplankton biomass
Kinvarra Bay Lagoons	Western	Bad	Marine plants, fish, phytoplankton biomass
Rincarna Pools	Western	Poor	Marine plants, fish, phytoplankton biomass

Table 5-1. Water bodies at poor and bad ecological status, together with the biological elements determining status.

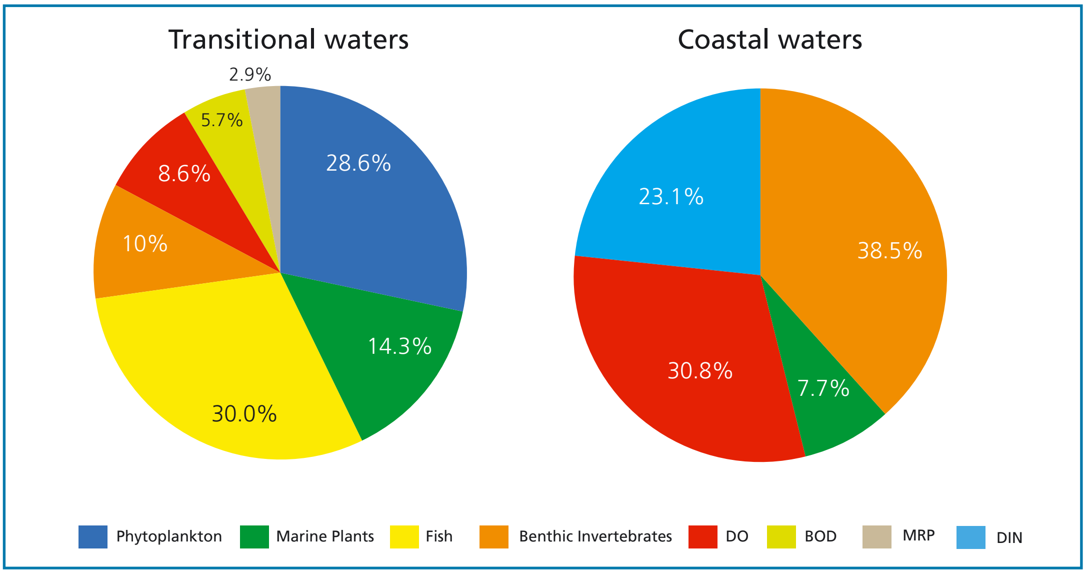


Figure 5-3. Percentage contribution of each element resulting in moderate or worse classification.

Physico-chemical elements

A number of general parameters are assessed to determine if the physico-chemical environment is capable of supporting the biological quality elements. Compliance of individual physico-chemical elements is assessed against the Environmental Quality Standards (EQSs) specified in the Surface Water Regulations (SI 272 of 2009). These include EQSs for inorganic nitrogen and phosphorus, dissolved oxygen, and biochemical oxygen demand (BOD).

Nitrogen and phosphorus in transitional and coastal waters

While phosphorus generally limits plant growth in freshwater and estuarine systems, nitrogen is considered to be the limiting nutrient in open coastal waters (Howarth and Marino, 2006). 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. Nutrient levels are also monitored in summer to capture the potential effect of seasonal changes in river flow and volume, which, in turn, can result in higher nutrient concentrations, particularly of phosphate, in some estuaries in summer.

The potential of phosphorus and nitrogen to limit phytoplankton growth in estuaries and coastal waters respectively, was the basis of the decision to establish an EQS for MRP in transitional waters and an EQS for DIN in coastal waters (S.I. 272 of 2009).

The highest DIN concentrations were found in the estuaries of the South-Eastern and South-Western River Basin Districts. High median winter DIN concentrations ranging between 3.8–6.2 mg/l N were observed in the Glashaboy (Glanmire) Estuary, the upper Slaney Estuary, the upper Barrow Nore Estuary, upper Barrow Estuary, and the upper Lee (Cork) and upper Blackwater estuaries. The lowest median winter DIN values, below 0.17 mg/l, were found in the high salinity coastal waters, including Kinsale Harbour, Kimackilloge Harbour, Outer Kenmare River, Sligo Bay and Kilkieran Bay.

It is also necessary to take into account the diluting capacity of seawater when reporting nutrient concentrations, and this is achieved by examining the percentage exceedance of concentrations against salinity-related thresholds. The highest exceedances were observed in the Glashaboy Estuary, lower Lee Cork Estuary, upper and lower Slaney Estuary, the Argideen Estuary, Barrow Nore Estuary upper and Clonakilty Harbour. Four coastal areas (Wexford Harbour, Courtmacsherry Bay, Valentia Harbour (Portmagee Channel) and Killybegs Harbour) failed to comply with the DIN environmental quality standard.

In relation to MRP concentrations, the majority (80%) of estuaries and coastal waters had MRP median winter and summer values less than 0.030 mg/l P, with half of these having levels less than 0.020 mg/l P. The highest winter median MRP concentrations were mostly found in the estuaries of the Shannon River Basin District, such as the Deel, Maigue, and Fergus. In some estuaries, concentrations of MRP were higher in summer than in winter, indicating that in these water bodies, point sources may be more important than diffuse sources. These include the Maigue, upper and lower Liffey, Tolka and lower Bandon Estuaries. Three transitional areas (Tralee, Deel and Maigue Estuaries) failed to comply with the MRP environmental quality standard in winter, and four areas (Broadmeadow Water, Rogerstown, Tolka and Maigue Estuaries) failed to comply with the standard in summer.

Dissolved oxygen and biochemical oxygen demand

In recent years, concern has grown about the spread of hypoxia (major oxygen deficiency) in the world's coastal seas as a result of coastal pollution. 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.

The assessment of dissolved oxygen levels in 95 Irish transitional and coastal water bodies between 2010-2012 shows that the vast majority of waters (90.4% of the surface area assessed; 3,984 km^2) had satisfactory oxygen conditions capable of supporting nearly all forms of aquatic life. Furthermore, no hypoxia or anoxia was observed in any of the water bodies surveyed (Table 5-2). These findings are in good agreement with previous assessments, and confirm the more than satisfactory nature of oxygen conditions in Irish estuaries and nearshore waters (O'Boyle *et al*., 2009). Oxygen deficiency (values below 6.0 mg/l) was observed in 12 water bodies. Just two water bodies, the upper Lee Estuary in Cork City and McSwyne's Bay in Co. Donegal, had levels close to or below the threshold, which is likely to cause adverse effects in some sensitive marine organisms (i.e. ≤ 4.6 mg/l (Vaquer-Sunyer and Duarte, 2008). The low DO levels in the upper Lee Estuary in Cork City are probably due to historically enriched sediments from untreated sewage, while the low levels in McSwyne's Bay appear to be linked to elevated biochemical oxygen demand, following the collapse of an exceptional phytoplankton bloom which occurred in the coastal waters of western Ireland in the summer of 2012 (**see Box 1**).

Category value (mg/l)	Anoxic (0 - 0.5)	Hypoxic (0.5 - 2.0)	Deficient (2.0 - 6.0)	Sufficient (6.0-10.0)
Number (n)	0	0	12	83
(%)	0	0	12.6	87.4
Surface Area (km^2)	0	0	384.3	3,599.8
(%)	0	0	9.6	90.4

Table 5-2. Proportion of monitored water bodies in each dissolved oxygen (DO) category by number and surface area (3,690 km^2; total surface area monitored). Based on minimum (5‰) dissolved oxygen levels.

The effect of organic enrichment on oxygen conditions, as indicated by the biochemical oxygen demand (BOD) concentration, is shown in Figure 5-4, which shows that the majority of the 102 waters assessed had acceptable levels of BOD (i.e. EQS of 95 percentile less than 4 mg/l O_2). Some notable improvements were noted in the Middle Suir Estuary, where BOD levels have decreased since the last assessment (down from 6.1 to 2.5 mg/l BOD), and this may reflect the provision of secondary wastewater treatment for Waterford City which was commissioned in 2010.

In 13 water bodies or 13% of those assessed, the level of oxygen demand observed indicated the presence of substantial organic enrichment, with eight of these estuaries - Nore, Rogerstown, Glashaboy, Lee Estuary upper, Barrow Nore, Broadmeadow Water, Argideen, Owenacurra and Lower Bandon, having BOD 95 percentile values ranging from 5.0-7.8 mg/l O_2.

Overall, levels of BOD appear to have reduced, with the current and previous assessment indicating a considerable improvement on the 2002-2006 assessment, when nearly 32% of water bodies were in breach of the EQS.

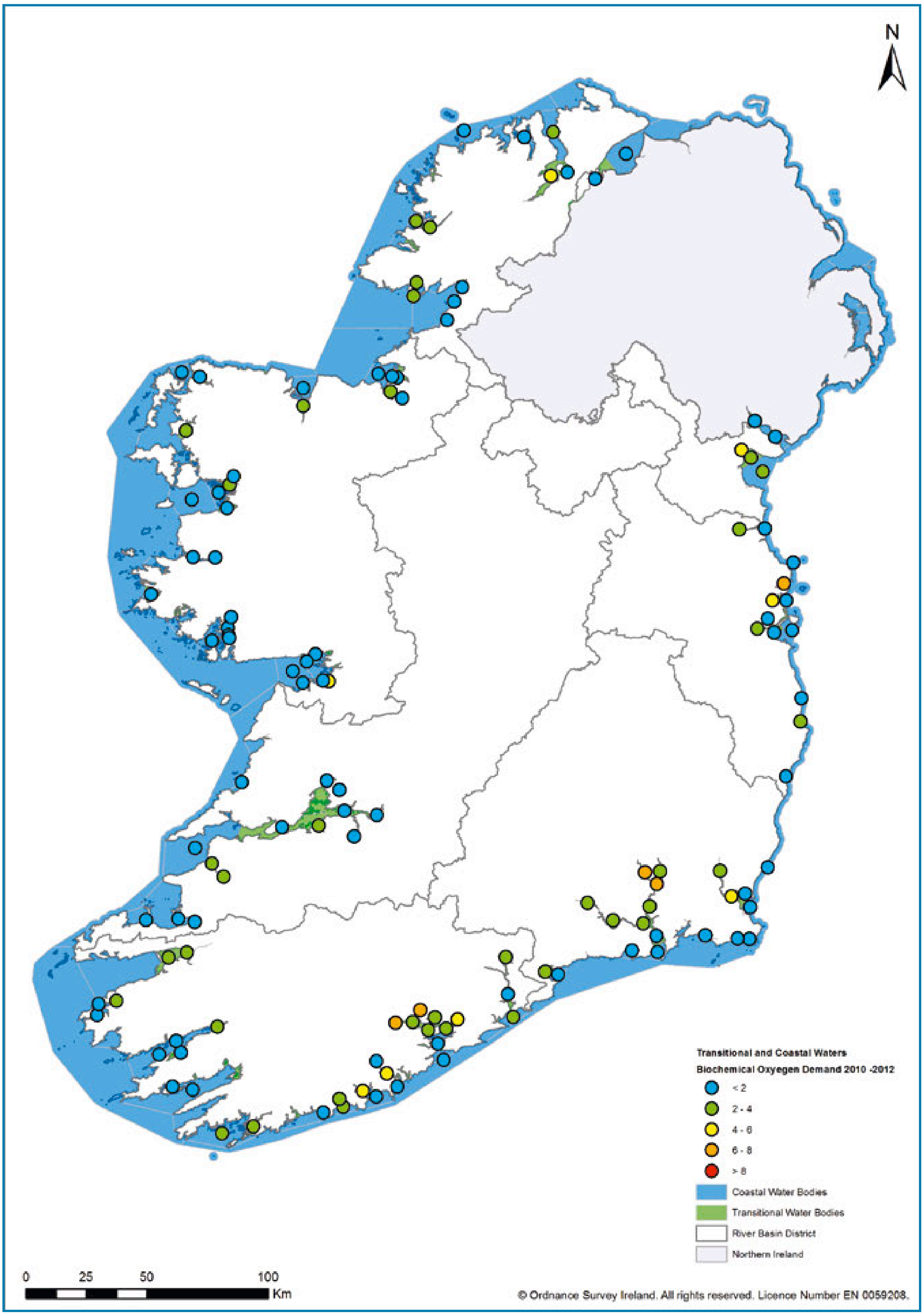
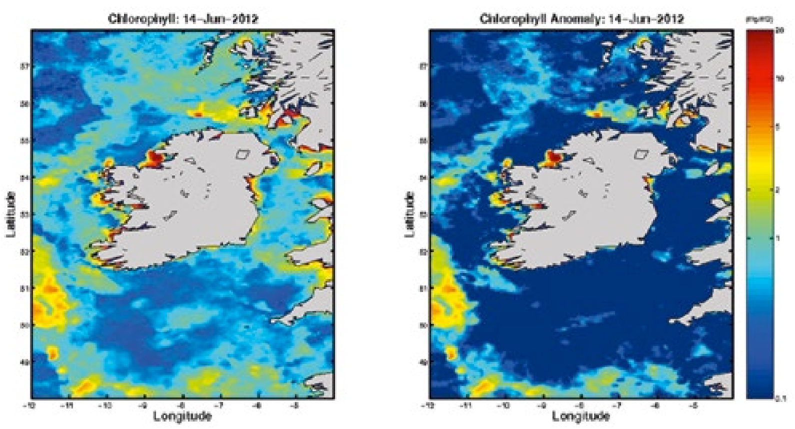


Figure 5-4. Summer (95%ile) biochemical oxygen demand concentration (mg/l) in transitional and coastal waters around Ireland 2010-2012.

Box 1. *Karenia mikimotoi* Bloom 2012

In the summer of 2012, there was an exceptional bloom of the dinoflagellate *Karenia mikimotoi* off Ireland's western seaboard. The formation of the bloom was associated with a period of calm settled weather. The bloom began in early June off the Donegal coast and persisted along the north-west coast until mid-July. A second bloom off Mayo began in mid-June and dissipated at the end of July. Maximum cell numbers of 4.5 million cells L^{-1} were reached at the beginning of July when the bloom peaked in Gweebarra Bay, Co. Donegal. Reddish-brown water was also reported in some coastal bays. The extent of the bloom was also apparent from satellite images, with the chlorophyll distribution and chlorophyll anomaly maps below showing the presence of the bloom in the surface waters of Donegal Bay on the 14th of June (Source: Marine Institute). While this phytoplankton species is non-toxic to humans, it does produce a toxin which can be an irritant to the gills of fish, shellfish and invertebrates, resulting in mortalities. There were considerable mortalities of vertebrates and invertebrates, including lugworms, cockles, Baltic Tellins, and sand eels. Dead fish were also found washed up onto the shore. The bloom also had a severe impact on oyster farms in Donegal Bay, where losses of between 20-80% occurred in some sites. Local sea anglers and prawn and lobster fishermen also reported low fish catches along the west and north-west during this time, which was probably due to fish avoiding the affected areas. Impacts on water quality were noticeable through changes in dissolved oxygen conditions in the water column. Supersaturation, excessively elevated dissolved oxygen levels, is associated with the bloom especially during the initial stages when the cells are growing and photosynthesing. This was very noticeable in late May in McSwyne's Bay and Gweebarra Bay, where a subsurface chlorophyll peak was associated with high dissolved oxygen levels. Another related impact is the depletion of oxygen in the water following the collapse of the bloom, which can affect organisms as well as water quality. This can be a problem, especially in areas where there is little water circulation. Dissolved oxygen levels in these areas were closely monitored by the EPA, and while some very low DO levels were found in the inner parts of some bays in Donegal during the 2nd week of July, these had nearly all returned to expected seasonal values by the end of August. In other more coastal waters, the bottom DO levels had returned to expected values by early 2013, probably due to winter mixing of the water column.



Biological quality elements

A number of biological elements have been used to provide an ecological assessment of transitional and coastal water status. In transitional waters, the biological element which displayed the greatest deviation from reference condition was the marine plants, with 40% of areas assessed using this element having moderate or worse ecological status. Marine plants include intertidal opportunistic macroalgae, rocky shore macroalgae and marine angiosperms. Of these three, opportunistic macroalgae is the element responsible for all the moderate or worse ecological status classifications. This element is responsible for the poor ecological status of the Argideen and Rogerstown estuaries in west Cork and County Dublin, where extensive mats of algae cover the intertidal area and impact negatively on the ecology of both estuaries. In the Rogerstown estuary, mats of opportunistic algae are found overgrowing the intertidal seagrass beds and this, in turn, is impacting on the status of both biological quality elements.

Opportunistic macroalgal accumulations in the Clonakilty Harbour, Co. Cork, August 2011.

The biological elements with the next highest percentage of moderate or worse classifications are the benthic invertebrates at 28%, followed by fish at 22%, and phytoplankton at 20%.

In coastal waters, and not surprisingly, given the much better status of these waters, the assessment of the biological elements indicates either high or good ecological status, with the exception of five water bodies where benthic invertebrates have shown a moderate deviation away from reference condition, and a single water body (Malahide Bay), where the element green opportunistic macroalgae was also at moderate status.

Overall, the status and response of the biological elements indicate that the main pressures impacting on biological status are nutrient and organic enrichment, and these impacts are mostly restricted to transitional waters. Furthermore, the strong correlation between phytoplankton biomass and biochemical oxygen demand (BOD) in these areas indicates that most of the organic enrichment is generated internally (endogenous) from phytoplankton blooms enriched by elevated nutrients, and not delivered externally (exogenous) from rivers or from discharges from wastewater treatment plants (O'Boyle et al., 2013). This implies that measures to control nutrient enrichment may be the most effective way of improving the ecological status of these waters. The absence of exogenous nutrient enrichment may be an indirect indicator of the improvements that have been achieved by reducing external loadings of organic matter to estuaries, primarily through the provision of improved levels of wastewater treatment.

Specific pollutants

Annual average concentrations for all WFD water bodies sampled in 2012 for copper, arsenic and zinc complied with national standards set in SI 272 of 2009. Total chromium is measured in water, and further speciation is required if concentrations are above the Environmental Quality Standard for chromium VI. This was not the case, so chromium is deemed compliant.

In the year 2012, the pesticides linuron and glyphosate were also tested for in TraC water bodies but not detected in any samples.

Similarly, volatile organic carbons (VOCs) (xylenes and toluene) were not detected in any samples, with the exception of one single measurable concentration in a sample from Kilkieran, albeit at a level far below the EQS.

Hydromorphological pressures

Hydromorphological pressures may also be relevant, particularly in relation to potential impacts on benthic invertebrates and fish populations, but the link between these pressures and ecological status in Irish tidal waters needs further investigation. As an initial step in assessing these pressures, a Geographical Information System (GIS) based tool called the Transitional and Coastal Waters Morphological Impact Assessment System (TraC-MImAS), developed by the UK Technical Advisory Group (UKTAG), has been adopted and applied in Ireland. The tool was designed to provide an assessment of the potential impact of physical structures and morphological alterations upon the overall hydromorphological condition of transitional and coastal waters. The principle is based on assessing the relative size of the footprint of different structural and morphological changes to water bodies. Footprints above specified size thresholds are considered to represent risk to the ecological status of the water body.

TraC-MImAS was first used in Ireland in 2007 to inform the morphological condition classification of TraC water bodies for the purposes of WFD assessment and reporting. The tool was reviewed and further developed in 2012 to provide a more accurate assessment of the current degree of alterations.

A recent assessment of 68 transitional and coastal waters in Ireland using TraC-MImAS indicated that, in 50 (73%) water bodies, the overall level of hydromorphological alteration was not likely to be causing an effect on ecological status. Of the remaining water bodies, nine water bodies (13%) were determined as being of moderate morphological condition, and 10 (14%) were determined to be of poor or bad morphological condition, indicating that 27% of water bodies assessed may be at risk of not being capable of supporting the biological elements due to the degree of structural modification. Work is ongoing to further investigate whether the levels of physical disturbance are actually impacting on biological communities.

Chemical status

Chemical status is assessed by compliance with environmental standards for priority substances and priority hazardous substances that are listed in the WFD (Annex X) and the Environmental Quality Standards (EQS) Directive (2008/105/EC). These priority substances and priority hazardous substances include metals, pesticides, and various industrial chemicals. The first round of the national monitoring programme for these substances commenced in late 2011, and was completed at the end of 2014. The monitoring was undertaken by the Marine Institute on behalf of the EPA. In the 2010-2012 assessment period, 14 areas were assessed for compliance against water-based EQSs, and 32 areas were assessed for compliance against biota-based EQSs.

Water sampling was undertaken monthly in 2012 between Lough Swilly in Co. Donegal and Kinvara Bay in Co. Galway (the remaining areas were sampled in 2013 and 2014). Biota sampling of the common mussel (*Mytilus edulis*) was undertaken in late 2011 from around the Irish coast. The compliance of water results for each water body is assessed against Annual Average (AA) EQSs and Maximum Allowable Concentration (MAC) EQSs. At present, biota EQSs are limited to three substances; mercury, haxachlorobenzene and hexachlorobutadiene. The results of these assessments are given in Appendices 6 and 7.

With the exception of mercury in water, which exceeded the MAC EQS in Broadhaven Bay and Mulroy Bay, there were no EQS exceedances in any of the other 12 areas where water-based EQSs were assessed. The exceedance in Mulroy and Broadhaven only occurred in one of 12 samples collected, so the overall confidence in this result is low. It cannot be ruled out that these anomalous measurements were artefacts of testing or sampling. Indeed, a thirteenth sample collected in Mulroy Bay in 2012, near to the WFD sampling site, was less than the analytical LOD of 0.01 µg $L^{-1.}$

Monitoring using the common mussel in 32 areas showed no exceedances in the biota-based EQS for mercury, hexachlorobenzene and hexachlorobutadiene, with the exception of four areas (Cork Harbour, Cromane, Lee (Tralee) Estuary and Rogerstown Estuary) which exceeded the EQS for mercury. The mercury EQS has been set at 20 µg Kg^{-1} wet weight to protect piscivorous wildlife against secondary poisoning. It should be noted that the concentrations were well below standards for fishery products[31] and therefore, do not pose a risk to human health. The EQS is at the analytical Limit of Quantification (LoQ) for the method of analysis for mercury in shellfish and, moreover, close to the concentration of mercury routinely detected in shellfish from Irish waters. Directive 2008/105/EC indicates that Member States can take account of background concentrations for metals if they prevent compliance with an EQS. OSPAR (Oslo Paris Convention) use a Background Assessment Concentration (BAC) of 90 µg kg^{-1} dry weight (~18 µg kg^{-1} wet weight). If this approach was taken, all the results from the 32 areas sampled would be within or close to the EQS+BAC. There is little guidance on how to apply the biota EQS (e.g. MAC vs. Average), or how to account for natural variability and interspecific and intraspecific biological factors that influence concentrations. It is clear that the mercury biota EQS would be consistently exceeded in marine and freshwater fish tissue, as concentrations in fish are higher than in mussels (McGovern et al., 2011; Vignati et al., 2013). Mercury has been identified as a ubiquitous PBT under Directive 2013/39/EU. These are persistent, bioaccumulative and toxic substances (PBTs), and other substances that behave like PBTs. They can be found for decades in the aquatic environment at levels posing a significant risk, even if extensive measures to reduce or eliminate emissions of such substances have already been taken. Some are also capable of long-range transport and are largely ubiquitous in the environment. Therefore, non-compliant results do not infer specific issues local to a water body or indeed river basin district.

There were very few detections for polyaromatic hydrocarbons (PAHs) measured in water [priority harzardous substances: –anthracene, benzo(a)pyrene, benzo(b+k) fluoranthene and benzo(ghi)perylene + indeno (1,2,30cd)-pyrene; and priority substances: fluoranthene, naphthalene]. Monitoring results all complied with AA-EQS and, where available, MAC-EQS, with the exception of sum of benzo(ghi)perylene + indeno (1,2,3 cd)-pyrene. In this case, no assessment could be carried out, as the reported LOQ exceeded the very low AA-EQS three-fold, although for each parameter, all reported results were below the Limit of Quantification.

Volatile Organic Compounds in water [benzene, trichlorobenzenes, dichloroethane, dichloromethane (all priority substances)] were generally below LOQs (only two detections from 168 samples for dichloromethane), and are all reported as compliant with AA-EQS and MAC-EQS (benzene only).

31 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

Alkylphenols [four nonylphenol (priority hazardous substances) and four octylphenol (priority substances)] were not detected in water at any of the WFD stations sampled in 2012. However the phthalate, DEHP, was detected in approximately 11% of samples, with an individual maximum of 1.76 µg L^{-1} found in Kinvarra Bay. While the two highest measurements were from Kinvarra (August and September, 2012), both exceeding the AA-EQS of 1.3 µg L^{-1}, all other values were <0.03 µg L^{-1} at this location, and the overall annual average for Kinvarra and all other water bodies sampled in 2012 complies with the AA-EQS.

The pesticides diuron, atrazine and simazine were not detected in any of the water samples and, as the detection capabilities for the methods are well below the AA-EQS, these are reported as compliant for all WFD water bodies sampled.

In biota, hexachlorobenzene (HCB) and hexachlorobutadiene (HCBD) were determined in mussel samples that were obtained from 32 of the 46 WFD target water bodies. Hexachlorobenzene was detected at low concentrations in all samples (range 0.01 – 0.06 µg Kg^{-1} wet weight) and this was well below the WFD EQS of 10 µg Kg^{-1} wet weight set for biota. Hexachlorobutadiene was not detected in any sample, indicating HCBD concentrations were below 0.002 µg Kg^{-1} wet weight in all samples, which is well below the WFD EQS of 55 µg Kg^{-1} wet weight.

In addition to monitoring these three substances in biota, the presence of tributyl tin (TBT) in the common mussel is also assessed. This information is not used for WFD chemical status assessment because there is no recognised biota-based EQS for this substance. However, this information, together with regular surveys of 'imposex' in the Common Dogwhelk (see **Box 2**), provides useful information on the presence and distribution of this contaminant in the marine environment.

As the WFD monitoring programme continues, further information on these contaminants in water will be provided, to ensure as complete a picture as possible of chemical status of transitional and coastal waters can be provided. Based on this initial analysis, however, it is expected that the chemical status of transitional and coastal waters is mostly good.

Box 2. TBT-specific effects in Dogwhelks (*Nucella lapillus*) around the Irish coast

The common dogwhelk is a useful biological indicator of tributyl tin (TBT) pollution effects. Female dogwhelks are particularly sensitive to TBT contamination and can develop male sex characteristics, including the development of male genetalia – a term referred to as 'imposex' .

In 2010 and 2011, the degree of imposex in female dogwhelks was assessed at 63 sites around the Irish coast from Carlingford Lough (Co. Louth) to Mulroy Bay (Donegal Bay) (Wilson et al., 2014). Trends in imposex since 1987 were also examined. Over 75% of the sites examined met the OSPAR Ecological Quality Objective, but a number of sterile females (EcoQO not met) were found at 14 of the 63 sites, including Killybegs, Castletownbere, Cork Harbour and Waterford Harbour (Dunmore East).

Comparison with previous surveys revealed little change up to 2005, but a substantial and significant improvement thereafter. At 10 locations, levels were shown to significantly decrease between middle (1996-2004) and early (1987-1995) surveys, with a more significant decrease evident between recent (2005-2011) and earlier surveys, indicating ongoing improvement.

Protected area status

The purpose of the WFD is to provide a general level of protection for all groundwater and surface waters (rivers, lakes, transitional and coastal waters) aiming to restore and maintain waters at good status or better. In addition, water-related protected areas may have other environmental objectives which must also be achieved under specific legislation. As the objectives and standards set by different directives may differ (as the function or attribute they protect may differ), it is possible for a water body to be at good or high status, while the protected areas within these water bodies may be failing to meet the requirements of the protected area legislation (e.g. microbiological standard in shellfish flesh). In many cases, the general objectives of the Water Framework Directive are compatible with the objectives of other directives. For example, in the case of the freshwater pearl mussel, the WFD objectives are compatible with the conservation objectives for this species (SI 296 of 2009). There are some other cases, however, where existing conditions may be favouring a protected species or habitat, but the status of the water body under the WFD is less than good. This may be due to the presence of a hydromorphological alteration (e.g. impoundment) or nutrient enrichment, which may be favouring a protected species or habitat, but which may be impacting on the general environmental conditions of the water body. In such circumstances, the general objectives of the WFD prevail (EC, 2011), as these seek to protect the entire ecosystem and not specific species or habitats. However, there are cases where the species or habitat should receive priority, if that particular water body or site is important to the conservation of that attribute on a national or regional biogeographic scale. These are just some of the considerations that need to be taken into account in the river basin management process, to ensure the correct balance is struck between water quality objectives, nature protection, and the sustainable use of these natural resources.

In the following sections, the authors provide an assessment of whether or not the water-related environmental objectives of protected areas, which occur in transitional and coastal waters, are being met.

Urban Wastewater Treatment Directive (UWWTD) designated sensitive waters

In Ireland, 19 estuaries have been designated as sensitive waters (S.I. 254 of 2001, S.I. 440 of 2004, S.I. 48 of 2010) under the Urban Wastewater Treatment Directive. The estuaries designated as sensitive (**Table 5-3**) were deemed to be displaying symptoms of eutrophication or potential eutrophication, as defined in both the Nitrates Directive and Urban Wastewater Treatment Directive. These symptoms include nutrient enrichment by compounds of nitrogen and phosphorus, accelerated growth of algae and higher forms of plant life, and the undesirable disturbance to the balance of organisms present and to the quality of the water concerned. The definitions used in both directives recognise the complexity of the linkages between the cause and response of water bodies to nutrient enrichment, and to be categorised as eutrophic, water bodies must display each of the symptoms listed above. This approach is different to the 'one-out-all-out' approach of the WFD, which means that moderate status under the WFD may not always correspond to eutrophic status under the Nitrates and UWWT Directives. The weight of evidence approach recognises that moderate deviations from reference conditions under the WFD may not necessarily result in an undesirable ecological disturbance. This may well be the case in a nutrient-enriched estuary, where factors, such as poor light availability in the water column and short residence times, inhibit the "accelerated growth of algae and higher forms of plant life", with the result that no undesirable ecological disturbance (e.g. algal bloom) arises (O'Boyle *et al.*, 2015). Conversely, a moderate deviation in any one of the elements included under the WFD may be indicative of an emerging environmental issue, and it might be more sensible to take action before this deviation results in a negative impact on the environment.

Area	
Broadmeadow Estuary (Inner)	Cashen / Feale Estuary
Liffey and Tolka Estuaries	Killybegs Harbour
Slaney Estuary (Upper)	Castletown Estuary
Slaney Estuary (Lower)	Blackwater Estuary Upper
Barrow Estuary	Blackwater Estuary Lower
Suir Estuary (Upper)	Lee Estuary/Lough Mahon
Bandon Estuary Upper	Owennacurra Estuary/North Channel
Bandon Estuary Lower	Clonakilty Harbour
Lee Estuary Upper (Tralee)	Boyne Estuary
Feale Estuary Upper	

Table 5-3. Estuaries designated as sensitive waters under the Urban Wastewater Treatment Directive.

Trophic status of Irish waters

In Ireland, the presence of eutrophication is assessed using the Trophic Status Assessment Scheme (Toner et al., 2005). The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state. 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. The occurrence of these symptoms of eutrophication is used to classify the trophic status of tidal waters as follows:

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% 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.

The assessment of estuarine and coastal waters for the period 2010-2012 is shown in **Figure 5-5.** Of the 102 water bodies included in the assessment, seven (6.9%) were classed as eutrophic, nine (8.8%) as potentially eutrophic, 28 (27.5%) as intermediate and 58 (56.9 %) were unpolluted (**Figure 5-5(a)**). In terms of surface area, only 78.5 km^2 or 1.7% of the total area assessed (4,314 km^2) is classed as either eutrophic or potentially eutrophic (**Figure 5-5(b)**).

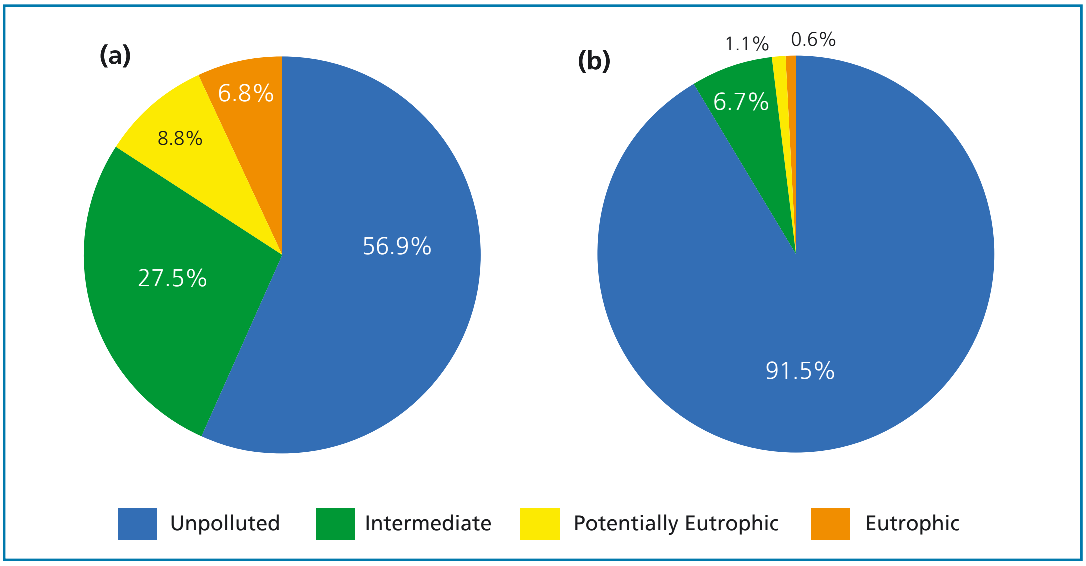


Figure 5-5. Percentage of water bodies in each of the trophic status categories by a) number (n = 102) and b) surface area (4,314 km^2).

The trophic status of nearly all water bodies nationally was based on monitoring results from a selection of representative water bodies. This national overview is shown in **Figure 5-6.** The national picture is similar to that from monitored water bodies, with 63% of water bodies classified as unpolluted, 20% as intermediate, 8% as potentially eutrophic, and 5% as eutrophic. In 4% of water bodies, there was insufficient information to extrapolate trophic status.

The results of this assessment appears to confirm an overall improvement in water quality which was evident in the last report (McGarrigle et al., 2010). Five fewer water bodies have been classed as eutrophic (or potentially eutrophic) when compared to the previous assessment (2007-2009). These are inner Dundalk Bay, Malahide Bay, North Channel Great Island, upper Barrow Estuary and the Colligan Estuary, with inner Dundalk Bay showing the most improvement, having improved from being eutrophic to unpolluted. The lower Blackwater Estuary has also improved in status and has, for the first time since assessments began, been classed as unpolluted. The reasons for this improvement in trophic status are elaborated upon in **Box 3**, which also includes a series of maps showing the temporal improvement in trophic status.

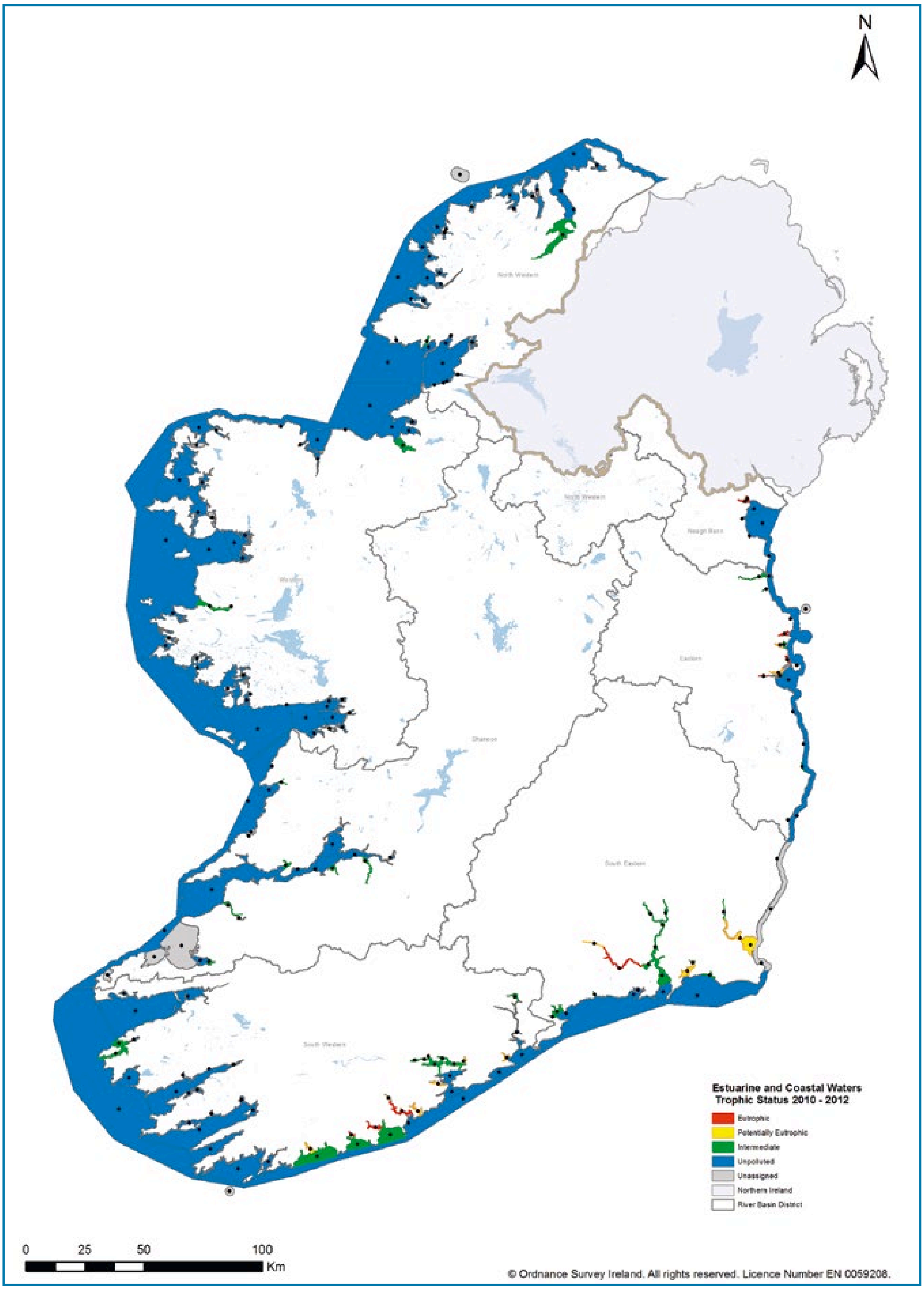


Figure 5-6. Trophic status of estuarine and coastal waters around Ireland 2010-2012.

There have also been some disimprovements. Rogerstown Estuary and the upper Liffey Estuary have deteriorated in status and are now categorised as eutrophic, while Wexford Harbour, Owenacurra Estuary and the Glasaboy Estuary have been classed as potentially eutrophic. These areas had previously been classed as intermediate. Clonakilty Harbour, which was not assessed previously, was also found to be eutrophic, mainly due to the presence of excessive amounts of green opportunistic macroalgae.

A comparison of trophic status assessments going back to the mid-1990s is shown in **Table 5-4**. While the number of areas included in this assessment has increased in recent years due to the implementation of the Water Framework Directive, 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 (see **Figure 5-6**).

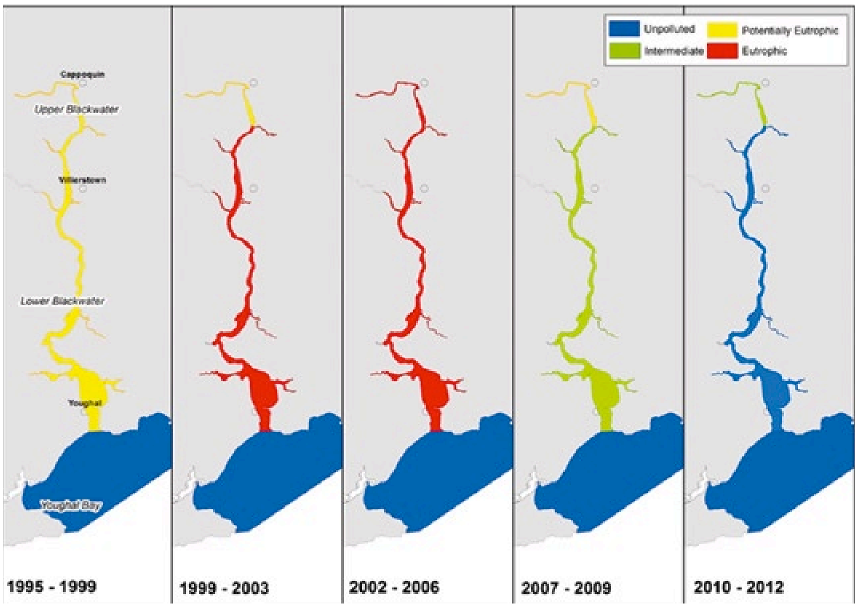
Water Bodies	Trophic Class	1995-1999	1999-2003	2002-2006	2007-2009	2010-2012
Numbers	Eutrophic	15	12	13	9	7
	Potentially Eutrophic	3	3	2	5	9
	Intermediate	18	28	27	31	28
	Unpolluted	24	26	27	44	58
	Total	**60**	**69**	**69**	**89**	**102**
Percentage	Eutrophic	25.0	17.4	18.9	10.1	6.9
	Potentially Eutrophic	5.0	4.3	2.9	5.6	8.8
	Intermediate	30.0	40.6	39.1	34.8	27.5
	Unpolluted	40.0	37.7	39.1	49.5	56.9
	Total	**100**	**100**	**100**	**100**	**100**

Table 5-4. Summary of Trophic Status Assessment Scheme analysis from 1995 to 2012.

Box 3. Improvements in the trophic status of the Blackwater Estuary

The Blackwater Estuary, which previously had been classed as eutrophic, has shown a marked improvement in water quality and is no longer considered to be eutrophic. The series of maps below show the improvement in trophic status, from eutrophic and potentially eutrophic in the mid-1990s and 2000s, to unpolluted in the period 2010-2012. An assessment of the main nutrient inputs to the catchment has shown, from 2000 to 2011, a decrease in nitrogen (N) and phosphorus (P) loads of 17% and 20% respectively. Over the same time period, inorganic fertiliser application rates in the catchment have declined, resulting in a 34% and 53% reduction in N and P loadings respectively. This reflects a drop in national fertiliser usage rates over the last decade (Lalor *et al.*, 2010). Sheep numbers in the catchment have also decreased by 70%, from 270,000 to 80,000, in the last 20 years. Wastewater treatment plants (WWTPs) and one-off housing, while representing a small fraction of the total load (1.3% of N and 7% of P), have increased slightly over the last 20 years. This increase is due to a rise in population of 21% which has offset, at least in mass balance terms, the improvement in the level of wastewater treatment. Long-term monitoring of river nutrient inputs reflect the reductions in calculated loadings over the last decade, with decreases in nitrogen and phosphorus to the estuarine system observed between 2000 to 2010 (Ní Longphuirt *et al.*, 2015).

Within the estuary, phosphate concentrations have shown significant reductions from 1997 to 2012, indicating a response to reduced loadings from the river catchment. Dissolved oxygen saturation has also improved throughout the estuary, with increases being most evident in the upper estuary, while chlorophyll a, a proxy for phytoplankton biomass, decreased significantly in the lower estuary. No decrease in nitrogen concentrations was observed, which suggests a de-coupling between nitrogen loading and estuarine responses, in that the phosphorus-driven decline in water column primary production may have resulted in a reduction in the biological uptake of available nitrogen. However, the potential impact of increased nitrogen transport downstream to N-limited coastal waters, as the nitrogen-filtering capacity of the upper estuary weakens, will require further investigation.



Urban wastewater treatment

The main environmental objective of the Urban Wastewater Treatment Directive, and the national regulations implementing the Directive, is to provide specified levels of treatment based on the size of the agglomeration and the type of water body to which the wastewater is discharged (freshwater, estuarine or coastal, sensitive or non-sensitive). The Directive also specifies mandatory effluent quality standards for discharges from larger agglomerations. In Ireland, there were 170 such larger agglomerations in 2012. The Directive requires 'appropriate treatment' at all other agglomerations, i.e. those below the threshold size of the larger agglomerations.

In 2012, 93.9% of the wastewater load generated at urban areas subject to the wastewater discharge licensing programme received at least secondary treatment, with the remaining 6.1% receiving primary treatment, preliminary treatment or no treatment (EPA, 2014). These figures illustrate the continued increase in the provision of secondary treatment. In 2001, for example, only 29% of the wastewater load received at least secondary treatment, with the remaining 71% receiving only primary treatment or no treatment.

Nevertheless, at the end of 2012, seven large urban areas which discharge to estuaries or coastal waters did not meet the UWWTD requirement to have secondary treatment in place (Arklow, Clifden, Cobh, Killybegs, Passage West/Monktown, Ringaskiddy and Youghal). In the case of Arklow, Killybegs and Ringaskiddy, the provision of treatment was due by the end of 2000. Furthermore, in 2012, nine agglomerations, with a population equivalent greater than 10,000, five of which discharge to estuaries and coastal waters, did not meet the requirement to provide infrastructure to reduce nutrients and did not meet nutrient quality standards for discharges to nutrient-sensitive areas. The five areas discharging to estuaries and coastal waters are: Killybegs, Dundalk, Cork City, Carrigtohill and Dublin City.

The directive sets mandatory limits on the concentration of biochemical oxygen demand (BOD), chemical oxygen demand (COD) and, in the case of certain discharges to sensitive areas, total phosphorus and total nitrogen in waste-water discharges from larger agglomerations. While almost 94% of urban wastewater received at least secondary treatment, 44 of the larger urban areas did not achieve the mandatory effluent quality and sampling standards set in the Directive in 2012.

Shellfish waters

The Shellfish Waters Directive (2006/113/EC) establishes mandatory values for a range of environmental parameters which must be complied with, as well as guide values which Member States must aim to achieve. The directive is implemented in Ireland by the Quality of Shellfish Waters regulation (S.I. No. 268 of 2006) which sets the guide and mandatory values for trace metals, organohalogens and microbiological pollutants in shellfish waters and shellfish flesh.

In Ireland, 64 areas have been designated as shellfish waters (S.I. No. 268 of 2006, S.I. No. 55 of 2009, S.I. No. 464 of 2009). In the sections below, the level of compliance against both mandatory and guide values for each of the parameters listed in the national regulations implementing the Directive is summarised.

Trace metals, organohalogens and physico-chemical parameters

In 2011, water samples for the assessment of metal concentrations were collected from 44 shellfish areas. In all samples, dissolved metal concentrations (arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc) were compliant with the mandatory values. Furthermore, these water concentrations were also less than the WFD EQS established in the Surface Water

Regulations (S.I. No. 272 of 2009). An analysis of physico-chemical parameters (i.e. salinity, temperature, dissolved oxygen, pH and suspended solids) did not indicate any significant disturbance to the physico-chemical environment and its ability to support shellfish populations.

Contaminant levels in shellfish flesh from different species (common mussel, native oyster, Pacific oyster and cockle) were sampled from 26 areas, to assess the compliance of these areas against guide values for metals and organohalogens in shellfish flesh. All areas, with the exception of a single sample of cockle, which exceeded the guide value for nickel, were in compliance with the guide values. This likely reflects the fact that different species of mollusc regulate trace metals differently and the relatively high concentration of nickel in cockles is typical of this species.

Microbiological quality

A guide value for faecal coliforms (Parameter 10) of ≤ 300 faecal coliforms in 100ml of shellfish flesh and intravalvular liquid is set out in the Annex to the Directive. The Directive stipulates that three-quarters (75%) of samples should conform to this guide value and that monitoring should be based on a programme of quarterly sampling.

In order to make use of existing monitoring and testing programmes using established and accredited analytical test procedures, levels of *E. coli,* rather than faecal coliforms, have been monitored to assess compliance with the guide value. Within shellfish, *E. coli* levels have been quoted as usually making up between 75 to 95% of the overall levels of faecal coliform present but may make up as little as 1% in some areas of low level faecal pollution. The value of 75% has been taken by many workers as a conservative average for an equivalence figure. Previously, this figure was used as the value for determining equivalence between *E. coli* and faecal coliforms in the shellfish hygiene directive. Therefore for assessment purposes, a value of ≤ 230 *E. coli* Most Probable Number (MPN) 100g-1 was considered equivalent to the directive guide value of ≤ 300 faecal coliforms MPN 100g-1.

This value is used by the Marine Institute to assess the microbiological quality of designated shellfish growing areas monitored between February 2009 and November 2012 (Marine Institute, 2013). Nearly two-thirds (65.1%) of the designated areas monitored over the four-year period were compliant with the guide value of ≤ 230 *E. coli* MPN 100g-1 on 75% or more of sampling occasions (Marine Institute, 2013). Of the non-compliant areas, the worst performing were Bannow Bay, Bantry, Dunmanus Inner, Kinsale, Tralee Bay, and Wexford Harbour Inner, where more than 50% of the samples exceeded the guide value. The compliance results for individual shellfish areas for this period are available from the Marine Institute (www.marine.ie).

Shellfish production areas

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 the EC Hygiene Regulations (Nos. 852/853/854 of 2004) which lay down specific rules for food of animal origin. 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 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 5-5**.

Classification	E. coli per 100g of live bivalve mollusc flesh and intravalvular 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 may be heat treated
Prohibited	>46,000	Harvesting not permitted

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

Table 5-5. Classification scheme for shellfish production areas.

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 2012 classification of shellfish production areas in Ireland classified 138 production beds in 61 production areas: 39 (28.3%) were classified as class A, 19 (13.8%) classified as 'seasonal' class A and 69 (50.0%) as class B, while a single production bed in each of Waterford Harbour and Wexford Harbour were classed as C. A small number of areas were given a preliminary classification and this occurs when an area is being classified for the first time or after a period of suspension in production. The term may also be used where results are incomplete. The results for each area can be viewed on the SFPA website (www.sfpa.ie).

Trends in pressures impacting on TraC waters

The EPA has been involved in two major programmes over many years to assess changes in pressures which potentially impact on the status of transitional and coastal waters. Both of these programmes have been instigated by the Oslo Paris Convention for the Protection of the marine environment of the North-East Atlantic – OSPAR. The OSPAR Riverine Inputs and Direct Discharges programme has been in operation since 1990, and assesses the annual river and direct input of nutrients and other substances to the marine environment. The OSPAR PARCOM Source Apportionment programme undertakes a periodic assessment of nutrient loadings from different sources.

Trends in river inputs

Analysis of trends in nutrient loads in 20 major Irish rivers between 1990 and 2010 (**Table 5-6**) indicate a statistically downward trend in total phosphorus and total ammonia in the majority of rivers, and a downward trend in total nitrogen in half the rivers. The Corrib river appears to show a slight upward trend in total ammonia, however this is due to a change in laboratory procedures and is unlikely to reflect a real increase in loadings from the Corrib catchment.

River	Total Phosphorus		Total Nitrogen		Total Ammonia	
	Trend	(Tonnes Yr-1)	Trend	(Tonnes Yr-1)	Trend	(Tonnes Yr-1)
Avoca	Downward**	-0.97	Downward***	-189.08	Downward***	-94.18
Bandon	No change	-0.91	Downward**	-46.92	No change	-1.12
Barrow	Downward***	-6.38	No change	-64.33	Downward***	-3.44
Blackwater	Downward***	-19.29	Downward*	-170.66	Downward**	-12.96
Boyne	Downward***	-4.28	Downward*	-74.85	Downward**	-3.02
Corrib	No change	-0.62	No change	-49.40	Upward*	2.24
Deel	Downward***	-3.54	No change	-23.89	Downward**	-2.07
Dodder	Downward***	-0.49	No change	-3.80	Downward*	-0.18
Erne	No change	-0.01	Downward*	-48.17	No change	0.47
Fergus	No change	-0.91	No change	-10.99	Downward*	-0.66
Lee	No change	-0.64	Downward**	-73.93	Downward*	-2.17
Liffey	Downward***	-3.88	Downward***	-35.62	Downward***	-3.36
Maigue	Downward***	-7.09	Downward**	-60.36	Downward**	-3.57
Moy	No change	-0.93	No change	-20.34	No change	-0.48
Nore	Downward***	-7.35	No change	-55.28	Downward***	-3.67
Shannon old channel	Downward***	-5.68	No change	-54.21	Downward**	-4.03
Shannon Tail race	Downward*	-5.75	Downward*	-114.87	No change	0.12
Slaney	Downward***	-7.30	No change	-38.32	Downward***	-4.13
Suir	Downward***	-10.59	No change	-7.16	Downward***	-9.46
Tolka	Downward***	-0.62	Downward***	-9.64	No change	-0.22

Table 5-6. Trends in river loadings of nutrients to the marine environment between 1990-2012. The degree of significance is indicated by a significance code: not significant (NS), *; p<0.05, **; p<0.01, ***; p<0.001. Asterisks indicate degree of significance.

Comparing nutrient loadings for the most recent three-year period (2010-2012) to the first three-year period (1990-1992) indicates how substantial the reduction has been in the loadings of these nutrients to the tidal waters environment. This is particularly evident for loadings of total ammonia and total phosphorus, which has shown a percentage decrease of 80.5% and 56.2% or 4,506 and 1,457 tonnes respectively. For total nitrogen, the corresponding percentage reduction is 35.5% or 33,759 tonnes. The figures for total nitrogen and total ammonia are skewed somewhat by inclusion of the figures for the Avoca river, which has seen a remarkable 93.7% and 99.2% reduction in total nitrogen and total ammonia respectively, following the introduction of a licensing regime in a large fertiliser production plant on the Avoca river in the late 1990s and its closure in 2002. If these reductions are removed from the national figures, the percentage reduction in national loadings of total phosphorus, total nitrogen and total ammonia would be 56.2% (unchanged), 25.2% and 36.1% respectively.

In the next section, the results of the OSPAR PARCOM Source apportionment work gives some initial indications of what might be responsible for the observed decreases in nutrient loadings to the marine environment.

Trends in nutrient sources

The PARCOM Source Apportionment (PSA) programme uses a set of published guidelines (Harmonised Quantification and Reporting Procedures for Nutrients) to estimate the potential loading from various sources, such as agriculture, urban wastewater treatment, industry, unsewered populations, and forestry. The estimated percentage contributions of nitrogen and phosphorus from each source are shown in **Figure 5-7.** For nitrogen, the largest source is agriculture (87.5%), followed by urban wastewater treatment (4.9%), and forestry (1.7%), with unsewered industry, and unsewered populations and other sources representing less than 6% of the total nitrogen loading. For phosphorus, the largest source is agriculture (49.2%), followed by urban wastewater treatment (28.7%), with peatlands, background losses, unsewered populations, and forestry each accounting for about 5% of the total phosphorus loading. These figures show that nitrogen sources are primarily coming from diffuse sources, while phosphorus sources are coming from a mixture of point and diffuse sources.

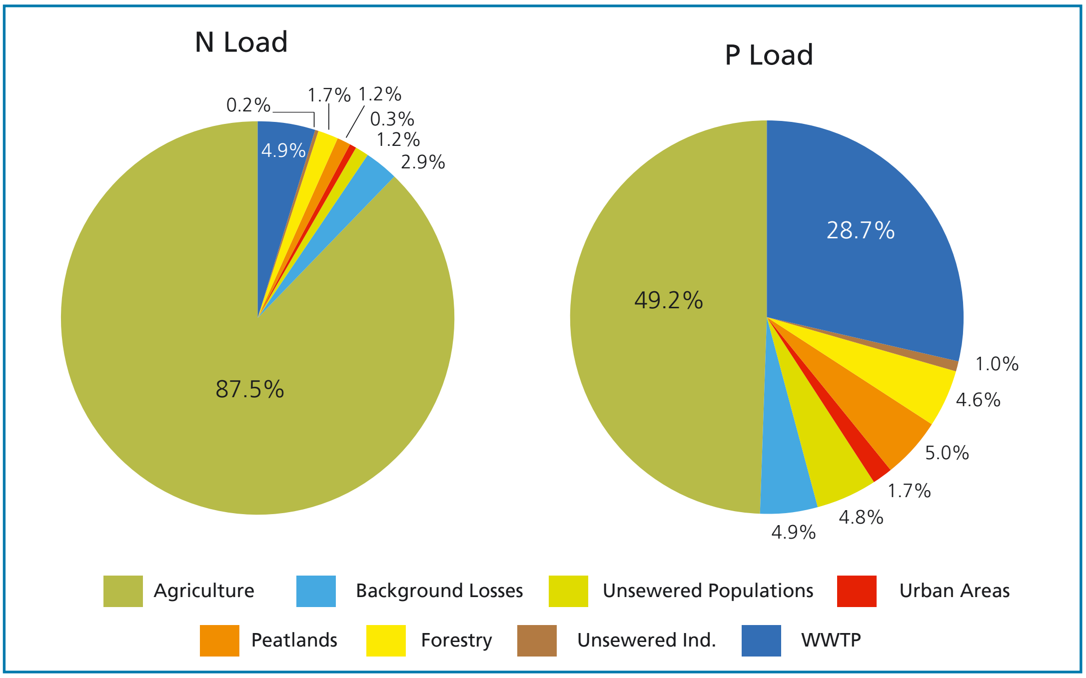


Figure 5-7. Relative contribution of sources of discharges and losses of nitrogen and phosphorus to the marine environment (Based on estimates from 2012).

A comparison of the relative change in nutrient sources between the present assessment and an earlier assessment carried out in 1995 is shown in **Table 5-7**. Before interpreting the values given in this table, it is important to point out that these values represent the potential amount of nutrient at source, and do not take into account the processes (e.g. retention and attenuation) which might occur between the source of the nutrient and its eventual input to the marine environment (i.e. the pathway). Nevertheless, this exercise provides a valuable assessment of the relative change in individual nutrient sources, which in turn provides valuable information on what is driving change in these sources. When all sources combined for the present period are compared to the earlier period, there has been an estimated 27.1% and 17.0% reduction in sources of phosphorus and nitrogen respectively. Sources of phosphorus from forestry, peatlands, urban areas and unsewered populations have increased, while sources from urban wastewater, unsewered industries, background losses and agriculture have decreased. Sources of nitrogen from urban wastewater, forestry, peatlands and urban areas have increased, while sources from unsewered industries, unsewered populations, background losses and agriculture have decreased.

The biggest reduction, in absolute terms, was seen in the agriculture sector, with a 37.7% reduction (equating to just under 2,000 tonnes) in phosphorus loadings. This is mostly accounted for by the reduction in the use of inorganic phosphorus fertiliser following the introduction of improved farming practices and, in particular, the management of inorganic fertiliser application. The amount of in organic phosphorus fertiliser usage in 2008, for example, is less than half of what it was in 1995 (Lalor *et al.*, 2010). The next most obvious reduction in both nitrogen and phosphorus is from unsewered industry, which is down by 74.8% and 86.6% respectively. While there is some uncertainty in relation to these figures, this reduction may reflect the connection of unsewered industries to municipal sewage treatment networks. This, in turn, may explain the increase in nitrogen loadings from municipal wastewater treatment plants, which might have been expected to have seen a reduction in nutrient loadings given the general improvement in the level of treatment seen in recent years (see earlier section on urban wastewater treatment). It would appear that improved levels of treatment and retention of nutrients has been offset somewhat by the increase in the loadings from newly-connected industries and previously unsewered populations, which has also seen a significant fall. Overall, improved wastewater treatment and capacity has reduced the nutrient loading that would otherwise be emitted to the water environment from these sectors.

2012	N Load Kg yr^{-1}	% Difference from 1995	P Load Kg yr^{-1}	% Difference from 1995
WWTP	8,451,652	6.1	1,863,268	-12.1
Unsewered Industries	305,761	-74.8	63,647	-86.6
Forestry	3,014,509	44.4	300,500	84.6
Peatlands	2,131,174	10.5	327,343	10.0
Urban Areas	592,467	94.3	112,545	90.7
Unsewered Populations	2,023,145	-32.7	312,526	9.2
Background Losses	5,041,712	-12.5	319,956	-16.1
Agriculture	151,413,194	-18.7	3,196,976	-37.7
Total	**172,973,615**	**-17.0**	**6,496,761**	**-27.1**

Table 5-7. PARCOM - National Source Apportionment Assessment 2012 and comparison with 1995 Source Apportionment Exercise.

If the authors compare the relative percentage reduction figures obtained from the PARCOM source apportionment work and that based on river inputs, they see that both approaches indicate a reduction in both nitrogen and phosphorus loads (**Table 5-8**). The reduction in nitrogen loads estimated from the two approaches are broadly similar, but the estimated reduction in phosphorus loading, based on river inputs, is more than double what it is from the source apportionment approach (56.2% versus 27.1%). Previous comparisons of both approaches had indicated good agreement for both nitrogen and phosphorus, so the reason why the agreement is less good on this occasion is unclear. One possible explanation which requires further research, is that as sources of phosphorus have decreased, the river catchment is becoming a much better filter for any available phosphorus. Another explanation could be the effect of measures which have been put in place in recent years to reduce the loss of nutrients from both diffuse and point sources.

	N Load (% Diff)	P Load (% Diff)
Source apportionment	-17.0	-27.1
River inputs	-25.2	-56.2

Table 5-8. Comparison of nutrient reductions derived from the PARCOM Source Apportionment Exercises undertaken in 1995 and 2012 and nutrient reductions in river loadings between 1990-1992 and 2010-2012.

Other issues relevant to the marine environment

Radioactivity in the marine environment

Radioactivity monitoring in the Irish marine environment is carried out by the EPA Office of Radiological Protection. 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 geographical and temporal distribution of artificial radionuclides in the marine environment.

The exposure of the Irish population to radioactivity in the marine environment is assessed by measuring concentrations of radioactivity in samples of a wide range of fish and shellfish collected from commercial landings at major Irish fishing ports and aquaculture areas. Seawater and seaweed are analysed from coastal sites and sediment samples are taken at offshore sites in the western Irish Sea. Caesium-137 is measured in sediments to assess levels of radionuclides from historic discharges, as remobilisation from sediments is now the predominant source of marine activity in the Irish Sea. The most recent report on marine monitoring covers the years 2010 and 2011 (McGinnity et al., 2012).

Analysis of seawater and seaweed samples showed that caesium-137 and technetium-99 trends were the same as in previous reports. Concentrations of caesium-137 have remained relatively constant since the mid-1990s, while technetium-99 has shown a reduction in activity since 2004. This corresponds to a reduction of discharges of this radionuclide. Both nuclides showed the same geographical distribution where the highest concentrations were found on the north-east coast. The monitoring of technetium 99 in seawater ceased at the end of 2010 due to the recent reductions in its concentrations. In seaweed, caesium-137 has remained relatively constant since the mid-1990s, while technetium-99 activity concentrations showed a similar pattern observed in seawater, where levels peaked in late 1997 and early 1998 and have reduced significantly over the last few years.

Caesium-137 concentrations in fish and shellfish were also similar to those detected in previous years. Most technetium-99, plutonium-238 and plutonium-239,240 activity concentrations in the samples were below detection limits.

In general, the levels of radioactive contamination present in the marine environment do not warrant any modification of the habits of people in Ireland, either in their consumption of seafood or in any other use of the amenities of the marine environment (McGinnity et al., 2012)[32].

A survey for tritium in Irish seawater began in 2008 (Currivan et al., 2013). Tritium is of importance as it is included in the list of radioactive substances of interest to the OSPAR Convention. Up to now, the low radio-toxicity of tritium means it has not been included as a radionuclide of interest in the ORP's routine environmental programme. Over the three-year period, 85 seawater samples were collected and the majority were found to have tritium concentrations below the minimum detectable activity of 1 Bq/L. Twelve (14%) samples analysed contained measureable amounts of tritium at concentrations 0.9-2.4 Bq/L. Overall, the concentration of tritium in seawater samples around the Irish coastline are low when compared to tritium concentrations measured in seawater in the eastern Irish Sea. The EPA is continuing to monitor tritium in seawater, as the operational discharges of tritium from Sellafield are expected to increase due to decommissioning activities for the period 2011-2015.

32 www.epa.ie/radiation

Oil pollution incidents

One of the responsibilities of the Irish Coast Guard is to develop and co-ordinate an effective regime in relation to preparedness and response to spills of oil and hazardous and noxious substances from ships and offshore platforms within the Irish Exclusive Economic Zone. The Coast Guard's responsibilities also include the establishment and the maintenance of a National Contingency Plan for marine pollution, preparedness and response.

The major maritime incidents causing, or with potential to cause, oil pollution that occurred between 2010 and 2012 are summarised in **Tables 5-9** and **5-10**.

The Irish Coast Guard investigated 46 incidents in 2010, 41 in 2011, and 47 in 2012. Mineral oils accounted for 63%, 39% and 51% respectively of the polluting material observed annually between 2010 and 2012, and of these, diesel and gas oils were most frequently identified. The majority of spills in 2011 and 2012 were less than one tonne. However, in 2011 the grounding of one fishing vessel resulted in a reported 35 tonnes of diesel fuel lost, and in 2012 an estimated spill of five tonnes of heavy oil took place in Dublin Port. There were 17 reported oil pollution events in 2012 where the estimated volume of discharges is not known. The number of reported oil pollution events that beached on the shoreline was respectively two, three and one in 2010, 2011 and 2012. However, because light oils disperse relatively quickly, a true picture of spills and the extent of spills is not known.

The overall geographical pattern indicates that the majority of oil discharges occurred in the smaller harbours and their surrounding areas. In 2010, 37% of incidents were reported in the open sea, with 12% in 2011, and 51% in 2012. The number of incidents reported for the open sea should be treated cautiously, as the Coast Guard has no dedicated aerial surveillance capability and depends on reports from shipping and commercial traffic. The number of reported incidents concerning offshore oil or gas installations remained similar to previous years (two in 2010, one in 2011 and five in 2012) (**Table 5-11**). Details of pollution incidents reported to the Irish Coastguard over the current assessment period are shown in Table **5-12**.

	Mineral Oil	Garbage	Sewage	Chemicals	Other Substances	Other*	Threats**	Total
2010	29	-	-	2	13			46
2011	16	-	-	-	6	19		41
2012	24	-	-	3	4		16	47

* Reported incidents including ship casualty, where pollution reports were investigated but reports could not be verified.

** Threats are incidents generating Coast Guard Pollution reports, such as a grounding, vessels not under command, tows, etc., but with no actual pollution.

Table 5-9. The total number of incidents reported by category of pollution in the Irish Exclusive Economic Zone from 2010 to 2012.

	Open Sea	Tidal River/ Estuary	Bay/near shore waters	Beach/ Shore	Port/ Harbour	Other*	Total
2010	17	4	9	10	6		46
2011	5	4	3	4	6	19	41
2012	24	2	5	4	12		47

* Reported incidents including ship casualty, where pollution reports were investigated but reports could not be verified.

Table 5-10. The distribution of received reports of pollution in 2010, 2011 and 2012 by marine environmental zone within the Exclusive Economic Zone.

	Shore	Unknown	Fishing Vessel	Oil Tanker	Cargo Vessel	Offshore Oil/Gas Installation	Pleasure Craft	Wreck	Dredger
2010	5	13	17	1	3	2	4	1	-
2011	3	8	5	-	2	1	2	1	-
2012	3	18	10	-	10	5	1	-	-

Table 5-11. The breakdown of pollution sources in 2010, 2011 and 2012.

Location	Year	Vessel	Incident	Outcome
Dublin Port	2012		An estimated spill of 5t of heavy oil.	Spill was contained within the port and Pollution and Water Services attended on behalf of the Port.
Irish Exclusive Economic Zone	2012	MSC Flaminia	Vessel caught fire in mid-Atlantic, with a number of containers lost overboard during an associated explosion.	At end of August, a number of containers from the casualty were reported adrift in the Irish Exclusive Economic Zone, some with residues of Hazardous and Noxious substances. Monitoring took place and assistance was given to salvage operators to locate and recover some of these.
Dingle Bay	2011	FV LeStiff	Vessel hit charted rock. Weather was favourable for dispersion.	Vessel not permitted to enter Dingle by harbour master due to pollution and no repair facilities. Vessel proceeded to Cork for dry dock. Lost 9t diesel from forward tanks and continued to lose up to 25t from mid-tank.
South-East of Helvick Head	2010	MV BG Dublin	7 containers lost overboard, one of which contained approx. 11t of a hazardous material.	Containers all sunk and contents started to come ashore. The hazardous material was Sodium Bromate which is soluble in water and the packaging was cardboard. There was no trace of this coming ashore. Extensive area of coastline showed signs of the other cargo (plastic containers, firelogs and surgical nappies) coming ashore, and local authorities were responsible for the clean-up.
Drogheda Harbour	2010	FV Ros Aine	Sunk	Booms were deployed to contain spill. The vessel was raised on the 12th and 450lts of diesel removed.

Table 5-12. Specific details of pollution incidents reported to the Irish coast guard between 2010-2012.

Conclusions

This chapter has provided one of the most comprehensive assessments of the environmental status of transitional and coastal waters ever undertaken. The analysis has shown that the vast majority of coastal waters (by surface area) are at good or high ecological status, indicating that these waters have the capacity to support ecologically healthy and diverse marine communities. The proportion of transitional waters at good and high status is considerably less, at 36% by number of water bodies and 45% by surface area, indicating the greater influence of human activity on this water category.

In terms of chemical status, the results to date indicate that the majority of transitional and coastal waters will be at good chemical status.

While nearly two-thirds (65.1%) of the designated shellfish areas monitored over the four-year period were compliant with the guide value for *Escherichia coli,* there were a number of non-compliant areas where more than 50% of the samples exceeded the guide value. The worst performing were Bannow Bay, Bantry, Dunmanus Inner, Kinsale, Tralee Bay, and Wexford Harbour Inner. It is likely that additional measures may be required to achieve the quality objectives for shellfish waters in these areas.

Radioactive substances from the nuclear reprocessing plant at Sellafield in England continue to be discharged to the Irish Sea, though exposure to these substances is not considered to pose a significant health risk to the Irish public.

Downward trends in nutrient loads to the marine environment are now apparent, with significant reductions in riverine nutrient inputs. This downward trend is also apparent in the reduction in nutrient sources, particularly from the agriculture sector, which has seen an 18.7% and 37.7% reduction in nitrogen and phosphorus sources respectively. The reduction in nutrient inputs is contributing towards an improvement in the trophic status of estuarine waters, as evidenced by the improvements seen in the Blackwater Estuary in recent years. A number of estuaries, however, mainly in the south-east and south of the country continue to display symptoms of nutrient enrichment and have been classed as eutrophic. The hydrological complexity and related sensitivity of these estuarine waters means that a thorough case-by-case characterisation of these estuaries will be required, to ensure that the most effective measures are put in place to improve their status.

6. CONCLUSIONS AND RECOMMENDATIONS

A comprehensive national environmental water monitoring programme is currently in place for assessing the condition of Ireland's groundwater, rivers, canals, lakes, transitional and coastal waters. The assessments, set out in the preceding chapters, provide a comprehensive picture of the quality of the groundwater and surface water bodies in the State for the period 2010-2012. The assessment is based on representative monitoring networks, including 336 groundwater monitoring sites, 3,051 river monitoring sites (13,300 km of channel length), 42 canal sites, 213 lakes, 193 transitional water bodies and 101 monitored coastal water bodies. These networks are used to assess the quantitative and chemical status of groundwater, and the ecological and chemical status of all surface waters in the State.

Nutrient enrichment

The most widespread water quality problem in Ireland continues to be elevated nutrient concentrations, arising primarily from human activities, such as agriculture and wastewater discharges to water from human settlements, including towns, villages and rural houses. There are two nutrients of concern, nitrogen and phosphorus. Excessive nutrient concentrations can lead to eutrophication impacts, including accelerated growth of algae and plants, leading to ecological impacts in rivers, lakes and marine waters, such as reduced oxygen levels and loss of sensitive species. Phosphorus tends to drive eutrophication impacts in freshwaters, while nitrogen tends to drive eutrophication impacts in coastal waters.

The water status assessment for 2010-2012 shows that 47% of rivers, 57% of lakes and 53% of estuarine and coastal water assessed were impacted primarily by the effects of nutrient enrichment[33]. These water quality problems tend to be greater in areas of intensive agriculture and where population densities are highest due to wastewater discharges to waters. There are areas of the country where 80% to 90% of the average surface water flow comes from groundwater, particularly during low flow conditions. Consequently, if the phosphorous or nitrogen concentrations in groundwater are elevated in these areas, then groundwater may contribute significantly to eutrophication downstream in rivers and lakes. There are catchment areas of the country, such as the south-east, where intensive agricultural practices have resulted in elevated nitrogen concentrations. These are causing eutrophication in some estuaries at the lower end of the catchments. In vulnerable karst limestone aquifers, in particular in the west, there is more potential for elevated phosphorus concentrations in groundwater due to the land spreading of fertilisers and septic tanks discharges. Therefore, groundwater may contribute to eutrophication in rivers and lakes in these areas.

The two most important suspected sources of pollution were agriculture and municipal wastewater discharges. It has been estimated, using the OSPAR PARCOM source apportionment method, that in 2012, the relative contribution of nitrogen and phosphorus to surface waters were mainly from agriculture (88% of nitrogen and 49% of phosphorus) and wastewater discharges (5% of nitrogen and 30% of phosphorus). These are annualised figures, and further consideration of contributions at times of highest biological activity will be needed, to determine which sources are causing water quality impacts in specific locations.

33 It should be noted that these figures represent global trends, and in reality, groups of water bodies in all categories and individual water bodies decline, improve and remain stable between assessment periods. The figures presented provide the net gains/losses between reporting periods.

Trends

The observed levels of nitrogen and phosphorus in groundwater, rivers, transitional waters and coastal waters have been mostly stable or decreasing since 2007. Both nitrate and phosphorus have shown significant decreases in groundwater, and the level of chemical status failures due to phosphorus had dropped from 13.6% to 1.5% between 2011 and 2014. Total oxidised nitrogen concentrations in rivers are stable or showing some degree of reduction. The greatest reductions in nutrients appear to be in the tillage and intensive agriculture areas in the South-East and Midlands. Phosphorus concentrations in rivers are stable in most parts of the country. The orthophosphate concentrations were less than the EQS for good ecological status (i.e. <0.025 mg/l P) threshold for approximately two-thirds of the rivers examined. These low levels are challenging to analyse in the laboratory, therefore it is difficult to demonstrate any significant trend between years. The greatest improvements have been observed in rivers where, in general, P values are around the good to moderate boundary (mean of 0.035 ug/l P). Over the same period, rivers have shown a 4% improvement in the high/good category to 73% of total channel length using the macroinvertebrate Q-Value assessment tool which is sensitive to eutrophication. Another welcome development has been the 2% increase in the number of sites at high status between 2009 and 2012 despite a steady decline since 1987. It is too early to determine if this improvement is a developing trend, and it will be important to track the number of high status sites on a continuing basis. This downward trend in nutrient inputs is also reflected in the reduction in nutrient sources, particularly from the agriculture sector, which has seen an 18.7% and 37.7% reduction in nitrogen and phosphorus sources respectively. Monitored loads also support these findings. The results of the Trophic Status Assessment for near-shore marine waters appear to also confirm an overall improvement in water quality, which was evident in the last report (2007-2009). Five fewer transitional water bodies have been classed as eutrophic (or potentially eutrophic) when compared to the previous assessment (2007-2009).

In relation to lakes, there was an overall 5% reduction (10 lakes) in the high or good status categories, and a corresponding increase in the moderate or worse status category compared to 2007-2009. The changes in status were generally as a result of changes in phosphorus concentrations. However, other factors, such as abstraction pressure, habitat limitations and the presence of alien species, may be impacting on status and requires further investigation.

The general decrease in nitrogen and phosphorus levels observed in groundwater, rivers and marine waters, and the associated reduction in eutrophication impacts, are welcome. However, the rate of improvement has been slow and the improvements are relatively modest. The progress is most likely due to better farming practices and improvements in the provision and management of wastewater infrastructure. Future risks which may threaten the modest improvements seen in recent years include the planned expansion in the agricultural sector under Food Harvest 2020, which may see increased applications of nutrients, as well as increased nutrient loadings to waters from municipal wastewater discharges due to population growth and increased numbers of connections from unsewered populations and industries to municipal wastewater treatment plants.

The future challenge will be to target management measures in such a way that will prevent any increases in nutrient levels in water, and which will accelerate further reductions to levels that will not cause eutrophication impacts. This can be most effectively done by taking an integrated catchment management-based approach, and understanding the connectivity between groundwater, rivers, lakes, transitional and coastal waters, as well as the landscape within the catchment area.

Hazardous substances

Overall, the level of non-compliances with Environmental Quality Standards for hazardous substances (including national specific pollutant standards and EU-wide priority and priority hazardous substance standards) is low in groundwater, rivers, lakes, transitional and coastal waters. The main exceedances were from metals in known, mineral-rich areas, particularly where mining has been carried out. A number of pesticides, including Mecoprop, MCPA and 2 4-D, were detected at low levels in a significant number of rivers (26%-56%) during routine monitoring. These require further investigation. Apart from two ubiquitous PBTs (mercury and PAHs), the amount of non-compliance with the Environmental Quality Standards for priority substances and priority hazardous substances is very low and not of significant concern. Further candidate priority substances / priority hazardous substances are currently being considered in a review at EU level. A number of pharmaceuticals are included for consideration. The likely presence and level of these substances in Irish waters needs to be investigated.

Other water quality indicators

Microbiological contamination of groundwater

With regard to other indicators of water quality, faecal contamination of groundwater continues to be a challenge, particularly in areas where groundwater is more vulnerable to pollution (particularly at spring monitoring locations) because they have little natural protection from organic inputs. Some monitoring points in karst limestone areas had faecal coliform counts greater than 100 cfu/100ml. Additional protection measures may be required for some drinking water sources in these areas.

Quality of designated shellfish waters

In relation to shellfish waters, an assessment of physico-chemical parameters (i.e. salinity, temperature, dissolved oxygen, pH and suspended solids) by the Marine Institute did not indicate any significant disturbance to the physico-chemical environment and their ability to support shellfish populations. In the case of faecal contamination, nearly two-thirds (65.1%) of the designated shellfish areas monitored over the four-year period were compliant with the guide value for Escherichia coli. However, of the remainder, there were a number of non-compliant areas where more than 50% of the samples exceeded the guide value. The worst performing were Bannow Bay, Bantry, Dunmanus Inner, Kinsale, Tralee Bay, and Wexford Harbour Inner. It is likely that additional measures may be required to achieve the quality objectives for shellfish waters in these areas.

Serious pollution of rivers

Serious pollution resulting from urban wastewater and industrial pollution was reduced to 17 km of river channel length. This was down from 53 km in the 2007-2009 period. There has also been a further decline in the number of fish kills to 70 reported in freshwaters (rivers and lakes) in the period under review (2010-2012) compared to 72 in the previous period (2007-2009). This is the lowest recorded to date, from a high of 235 in the 1980s.

Radioactivity in marine waters

Radioactive substances from the nuclear reprocessing plant at Sellafield in England continue to be discharged to the Irish Sea, though exposure to these substances is not considered to pose a significant health risk to the Irish public. In general, the levels of radioactive contamination present in the Irish marine environment are low.

Distance to target

47% of rivers, 57% of lakes, 55% of transitional waters and 7% of coastal waters require improvement to achieve satisfactory condition. This will require significant additional targeted action to achieve the objectives set out in the Water Framework Directive. In addition to achieving ecological health of aquatic ecosystems, focus will be required on ensuring that the public health requirements are also met. The contamination of groundwater with faecal coliforms in 51% of samples highlights the significant challenge facing the country to protect both public and private drinking sources. When taken together with the 35% of designated shellfish waters with elevated faecal contamination, it is clear that additional measures may be required to ensure that Ireland's waters are both healthy and safe.

Strengthening science

Ecological monitoring tools

As a result of the Water Framework Directive, ecological monitoring has required the development of assessment tools for assessing all biological elements in surface waters where relevant. These elements include phytoplankton, macrophytes and phytobenthos, macroalgae, angiosperms, benthic invertebrate fauna, and fish fauna. These elements often respond differently to a range of environmental pressures (e.g. organic pollution, chemical pollution, water abstraction and physical modification to surface waters), some being more sensitive to certain pressures than others. While a number of these elements have been used as indicators of environmental health for a long period of time, over 10 new ecological monitoring tools have had to be developed to date. Ecological monitoring tools also need to be benchmarked against other similar tools used across Europe through the formal intercalibration process. This means that far more comprehensive environmental assessments are now being carried out than in the past. There are still a number of tools which are under development (e.g. assessment tools for macrophytes and phytobenthos in rivers) but will be applied once finalised. Some tools (e.g. fish assessment tools) are new and may require further refinements as experience is gained in their use. It is not always clear what environmental pressures the new tools are responding to. For example, fish assessments downgraded the ecological status in 18% of rivers surveillance sites and also in the case of 20 monitored lakes. Similarly, a small number of marine water bodies were assigned poor status on the basis of the fish status assessments. These assessments did not appear to be responding to the impacts of pollution enrichment and may be caused by other environmental pressures, such as physical habitat modifications, barriers to migration, or abstraction pressures. These need to be evaluated further.

Hydromorphological and water abstraction pressures

Many surface waters (rivers, lakes, transitional and coastal waters) are regulated or have been modified to support flood protection, navigation, freshwater supply, or hydropower production. While the extent of these pressures is significantly less than in the rest of Europe (from 1% to 25% depending on the pressure concerned)[34], the ecological impacts of these physical modifications are poorly understood, and the extent to which these impacts can be effectively reversed or mitigated needs to be evaluated[35]. A number of hydromorphological assessment tools have been developed in collaboration with environmental agencies in the UK, for the purpose of WFD ecological status assessments. These include the River Hydromorphological Assessment Technique, the Lake Morphological Impact Assessment System tool and the TraC - Morphological Impact Assessment System tool for transitional and coastal waters. These are new tools which will require refinement following experience in their application. There

34 EU Commission (2012). Assessment of Ireland's River Basin Management Plans. SWD (2012) 379 Final.

35 http://www.reformrivers.eu/

is a need to review available scientific evidence regarding the relationship between pressures, such as physical habitat modifications and water abstraction/impoundment pressures, and their ecological impacts, using available environmental assessments information and reviewing available scientific evidence, both nationally and internationally.

Modelling the sensitivity of transitional and coastal waters to elevated nutrients

The improvement in the trophic status of estuarine waters, as evidenced by the improvements seen in the Blackwater Estuary in recent years, is due to the reduction in nutrient inputs. A number of estuaries, mainly in the south-east and south of the country, continue to display symptoms of nutrient enrichment and have been classed as eutrophic. The relative sensitivity of transitional and coastal waters to elevated nutrients will need to be assessed, to ensure that the right measures are put in place to improve their status. The response of systems to these measures depends not only on the direct relationships between nutrient loadings and primary productivity (benthic and pelagic) but also on a number of physiochemical and hydromorphological factors, such as the availability of light, residence time and nutrient cycling processes.

Bio-physical models, which incorporate these factors, have been tested successfully on a number of Irish transitional and coastal water bodies. These models can help identify the required nutrient reduction necessary to ensure a water body reaches its WFD objectives. Further modelling is needed.

Hazardous substances – emerging issues

As the review of priority substances and priority hazardous substances happens at EU level, the likely presence and level of these substances in Irish waters needs to be investigated. Pharmaceuticals in waters are likely to be an emerging environmental issue which needs to be addressed. A number of pesticides, including Mecoprop, MCPA and 2 4-D, were detected at low levels in a significant number of rivers (26%-56%) during routine monitoring. A more comprehensive review of the data and other evidence is required. Depending on the concentrations found, it may be necessary to consider regulating some of these substances during the next river basin planning cycle.

General recommendations

On the basis of the findings of this assessment of water quality in Ireland for the period 2010 to 2012, the following recommendations are made below. More specific recommendations are made in the earlier individual chapters of this report.

Implementing an integrated catchment management approach

The assessment of the quality of groundwater and surface waters in Ireland during the period 2010-2012 represents an important baseline for the preparation of the next (second) cycle river basin management plans. It provides an interim check on progress in achieving the objectives for water established in river basin management plans in 2010. At this stage, while the quality of waters is generally improving, the improvements are modest, and at the current rate of change, the targets set in the first river basin management plans are unlikely to be met. The target in the first cycle river basin management plans for surface waters was a 13.6% improvement in ecological status by 2015 from the 2009 baseline. This is unlikely to be achieved. For example, there was a 1% improvement in the number of river water bodies in satisfactory ecological status by 2012 (4% in terms of river channel length). However, the target for 2015 was an 18% improvement from the 2009 baseline.

While it may be necessary to adjust the objectives set in the first cycle river basin management plans for the second cycle, there are steps which can be taken to try and accelerate the rate of water quality improvements. This requires a more targeted approach to ensure that measures are focussed towards areas that will yield the greatest environmental improvements for the effort invested. An Integrated Catchment Management approach to assessing and managing the risks to water quality and condition from environmental pressures is the most appropriate approach. The catchment management approach ultimately seeks to identify the significant sources and critical source areas for nutrients in catchment areas where control measures can be targeted and implemented with maximum effect. The process is outlined in **Figure 6-1**. In this context, monitoring will be focussed to confirm and quantify environmental impacts and to track the effectiveness of programmes of measures implemented to bring about environmental improvements.

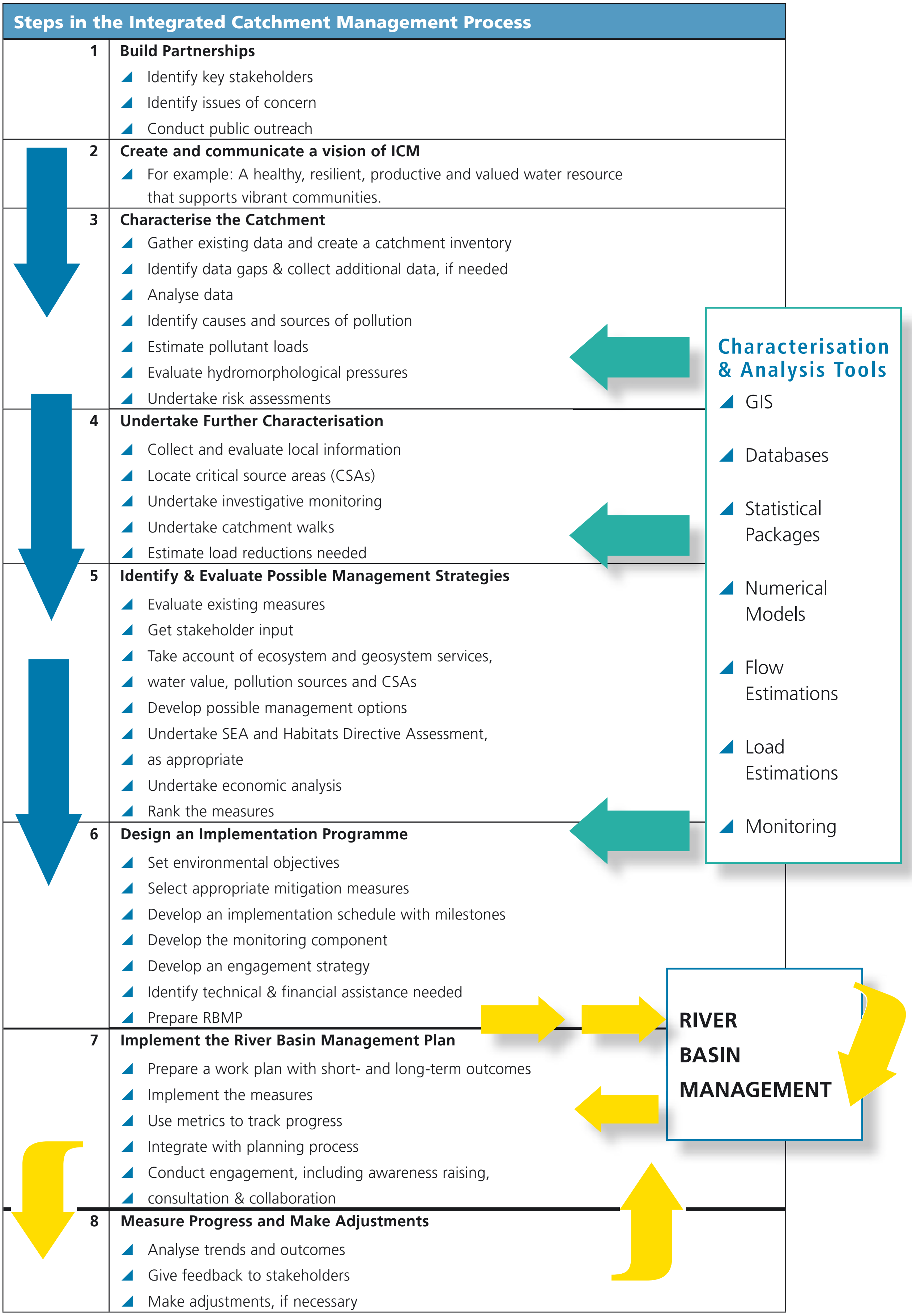


Figure 6-1. Integrated Catchment Management process. Daly et al (2014).

Integrated assessments

The monitoring and assessment of the condition of groundwater and surface waters has become more comprehensive, and continues to change as new monitoring tools are developed and refined. When taken together with the catchment-based risk assessments, they provide for the undertaking of more integrated environmental assessments. The move towards more integrated assessment is a welcome one, as it should facilitate the identification of more targeted management measures for the second cycle of river basin management planning and implementation.

Collaboration and co-ordination

A new governance framework has been put in place[36]. The framework is intended to provide far better clarity on who is responsible for undertaking the tasks involved in preparing and leading the implementation of river basin management plans. However, there are many other organisations involved in activities that have the potential to impact positively and negatively on the water environment, and it is important to include them in any broader approach to integrated catchment management. They include government departments, state agencies, local authorities, public and private organisations, NGOs, homes, and communities. The ability and capacity of public bodies to perform their statutory water protection and management duties creates the need for mechanisms to co-ordinate their activities, so that positive impacts can be promoted and negative ones mitigated. The establishment of the new goverance framework has included the following;

- The Minister of the Environment, Community and Local Government has established a new Water Policy Advisory Committee to assist in the making of plans, and to provide for a co-ordinated approach to implementation across government departments and Agencies.
- The Minister of the Environment, Community and Local Government has decided that a national approach will be taken to river basin planning.
- The EPA has established a National Implementation Group and a Catchment Management Network to foster information sharing and collaboration across public bodies and agencies in the development of the new plans.
- The Catchment Management Network is establishing working groups on a variety of topics, including characterisation, monitoring, and measures (actions to deal with issues), to ensure consistent action across organisations.
- Local Authorities have been given responsibility for regional co-ordination and engagement to progress the development and implementation of plans.

Collaboration and co-ordination of activities between government departments and state agencies will be critical to ensuring that the new governance arrangements are effective and ultimately support the achievement of water quality improvements.

36 2014 European Water Policy (Amendment) Regulations (SI 350 of 2014)

Reporting

The purpose of reporting on the condition of waters is firstly to inform on the progress or otherwise towards achieving good water status, and secondly, to inform action to address issues with water quality. In this context, the format of future reporting on the quality and condition of groundwater and aquatic ecosystems is likely to change significantly over the coming years. This is due to a number of drivers, including:

1. monitoring and assessment has become more comprehensive and continues to change as new monitoring tools are developed and refined,
2. the governance and the administrative structures for river basin planning, including the river basin districts, are being revised, and
3. a more integrated approach to assessment is needed to effectively protect and improve the status of waters.

The EPA is currently reviewing its reporting outputs on the aquatic environment so that future reporting on assessment provides information on both status and future action. The EPA intends to report more frequently on water status, as well as developing key indicators to support water management activities. Monitoring and assessment results for the period 2013-2015 will be published in 2016.

REFERENCES

Bowman, J.J., Clabby, K.J., Lucey, J., McGarrigle, M.L. and Toner, P.F. (1996). Water Quality in Ireland 1991-1994. Environmental Protection Agency, Wexford.

Clabby, K.J., Bowman, J.J., Lucey, J., McGarrigle, M.L., and Toner, P.F. (1992). Water Quality in Ireland 1987-1990. Environmental Research Unit, Dublin.

Clabby, K.J., Bradley, C., Craig, M., Daly, D., Lucey, J., McGarrigle, M., O'Boyle, S., Tierney, D. and Bowman, J. (2008). Water Quality in Ireland (2007-2009).

Collins, R., Brack, W., Lützhøft, H.-C.H., Eriksson, E., Bjerregaard, P., Boxall, A., Hutchinson, T., Adler, N., Kuester, A., Backhaus, T., Dubus, I. & Otto, R.L. (2011). Hazardous substances in Europe's fresh and marine waters: An overview. European Environment Agency, Copenhagen., ISBN 978-92-9213-214-9.

Craig, M. and Daly, D. (2010). Methodology for establishing groundwater threshold values and the assessment of chemical and qualitative status of groundwater, including an assessment of pollution trends and trend reversal. Environmental Protection Agency.

Currivan, L., Kelleher, K., McGinnity, P., Wong, J. and McMahon, C. (2013). A survey of tritium in Irish Seawater. Radiological Protection Institute of Ireland, Dublin.

Daly, D., Archbold, M. and Deakin, J. (2014). Water Framework Directive implementation and integrated Catchment Management. Where are we now? Where are we going? An EPA view. 2014 National Hydrology Conference.

EPA (Environmental Protection Agency). (2012). Online Rivers Interim Reports http://www.epa.ie/QValue/webusers/

EPA (Environmental Protection Agency) (2013) Focus on urban wastewater treatment in 2013. Environmental Protection Agency, Wexford.

EP (European Parliament) and CEU (Council of the European Union). (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (00/60/EC). Official Journal of the European Communities. L 327/1.

EPA (Environmental Protection Agency). (2006). EU Water Framework Directive Monitoring Programme. Prepared to meet the requirements of the EU Water Framework Directive (2000/60/EC) and National Regulations implementing the Water Framework Directive (S.I. No. 722 of 2003) and National Regulations implementing the Nitrates Directive (S.I. No. 788 of 2005). EPA. Wexford.

EPA (Environmental Protection Agency). (2010). Water Quality in Ireland 2007-2009,

http://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2007-2009.html

EPA (Environmental Protection Agency). (2012). Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources ((1/676/EEC), Article 10 Report for the Period 2008-2011

EPA (Environmental Protection Agency). (2011). Ecological Status and Chemical Status of Surface Waters and Chemical and Quantitative Status of Groundwaters. Prepared in fulfilment of Articles 24 and 25 of SI 272 of 2009.

http://www.epa.ie/pubs/reports/water/waterqua/waterframeworkstatusupdate.html

EPA (Environmental Protection Agency). (2013). Drinking Water Report 2013. EPA, Wexford.

EPA (Environmental Protection Agency). (2014). Focus on Urban Wastewater Discharges in Ireland in 2012. Environmental Protection Agency, Co. Wexford, Ireland.

European Commission. (2011). Links between the Water Framework Directive (WFD 2000/60/EC) and Nature Directives (Birds Directive 79/409/EEC and Habitats Directive 92/43/EEC).

European Commission. (2013). COMMISSION DECISION (2013/480/EU) of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC (notified under document C(2013) 5915)

European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).

European Environment Agency. (2012). European Environment Agency Indicators: Nutrients in water.

http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-3

European Environment Agency. (2013). Chemical Status Indicators for water across Europe

http://www.eea.europa.eu/data-and-maps/indicators/wfd-indicator-chemical-status/assessment

European Union (Drinking Water) Regulations. (2014). (S.I. No. 122 of 2014).

http://www.irishstatutebook.ie/pdf/2014/en.si.2014.0122.pdf

Flanagan, P.J. and Toner, P.F. (1972). The National Survey of Irish Rivers. A Report on Water Quality . An Foras Forbartha, Dublin.

Flanagan, P.J. and Toner, P.F. (1975). A Preliminary Survey of Irish Lakes. An Foras Forbartha, Dublin.

Flanagan, P.J. (1974). The National Survey of Irish Rivers. A Second Report on Water Quality. An Foras Forbartha, Dublin.

Geological Survey of Ireland. (2000). The Karst of Ireland, GSI, Dublin.

Howarth, R. W., & Marino, R. (2006). Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: evolving views over three decades. Limnology and Oceanography, 51(1part2), 364-376.

Kodeš, V., Bjerkeng, B., Fanta, M., Green, N., Noerrevang Jensen, J., Kova i , M., Künitzer, A., Ranneklev, S., Semerádová, S. (2013). Hazardous substances in European waters. European Environment Agency, Copenhagen, ISBN 978-80-85087-15-4.

Lalor, S.T.J., Coulter, B.S., Quinlan, G. and Connolly, L. (2010). A survey of fertiliser use in Ireland from 2004-2008 for grassland and arable crops. Teagasc, Johnstown Castle, Wexford.

Lennox, L.J. and Toner, P.F. (1980). The National Survey of Irish Rivers. A Third Report on Water Quality. An Foras Forbartha, Dublin.

Lucey, J., Bowman, J.J., Clabby, K.J., Cunningham, P., Lehane, M., MacCárthaigh, M., McGarrigle, M.L. and Toner, P.F. (1999). Water Quality in Ireland 1995-1997. Environmental Protection Agency, Wexford.

Marine Institute. (2013). An Assessment of the Bacteriological Quality of Shellfish Growing Waters Designated under Directive 2006/113/EC on the Quality Required of Shellfish Waters between 2009 and 2012. A report by the Marine Institute for the Department of Environment, Community and Local Government. February 2013.

McGarrigle, M.L., Bowman, J.J., Clabby, K.J., Lucey, J., Cunningham, M., MacCarthaigh, M., Keegan, M., Cantrell, B., Lehane, M., Clenaghan, C. and Toner, P.F. (2002). Water Quality in Ireland 1998-2000. Environmental Protection Agency, Wexford.

McGarrigle, M., J. Lucey and O'Cinneide, M. (2010). Water Quality in Ireland 2007-2009. *Environmental Protection Agency, Wexford:* 148.

McGinnity, P., Currivan, L., Dowdall, A., Hanley, O., Kelleher, K., McKittrick, L., Pollard, D., Somerville, S., Wong, J. and McMahon. C. (2012). Radioactivity Monitoring of the Irish Environment 2010-2011. Radiological Protection Institute of Ireland, Dublin.

McGovern E., McHugh B., O'Hea L., Joyce E., Tlustos C., and Glynn D. (2011). Assuring Seafood Safety: Contaminants and Residues in Irish Seafood 2004-2008. Marine Institute. Special Report ISBN 978-1-902895-48-2 http://oar.marine.ie/handle/10793/706

Met Éireann. (2009). Year Summary 2009, December 2009

http://www.met.ie/climate/MonthlyWeather/clim-2009-ann.pdf

Mitchell, F. and Ryan, M. (1986). The Shell Guide to Reading the Irish Landscape.

Ni Longphuirt, S., O'Boyle, S., Stengel, D. (2015). Environmental response of an Irish Estuary to changing land management practices. Submitted to Science of the Total Environment. 521 – 522, 388-399

O'Boyle, S., McDermott, G., Noklegaard, T., & Wilkes, R. (2013). A simple index of trophic status in estuaries and coastal bays based on measurements of pH and dissolved oxygen. *Estuaries and coasts*, 36(1), 158-173.

O'Boyle, S., McDermott, G. and Wilkes, R. (2009). "Dissolved oxygen levels in estuarine and coastal waters around Ireland." Marine pollution bulletin 58.11 (2009): 1657-1663.

O'Boyle, S., Wilkes, R., McDermott, G., Ní Longphuirt, S. and Murray, C. (2015). Factors affecting the accumulation of phytoplankton biomass in Irish estuaries and nearshore coastal waters: A conceptual model. Estuarine, Coastal and Shelf Science.

Scott, H.E., Aherne, J. & Metcalfe, C.D. (2012). Fate and transport of polycyclic aromatic hydrocarbons in upland Irish headwater lake catchments. The Scientific World Journal, 2012.

South Western River Basin District Project (2008). Heavily modified water bodies and artificial water bodies. Overall summary report. Available at: http://www.wfdireland.ie/docs/16_HeavilyModifiedAndArtificialWaterBodies/

Teagasc, Soil Geochemical Atlas of Ireland. http://erc.epa.ie/safer/iso19115/display?isoID=105

Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C. & Quinn, R. (2005). Water quality in Ireland. Environemental Protection Agency, Co. Wexford, Ireland.

Toner, P.F., Clabby, K.J,, Bowman, J.J, and McGarrigle, M.L. (1986). Water Quality in Ireland: The Current Position. Part one: General Assessment. An Foras Forbartha, Dublin.

UKTAG. (2008a). *Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Daughter Directive*. Paper 11b(i), UK Technical Advisory Group on the Water Framework Directive, pp 28. Report available on: http://www.wfduk.org/resources%20/paper-11bi-groundwater-chemical-classification-march-2012

Vaquer-Sunyer, R. and Duarte, C.M. (2008). "Thresholds of hypoxia for marine biodiversity." Proceedings of the National Academy of Sciences 105.40 (2008): 15452-15457.

Vignati, D.A., Polesello, S., Bettinetti, R., Bank, M.S. (2013). Mercury environmental quality standard for biota in Europe: Opportunities and challenges. Integrated Environmental Assessment and Management 9, 167–168.

Wilson, J.G., Minchin, D., McHugh, B., McGovern, E. and Giltrap, M. (2014). Imposex in Dogwhelks (Nucella lapillus) around the Irish coast as an indicator TBT pollution effects: current status and trends. A report prepared for the Environmental Protection Agency, Wexford, Ireland. p. 25

WPAC (Water Pollution Advisory Council). (1983). A Review of Water Pollution in Ireland. A Report to the Council by An Foras Forbartha. Water Pollution Advisory Council, Dublin.

ACRONYMS

2, 4-D	2,4-Dichlorophenoxyacetic acid
AA	Annual Average
AA-EQS	Annual Average-Environmental Quality Standard
AWB	Artificial Water Body
BAC	Background Assessment Concentration
BOD	Biochemical Oxygen Demand
CFU	Colony Forming Unit
COD	Chemical Oxygen Demand
CSA	Critical Source Area
DEHP	Di(2- ethylhexyl)- phthalate
DIN	Dissolved Inorganic Oxygen
DO	Dissolved Oxygen
EEA	European Environment Agency
EPA	Environmental Protection Agency
EQS	Environmental Quality Standard
EQS	Environmental Quality Standard
ERBD	Eastern River Basin District
EU	European Union
FCS2	Fish Classification Scheme 2
GEP	Good Ecological Potential
GIS	Geographical Information System
GPC	General Physico-Chemical
GSI	Geological Survey of Ireland
GWDTE	Groundwater Dependent Terrestrial Ecosystem
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HMWB	Heavily-Modified Water Bodies
IAS	Invasive Alien Species
IFI	Inland Fisheries Ireland
LOD	Limit of Detection
LoQ	Limit of Quantification
MAC	Maximum Allowable Concentration
MEP	Moderate Ecological Potential
MCPA	2-methyl-4-chlorophenoxyacetic acid
Mecoprop	methylchlorophenoxypropionic acid
MP	Monitoring Programme
MPN	Most Probable Number

MRP	Molybdate Reactive Phosphorous
NWIRBD	North-Western International River Basin District
OOAO	One-Out-All-Out
OSPAR	Oslo Paris Convention
PAH	Polyaromatic Hydrocarbon
PHS	Priority Hazardous Substances
PSA	PARCOM Source Apportionment
PWS	Public Water Supply
RBD	River Basin District
RBMP	River Basin Management Plan
SERBD	South-Eastern River Basin District
SFPA	Sea Fisheries Protection Authority
SIRBD	Shannon International River Basin District
SWRBD	South-Western River Basin District
TBT	Tributyl Tin
TON	Total oxidised nitrogen
TP	Total phosphorous
TraC-MImAS	Transitional and Coastal Waters, Morphological Impact Assessment System
UKTAG	UK Technical Advisory Group
uPBT	Ubiquitous Persistent, Bio-accumulative and Toxic Substances
UWWTD	Urban Wastewater Treatment Directive
VOC	Volatile Organic Compound
WFD	Water Framework Directive
WRBD	Western River Basin District

APPENDIX 1

Priority and priority hazardous substances in Rivers (2007-2012)

Substance	Period of monitoring	Number of river sites monitored	Number of rivers sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of rivers sites exceeding the Maximum Allowable Concentration (MAC)
Priority substances					
Alachlor	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Atrazine	2007-2009	118	0	0	0
	2010-2012	79	0	0	0
Benzene	2007-2009	212	0	0	0
	2010-2012	68	0	0	0
Carbon-tetrachloride	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Chlorfenvinphos	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Chlorpyrifos (Chlorpyrifos-ethyl)	2007-2009	180	0	0	0
	2010-2012	19	0	0	0
Cyclodiene pesticides: Aldrin, Dieldrin, Endrin and Isodrin	2007-2009	180	0	0	NA
	2010-2012	nm	-	-	-
DDT total para-para-DDT	2007-2009	180	0	0	NA
	2010-2012	nm	-	-	-
1,2-Dichloroethane	2007-2009	212	0	0	NA
	2010-2012	69	0	0	NA
Dichloromethane	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Di(2-ethylhexyl)-phthalate (DEHP)	2007-2009	180	0	0	NA
	2010-2012	18	0	0	NA
Diuron	2007-2009	180	0	0	0
	2010-2012	79	0	0	0
Fluoranthene	2007-2009	180	0	0	0
	2010-2012	79	0	0	0
Isoproturon	2007-2009	180	3	1	3
	2010-2012	79	1	1	1
Lead and its compounds	2007-2009	327	18	18	NA
	2010-2012	203	13	13	NA
Naphthalene	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Nickel and its compounds	2007-2009	324	8	8	NA
	2010-2012	203	4	4	NA
Octylphenol ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	2007-2009	nm	-	-	-
	2010-2012	nm	-	-	-
Pentachloro-phenol	2007-2009	123	0	0	0
	2010-2012	19	2	1	2

Substance	Period of monitoring	Number of river sites monitored	Number of rivers sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of rivers sites exceeding the Maximum Allowable Concentration (MAC)
Priority substances					
Simazine	2007-2009	194	0	0	0
	2010-2012	79	0	0	0
Tetrachloro-ethylene	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Trichloro-ethylene	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Trichloro-benzenes	2007-2009	212	0	0	NA
	2010-2012	68	0	0	NA
Trichloro-methane	2007-2009	212	2	2	NA
	2010-2012	68	0	0	NA
Trifluralin	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-

Substance	Period of monitoring	Number of river sites monitored	Number of rivers sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of rivers sites exceeding the Maximum Allowable Concentration (MAC)
Priority Hazardous Substances					
Anthracene	2007-2009	180	0	0	0
	2010-2012	79	0	0	0
Cadmium and its compounds[2]	2007-2009	312	8 4	5	7
	2010-2012	204	114	11	5
C10-13 Chloroalkanes[3]	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Endosulfan	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Hexachloro-benzene	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Hexachloro-butadiene	2007-2009	180	1	1	1
	2010-2012	68	0	0	0
Hexachloro-cyclohexane	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-
Nonylphenol (4-Nonylphenol)	2007-2009	66	0	0	0
	2010-2012	nm	-	-	-
Pentachloro-benzene	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-

Substance	Period of monitoring	Number of river sites monitored	Number of rivers sites confirmed as exceeding an EQS (either AA or MAC)	Number of river sites exceeding the Annual Average (AA) EQS	Number of rivers sites exceeding the Maximum Allowable Concentration (MAC)
Ubiquitous PBTs					
Brominated diphenylether	2007-2009	180	0[2]	0[2]	NA
	2010-2012				
Mercury and its compounds	2007-2009	251	0[3]	0[3]	0[3]
	2010-2012	197	0[3]	0[3]	0[3]
Polyaromatic hydrocarbons (PAHs)	2007-2009				
-Benzo(a)pyrene		180	0	0	5
-Benzo(b)fluor-anthene -Benzo(k)fluor-anthene	(Sum)	180	1	1	NA
-Benzo(g,h,i)-perylene -Indeno(1,2,3-cd)-pyrene	(Sum)	180	34[3]	34	NA
Polyaromatic hydrocarbons (PAHs)	2010-2012				
-Benzo(a)pyrene -Benzo(b)fluor-anthene	(Sum)	79	0	0	0
-Benzo(k)fluor-anthene		79	0	0	NA
-Benzo(g,h,i)-perylene -Indeno(1,2,3-cd)-pyrene	(Sum)	79	40	40	NA
Tributyltin compounds[3]	2007-2009	180	0	0	0
	2010-2012	nm	-	-	-

Notes:

1. NA = No MAC value applicable.
2. Limits of detection for this parameter are above the EQS threshold.
3. EQS in biota (trout and perch) are assessed on concentrations in μg kg-1.

APPENDIX 2

The number of lakes, lake area and their respective percentages in each ecological status class is presented for each RBD and summarised at national level for the periods 2010-2012.

Ecological status							
RBD		**High**	**Good**	**Moderate**	**Poor**	**Bad**	**Total**
Eastern	Water bodies (number)	0	3	5	2	2	**12**
		0%	25%	41%	17%	17%	**100%**
	Area (km^2)	0	1	3	7	5	**16**
		0%	8%	17%	45%	30%	**100%**
South-Eastern	Water bodies (number)	0	0	4	1	0	**5**
		0%	0%	80%	20%	0%	**100%**
	Area (km^2)	0	0	<1	<1	0	**<1**
		0%	0%	71%	29%	0%	**100%**
South-Western	Water bodies (number)	3	8	7	3	0	**21**
		14%	38%	34%	14%	0%	**100%**
	Area (km^2)	4	33	9	2	0	**48**
		9%	70%	20%	1%	0%	**100%**
Shannon	Water bodies (number)	3	13	21	5	4	**46**
		7%	28%	45%	11%	9%	**100%**
	Area (km^2)	4	35	164	153	4	**359**
		1%	10%	46%	42%	1%	**100%**
Western	Water bodies (number)	13	26	12	5	2	**58**
		22%	45%	21%	9%	3%	**100%**
	Area (km^2)	28	164	79	128	2	**401**
		7%	41%	20%	32%	0%	**100%**
North-Western South-Western	Water bodies (number)	4	17	18	16	9	**64**
		6%	27%	28%	25%	14%	**100%**
	Area (km^2)	2	23	31	65	4	**125**
		1%	19%	25%	52%	3%	**100%**
Neagh Bann	Water bodies (number)	0	1	3	1	2	**7**
		0%	14%	43%	14%	29%	**100%**
	Area (km^2)	0	<1	<1	<1	4	**5**
		0%	2%	9%	2%	87%	**100%**
National total	Water bodies (number)	23	68	70	33	19	**213**
		11%	32%	33%	15%	9%	**100%**
	Area (km^2)	38	257	287	354	19	**955**
		4%	27%	30%	37%	2%	**100%**

APPENDIX 3

Priority and priority hazardous substances in lakes for 2007-2009 and 2010-2012. Several parameters not detected in the 2007-2009 monitoring were removed from subsequent programmes: nm = not measured; PBT = Persistent, Bio-accumulative, and Toxic.

Substance	Period of monitoring	Number of lakes monitored	Number of lakes confirmed as exceeding an EQS (either AA or MAC)	Number of lakes exceeding the Annual Average (AA) EQS	Number of lakes exceeding the Maximum Allowable Concentration (MAC)
Priority Substances					
Alachlor	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Atrazine	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Benzene	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Carbon-tetrachloride	2007-2009	74	0	0	NA[1]
	2010-2012	34	0	0	NA
Chlorfenvinphos	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Chlorpyrifos (Chlorpyrifos-ethyl)	2007-2009	nm	-	-	-
	2010-2012	19	0	0	0
Cyclodiene pesticides: Aldrin, Dieldrin, Endrin and Isodrin	2007-2009	74	0	0	NA
	2010-2012	nm	-	-	-
DDT total	2007-2009	74	0	0	NA
para-para-DDT	2010-2012	nm	-	-	-
1,2-Dichloroethane	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Dichloromethane	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Di(2-ethylhexyl)-phthalate (DEHP)	2007-2009	74	0	0	NA
	2010-2012	19	0	0	NA
Diuron	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Fluoranthene	2007-2009	74	0	0	0

Substance	Period of monitoring	Number of lakes monitored	Number of lakes confirmed as exceeding an EQS (either AA or MAC)	Number of lakes exceeding the Annual Average (AA) EQS	Number of lakes exceeding the Maximum Allowable Concentration (MAC)
Priority Substances					
	2010-2012	34	0	0	0
Isoproturon	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Lead and its compounds	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Naphthalene	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Nickel and its compounds	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Octylphenol ((4-(1,1′,3,3′-tetramethylbutyl)-phenol))	2007-2009	74	0	0	NA
	2010-2012	nm	-	-	-
Pentachloro-phenol	2007-2009	74	0	0	NA
	2010-2012	19	0	0	NA
Simazine	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Tetrachloro-ethylene	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Trichloro-ethylene	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Trichloro-benzenes	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Trichloro-methane	2007-2009	74	0	0	NA
	2010-2012	34	0	0	NA
Trifluralin	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-

Substance	Period of monitoring	Number of lakes monitored	Number of lakes confirmed as exceeding an EQS (either AA or MAC)	Number of lakes exceeding the Annual Average (AA) EQS	Number of lakes exceeding the Maximum Allowable Concentration (MAC)
Priority Hazardous Substances					
Anthracene	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Cadmium and its compounds	2007-2009	74	0	0	0
	2010-2012	34	1	1	1
C10-13 Chloroalkanes[2]	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Endosulfan	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Hexachloro-benzene	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Hexachloro-butadiene	2007-2009	75	0	0[2]	0
	2010-2012	34	0	0	0
Hexachloro-cyclohexane	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Nonylphenol (4-Nonylphenol)	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Pentachloro-benzene	2007-2009	74	0	0	NA
	2010-2012	nm	-	-	-

Substance	Period of monitoring	Number of lakes monitored	Number of lakes confirmed as exceeding an EQS (either AA or MAC)	Number of lakes exceeding the Annual Average (AA) EQS	Number of lakes exceeding the Maximum Allowable Concentration (MAC)
Ubiquitous PBTs					
Brominated diphenylether[2]	2007-2009	74	0	0	NA
	2010-2012	nm	-	-	-
Mercury and its compounds[2]	2007-2009	74	0	0	0
	2010-2012	34	0	0	0
Polyaromatic hydrocarbons (PAH)					
-Benzo(a)pyrene	2007-2009	74	1	0	1
	2010-2012	34	1	0	1
-Benzo(b) fluoranthene }sum -Benzo(k) fluoranthene	2007-2009	75	0	0	NA
	2010-2012	34	1	1	NA
-Benzo(g,h,i)-perylene }sum -Indeno (1,2,3-cd)-pyrene	2007-2009	75	1[2]	1	NA
	2010-2012	34	15	15	NA
Tributyltin compounds[2]	2007-2009	74	0	0	0
	2010-2012	nm	-	-	-
Priority Hazardous Substances in biota[3]					
Hexachlorobenzene	2012	21	0	NA	NA
Hexachloro-butadiene	2012	21	0	NA	NA
Mercury and its compounds	2012	21	21	NA	NA

Notes:

1. NA = No MAC value applicable.
2. Limits of detection for this parameter are above the EQS threshold.
3. EQS in biota (trout and perch) are assessed on concentrations in μg kg^{-1}.

APPENDIX 4

Summary of ecological status (2007-2012) - Transitional Waters

Ecological status								
RBD		**High**	**Good**	**Moderate**	**Poor**	**Bad**	**UA**	**Total**
Eastern	Water bodies (number)	0	0	10	1	0	0	11
		0%	0%	90.9%	9.1%	0%	0%	100%
	Area (km²)	0.0	0.0	12.5	3.0	0.0	0.0	15.5
		0%	0%	80.4%	19.6%	0%	0%	100%
South-Eastern	Water bodies (number)	0	1	14	3	1	0	19
		0%	5.3%	73.7%	15.8%	5.2%	0%	100%
	Area (km²)	0.0	0.8	54.0	22.1	3.0	0	79.9
		0%	1.0%	67.5%	27.7%	3.8%	0%	100%
South-Western	Water bodies (number)	3	9	24	5	0	3	44
		6.8%	20.5%	54.5%	11.4%	0%	6.8%	100%
	Area (km²)	3.3	90.5	59.5	9.1	0	0.1	162.5
		2.0%	55.7%	26.6%	5.6%	0%	0.1%	100%
Shannon	Water bodies (number)	0	7	6	1	0	3	17
		0%	41.2%	35.3%	5.9%	0%	17.6%	100%
	Area (km²)	0	136.6	124.5	0.2	0	0	261.3
		0%	52.3%	47.7%	0.1%	0.0%	0%	100%
Western	Water bodies (number)	20	16	14	1	1	18	70
		28.6%	22.9%	20.0%	1.4%	1.4%	25.7%	100%
	Area (km²)	25.7	96.1	31.0	0.0	0.1	0.2	153.1
		16.8%	62.8%	20.3%	0%	0.1%	0.2%	100%
North-Western	Water bodies (number)	4	8	4	3	0	4	23
		17.4%	34.8%	17.4%	13.0%	0%	17.4%	100%
	Area (km²)	1.4	22.5	46.2	62.0	0.0	0.3	132.3
		1.0%	17.0%	34.9%	46.9%	0%	0.2%	100%
Neagh Bann	Water bodies (number)	0	2	4	0	0	3	9
		0%	22.2%	44.5%	0%	0%	33.3%	100%
	Area (km²)	0.0	0.3	38.7	0.0	0.0	0.1	39.1
		0%	0.9%	99.0%	0%	0%	0.1%	100%
National total	Water bodies (number)	27	43	76	14	2	31	193
		14.0%	22.3%	39.4%	7.3%	1.0%	16.1%	100%
	Area (km²)	30.3	346.9	366.3	96.4	3.1	0.7	843.8
		3.6%	41.1%	43.4%	11.4%	0.4%	0.1%	100%

APPENDIX 5

Summary of ecological status (2007-2012) - Coastal Waters

Ecological status								
RBD		**High**	**Good**	**Moderate**	**Poor**	**Bad**	**UA**	**Total**
Eastern	Water bodies (number)	1 12.5%	4 50.0%	2 25.0%	0 0%	0 0%	1 12.5%	8 100%
	Area (km²)	117.7 30.9%	244.0 64.2%	6.9 1.8%	0.0 0%	0.0 0%	11.8 3.1%	380.4 100%
South-Eastern	Water bodies (number)	2 25.0%	3 37.5%	3 37.5%	0 0%	0 0%	0 0%	8 100%
	Area (km²)	804.1 78.4%	68.4 6.7%	153.0 14.9%	0.0 0%	0.0 0%	0.0 0%	1025.6 100%
South-Western	Water bodies (number)	6 27.3%	9 40.9%	6 27.3%	0 0%	0 0%	1 4.5%	22 100%
	Area (km²))	2865.8 79.8%	528.9 14.7%	185.7 5.2%	0.0 0%	0.0 0%	10.9 0.3%	3591.3 100%
Shannon	Water bodies (number)	7 58.3%	2 16.7%	0 0%	1 8.3%	0 0%	2 16.7%	12 100%
	Area (km²)	871.7 71.3%	350.8 28.7%	0.0 0%	0.2 0.02%	0.0 0%	0.1 0.01%	1222.8 100%
Western	Water bodies (number)	14 53.9%	6 23.1%	3 11.5%	0 0%	0 0%	3 11.5%	26 100%
	Area (km²)	3606.7 77.9%	947.1 20.5%	50.7 1.1%	0.0 0%	0.0 0%	23.5 0.5%	4628.1 100%
North-Western	Water bodies (number)	1 5.0%	11 55.0%	7 35.0%	0 0%	0 0%	1 5.0%	20 100%
	Area (km²)	16.3 0.8%	1882.6 90.4%	147.3 7.1%	0.0 0%	0.0 0%	36.3 1.7%	2085.4 100%
Neagh Bann	Water bodies (number)	2 40.0%	0 0%	1 20.0%	0 0%	0 0%	2 40.0%	5 100%
	Area (km²)	166.8 42.3%	0.0 0%	44.5 11.3%	0.0 0%	0.0 0%	182.8 46.4%	394.1 100%
National total	Water bodies (number)	33 32.7%	35 34.7%	22 21.8%	1 1.0%	0 0%	10 9.8%	101 100%
	Area (km²)	8449.1 63.4%	4021.8 30.2%	588.2 4.4%	0.2 <0.01%	0.0 0%	265.5 2.0%	13324.7 100%

APPENDIX 6

Summary of results for hazardous substances in Transitional waters (2010-2012)

Priority and priority hazardous substances in Transitional waters

Substance	Period of monitoring	Matrix (Note[2])	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Priority substances						
Alachlor #	2010-2012					
Atrazine	2012	Water	7	0	0	0
Benzene	2012	Water	7	0	0	0
Carbon-tetrachloride #	2010-2012					
Chlorfenvinphos #	2010-2012					
Chlorpyrifos (Chlorpyrifos-ethyl) *	2010-2012					
Cyclodiene pesticides: Aldrin, Dieldrin, Endrin and Isodrin ø	2010-2012					
DDT total	2010-2012					
para-para-DDT ø						
1,2-Dichloroethane	2012	Water	7	0	0	
Dichloromethane	2012	Water	7	0	0	
Di(2-ethylhexyl)-phthalate (DEHP) **	2012	Water	7	0	0	
Diuron	2012	Water	7	0	0	0
Fluoranthene	2012	Water	7	0	0	0
Isoproturon #	2010-2012					
Lead and its compounds ø	2012	Water	7	0	0	
Naphthalene	2012	Water	7	0	0	
Nickel and its compounds ø	2012	Water	7	0	0	
Octylphenol ((4-(1,1′,3,3′-tetramethylbutyl)-phenol))	2012	Water	7	0	0	
Pentachlorophenol #	2010-2012					
Simazine	2012	Water	7	0	0	0
Tetrachloroethylene ~	2010-2012					
Trichloroethylene ~	2010-2012					
Trichlorobenzenes	2012	Water	7	0	0	
Trichloromethane ~	2010-2012					
Trifluralin #	2010-2012					

Substance	Period of monitoring	Matrix (Note²)	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Priority Hazardous Substances						
Anthracene^Ø	2012	Water	7	0	0	0
Cadmium and its compounds^Ø	2012	Water	7	0	0	0
C10-13 Chloroalkanes #	2010-2012					
Endosulfan^Ø	2010-2012					
Hexachloro-benzene^Ø	2011-2012	Biota	20	0		0
Hexachloro-butadiene^Ø	2011-2012	Biota	20	0		0
Hexachloro-cyclohexane^Ø	2010-2012					
Nonylphenol (4-Nonylphenol)	2012	Water	7	0	0	0
Pentachloro-benzene^Ø	2010-2012					
Ubiquitous PBTs						
Brominated diphenylether^Ø	2010-2012					
Mercury and its compounds^Ø	2012	Water	7	0	0	0
	2011-2012	Biota	20	0		0
	2011-2012	Total	23	0	0	0
Polyaromatic hydrocarbons (PAHs)^Ø	2012	Water	7	0	0	
-Benzo(a)pyrene^Ø						
-Benzo(b)fluor-anthene^Ø						
-Benzo(k)fluor-anthene^Ø						
Sum of:	2012	Water	**7**	**Note 1**	**Note 1**	
-Benzo(g,h,i)-perylene^Ø						
-Indeno(1,2,3-cd)-pyrene^Ø						
Tributyltin compounds^Ø§	2010-2012					

Note 1 For sum of Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene LoQ (0.005)>EQS (0.002). However, all values in 2012 were reported as <0.005 µg l-1 . This LOQ was lowered in February 2013 to <0.002 µg l-1.

Note 2: Mussels are the preferred target sampling organism for biota monitoring in TCW. An agreed conversion methodology for assessing against fish-based EQS is required. This has not been implemented in the above assessment. It is clear that mercury levels would not comply with the EQS if sampled in fish at trophic level =4. HCB and HCBS, however, are present in mussels at levels far below the EQS.

* Substance analysed in biota

** Substance analysed in sediment

Ø analysed in biota and sediment

§ Monitoring of TBT-related biological effects was undertaken

Screened out of the monitoring programme

~ Included as part of VOC suite

Specific pollutants in Transitional waters

Substance	Period of monitoring	Matrix (Note²)	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Arsenic[Ø]	2012	Water	7	0	0	
Chromium III[2]	2012	Water	7	0	0	
Chromium IV	2012	Water	7	0	0	
Copper[Ø]	2012	Water	7	0	0	
Cyanide[#]	2010-2012					
Diazinon[#]	2010-2012					
Dimethoate[#]	2010-2012					
Fluoride[#]	2010-2012					
Glyphosate	2012	Water	7	0	0	
Linuron	2012	Water	7	0	0	0
Mancozeb[#]	2010-2012					
Monochlorobenzene[#]	2010-2012					
Phenol[#]	2010-2012					
Toluene	2012	Water	7	0	0	
Xylenes	2012	Water	7	0	0	
Zinc[Ø]	2012	Water	7	0	0	

[Ø] analysed in biota and sediment

[2] WFD SP Freshwater standard.

[#] Screened out of the monitoring programme

Note: Total Chromium is measured in water and biota

APPENDIX 7

Summary of results for hazardous substances in Coastal waters (2010-2012)

Priority and priority hazardous substances in Coastal waters

Substance	Period of monitoring	Matrix (Note[2])	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Priority substances						
Alachlor #	2010-2012					
Atrazine	2012	Water	7	0	0	0
Benzene	2012	Water	7	0	0	0
Carbon-tetrachloride #	2010-2012					
Chlorfenvinphos #	2010-2012					
Chlorpyrifos (Chlorpyrifos-ethyl)*	2010-2012					
Cyclodiene pesticides: Aldrin, Dieldrin, Endrin and IsodrinØ	2010-2012					
DDT total	2010-2012					
para-para-DDTØ						
1,2-Dichloroethane	2012	Water	7	0	0	
Dichloromethane	2012	Water	7	0	0	
Di(2-ethylhexyl)-phthalate (DEHP)**	2012	Water	7	0	0	
Diuron	2012	Water	7	0	0	0
FluorantheneØ	2012	Water	7	0	0	0
Isoproturon #	2010-2012					
Lead and its compoundsØ	2012	Water	7	0	0	
Naphthalene	2012	Water	7	0	0	
Nickel and its compoundsØ	2012	Water	7	0	0	
Octylphenol ((4-(1,1′,3,3′-tetramethylbutyl)- phenol))	2012	Water	7	0	0	
Pentachlorophenol #	2010-2012					
Simazine	2012	Water	7	0	0	0
Tetrachloroethylene ~	2010-2012					
Trichloroethylene ~	2010-2012					
Trichloro-benzenes	2012	Water	7	0	0	
Trichloro-methane ~	2010-2012					
Trifluralin #	2010-2012					

Substance	Period of monitoring	Matrix (Note2)	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Priority Hazardous Substances						
Anthracene^Ø	2012	Water	7	0	0	0
Cadmium and its compounds^Ø	2012	Water	7	0	0	0
C10-13 Chloroalkanes #	2010-2012					
Endosulfan^Ø	2010-2012					
Hexachlorobenzene^Ø	2011-2012	Biota	14	0		0
Hexachlorobutadiene^Ø	2011-2012	Biota	14	0		0
Hexachlorocyclohexane^Ø	2010-2012					
Nonylphenol (4-Nonylphenol)	2012	Water	7	0	0	0
Pentachlorobenzene^Ø	2010-2012					
Ubiquitous PBTs						
Brominated diphenylether^Ø	2010-2012					
Mercury and its compounds^Ø	2012	Water	7	0	0	0
	2011-2012	Biota	14	0		0
	2011-2012	Total	16	0	0	0
Polyaromatic hydrocarbons (PAHs)^Ø	2012	Water	7	0	0	0
Benzo(a)pyrene^Ø						
Benzo(b)fluor-anthene^Ø						
Benzo(k)fluor-anthene^Ø						
Sum of:	2012	Water	7	Note 1	Note 1	
Benzo(g,h,i)-perylene^Ø						
Indeno(1,2,3-cd)-pyrene^Ø						
Tributyltin compounds^Ø	2010-2012					

Note 1: For sum of Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene LoQ (0.005)>EQS (0.002). However, all values in 2012 were reported as <0.005 µg l-1 . This LOQ was lowered in February 2013 to <0.002 µg l-1.

Note 2: Mussels are the preferred target sampling organism for biota monitoring in TCW. An agreed conversion methodology for assessing against fish-based EQS is required. This has not been implemented in the above assessment. It is clear that mercury levels would not comply with the EQS if sampled in fish at trophic level =4. HCB and HCBS, however, are present in mussels at levels far below the EQS.

* Substance analysed in biota

** Substance analysed in sediment

^Ø analysed in biota and sediment

§ Monitoring of TBT-related biological effects was undertaken

\# Screened out of the monitoring programme

~ Included as part of VOC suite

Specific pollutants in Coastal waters

Substance	Period of monitoring	Matrix	Number of sites monitored	Number of sites confirmed as exceeding an EQS	Number of sites exceeding the Annual Average (AA) EQS	Number of sites exceeding the Maximum Allowable Concentration (MAC)
Arsenic[Ø]	2012	Water	7	0	0	
Chromium III[2Ø]	2012	Water	7	0	0	
Chromium V[I2Ø]	2012	Water	7	0	0	
Copper[Ø]	2012	Water	7	0	0	
Cyanide[#]	2011-2012					
Diazinon[#]	2011-2012					
Dimethoate[#]	2011-2012					
Fluoride[#]	2011-2012					
Glyphosate	2012	Water	7	0	0	
Linuron	2012	Water	7	0	0	0
Mancozeb[#]	2011-2012					
Monochlorobenzene[#]	2011-2012					
Phenol[#]	2011-2012					
Toluene	2012	Water	7	0	0	
Xylenes	2012	Water	7	0	0	
Zinc[Ø]	2012	Water	7	0	0	

[Ø] analysed in biota and sediment

[2] WFD SP Freshwater standard.

[#] Screened out of the monitoring programme

Note: Total Chromium is measured in water and biota

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú

- Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola (m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- an diantalmhaíocht (m.sh. muca, éanlaith);
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe (OGM);
- foinsí radaíochta ianúcháin (m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha);
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce

- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil (m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí).

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn

Taighde agus Forbairt Comhshaoil

- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta

- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn (m.sh. mórphleananna forbartha).

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas

- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol (m.sh. Timpeall an Tí, léarscáileanna radóin).
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta

- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Measúnú Comhshaoil
- An Oifig um Cosaint Raideolaíoch
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters
PO Box 3000,
Johnstown Castle Estate
County Wexford, Ireland

T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie
LoCall: 1890 33 55 99

Regional Inspectorate
McCumiskey House,
Richview, Clonskeagh Road,
Dublin 14, Ireland

T: +353 1 268 0100
F: +353 1 268 0199

Regional Inspectorate
Inniscarra, County Cork,
Ireland

T: +353 21 487 5540
F: +353 21 487 5545

Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny, Ireland

T +353 56 779 6700
F +353 56 779 6798

Regional Inspectorate
John Moore Road, Castlebar
County Mayo, Ireland

T +353 94 904 8400
F +353 94 902 1934

Regional Inspectorate
The Glen, Monaghan, Ireland

T +353 47 77600
F +353 47 84987

Regional Offices
The Civic Centre
Church St., Athlone
Co. Westmeath, Ireland
T +353 906 475722

Room 3, Raheen Conference Centre,
Pearse House, Pearse Road
Raheen Business Park, Limerick,
Ireland
T +353 61 224764

Printed on environmentally friendly paper stock