Report on the State of Implementation of the Nitrates Directive in the United Kingdom (Northern Ireland)

2012-2015

(In accordance with Article 10 of the Nitrates Directive (91/676/EEC))

August 2016

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Agri-Food and Biosciences Institute

Northern Ireland Environment Agency
www.doeni.gov.uk/niea

College of Agriculture, Food & Rural Enterprise

CONTENTS **Page No**

1. Water quality: monitoring, assessment and maps

The Department of Agriculture, Environment and Rural Affairs (DAERA) has responsibility for monitoring water quality which includes providing monitoring data collected from surface waters (rivers, lakes, transitional and coastal marine waters) and groundwaters across Northern Ireland. The 'Nitrates Directive Development Guidance Notes for Member States', issued in 2011, indicates that for the purposes of reporting, data may be averaged over more than one year. For the purposes of this report DAERA will use 2008-2011 to represent the previous reporting period and 2012-2015 to represent the current reporting period. The Water Framework Directive (2000/60/EEC) (WFD) 2015 classification data for Northern Ireland will also be used to assess eutrophication in both rivers and lakes, and transitional and coastal marine waters.

For the purposes of data comparison between the previous and current reporting periods, data within this report has been summarised and presented throughout Section 1 for both reporting periods 2008-2011 and 2012-2015. Summary data tables for 2008-2011 reporting period was previously supplied via ReportNet to the Commission in 2012.

In 2009, the surface freshwater monitoring network was revised to include broadening of the monitoring coverage in Northern Ireland under WFD for the six-year period 2009-2014. The proposal aimed to reduce the numbers of monitored sites from 579 to 528 whilst continuing to fulfil monitoring obligations under WFD, Freshwater Fish Directive (2006/44/EC) (FFD) and Nitrates Directive (91/676/EEC) (ND). Further financial constraints, however, have led to additional revisions of the surface freshwater monitoring network. In 2010, the new monitoring approach incorporated monthly sampling at a reduced number of core sites (258) with the remainder of sites (270) monitored for two years within the six-year River Basin Management Plans (RBMPs) cycle on a rolling programme basis (2009-2014). The average number of monthly samples analysed for nutrients reduced from 579 to an average of 348 in each year. Due to further current resources and budgetary constraints, changes to the monitoring programme were implemented in 2015 for the second six-year cycle of the RBMPs (2015-2021). Although WFD surveillance stations (monitoring sites) will continue to be sampled monthly, the remainder of the stations are sampled on a quarterly basis, i.e. four samples per year. In 2015, the average number of monthly samples analysed for nutrients was 157. 368 stations were monitored quarterly. The modifications to the monitoring network programme have also taken into account the need to ensure long-term reporting of nitrate and phosphorus concentrations in surface waters in Northern Ireland.

Groundwater monitoring from 2012-2015 was carried out at 56 monitoring sites. The groundwater monitoring sites are the same as those sampled for the WFD groundwater monitoring network in order to meet the requirements of that Directive. Within the groundwater monitoring network the Northern Ireland Environment Agency (NIEA) depends largely on third party owned groundwater boreholes to collect samples from sites, as there is little public drinking water supplies sourced from groundwater.

Transitional and coastal marine waters monitoring, prior to the current reporting period (2012-2015), used a network of localised eutrophication monitoring points in transitional and coastal marine waters which were associated with known pressures and specific areas of concern. These included licensed shellfish water points to address reporting of 'eutrophication' against existing legislative drivers such as the Nitrates Directive and the Urban Waste Water Treatment Directive (91/271/EEC) (UWWTD).

More recently the DAERA Marine and Fisheries Division established a network of monitoring sites to provide adequate coverage for assessment of nutrient enrichment of all Northern Ireland transitional and coastal marine water bodies to address the requirements of the WFD and other statutory drivers. Northern Ireland marine waters (both transitional and coastal) are now assessed for nutrient and ecological status using the WFD classification tools. The nutrient tool is based on the Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic) (OSPAR) criteria.

Structure of the water quality assessment chapter

The following sections in the water quality chapter present the assessment of water quality in Northern Ireland for all surface and groundwaters in accordance with the '*Nitrates Directive Development Guidance for Member States*', 2011. The chapter is divided into seven parts as follows:-

1.1. Assessment and classification of nitrate in groundwaters;
1.2. Assessment and classification of nitrate in surface freshwaters;
1.3. Assessment and classification of nitrate in coastal and transitional marine waters
1.4. Overview of assessment of eutrophic indicators in rivers, lakes and transitional and coastal marine waters;
1.5. Current overall WFD assessment of trophic status of rivers, 2012-2015;
1.6. Assessment of eutrophic indicators in lakes; and
1.7. Assessment of eutrophic indicators in transitional and coastal marine waters.

1.1. Assessment and classification of nitrate in groundwater

1.1.1. Groundwater monitoring network

Northern Ireland, in comparison with most of the rest of the UK has a particularly diverse and complex geology. The nature of the rocks and their associated geological 'history' is such that associated groundwater flow is predominately through fractures, concentrated in the upper part of the aquifer and discharging locally. These factors produce generally small, compartmentalised aquifers with fast groundwater through-flow which have, for the most part, only limited to moderate productivity with respect to water abstraction. The bedrock aquifers in Northern Ireland can be locally confined by glacial deposits. Superficial aquifers are also found in Northern Ireland – mostly in the form of sand and gravel or alluvial deposits which are generally restricted in their extent. For these reasons and for the purposes of this report, groundwater monitoring sites have not been categorised into any of the above mentioned types.

Groundwater quality in Northern Ireland is assessed in accordance with NIEA's groundwater monitoring programme through the collection of groundwater water samples from boreholes and springs that are mostly owned and operated by third parties. The public drinking water supply provider (Northern Ireland Water Ltd) does not currently utilise groundwater with the exception of Rathlin Island, a small island off the north coast of Northern Ireland. Hence, NIEA rely mostly on third party owned groundwater boreholes and the co-operation of land/property owners to continue sampling from their groundwater sources for chemical monitoring and analysis. This means that the groundwater monitoring network can change due to businesses closing or changing their groundwater usage and in addition datasets available for trend assessments can be small. The monitoring network consists mainly of industrial boreholes where groundwater is utilised for manufacturing or food/drinks production. A small number of springs or boreholes purpose-installed by NIEA are also monitored. The selection of monitoring sites to date has been based on a pressure-pathway assessment of the groundwater bodies and the availability of potential monitoring sites.

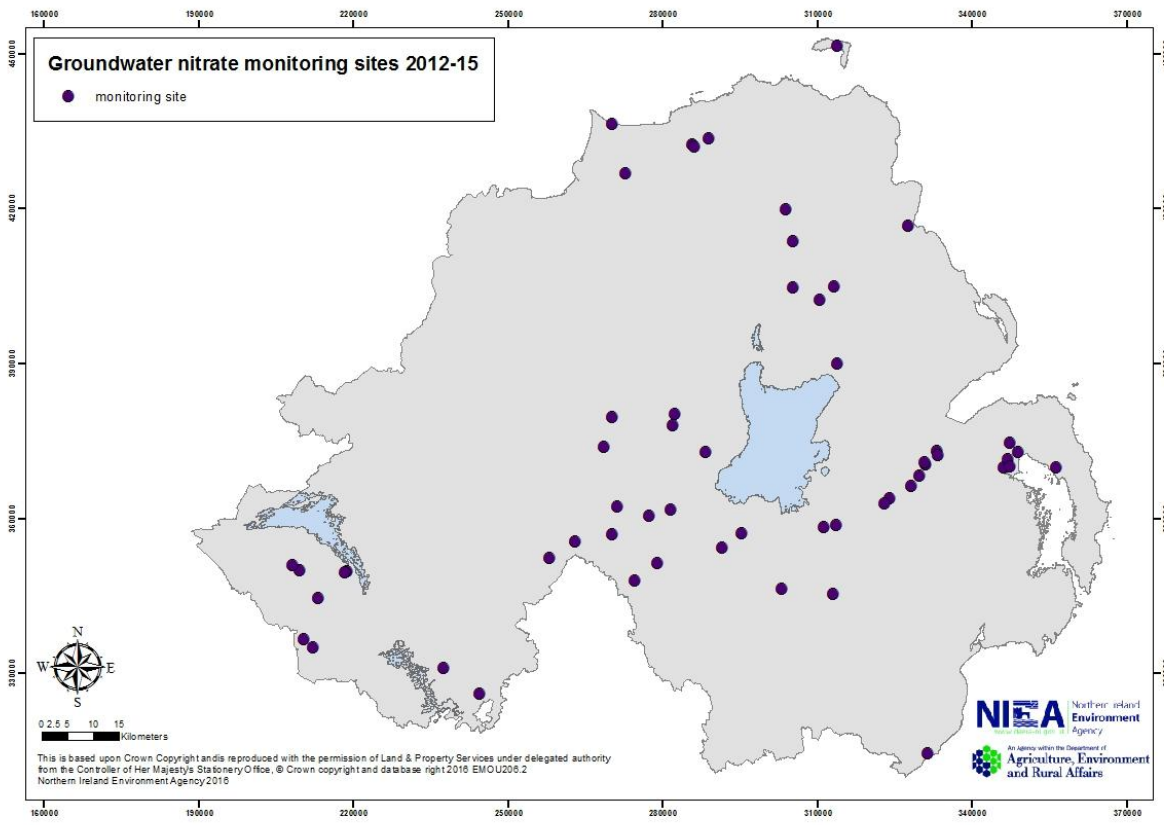
Regional monitoring of groundwater across Northern Ireland began in 2000. A major review of the groundwater monitoring network was undertaken in 2007 to ensure that the requirements of the WFD would be met. The modifications to the network have also taken into account the need to ensure long-term reporting of nitrate concentrations in groundwater across Northern Ireland.

In the previous Article 10 report (2008-2011) Northern Ireland presented groundwater data from 2008-2011. As discussed in the previous section, access to groundwater monitoring sites can be lost when business requirements change. Therefore, the numbers of monitoring sites presented in this report differs from the numbers previously reported in 2012. As a result of the changes to the monitoring network there are 35 sites monitored in the 2012-2015 reporting period which were also monitored in the 2008-2011 reporting period (see Table 1.1). For the purposes of this report groundwater monitoring data from 2012-2015 is compared with data from the previous reporting period (2008-2011).

Table 1.1: Numbers of groundwater monitoring sites for nitrate concentrations (NO_3 mg/l) in Northern Ireland

	Former reporting period: 2008-2011	Current reporting period: 2012-2015	Common sites monitored both in 2008-2011 and 2012-2015
Number of Groundwater monitoring sites	58	56	35

Figure 1.1: Location of groundwater monitoring sites: (2012-2015)



1.1.2. Evolution of nitrate concentrations (<u>NO_3 mg/l)</u> in groundwaters

During reporting period 2012-15, NIEA collected data on groundwater nitrate concentrations from 56 groundwater monitoring sites across Northern Ireland. For the purposes of this report all available data collected in the period 2012-15 was included to calculate the average and maximum nitrate concentrations.

Table 1.2 shows that, for the most part, monitored average nitrate concentrations for the previous reporting period 2008–2011 in groundwater in Northern Ireland were generally low. Results show that all 58 sites had an annual average of less than 40 mg/l NO_3 and 55 had less than 25 mg/l NO_3.

During the reporting period 2012-2015, NIEA collected data on groundwater nitrate concentrations from 56 monitoring sites sampled across Northern Ireland. The monitoring sites with at least five samples collected and which were also monitored within both reporting periods 2008-2011 and 2012-2015 were determined and the concentrations compared. A total of 35 groundwater monitoring sites were monitored during both reporting periods 2008-2011 and 2012-2015.

Table 1.2: Average and maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2008-2011 (numbers of groundwater monitoring sites)

	Numbers of monitoring sites (NO_3 mg/l)			
	0-24.99	**25-39.99**	**40-50**	**>50**
Groundwater annual average (NO_3 mg/l)	55	3	0	0
Groundwater annual maximum (NO_3 mg/l)	49	5	3	1

Tables containing the summary data collected during 2012-15 displaying, for each borehole, the average nitrate concentration and the measured maximum nitrate concentration are available at ReportNet. Links attached:

- ***http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate_Directive_NI_Final._NiD_GW_Conc.xml***
- **http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate_Directive_NI_Final._NiD_GW_AnnConc.xml**

Table 1.3: Average and maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2012–2015 (numbers of groundwater monitoring sites)

	Number of monitoring sites (NO_3 mg/l)			
	0-24.99	**25-39.99**	**40-50**	**>50**
Groundwater annual average (NO_3 mg/l)	55	0	0	1
Groundwater annual maximum (NO_3 mg/l)	53	2	0	1

Monitoring for the current reporting period 2012-2015 shows generally low nitrate concentrations with 55 of the 56 sites showing an annual average of less than 25 mg/l

NO_3. When maxima are considered, 53 of the 56 sites had concentrations less than 25 mg/l NO_3 (Table 1.3, Figures 1.2 and 1.3).

Nitrate concentrations are influenced by a range of factors including land use type, history and intensity, rainfall rates, soil types, the presence of glacial deposits providing some protection to the underlying water table and the small compartmentalised nature of the aquifers, as described in section 1.1.1. Northern Ireland is dominated by relatively poorly draining soils and low permeability glacial deposits which combine to reduce infiltration and offer opportunities for denitrification. Relatively high rainfall rates (mean annual rainfall 1,113 mm/yr; Betts, 1997) also act to reduce nitrate concentrations. Where nitrate concentrations are locally elevated this can coincide with superficial and bedrock aquifers which have some primary porosity potentially resulting in delayed release of nitrates to the water table via the unsaturated zone.

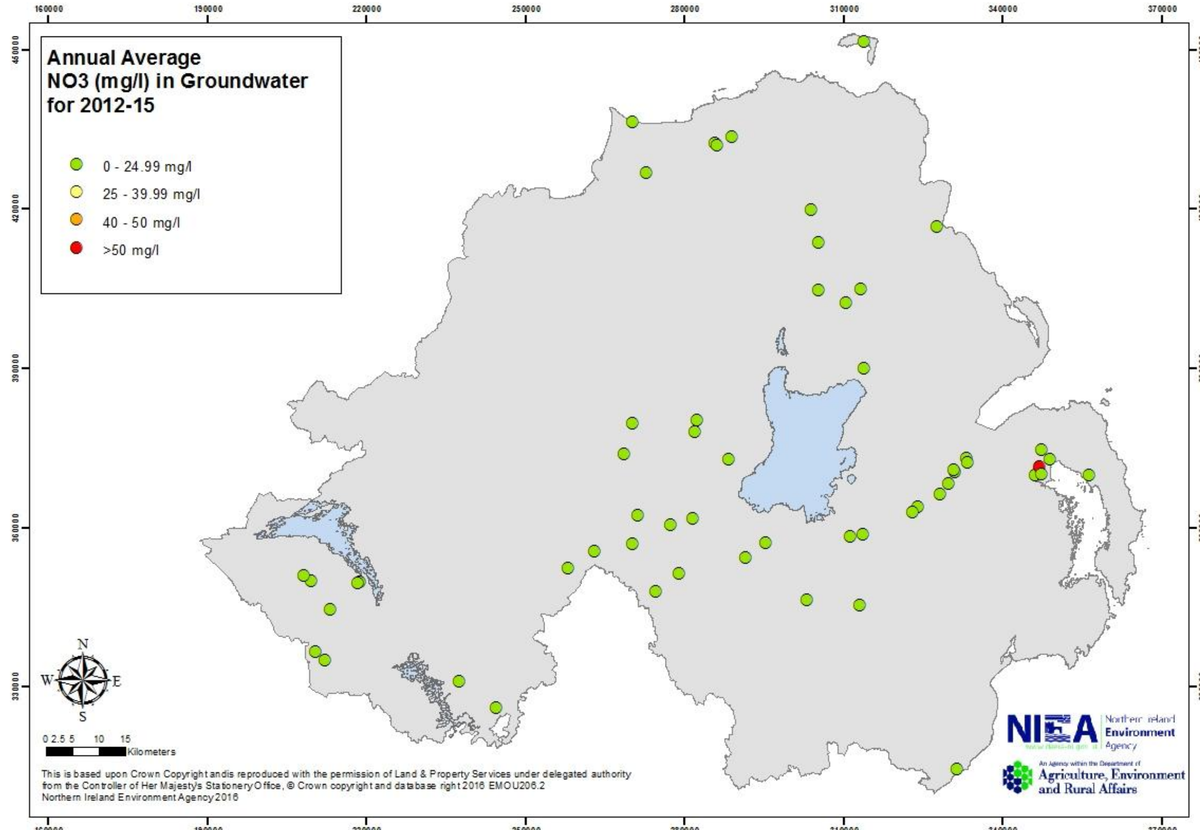


Figure 1.2: Annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2012-2015

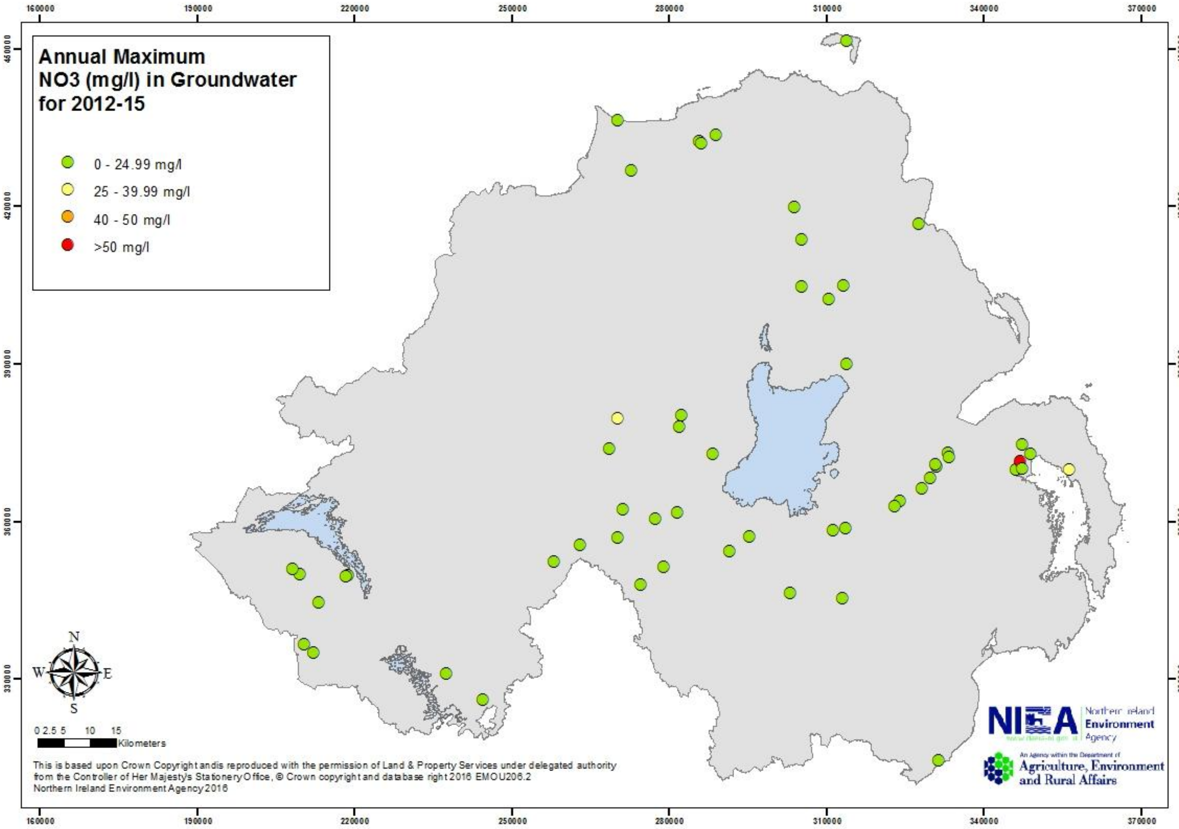


Figure 1.3: Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2012-2015

1.1.3. Changes in nitrate concentrations between previous and current reporting periods

The data in Table 1.4 and Figure 1.4 display the change between the average nitrate concentrations for the 35 common boreholes in the period 2008-2011 compared with concentrations in the period 2012-2015. Further details are available ont *ReportNet*.

***http://cdr.eionet.europa.eu/gb/eu/nid/*envv4izog//Nitrate_Directive_NI_Final._NiD_GW_Conc.xml**

Table 1.4: Changes in groundwater nitrate concentrations (NO_3 mg/l) based on annual average and maximum values for 2008-2011 and 2012-2015 reporting periods (number of ground water monitoring sites)

	Number of sites (based on mg/l difference)				
	<= -5 Strong decrease	>-5 to ≤ -1 Weak decrease	>-1 to ≤ + 1 Stable	>+1 to ≤ +5 Weak increase	> +5 Strong increase
Groundwater annual average	1	8	21	5	0
Groundwater annual maximum	5	10	6	11	3

Information on changes in average concentrations between the previous and current reporting periods indicates that 30 of the 35 sites experienced a decrease or stabilisation in groundwater nitrate concentrations.

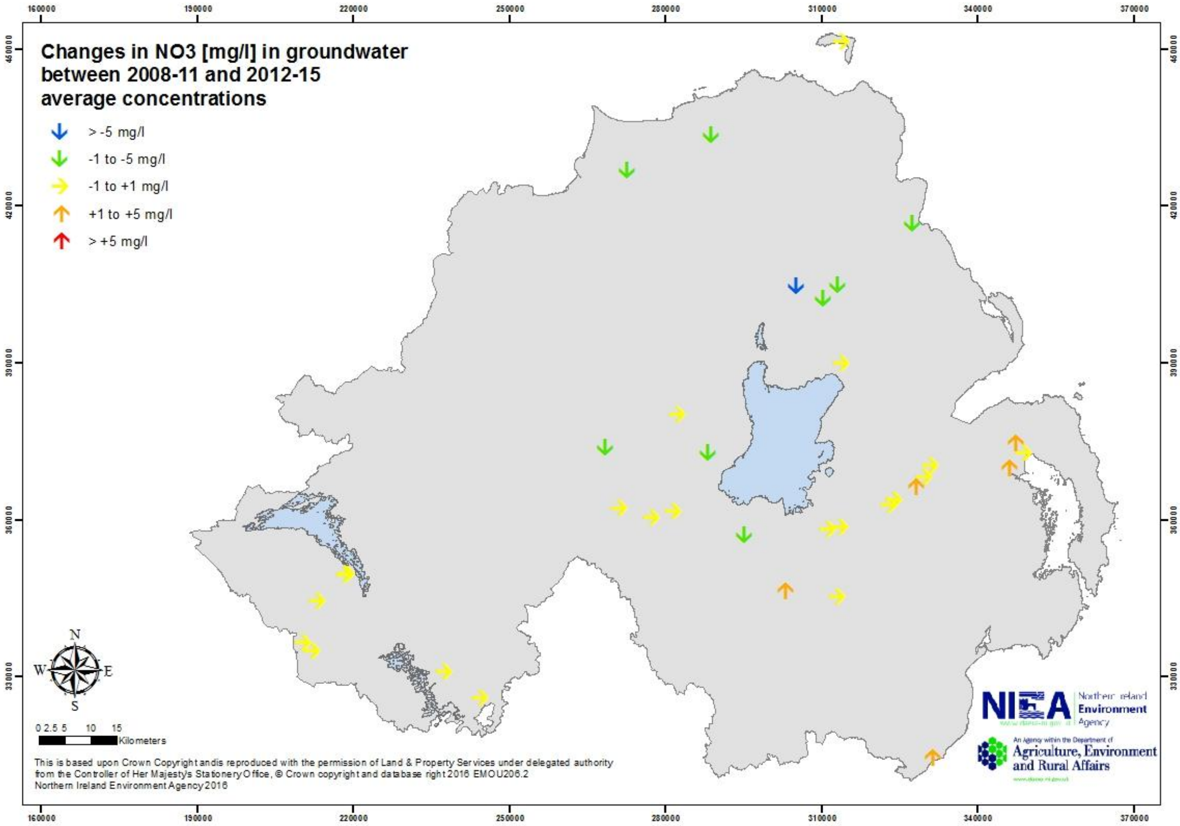


Figure 1.4: Change in annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites between previous and current reporting periods (negative values indicate a decrease).

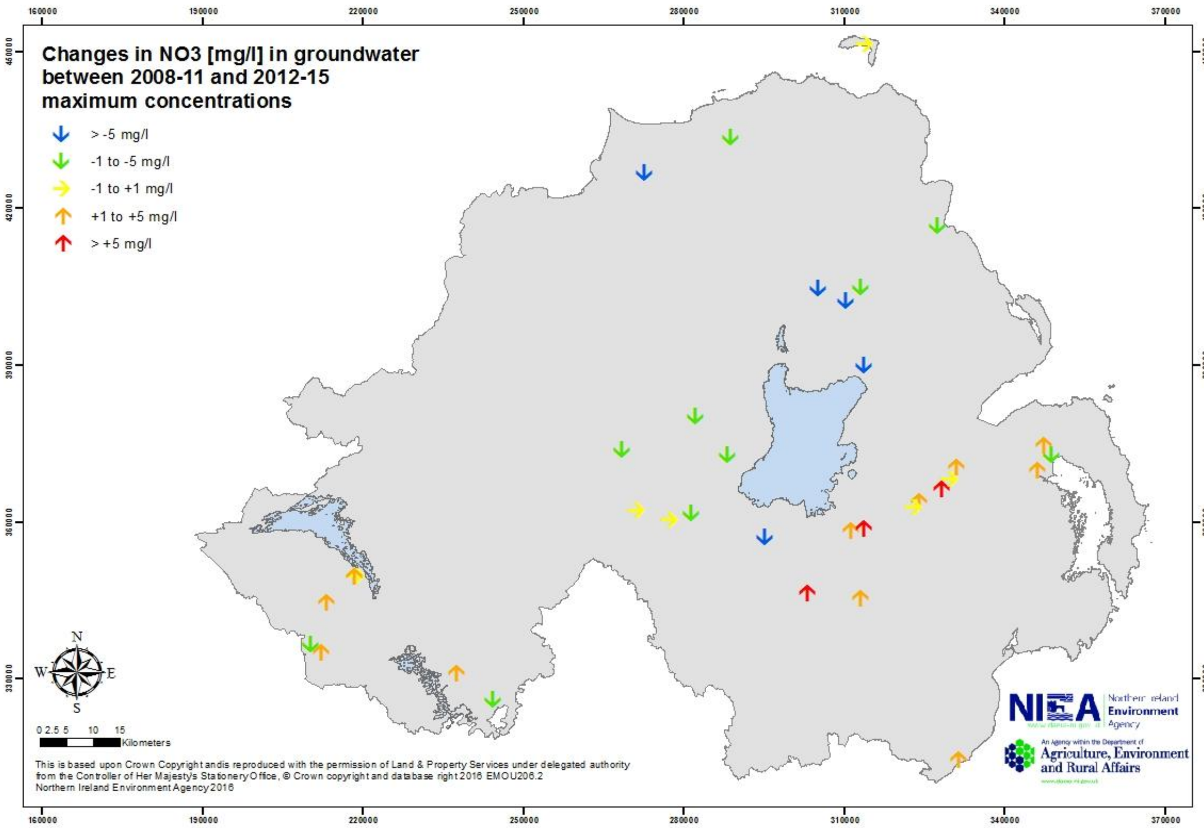


Figure 1.5: Change in annual maximum nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites between previous and current reporting periods (negative values indicate a decrease).

For groundwater monitoring stations where the annual maximum concentrations are above 25 mg/l an increased monitoring frequency will be introduced to observe concentrations and any possible trends in more detail. These stations will be subject to further investigation as actions within the relevant River Basin District (RBD) programme of target catchment projects under WFD.

1.2. Assessment and classification of nitrate in surface freshwaters

1.2.1. Surface freshwater monitoring network

In the previous Article 10 report (2008-2011) submitted to the EU Commission in 2012, Northern Ireland presented data for surface waters averaged over the four-year periods 2004-2007 and 2008-2011. In this report Northern Ireland is presenting surface water data averaged over the four-year periods 2008-2011 and 2012-2015. Therefore, the number of monitoring sites presented will differ from those previously reported.

Table 1.5: Numbers of surface freshwater monitoring sites for nitrate concentrations (NO_3 mg/l) in Northern Ireland

	Former reporting period: 2008-2011	Current reporting period: 2012-2015	Common points
Rivers	567	316	301
Lakes	27	21	20
Drinking Waters	28	0	0
Total	622	337	321

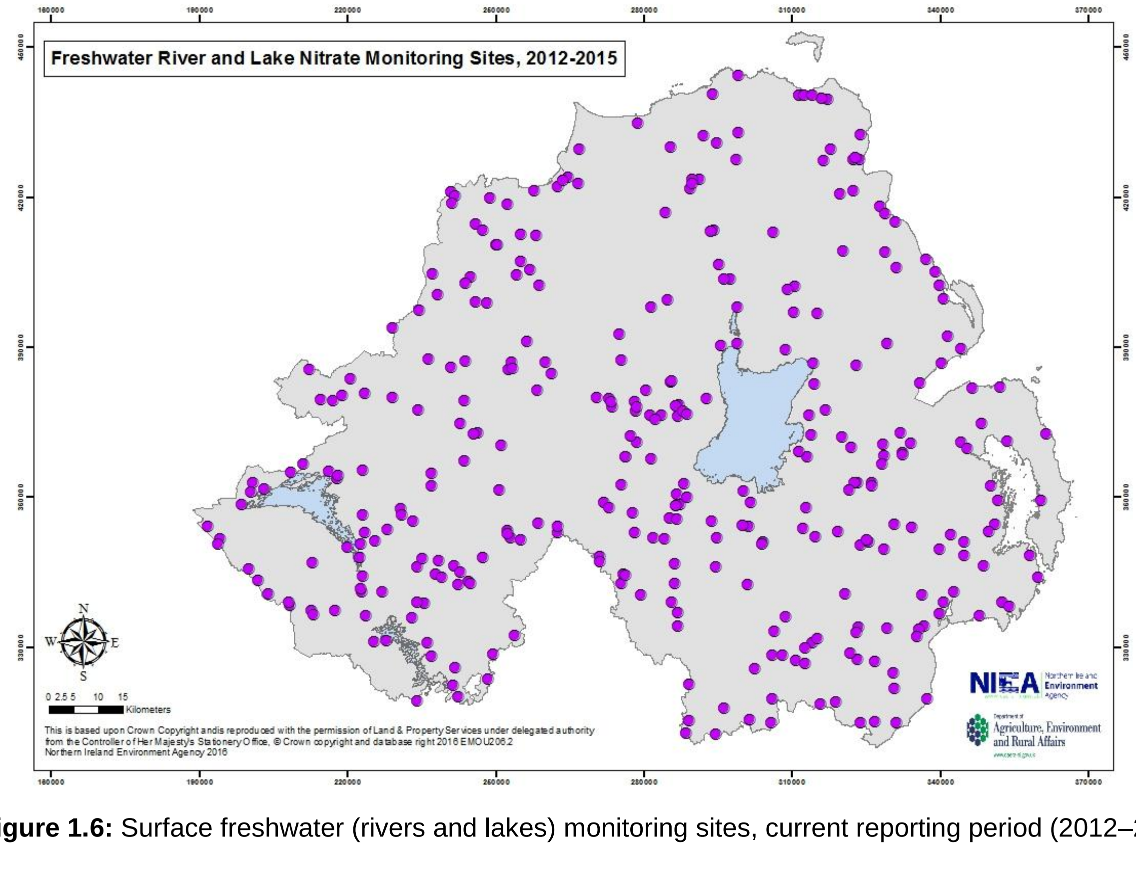


Figure 1.6: Surface freshwater (rivers and lakes) monitoring sites, current reporting period (2012–2015)

In the previous four-year reporting period (2008–2011) monitoring was carried out at 760 river and lake sites. Sufficient numbers of samples (i.e. >=20 samples for annual averages and >=10 samples for winter averages) over four years were available at 567 of the river sites, 27 lake sites and at 28 surface drinking water sites, giving a total of 622 sites. In the current four-year reporting period (2012–2015) monitoring was carried out at 632 river and lake sites. Sufficient numbers of samples over four years were available at

316 of the rivers' sites and 21 lake sites, giving a total of 337 sites (Table 1.5 and Figure 1.6).

1.2.2. Evolution of nitrate concentrations (NO_3 mg/l) in surface waters: rivers, lakes and surface drinking waters

Annual average, winter average and the maximum nitrate concentrations for both the previous reporting period and the current reporting period for river and lake sites are summarised in Tables 1.6 and 1.7 and shown in Figures 1.7–1.9.

In the period 2008–2011, data were presented for 622 surface freshwater sites. Table 1.6 shows that 99 % of surface water sites had an average nitrate concentration below 25 mg/l NO_3 with 89 % below 10 mg/l NO_3. When maxima were considered, 96 % of sites had concentrations less than 25 mg/l NO_3. The majority (99.8 %) of sites monitored over the winter period, of October to March each year, had concentrations less than 25 mg/l NO_3.

Table 1.6: Nitrate concentrations (NO_3mg/l) in rivers, lakes and surface drinking waters: 2008-2011 (% of sites)

	% of sites (NO_3 mg/l) (n=622)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Rivers, lakes and drinking waters annual average	29.1	60.3	10.5	0.2	0	0
Rivers, lakes and drinking waters winter average	23.1	62.3	14.5	0.2	0	0
Rivers, lakes and drinking waters maximum	8.4	51.1	36.7	3.2	0.5	0.2

From the period 2012-2015, data were presented for 337 surface freshwater river and lake sites. Table 1.7 and Figures 1.7–1.9 illustrate that 100 % of surface water sites have an average nitrate concentration below 25 mg/l NO_3 with 89 % being below 10 mg/l NO_3. The majority (99.7 %) of sites monitored over the winter period, of October to March each year, had concentrations less than 25 mg/l NO_3. When maxima were considered, 97 % of sites had concentrations less than 25 mg/l NO_3.

Table 1.7: Nitrate concentrations (NO_3 mg/l) in rivers and lakes: 2012-2015 (% of sites)

	% of sites (NO_3 mg/l) (n=337)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Rivers and lakes annual average	24.9	64.4	10.7	0	0	0
Rivers and lakes winter average	21.1	65.9	12.7	0.3	0	0
Rivers and lakes annual maximum	6.5	51.6	38.9	2.4	0.6	0

The tables containing the summary data collected monthly from the surface water monitoring network during 2012-2015 including, for each sampling site, the average nitrate concentration, the measured maximum nitrate concentration and the winter average nitrate concentrations in rivers and lakes are available on *ReportNet*.

http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate_Directive_NI_Final._NiD_SW_Conc.xml; and

http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate_Directive_NI_Final._NiD_SW_AnnConc.xml

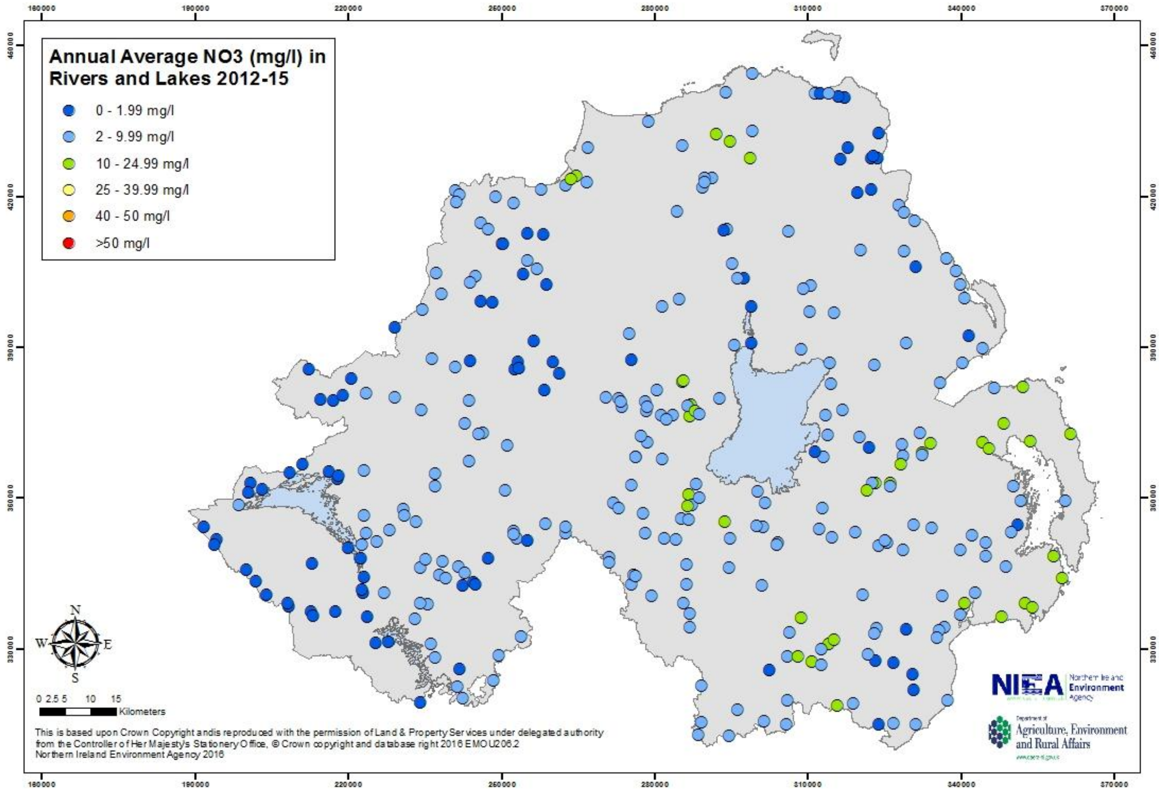


Figure 1.7: Annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2012–2015

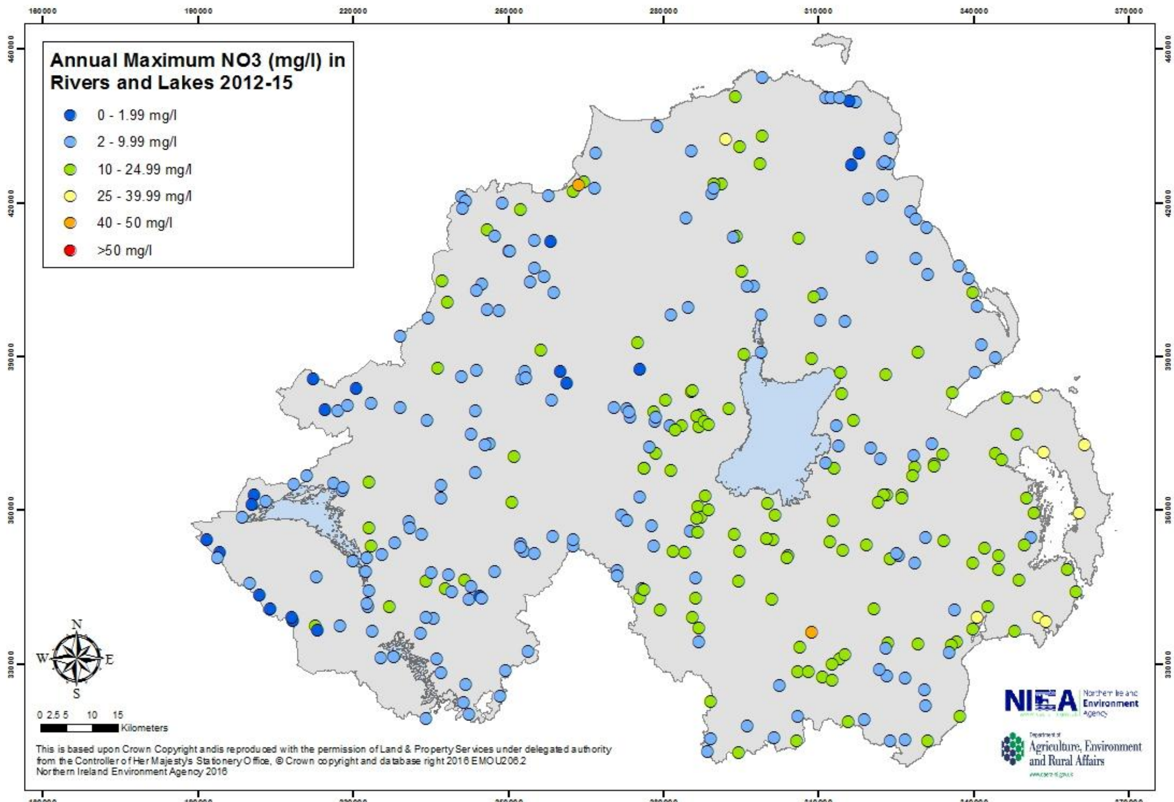


Figure 1.8: Annual maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2012–2015

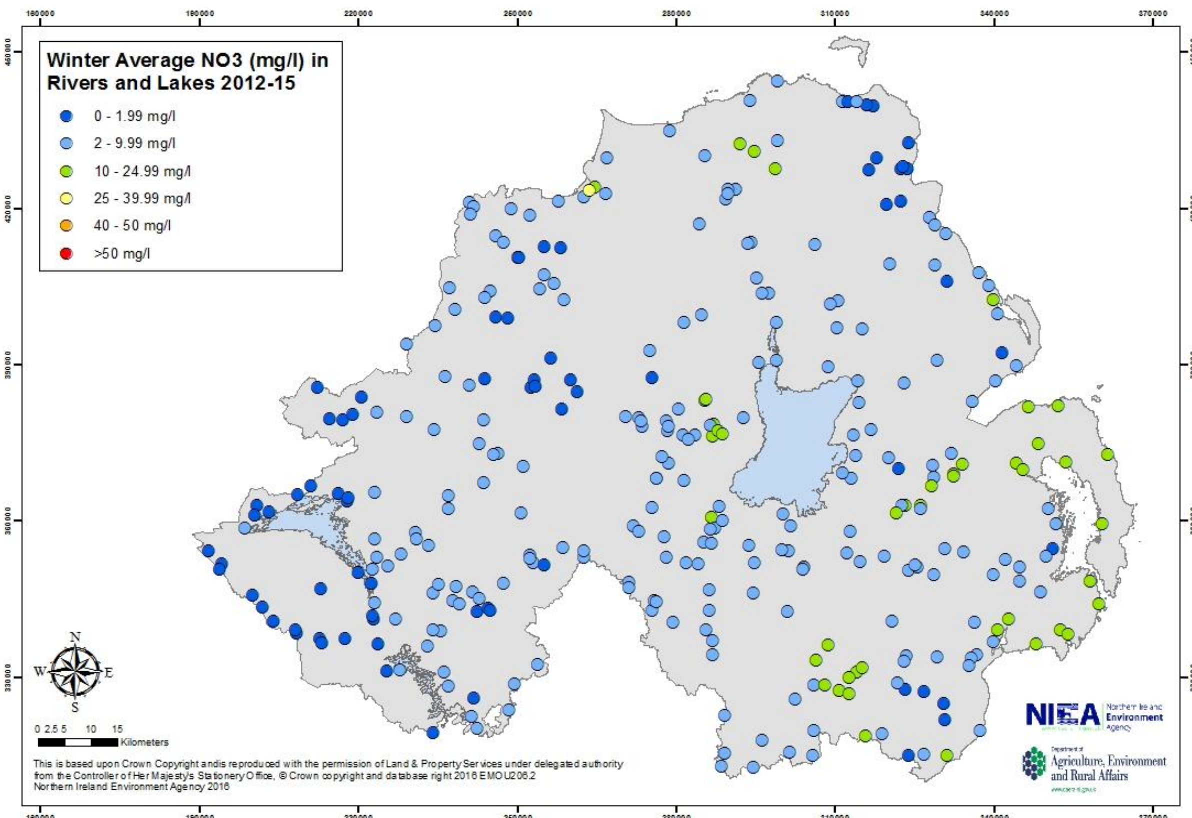


Figure 1.9: Annual winter nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2012–2015

1.2.3. Changes between previous and current reporting periods

The nitrate concentrations for 2012-2015 are compared against results from the previous reporting period (2008-2011) for the river and lake sites that are common to both reporting periods. A total of 321 sites are common between both reporting periods for annual average and maximum NO_3, and 315 sites for nitrate winter average. Table 1.8 and Figures 1.10–1.12 show the evolution of annual average, maximum and winter average nitrate concentrations at these river and lake sites between the two reporting periods.

The changes between the average concentration in the previous reporting period, 2008-2011 and the current reporting period, 2012-2015 for the rivers and lakes common sites are available on *ReportNet.*

http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate_Directive_NI_Final._NiD_SW_Conc.xml

Table 1.8: Changes in surface water nitrate concentrations (NO_3 mg/l) based on annual average and maximum values for the previous and current reporting periods (% of sites)

	% of sites (based on mg/l difference)				
	≤- 5 - Strong decrease	**>-5 to ≤ -1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Rivers and lakes annual average (n=321)	0.6	19.9	77.6	1.9	0
Rivers and lakes maximum (n=321)	12.8	35.2	33	14.3	4.7
Rivers and lakes winter average (n=315)	0.6	33	65.1	1.3	0

Table 1.8 and Figure 1.10 show that the annual average nitrate concentrations in rivers and lakes were generally stable or decreasing (98.1 % of sites) between the two reporting periods. Results also show a similar pattern in winter average nitrate concentrations where 98.7 % of sites were generally decreasing or stable between the two reporting periods. (Table 1.8 and Figure 1.11). When maxima were considered, 81 % of sites remained stable or showed a decrease whilst 14.3 % of sites showed a weak increase. 4.7 % (15 sites) show a strong increase in maximum concentrations but it should be noted that of these, 13 sites exhibit a maximum concentration <25 mg/l NO_3 (Table 1.8 and Figure 1.12). Further investigations and actions will be implemented in these catchments. This will include engagement with sewerage undertakers, home owners and farmers in local areas.

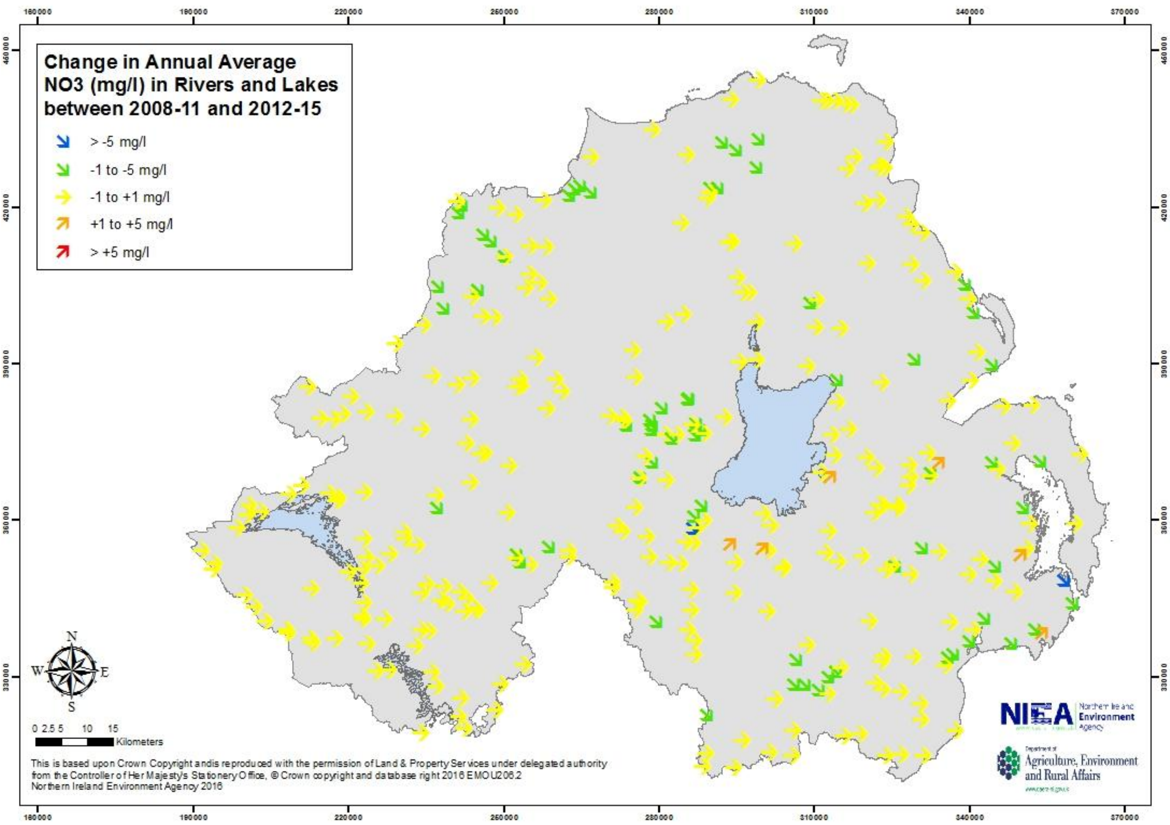


Figure 1.10: Change in annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

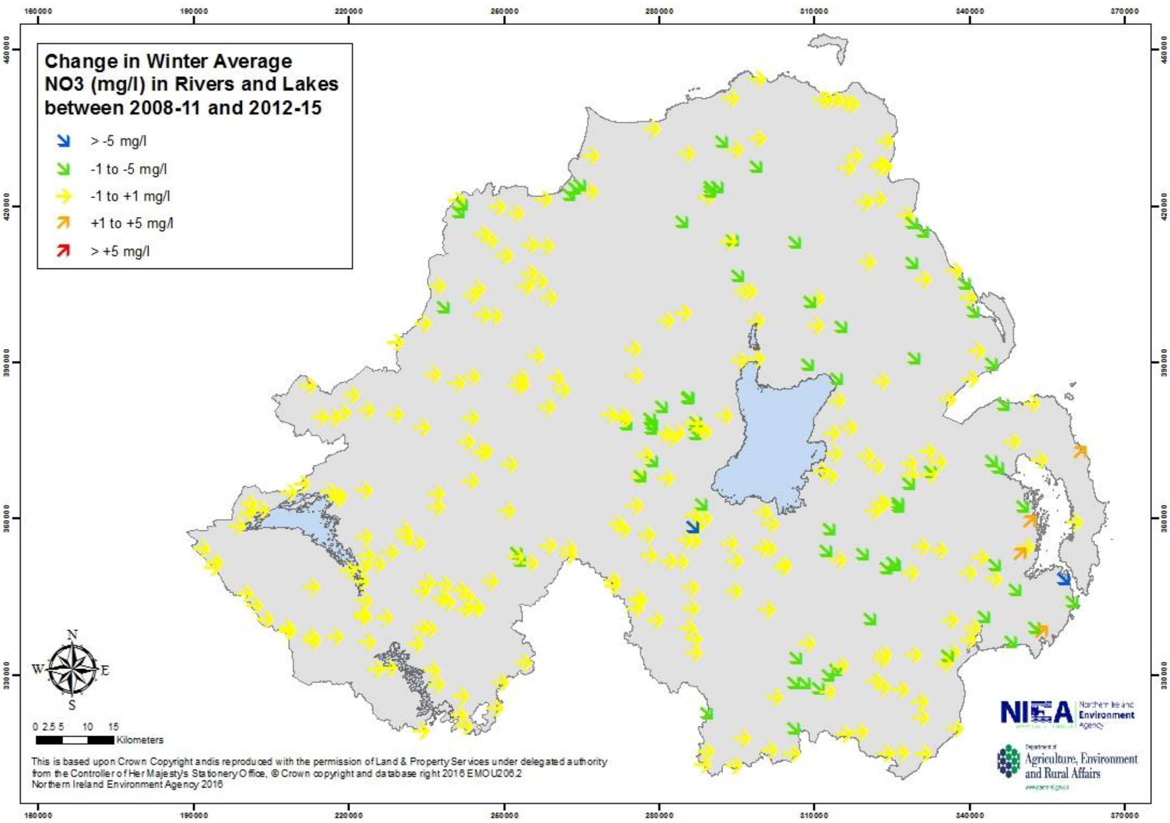


Figure 1.11: Change in winter average concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

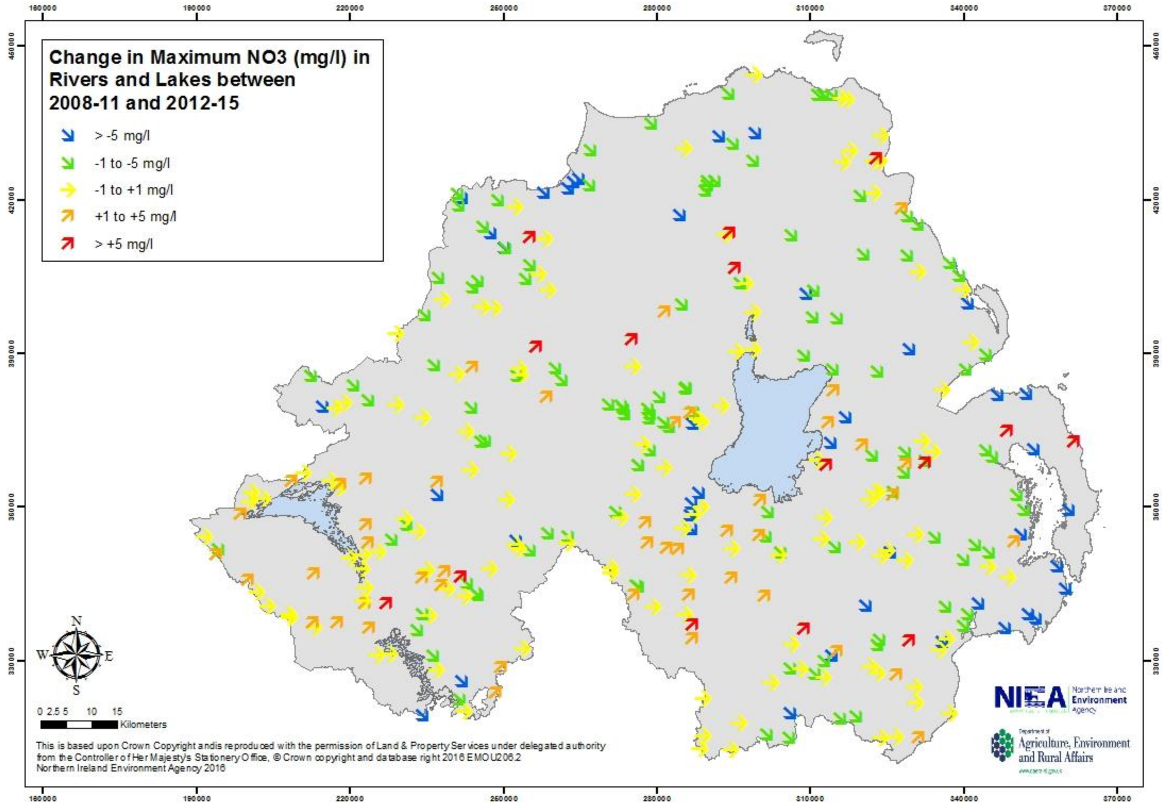


Figure 1.12: Change in maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods

1.2.4. Long-term trend analysis of nitrate concentration

To fulfil the obligations of reporting as outlined in the *'Nitrates Directive Development Guidance Notes for Member States'* 2011, NIEA carried out a statistical analysis to enable an assessment of long-term temporal trends of measured nitrate concentrations in monitored surface waters in Northern Ireland between January 1992 and December 2015. A total of 622 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 302 sites passed secondary quality validation screening (Stuart, 2012). The non-parametric Seasonal Mann-Kendall Tau (SMK) test (Hirsch *et al.,* 1982) was used along with Theil-Sen test to determine trends and provided a measure of the overall trend for each of the individual 302 monitoring sites. Seasonal trend analysis showed that the monthly trends in average nitrate concentrations in 288 rivers in Northern Ireland were decreasing or stable over the 24-year period, 1992-2015 (95 % of sites). Only 14 sites (4.6 % of sites) showed a significant increasing trend (Tables 1.9 and Figure 1.13). Figure 1.14 shows the distribution of long-term nitrate trends across Northern Ireland at individual sites.

For the Northern Ireland dataset as a whole, the mean monthly nitrate concentrations of the 622 rivers sites (>6 years data) were calculated from the 24-year data set (Figure 1.15). The SMK and Sen tests indicated a significant decreasing slope for this combined dataset.

It is recognised that climatic factors may have a significant impact on trends in Northern Ireland's rivers (DOE-DARD, 2002). In a large proportion of rivers, peaks in nitrate concentrations since the 1970s have occurred quite regularly at intervals of approximately six years following exceptionally dry summers. This series may reflect a climatic signal in low summer rainfall detected at Armagh Observatory and extending back to 1840 (Butler *et al.,* 1998). In the total period 1992-2015 peaks can be seen in the years 1997, 2002 and 2006 and 2014.

Table 1.9: Summary of numbers of monitoring sites showing overall and seasonal significant decreases, increases or stable trends of nitrate (NO_3) between 1992 and 2015

Time Period	NO_3 (n=302): 1992-2015		
	Decrease (p=<0.05)*	Stable (NS)*	Increase (p=<0.05)*
Overall	***176 (58 %)***	***112 (37 %)***	***14 (4.6 %)***

**(Significance levels determined by the Seasonal Mann-Kendall were where z-statistic = <-1.94 = significant (p=<0.05); z-statistic = >1.94 to <= +1.94 = NS; z-statistic = > +1.94 = significant (p=0.05))*

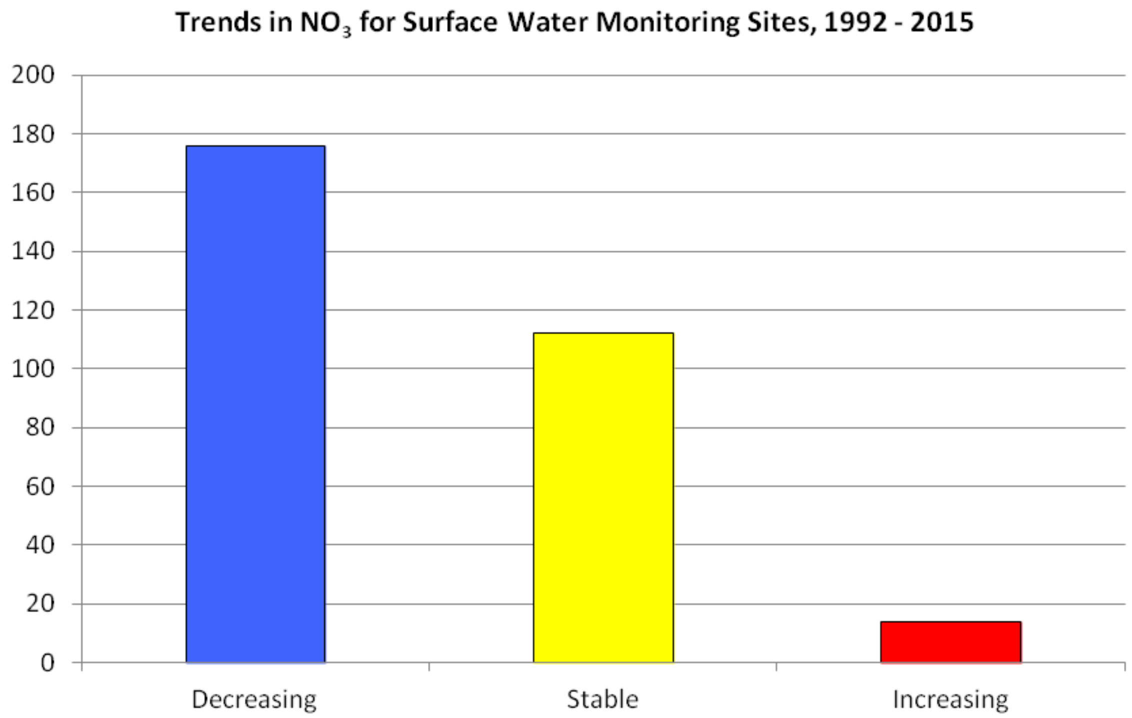


Figure 1.13: Numbers of monitoring sites showing increases, decreases or remaining stable, 1992-2015

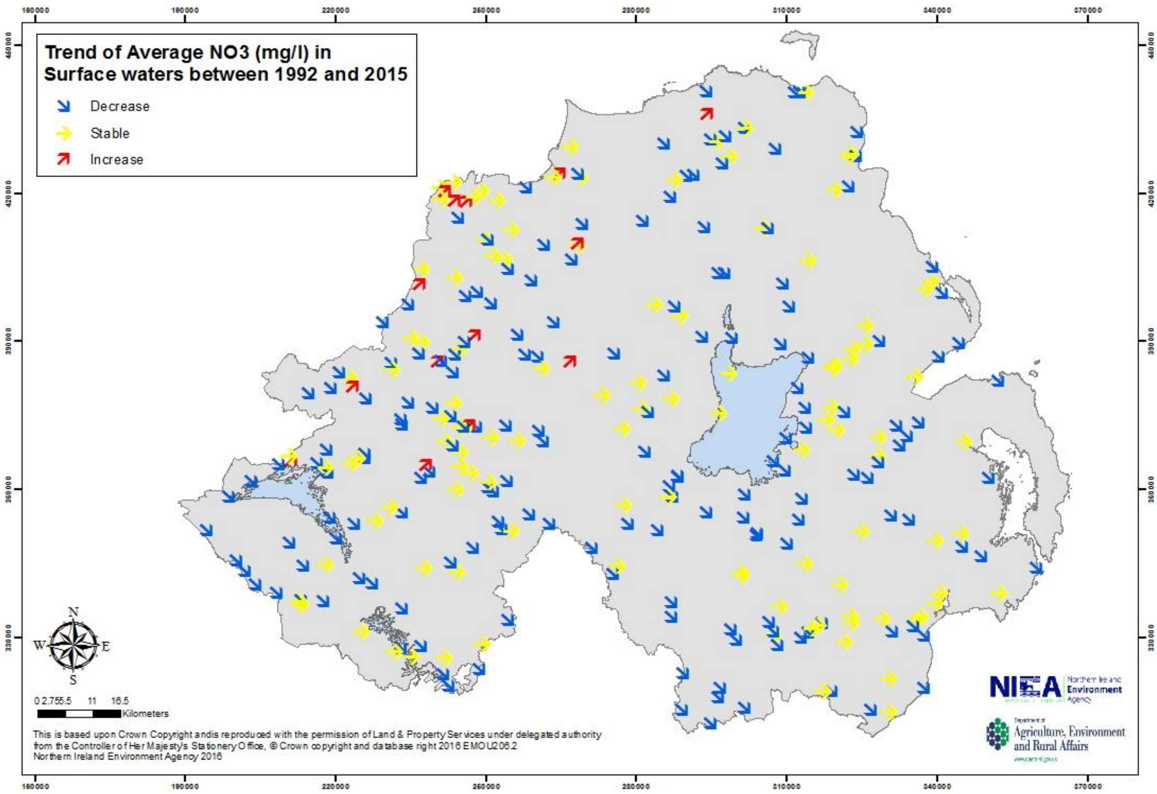


Figure 1.14: Overall trend of average nitrate (NO_3 mg/l) in surface waters across Northern Ireland in the period January 1992 to December 2015

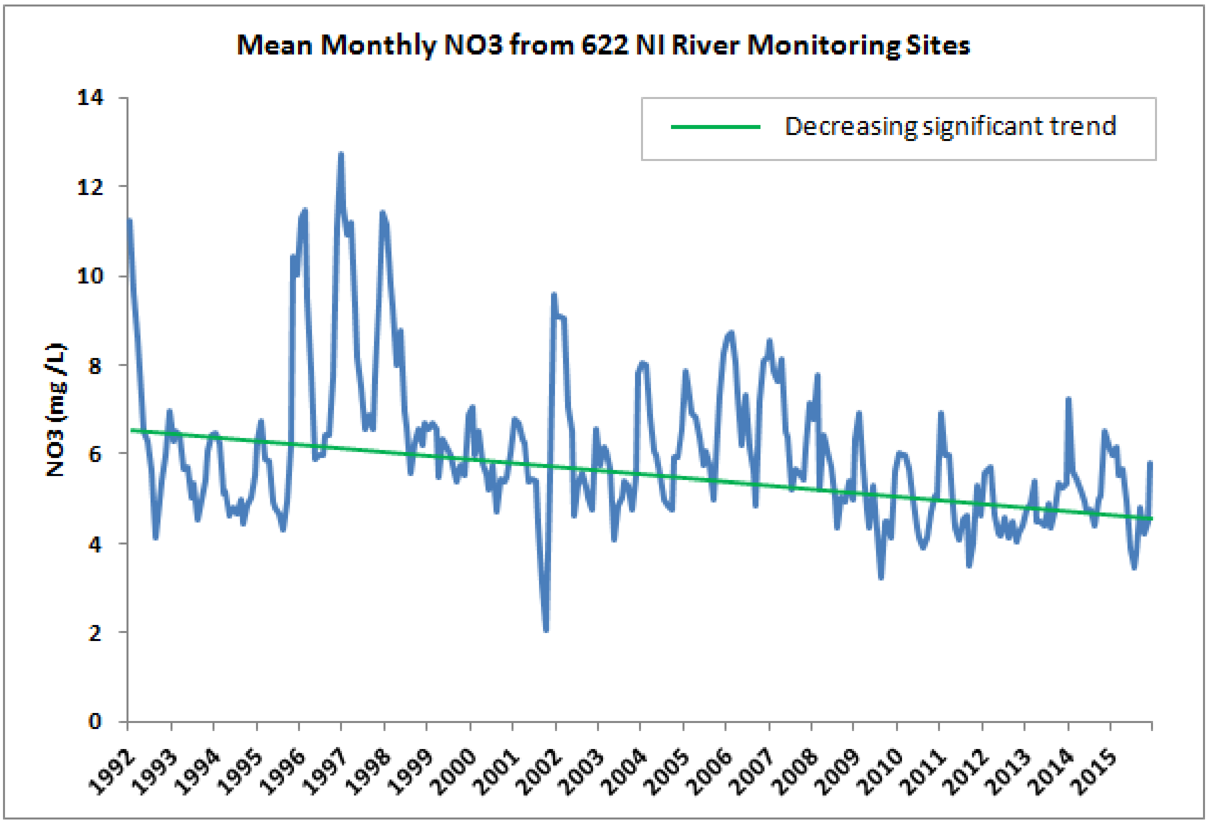


Figure 1.15: Nitrate (NO_3) concentrations in 622 river monitoring sites summarized by month into annual mean values of the site population, 1992-2015

1.3 Assessment and classification of nitrate in coastal and transitional marine waters

1.3.1 Changes between previous and current reporting periods.

In the previous reporting period 2008–2011, NIEA collected data on transitional and coastal marine waters at 126 sites across the main sea loughs in Northern Ireland. Sampling frequency was variable. Summary data was collected monthly by DAERA Marine and Fisheries Division, during the winter assessment period (November–February) at three representative sites per water body from the marine monitoring network during 2012-2015, and included, for each sampling site, the average nitrate concentration, and the measured maximum and minimum nitrate concentration.

Table 1.10: Nitrate concentrations (NO_3 mg/l) in transitional and coastal marine waters: 2008–2011 (% of water bodies)

	% of water bodies (NO_3 mg/l) 2008-2011					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Transitional and coastal annual average	100	0	0	0	0	0
Transitional and coastal maximum	100	0	0	0	0	0

Table 1.10 shows that all marine waters monitored in the period 2008-2011 had annual average and maximum nitrate concentrations below 2.0 mg/l NO_3.

Since the previous report covering 2008-2011, monitoring programmes and practices have been modified in order to address the data demands and data integrity required for reporting on individual water bodies for the WFD and other statutory drivers.

These changes included the addition of more representative coastal transect data by area, and a more focussed winter monitoring programme, in place of the previous temporal spread of monitoring. As a result of the changes to the network, trends in nitrate levels are possible only at the water body level.

Table 1.11: Nitrate concentrations (NO_3 mg/l) in transitional and coastal marine waters: 2012-2015 (% of water bodies)

	% of water bodies (NO_3 mg/l) 2012-2015					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Transitional and coastal annual average.	76.92	23.08	0	0	0	0
Transitional and coastal maximum.	65.4	34.6	0	0	0	0

Monitoring for the current assessment period 2012-2015 (Table 1.11) shows that nitrate concentrations in marine waters demonstrate an increase in both annual average and maximum nitrate levels as a percentage of water bodies assessed since the last report. The changes to monitoring programmes previously described have resulted in sampling being focussed on the more relevant winter period (November–February), and this in turn has lead to an increase in ‘face value’ nitrate average and maximum annual values. This is due to the absence of lower summer values carried in the calculation during the previous assessments.

For 27 transitional and coastal water bodies common to the previous and current reporting periods, the summary table below displays the changes between the average nitrate concentrations in the previous reporting period (2008-2011) and the current reporting period (2012-2015).

Table 1.12: Changes in transitional and coastal marine surface waters nitrate concentrations (NO_3 mg/l) based on annual winter mean values, between former (2008-2011) and current (2012-2015) reporting periods (% of sampling points)

	Marine Nitrate trends by Water body 2008-11 to 2012-15		
Water Body	2008-11 Mean Winter Nitrate mg/L	2012-15 Mean Winter Nitrate mg/L	2012-15 Change
Lough Foyle	0.502	1.13	↔
Portstewart Bay	0.184	0.488	↔
Rathlin	0.1	0.364	↔
North Coast	0.125	0.368	↔
North Channel	0.105	0.428	↔
Maidens	0.1	0.345	↔
Larne Lough North (HMWB)	0.109	0.48	↔
Larne Lough Mid	0.123	0.51	↔
Larne Lough South	0.132	0.429	↔
Belfast Lough Outer	0.108	0.435	↔
Belfast Lough Inner	0.141	0.95	↔
Belfast Harbour (HWMB)	0.646	3.46	↗
Ards Peninsula	0.082	0.374	↔
Strangford Lough North	0.129	0.53	↔
Strangford Lough South	0.1	0.507	↔
Strangford Lough Narrows	0.099	0.35	↔
Dundrum Bay Outer	0.1	0.379	↔
Dundrum Bay Inner	0.112	0.9	↔
Mourne Coast	0.093	0.454	↔
Carlingford Lough	0.208	0.92	↔
Foyle and Faughan (HMWB)	0.507	2.97	↗
Roe Estuary	0.806	2.47	↗
Bann Estuary (HMWB)	0.76	2.43	↗
Lagan Estuary (HMWB)	1.756	7.1	↑
Connswater (HMWB)	0.63	2.45	↗
Quoile Pondage (HMWB)	1.474	6.5	↑
Newry Estuary (HMWB)	0.547	1.98	↗

Key		
	↑	Strong increase >5 mg/L
	↗	Weak increase >1<5 mg/L
	↔	Stable >-1<+1 mg/L

1.4 Overview of assessment of eutrophic indicators in rivers, lakes and transitional and coastal marine waters

1.4.1 Eutrophication parameters

DAERA's NIEA, and Environment, Marine and Fisheries Division monitor a number of quality elements and parameters when considering eutrophication pressures for WFD on all water body types, which are outlined in Table 1.13. Eutrophic waters are identified using WFD nutrient standards and Biological Quality Element (BQE) classification tools which are known to be sensitive to nutrient enrichment. For each water body type (rivers, lakes and transitional and coastal marine waters) the overall trophic status, using a combination of nutrients and responsive biological parameters is discussed in general. This is followed in each case by a more detailed discussion of each of the nutrient parameters.

Table 1.13: WFD quality elements and parameters relevant to eutrophication in 2012-2015*****

QUALITY ELEMENT	RIVERS	FRESHWATER LAKES	TRANSITIONAL WATERS	COASTAL WATERS
GENERAL CONDITIONS	Soluble Reactive Phosphorus	Total Phosphorus (TP)	Dissolved Inorganic Nitrogen Dissolved Oxygen	Dissolved Inorganic Nitrogen Dissolved Oxygen
PHYTOPLANKTON	-	Chlorophyll-α % Cyanobacteria Phytoplankton	Chlorophyll-α	Chlorophyll-α
MACROPHYTES & PHYTOBENTHOS	Diatoms Macrophytes	Diatoms Macrophytes	-	-
MACROALGAE & ANGIOSPERMS	N/A	N/A	Macroalgae: (Blooming Tool) (Rsl)**	Macroalgae: (Blooming Tool) (Rsl)**

***** *Standards (*elements and parameters) *used in Table 1.14 are those current in 2015. Revised standards may be included in the future*

Information collected on the above indicators is assessed against the three elements of 'eutrophication' as set out in guidance issued by the EU Commission closely aligning with the OSPAR Common Assessment Criteria for Eutrophication, under ND, UWWTD and WFD (see figure 1.34). Assessment of the indicators is used to determine whether a water body is eutrophic or may become eutrophic in the near future if protective action is not taken. The three elements are:

1. if the water body is enriched by nitrogen and/or phosphorus;
2. this enrichment causes accelerated growth of algae and higher forms of plant life; and
3. the accelerated growth produces an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.

According to the European guidance, High and Good status under WFD correspond with non-eutrophic status under the UWWTD and the Nitrates Directive; Poor and Bad status under WFD correspond with 'eutrophic' under the other two Directives. Moderate status can be thought of as transitional zone between good status, where the probability of 'undesirable disturbances' occurring is zero, and Poor/Bad status where they are increasingly common and severe. Moderate status may be thought of as broadly equivalent to 'may become eutrophic'. Each of the WFD classes has been interpreted as High equating to Ultra-Oligotrophic status, Good equating to Oligotrophic status, Moderate equating to Mesotrophic status, Poor equating to Eutrophic status and Bad equating to hypertrophic status (Table 1.14).

Table 1.14: WFD status in relation to trophic status

WFD Status	Trophic Status
High	Ultra-oligotrophic
Good	Oligotrophic
Moderate	Mesotrophic
Poor	Eutrophic
Bad	Hypertrophic

In 2015, DOENI carried out an assessment of the trophic status of surface freshwaters and transitional and coastal marine waters under the UWWTD Sensitive Area Review using all the trophic parameters (i.e. chemical and biological) outlined in Table 1.13. The review used data from the years 2008-2013 and focussed on areas previously identified as Sensitive (Eutrophic) under the UWWT Directive in Northern Ireland and the remaining catchments not identified as sensitive. The 2015 UWWTD Sensitive Area Review (SAR), as well as an interim review in 2012 identified further designations, bringing the total existing area of land draining to water bodies which are sensitive to eutrophication to approximately 86 % of the Northern Ireland land area. The next SAR under the UWWTD will be carried out in 2019.

1.5 Current overall WFD assessment of trophic status of rivers, 2012-2015

River water bodies can contain more than one river and more than one monitoring station (monitoring site). There are rules governing how water bodies with one monitoring station are classified but commonly they are averaged. A water body with one monitoring station is classified by that station and a water body with no monitoring stations is classified by an adjacent water body either upstream or downstream. Not all monitoring sites are monitored for both biology and chemistry elements, therefore, different monitoring stations may be used to classify a water body for different quality elements.

For eutrophic pressures, macrophytes, diatoms and soluble reactive phosphorus (SRP) are considered. WFD assessment of trophic status is based on 2015 WFD classification data. NIEA monitored phosphorus concentrations at 471 surface freshwater sites across Northern Ireland. Macrophyte surveys were carried out on a catchment basis at 479 river sites and benthic diatoms samples were collected at 486 selected river sites to inform 2015 WFD classification. Each of the parameters was assessed using the WFD classification system. The results of each assessment were then put together using the WFD overall classification criterion of deferring to the lowest class in each case to give an overall WFD Trophic class for a river water body.

To date, Northern Ireland has identified 450 water bodies for WFD classification and one overall class is given to each water body. Each trophic parameter is also assessed for each monitoring site (559 were used in 2015 WFD classification) within all of the water bodies. *Note that these trophic status classifications do not include the full suite of WFD classification elements at all locations.*

WFD 2015 trophic classifications show that 54.4 % of river water bodies across Northern Ireland are considered to be of High/Good trophic status. 40.6 % of river water bodies are classed as Moderate/Poor status which is indicative of eutrophic conditions. 0.2 % of river water bodies (Lough Neagh peripherals which are classified using Lough Neagh lake data) are considered to be of Bad status equating to hyper-eutrophic. Data was not available for 4.7 % of river water bodies. 57.2 % of river sites across Northern Ireland are considered to be of High/Good trophic status. No river sites are considered to be of Bad trophic status. However, 42.8 % of river sites are classed as Moderate/Poor status which is indicative of eutrophic conditions. The distribution of WFD classes for sites and water bodies across Northern Ireland is shown in Figure 1.16 and Table 1.15.

Note that for the purposes of this report 'Eutrophic State' reported in ReportNet tables is based solely on classification of SRP. Each of the WFD classes except Bad has been interpreted according to those described in Table 1.14.

Table 1.15: Overall 2015 WFD classification of trophic indicator quality elements for 450 river water bodies and 559 monitoring sites in Northern Ireland (based on SRP, macrophytes and diatoms)

WFD CLASS	% Sites (559)	% Water Bodies (450)
HIGH	16.1	13.1
GOOD	41.1	41.3
MODERATE	35.8	34.4
POOR	7.0	6.2
BAD	0	0.2
NO DATA	0	4.7

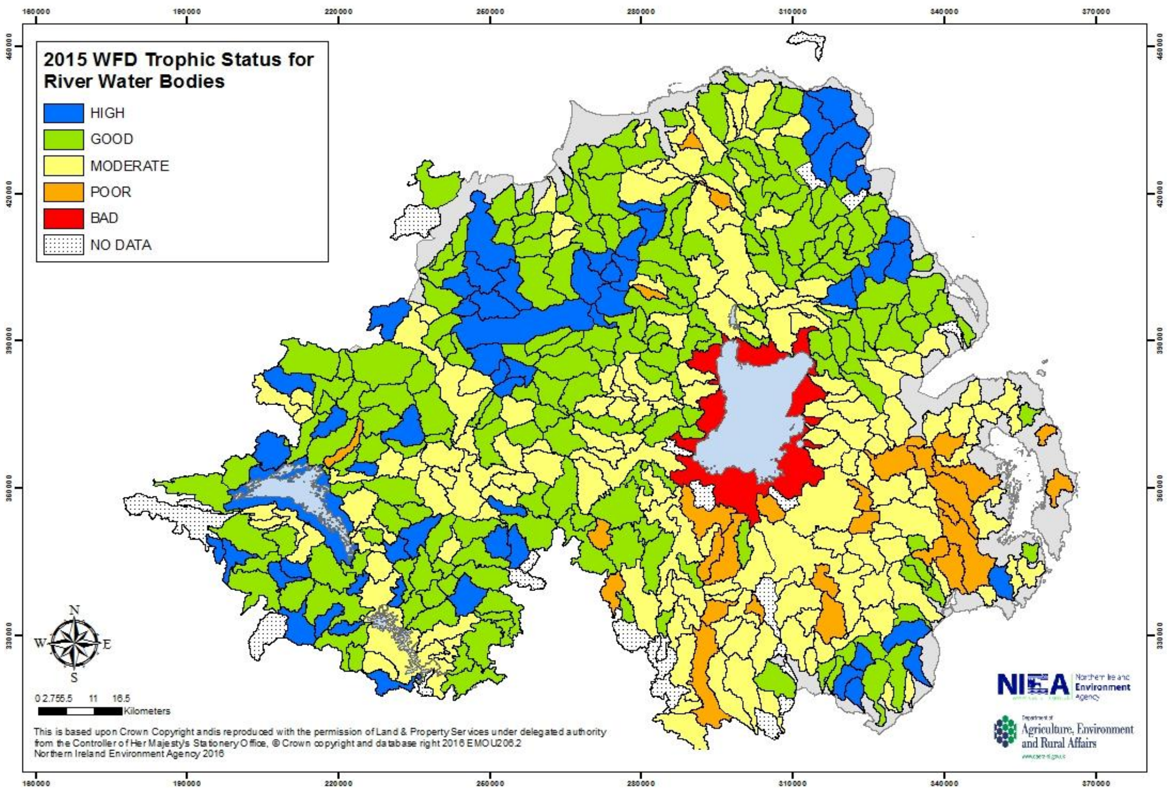


Figure 1.16: Distribution of overall 2015 WFD trophic classes across Northern Ireland's 450 river water bodies (*based on Table 1.15 - WFD quality elements and parameters relevant to eutrophication in 2012-2015'-Soluble reactive phosphorus (SRP), macrophytes and diatoms)*

1.5.1 Soluble Reactive Phosphorus (SRP)

The importance of phosphorus is recognised by the inclusion of SRP in WFD classification. Increasing nutrient concentrations are capable of changing the biomass and composition of biological communities with the most obvious primary impact being enhanced plant and algal production. Secondary impacts can include reduced dissolved oxygen levels caused by the overnight respiration of higher aquatic plants or macrophytes which can have a negative impact on fish. Elevated nutrient levels can also cause toxic blooms of blue-green algae leading to potential negative impacts on livestock and other animals as well as overgrowth of other species. Classification provides a way of comparing waters and a way of looking at changes over time, therefore, where the trend of phosphorus deteriorates from good status to moderate status the water body would be considered to be 'at risk of eutrophication'.

A scientific review of biological and chemical data by the UK Technical Advisory Group (UKTAG) led to the development of a revised approach to identifying phosphorus standards. The revised standards benefit from improvements in understanding of the relationship between phosphorus concentrations and the response of river plant communities. They have been derived using a new approach to setting phosphorus standards that produces site-specific estimates of natural phosphorus concentrations, taking account of a site's alkalinity and altitude (UKTAG, 2015). The revised standards have the effect of reducing the mismatch between classifications based on biology and phosphorus. Further information on the application of the WFD standards for phosphorus is at:
www.wfduk.org/sites/default/files/Media/UKTAG %20Phosphorus %20Standards %20for %20Rivers_Final %20130906_0.pdf

Previously, SRP was assessed and reported using the Organisation for Economic Co-operation and Development (OECD, 1982) scheme, based on concentrations of phosphorus. To demonstrate transparency in the use of WFD standards in place of OECD, and for temporal comparative purposes, Northern Ireland has assessed annual average data from 2008-2011 and 2012-2015 using the latest version of the SRP standards calculator (recommended by UKTAG) to obtain a SRP classification for each site.

NIEA monitored SRP concentrations at 568 surface freshwater stations across Northern Ireland in 2008-2011. During the 2012-2015 reporting period 631 sites were monitored. Sufficient numbers of samples (i.e. >=12 samples) over four years were available at 391 sites. Of these sites, 374 are common with those sites monitored in the previous period.

Results in Table 1.16 and Figure 1.17 show that in the 2008–2011 reporting period, 71 % of river sites were classified as High or Good for SRP status. The remaining 29.1 % of river sites had WFD SRP classification less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 5.5 % were classified as Poor status for SRP, indicative of nutrient enrichment. No sites were classified as Bad status

Table 1.16: WFD Soluble reactive phosphorus classification in rivers: 2008-2011 (number and % of sites)

	Number and % of sites				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Rivers SRP WFD classification 2008-2011 (n=568)	213	190	134	31	0
	37.5 %	33.5 %	23.6 %	5.5 %	0

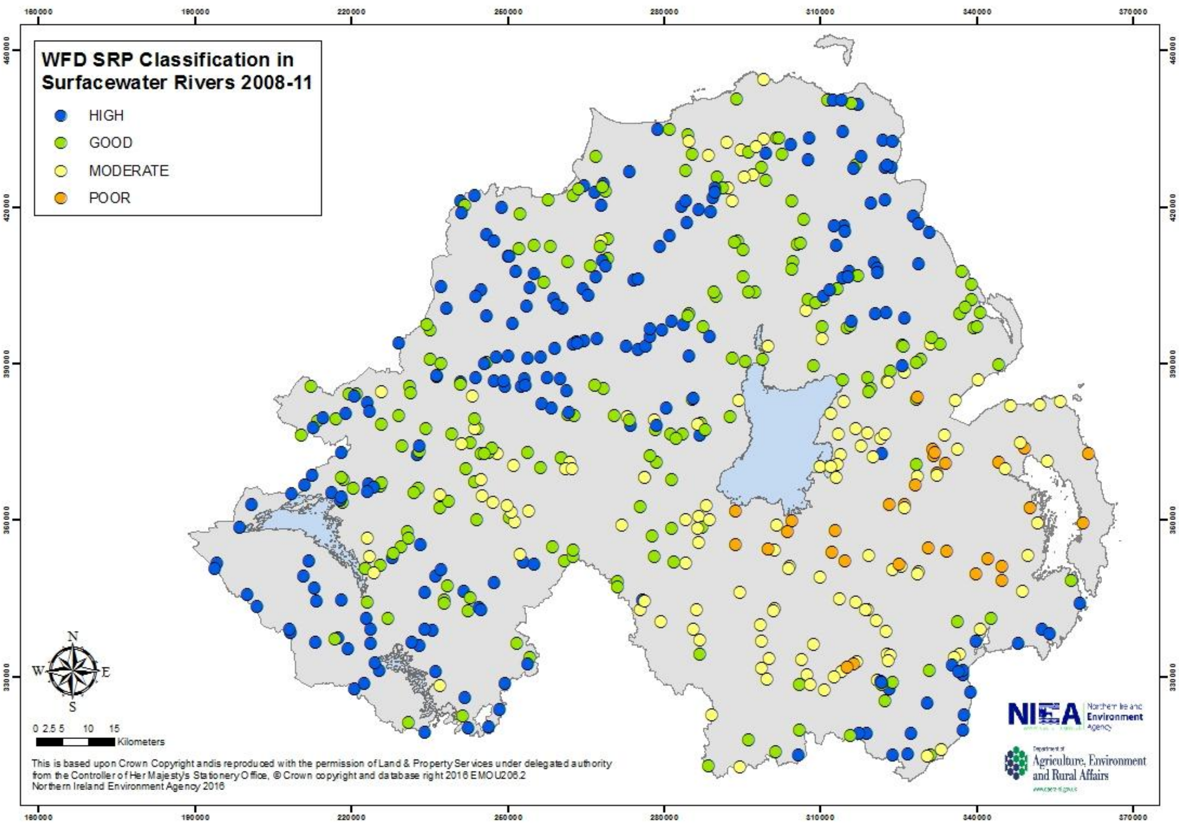


Figure 1.17: WFD soluble reactive phosphorus classification in river monitoring sites, 2008–2011

Table 1.17 shows that in the current reporting period 2012–2015, 66.3 % of river sites were classified as High or Good for SRP status. Compared with the previous reporting period there was a decrease in the number of sites that were classified as High or Good. 33.7 % of river sites had WFD SRP classification less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 5.6 % were classified as Poor status for SRP, indicative of nutrient enrichment. No sites were classified as Bad status.

Table 1.17: WFD Soluble reactive phosphorus classification in rivers: 2012-2015 (number and % of sites)

	Number and % of sites				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Rivers SRP WFD classification 2012-2015 (n=391)	127	132	110	22	0
	32.5 %	33.8 %	28.1 %	5.6 %	0

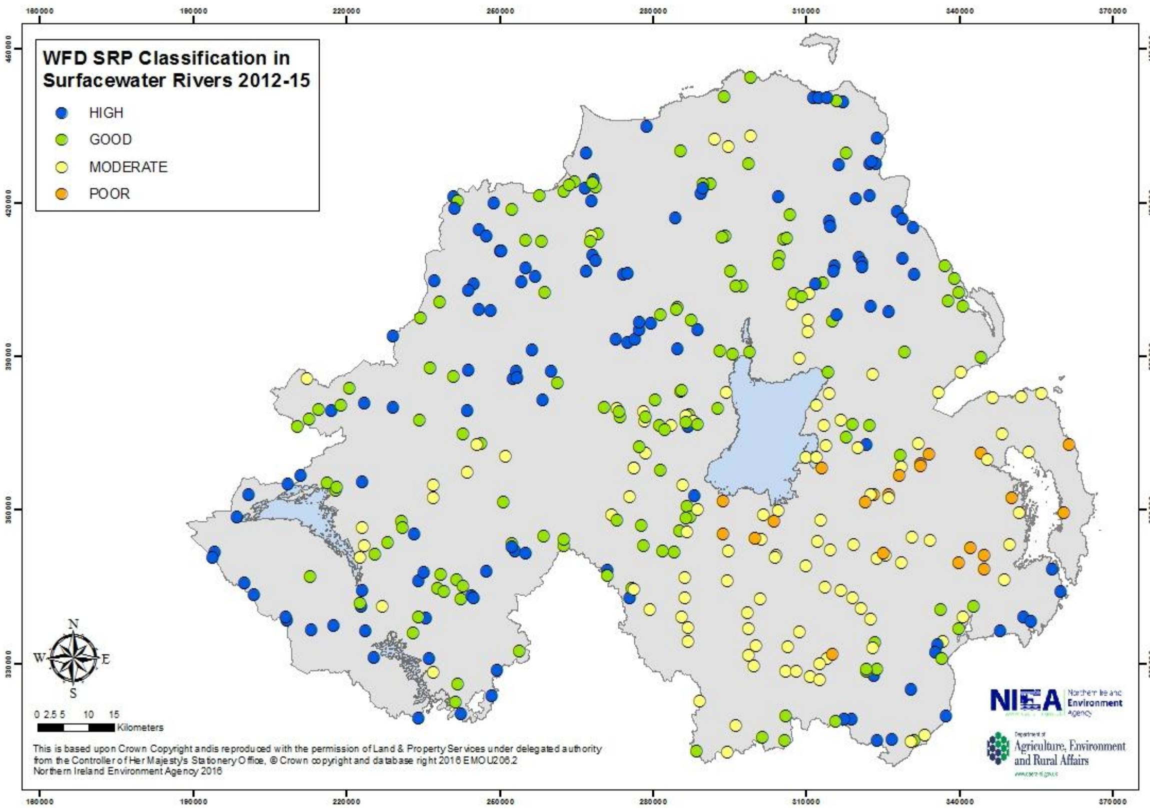


Figure 1.18: WFD soluble reactive phosphorus classification in river monitoring sites, 2012-2015

Overall changes in Table 1.18 indicate that the majority (87.1 %) of river sites experienced a decrease or stabilisation in WFD SRP classification status between the previous and current reporting periods. 12.8 % of sites exhibited a weak increase in SRP between the two reporting periods as they deteriorated by one class (Figure 1.19). All sites showing an increasing trend in SRP WFD status will be subject to further investigations and actions as part of the relevant River Basin District (RBD) programme of targeted catchment projects under WFD. This will include engagement with sewerage undertakers, home owners and farmers in local areas to follow up actions arising from reported pollution incidents and improve water protection.

Table 1.18: Changes in river SRP WFD classification between former and current reporting periods (number and percentage of river sites)

	Number and % of sites				
	Strong decrease[1]	**Weak decrease**[2]	**Stable**[3]	**Weak increase**[4]	**Strong increase**[5]
Rivers WFD SRP classification (n=374)	3	27	296	48	0
	0.8 %	7.2 %	79.1 %	12.8 %	0 %

[1] *Strong Decrease = ≥2 improvements in class*
[2] *Weak Decrease = 1 improvement in class*
[3] *Stable = No change in class*
[4] *Weak Increase = 1 deterioration in class*
[5] *Strong Increase = ≥2 deteriorations in class*

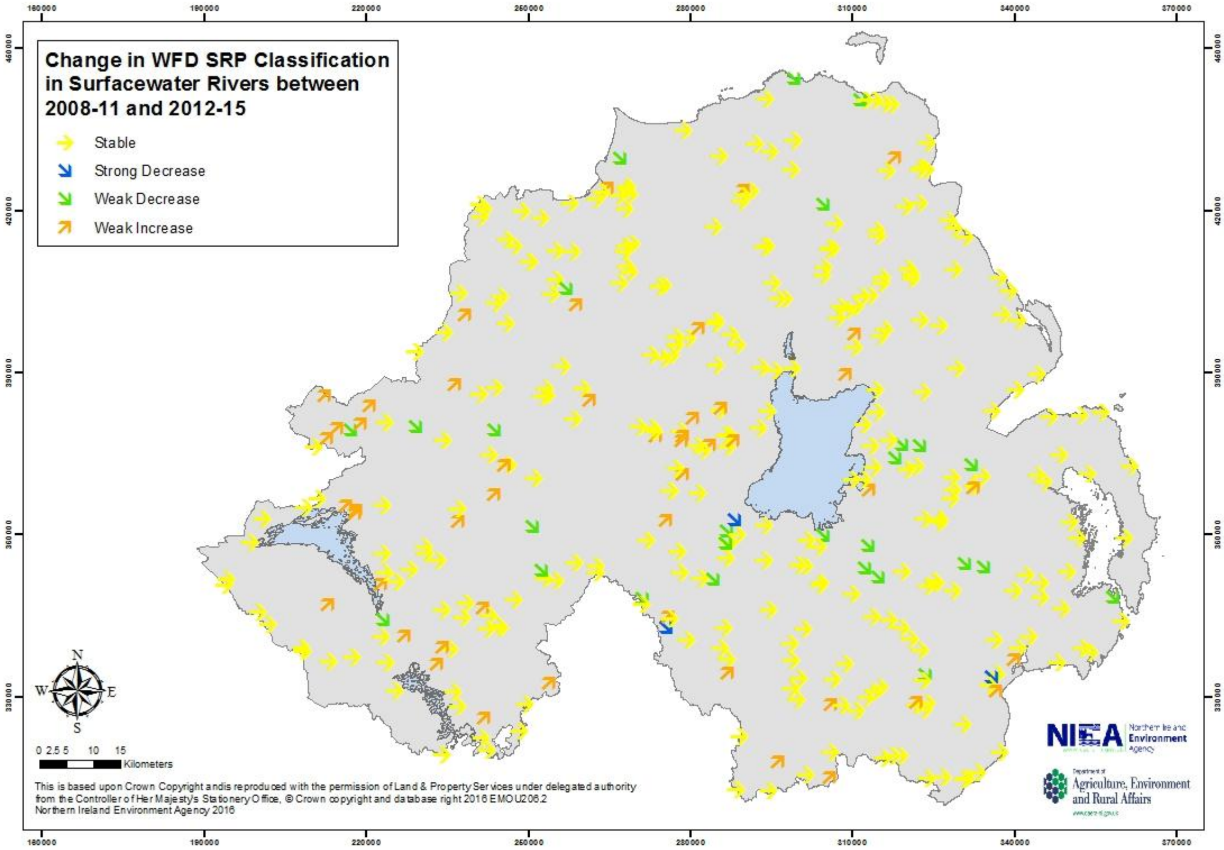


Figure: 1.19: Change in WFD soluble reactive phosphorus classification in river monitoring sites between previous and current reporting period, 2008-2011 and 2012-2015

1.5.2 Long-term trend analysis of Soluble Reactive Phosphorus concentration

As discussed in Section 1.2.4, NIEA carried out a statistical analysis to enable an assessment of long-term temporal trend of measured nitrate concentration concentrations in monitored rivers and streams in Northern Ireland between January 1992 and December 2015. The SRP data-set is for a shorter time period (1998-2015) due to a change in the laboratory limit of detection for SRP from 0.05 to 0.01 mg/l in 1998, as some sites would have previously had values less than the limit of detection.

A total of 622 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 165 sites passed secondary quality validation screening (Stuart, 2012). The non-parametric Seasonal Mann-Kendall Tau (SMK) test (Hirsch *et al.,* 1982) was used along with Theil-Sen test to determine trends and provided a measure of the overall trend for each of the 165 individual monitoring sites. Seasonal trend analysis showed that the monthly trends in average phosphorus concentrations in 160 rivers in Northern Ireland were decreasing or stable over the 18-year period, 1998-2015 (97 % of sites). Only five sites (3 % of sites) showed a significant increasing trend (Tables 1.19 and Figure 1.20). Figure 1.21 shows the distribution of long-term phosphorus trends across Northern Ireland at individual sites.

For the Northern Ireland dataset as a whole, the mean monthly phosphorus concentrations of the 622 rivers sites were calculated from the 18-year data set (Figure 1.22). Peak values tended to occur in the summer months. The SMK and Sen tests indicated a significant decreasing slope for this combined dataset.

Table 1.19: Summary of numbers of monitoring sites showing overall and seasonal significant decreases, increases or stable trends of phosphorus between 1998 and 2015

Time Period	**SRP (n=165): 1998-2015**		
	Decrease (p=<0.05)*	**Stable (NS)***	**Increase (p=<0.05)***
Overall	***127 (77 %)***	***33 (20 %)***	***5 (3 %)***

**(Significance levels determined by the SMK were where z-statistic = <-1.94 = significant (p=<0.05); z-statistic = >1.94 to <= +1.94 = NS; z-statistic = > +1.94 = significant (p=0.05))*

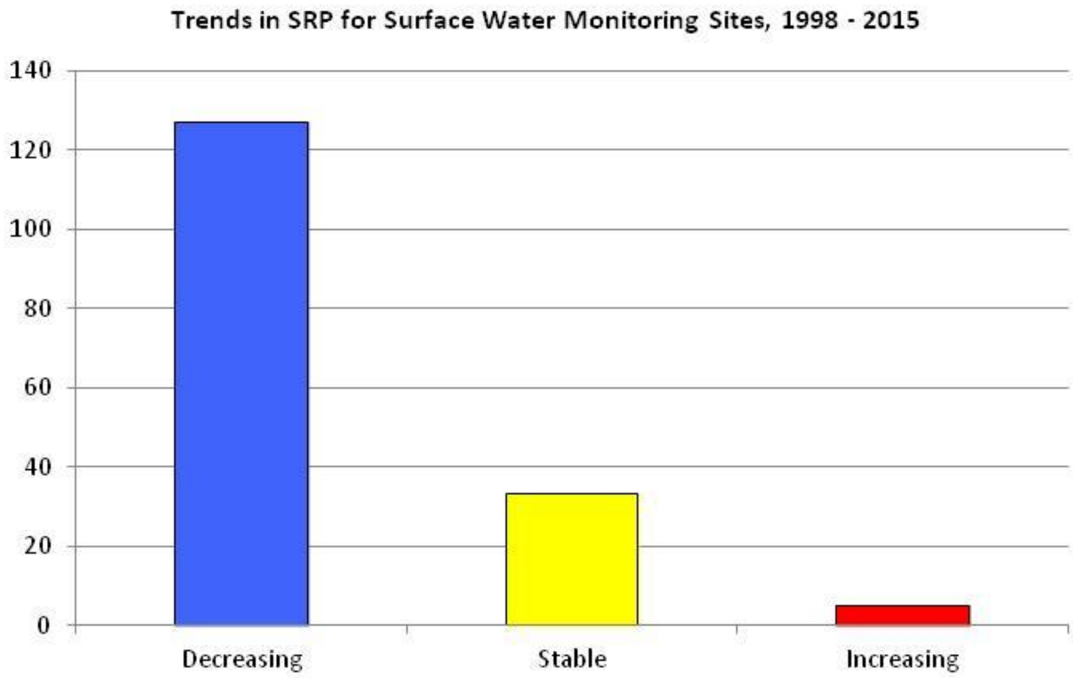


Figure 1.20: Numbers of monitoring sites showing increases, decreases or stability for soluble reactive phosphorus concentrations, 1998-2015

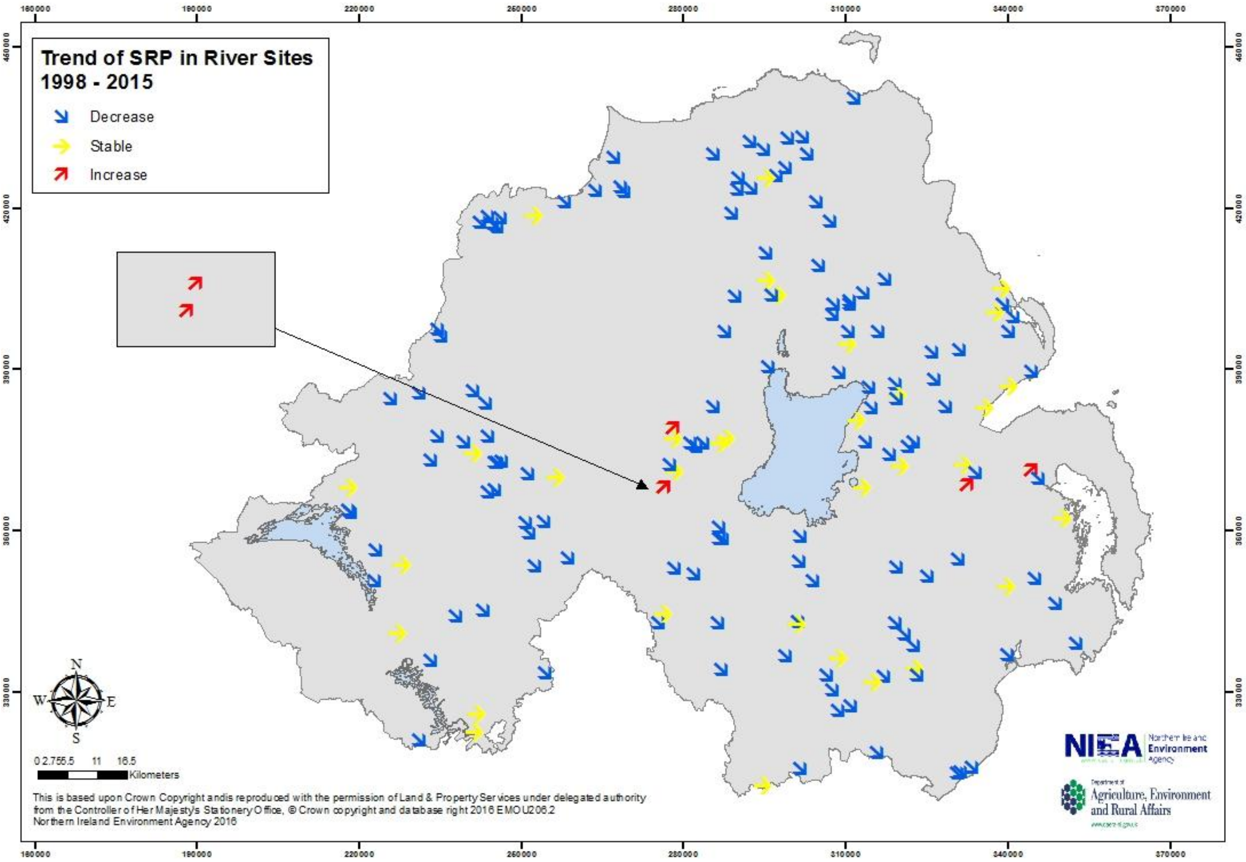


Figure 1.21: Trend of average soluble reactive phosphorus (SRP mg /l) in rivers across Northern Ireland: 1998–2015

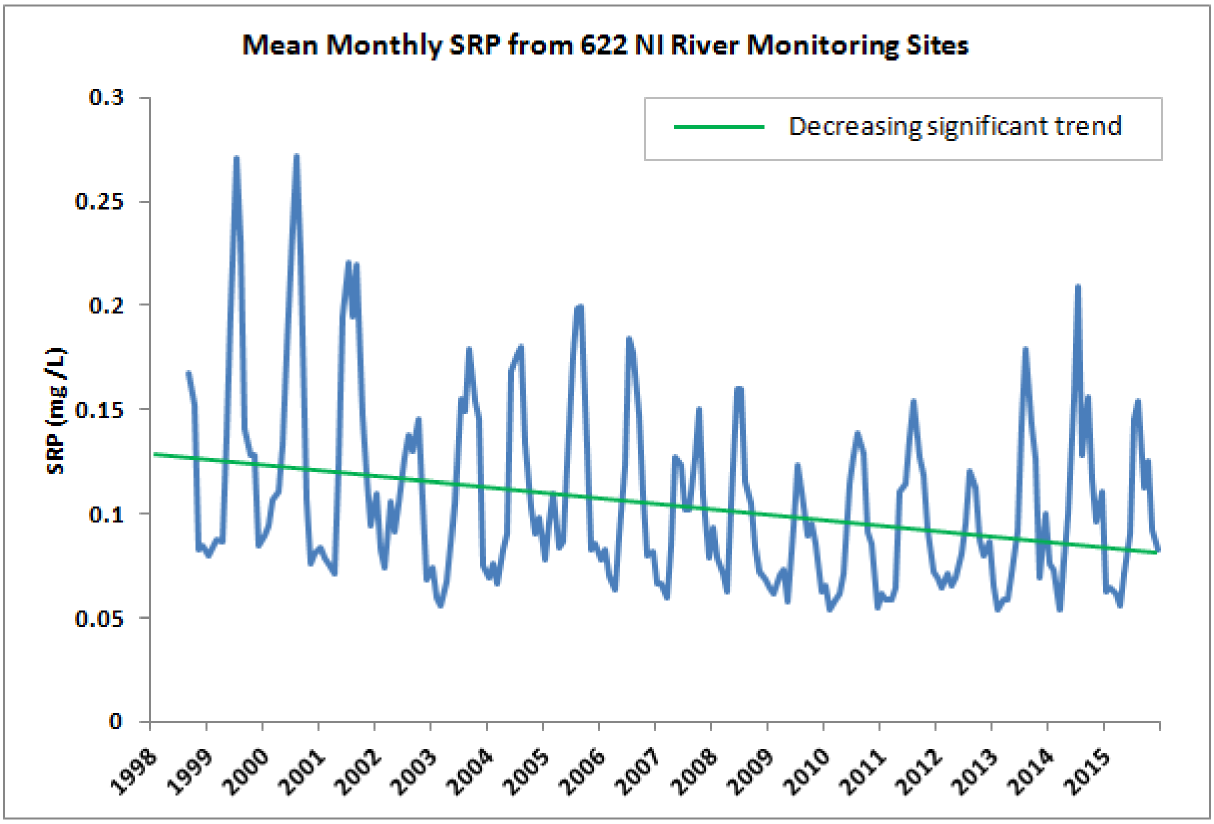


Figure 1.22: Soluble reactive phosphorus concentrations (SRP mg /l) in 622 river monitoring sites summarized by month into annual mean values of the site population, 1998-2015

1.6 Current WFD assessment of trophic status of lakes

The WFD introduced a formal classification system for lakes. Although the term eutrophication is not explicitly defined in the WFD, there is a requirement to classify each lake water body in terms of its ecological and chemical status. Lakes over 50 hectares (ha) in size are water bodies in themselves, but lakes less than 50 ha are subsumed under river water bodies. Lakes which are not considered to be eutrophic are classed as high or good, and lakes considered to be eutrophic/hyper-eutrophic are classed as poor or bad status. Lakes which fall into moderate class equate to 'indicative of unacceptable or worsening eutrophic conditions'. The WFD, therefore, has an implicit requirement to assess eutrophication when classifying the status of water bodies where nutrient enrichment affects biological and physiochemical quality elements. Similar to rivers classification this provides a way of comparing the trophic status of lakes and a way of looking at changes over time.

In the WFD classification period 2009-2011, NIEA monitored total phosphorus (TP), phytoplankton, macrophytes and benthic diatoms at 27 lakes across Northern Ireland on a three-year rolling basis. This included lakes with a surface area greater than 50 ha (known as surveillance lakes) and a number selected for intercalibration purposes. In the WFD classification period 2012-2014, the lake surveillance network comprised of 21 ≥50 ha lake monitoring sites. The smaller lakes (≤50 ha) that were previously monitored in the period 2009-2011 for intercalibration purposes are no longer monitored on a monthly basis. Lower Lough Erne is now divided into two water bodies and it should also be noted that the monitoring station (monitoring site) located at Lough Neagh at Churchtown Point has been closed. The monitoring station located at Lower Bann at Toome Bridge is representative of the lake water body and thus will be included in the evolution of water quality of Lough Neagh between the two reporting periods.

Macrophytes and benthic diatoms were surveyed at each lake on a three-year rolling basis. Samples for TP analysis were collected at monthly intervals, giving a maximum of 12 samples per year. In the previous reporting period 2008-2011, phytoplankton samples were collected in spring, summer and autumn at each lake on a three year rolling basis. The adaption of the new phytoplankton tool (PLUTO) means all surveillance lakes from 2012 onwards are sampled in July, August and September for three consecutive years to give a total of nine samples.

The results of each parameter were then collated using the WFD classification criterion of deferring to the lowest class in each case to give an overall trophic classification for each water body. However, the UK Technical Guidance (2008) recommends that macrophytes are not used for classification where lakes are classed as Heavily Modified Water Bodies (HMWB) unless they are known to be ecologically sensitive. It will be assumed that if a lake HMWB passes its lake level standards this indicates that the habitat should be favourable for macrophyte colonisation and that macrophytes should be included in trophic status assessments. If a lake fails the hydrology standards then macrophytes will not be included in trophic status assessments. There are currently 12 HMWB lake designations in Northern Ireland: Lough Beg, Cam Lough, Castlehume Lough, Lough Fea, Lower Lough Erne (both water bodies), Lough Island Reavy, Lough Mourne, Lough Neagh, Silent Valley Reservoir, Spelga Dam and Upper Lough Erne.

The development of both chemical and biological standards for the WFD over the past few years means that the classification tools and standards used in the WFD classification period 2012-2014 have changed from the previous reporting period. The new or revised standards have been developed from the earlier standards, using larger data sets, to better correlate with one another and to provide a more robust overall ecological assessment. The changes to the classification methods and environmental standards between the reporting periods make a difference to the number of water bodies classified as High, Good, Moderate, Poor and Bad, thus having an impact on the overall trophic status of lake water bodies. For this reason, in this report WFD trophic assessments will be made using data from the current reporting period only. Section 1.6.1 and 1.6.2 will investigate the evolution of trophic status using TP and chlorophyll-α data thereby providing a comparative eutrophic assessment between the two reporting periods 2009-2011 and 2012-2014.

Table 1.20 and Figure 1.23 show that five of the 21 lake water bodies were classed as High/Good overall trophic status in 2012-2014 whilst the other 16 lakes were classed as Moderate, Poor or Bad trophic status which is indicative of eutrophic conditions. Two lakes, Lough Fea and Silent valley were classed as High trophic status. The TP concentration, phytoplankton and diatom communities were not impacted in these lakes. Due to the fact they are both HMWBs with failures in the lake level standards; macrophytes were not included in trophic status assessment. Four lakes were classed as Bad trophic status (hypertrophic conditions), namely Lough Neagh, Portmore Lough, Lough Gullion and Lower Lough MacNean. Two of the lakes, Lough Neagh and Portmore Lough were classed as Bad trophic status with the main drivers for status being elevated TP concentrations resulting in disturbances to the diatom, planktonic and macrophyte communities. The main driver for Bad trophic status in Lough Gullion was elevated TP concentrations and resulting disturbance to the diatom and macrophyte communities. Lower Lough MacNean was classed as Bad trophic status due to disturbances to the macrophyte communities despite low levels of TP. Six lakes were classed as Poor trophic status, namely Lough Beg, Cam Lough, Clea Lakes, Lough Mourne, Lough Ross and Stoneyford. Elevated TP concentrations resulted in varying levels of disturbances to the diatom, macrophyte and planktonic communities. All lakes exhibiting eutrophic conditions will be subject to further investigations and actions as part of the relevant River Basin Management programme of targeted catchment projects under WFD. This will include engagement with sewerage undertakers, home owners and farmers in local areas to follow up actions arising from reported pollution incidents and improve water protection.

Table 1.20: Overall Water Framework Directive (2000/60/EEC) classification of trophic indicator quality elements for 21 lakes in Northern Ireland, 2012-2014 *(based on Total Phosphorus (TP), phytoplankton, macrophytes and diatoms)*

WFD CLASS	2015 Classification	
	Number of Sites (n=21)	% of Sites
HIGH	2	9 %
GOOD	3	14 %
MODERATE	6	29 %
POOR	6	29 %
BAD	4	19 %

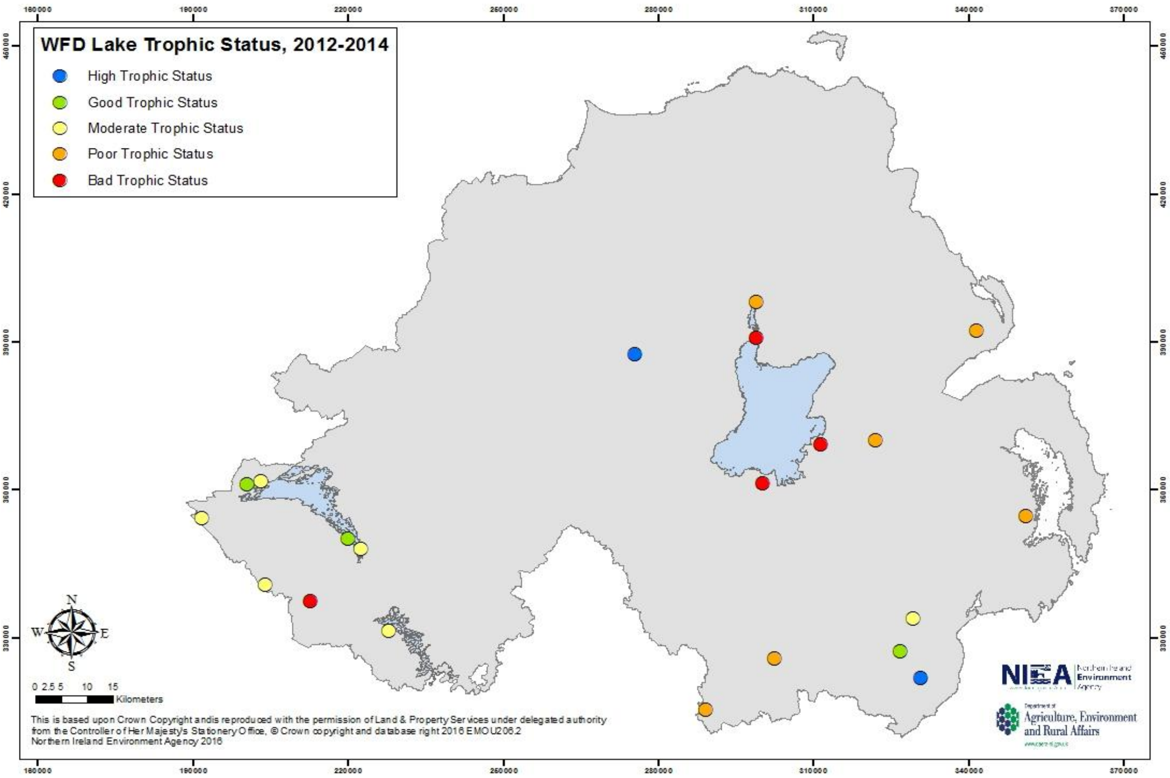


Figure 1.23: Overall WFD trophic classes across Northern Ireland 21 lake monitoring stations in the period 2012-2014 *(based on TP, phytoplankton, macrophytes and diatoms)*

For the purposes of this report, data which describes eutrophic state reported in the ReportNet tables is based solely on classification of total phosphorus (TP) and chlorophyll-α. These are discussed in the following paragraphs separately without the supporting biological parameters (but these can be supplied if requested).

1.6.1 Total phosphorus

Previously, the trophic status of lakes was assessed and reported using the Organisation for Economic Co-operation and Development (OECD, 1982) classification scheme, based on concentrations of TP. To demonstrate transparency in the use of WFD standards in place of OECD and for temporal comparative purposes Northern Ireland has assessed data from 2009-2011 and 2012-2014 using the latest version of the WFD Lake TP reference boundary calculator (v4) to obtain a TP classification. This review is based on 2012 and 2015 lake TP classifications. Twenty-one lakes in Northern Ireland were routinely monitored on a monthly basis for TP for both classification periods. The same 21 lakes were monitored during both reporting periods.

Table 1.21: Total Phosphorus, classification in Northern Ireland, 2009-2011 and 2012-2014

Reporting Period (n=21)	High	Good	Moderate	Poor	Bad
2009-2011	6	2	4	7	2
2012-2014	5	4	3	7	2

Table 1.21 shows that of the 21 lakes monitored for TP in the previous reporting period (2009-2011), eight lakes were classed as High/Good. Thirteen lakes had TP classifications less than Good which is indicative of nutrient enrichment or considered to be eutrophic. Of these, seven (Lough Ross, Lough Beg, Clea Lakes, Lough Gullion,

Lough Mourne, Stoneyford and Cam Lough) were classified as Poor status for TP, considered to be eutrophic. Two lakes were classified as Bad status for TP in the previous reporting period (Lough Neagh and Portmore), indicative of hypertrophic conditions (Figure 1.24).

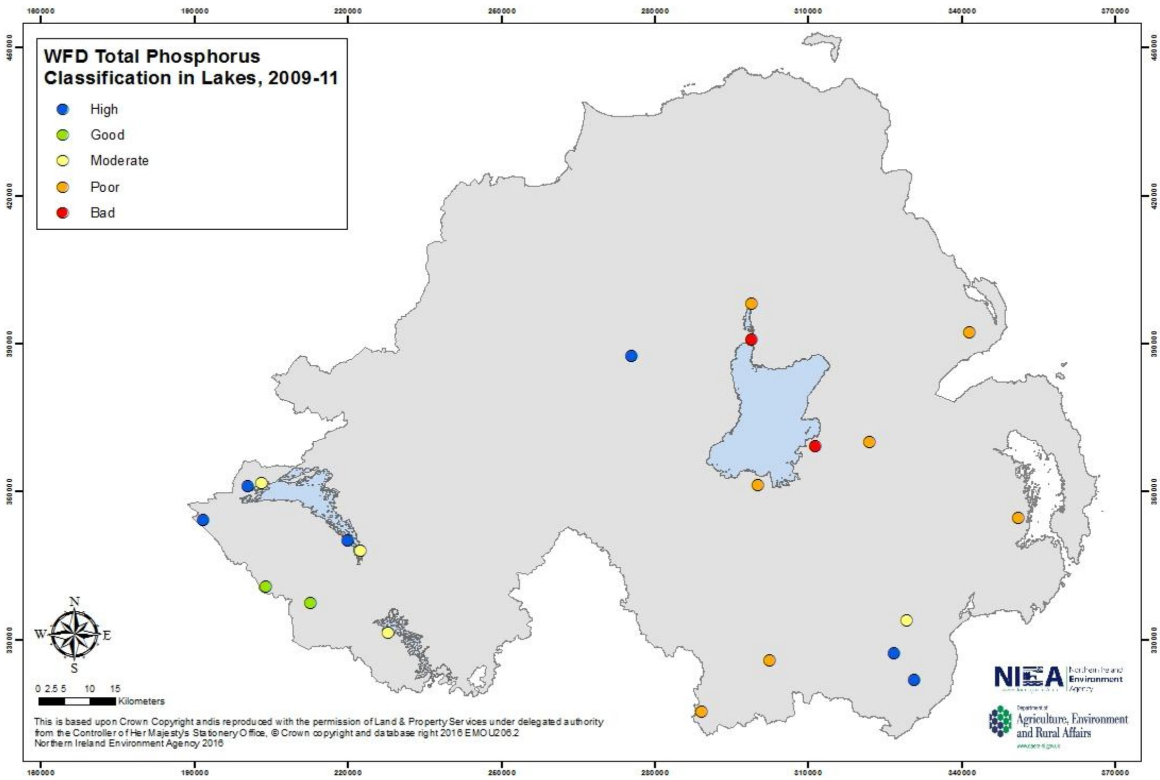


Figure 1.24: WFD Total Phosphorus classification in lakes, 2009–2011

In the current reporting period (2012-2014), nine lakes were classed as High/Good. This is a slight improvement from the previous reporting period as Lower Lough Erne at Kesh improved from Moderate to Good TP status. Twelve lakes had TP classifications less than Good which is indicative of nutrient enrichment or considered to be eutrophic. Of these, seven lakes were classified as Poor status for TP, which are considered to be eutrophic (the same lakes as the in the previous reporting period). Lough Neagh and Portmore Lough were classified as Bad status for TP classification which is indicative of hypertrophic conditions (Figure 1.25).

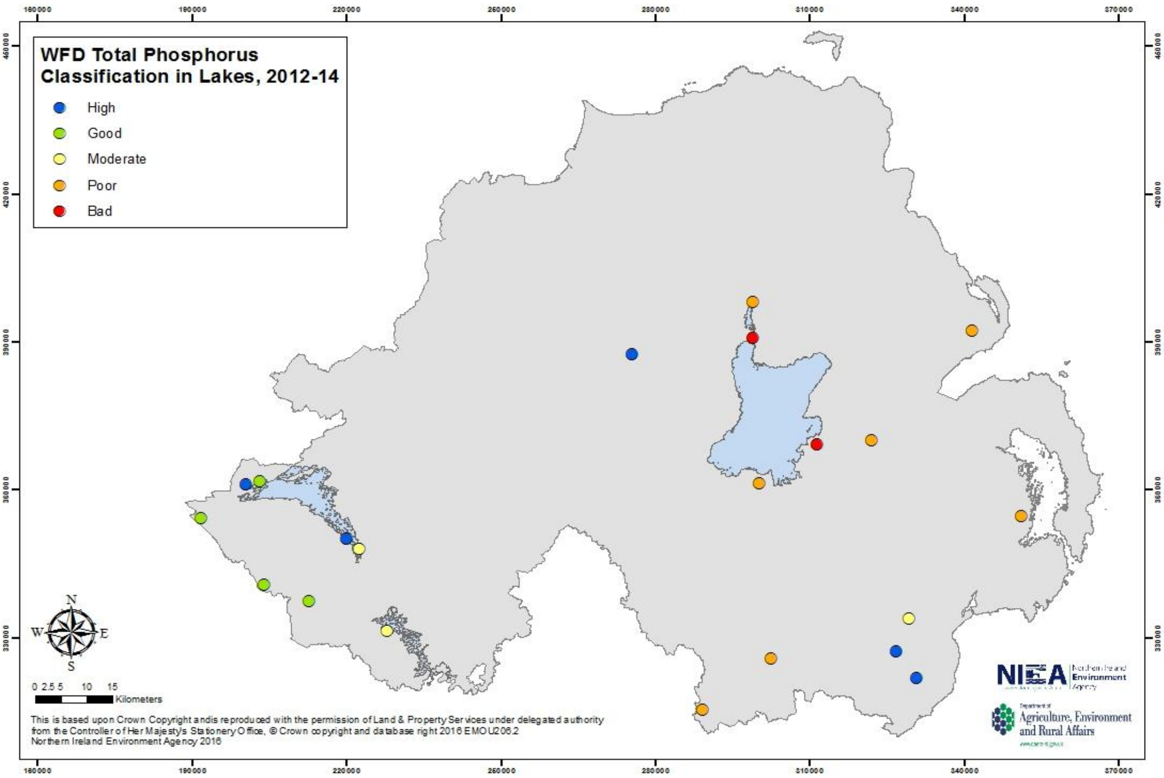


Figure 1.25: WFD Total Phosphorus classification in lakes, 2012-2014

Overall changes shown in Table 1.22 indicate that for the 21 common lake monitoring sites, one lake, Lower Lough Erne at Kesh has shown improvement in WFD TP classification between the reporting periods, improving Moderate to Good status. Nineteen lakes remained stable between the previous and the current reporting periods, one lake showed deterioration. Lough Melvin deteriorated from High to Good status for TP classification. Overall, for the majority of the 21 lakes monitored in Northern Ireland the TP classification status has remained stable between the reporting periods (Figure 1.26).

Table 1.22: Changes in WFD Total Phosphorus classification in lakes between former and current reporting periods (numbers and % of lake sampling points)

	Number and % of points				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Lakes WFD TP classification (n=21)	0	1	19	1	0
	0 %	4.8 %	90.4 %	4.8 %	0 %

[1] *Strong Decrease = ≥2 improvements in class*
[2] *Weak Decrease = 1 improvement in class*
[3] *Stable = No change in class*
[4] *Weak Increase = 1 deterioration in class*
[5] *Strong Increase = ≥2 deteriorations in class*

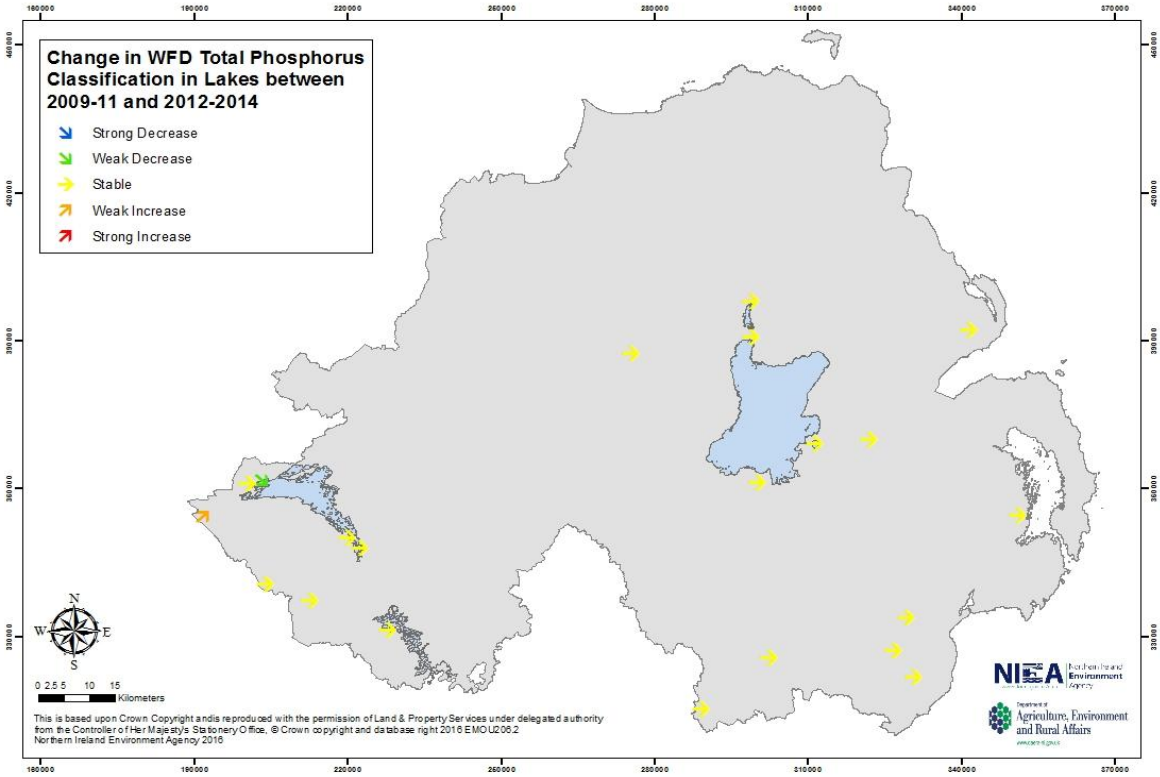


Figure 1.26: Change in WFD Total Phosphorus classification in lake sampling sites between previous and current reporting period, 2009-2011 and 2012-2014.

1.6.2 Chlorophyll-α

Previously, the trophic status of lakes was assessed and reported using the Organisation for Economic Co-operation and Development (OECD, 1982) classification scheme, based on concentrations of chlorophyll-α. To demonstrate transparency in the use of WFD standards in place of OECD and for temporal comparative purposes, Northern Ireland has assessed data from 2008-2011 and 2012-2015 using the latest version of the WFD PLUTO Single Site Calculator (V4h). Only the chlorophyll-α component of the PLUTO classification tool will be considered in this section of the report, without the supporting biological data and only summer data is included (April to October). In the reporting period 2008–2011, 21 lakes in Northern Ireland were routinely monitored on a monthly basis for chlorophyll-α. In the period 2012-2015, the same 21 lakes were routinely monitored.

Table 1.23: WFD chlorophyll-α classification in Northern Ireland, 2008-2011 and 2012-2015

Reporting Period (n=21)	High	Good	Moderate	Poor	Bad
2008-2011	6	8	4	3	0
2012-2015	5	8	4	4	0

Table 1.23 shows that of the 21 lakes monitored for chlorophyll-α in the previous reporting period (2008-2011), 14 lakes were classed as High/Good. Seven lakes had chlorophyll-α classifications less than Good which is indicative of nutrient enrichment. Of these, three (Lough Neagh, Lough Ross and Cam Lough) were classified as Poor chlorophyll *α,* considered to be eutrophic. No lakes were classified as Bad status for chlorophyll-α in the previous reporting period (Figure 1.27).

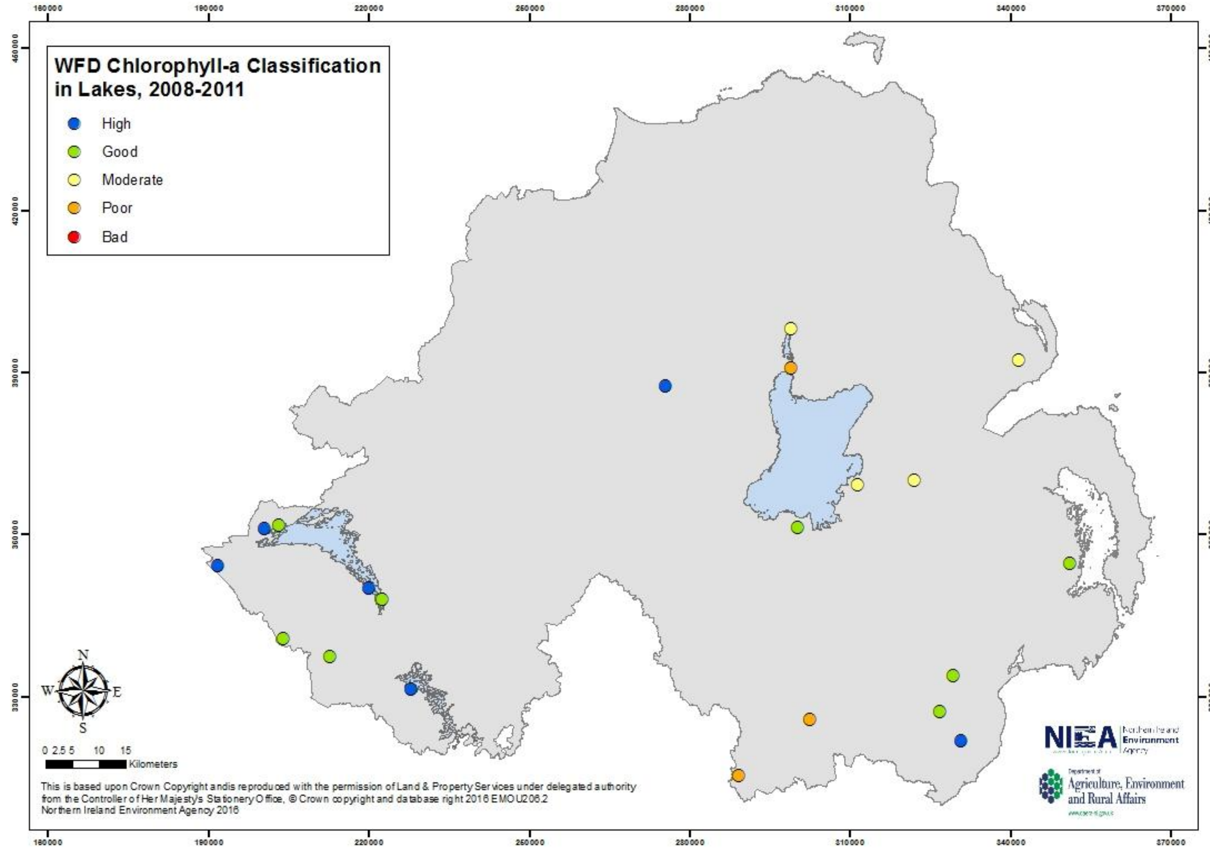


Figure 1.27: WFD chlorophyll-α classification in lakes, 2008–2011

In the current reporting period (2012-2015), 13 lakes were classed as High/ Good. Four lakes (Lough Island Reavy, Lough Mourne, Lough Ross and Lough Beg) were classed as Moderate status for chlorophyll-α which indicates that they may become eutrophic. Four lakes (Lough Neagh, Stoneyford, Cam Lough and Portmore Lough) were classed as Poor status for chlorophyll-α which is indicates eutrophic conditions. No lakes were classified as Bad status for chlorophyll-α in the current reporting period (Figure 1.28).

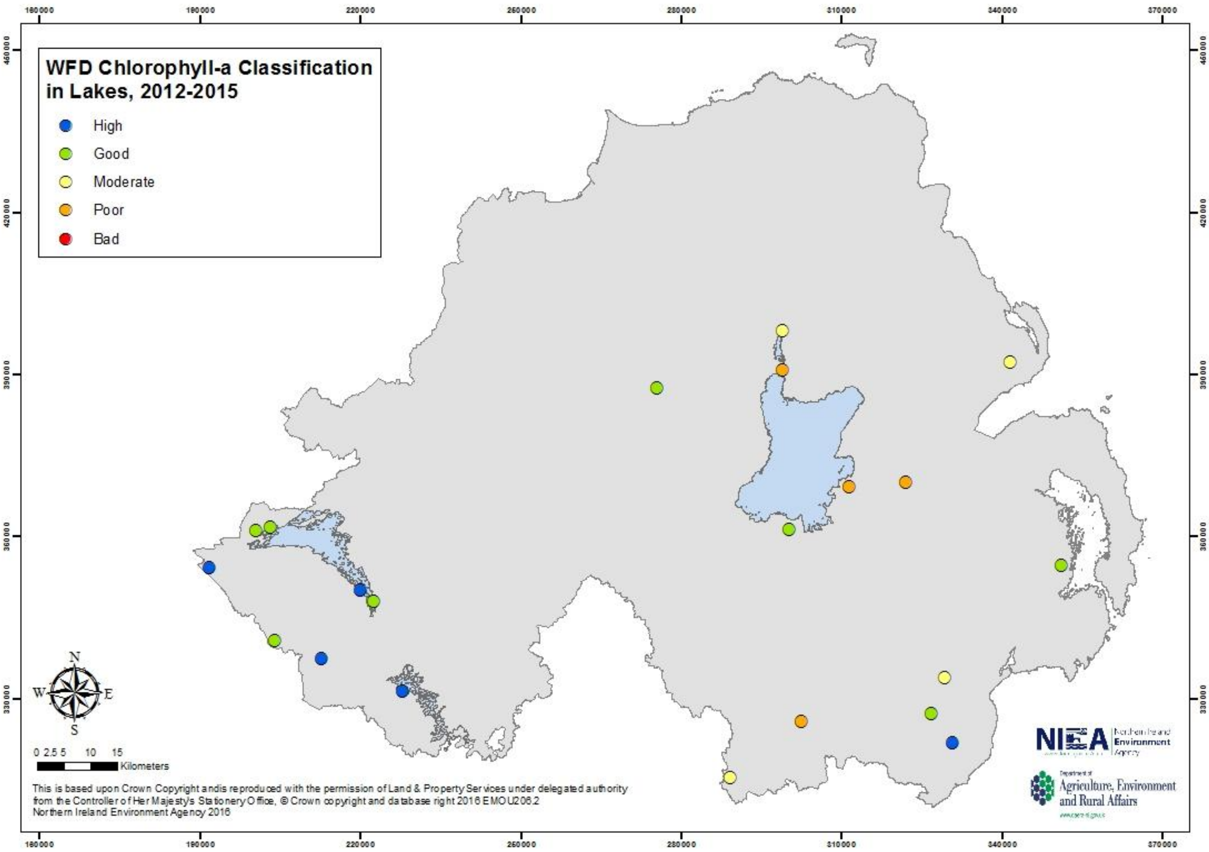


Figure 1.28: WFD chlorophyll-α classification in lakes, 2012-2015

Overall changes shown in Table 1.24 indicate that for the 21 common lake monitoring stations, two lakes (Lower Lough MacNean and Ross) have shown improvement in chlorophyll-α WFD classifications between the reporting periods. The levels of chlorophyll-α have decreased in the two lakes and Lower MacNean improved from Good to High status whilst Lough Ross improved from Poor to Moderate for chlorophyll-α status. Fourteen lakes remained stable between 2008-2011 and 2012-2015 reporting periods, however, five lakes - Lough Fea, Lough Scolban, Lough Island Reavy, Stoneyford and Portmore Lough have shown deterioration. Lough Fea and Lough Scolban deteriorated from High to Good status, Lough Island Reavy deteriorated from Good to Moderate status and Stoneyford and Portmore Lough deteriorated from Moderate to Poor status. Further investigation of these lakes is planned as part of the second cycle River Basin Management Plans (RBMPs). Overall, for the majority of the 21 lakes monitored in Northern Ireland the trophic status has remained stable between the reporting periods (Figure 1.29).

Table 1.24: Changes in lake WFD chlorophyll-α classification between former and current reporting periods (numbers and % of lake sites)

	Number and % of sites				
	Strong decrease[1]	**Weak decrease**[2]	**Stable**[3]	**Weak increase**[4]	**Strong increase**[5]
Lakes WFD chlorophyll-α classification (n=21)	0	2	14	5	0
	0 %	9.5 %	66.7 %	23.8 %	0 %

[1] Strong Decrease = ≥2 improvements in class
[2] Weak Decrease = 1 improvement in class
[3] Stable = No change in class
[4] Weak Increase = 1 deterioration in class
[5] Strong Increase = ≥2 deteriorations in class

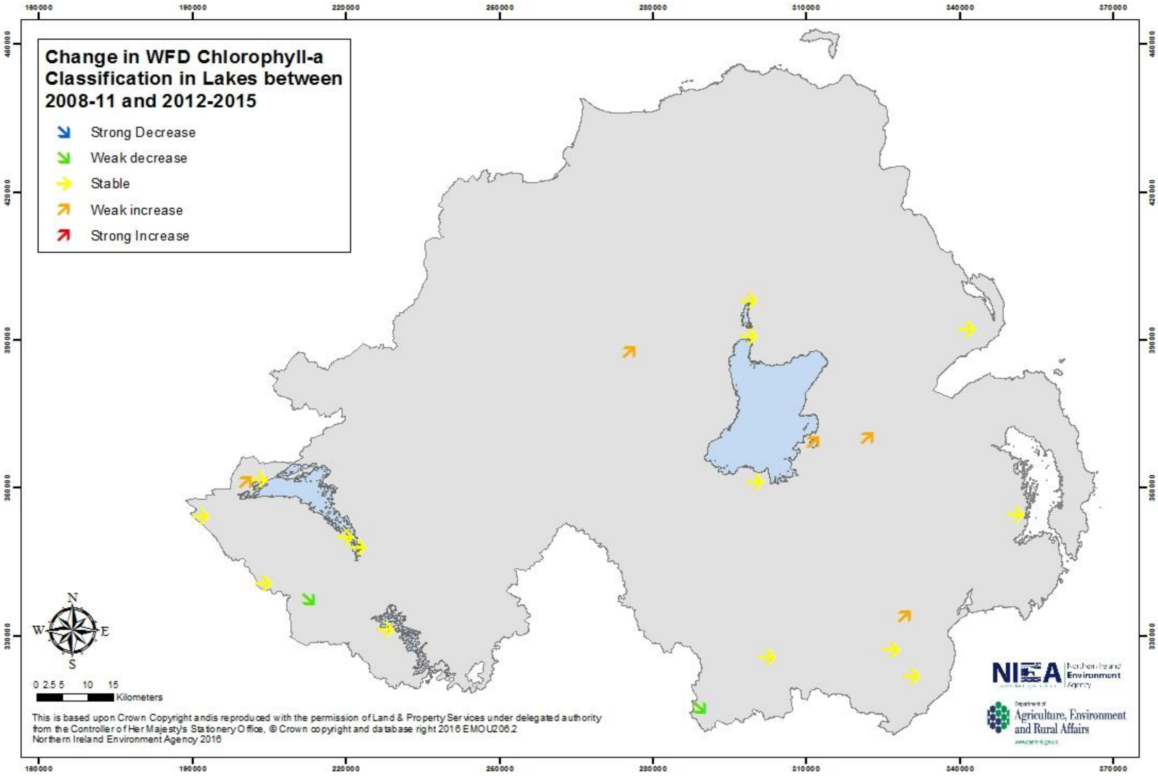


Figure 1.29: Change in WFD chlorophyll-α classification in lakes sites between previous and current reporting period.

1.7 Current Water Framework Directive (2000/60/EEC) assessment of trophic status of transitional and coastal marine waters

The DAERA Environment, Marine and Fisheries Group carry out monitoring of causative and biological response parameters in transitional and coastal waters Through six-yearly reviews, carried out for the WFD and corroborative assessments for OSPAR and the UWWTD the pressures that lead to high nutrient concentrations in estuaries are assessed along with the likely effectiveness of current and proposed regulatory actions.

OSPAR adopted the Common Procedure for the Identification of the Eutrophication Status of the Maritime Area of the OSPAR Convention in September 1997 (OSPAR 97/15/1, Annex 24). This procedure comprises two steps. The first step is a Screening ("broad brush") Procedure to identify areas which in practical terms are likely to be non-problem areas with regard to eutrophication. The second step is the Comprehensive (iterative) Procedure which should enable the classification of the maritime area in terms of problem areas, potential problem areas and non-problem areas with regard to eutrophication. Following application of the Screening Procedure, the Western Irish Sea and the offshore marine areas to the north of Northern Ireland (Minch-Malin) were not considered to be eutrophic, leaving only the inshore coastal and transitional water bodies described in the WFD to be assessed via the Common Procedure (see link to OSPAR report in references page) and subsequently via WFD assessment tools.

The OSPAR Riverine Inputs and Direct Discharges monitoring programme (RID) estimates the river borne and direct inputs of nutrients to the waters covered by the WFD marine review. This gives an overview of annual loadings to receiving marine waters and provides a confirmation of data assessments and a focus for monitoring. The main pressures covered are nutrients arising from agriculture, wastewater treatment plants and industrial installations and aquaculture.

Significant reductions in nitrates and phosphorus inputs have been realised in recent years following application of the UWWTD. Atmospheric nitrogen and ammonia emissions have also decreased and are expected to decrease further in future as implementation of existing legislation continues, and new controls are introduced for activities such as shipping.

Water Framework Directive

To meet the aims of the WFD, for at least ‘good’ ecological status, more rigorous application and implementation of the Nitrates Directive, together with changes in the Common Agriculture Policy (CAP) and farming practice have been required. Even then, the slow response of the natural environment to change and the inherent variability of estuaries means that their responses may not be as predicted. Focused monitoring plans are needed to investigate the relationship between policy drivers and environmental responses, and to ensure actions taken will achieve the planned results.

Despite differences in the process of the overall quality classification of a water body with regard to its eutrophication status, a considerable degree of coherence has been achieved in setting the relevant boundaries for quality classes in OSPAR and under the WFD for the purpose of identifying the eutrophication status of a water body.

WFD does not specifically define eutrophication. Yet, the “good ecological status”, one of the two elements of “good water status” to be achieved under WFD, is primarily concerned with the biological balance of organisms which is also relevant in the eutrophication context.

Urban Waste Water Treatment Directive

The WFD since its adoption in 2000 has introduced additional controls over nutrients. This includes compliance with nutrient standards and ecological standards. Sensitive areas (eutrophic) under the UWWTD are Protected Areas under WFD and compliance with the UWWTD is a basic measure under the WFD River Basin Management Plans (RBMPs). WFD nutrient and biology standards are being applied to identify eutrophic water bodies. Sources of nutrients can then be controlled via measures under the UWWTD, action programmes under the ND and/or by other measures under the WFD.

The UWWTD review for the 2008–2013 period provided a trophic status assessment of the marine and freshwaters of Northern Ireland using the WFD assessment methods, as agreed by the UK Technical Advisory Group (UKTAG) in 2008. In Northern Ireland the approach for sensitive area identifications is on a catchment basis but the review detail is on a water body basis as defined under the WFD. The review is also based on a ‘weight of evidence approach’ in deciding whether the surface waters in a catchment should be recommended for identification as a sensitive area (eutrophic). The results presented under the WFD assessment of marine water bodies in Northern Ireland are broadly in agreement with previous assessments carried out under the ND and UWWTD to date.

When monitoring programmes were established to address the requirements of WFD, existing transitional and coastal marine sites were rationalised, and new sites were added to provide more comprehensive monitoring coverage. In addition to fixed point surveys, nutrient monitoring transects are also included. The outcome of this process led to a change in the methodology for assessment of nutrient inputs, as assessment at the water body level was required. The current monitoring network provides a much more representative dataset for assessment (Figures 1.30 and 1.31). The increase in monitoring intensity (including novel coastal transect surveys) reflects the need to address the additional demands of WFD drivers since 2008.

All of the relevant parameters are not monitored at all sites every year but rather rotated on a ‘rolling program’ basis annually to focus on areas of concern with known pressures. Therefore, reporting of trends for the purposes of this report is carried out at the water body level. This process also means that the ‘true’ or accurate assessment status of a water body becomes clear with time and can lead to some variation in status class over assessment cycles.

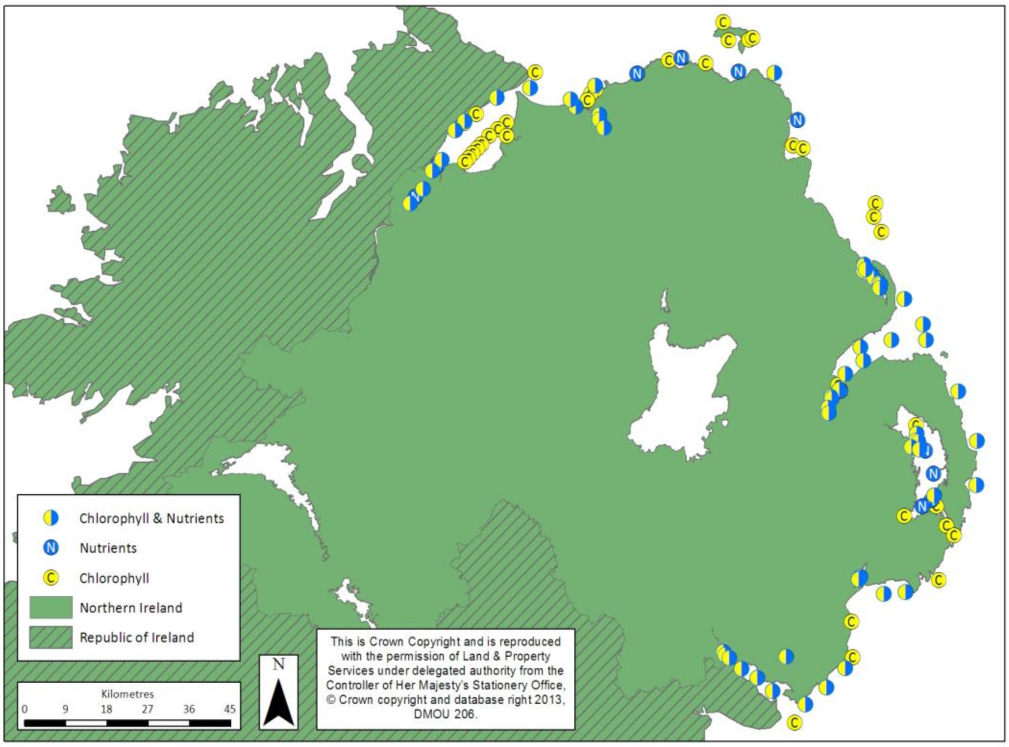


Figure 1.30: Northern Ireland marine monitoring station network assessed for 2012-2015 reporting period

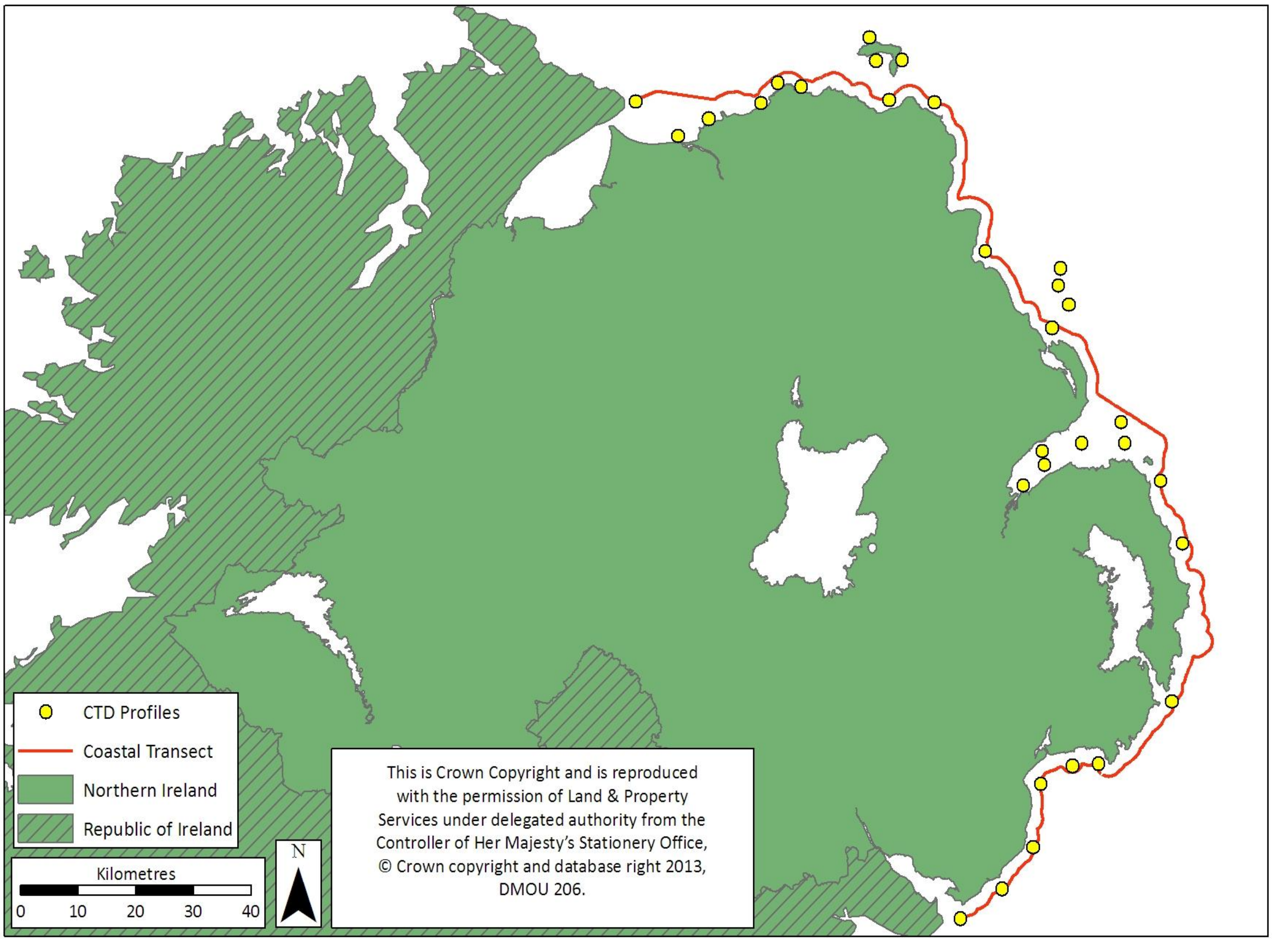


Figure 1.31: Northern Ireland Coastal monitoring transect and water column profile stations assessed 2012-2015

1.7.1 Water Framework Directive (WFD) marine assessment methods

Degree of Nutrient Enrichment: Dissolved Inorganic Nitrogen (DIN)

Nutrient inputs to marine waters are assessed using the winter mean of DIN. The thresholds for high and good status are based on the thresholds developed for UK assessments made for the OSPAR Convention. The boundary between high and good status is given as OSPAR's "background" value. The boundary between good and moderate is OSPAR's "Assessment Level". This reflects the natural variability in water quality, plus a "slight" disturbance, as defined by OSPAR. This has been used to define offshore thresholds and reference conditions for the WFD. The UK WFD Technical Advisory Group (UKTAG) proposed inshore and offshore threshold values related to salinity for the assessment of transitional and coastal marine waters. DAERA Marine Division have used the UK WFD DIN classification tool to place water bodies in high, good, moderate, poor and bad status using the boundaries in the threshold Table 1.25.

Table 1.25 - WFD Dissolved Inorganic Nitrogen (DIN uMol/L) thresholds for Coastal and Transitional waters

Area	Salinity range	DIN (µM) HIGH	DIN (µM) GOOD	DIN (µM) MODERATE	DIN (µM) POOR	DIN (µM) BAD
Coastal (at salinity 32)	30-34.5	<12	≥12 ≤18	>18 ≤27	>27 ≤40.5	>40.5
Transitional (at salinity 25)	<30	<20	≥20 ≤30	≥30 ≤45	≥45 ≤67.5	>67.5

The distribution of inorganic nitrogen and phosphorus, and bioassay experiments specific to both, shows that nitrogen is the critical limiting factor to algal growth and eutrophication in coastal marine waters, and that any ecological impact in coastal waters is less likely to be caused by phosphorus. In transitional waters, the growth limiting nutrient can fluctuate between nitrogen and phosphorus, and in these situations, nitrogen and phosphorus removal need to be considered. DAERA Marine Assessment monitors nitrogen only during the winter period defined as November–February. This is in the form of on winter dissolved inorganic nitrogen (DIN) (DIN = NO_2 + NO_3 + NH_4) which is assessed in the winter period in the presumed absence of significant plant growth. This is the primary criterion and is used in each assessment area/salinity regime, normalised to the relevant salinity. Northern Ireland have used winter dissolved inorganic phosphorus (DIP) historically as a primary criterion, but only when assessment of the winter DIN/DIP (DIP = Dissolved Inorganic Phosphorus) ratio suggested phosphorus limitation.

The boundary between good and moderate WFD status is OSPAR's "Assessment Level". This reflects the natural variability in water quality, plus a "slight" disturbance, as defined by OSPAR (It is actually OSPAR's "background", increased by 50 per cent). The UKTAG used this to define offshore thresholds and reference conditions for the WFD.

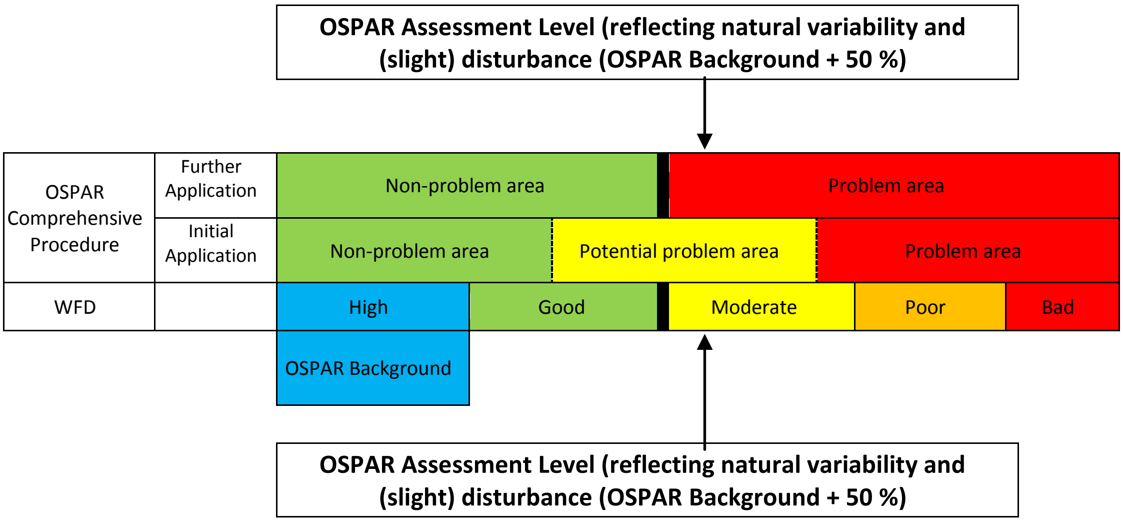


Figure 1.32 - Harmonisation of OSPAR Comprehensive Procedure classes and Water Framework Directive status class

The UKTAG then derived standards for coastal and transitional waters that are related to salinity. This provides single values for UK offshore, coastal and transitional waters (normalised for salinity) for:-

- reference values (or the boundary between high and good status);
- threshold values (or the boundary between good and moderate status).

Marine transitional and HMWBs are a natural receptacle for runoff from their catchments and, therefore, show a natural tendency for nutrient accumulation and eutrophication. They tend to be inshore, semi-enclosed waters and areas of restricted natural exchange, whose dynamics and eutrophication risk depends on the rate of water exchange with the sea; they include estuaries and tidal river stretches, and comprise a large proportion of eutrophic areas in Northern Ireland. This is due largely to the impacts of upstream agricultural inputs and storm discharges from sewage treatment works and their related nutrient introductions. This is reflected in Figure 1.33.

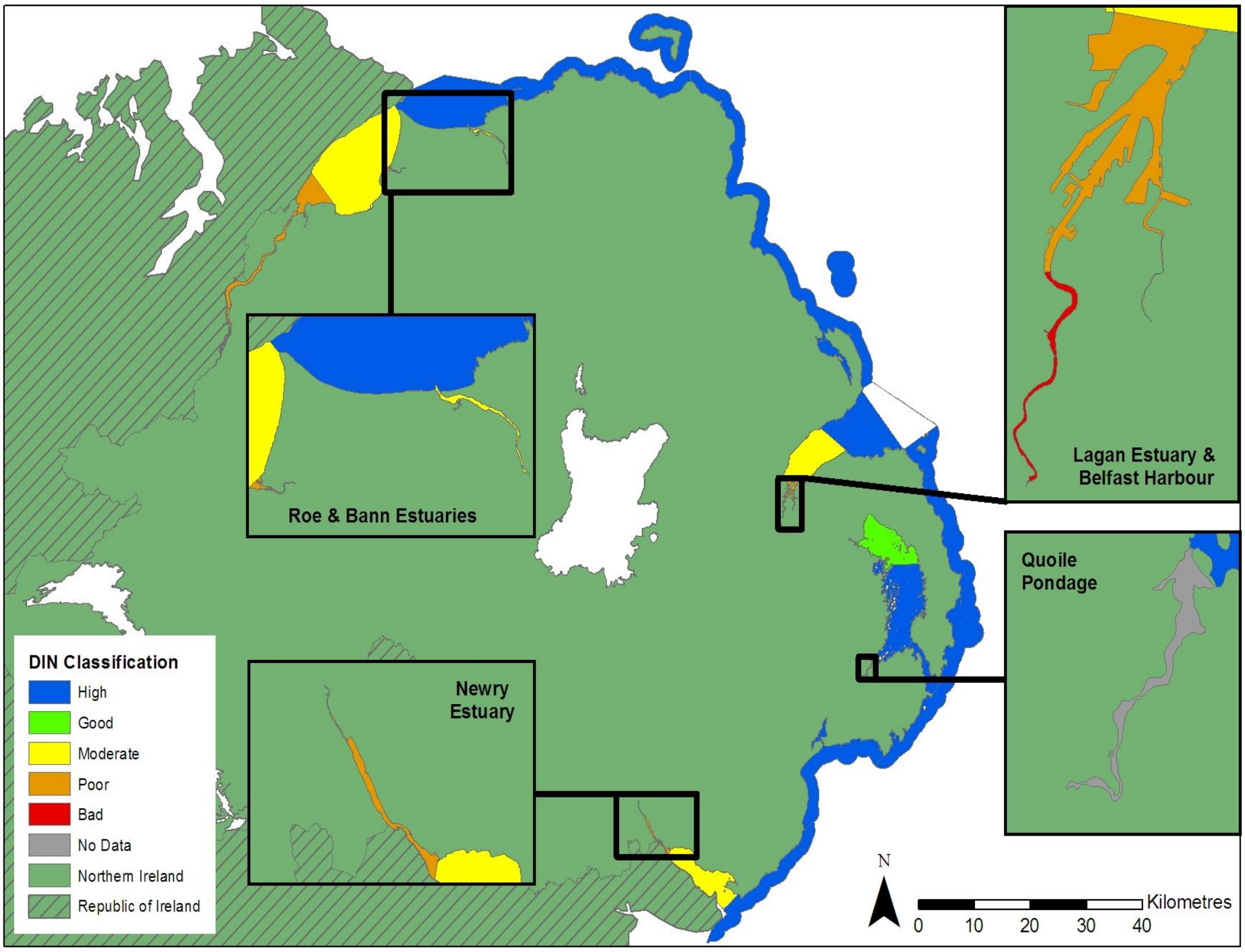


Figure 1.33: Northern Ireland water body classification based on the Water Framework Directive (2000/60/EEC) DIN (Dissolved Inorganic Nitrogen) tool. Small transitional water bodies difficult to identify at this scale are labelled

Chlorophyll-α

Measurements of chlorophyll-α, used as an estimate of phytoplankton biomass, are included in most eutrophication assessment monitoring programmes. Chlorophyll-α biomass is assessed as a 90th percentile against accepted threshold standards (see Table 1.26). Elevated chlorophyll biomass (moderate or worse status) can be indicative of nutrient enrichment, as increased chlorophyll-α concentrations mainly occur in nutrient-enriched waters.

Table 1.26: Reference Thresholds for Water Framework Directive (2000/60/EEC) Coastal Chlorophyll-α tool

Water Ref. Area		Status				
		High	Good	Moderate	Poor	Bad
North/Irish Sea	Chl ug l^{-1}	<5	5-10	10-15	15-20	>20
	Ecological Quality Ratio (EQR)	0 -1.0	1.0-0.8	0.8-0.6	0.6-0.4	0.4-0.2

Table 1.27: Reference Thresholds for Water Framework Directive (2000/60/EEC) Transitional Chlorophyll-α tool

		EA Boundaries				
		High	Good	Moderate	Poor	Bad
10 (5 sub-metrics for each zone) (2 salinity zones present) 1-25psu & >25-35psu	Face Value (passes)	9	7	5	3	<2
	Ecological Quality Ratio (EQR)	0.9	0.7	0.5	0.3	0
5 (only 1 salinity zone present)	Face Value (passes)	4	3	2	1	0
	Ecological Quality Ratio (EQR)	0.8	0.6	0.4	0.2	0

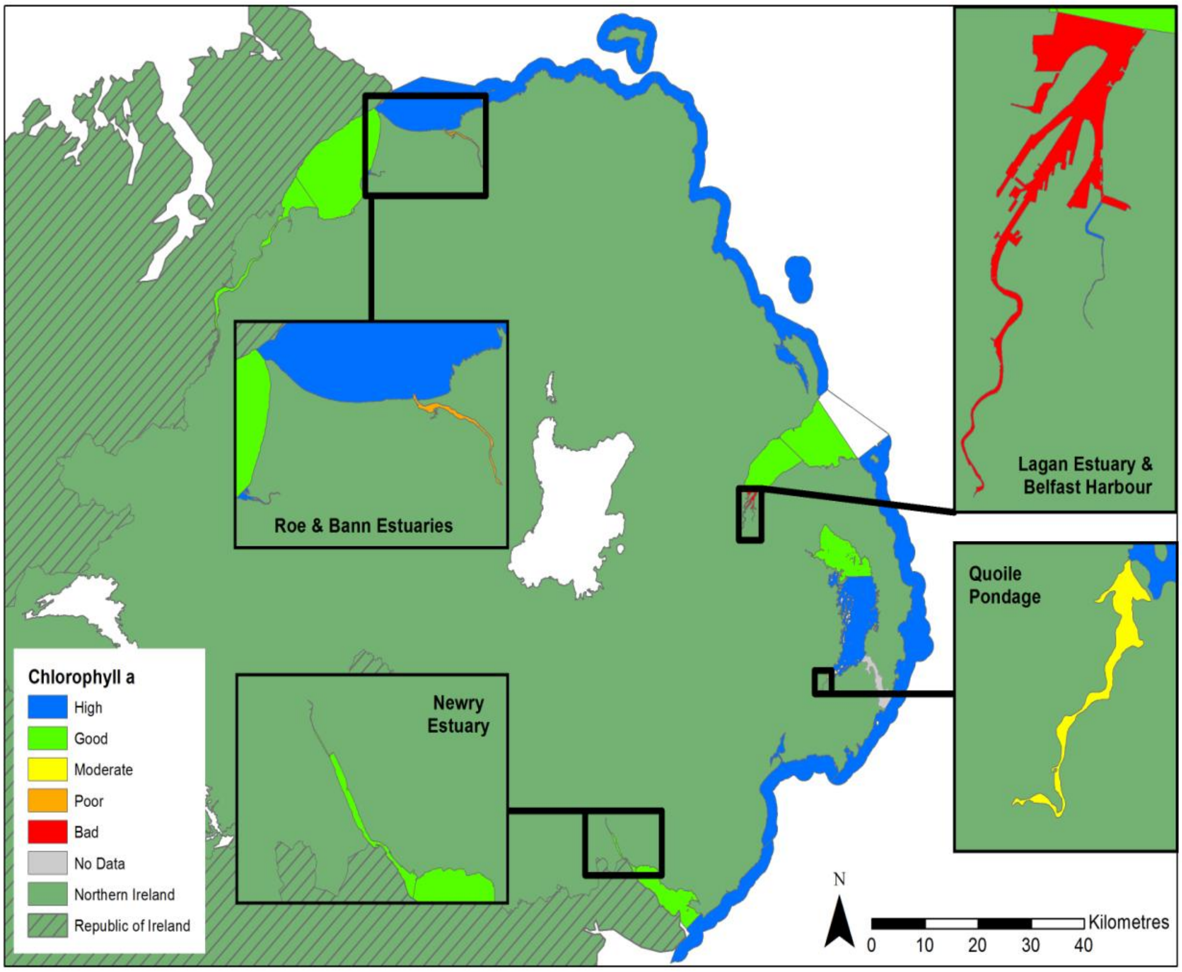


Figure 1.34: Northern Ireland marine water body classification based on the 90th Percentile Chlorophyll-α Tool. Small water bodies difficult to identify at this scale are labelled

1.7.2 Assessment methods for macroalgae:

Plant tools are utilised to monitor the growth of green algal species which can form dense mats in response to localised nutrient enrichment. The tool for marine macroalgae uses basic indices to assess nutrient enrichment and disturbance pressures; and specifically the Macroalgal Blooming Tool (MBT) is designed to determine the extent of algal cover and associated biomass of green algal species which develop in response to local nutrient enrichment pressure.

The assessment methods for macroalgae were developed for the WFD. Status is classified into five categories from high to bad status. Moderate to bad status is indicative of pressure such as nutrient enrichment and eutrophication. The Reduced and Full Species List (RSL) for marine macroalgae uses basic indices to assess nutrient enrichment and disturbance pressures. The use of this tool is restricted to rocky shore environments. The indices are:-

- shore description;
- species richness;
- proportion of chlorophyta (green seaweed);
- proportion of rhodophyta (red seaweed); and
- Ecological Status Group ratio (ESG ratio) indicates shift from a pristine state (EGS1 – late successionals or perennials) to a degraded state (ESG2 – opportunistic or annuals); and proportion of opportunists.

The Macroalgal Blooming Tool (MBT) is designed to determine the extent of algal cover and associated biomass of green algal species which develop in response to local nutrient enrichment pressure. The use of this tool is restricted to specific sedimentary habitats which favour the growth of green algal species which form dense mats in response to localised nutrient enrichment. The indices are:-

- total extent of macroalgae bed;
- % cover of available intertidal habitat at site (derived measure) and at quadrant level;
- biomass of opportunistic macroalgal mats (g m-2);
- biomass over available intertidal habitat; and
- presence of entrained algae.

Angiosperm (Seagrass) is reported as an Ecological Quality Ratio (EQR). An EQR with a value of one represents reference conditions and a value of zero represents a severe impact. The EQR is divided into five ecological status classes (high, good, moderate, poor and bad) that are defined by the changes in the biological community in response to disturbance. Once the EQR score and ecological status class have been calculated an assessment must be made to consider the certainty of the classification (i.e. confidence in the assigned class). The basic indices are:-

- Taxonomic composition – seagrass species present.
- Shoot density – measured as the estimated percentage cover of seagrass using ≤1m^2 quadrates in a sampling grid.
- Bed extent – measured as area cover in m^2 of the continuous bed (deemed to be at >5 % shoot density) and, where possible, the whole bed (<5 % shoot density).

1.7.3 Indirect effects: Dissolved Oxygen

The amount of oxygen dissolved in a water body is an indication of the degree of health of the area and its ability to support a balanced aquatic ecosystem. The discharge of an organic waste or nutrient to a water body imposes an oxygen demand on it. If there is an excessive amount of organic matter, the oxidation of waste by microorganisms will consume oxygen more rapidly than it can be replenished. When this happens, the dissolved oxygen (DO) is depleted and can have detrimental effects on the higher forms of life. DO classification is based on comparison of a 5th percentile against WFD reference standards.

Table 1.28: Dissolved Oxygen thresholds for transitional and coastal marine waters

WFD Status	Marine 5 %ile	Objectives
HIGH	≥5.7 mg/L	All life stages of salmonids and transitional fish
GOOD	≥4.0 <5.7 mg/L	Presence of salmonids and transitional fish
MODERATE	≥2.4 <4.0 mg/L	Most life stages of non-salmonid adults
POOR	≥1.6 <2.4 mg/L	Presence of non-salmonids, poor survival of salmonids
BAD	<1.6 mg/L	No salmonids present, marginal survival of resident species

NB: Dissolved Oxygen (DO) assessment is carried out for all transitional and coastal marine water bodies and is based on site profiling and a combination of continuous monitoring using mooring buoys and vessel transect monitoring data. Hence, site and sample numbers cannot be assigned.

1.7.4 Overall trophic assessment of transitional and coastal marine waters.

Nutrient assessment (Winter DIN)

Over the assessment period of the report, four coastal water bodies (Belfast Harbour, Belfast Lough Inner, Lough Foyle and Carlingford Lough) fell below good status for DIN. All of the transitional water bodies monitored failed the nutrient standard significantly and consistently.

There are a number of water bodies where assessment status annually fluctuates above and below the good/moderate boundary for DIN and this produces a status assessment that requires corroboration through the biological tools outlined above.

The overall combined assessment of direct and indirect eutrophication related parameters demonstrates changes in status over the period of this report (Figure 1.35 and Table 1.29). The results of the WFD assessment broadly align with previous assessments under both the ND and the UWWTD.

Table 1.29 illustrates that several Northern Ireland marine water bodies have been below ‘good status’ for WFD assessment in recent years. These have been in areas where there have been long standing issues over nutrient enrichment, and also tend to be transitional and/or HMWB.

Chlorophyll-α assessment

One coastal water body (Belfast Harbour) failed the chlorophyll standard with two transitional areas (Lagan and Bann Estuaries) falling below good status annually and repetitively. In the case of the Bann the nutrient enrichment and subsequent failures in the biological response are attributed to upstream freshwater nutrient sources (>90 % of total). Adjustments to sampling methods around salinity have provided corroborative chlorophyll failures in recent years.

Macroalgal assessment

Inner Dundrum bay is the only water body (where the tool was applicable) to fall below good status for the Macroalgal tool over the assessment period.

Angiosperms
Inner Dundrum bay was the only area where the tool was applicable to fail WFD tool assessment. The 2012 seagrass assessment found that large areas where seagrass had been previously been reported (2003), were no longer present. Instead, these areas were covered in opportunistic algae (see above) which have in all likelihood smothered the underlying seagrass.

Dissolved Oxygen
In general, DO levels tend not to be an issue in coastal marine waters; however some transitional and heavily modified water bodies have exhibited short lived and intermittent yet still significant DO depressions e.g. the barraged Quoile, and the impounded River Lagan.

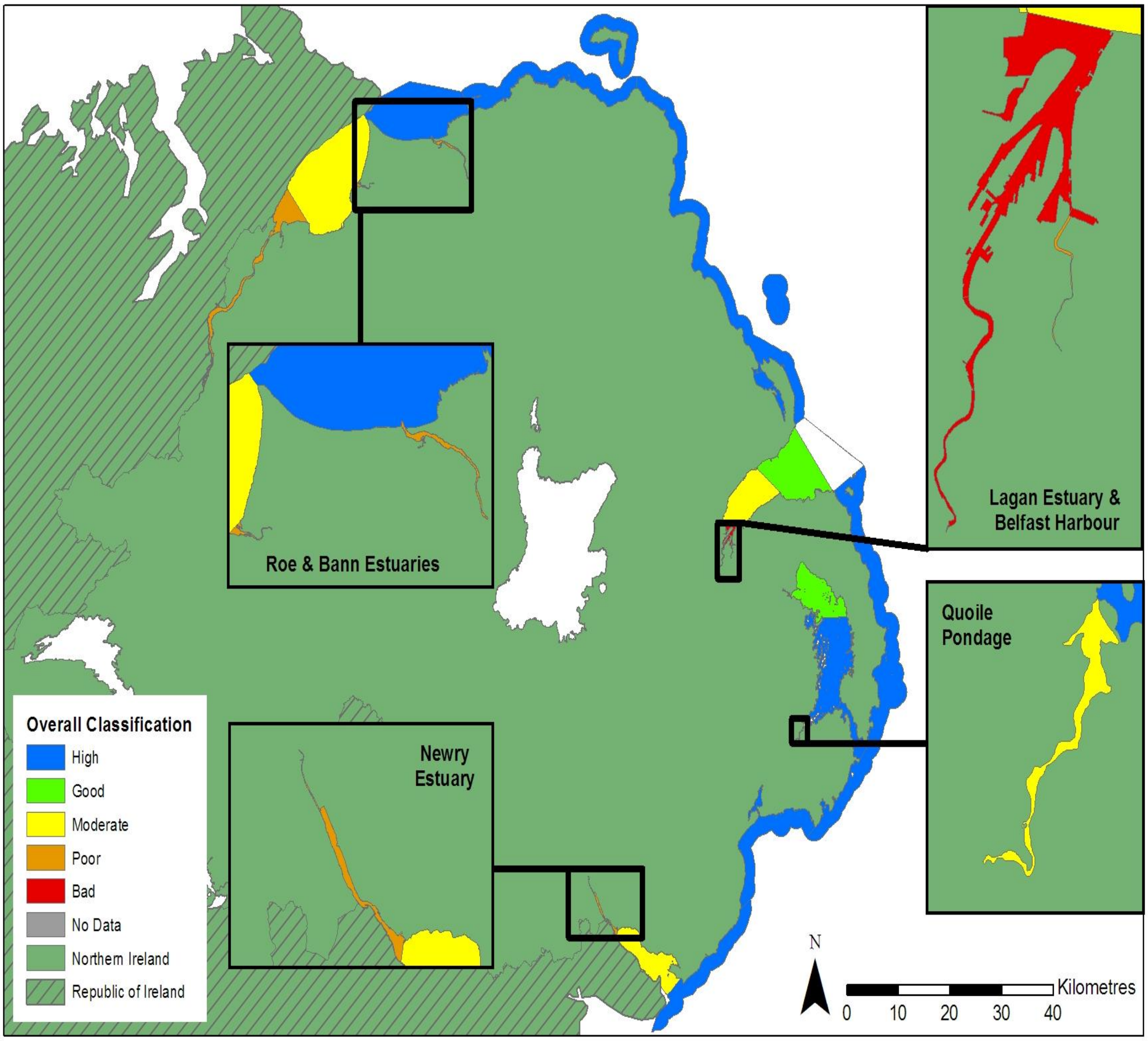


Figure 1.35: Northern Ireland overall water body classification based on the combination of all relevant direct and indirect eutrophication related parameters. Small transitional water bodies difficult to identify at this scale are labelled

Table 1.29: Northern Ireland overall water body classification based on the combination of all relevant direct and indirect eutrophication related parameters

	Nitrates Directive assessment 2012-2015						
Water Body	2012-15 DIN	2012-15 DO	2012-15 Chpl-a	2012-15 MBT	2012-15 RSL	2012-15 Seagrass	2012-15 Overall
Lough Foyle							
Portstewart Bay				TNA		TNA	
Rathlin				TNA		TNA	
North Coast				TNA		TNA	
North Channel				TNA		TNA	
Maidens				TNA		TNA	
Larne Lough North (HMWB)				TNA		TNA	
Larne Lough Mid				TNA		TNA	
Larne Lough South					TNA		
Belfast Lough Outer				TNA		TNA	
Belfast Lough Inner				TNA		TNA	
Belfast Harbour (HWMB)				TNA		TNA	
Ards Peninsula				TNA		TNA	
Strangford Lough North							
Strangford Lough South				TNA		TNA	
Strangford Lough Narrows				TNA		TNA	
Dundrum Bay Outer				TNA		TNA	
Dundrum Bay Inner					TNA		
Mourne Coast				TNA		TNA	
Carlingford Lough							
Foyle and Faughan (HMWB)					TNA	TNA	
Roe Estuary					TNA	TNA	
Bann Estuary (HMWB)				TNA	TNA	TNA	
Lagan Estuary (HMWB)				TNA	TNA	TNA	
Connswater (HMWB)					TNA	TNA	
Quoile Pondage (HMWB)	TNA		TNA		TNA	TNA	
Newry Estuary (HMWB)				TNA	TNA	TNA	

Table 1.30: Timeline of Northern Ireland overall water body classification based on the combination of all relevant direct and indirect eutrophication related parameters for most recent statutory assessments

	ND 2012	OSPAR 2006-14	UWWTD 2015	WFD 2015	ND 2016
Water Body	**Overall**	**Overall**	**Overall**	**Overall**	**Overall**
Lough Foyle	Moderate	Good	Good	Good	Moderate
Portstewart Bay	Good	High	High	High	High
Rathlin	High	High	High	High	High
North Coast	High	High	High	High	High
North Channel	High	High	High	High	High
Maidens	High	High	High	High	High
Larne Lough North (HMWB)	Good	High	Good	High	High
Larne Lough Mid	Good	Good	Good	High	Good
Larne Lough South	Good	Good	Good	High	Good
Belfast Lough Outer	Good	Good	Good	High	Good
Belfast Lough Inner	Moderate	Moderate	Poor	Moderate	Moderate
Belfast Harbour (HWMB)	Moderate	Bad	Bad	Bad	Bad
Ards Peninsula	Good	High	High	High	High
Strangford Lough North	Good	Good	Good	Good	Good
Strangford Lough South	Good	High	Good	High	High
Strangford Lough Narrows	Good	High	Good	High	High
Dundrum Bay Outer	Good	High	Good	High	High
Dundrum Bay Inner	Moderate	Moderate	Poor	Moderate	Moderate
Mourne Coast	Good	High	Good	High	High
Carlingford Lough	Moderate	Moderate	Moderate	Moderate	Moderate
Foyle and Faughan (HMWB)	Moderate	Poor	Moderate	Poor	Poor
Roe Estuary	Moderate	Poor	Moderate	Moderate	Poor
Bann Estuary (HMWB)	Moderate	Poor	Poor	Poor	Poor
Lagan Estuary (HMWB)	Moderate	Bad	Bad	Bad	Bad
Connswater (HMWB)	Moderate	Poor	Poor	Poor	Poor
Quoile Pondage (HMWB)	Moderate	Moderate	Moderate	Moderate	Moderate
Newry Estuary (HMWB)	Moderate	Poor	Poor	Poor	Poor

Table 1.31: WFD status class (by % Water Bodies) of Northern Ireland coastal and transitional marine water bodies for current and previous assessment periods for individual eutrophication related parameters (Dissolved Inorganic Nitrogen (DIN), Dissolved Oxygen (DO), Chlorophyll-α (Chl-α), Macroalgal Blooming (MBT) and Reduced Species List (RSL)) and for overall combined assessment of all chemical and biological quality elements

WFD Status class	DIN		DO		Chl-α		MBT		RSL		Overall	
	2008-2011	2012-2015	2008-2011	2012-2015	2008-2011	2012-2015	2008-2011	2012-2015	2008-2011	2012-2015	2008-2011	2012-2015
HIGH	12	57.69	96.3	88.88	55	61.53	62.5	66.66	83.3	77.77	14.82	40.74
GOOD	52	3.85	0	3.85	35	23.08	25	22.22	11.1	16.66	40.74	14.82
MODERATE	16	15.38	3.7	7.41	5	3.85	12.5	11.11	5.6	5.55	25.93	18.52
POOR	4	19.23	0	0	0	3.85	0	0	0	0	3.7	18.52
BAD	16	3.85	0	0	5	7.69	0	0	0	0	14.81	7.41

Table 1.32: Percentage water body change in status class from assessment 2008-2011 to assessment 2012-2015 using WFD eutrophication related parameters ((Dissolved Inorganic Nitrogen (DIN), Dissolved Oxygen (DO), Chlorophyll-α (Chl-α), Macroalgal Blooming (MBT) and Reduced Species List (RSL)) and overall combined assessment

	DIN	DO	Chl-α	MBT	RSL	Overall
Up two classes	8	0	0	0	0	0
Up one class	48	0	30	0	0	25.93
No change	36	92.59	65	100	94.45	48.15
Down one class	8	7.41	5	0	5.55	14.81
Down two classes	0	0	0	0	0	11.11*

***** In the first phase of intercalibration of WFD tools (to 2009), it was not possible to intercalibrate all biological quality elements in all water categories. This resulted in a delay in the sign-off of some WFD compliant national assessment methods and a lack of data for some quality elements. As a result of a lack of data and data integrity covering the initial period of assessment, it was decided to classify down to moderate overall status at worst, for the first round of classification, whilst indicating status below moderate for individual supporting elements and biological tools.

The UK released a *Programme of Measures* (DEFRA, 2015) relating to the Marine Strategy Framework Directive (MSFD) in December 2015. The measures related to MSFD Descriptor 5 carry the intention that ‘Human-induced eutrophication in UK seas is minimised and all UK marine waters are non-problem areas.’

In Northern Ireland the main existing measures to address the above target are taken through the Northern Ireland second cycle River Basin management plans (RBMPs) developed under the WFD: These include measures to achieve the objectives for specific water bodies, particularly where nitrogen thresholds set under the WFD have resulted in the classification of ‘moderate status’ and an additional assessment of the biological quality indicates that measures to tackle eutrophication are necessary.

The particular types of measures which have been included in RBMPs are mentioned previously in this report and include monitoring and taking steps to reduce nutrientss from sewage treatment works through the creation of ‘UWWT Directive Sensitive Areas’ (most recently Dundrum Bay Inner and Newry River in 2015).

2. Action programme 2015-2018

The Nitrates Action Programme (NAP) is required to be reviewed and, where necessary, revised, at least every four years. There have been two NAPs implemented in Northern Ireland since 2006. Following a scientific review, public consultation and discussion with the Commission, a third NAP for the period 2015-2018 came into effect on 1 January 2015 through the Nitrates Action Programme Regulations (Northern Ireland) 2014 (the 2014 NAP Regulations).

A Nitrates Derogation for Northern Ireland for the period 2015-2018 was also approved under Commission Decision EU 2015/346 following a positive Member State vote at the December Nitrates Regulatory Committee meeting in December 2014. The 2014 NAP Regulations, therefore, continue to include measures to allow derogation from the 170 kg/ha/year N limit up to a limit of 250 kg/ha/year N for intensive grassland farms which meet certain criteria. A summary of the measures contained in the 2014 NAP Regulations is provided at section 4.2.

3 Development, promotion and implementation of the code of good practice

3.1. The status of agriculture in Northern Ireland

Agriculture plays an important role in the Northern Ireland economy. In 2015 it accounted for approximately 1 % of Gross Value Added (GVA) and supports 2.8 % of civil employment in Northern Ireland. It is, therefore, proportionately almost two and a half times as important to the local economy compared to agriculture in the overall UK economy. When food processing is included, the shares of GVA and employment in Northern Ireland rise to 3.2 % and 4.5 % respectively.

There are currently 24,900 farm businesses in Northern Ireland, of which approximately 23 % are regarded as large enough to provide full-time employment for one or more persons (based on a standardised labour requirement). Farm numbers have been declining at an annual average rate of 0.8 % over the past 10 years (Figure 3.1). However, farm numbers increased in the years 2013 and 2015. It is estimated that 48,000 people were engaged in some form of agricultural activity in 2015, although the majority do so on a casual or part-time basis. The size of the agricultural labour force has been reducing at an annual average rate of 0.61 % over the last 10 years. The stabilisation and modest upturn in farm numbers in recent years, reflects an increase in farm business demergers, as activities such as poultry are separated from the parent farm.

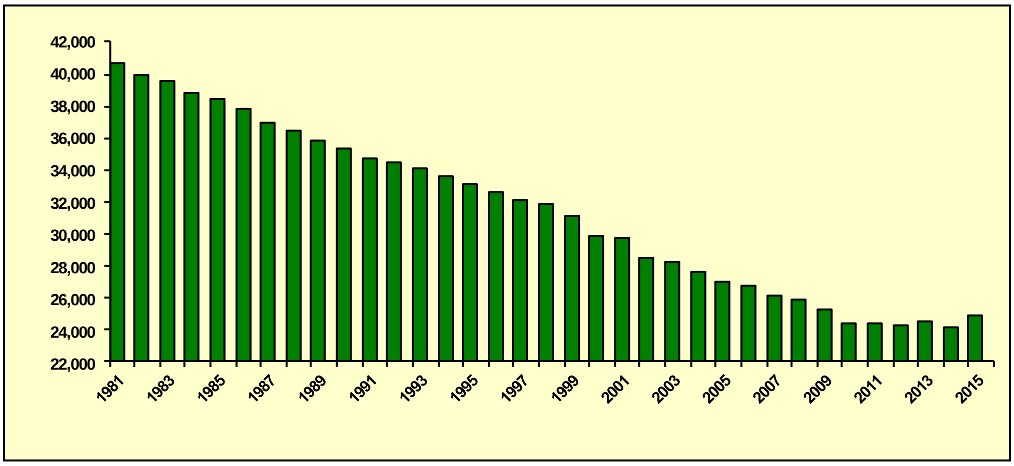


Figure 3.1 Trend in farm numbers in Northern Ireland (1981-2015)

Farms in Northern Ireland are almost entirely owner-occupied and are small by UK standards but the average area of farm businesses of 40.1 ha in 2015 is 45 % bigger than the average size of EU-28 countries of 16.1 ha in 2013. Since 1990 average farm size has increased by just under 10 ha and there has been a modest reduction in the total area farmed in Northern Ireland. Although the quantity of land sold annually on the open market is small, annual leasing of land is common and facilitates both farm business expansion and contraction.

Farming in Northern Ireland is dominated by cattle and sheep production with some 89 % of farms designated as mainly dairy, beef cattle or sheep using EU farm classification typology (Table 3.1). The dominant land use is grassland. Managed or permanent grassland accounted for 79 % of the agricultural area from 2012-2015. By comparison, arable crops accounted for only 5 % of the agricultural area. The other main component of agricultural land is rough grazing, which mostly consists of upland areas of moorland and mountains with low agricultural potential. From 2012-2015 rough grazing represented 14 % of the agricultural area but would not normally be expected to receive any application of chemical fertiliser or applications of manure in the form of slurry or farm yard manure. The land areas available for such applications are taken to be the sum of the permanent grass and arable crops.

Table 3.1: Agricultural census/land use data for Northern Ireland.

	Reporting Period			
	2004-2007	**2008-2011**	**2012-2015**	**Units**
Total land area	13,500			km^2
Agricultural land	10,338	10,003	9,959	km^2
Agricultural land available for application of manure	8,635	8,409	8,395	km^2
Arable crops	516	565	504	km^2
Permanent grass	8,119	7,844	7,890	km^2
Perennial crops[a]	15	15	15	km^2
Agricultural land under Agri-environment Scheme[b]	3,560	4,550	4,075	km^2
Annual use of organic N from livestock manure	107,734	96,666	97,864	tonnes N per year$^-$
Annual use of organic N other than livestock manure	10,100	273	91	tonnes N per year$^-$
Annual use of mineral N	85,827	68,276	71,042	tonnes N per year
Number of farms[c]	26,146	24,436	24,907	
Number of farms with livestock[c]	25,164	23,600	23,817	
Cattle[d]	1,681	1,594	1,597	thousand
Sheep	2,116	1,901	1,946	thousand
Pigs	407	422	499	thousand
Poultry	18,455	17,537	20,052	thousand
Other[e]	12	15	15	thousand

[a] *Perennial crops are orchards plus small fruit. They exclude forestry.*
[b] *Area given is a mean value for the four year period*
[c] *Numbers of farms refer to years 2007, 2011 and 2015.*
[d] *Livestock numbers include adults and young stock. There are based on the results of the annual agricultural census undertaken by the Department of Agriculture, Environment & Rural Affairs (DAERA) and available in the Statistical Review of Northern Ireland Agriculture. This is published annually by DAERA (*www.daera-ni.gov.uk/publications/statisticsal-review-ni-agriculture-2007-onward*).*
[e] *Horses (12,000) and goats (3,000).*

3.2. Nitrogen discharges to the environment

Table 3.2 summarises estimates of discharges of nitrate from land to the aquatic environment in Northern Ireland for the periods 2004-2007, 2008-2011 and 2012-2015. Estimates of the diffuse losses of nitrate from agriculture were based on mean annual nitrate-N export coefficients derived using NIEA river monitoring data as explained in Section 6.3, with allowance made for changes in annual fertiliser-N and cattle excreta-N usage (50 % of the latter has been assumed to be available for leaching).

Human population data were taken from the Northern Ireland Statistics and Research Agency (NISRA) website to estimate the average annual domestic sewage discharge of nitrate-N for both periods. Data provided in Section 4 provide a more detailed breakdown of the amount of nitrogen applied to land and, in particular, the residue of nitrogen that is unaccounted for by the difference between inputs via fertiliser and imported feedstuffs and outputs removed in agricultural product.

Agriculture is computed to be the largest source of nitrogen (N) discharges to surface waters. This reflects the large proportion of the land area of Northern Ireland devoted to agriculture (75 %) and the current level of animal production within agriculture which can lead to loss rates in the region of 20 kg/(ha/year) N or 2 tonnes/(km^2/year) N. By comparison, the average human population density in the period 2012-2015 is approximately 136 persons/km^2 which, on the basis of a per capita nitrogen loading of 2.45 kg/(person/year) N (6.7 g/(person/day) N ; Smith, 1976; Jordan & Smith, 2005), equates to an area-weighted loss of nitrogen from the urban population of 0.333 tonnes/(km^2/year) N. There was an overall increase of 5 % from the previous period in the combined total nitrogen discharged resulting from a 6 % increase in the agricultural component and a 3 % increase in the domestic sewage (human population) component of the total.

Table 3.2: Annual mean discharges of nitrate-N to the aquatic environment by sector

	2004-2007	2008-2011	2012-2015	Units
Agricultural NO_3N	19199	16177	17148	tonnes N per year$^-$
Domestic sewage NO_3N	4240	4386	4496	tonnes N per year$^-$
Total	23439	20563	21644	tonnes N per year$^-$

3.3. Code of Good Agricutural Practice

Table 3.3: Summary data on codes of good agricultural practice

Date of first publication	1999
Dates of revision	2002
	2008

In Northern Ireland, the Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil (the Code) was developed prior to the first designation of Nitrate Vulnerable Zones in 1999. It outlined management practices for preventing pollution of water, air and soil. The Code was first revised and updated in 2002, comprising two booklets, one of which applied specifically to water. DARD (now DAERA) issued this 'Code' to all farmers in Northern Ireland in 2003.

Following extensive consultation within Government and a 12-week public consultation period in 2007, the Code was fully revised and updated to take account of the Nitrates Action Programme Regulations and other legislation changes at the time. This most recent Code was published in 2008 and outlines legislative requirements at that time for farmers regarding water, air and soil. It combines these with practical advice on management practices designed to reduce any negative impact from agricultural activities on the environment. It is reader friendly in that it is activity-based rather than guidance for a specific piece of legislation.

A further update of the Code is scheduled for 2017 to accommodate recent changes to the Nitrates Action Programme (Northern Ireland) Regulations 2014 (the 2014 NAP Regulations) and other relevant legislation. In the meantime, DAERA ensures that farmers are kept updated about any changes to the Nitrates Action Programme (NAP) requirements through updated NAP Guidance documents, stakeholder events, press articles, and via the DAERA website.

3.4. Compliance with Code of Good Agricutural Practice

As a consequence of the total territory approach in Northern Ireland the sections of the Code relevant to livestock manure storage and nitrogen fertiliser application are incorporated into the 2014 NAP Regulations and compliance is a legal requirement for all farm businesses in Northern Ireland. All NAP information literature was reviewed, updated and re-published in 2015. Discussion on compliance with the NAP Regulations is set out in Section 5 and summarised in Table 5.2.

3.5. Factors affecting uptake of environmental measures

In the period 2012 to 2015, the DAERA College of Agriculture, Food and Rural Enterprise (CAFRE) held training workshops entitled Cross Compliance, Nitrates Information, Nitrates Derogation and Nutrient Management Planning.

Successive research among agri-environment participants indicate that a significant majority of farmers value agri-environment schemes and are very willing to participate in them.

DAERA is currently finalising a new agri-environment climate scheme as part of its commitment under the Northern Ireland Rural Development Programme 2014-2020. The new scheme, the Environmental Farming Scheme (EFS), will launch in 2017 and will provide a range of voluntary options and strategies aimed at improving water quality.

A key feature of EFS development has been the close engagement with colleagues across the previous two main Government Departments – Department of Agriculture and Rural Affairs (DARD) and Department for the Environment (DOE) – which from the 9 May 2016 have combined to form the new Department for Agriculture, the Environment and Rural Affairs (DAERA) (the Department). Information from both the original Departments has already been combined spatially and will enable much more accurate targeting of measures impacting on water quality.

Uptake of the new EFS will be kept under review and, if necessary, appropriate adjustments made.

3.6. Other activities to reduce diffuse water pollution from agriculture

A number of other activities are carried out by public bodies, the agricultural industry and environmental non-governmental organisations to reduce diffuse water pollution from agriculture. The most substantial of these are outlined below.

3.6.1. Activities by the Department

Awareness raising- Agriculture

In recent years DARD (now DAERA) has produced numerous advisory articles to raise awareness of the Code and water quality issues. This publicity is ongoing and the articles coincide with seasonal activities such as slurry spreading and silage cutting to maximise their impact on protecting water quality.

DARD (now DAERA) Countryside Management Branch published a total of 77 press articles dealing with farm nutrient and waste management during the period 2007–2016.

Advice

From 2012 DARD (now DAERA) Countryside Management Delivery Branch has provided farm nutrient management and pollution control advice to approximately 700 farm businesses.

Guidance and training

In the period 2012 to 2016 CAFRE held training workshops that included coverage of Cross Compliance, Nitrates and Nutrient Management Planning. Details of these are included in Table 3.4.

Table 3.4: Details of attendance at CAFRE training workshops 2012/2013–2015/2016 (summarised by financial rather than calendar year)

Year	No. of workshops	No. of farmers attended
2012/2013	36	430
2013/2014	54	860
2014/2015	15	196
2015/2016	32	576
Total	**169**	**2,638**

Agri-environment schemes

The Department's agri-environment schemes support agricultural production methods which protect the water quality of surface and groundwaters. Effective pollution control is a requirement of all agri-environment schemes and scheme participants are provided with farm nutrient and pollution control advice as part of their application process. Since May 2005, this advice has included guidance on the preparation and maintenance of a 'Farm Waste Management Plan'. The number of agri-environment participants are currently declining pending the opening of the new agri-environment climate scheme within the Rural Development Programme (RDP). As of 1 January 2016 approximately 5,800 agri-environment scheme participants managed more than 225,000 ha of land to enhance biodiversity, improve water quality and enhance the landscape.

Under the Northern Ireland Rural Development Programme (NIRDP) 2007-2013, the Northern Ireland Countryside Management Scheme (NICMS) helped to reduce water pollution from agricultural sources and to improve water quality on farms. NICMS participants continue to maintain and review annually their obligatory farm nutrient and waste management plans. A number of participants have also taken up farm waterway and riparian zone management measures which aim to enhance river and riverbank biodiversity and help local agriculture meet the requirements of the WFD.

Catchment initiatives

Several initiatives focusing on very tightly defined water bodies have been undertaken in a multi-agency approach. Input has ranged from public meetings, a planned awareness raising campaign and individual, business specific, advice to surrounding landowners.

Other grant schemes

Through the Manure Efficiency Technology Scheme (METS), the Department provided capital grant support to farmers to encourage uptake of advanced slurry spreading equipment such as the trailing shoe system. There have been three tranches of the Scheme. In total, METS funded over 300 machines. This represents a total investment of over £7 million in advanced slurry spreading technology.

The increased nutrient efficiency from using these spreading systems results in reduced chemical fertiliser costs, lower greenhouse gas emissions and reduced risk of phosphorus run-off. They also deliver a range of other practical and environmental benefits, including flexibility in timing of slurry spreading and reduced odour. The METS closed in April 2014.

Research

The Department funds an extensive programme of research at the Northern Ireland Agri-food and Biosciences Institute (AFBI). A significant portion of this is focussed on issues related to the effect of agricultural practices on water quality. For example, on-going long-term projects include: '*Monitoring the effectiveness of the Nitrates Action Programme for Northern Ireland*', and the '*UK Environmental Change Network: Freshwater'*. In addition to these on-going projects, a number of new three year projects are about to be commissioned including: '*Monitoring, modelling and mitigation of Nitrogen and Phosphourous losses from land to water under derogated and non-derogated conditions in the Colebrooke and Upper Bann Catchments*' (costing £1,286,832), '*Management of manure nutrients for sustainable grass-based dairy production in Northern Ireland'* (costing £524,000), and 'Quantification of phosphorus release from sediments in Lough Neagh and factors affecting the recovery of water quality' (costing £536,328).

Awareness raising - Water Framework Directive (2000/60/EEC) (WFD)

Within Northern Ireland the strategic implementation of WFD is overseen and co-ordinated by an Inter-departmental Board. The Board had established an Implementation Working Group to co-ordinate the activities of government departments and agencies that deliver the requirements of the Directive. The implementation of the first cycle River Basin Management Plans (RBMP) 2009-2015 was taken forward through the development and implementation of 26 Local Management Area action plans over a three year rolling programme over the period 2010/2011 to 2012/2013.

Stakeholder engagement on the implementation of the RBMPs took place through a WFD Stakeholder Forum, linked to a network of nine Catchment Stakeholder Groups, which were set up by the NIEA. The Groups covered all of Northern Ireland and were open to anyone who had an interest in the water environment and were publicised through local media and email communication to key stakeholders. The Groups met twice each year in spring and autumn and representatives from agricultural organisations, as well as individual farmers, attended. For the second cycle RBMPs (2015-2021) each River Basin District will set up a stakeholder group which will work in partnership to target actions through a series of catchment projects.

NIEA's 2012 and 2013 Water Environment Community Awards were open to organisations/groups within the Catchment Stakeholder Group areas. Each of the 18 winning applicants was awarded a grant award of £1,000 to take forward a project to raise awareness of protecting the water environment.

NIEA funded a part time Rivers Trust Development Officer post to promote the development of River Trusts in Northern Ireland and established a start up fund to assist their development up to 2015. River Trusts deliver practical river improvements in water quality and help to raise awareness and educate the wider public on river issues. There are now seven Rivers Trusts in Northern Ireland (Ballinderry, Erne, Main, Six Mile, Lagan, Strule, and Blackwater).

Water quality improvement schemes

NIEA has piloted a dedicated competitive grant scheme which was used to allocate funds to voluntary 'not for profit' bodies and local councils to support their operational work in the delivery of agreed water focused environmental objectives identified in the Department's and NIEA business plans. The scheme focused on the WFD objectives as identified in the RBMPs 2009-2015. A total of £150,000 was awarded for projects in 2012/2013 and 2013/2014. The scheme has since been integrated to a broader Environmental Challenge Fund in 2014/2015.

3.6.2. Activities by the agricultural industry

Voluntary agreement on phosphate reduction in livestock feed

There is a voluntary agreement with the local feed industry in Northern Ireland to lower Phosphourus (P) in livestock diets; particularly dairy and pig diets. The target for the Northern Ireland Grain Trade Association (NIGTA) was to achieve an average P level in dairy compound feed of 0.58 %. The Department has reported that the average P level in dairy compound feed is now 0.54 %.

The Voluntary Initiative to promote responsible pesticide use

The Voluntary Initiative (VI) was set up in 2001 as an industry-led partnership that works with government, regulators and stakeholders to promote the responsible use of agricultural and horticultural pesticides. Through its national groups the VI provides a UK wide framework for promoting best practice at the local level.

The VI established a National Sprayer Testing Scheme (NSTS) and a National Register of Sprayer Operators (NRoSO) to encourage adoption of best practice in pesticide handling and application. NRoSO membership is now included in the audit procedures of the major assurance schemes.

The VI works closely with other industry-led initiatives to ensure that the best possible advice is provided to farmers and sprayer operators.

3.6.3. Activities by environmental NGOs

For second cycle River Basin Management Plans (RBMPs) a new targeted approach to operational delivery will be implemented through the formation of NIEA Water Management Unit River Basin District Groups delivering in partnership with other government agencies and stakeholders.

Environmental farming schemes will provide options for mitigating the effects of diffuse pollution to supplement regulatory controls through Nitrates Action Programme (NAP) and cross compliance. This will be faciltated by groups such as local Rivers Trusts identified in 3.6.1, and proposed cross border projects supported through INTERREG programmes.

4. Principal Measures applied in the Action Programmes

4.1 Agricultural activities, development and nitrogen assessment

This section presents a summary of trends in both the quantities of manure nitrogen (N) produced on farms in Northern Ireland and the land areas that have been available for manure applications in Northern Ireland. The basic period of comparison is the current reporting period 2012-2015 with the previous reporting period 2008-2011. For further comparison data for the period 2004-2007 are also given.

4.1.1. Livestock manure N

Between the current (2012-2015) and the previous reporting period (2008-2011), the total amount of manure N produced on farms in Northern Ireland has remained virtually unchanged.

Table 4.1: Livestock manure nitrogen production in Northern Ireland from cattle, sheep, pigs and poultry for 1996-1999, 2000-2003, 2004-2007, 2008–2011 and 2012-2015

	Period				
Animal category	**1996-1999**	**2000-2003**	**2004-2007**	**2008-2011**	**2012-2015**
	kg N ha^{-1}				
Cattle	94.9	91.6	95.4	87.4	87.1
Sheep	21.7	18.5	16.4	15.1	15.5
Pigs	6.1	4.0	4.0	4.2	4.8
Poultry	8.4	8.2	9.0	9.5	10.6
Total manure N	**131.1**	**122.6**	**124.8**	**116.8**	**118.1**

Manure production has continued to be dominated by cattle with the cattle component accounting for more than 70 % of the total manure N production since 1996-1999. While N produced from sheep has continued to decline, excretions from pigs and poultry have increased since the last reporting period.

Cattle and sheep are only housed for part of the year, so that only manure N produced during housing will be actively managed for crop production either as slurry or farmyard manure applications. Assuming that cattle are housed for five months of the year and sheep for one month (typically close to lambing), then the quantity of manure-N collected from housed animals, including pigs and poultry and applied to land has remained quite constant at 54/(ha/year) N in 2004-2007, 52 kg/(ha/year) N in 2008-2011, and 53 kg/(ha/year) N in 2012-2015.

4.1.2 Land use

Table 4.2 illustrates that, while total agricultural area has decreased slightly since the last reporting period (by 0.6 %), agricultural land use continues to be dominated by managed grassland (accounting for 78 % in 2008-2011 and 79 % in 2012-2015).

The area of grass under five years old has increased by 20,763 ha since the last reporting period, whereas the areas of older grass (5+ years) and that under arable cropping have decreased by 16,054 ha and 6,064 ha, respectively. In other words, 20,763 ha of older grassland plus some arable land have been re-seeded with grass since the last reporting period.

This is an encouraging trend as it suggests an increased commitment by farmers to systems of livestock production relying on grass rather than on N and phosphorus (P)-containing concentrate feeds, which inflate farm N and P surpluses.

Table 4.2: Composition of agricultural land area within Northern Ireland land for 2000-2003, 2004-2007, 2008 – 2011, and 2012-2015

Land use	Period			
	2004-2007	2008-2011	2012-2015	2008-2011 vs. 2012-2015
	Area (ha)			% change
Grass <5 years old	131,509	121,537	142,300	17.08
Grass 5+ years old	680,390	662,804	646,750	-2.42
Grass (total)	811,899	784,341	789,025	0.60
Arable crops and horticulture	51,595	56,514	50,450	-10.73
Rough grazing	149,408	142,589	137,525	-3.55
Other land*	20,941	19,246	18,875	-1.93
Total agricultural area	**1,033,843**	**1,002,690**	**996,689**	**-0.60**

** For a breakdown of Other land category see Table 4.3*

Table 4.2 also illustrates that there has been little change in the total area of crops and grass available for manure N applications. A decrease occurred in the area of land reported as rough grazing (reduced by 3.55 %), which is typically unenclosed upland moor and mountains. This category of land would not be expected to receive any fertiliser and indeed is capable of sustaining only low animal stocking rates. The components showing increase were the *grass <5 years old and the grass (total)* categories. These areas increased by 17.08 % and 0.60 % respectively. A breakdown of components of the *Other land* category in Table 4.3 show a slight increase in woodland area and impact of eliminating set-aside following implementation of the 2005 Common Agricultural Policy (CAP) reforms.

Table 4.3: Components of the *Other land* category of reported agricultural land within Northern Ireland land for 2004-2007, 2008-2011 and 2012-2015

Land use	Period			
	2004-2007	2008-2011	2012-2015	2008-2011 vs. 2012-2015
	Area (ha)			% change
Set-aside	2,496	400	0	-100.0
Woodland	9,100	10,273	10,883	5.9
Other (e.g. buildings, roads, ponds)	9,345	8,572	7,979	-6.9
Total other land	**20,941**	**19,246**	**18,861**	**-2.0**

It is not entirely clear why a trend of lower agricultural land area was evident between the first and second reporting periods, as there was no evidence of significant land abandonment or compensating expansion in land use for non-agricultural purposes. A relatively large proportion (currently 29 %) of land continues to be leased on short one year leases each year. The decline in reported agricultural area observed in 2012 may have been a consequence of changes in the way that some land owners reported these short-term leasing relationships and linked to conditions associated with the operation of the Single Payment Systems which was introduced in 2005. Stabilisation in the total agricultural land area in recent years supports this theory.

4.2 Action programme measures

The action programme measures contained in the 2006 and 2010 NAP Regulations were detailed in the previous Article 10 report (2008-2011). As referred to in section 2.1, a revised action programme, applying to all farmers across Northern Ireland, came into operation on 1 January 2015. The 2014 NAP Regulations measures are summarised in the following subsections.

4.2.1 Closed spreading periods

- Chemical N and P fertiliser must not be applied to grassland from midnight 15 September to midnight 31 January.
- All types of chemical fertiliser must not be applied to arable land from midnight 15 September to midnight 31 January unless there is a demonstrable crop requirement.
- Organic manures, including slurry, poultry litter, digestate, sewage sludge and abattoir waste, must not be applied from midnight 15 October to midnight 31 January.
- Farmyard manure (FYM) must not be applied from midnight 31 October to midnight 31 January.
- There is no closed spreading period for dirty water.

4.2.2 Land application restrictions

Land application restrictions listed below apply to spreading of all fertilisers, including dirty water.

- All fertilisers, chemical and organic, must not be applied:-
  - on waterlogged soils, flooded land or land liable to flood;
  - on frozen ground or snow covered ground;
  - if heavy rain is falling or forecast in the next 48 hours;
  - on steep slopes (that is an average incline of 20 % or more on grassland or an average incline of 15 % or more on all other land) where other significant risks of water pollution exist. Risk factors to be considered include the proximity to waterways, the length of time to incorporation, the type and amount of fertiliser being applied and/or the soil and weather conditions; or
  - on less steep slopes (with an average incline of 15 % or more on grassland or 12 % or more on all other land), organic manures must not be applied within 30 m of lakes and 15 m of other waterways; chemical fertilisers must not be applied within 10 m of lakes and 5 m of other waterways.
- Entry of fertilisers to waters must be prevented and it must be ensured that fertiliser application is accurate, uniform and not in a location or manner likely to cause entry to waters.
- All types of chemical fertilisers must not be applied within 2 m of any waterway.
- Organic manures including dirty water must not be applied within:-
  - 20 m of lakes;
  - 50 m of a borehole, spring or well;
  - 250 m of a borehole used for a public water supply;
  - 15 m of exposed cavernous or karstified limestone features; or
  - 10 m of a waterway other than lakes; this distance may be reduced to 3 m where slope is less than 10 % towards the waterway and where organic manures are spread by bandspreaders, trailing shoe, trailing hose or soil injection or where adjoining area is less than 1 ha in size or not more than 50 m in width.
- Application rates:-
  - no more than 50 m^3/ha (4,500 gal/ac) or 50 tonnes/ha (20 t/ac) of organic manures to be applied at one time, with a minimum of three weeks between applications; or
  - no more than 50 m^3/ha (4,500 gal/ac) of dirty water to be applied at one time, with a minimum of two weeks between applications.

- Slurry can only be spread by inverted splashplate, bandspreaders, trailing shoe, trailing hose or soil injection.
- Dirty water to be spread by same methods as slurry and by irrigation.
- Sludgigators and upward facing splash plates must not be used.

4.2.3 Livestock manure nitrogen limits

Loading limited to 170 kg/ha/year N livestock. Farms with at least 80 % grassland may apply annually for a derogation to permit application of up to 250 kg/ha/year N from grazing livestock manure subject to certain additional criteria and conditions.

4.2.4 Nitrogen fertiliser application limits

- Maximum kg/ha/year N on grassland (apart from N in livestock manure):-
  Dairy farms* 272 ($8^1/4$ bags/ac)**
  Other farms 222 ($6^3/4$ bags/ac)**
  *More than 50 % of N in livestock manure comes from dairy cattle.
  ** Approximate number of 50 kg bags of a 27 % N type fertiliser
- When applying chemical nitrogen fertiliser, N from organic manures other than livestock manure and anaerobic digestate containing digested livestock manure must be subtracted.
- For non-grassland crops, maximum N applied (from all types of fertiliser, including livestock manure) must not exceed crop requirement, and for certain arable crops an N-Max limit applies to the total crop area.

4.2.5 High phosphorus manures

From 1 January 2017, organic manure with more than 0.25 kg of total phosphorus (TP) per 1 kg of total N (e.g. some anaerobic digestates) can only be applied where soil analysis shows there is a crop requirement for P.

4.2.6 Livestock manure and Silage effluent storage requirements

- Manure storage for pig and poultry enterprises limited to 26 weeks.
- Storage for other enterprises limited to 22 weeks.
- Provided certain criteria are met there are allowances for out-wintering, animals on bedded accommodation, separated cattle slurry, renting additional tanks, poultry litter stored in a midden or field heap and exporting manure to approved outlets.
- Livestock manure and silage effluent storage must be maintained and managed to prevent seepage or run-off.
- Silage and slurry stores constructed or substantially modified after 1 December 2003 must comply with certain construction standards (set out in the 2014 NAP Regulations) and be notified at least 28 days before they are brought into use.
- Silage bales must be stored at least 10 m from any waterway and stored and managed in such a way as to prevent seepage into the waterway.
- FYM and poultry litter storage: -
  - both may be stored in middens with adequate effluent collection facilities;
  - both may be stored in a field heap where they are to be applied but for a maximum of 120 days; and
  - field storage of poultry litter is subject to authorisation by NIEA.
- FYM and poultry litter field heaps must not be stored:-
  - in the same location of the field year after year;
  - within 50 m of a borehole, spring or well;
  - within 250 m of a borehole used for a public water supply;
  - within 50 m of exposed cavernous or karstified limestone features;
  - on land that is water logged, flooded or likely to flood;

- FYM field heaps must not be stored within 20 m of any waterway and 50 m of lakes;
- Poultry litter field heaps must not be stored within 100 m of lakes and 40 m of a waterway; or
- Poultry litter field heaps must be covered with an impermeable membrane as soon as possible and within 24 hours of placement in the field.

- Storage for dirty water must be provided during periods when conditions for land application are unsuitable.

4.2.7 Land management

From harvest of a crop other than grass until 15 January of the following year, the controller must manage the land to ensure minimum soil cover and to minimise soil erosion and nutrient run off.

Residues of crops harvested late must be left undisturbed until just before sowing the following spring.

4.2.8 Additional Measures relating to derogated farms

- Annual application is required to the controlling authority for derogation.
- Annual fertilisation plan must be completed by 1 March, and kept on farm for inspection.
- Where the fertilisation plan indicates a proposal to disturb soil as part of grass cultivation, for example ploughing, there must be no application to that parcel of land of any organic manures, including FYM and dirty water, from midnight 15 October in any year to midnight 31 January of the following year.
- At least every four years, soil testing over every four hectares for must be carried out across the agricultural area of the holding under the same cropping regime and soil type.
- When available, soil analysis results must be produced during inspection.
- Annual fertilisation account must be completed and submitted to controlling authority.
- 250 kg/ha/year N limit from grazing livestock manure, 170 kg/ha/year N limit from all other livestock.
- At least 80 % of controlled agricultural area must be grassland.
- Temporary grassland is only permitted to be ploughed in spring.
- Ploughed grass is followed immediately by a crop with a high N demand.
- Crop rotation must not include leguminous or other plants fixing N except for grassland with less than 50 % clover and to areas with cereals and peas undersown with grass.
- There must not be an exceedance of a surplus of 10 kg P/ha/year on a derogated holding.

4.2.9 Record Keeping Requirements

Following records must be kept:-

- Agricultural area, field size and location.
- Cropping regimes and areas, Soil Nitrogen Supply (SNS) index for crops other than grassland.
- Livestock numbers, type, species and time kept.
- Organic and chemical fertiliser details including imports and exports.
- Evidence of a crop phosphate requirement from soil analysis if chemical phosphate fertiliser is applied.
- From 1 January 2017, evidence of crop P requirement from soil analysis if organic manure with over 0.25 kg TP per 1 kg total nitrogen is applied.

- Storage capacity and, where applicable, details of rental agreements, authorisation to store poultry litter in field heaps and associated evidence to support allowances to reduce capacity.
- Records relating to export of organic manure to be submitted annually by 31 January of the following year and by 1 March for derogated holdings.

Records must be available for inspection by 30 June of the following calendar year and must be retained for a period of five years.

4.3 Additional measures

Given that eutrophication of Northern Ireland's surface waters occurs primarily in freshwaters where P is the main contributor, the Phosphorus (Use in Agriculture) Regulations (Northern Ireland) 2006 (The Phosphorus Regulations) came into operation on 1 January 2007. The Regulations limit the application of chemical P fertiliser to crop requirement, based upon a soil analysis, and introduce land application restrictions similar to those for N fertilisers. The Phosphorus Regulations were also reviewed in 2014 as part of the NAP review. Revised Phosphorus Regulations came into operation on 1 January 2014. The Regulations set new values for P recommendations for grassland and P availabilities for organic manures.

4.4 Guidance and training

To help farmers understand the requirements of the action programme and to continue to promote best working practice DAERA has produced updated guidance information for the 2014 NAP Regulations.

The guidance documents include:-

- Summary of the changes to the Nitrates Action Programme 2015-2018 and Phosphorus Regulations
- NAP 2015-2018 and Phosphorus Regulations Guidance Booklet
- NAP 2011-2014 and Phosphorus Regulations Workbook
- Nitrates Directive Derogation Guidance Booklet 2015 – 2018
- Nitrates Directive Derogation fertilisation plan
- Nitrates Directive Derogation fertilisation account

DAERA also continues to provide press articles, workshops and other outreach and training events to assist farmers in complying with the action programme, as well as outline tools for record keeping and fertiliser application and manure production calculations.

5. Evaluation of the implementation of the action programme measures

5.1. Statistics on farm inspections

Inspection and enforcement of the 2014 NAP Regulations is carried out by NIEA which is also responsible for the enforcement of a range of other environmental regulations on farms. From 1 January 2007, Northern Ireland adopted a total territory approach to implementation of the ND and all farm businesses are required to comply with the NAP Regulations.

Additionally, 'Cross Compliance' requirements for farm businesses claiming direct aid payments were introduced during the previous reporting period. From 2005, NIEA has been the Competent Control Authority in Northern Ireland for Cross Compliance inspections for the Statutory Management Requirements (SMRs) relating to the Birds Directive (2009/147/EC), Habitats Directive (92/43/EEC), Groundwater Directive (2006/118/EC), UWWTD and ND in Northern Ireland. For each Statutory Management Requirement (SMR), NIEA selects 1 % of farm businesses claiming direct aid for annual inspection using a risk based approach. In addition, 5 % of the farm businesses operating under the 2014 NAP Regulations derogation are also inspected. Around 300 farm businesses are now selected for inspection each year.

Tables 5.1 and 5.2 present data on compliance with the 2014 NAP Regulations from the annual programme of scheduled inspections. For the current reporting period, additional data from reactive inspections made in response to referrals from other agencies, complaints from members of the public, etc, are also included. Table 5.1 shows these referrals have increased as the requirements of the 2014 NAP Regulations have become better understood. Figures for 2015 are not fully finalised, and also reflect changes to the classification of active farm businesses in Northern Ireland, resulting in fewer farm businesses overall.

All such reports are investigated by NIEA and enforcement action is taken when a breach of the 2014 NAP Regulations is confirmed. The great majority of these reports are substantiated, accounting for the higher rate of non-compliance reported from reactive inspections as shown in Table 5.2. All substantiated breaches (from both scheduled and reactive inspections) are also reported to DAERA, who are responsible for applying any reductions in direct aid claims under Cross Compliance.

Table 5.1: Number of farm inspections

Reporting period	2008 – 2011 All inspections	2012 – 2015 Scheduled inspections	2012 – 2015 All inspections
Number of farm businesses visited	2008 – 466 2009 – 453 2010 – 483 2011 – 648	2012 – 392 2013 – 380 2014 – 322 2015 – 296	2012 – 605 2013 – 598 2014 – 679 2015 – 402
Percentage of relevant farm businesses visited each year	2008 – 1.2 % 2009 – 1.2 % 2010 – 1.2 % 2011 – 1.7 %	2012 – 1 % 2013 – 1 % 2014 – 1 % 2015 – 1 %	2012 – 1.5 % 2013 – 1.6 % 2014 – 2.1 % 2015 – 1.3 %

Data are the percentage of farms inspected out of the total number of claimants of direct agricultural support payments in Northern Ireland

Under the 2014 NAP Regulations farm records do not have to be available for inspection until 30 June of the following calendar year. It is, therefore, not possible to check against certain measures in year x until records are available in year x+1. It should also be noted that non-compliances are reported relating to the year of detection which is not necessarily the year of occurrence.

Table 5.2: % of the inspected farm businesses compliant with the 2014 NAP Regulations

Reporting period	Compliance from all inspections: 2008-2011	Compliance from scheduled inspections: 2012-2015	Compliance from all inspections: 2012-2015
Closed spreading periods for chemical fertiliser	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 % %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %
Closed spreading periods for organic manures	2008 – 100 % 2009 – 98.5 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 99 %	2012 – 94.5 % 2013 – 99.5 % 2014 – 100 % 2015 – 99 %
Land Application Restrictions	2008 – 86 % 2009 – 90.5 % 2010 – 90 % 2011 – 90 %	2012 – 100 % 2013 – 99.5 % 2014 – 99.5 % 2015 – 99.5 %	2012 – 97 % 2013 – 95 % 2014 – 97 % 2015 – 94 %
Nitrogen fertilizer entering a waterway or water contained in underground strata	2008 – 89 % 2009 – 83 % 2010 – 80 % 2011 – 60 %	2012 – 94 % 2013 – 94 % 2014 – 93.5 % 2015 – 96.5 %	2012 – 75 % 2013 – 80 % 2014 – 72 % 2015 – 88 %
Nitrogen fertiliser crop requirement limits	2008 – 99.5 % 2009 – 98 % 2010 – 99 % 2011 – 98 %	2012 – 99 % 2013 – 99 % 2014 – 99 % 2015 – 99.5 %	2012 – 99 % 2013 – 99 % 2014 – 99 % 2015 – 99.5 %
Livestock manure nitrogen limits	2008 – 99 % 2009 – 89 % 2010 – 98 % 2011 – 97 %	2012 – 90 % 2013 – 95 % 2014 – 96 % 2015 – 97.5 %	2012 – 90 % 2013 – 95 % 2014 – 96 % 2015 – 97.5 %
Livestock manure storage requirements	2008 – 84 % 2009 – 84.5 % 2010 – 80.5 % 2011 – 62 %	2012 – 90 % 2013 – 93 % 2014 – 91.5 % 2015 – 93 %	2012 – 83 % 2013 – 82.5 % 2014 – 75 % 2015 – 87.5 %
Land management	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %
Record keeping	2008 – 92.5 % 2009 – 82 % 2010 – 93 % 2011 – 88.5 %	2012 – 91.5 % 2013 – 95.5 % 2014 – 97.5 % 2015 – 96.5 %	2012 – 91.5 % 2013 – 95.5 % 2014 – 97.5 % 2015 – 96.5 %

5.2. Commentary on points of difficulty regarding compliance

Overall, compliance in most areas was good. The most frequent areas of non-compliance were water pollution, often associated with poorly managed or inadequate manure storage facilities, and exceeding livestock manure limits. There was limited non-compliance arising from land application restrictions, generally spreading on water-logged ground or too close to waterways. However, compared with the previous reporting period, there was sustained improved compliance in record keeping and land application restrictions, indicating the success of additional advisory initiatives and education.

Pollution impacts arising from discharges of farm effluents containing nitrogen were recorded on a number of referral visits, pollution signs such as fungal growths being reported by members of the public. Lower compliance rates align with wetter years, and particularly with intense rainfall coinciding with critical periods of the farming year such as silage harvesting and when storage capacity is under pressure. The opposite was true of 2015, resulting in improved compliance in these areas. However, pollution risk remains, and NIEA is concentrating inspection effort on sub-catchments where agricultural pressures have been identified as adversely impacting on water quality.

5.3. Measurable criteria for assessing the impact of the Nitrates Action Programme on practices in the field

A key aspect of the NAP is to improve the efficiency by which farms utilise the nutrients, particularly nitrogen, present in organic manures. By substituting nitrogen in imported chemical fertilisers with manure nitrogen, the surplus of nitrogen on farms can be lowered. As the surplus represents nutrients not exported from farms in agricultural product it can be potentially lost to the environment. The only other fate is for it to accumulate in the soil.

As part of NAP the maximum allowable chemical fertiliser/other organic manure application rate for nitrogen has been lowered from the economic optimum, to take into account the livestock manure nitrogen that is produced on farms. Therefore, by reducing the maximum rates of chemical fertiliser/other organic manure nitrogen, NAP endeavours to ensure that the full crop response potential to nitrogen in livestock manures is taken into account when planning fertiliser applications. For nitrogen, this can be achieved by optimising the timing of manures applications to avoid periods when crop response is low, and also the use of application methods that minimise losses of nitrogen to the atmosphere.

The degree by which the nitrogen surplus is being lowered can, therefore, be used as an indicator for evaluating the effectiveness of the 2014 NAP Regulations in achieving the aims of the Nitrates Directive in Northern Ireland. A secondary and related indicator is the change in nitrogen efficiency on farms. In Section 5.4, changes in the nitrogen surplus and nitrogen efficiency are presented. Given the importance of phosphorus in the eutrophication process, the effectiveness of control measures can also be assessed on a broad scale by the scale of reductions in the phosphorus surplus on farms; trends in phosphorus surplus or balance are, therefore, also presented.

The nitrogen and phosphorus balances were determined using the methodology set out by Foy, R.H., Bailey, J.S. and Lennox, S.D (2002). The balances are based on the difference between inputs of nutrients to farms in chemical fertilisers and imported feedstuffs less outputs of agricultural product that are exported from farms. In all calculations, the protein content of feedstuffs (concentrates) has been assumed to be 17 %. Inevitably the balances are positive i.e. the balance is always in surplus.

The data used are sourced from the Statistical Review of Northern Ireland Agriculture which is published each year by DARD (now DAERA) (www.daera-ni.gov.uk/publications/statisticsal-review-ni-agriculture-2007-onward). This summarises the agricultural census undertaken by the previous agricultural Department in Northern Ireland, DARD, in June of each year. In addition to data on land use and stock numbers, the Review provides statistics on inputs of fertilisers and imported feedstuffs to agriculture together with measures of agricultural outputs such as milk, meat and crops. The basic period of comparison is the current reporting period 2012-2015 with the previous reporting period 2008-2011. For further comparison data for 2000-2003 and 2004-2007 are also given to highlight how nitrogen efficiency has generally improved in recent years.

5.4. Difference between input and output of nitrogen (mineral & organic)

For agriculture in Northern Ireland, time series of nitrogen inputs and outputs are plotted in Figure 5.1. Following a pronounced decline in the use of chemical nitrogen (N) fertiliser between 2003 and 2009, fertiliser N inputs have fluctuated up and down, and currently (2015) are 78 kg/(ha/year) N, just 2 kg/(ha/year) N greater than in 2011.

Over the recent reporting period, the amount of nitrogen imported in feedstuffs has also marginally increased. As a consequence, the total amount of nitrogen entering the system has increased from 155 kg/(ha/year) N in 2011 to 162 kg/(ha/year) N in 2015, i.e. a 4.5 % increase.

However, alongside the increased nitrogen inputs, outputs of nitrogen from agriculture, which are dominated by exports of meat and milk, also increased from 38 kg/(ha/year) N in 2011 to 41 kg/(ha/year) N in 2015, and hence nitrogen efficiency within agriculture remained stable. It is important to note, though, that inputs of both fertiliser and feedstuff N appear to have stabilised again over the past two years, possibly in response to the economic pressures facing the industry and particularly the dairy sector.

The data presented in Figure 5.1 are summarised in Tables 5.3 and 5.4. Table 5.3 gives the gross amounts in tonnes nitrogen per year for N utilised and exported from agriculture in Northern Ireland as well as the N balance. The gross inputs of nitrogen to agriculture increased by 7.1 % in the current reporting period compared to the previous period causing a 7.1 % increase in the N balance, which was primarily driven by the 6.5 kt increase in feedstuff N input. However, outputs of nitrogen also increased by 7.2 % and as a result N efficiency remained stable at 23 %.

The data for nitrogen inputs and outputs are also summarised in Table 5.4 but normalised to the area of crops and grass in Northern Ireland, thus giving slightly different percentage changes for the nitrogen input, output and balance compared to those in Table 5.3. The nitrogen balance increased by 7.3 % compared to the previous period, i.e. from about 121 to 130 kg/(ha/year), primarily as a result of the 10.5 % increase in feedstuff N input. However, it should be noted that this balance remains substantially lower than previous peak N balances during the mid 1990s which exceeded 165 kg/ha/year N .

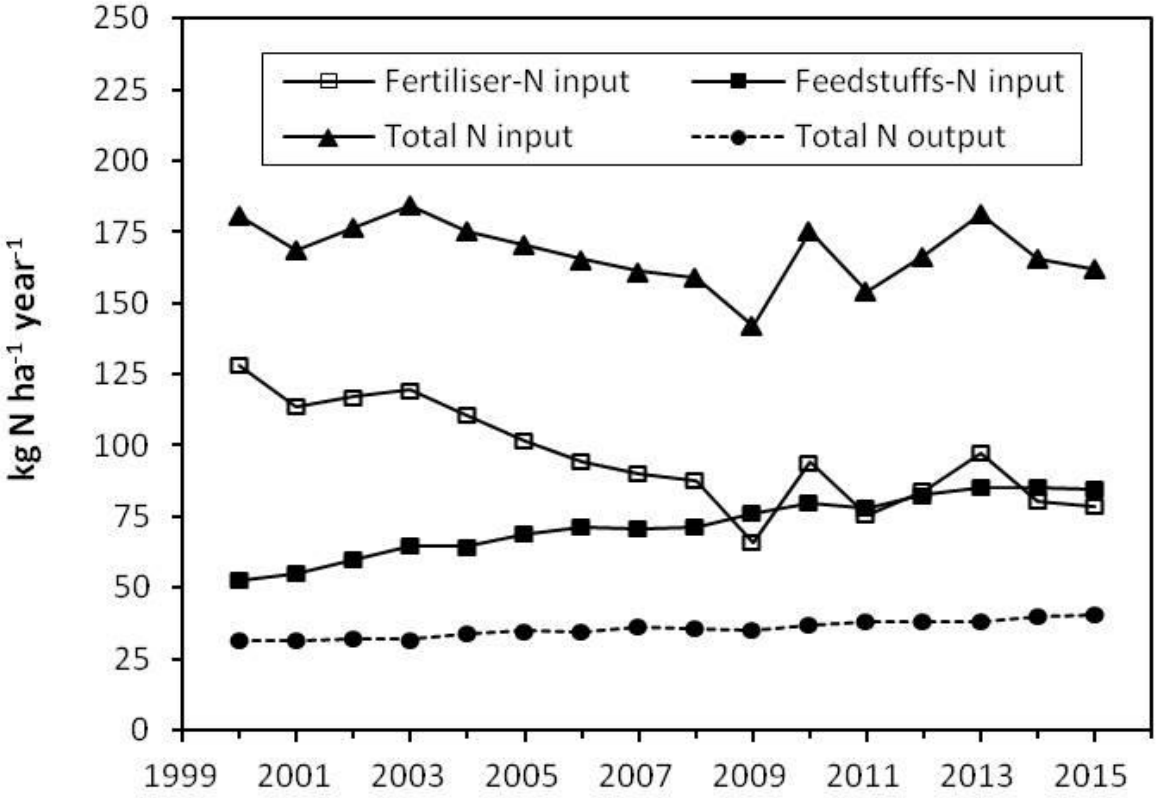


Figure 5.1 Time series of nitrogen (N) inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2015

Table 5.3 Nitrogen (N) input, output, balance and efficiency for agriculture in Northern Ireland

Period	**2000-2003**	**2004-2007**	**2008-2011**	**2012-2015**	**2012-2015 vs. 2008-2011**
	(tonnes N per year)				(% change)
Input N					
Fertiliser N	107,161	85,827	68,276	71,042	4.1
Feed N	52,136	59,486	64,284	70,813	10.4
Total N inputs	159,297	145,313	132,560	141,855	7.1
N outputs	28,378	30,074	30,539	32,830	7.2
N balance	130,919	115,239	102,021	109,026	7.1
N efficiency (%)	17.8	20.7	23.0	23.2	0.3

(Inputs are purchases of N in chemical fertilisers and imported feeds while N exports are in agricultural outputs leaving farms. The balance is the difference between inputs and outputs and the efficiency is expressed as the ratio of outputs/inputs).

Table 5.4 Nitrogen (N) input, output, balance and efficiency data normalised to the area of crops and grass

Period	2000-2003	2004-2007	2008-2011	2012-2015	2008-2011 vs. 2004-2007
	(kg/(ha/year) N)				(% change)
Input N					
Fertiliser N	119.5	99.1	81.2	85.1	5.2
Feed N	58.1	68.9	76.5	84.4	10.5
Total N inputs	177.6	168.0	157.7	169.0	7.3
N outputs	31.6	34.8	36.3	39.1	7.3
N balance	146.0	133.2	121.4	129.9	7.3
N efficiency (%)	17.8	20.8	23.1	23.2	0.3

Although nitrogen inputs have increased in recent years and caused a dip in N efficiency from 24.8 % in 2011 to just 21 % in 2013, as already noted, in the last couple of years, N inputs have begun to decline again (Figure 5.1), and N efficiency is currently 25.1 %, i.e. its highest level since 1967 (Figure 5.2).

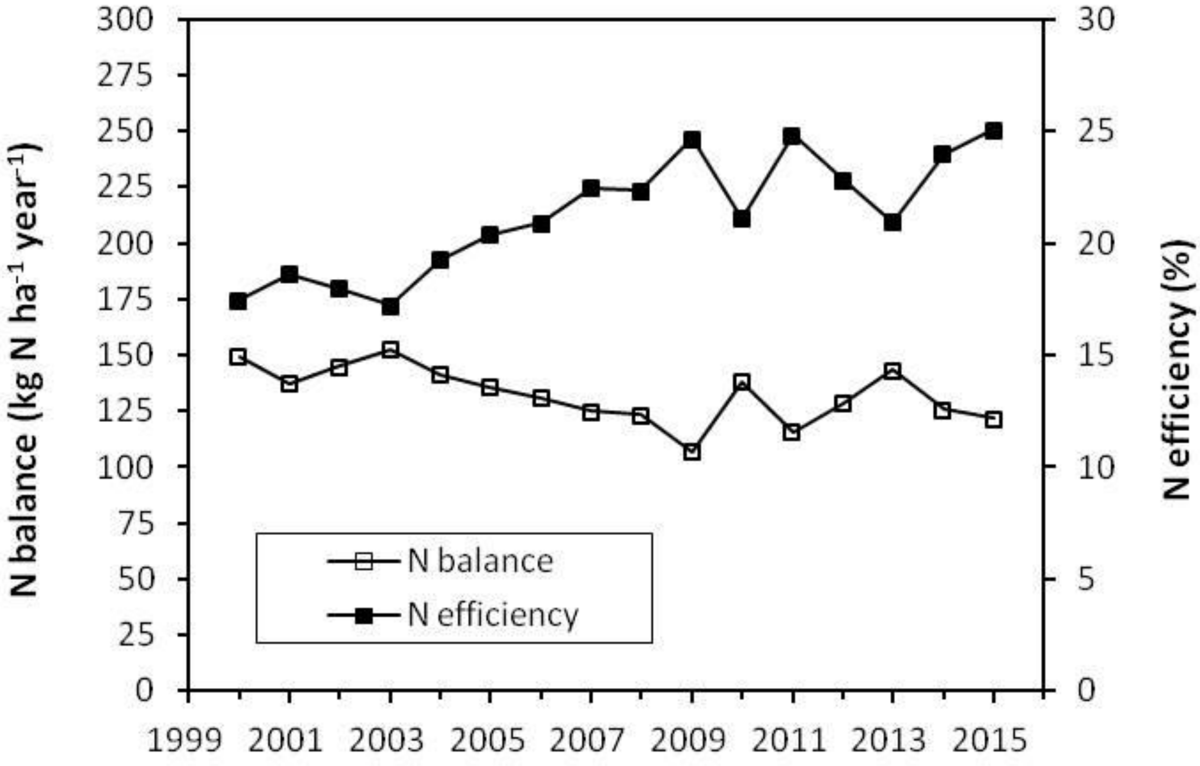


Figure 5.2 Time series of nitrogen (N) balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2015. (Data normalised to the area of crops and grass)

The apparent stabilisation of the N balance for agricultural land in Northern Ireland at levels comparable with those in the 1970s and early 1980s (Figure 5.2), should help to minimise the risk of excessive nitrogen losses to water. Currently, for environmental and economic reasons, the intensive dairy and beef sectors are being encouraged to increase the amounts of meat and milk produced from grass and forage, and reduce the amounts produced from purchased concentrate feeds. While this strategy may lead to some increases in fertiliser N inputs, i.e. to produce more grass and forage of higher protein and energy content, these should be more than outweighed by reductions in feedstuff N inputs.

The need to control phosphorus (P) as well as nitrogen has also been a key message of advice, workshops and the consultative process, and is now being given greater emphasis to try to counteract a trend in increased feedstuff and fertiliser P inputs over the last few years. In autumn 2015, a major stakeholder workshop was held with farming industry representatives and various stakeholders including the supply trade to discuss and agree options for reducing farm P surpluses.

Following this workshop, a Phosphorus Working Group comprising scientists, advisors and technical experts, environmental regulators and policy makers, was established and tasked with preparing a strategy for tackling high P surpluses and high P soils. In July 2016 the group produced its draft report outlining the actions that the farming industry and the supply trade should take to correct the problems.

Figure 5.3 shows the time series of inputs and outputs of P to Northern Ireland Agriculture from 2000 until 2015. Chemical fertiliser inputs declined dramatically from 2003 and reached its lowest level since records began (ninety years ago) in 2009 (2.5 kg/(ha/year) P), but then increased again before levelling off at 4.1 kg/(ha/year) P in 2014-2015 (Figure 5.3). Feedstuffs P inputs declined between 2006 and 2008 but then increased and levelled off at 16 kg/(ha/year) P in 2014-2015. As a result, total P inputs are currently about 20 kg/(ha/year) P.

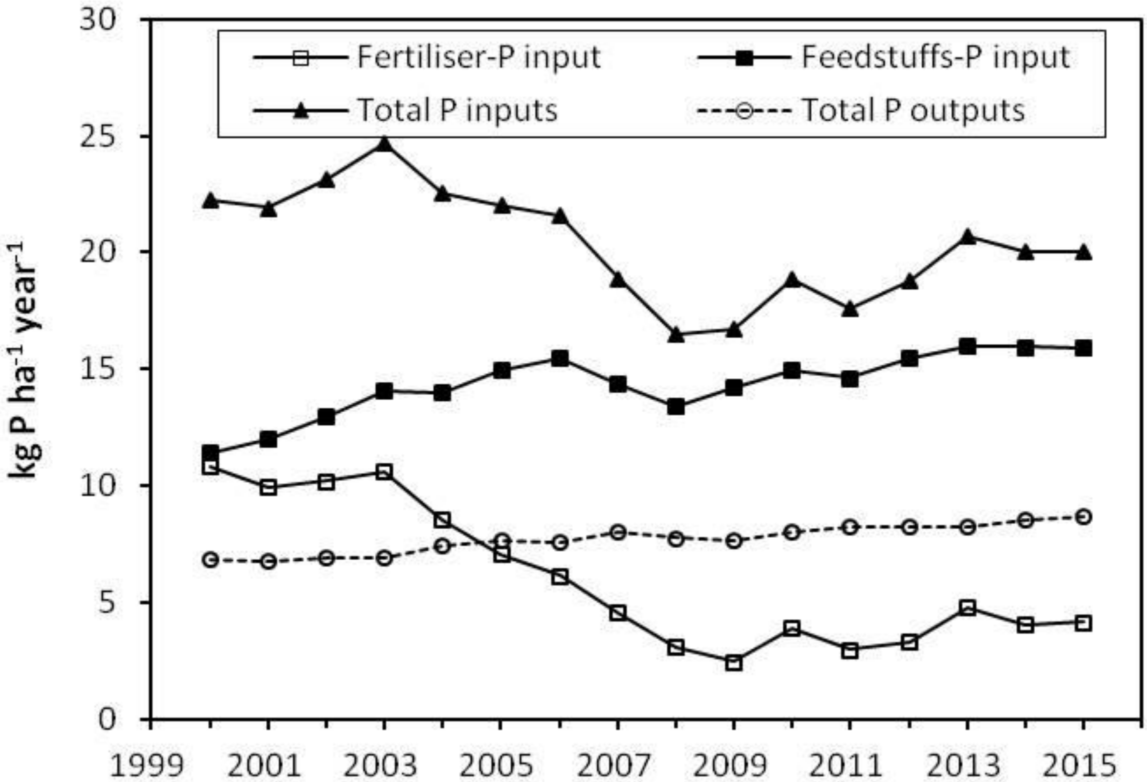


Figure 5.3 Time series of phosphorus inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2011. (Data normalised to the area of crops and grass)

From 2003 to 2011, the net P balance or surplus declined from 17.7 kg/(ha/year) P in 2003 to 9.5 kg/(ha/year) P in 2011 (Figure 5.4). This decline reflects both declining inputs and small increases in outputs. As a consequence, the P efficiency for agriculture in Northern Ireland showed a very marked increase from 28 % in 2003 to 46 % in 2011. After 2011, owing to the increases in chemical fertiliser P and feedstuffs P, the P balance increased and the P efficiency declined to 43 % in 2014-2015, which is still considerably better than it was just 12 years ago (Figure 5.4). However, there is still scope for improvement in P efficiency and for reductions in the agricultural P surplus or balance.

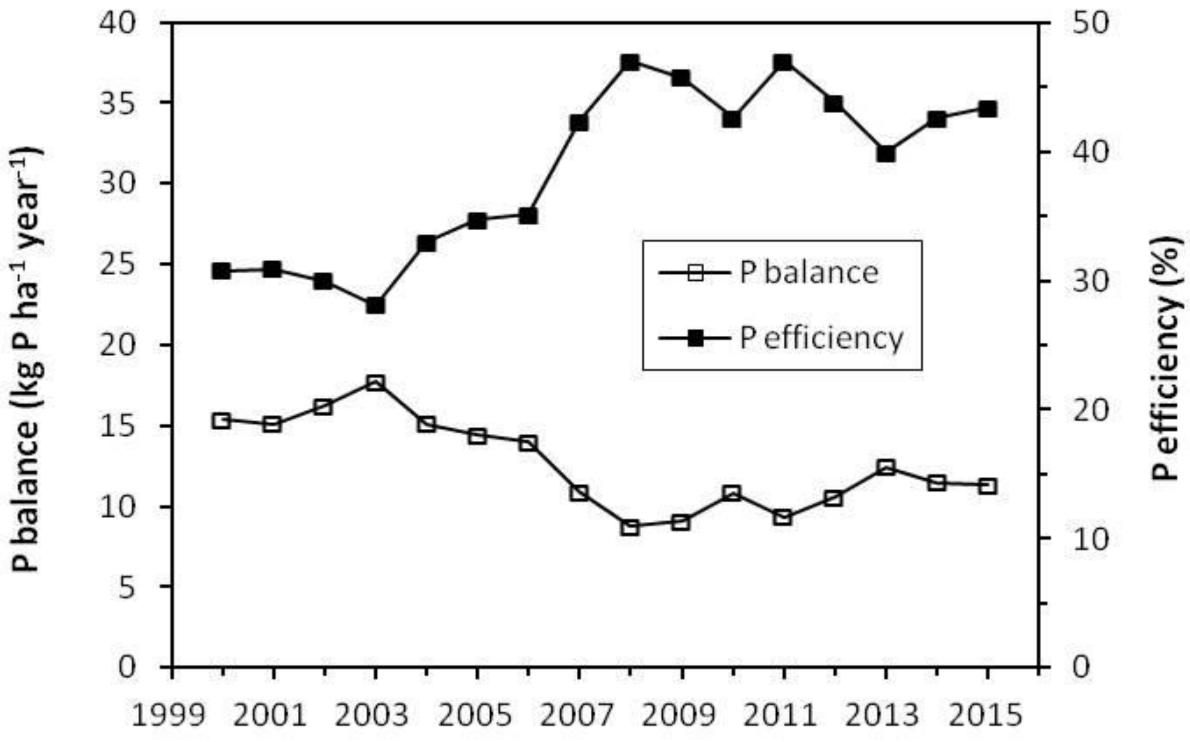


Figure 5.4 Time series of phosphorus balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2015

5.5 Individual cost effectiveness studies

The measures in the 2014 NAP Regulations do not go beyond the measures set out in Article 4(1) (a) and Annex III of the ND. Therefore, studies on cost effectiveness of measures under Article 5(5) of the ND are not required, as no additional measures have been taken in the framework of the action programme.

As part of the development of the 2014 NAP Regulations, a Regulatory Impact Assessment (RIA) was carried out. This examined different options for revisions to the 2014 NAP Regulations and included analysis of costs of the different options to both the agricultural industry and the regulator and identification of qualitative and economic benefits. The finalised RIA is available on the DAERA website at:-
www.daera-ni.gov.uk/publications/2015-2018-nitrates-action-programme-and-phosphorus-regulations-and-associated-documents

In addition, the Northern Ireland 2014 NAP Regulations are one of the basic measures for agriculture under the Water Framework Directive (2000/60/EEC) (WFD) River Basin Management Plans (RBMP) programmes of measures. Under WFD, for the agriculture sector, additional (supplementary) measures are targeted at further reducing phosphorus levels, improving nutrient management and mechanisms to identify and target diffuse pollution in general from agricultural sources.

For the development of the second cycle of river basin management plans under WFD, the proposed additional measures were subject to an economic analysis to assist in identifying the potential costs, impacts and the benefits they might bring. The economic analysis paper is available on the DAERA website at:-
www.daera-ni.gov.uk/publications/economic-analysis-paper-programme-measures-river-basin-management-plans-2015

6. Forecasting future water quality

The ND requires Member States to extrapolate to estimate future water quality beyond the current reporting period. For this purpose a range of methods are suggested, including extrapolation of measured trends derived from current monitoring, use of data modelling integrating pressures and nitrogen flux data, and use of data from experiments, similar catchments or other sources.

6.1. Methodology for forecasting future water quality

Northern Ireland continues to develop methods to enable forecasting of water quality and estimation of recovery times. These rely on:-

- economic modelling to predict future livestock and cropping production levels;
- forecast of diffuse nitrogen loss from agricultural land; and
- forecast of water quality using statistical trend analysis.

Estimates are given in Section 6.2 of projected land use and nitrogen excretion for 2019. The latter depend on estimates of livestock numbers for 2019 which in turn are based on extrapolation of recent observed trends, adjusted to reflect the possible impact of anticipated economic and structural conditions. As a result these projections are uncertain and must be viewed as only indicative of possible outcomes for 2019.

6.2. Forecast of future agricultural land use and nitrogen (N) loading from livestock manure

In the previous 2011 Article 10 Report, the total area of agricultural land in Northern Ireland was predicted to decline by 2.3 % between 2011 and 2015 such that the area available for manure application would decline by 1.6 %. In reality, though, there was little change in the agricultural area and in fact the total area of permanent pasture and arable cropping land available for manure application increased by 2 % (Table 6.1; based on data for 2011 and 2015 taken from the DARD (now DAERA) Statistical Review of Northern Ireland Agriculture 2015).

Looking forward to 2019, results from the Food and Agricultural Policy Research Institute (FAPRI) UK model predict that the total area of Agricultural land will increase by 1 %, i.e. by 1,199 km^2, and will increase the area available for manure application by this amount, and that there will be a 1.4 % increase in the area of permanent pasture, but a 2.7 % reduction in the arable area.

In the previous 2011 Article 10 Report, it was also predicted that total Nitrogen (N) excretion by animals would decrease by 3.3 % by 2015, whereas in reality it increased by 3 %, with increases occurring in all the main livestock sectors, the biggest increases in the pig (13.7 %), poultry (5.8 %) and sheep (5.2 %) sectors, and the smallest increase in the cattle sector (1.4 %).

Looking forward to 2019, based on Food Agriculture Policy and Research Institute (FAPRI) UK model predictions, animal numbers in the sheep, pig and poultry sectors are expected to increase with related increases in N excretion. However, cattle numbers are predicted to decline, and, therefore, total N excreted by livestock is not expected to change noticeably by 2019, and if anything, may decline by about 0.4 %.

A Government backed loan scheme on the Sustainable Use of Poultry Litter was launched in 2014. The aim of the scheme is to find sustainable alternatives to the practice of spreading poultry litter on agricultural land in Northern Ireland. The scheme has recently provided funding towards the capital costs of two 'demonstrator' projects for treatment of poultry litter. The two projects in conjunction with other outlets, will enable approximately 195 kilotonnes of Northern Ireland poultry litter to be sustainably utilised per annum. The two plants are due to be operational in 2017.

Given that predicted increases in livestock numbers in sheep, pig and poultry sectors are expected to be balanced by a decrease in bovine numbers, going forward, improvements in the nitrogen balance will depend on the degree to which protein content and total usage of imported animal feedstuffs may be reduced, as opposed to reductions in chemical fertiliser Nitrogen (N) usage.

Currently fertiliser N usage is at its lowest level in 40 years, and will need to increase if more livestock products are to be produced from grass and less from imported N and P-containing feedstuffs. Nitrate losses from land to water are directly correlated with agricultural N surpluses. Reducing feedstuff N inputs, and increasing the use of grass and forage in ruminant diets, would reduce farm N surpluses, and also reduce the amount of N excreted by animals, and thereby the risk of nitrate loss from land to water.

Table 6.1: Prediction of agricultural activities in 2019

	2011	2015	2019	Units
Total land area	13,500			km^2
Agricultural area	9,914	9,977	10,076	km^2
Agricultural area available for manure application	8,315	8,477	8,576	km^2
Change in farming practices				
Permanent pasture	7,771	8,003	8,115	km^2
Arable crops	544	473	461	km^2
N excretion by animals				
Cattle	70,169	71,132	69,446	tonnes $year^{-1}$
Sheep	16,988	17,874	18,450	tonnes $year^{-1}$
Pigs	5,651	6,427	6,881	tonnes $year^{-1}$
Poultry	6,858	7,259	7,542	tonnes $year^{-1}$
Horses + Ponies	528	484	480	tonnes $year^{-1}$
Goats	28	35	35	tonnes $year^{-1}$
Total	100,222	103,210	102,834	tonnes $year^{-1}$

6.3. Forecast of diffuse nitrogen loss from agricultural land

Due to their contribution to freshwater and marine eutrophication, losses of nutrients via drainage and surface runoff from agricultural sources potentially have a major detrimental impact on water quality within Northern Ireland.

Increasing efforts are being made to control nutrient losses from agriculture and the 2014 NAP Regulations 2014 and the Phosphorus (Use in Agriculture) Regulations (Northern Ireland) 2014 apply to all farms across Northern Ireland. These Regulations seek to increase efficiency of nitrogen and phosphorus use on farms and so reduce the surplus that is available for loss to water as nutrients. Under the ND, Member States are required to estimate and report the time for stabilisation or recovery of waters polluted or threatened by nitrogen pollution and eutrophication which lie wholly within their territory.

In 2008, NIEA commissioned a project by the Northern Ireland Agri-food and Biosciences Institute (AFBI) to develop and apply geo-statistical techniques within a Geographical Information System (GIS) model to enable spatial and temporal forecasting to be carried out. The aims of the project were to:-

1) Determine the degree to which a regionalisation approach could assist in assessing water quality responses to the ND in Northern Ireland. Previous analyses of nitrate losses showed much greater seasonal variation in nitrate concentrations in the east of Northern Ireland compared to the west.
2) Test if river nitrate concentration data, monitored on a monthly basis, could be used to model nitrate losses to rivers using an export coefficient modelling approach. The model was extended to include losses of ammonium-nitrogen in both modelling and spatial analysis.

Spatial data sets developed by AFBI on soil type, land cover and farming intensity were linked with 2003-2005 and 2006-2008 NIEA water quality data sets to determine seasonality in concentrations and compliance with ND standards associated with land-use in river catchments.

Findings of this research project to date were submitted to the Commission in 2011 ('*2010 Derogation Report for Northern Ireland in Accordance with Article 10 Commission Decision 2007/863/EC*'). This approach will be reviewed and re-evaluated in coming years as the operation of the Nitrates Action Programme approaches a 10-year milestone.

6.4. Forecast of water quality

6.4.1. Forecast response for nitrate and phosphorus in surface freshwaters

Nitrate (NO_3 mg/l)
To enable a forecast of the future trend of nitrates in surface waters, NIEA carried out a statistical trend analysis using non-parametric Seasonal Mann-Kendall test and Theil-Sen test to predict the concentrations of nitrate of surface waters in Northern Ireland for 2019 and 2023 using long term averages from 302 monitoring sites between 1992 and 2015. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of nitrate in 2019 and 2023 is shown in the Technical Annex.

Table 6.2: Nitrate concentrations (NO_3 mg/l) in surface waters: Forecast for 2019 and 2023

	% of points (NO_3 mg/l) (n=302)				
	0 – 9.99	**9.99 – 24.99**	**25 – 39.99**	**40 - 50**	**> 50**
Surface water annual average in 2019	90.7	8.9	0.3	0	0
Surface water annual average in 2023	91.4	8.3	0.3	0	0

Results from trend analysis shown in Table 6.2 indicate that in both 2019 and 2023, 99.7 % of average nitrate concentrations are predicted to be below 25 mg/l NO_3.

Table 6.3: Predicted trends in annual average surface water Nitrate concentrations (NO_3 mg/l) in rivers (change between 2012-2015 and 2019 and 2023).

	% of points (based on mg/l difference) (n=177)				
	≤ - 5 Strong decrease	>-5 to ≤ -1 Weak decrease	>-1 to ≤ + 1 Stable	>+1 to ≤ +5 Weak increase	> +5 Strong increase
Surface water annual average in 2019	1.1	18.1	77.4	2.8	0.6
Surface water annual average in 2023	4	30.5	61.6	3.4	0.6

Information on the trend of average concentrations in rivers between 2012-2015 and 2019 and 2023 (Table 6.3 and Figures 6.3 and 6.4) indicates that there will be a 19.2 % decrease and 77.4 % stabilisation across all sites in the next four years to 2019. Predictions of trend of nitrate concentrations for 2023 indicate that 96.1 % of sites will show a decrease or remain stable.

It should be noted that experimental investigations have shown that short term variation in nitrate concentration in Northern Ireland reflect climatic influences on nitrate leaching, as high leaching occurs after dry summers (Watson et al., 2000a). Longer term trends have shown that peaks in nitrate concentrations occur at quite regular intervals of approximately six years and this series may reflect a climatic signal in low summer rainfall extending back to 1840. The climatic influence on river nitrate concentrations in Northern Ireland is recognised as a consideration for a long-term monitoring programme to assess the effectiveness of the action programme measures.

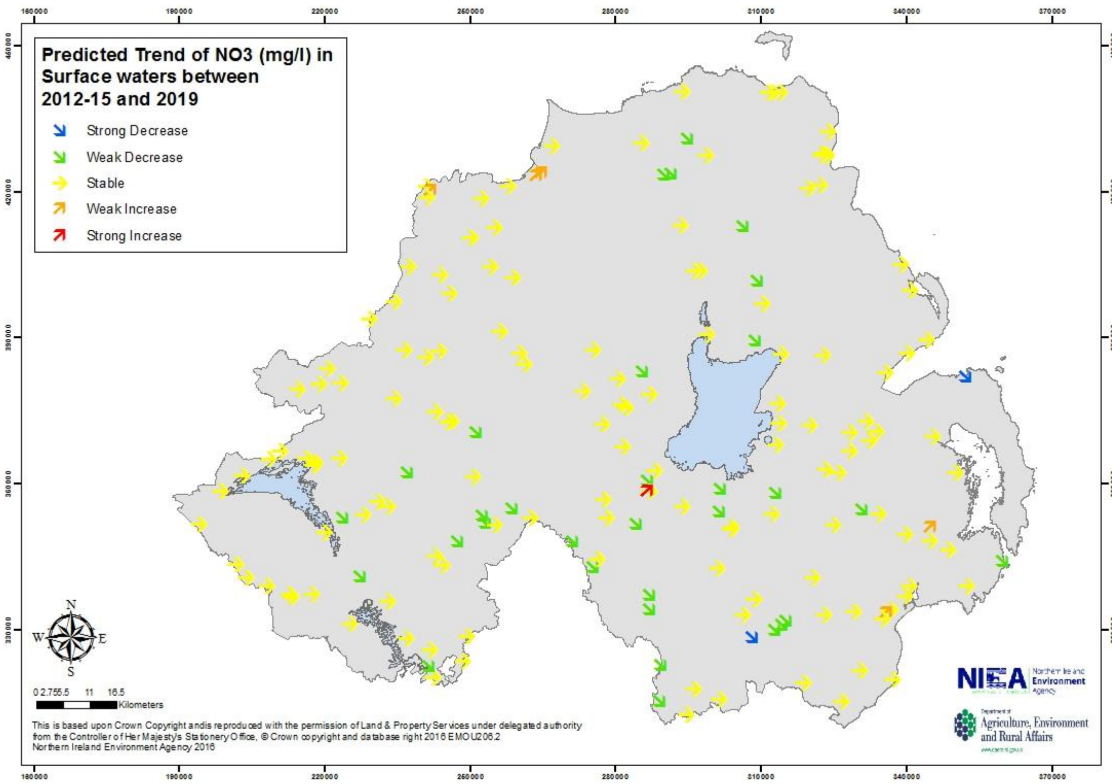


Figure 6.3: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2012-2015 and 2019

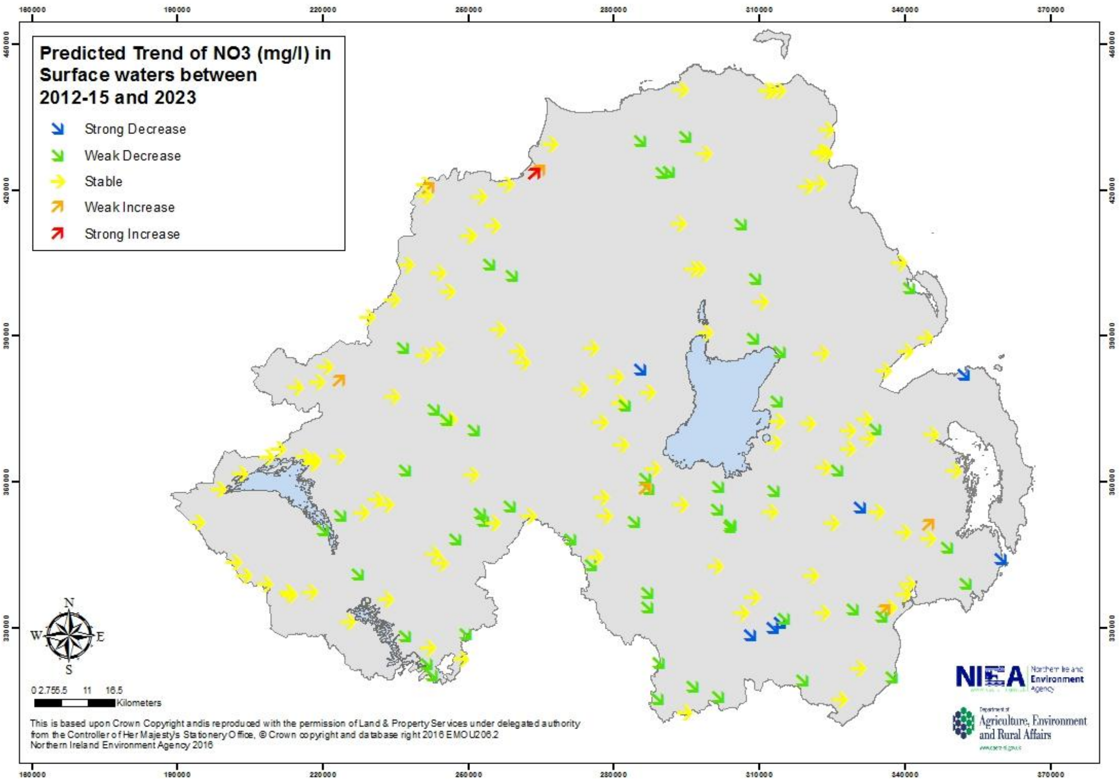


Figure 6.4: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2012-2015 and 2023

Soluble reactive phosphorus (SRP mg/l)

NIEA carried out similar statistical trend analysis using non-parametric Seasonal Mann-Kendall test and Theil-Sen test to predict the concentrations of phosphorus of rivers in Northern Ireland for 2019 and 2023 using long term averages from 165 common river sites between 1998 and 2015. Of these, 114 were common with the 2012-2015 reporting period. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of phosphorus in 2019 and 2023 is shown in the Technical Annex.

Table 6.4: WFD phosphorus classification in rivers: Forecast for 2019 and 2023

	% of points (n=165)				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Rivers SRP WFD classification 2019	58.2	18.2	19.4	4.2	0
Rivers SRP WFD classification 2023	66.1	12.7	17.0	4.2	0

Results from predicted trend analysis shown in Table 6.4 indicate that 76.4 % of river sites are predicted to be High or Good status for SRP classification in 2019 and 78.8 % in 2023.

Table 6.5: Predicted trends in WFD phosphorus classifications in rivers (change between 2012-2015 and 2019 and 2023)

	% of points (n= 114)				
	Strong decrease (≥2 improvements in class)	**Weak decrease (1 improvement in class)**	**Stable (No change in class)**	**Weak increase (1 deterioration in class)**	**Strong increase (≥2 deteriorations in class)**
Rivers SRP WFD classification in 2019	11.4	40.4	48.2	0	0
Rivers SRP WFD classification 2023	15.8	45.6	37.7	0.9	0

The trend of WFD phosphorus classification in rivers between the current reporting period, 2012-2015 and 2019 and 2023 (Table 6.5 and Figures 6.5 and 6.6) indicates that there will be a 51.8 % decrease and 48.2 % stabilisation across all sites in the next four years to 2019. Predictions of trend of phosphorus concentrations for 2023 indicate that over 99 % of sites will show a decrease or remain stable.

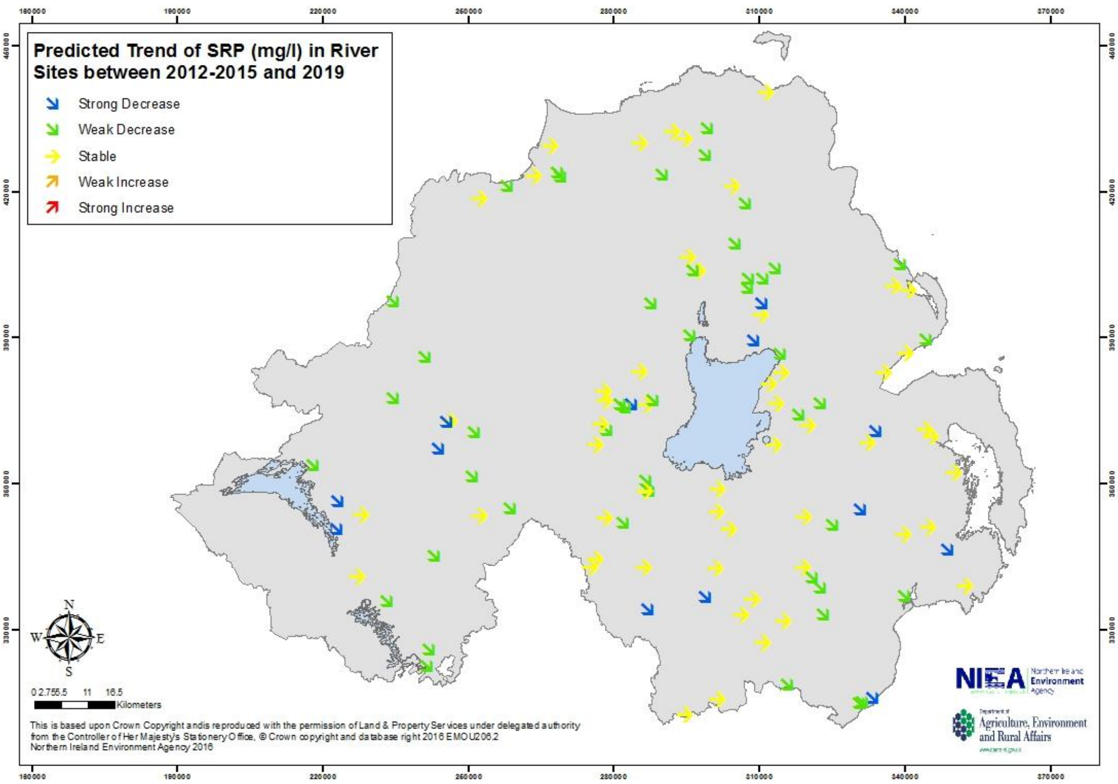


Figure 6.5: Trends of predicted Soluble reactive phosphorus (mg/l) in rivers between 2012-2015 and 2019

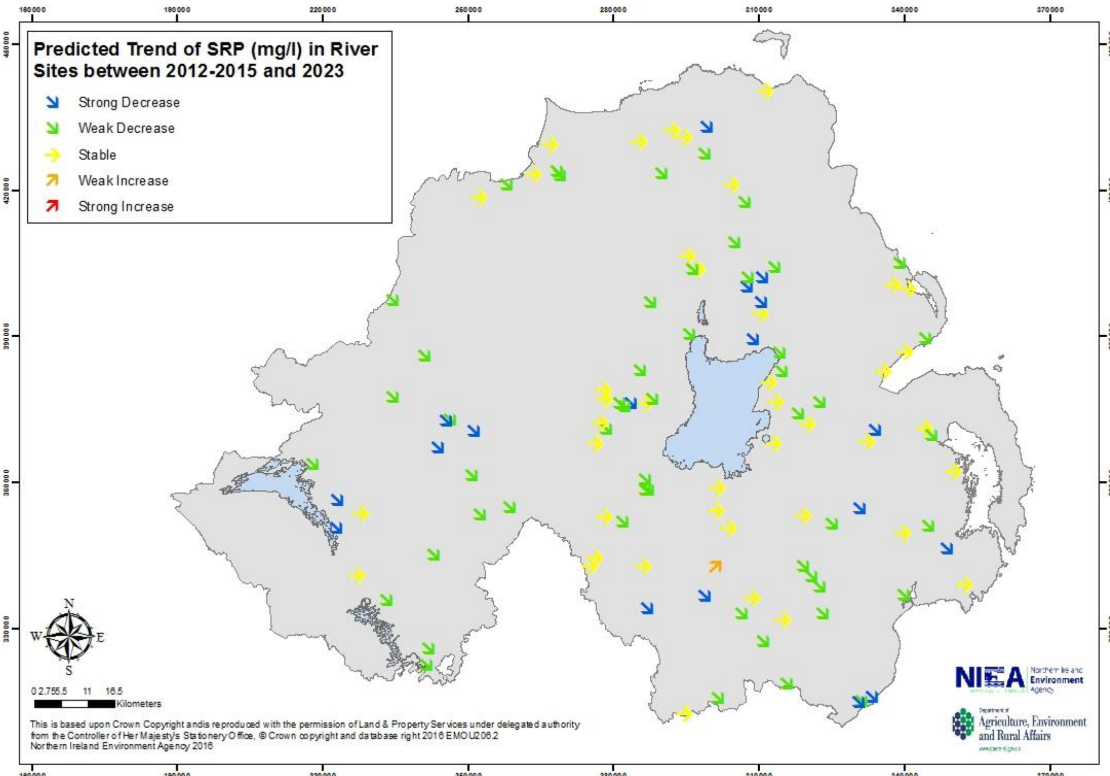


Figure 6.6: Trends of predicted Soluble reactive phosphorus (mg/l) in rivers between 2012-2015 and 2023

6.4.2. Forecast response for groundwaters

Forecasting of response in groundwater nitrate concentrations to changes in land use is particularly difficult in Northern Ireland given the dominance of locally discharging, shallow flow groundwater systems with relatively limited groundwater residence times. The extensive and variable cover of glacially-derived deposits, which strongly influences the vertical migration of nitrates from near surface to the underlying groundwater body, also complicates predictions.

Groundwater monitoring and results analysis to date has indicated that measured groundwater concentrations are, for the most part, below concentrations of significance (for 2012-2015 period 98 % of monitored boreholes with annual average < 25 mg/l NO_3).

To enable a forecast of the future trend nitrates in groundwater average groundwater nitrates concentrations were assessed using the Aquachem software. The software was used to establish whether the time series exhibit statistically significant trends of nitrate concentrations. The method used is described in the technical annex.

Analysis showed that the groundwater monitoring sites that were determined to have a statistically significant trend all have average and maximum nitrate concentrations below the 25 mg/l standard for the period 2012-2015.The predicted concentrations for 2020/2021 are expected to remain below the 25 mg/l value.

References

Betts, N.L. (1997). Climate. In: Cruickshank, J.G. (Ed) *Soil and Environment: Northern Ireland* pp 63-84. Agriculture and Environmental Science Division, Department of Agriculture for Northern Ireland.

Butler, C.J., Coughlin, A.D.S., and Fee, D.T. (1998). Precipitation at Armagh Observatory 1838-1997. Biology and Environment, 98B: 123-140.

DEFRA (2015). Marine Strategy Part Three: UK programme of measures. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/486623/marine-strategy-part3-programme-of-measures.pdf : 114

DoE-DARD (2002). *Report on the Environmental Aspects of the Nitrates Directive in Northern Ireland.* Department of the Environment and Department of Agriculture and Rural Development for Northern Ireland. Belfast.

European Commission, (2009) *WFD CIS Guidance Document No 23. Guidance Document on Eutrophication Assessment in the context of European Water Policies*

European Commission (2011), Nitrates Directive (91/676/EEC): Status and Trends of Aquatic Environment and Agricultural Practice, Development Guide for the Member State's Reports, EC (DG Environment), Office for the Official Publications of the EC, Luxembourg.

Eutrophication Status of the UK Maritime Area: Northern Ireland assessment 2006-2014 https://www.daera-ni.gov.uk/publications/ospar-common-procedure-identification-eutrophication-status-uk-maritime-area-northern-ireland

Foy, R.H., Bailey, J.S. and Lennox, S.D. (2002). Mineral balances for the use of phosphorus and other nutrients by agriculture in Northern Ireland from 1925 to 2000. Irish Journal of Agricultural and Food Research, 41: 247-263.

Hirsch, R.M., Slack, J.R., and Smith, R.A. (1982). Techniques of trend analysis for monthly water quality data. Water Resources Research, 18:107-121.

Jordan, C. and Smith, R.V. (2005). Methods to predict the agricultural contribution to catchment nitrate loads: designation of nitrate vulnerable zones in Northern Ireland. Journal of Hydrology, 304: 316-229.

OECD. (1982) Eutrophication of waters, monitoring assessment and control. Organisation for Economic Co-operation and Development, Paris, France

OSPAR.Common.Procedure-http://www.ospar.org/work-areas/hasec/eutrophication/common-procedure.-

OSPAR Eutrophication Status of the Maritime Area
Second OSPAR Integrated Report. - http://www.ospar.org/documents?v=7107

Smith, R.V. (1976). Nutrient budget of the River Main, Co. Antrim. Technical Bulletin No 32, MAFF, London, UK pp.315-339.

Stuart, M. E. (2012) Trend analysis and prediction for small groundwater quality datasets from Northern Ireland. *British Geological Survey Commissioned report*, CR/12/037. 38pp.

Synergies between the OSPAR Comprehensive Procedure, the integrated set of OSPAR Ecological Quality Objectives (EcoQOs) for eutrophication and the EC Water Framework Directive - http://www.ospar.org/documents?v=7004

UKTAG. (2008) UK Environmental Standards and Conditions (Phase 1), Final Report., Internal Document prepared by UK Technical Advisory Group on the Water Framework Directive.

UKTAG. (2015) *Updated recommendations on phosphorus standards for rivers: River Basin Management (2015-2021)*, Internal Document prepared by UK Technical Advisory Group on the Water Framework Directive.

Watson, C.J., Jordan, C., Lennox, S.D., Smith, R.V. and Steen, R.W.J. (2000a) Inorganic nitrogen in drainage water from grazed grassland in Northern Ireland. Journal of Environmental Quality, 29: 225-232.

TECHNICAL ANNEX - Water Quality Datasets

All tables of water quality information for Northern Ireland for the current reporting period 2012-2015 are presented through ReportNet and use the Excel templates downloaded from the Data Dictionary. All entries are formatted according to the Annex to the European Guidance – '*Reporting templates and formats for Geographical Information and summary tables on water quality'* and the data dictionary *'Definition of Evaluation of water quality under the Nitrates Directive (February 2012)'.*

1. Groundwater nitrates

Northern Ireland groundwater monitoring stations 2008-2011

ReportNet Location –

http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/**Nitrate_Directive_NI_Final._NiD_GW_Stat.xml**

Nitrate concentrations in Northern Ireland groundwater 2008-2011

ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate Directive NI Final. NiD_GW_AnnConc.xlm***

and http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/***Nitrate Directive NI Final. NiD_GW_Conc.xml***

This table contains the national station codes, the beginning and end dates for data sampling, the units of measurement, number of samples, annual average nitrate concentrations, maximum nitrate concentrations and the trend of average Nitrate (NO_3) based on mg/l differences between the current and previous reporting periods. Trends are only calculated for monitoring stations common to both the current and previous reporting periods and a minus symbol indicates a decrease or negative trend. Prior to calculation of summary values, raw data values which are less than the Limit of Detection (LoD) have been reported as half the LoD.

2. Surface water nitrates (rivers, lakes, drinking waters and transitional and coastal marine waters)

Northern Ireland Surface Water Monitoring Stations 2012-2015

ReportNet Location – ***http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate Directive NI_Final._NiD_SW_Stat.xlm***Nitrate concentrations in Northern Ireland surface waters 2008-2011

ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate Directive NI Final. NiD_SW_Conc.xlm***

and http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/***Nitrate Directive NI Final. NiD_SW_AnnConc.xlm***

This table contains the national station codes, the beginning and end dates for data sampling, the units of measurement, number of samples, annual average nitrate concentrations, maximum nitrate concentrations and winter average concentrations. Winter average data are based on all freshwater monitoring data collected in each year between 1 October 2012 and 31 March 2015. Winter average data are based on all marine water monitoring data collected in each year between 1 January and 31 March. The table also contains the trend of average NO_3 based on mg/l differences between the current and previous reporting periods. Trends are only calculated for monitoring stations common to both the current and previous reporting periods and a minus symbol indicates a decrease or negative trend. Prior to calculation of summary values, raw data values which are less than the LoD have been reported as half the LoD.

3. Surface waters eutrophication parameters

Eutrophication parameter concentrations in Northern Ireland surface waters 2012-2015

ReportNet Location - ***http://cdr.eionet.europa.eu/gb/eu/nid/envv4izog/Nitrate Directive NI Final. NiD_SW_EutroMeas.xlm***

These tables contain the national station codes, the beginning and end dates for data sampling, the parameters, units of measurement, number of samples, annual average soluble reactive phosphorus (SRP), total phosphorus concentrations and summer chlorophyll-α concentrations. Summer average data are based on all monitoring data collected in each year between 1 April and 30 September. Prior to calculation of summary values, raw data values which are less than the LoD have been reported as half the LoD.

4. Datasets supporting forecasting of water quality

Surface water data 1992-2015

Trend analysis was applied to this dataset for the purposes of extrapolating water quality (nitrate and phosphorus) derived from the current surface water monitoring network identifying those surface waters which could exceed the 50mg/l NO_3 or deteriorate from High or Good Water Framework Directive (2000/60/EC) status for Soluble reactive phosphorus (SRP) if protective action is not taken. The forecasting data file contains the summary data for 622 surface water sites for the years January 1992 – December 2015.

The trend analysis was carried out using the software package “AquaChem” which provided a Seasonal Mann-Kendall derived output of trend significance and direction, a Theil-Sen test of slope with intercept along with confidence intervals and a Linear regression.

Sites were screened to ensure that a minimum of six years and 10 samples were available and that less than 80 % of values were at the limit of detection. Secondary screening of the analysis data checked that Theil-Sen and Linear regression slopes agreed within 10 %, predictive values agreed to within 10 % and Linear r squared was better than 50 % (0.5).

Sites were crossed checked against the Seasonal Mann-Kendall trend to confirm trend significance and direction.

Groundwater data 2008-2015

Monitoring data for all 56 stations were imported into the Aquachem software in order to establish whether the data exhibit a statistically significant upward or downward trend. Where available data were included from 2008 to 2015, but data records for some monitoring boreholes can be shorter. The minimum record length was set to five data points and two years.

For the data analysis the methodology outlined below was followed:

1. At the primary level all results where the Mann Kendall confidence was below 80 % were excluded. This is reported as “no trend” by AquaChem. Following this a series of secondary criteria were applied to the data.
2. A Sen slope was returned. This assessment is returned automatically and reports where there is an “increasing” or “decreasing” trend or no trend.
3. Comparisons of the Sen and linear regression slopes reported by AquaChem. This was done here by calculating the coefficient of variation (CV = standard deviation/ average) of the two slopes and applying an empirical limit, here 10 %.

4. Assessments of the regression fit (using the available r^2) by using a limit of >0.5.
5. Comparison of predicted value at a given time using the different slopes and appropriate intercepts from step 1. This was done here by calculating the CV of the two values and applying an empirical limit, here 10 %.

As the fitted trend is a linear function a time to stabilisation of the present pollution cannot be calculated. The software only assesses if there is a statistically significant trend, but not if concentrations are constant or almost constant. The return ‘no trend’ applies to datasets that are too scattered to establish a trend as well as to constant datasets.

Where the methodology established that the data showed a statistically significant trend the concentrations on 31 December 2020 were calculated.