Nutrients Action Programme Implementation Report for 2020-2023

Department of Agriculture, Environment and Rural Affairs
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Summary and Key Findings

This Implementation Report for the Nutrients Action Programme (NAP) is in accordance with regulation 34 of the NAP (Northern Ireland) Regulations 2019. It covers the period 2020 – 2023 and follows three previous reports covering four-year periods. Those reports were completed in accordance with Article 10 of the EU Nitrates Directive prior to EU exit.

A summary of the report’s assessment of surface, ground and marine water quality along with an outline of training and advice for farmers support is provided below.

Water quality assessment – surface waters

<u>Nitrate in surface waters</u>
In recent years there has been an increase in the number of sites showing increasing levels of nitrate in freshwaters, which is a cause for concern. In the current reporting period (2020-23) 100% of surface water sites had an average nitrate concentration below 25 mg NO3/l, of which 85% were below 10 mg NO3/l. However, the proportion of surface freshwater sites with an annual average nitrate concentration below 10 mg NO3/l has been declining since 2012. Overall, the annual average nitrate concentrations in surface water rivers and lakes were generally stable or decreasing (77.6% of sites) when compared to the previous reporting period. However, a higher proportion of sites are showing an increase in annual average nitrate concentrations compared to the previous review when 98.1% were reported as stable or decreasing.
Similarly, a decline in the proportion of surface water sites with maximum NO3 concentrations below 10 mg/l has also been observed. A greater percentage of surface water sites recorded maximum concentrations in the 10-24.99 mg/l NO3 category than in previous reporting periods.
Seasonal trend analysis showed that the monthly trends in average nitrate concentrations were mainly stable or decreasing in 77.6% of rivers in Northern Ireland over the 31-year period, 1992-2023. The percentage of monitoring sites showing an increasing long-term trend went from 4.6% in 2016 to 9.8% in 2020. The percentage of monitoring sites showing an increasing long-term trend in 2024 is 23.6%.

<u>Assessment of trophic status of rivers</u>
At individual river site level, trophic assessments using WFD 2021 classification data shows that 51% of river sites across NI were considered to be of High/Good trophic status, a decrease from the previous two classification periods. 49% of river water bodies are classed as Moderate/Poor status (indicative of eutrophic conditions).
At river water body level, trophic assessments using WFD 2021 classification data shows that 44.4% of river water bodies across NI were considered to be of High/Good trophic status, a decrease from the previous two classification periods. 52.2% of river water bodies are classed as Moderate/Poor status (indicative of eutrophic conditions) and of these, 0.2% bodies were considered to be of Bad status (equating to hyper-eutrophic conditions). Data were not available for 3.3% of river water bodies.
When trophic status classes were applied, 44.4 % of river water bodies across Northern Ireland are considered to be in a non-eutrophic state, 8% may become eutrophic and 43.8% of the river water bodies are considered to be eutrophic. Data was not available for 3.8% of the river water bodies.
Within the overall trophic assessment of rivers, the majority of river sites (91.4 %) showed stable or decreasing SRP concentrations at monitored sites compared to the previous reporting period. 58.5 % of rivers were classified as High or Good for SRP status, whilst

41.5 % of river sites had a WFD SRP classification of less than Good status which means they are at risk from eutrophication or are eutrophic.
Seasonal trend analysis showed that the monthly trends in average SRP concentrations were mainly stable or decreasing in 87.5% of rivers in Northern Ireland over the 25-year period, 1998-2023. However, very high baseline levels since 1998, masks the recent increases in phosphorus, particularly over the past 10 years.

Assessment of trophic status of lakes
Of the 21 lakes monitored in NI, 18 lakes were classed as Moderate, Poor or Bad trophic status (indicative of eutrophic conditions). When trophic status classes were applied, three lakes in Northern Ireland were considered to be in a non-eutrophic state and 16 lakes were assessed as eutrophic. Two lakes were assessed as may become eutrophic.
When annual average TP concentrations were compared with the previous reporting period, no lakes showed improvement in TP, 14 lakes remained stable and concentrations in seven lakes increased.
When chlorophyll-α concentrations were considered the majority of the 21 lakes remained stable when compared to previous reporting period. Six lakes showed improvement, however three lakes showed deterioration.

Forecasting water quality trends
Results from water quality trend analysis indicate that in 2027 96.3% and in 2031, 96.9% of average nitrate concentrations are predicted to be below 25 mg/l NO_3. Predictions of trend of nitrate concentrations indicate that 26.7 % of sites will decrease and 53.3 % will stabilise across all sites in the next four years to 2027. Predictions of trend of nitrate concentrations for 2031 indicate that 76.7 % of sites will show a decrease or remain stable.
Results from water quality trend analysis indicate that in 57.7 % of river sites are predicted to be High or Good status for SRP classification in 2027 and 2031. 42.3 % of river sites are predicted to be less than Good status for SRP classification in 2027 and 2031.The trend of WFD phosphorus classification in rivers between the current reporting period, indicates in the next four years to 2027, there will be an 11.5 % decrease and 84.6 % stabilisation across all sites. 3.8 % of sites are expected to deteriorate by one class. Predictions of trend of phosphorus concentrations for 2031 indicate that that there will be a 11.5 % decrease and 84.6 % stabilisation across all sites. 3.8 % of sites are expected to deteriorate by one class.

Groundwater Data

Nitrate
Groundwater monitoring is comprised of boreholes, wells and springs, the majority of which are owned privately. As a result the location of monitoring sites is based on availability and this availability can change regularly. Groundwater monitoring for the reporting period of 2020-2023 was carried out across a total of 70 monitoring sites.
Analysis of the average nitrate concentration of groundwater shows that over 90% of monitoring stations are below 25mg/l nitrate for the last three reporting periods, however this has decreased each cycle, from 98.2% to 93%. A similar trend can be observed with the maximum nitrate concentrations of the last three reporting cycles. Analysis of the change in nitrate concentrations between previous and current reporting periods across the common monitoring sites indicate that the majority are relatively stable with some localised areas of

increases and decreases. Forecasting analysis indicates that one monitoring station has a statistically significant increasing trend in nitrate concentration.

Phosphate

As part of the Water Framework Directive – River Basin Management Plan, the classification for groundwater bodies requires a variety of tests – one of which considers phosphate loading from groundwater to surface water via baseflow. For this test 93% of groundwater bodies were classified at good status in 2021, in the previous cycle (2015) it was 75%, this increase is most likely due to a change in sampling methodology.

Transitional and coastal waters

Nitrate levels in transitional (estuarine) and coastal water bodies were assessed at the Water Framework Regulations water body level. A total of 25 water bodies have been identified. Mean and maximum nitrate levels did not exceed 25 mgl-1; water bodies with relatively high values (>10 mgl-1) were either transitional (estuarine) waters or inshore coastal sea loughs. This indicates catchment-based inputs of nutrients to the marine environment, particularly inshore estuaries, and sheltered sea loughs.

A comparison of nitrate values with previous reporting periods indicates that most water bodies were stable. However, when absolute values are considered, over 60% of water bodies exhibited an increase in mean and maximum nitrate values relative to the previous reporting periods. Long-term trends in nitrate levels indicate that, although a decline was observed over the period 2008 to 2017, values have shown a steady increase from 2017 onwards.

Eutrophication status showed that transitional (estuarine) waters or nearshore sea loughs were most affected (moderate or worse). A preliminary analysis of individual eutrophication quality elements has revealed an increase in nutrient concentration and a decline in the quality of eutrophication response variables such as phytoplankton, macroalgae, and dissolved oxygen for numerous of water bodies. In addition to nutrients, high levels of some pesticides and herbicides indicate that catchment-based agricultural activities are a contributing factor to the water quality status of transitional and coastal waters.

Training and advice for farmers

The College of Agriculture, Food and Rural Enterprise (CAFRE) continues to deliver training and advice on the NAP to farmers and agrifood professionals through the Knowledge Advisory Service (KAS) while also promoting the need for improved water and air quality. Delivery takes place through farmer engagement via the Business Development Groups (BDG's) as well as focussed events, social media and press releases. CAFRE will continue to deliver training on the NAP and any changes coming from the new NAP as well as subjects such as nutrient management planning via the new Sustainable Business Groups (SBG's) and other platforms.

CAFRE will continue to deliver the Soil Nutrient Health Scheme training alongside the new SBG's. KAS continues to engage with industry professionals to increase the understanding around NAP and its importance in helping to deliver improved water quality. CAFRE also continues to promote and update the online nutrient calculators, which farmers can use to assist with NAP compliance.

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 (ND) aims to improve water quality by protecting water against pollution caused by nitrates from agricultural sources. The requirements of this Directive remain enshrined in the domestic Northern Ireland water protection legislation following EU exit. In accordance with regulation 34 of the Nutrients Action Programme Regulations (Northern Ireland) 2019, Northern Ireland is required to review implementation of our Nutrients Action Programme (NAP) and the impact on water quality every four years.

The coverage of the surface freshwater monitoring network in Northern Ireland aims to fulfil all monitoring obligations under multiple directives such as the Water Framework Directive (WFD) and the ND. To ensure efficient use of resources, changes to the monitoring programme were implemented for the 2nd cycle (2015 to 2020) of the River Basin Management Plan (RBMP) and have continued in the 3rd cycle. The 3rd cycle River Basin Management Plan runs from 2021 – 2027. Any modifications to the monitoring network programme have taken into account the need to provide sufficient coverage for reporting under the WFD, ND and Urban Waste Water Treatment Directive (UWWTD).

The format of the water quality sections of this report will be guided by the criteria presented in the 'Nitrates Directive Development Guide for Member States' (2020). Where data availability permits, a three-period comparison is presented for some assessments, as advised in the Development Guide (2020). For the purposes of this report DAERA will use 2012-2015 and 2016-2019 to represent the two previous reporting periods and 2020-2023 to represent the current reporting period.

The WFD nutrient and ecology standards are used to identify eutrophic water bodies, which can then be identified under the Nitrate Directive. The WFD 2015 and WFD 2018 classification data will represent the two previous reporting periods. The WFD 2021 classification data will be used to assess eutrophication in both rivers and lakes, and transitional and coastal marine waters in the current reporting period. Analysis is currently underway on the interim classification update for WFD 2024, and the results will be reported in the next ND review.

The number of monitoring sites presented will differ during each reporting period. In the period 2012-2015, NIEA monitored nitrate concentrations at 337 surface freshwater monitoring stations across Northern Ireland. In the reporting period 2016-2019, NIEA monitored nitrate concentrations at 493 surface freshwater monitoring stations across Northern Ireland. In the current reporting period 2020-2023, NIEA monitored nitrate concentrations at 487 surface freshwater monitoring stations across Northern Ireland.

Groundwater monitoring from 2020-2023 was carried out at 70 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 (which is transposed into Northern Ireland Regulations). 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 are little public drinking water supplies sourced from groundwater.

Nutrient monitoring in Northern Ireland's transitional and coastal waters has been primarily developed to fulfil the requirements of the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 as well as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). Nutrient status is typically determined through the assessment of winter (November-February) dissolved inorganic nitrogen (DIN) concentrations and are reported at the water body level.

In addition to surveillance nutrient monitoring, a number of investigative monitoring programmes in response to known pressures and specific areas of concern, have also been undertaken. For this assessment, nutrient (NO_3) data from a variety of monitoring programmes, including investigative monitoring, were collated to provide a comprehensive historical and contemporary dataset. In order to ensure a robust and realistic assessment, nitrate data in transitional and coastal waters only included winter samples and was analysed at the water body level. The data were assessed over the period 2020-2023; a comparative analysis was also undertaken relative to 2012-2015, and 2016-2019 data. While assessed at the water body level, results are presented at a representative site for each water body.

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 Guide for Member States*', 2020. The chapter is divided into seven parts as follows:-

1.1. Assessment and classification of nitrate in groundwaters;
1.2 Assessment and classification of phosphate in groundwaters;
1.3. Assessment and classification of nitrate in surface freshwaters;
1.4. Assessment and classification of nitrate in coastal and transitional marine waters
1.5. Overview of assessment of eutrophic indicators in rivers, lakes and transitional and coastal marine waters;
1.6. Assessment of eutrophic indicators in rivers
1.7. Assessment of eutrophic indicators in lakes; and
1.8. 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 discharges 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.

Groundwater quality in Northern Ireland is assessed in accordance with NIEA's groundwater monitoring network through the collection of groundwater water samples from boreholes, wells, and springs. The monitoring network consists mainly of industrial boreholes where groundwater is utilised for manufacturing or food/drinks production. The public drinking water supply provider has limited groundwater supplies currently licenced or in active use. A small number of boreholes 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.

NIEA rely mostly on third party owned groundwater boreholes, wells or springs and the co-operation of land/property/business 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 changes in their groundwater usage.

In the previous Article 10 report (2020) Northern Ireland presented groundwater data from 2016-2019. 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 2020. As a result of the changes to the monitoring network there are 48 sites monitored in the 2020-2023 reporting period which were also monitored in the 2012-2015 and 2026-2019 reporting periods (see Table 1.1). However, there were 70 sites monitored in total during the reporting period 2020 – 2023, and their locations are presented in Figure 1.1

For the purposes of this report groundwater monitoring data from 2020-2023 is compared with data from the previous reporting periods 2012-2015 and 2016-2019.

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

	2012-2015 reporting period	2016-2019 reporting period	2020-2023 reporting period	Common points 2012 - 2023
Phreatic groundwater (0-5m)	2	2	2	1
Phreatic groundwater (5-15 m)	36	38	35	29
Phreatic groundwater deep (15-30 m)	0	0	1	0
Phreatic groundwater > 30m	7	7	21	9
Captive groundwater	5	4	6	4
Karstic groundwater	5	5	5	5
Overall Summary	55	56	70	48

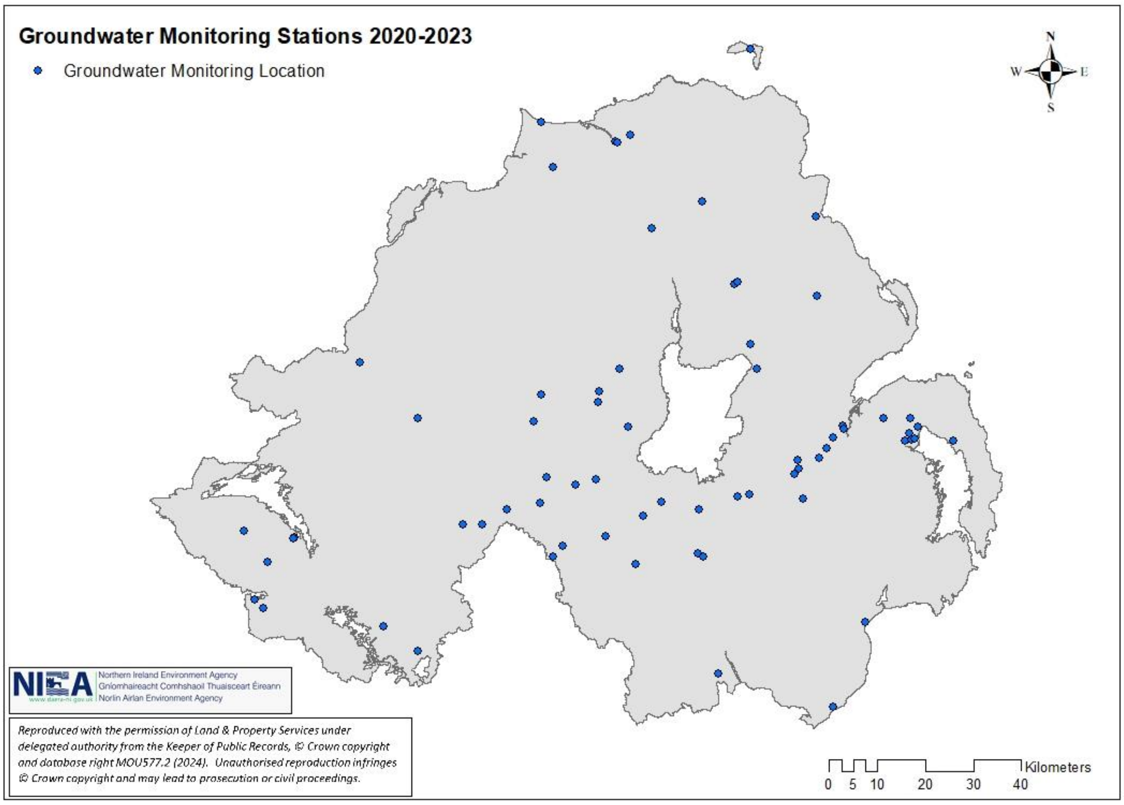

Figure 1.1: Location of groundwater monitoring sites: (2020-2023)

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

During the reporting period 2020-23, NIEA collected data on groundwater nitrate concentrations from 70 groundwater monitoring sites across Northern Ireland. For the purposes of this report all available data collected in the period 2020-23 was included to calculate the average and maximum nitrate concentrations.

Table 1.2 shows the percentage of monitored average nitrate concentrations for the reporting period 2012–2015 in groundwater in Northern Ireland. Results show that of the 55 sites sampled during 2012-2015, 98.2% (54 sites) had an annual average of less than 25 mg/l NO_3 and 1.8% (1 site) had greater than 50 mg/l NO_3.

Table 1.3 shows the percentage of monitored average nitrate concentrations for the previous reporting period 2016–2019 in groundwater in Northern Ireland. Results show that of the 56 sites sampled during 2016-2019, 96.4% (54 sites) had an annual average of less than 25 mg/l NO_3 and no sites had an annual average value greater than 50 mg/l NO_3.

Table 1.4 shows the percentage of monitored average nitrate concentrations for the current reporting period 2020–2023 in groundwater in Northern Ireland. Results show that of the 70 sites, 93% (65 sites) had an annual average of less than 25 mg/l NO_3 and no sites had an annual average value greater than 50 mg/l NO_3.

Table 1.2: Average nitrate concentrations (NO_3 mg/l) in groundwater: 2012-2015 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO3/L) in groundwater (% of sampling points) 2012-2015				
	% of points mg nitrate / L			
	< 25	25-39.99	40-49.99	≥50
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	100	0	0	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	80	0	0	20
Karstic groundwater	100	0	0	0
Overall Summary	98.2	0	0	1.8

Table 1.3: Average nitrate concentrations (NO_3 mg/l) in groundwater: 2016-2019 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO3/L) in groundwater (% of sampling points) 2016-2019				
	% of points mg nitrate / L			
	< 25	25-39.99	40-49.99	≥50
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	97.37	0	2.63	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	75	0	25	0
Karstic groundwater	100	0	0	0
Overall Summary	96.43	0	3.57	0

Table 1.4: Average nitrate concentrations (NO_3 mg/l) in groundwater: 2020-2023 (% of monitoring sites)

Quality classes for average nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2020-2023				
	% of points mg nitrate / L			
	< 25	25-39.99	40-49.99	≥50
Phreatic groundwater (0-5m)	78	11	11	0
Phreatic groundwater (5-15 m)	97	3	0	0
Phreatic groundwater deep (15-30 m)	100	0	0	0
Phreatic groundwater > 30m	95	5	0	0
Captive groundwater	80	20	0	0
Karstic groundwater	100	0	0	0
Overall Summary	93	6	1	0

Since the last reporting cycle there have been multiple changes to the monitoring network, for example, since the last reporting period of 2016-2019 there have been the loss of 5 monitoring sites and the addition of 15 new monitoring sites (more information is provided in the appendix - modified groundwater and surface water monitoring stations). This makes it challenging when comparing results, however it can be noted that the % of sampling points with average nitrate concentrations in groundwater <25mg/l has decreased each reporting cycle.

The maximum values detected show if there is any peak period where the nitrate concentrations show an extreme high. Potential causes could be due to a period of dry weather or in response to seasonal agricultural practices. This information is provided in tables 1.5 – 1.7 for each of the reporting rounds 2012-2015, 2016-2019 and 2020-23, respectively.

Table 1.5 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2012-2015 (% of monitoring sites)

Quality classes for maximum nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2012-2015				
	< 25	**25-39.99**	**40-49.99**	**≥50**
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	94.44	5.56	0	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	80	0	0	20
Karstic groundwater	100	0	0	0
Overall Summary	94.64	3.57	0	1.79

Table 1.6 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2016-2019 (% of monitoring sites)

Quality classes for maximum nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2016-2019				
	< 25	**25-39.99**	**40-49.99**	**≥50**
Phreatic groundwater (0-5m)	100	0	0	0
Phreatic groundwater (5-15 m)	94.74	2.63	0	2.63
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	100	0	0	0
Captive groundwater	75	0	0	25
Karstic groundwater	100	0	0	0
Overall Summary	94.64	1.79	0	3.57

Table 1.7 Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater: 2020-2023 (% of monitoring sites)

Quality classes for maximum nitrate concentrations (mg NO_3/L) in groundwater (% of sampling points) 2020-2023				
	< 25	**25-39.99**	**40-49.99**	**≥50**
Phreatic groundwater (0-5m)	66.67	22.22	0	11.11
Phreatic groundwater (5-15 m)	96.77	3.23	0	0
Phreatic groundwater deep (15-30 m)	100	0	0	0
Phreatic groundwater > 30m	84.21	15.79	0	0
Captive groundwater	80	0	0	20
Karstic groundwater	100	0	0	0
Overall Summary	88.57	8.57	0	2.86

It should be noted that 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. Despite the challenges when comparing results, it can be noted that the % of sampling points with maximum nitrate concentrations in groundwater <25mg/l has decreased since the previous reporting cycles. The spatial distribution of results is provided in Figure 1.2 and 1.3.

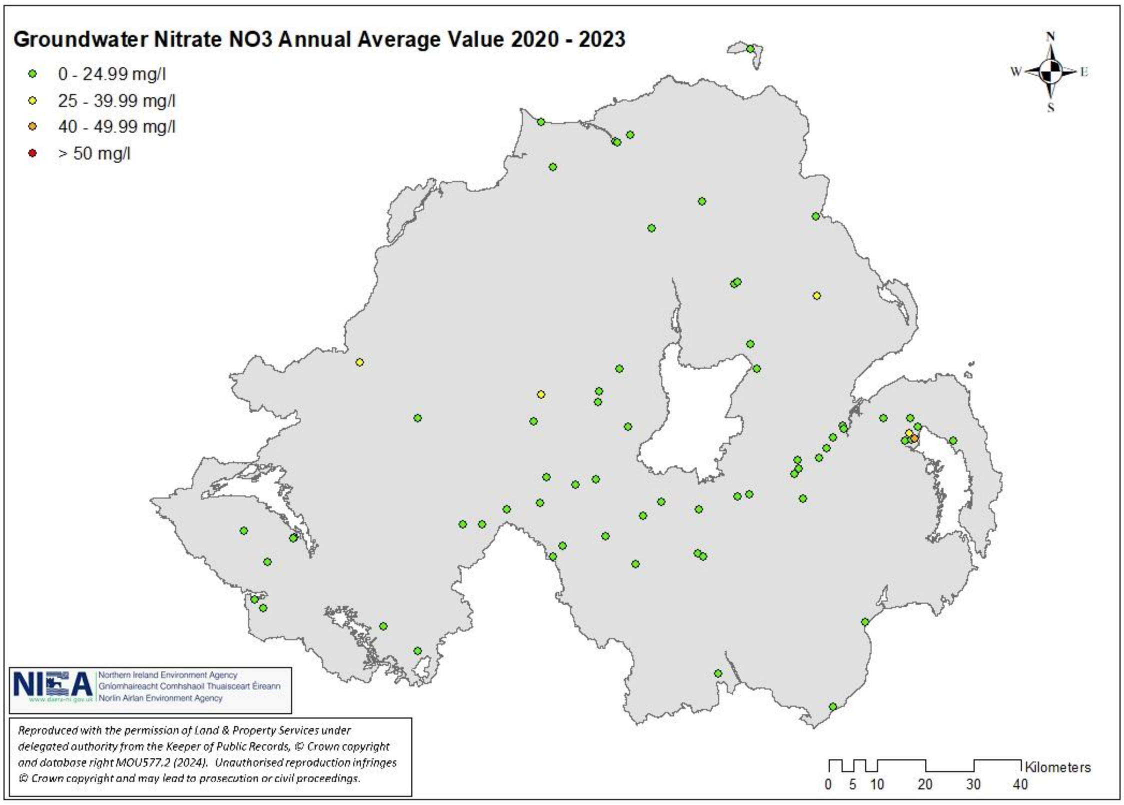

Figure 1.2: Annual average nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2020-2023

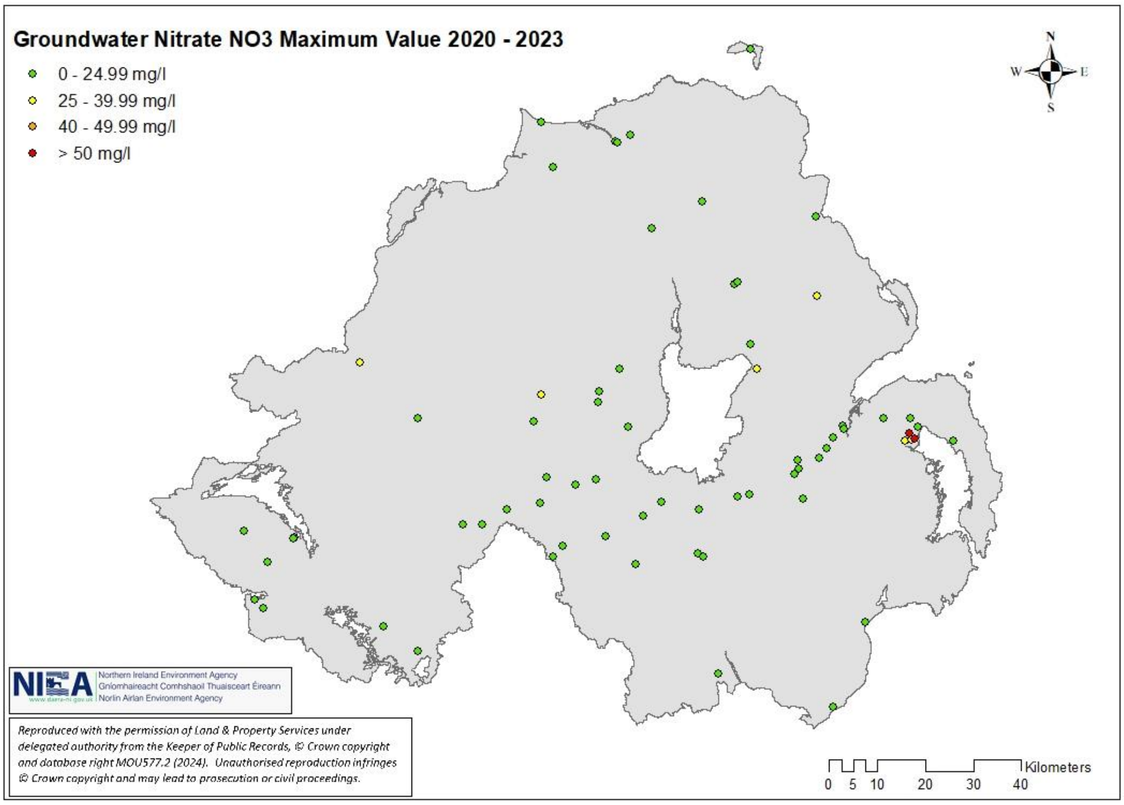

Figure 1.3: Annual maximum nitrate concentrations (NO_3 mg/l) in groundwater monitoring sites: 2020-2023

1.1.2 Changes in nitrate concentrations between previous and current reporting periods

The change between the average nitrate concentrations for the common boreholes in different reporting periods has been compared to provide further analysis. The data in Table 1.8 displays the change between the annual average nitrate concentrations for the common boreholes between the previous reporting periods 2012-2015 and 2016-2019.The data in Table 1.9 displays the change between the annual average nitrate concentrations for the common boreholes between the reporting periods 2016-2019 and 2020-2023. There is an increase in the percentage of monitoring sites with a stable and an increasing trend in the most recent comparison, albeit 77% of sites showing stable concentrations in between reporting periods 2016-2019 and 2020-2023.

The spatial distribution of results is provided in Figure 1.4 and 1.5.

Table 1.8: Changes in groundwater nitrate concentrations (NO_3 mg/l) based on annual average between 2012-2015 and 2016-2019 reporting periods (percentage of water monitoring sites)

	% of sampling points within each category nitrate (mg / L)				
	< - 5	**>-1 and ≤ –5**	**≥– 1 and ≤ + 1**	**>+1 and ≤+5**	**> +5**
Phreatic groundwater (0-5m)	0	50	50	0	0
Phreatic groundwater (5-15 m)	11.43	5.71	71.43	8.57	2.86
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	0	14.29	57.14	28.6	0
Captive groundwater	25	0	50	25	0
Karstic groundwater	0	25	75	0	0
Overall Summary	9.4	9.4	69.8	5.7	5.7

Table 1.9: Changes in groundwater nitrate concentrations (NO_3 mg/l) based on annual average between 2016-2019 and 2020-2023 reporting periods (percentage of water monitoring sites)

	% of sampling points within each category nitrate (mg / L)				
	< - 5	**>-1 and ≤ –5**	**≥– 1 and ≤ + 1**	**>+1 and ≤+5**	**> +5**
Phreatic groundwater (0-5m)	0	0	83.33	16.67	0
Phreatic groundwater (5-15 m)	0	12.50	81.25	6.25	0
Phreatic groundwater deep (15-30 m)	N/A	N/A	N/A	N/A	N/A
Phreatic groundwater > 30m	0	0	60	20	20
Captive groundwater	33.33	0	66.67	0	0
Karstic groundwater	0	0	80	20	0
Overall Summary	1.79	7.14	76.79	10.71	3.57

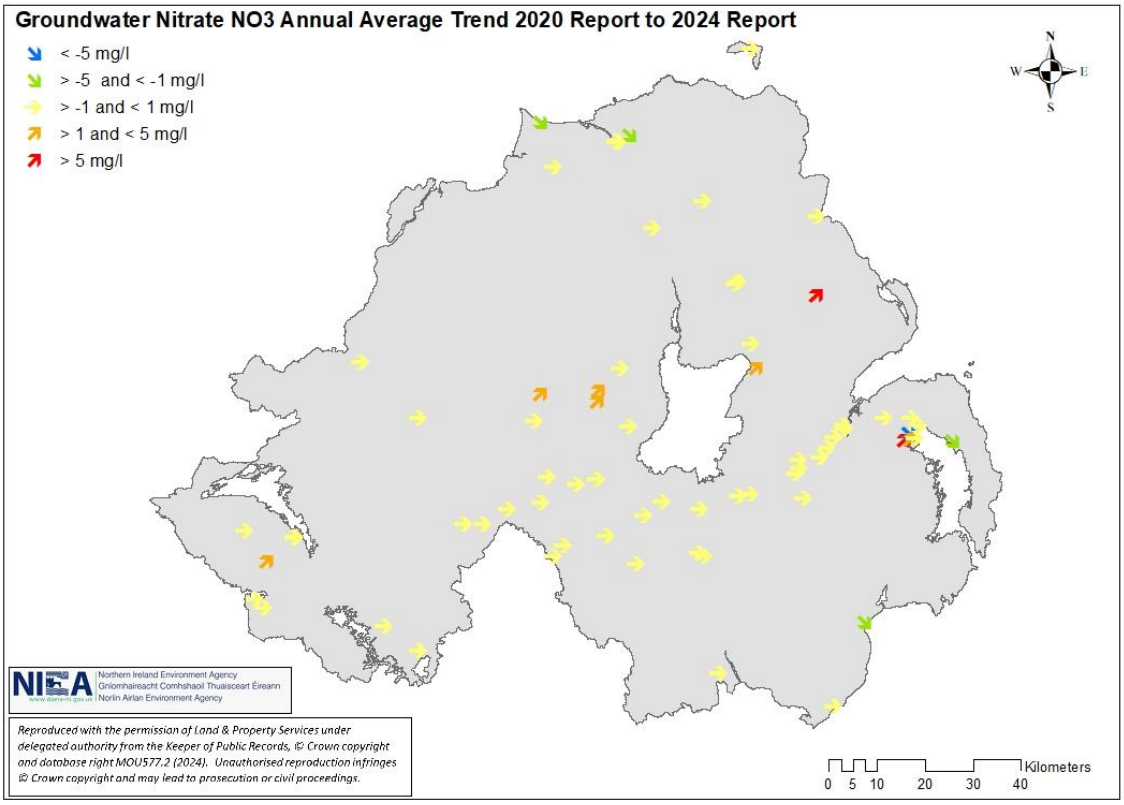

Figure 1.4: Change in annual average nitrate concentrations (NO3 mg/l) in groundwater monitoring sites between previous (2016-2019) and current (2020-2023) reporting period (negative values indicate a decrease).

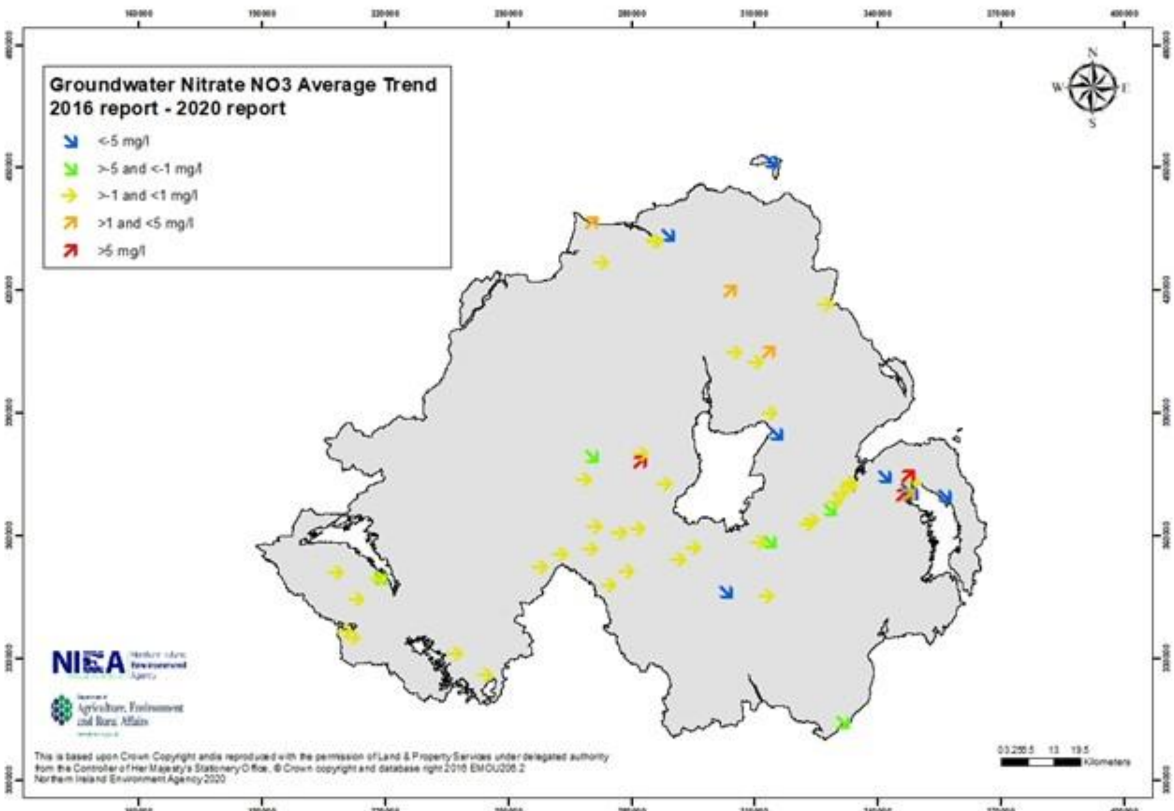

Figure 1.5: Change in annual average nitrate concentrations (NO3 mg/l) in groundwater monitoring sites between (2012-2015) and previous (2016-2019) reporting period (negative values indicate a decrease).

1.2. Assessment and classification of phosphate in groundwaters

Phosphate in groundwater typically is not considered a pollution problem due to its interactions in the subsurface (often becoming attached to clay or iron minerals)[1]. However, if sorption capacity within the subsurface is low it is possible that groundwater can provide a pathway for phosphate to reach surface water receptors e.g. through baseflow to rivers. There is currently no groundwater standard for phosphate.

As part of the Water Framework Directive – River Basin Management Plan, the classification for groundwater bodies requires a variety of tests. One of these tests is the 'surface water qualitative test' checks whether chemicals, namely phosphorous, contained in the groundwater baseflow contributes to the status failure of the respective surface water body. The purpose of this test is to determine if groundwater is a significant pathway for pollutants being transported to surface water bodies resulting in a less than good status assessment of a surface water body. The method is derived from the UKTAG guidance for chemical classification, updated for the second River Basin Planning Cycle (UKTAG, 2012) and available on the DAERA website.

The methodology consists of firstly identifying hydraulic connection between surface water monitoring points and groundwater monitoring points. The load of phosphate entering a surface water body from groundwater as baseflow is calculated and then it is assessed whether the loading of phosphate entering a surface water body from groundwater is greater than 50 % of the total annual load of phosphate (in the surface water), if it is the groundwater body is classified as poor status for the 'surface water qualitative test'.
The results of the 'surface water qualitative classification test' for groundwater bodies is summarized below for 2015 and 2021.

Table 1.10: Groundwater body classification for the Surface water quantitative test for 2015 and 2021

	Surface water qualitative classification result for groundwater bodies	
	Good	**Poor**
% of Groundwater Bodies 2015 (n=75)	74.7%	25.3%
% of Groundwater Bodies 2021 (n=75)	96%	4%

The change in results between 2015 and 2021 are most likely a result of a change in methodology sampling. This is because during the 2009 - 2015 cycle a unique sampling round was conducted. This sampling took place in summer 2013, where after an extended period of dry weather, surface waters were sampled and assumed to represent groundwater quality/baseflow. These results generally showed higher phosphorus and caused many groundwater bodies to be classified as 'poor status' in 2015. This type of sampling round was not conducted for the subsequent river basin cycle of 2015-2021.

[1] phosphorus-pressure-rbmp-2021.pdf (environment-agency.gov.uk)

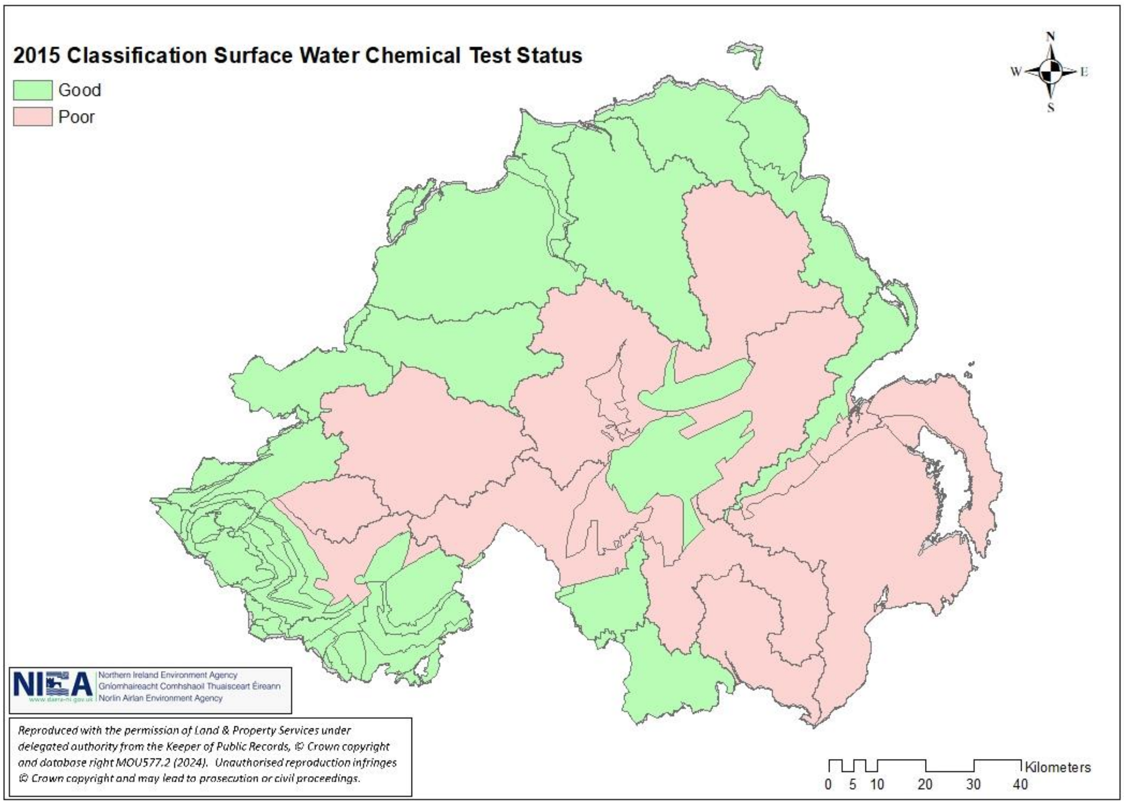

Figure 1.6: 2015 Groundwater body classification test result for the Surface Water Quantitative Test

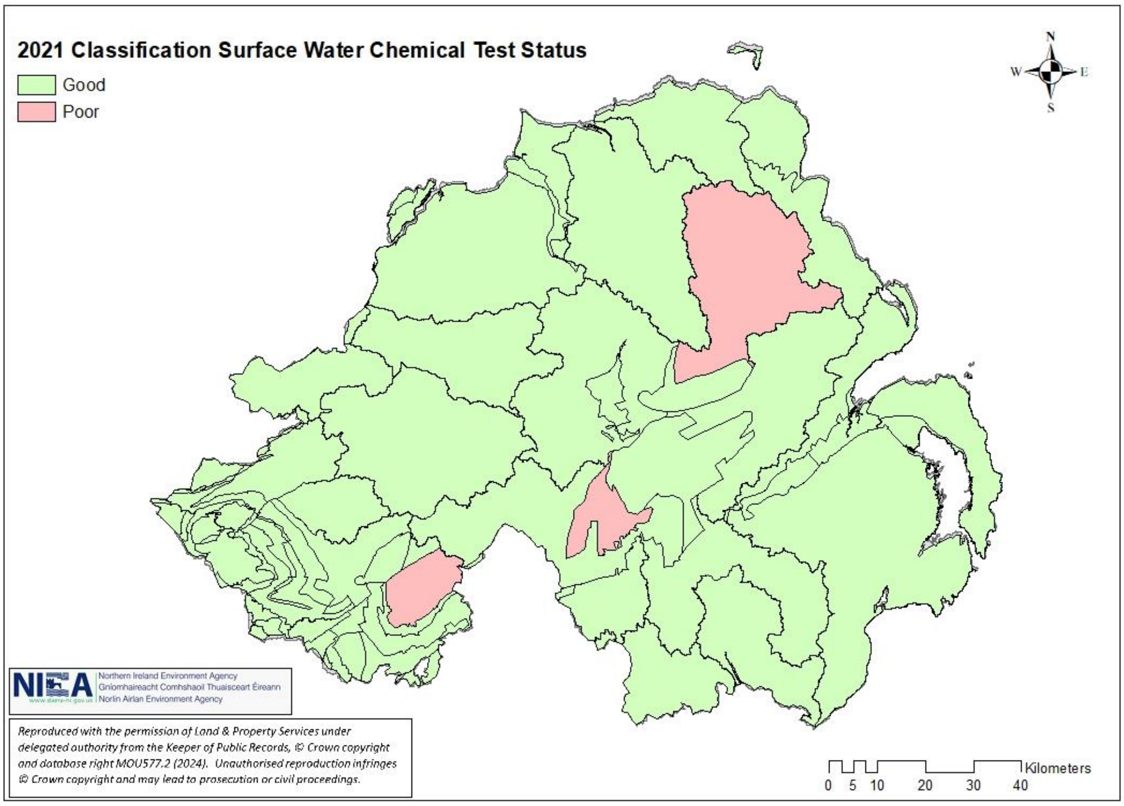

Figure 1.7: 2021 Groundwater body classification test result for the Surface Water Quantitative Test

1.3. Assessment and classification of nitrate in surface freshwaters

1.3.1. Surface freshwater monitoring network

In the previous report submitted to DEFRA in 2020, DAERA presented data for surface waters averaged over the four-year periods 2008-2011, 2012-2015 and 2016-2019 to allow a three-period comparison. In this report, surface water data averaged over the four-year periods 2012-2015, 2016-2019 and 2020-2023 is presented.

In the period 2012–2015 monitoring was carried out at 632 river and lake sites. Sufficient numbers of samples[2] over four years were available at 316 of the rivers' sites and 21 lake sites, giving a total of 337 sites. In the four-year reporting period (2016–2019) monitoring was carried out at 534 river and lake sites. Sufficient numbers of samples over four years were available at 472 of the rivers' sites and 21 lake sites, giving a total of 493 sites. In the current four-year reporting period (2020–2023) monitoring was carried out at 506 river and lake sites. Sufficient numbers of samples over four years were available at 466 of the rivers' sites and 21 lake sites, giving a total of 487 sites (Table 1.11 and Figure 1.8).

Table 1.11: Numbers of surface freshwater monitoring sites for nitrate concentrations (NO_3 mg/l) in Northern Ireland, 2012-2023

	2012-2015	2016-2019	2020-2023	Common points between 2016-19 and 2020-2023
Rivers	316	472	466	465
Lakes	21	21	21	21
Total	337	493	487	486

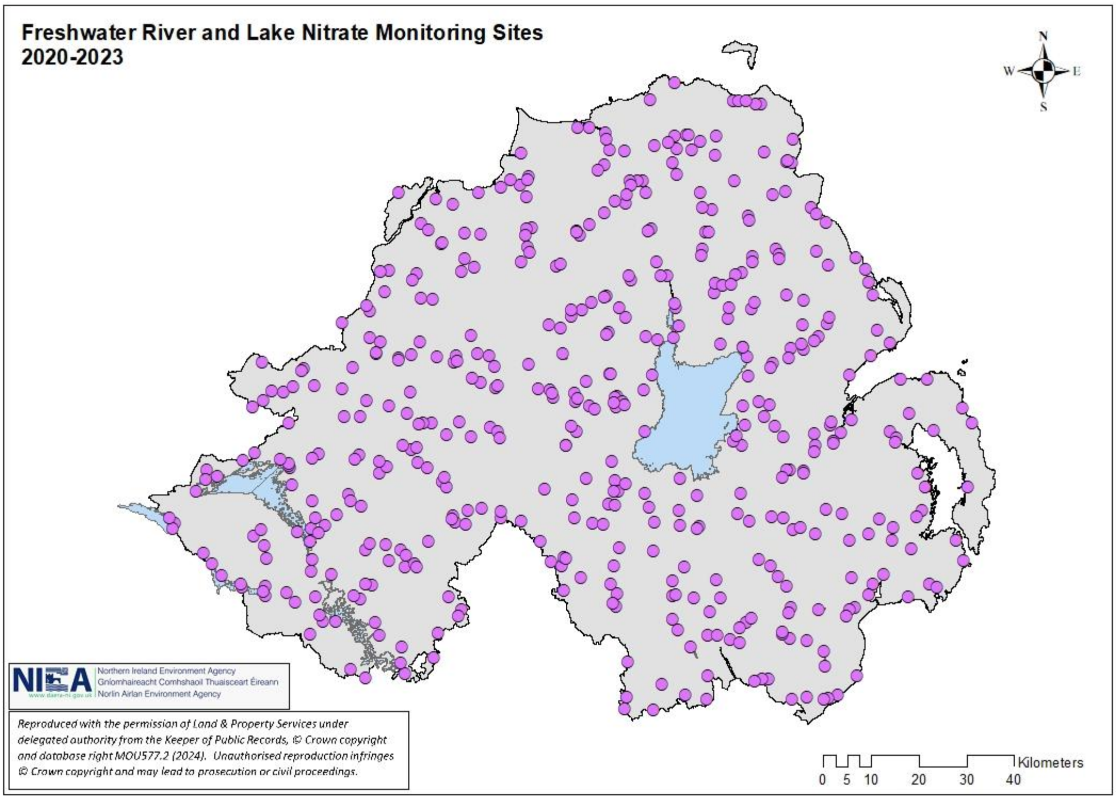

Figure 1.8: Surface freshwater (rivers and lakes) monitoring sites, current reporting period (2020–2023)

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2 Sufficient numbers of samples, for annual average, in the four-year period 2020-2023 were considered to be ≥20 samples

Normally the samples for nitrate analysis are collected at monthly intervals, giving a maximum of 12 samples per year. It is important to note that the 2020 sampling coverage was greatly reduced due to the Covid 19 Pandemic. The majority of lakes were sampled for nitrates between six to nine times during 2020. However, Portmore Lough is collected by boat and was only sampled twice in 2020 (January and February) due to restrictions imposed on boat working.

As part of the guidance issued in 2020, the Commission requested that further information is provided for any monitoring station that has been supressed since the previous reporting period. For continuity we will also present this information in this report. The key information to be presented is the reason why the station was removed from the monitoring scheme (e.g. recorded nitrates values under 25 mg/l over the last reporting period or some other reason to be specified) and the identification of the alternative monitoring station(s) that ensure the continuity of monitoring of the pollution that the suppressed station identified, as well as the results of this station. None of the stations suppressed since the last reporting period had annual average values exceeding 25 mg/l but in the interests of full traceability the reason for closure has been identified. The tables can be found in the Appendix.

1.3.2. 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 the two previous reporting periods and the current reporting period for river and lake sites are summarised in Tables 1.12, 1.13 and 1.14. Figures 1.9–1.11 illustrate the data from the current reporting period only (2020-2023).

Table 1.12: Rivers and lakes annual average, 2012-2023

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2012-2015 *(n=337)*	24.9	64.4	10.7	0	0	0
2016-2019 *(n=493)*	23.1	62.9	14.0	0	0	0
2020-2023 *(n=487)*	20.9	64.3	14.8	0	0	0

Table 1.12 shows the rivers and lakes annual average concentration for the periods 2012-2015, 2016-2019 and 2020-2023. In all reporting periods, 100 % of surface water sites had an average nitrate concentration below 25 mg/l NO_3. However, there has been a decline in the proportion of surface water sites being below 10 mg/l NO_3. In the period 2012-2015, 89.3 % of surface water sites had an average nitrate concentration below 10 mg/l NO_3. In the period 2016-2019, 86 % of surface water sites had an average nitrate concentration below 10 mg/l NO_3. In the current reporting period 2020-2023, 85.2% of surface water sites had an average nitrate concentration below 10 mg/l NO_3 (Figure 1.9).

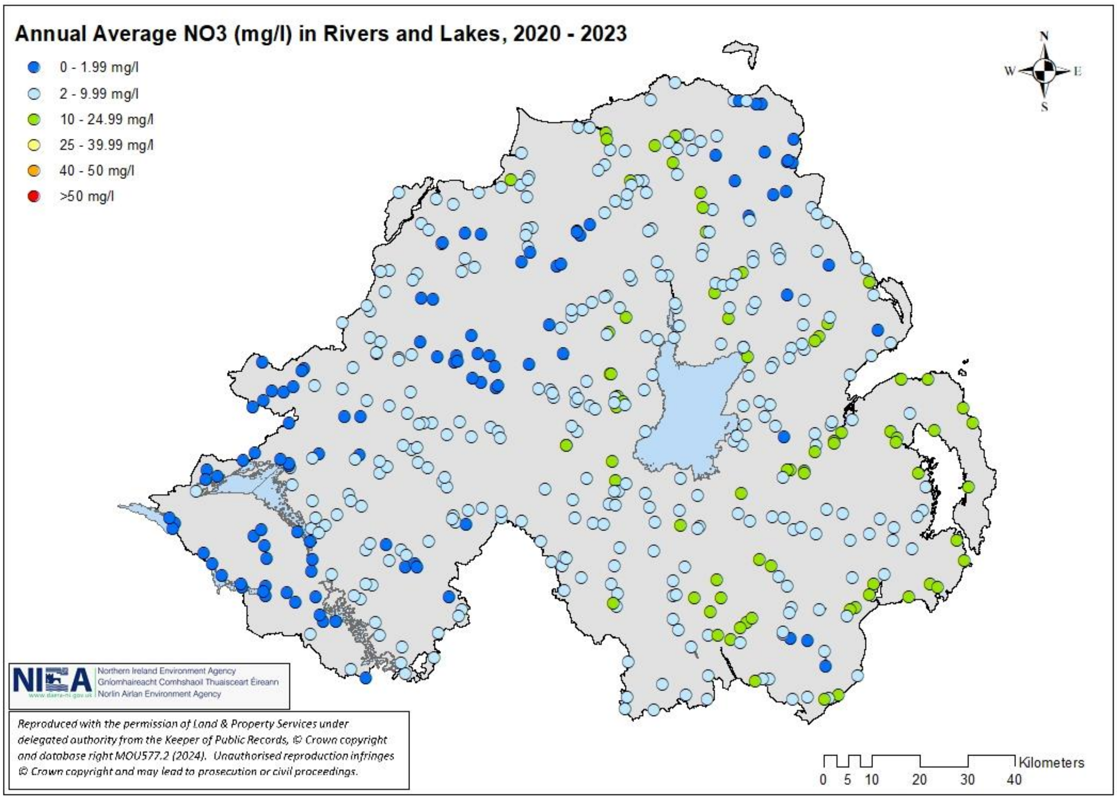

Figure 1.9: Annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2020–2023

There has been a decline in the proportion of surface water sites being below 10 mg/l winter average NO_3 concentrations. Table 1.13 shows the rivers and lakes winter average concentrations over the three reporting periods 2012-2015, 2016-2019 and 2020-2023. In the period 2012-2015, the majority (87 %) of sites monitored over the winter period of October to March each year, had concentrations less than 10 mg/l NO_3. However, in the period 2016-2019, this declined to 81.1 % of sites monitored over the winter period that had concentrations less than 10 mg/l NO_3. In the current period 2020–2023, this declined further to 79.5 % of sites monitored over the winter period that had concentrations less than 10 mg/l NO_3 (Figure 1.10).

Table 1.13: Rivers and lakes winter average, 2012-2023

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2012-2015 *(n=337)*	21.1	65.9	12.7	0.3	0	0
2016-2019 *(n=493)*	22.1	59.0	18.3	0.6	0	0
2020-2023 *(n=487)*	17.9	61.6	20.3	0.2	0	0

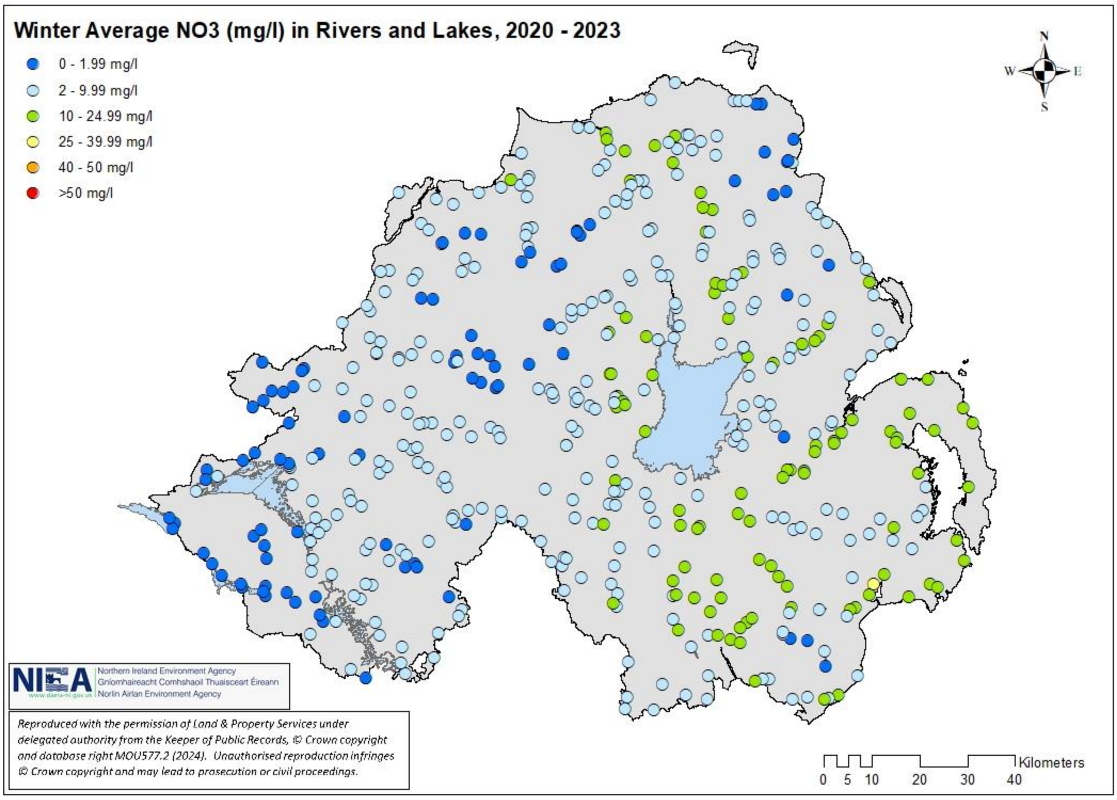

Figure 1.10: Annual winter nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2020–2023

A decline in the proportion of surface water sites with maximum NO_3 concentrations below 10 mg/l has also been observed. Table 1.14 shows river and lake maxima concentrations over the three reporting periods 2012-2015, 2016-2019 and 2020-2023. In the period 2012-2015, 58.1 % of sites had concentrations less than 10 mg/l NO_3. In the period 2016–2019, when maxima were considered, 48.7 % of sites had concentrations less than 10 mg/l NO_3. In the current reporting period 2020-2023, this decreased to 40.3 % of sites that had concentrations less than 10 mg/l NO_3. A greater percentage of surface water sites recorded maximum concentrations in the 10-24.99 mg/l NO_3 category than in previous reporting periods (Figure 1.11). One site (0.2%), Ardilea River along Dundrum Road recorded a maximum concentration greater than 50 mg/l. A measurement of 68.5 mg/l NO_3 was recorded in January 2020

Table 1.14: Rivers and lakes maximum, 2012-2023

	% of sites (NO_3 mg/l)					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-49.99**	**>50**
2012-2015 *(n=337)*	6.5	51.6	38.9	2.4	0.6	0
2016-2019 *(n=493)*	8.7	40.0	38.7	8.5	2.0	2.0
2020-2023 *(n=487)*	3.1	37.2	51.1	8	0.4	0.2

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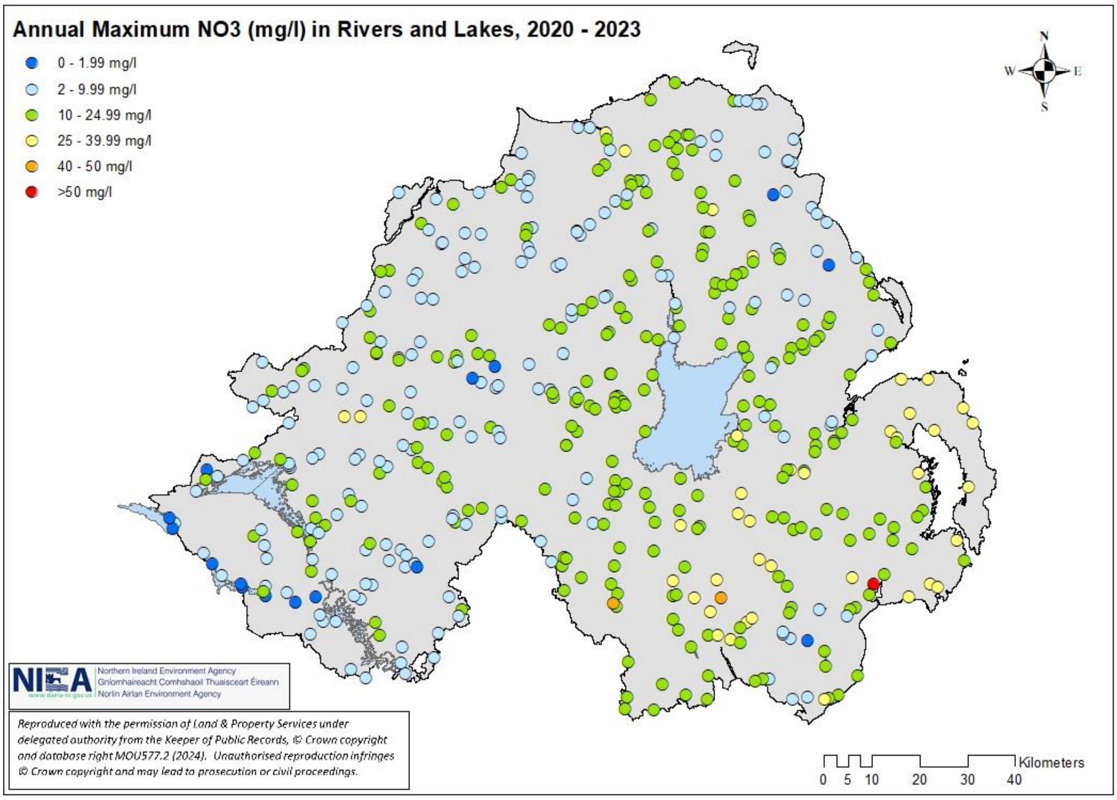

Figure 1.11: Annual maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes, 2020–2023

1.3.3. Changes between previous and current reporting periods

The nitrate concentrations for 2020-2023 are compared against results from the previous reporting period (2016-2019) for the river and lake sites that are common to both reporting periods. A total of 486 sites are common between both reporting periods. Table 1.15 and Figures 1.12–1.14 show the evolution of annual average, maximum and winter average nitrate concentrations at these river and lake sites between the two reporting periods.

Table 1.15: Changes in surface water nitrate concentrations (NO_3 mg/l) based on annual average, winter average and maximum values for the previous and current reporting periods (% of sites)

	% of sites *(n= 486)*				
	Strong decrease	**Weak decrease**	**Stable**	**Weak increase**	**Strong increase**
Rivers and lakes annual average	0.2	7.4	70	22.2	0.2
Rivers and lakes winter average	1.6	10.7	62.6	25.1	0
Rivers and lakes maximum	16.3	15.8	22	30.9	15

Based on mg/l difference - Strong Decrease = < -5; Weak Decrease = ≥ -5 to < -1; Stable = ≥ -1 to ≤ +1; Weak Increase = > +1 to ≤+5; Strong Increase = > +5

Table 1.15 and Figure 1.12 show that the annual average nitrate concentrations in rivers and lakes were stable or decreasing in 77.6 % of sites between the two reporting periods. For comparison, this is similar to the 77.2% of sites were stable or decreasing as noted in the previous report (2020) when changes in the annual average nitrate concentrations between the reporting periods of 2012-2015 and 2016-19 were assessed.

Results also show a similar pattern in winter average nitrate concentrations where 74.9 % of sites were decreasing or stable between the two reporting periods. (Table 1.15 and Figure 1.13). For comparison, 74.2% of sites were stable or decreasing as noted in the previous report (2020) when changes in the winter average nitrate concentrations between the reporting periods of 2012-15 and 2016-19 were assessed.

However, when maxima were considered, only 54.1 % of sites remained stable or showed a decrease. 15 % (73 sites) (Table 1.15 and Figure 1.14) show a strong increase in maximum concentrations but it should be noted that of these 73 sites, 62 sites exhibit a maximum concentration <25 mg/l NO_3. For comparison, 45.5% of sites were stable or decreasing as noted in the previous report (2020) when changes in the maximum nitrate concentrations between the reporting periods of 2012-15 and 2016-19 were assessed.

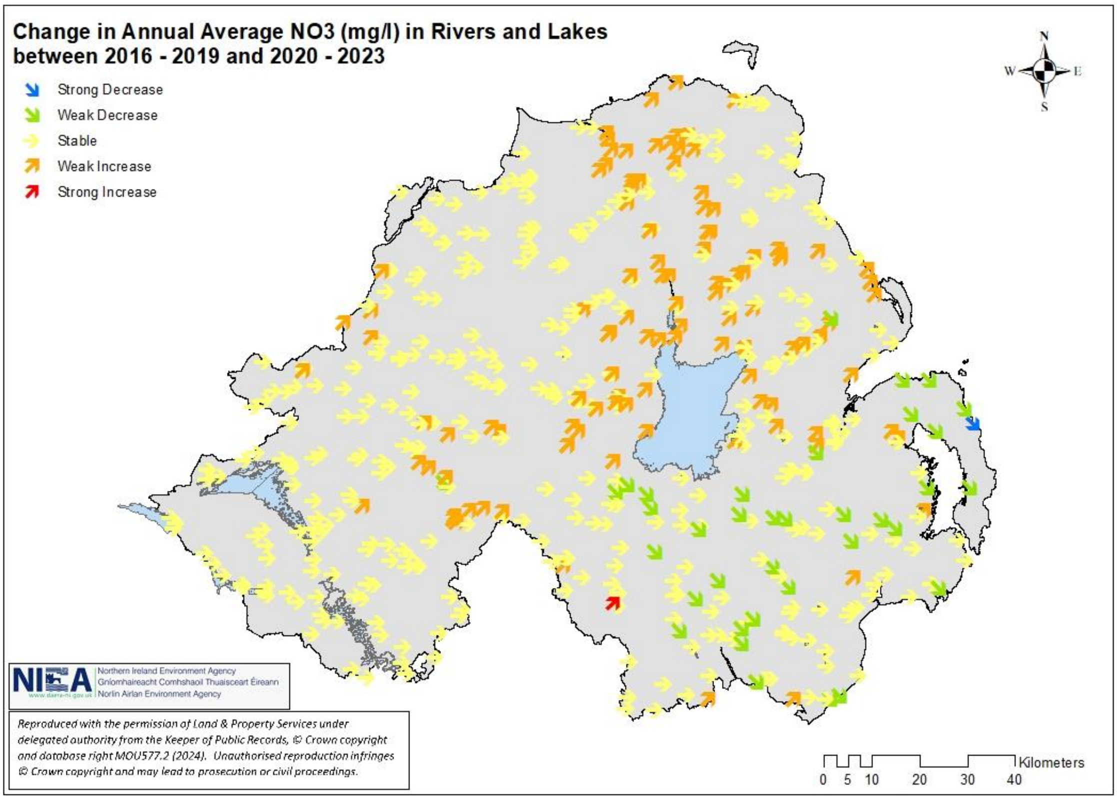

Figure 1.12: Change in annual average nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods.

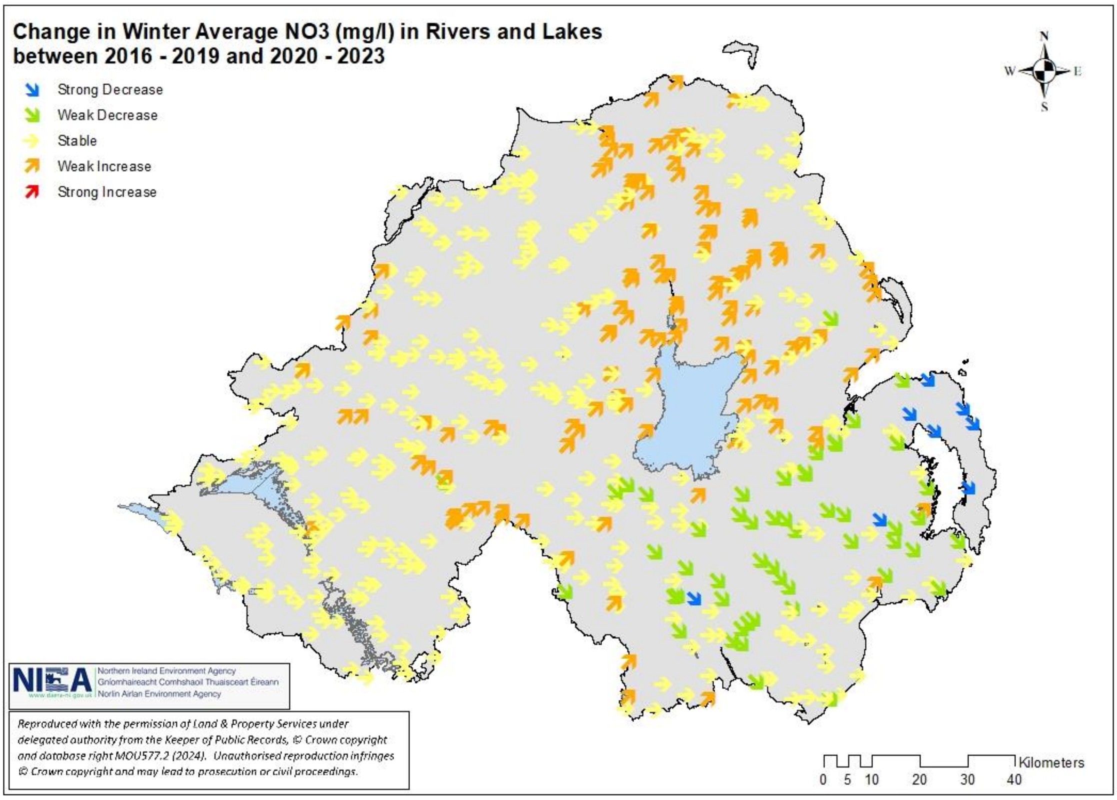

Figure 1.13: Change in winter average concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods.

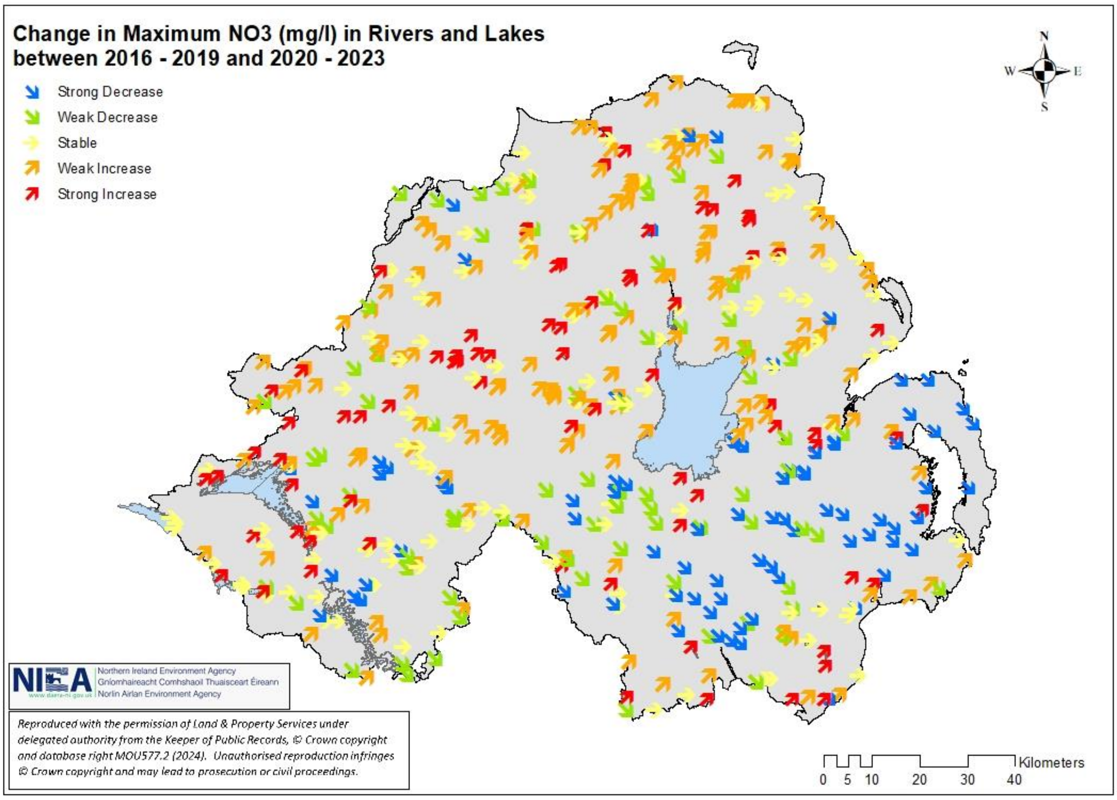

Figure 1.14: Change in maximum nitrate concentrations (NO_3 mg/l) in rivers and lakes between previous and current reporting periods.

1.3.4. 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'* 2020, 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 2023. A total of 499 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 137 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 137 monitoring sites. Seasonal trend analysis showed that the monthly trends in average nitrate concentrations in 105 rivers in Northern Ireland were decreasing or stable over the 31-year period, 1992-2023 (77.64 % of sites). Thirty-two sites (23.36% of sites) showed a significant increasing trend (Tables 1.16 and Figure 1.15). Figure 1.16 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 499 surface water sites (>6 years data) were calculated from the 31-year data set (Figure 1.17). 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).

A strong contributing factor to the decreasing long-term trend in Fig 1.17 is the initial high nitrate levels in the early 1990s, from which there has been a gradual decrease. However, the Seasonal-Mann Kendall long-term trend analysis does not indicate changing trends across the set time period; it cannot go in two directions. As such a recent switch from decreasing to increasing, as shown in Figures 1.12-1.14 would be masked by the overall downward trend. Any gradual increases in the long-term trends would initially be identified in a stabilisation of the trend before showing increases. The exception to this would be significant nitrate rises above previous concentrations. A high concentration spike is shown in Fig 1.17 post 2018. To help evaluate this spike we can compare the long-term trend analysis from the 2016 report against the data in the 2020 report. The comparison shows the percentage of monitoring sites decreasing went from 58% in 2016 to 64.49% in 2020 following the expected long-term trend. Stabilising monitoring sites decreased from 37% in 2016 to 25.7% in 2020. Worryingly however the percentage of monitoring sites showing an increasing long-term trend went from 4.6% in 2016 to 9.8% in 2020. Comparison with 2024 shows that the percentage of monitoring sites showing an increasing long-term trend in 2024 is 23.6%.

Table 1.16: Summary of numbers of monitoring sites showing overall, increases or stable trends of nitrate (NO_3) between 1992 and 2023

Time Period	NO_3 (n=137): 1992-2023		
	Decrease (p=<0.05)*	**Stable (NS)***	**Increase (p=<0.05)***
Overall	***68 (49.64 %)***	***37 (27.01 %)***	***32 (23.36 %)***

**(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))*

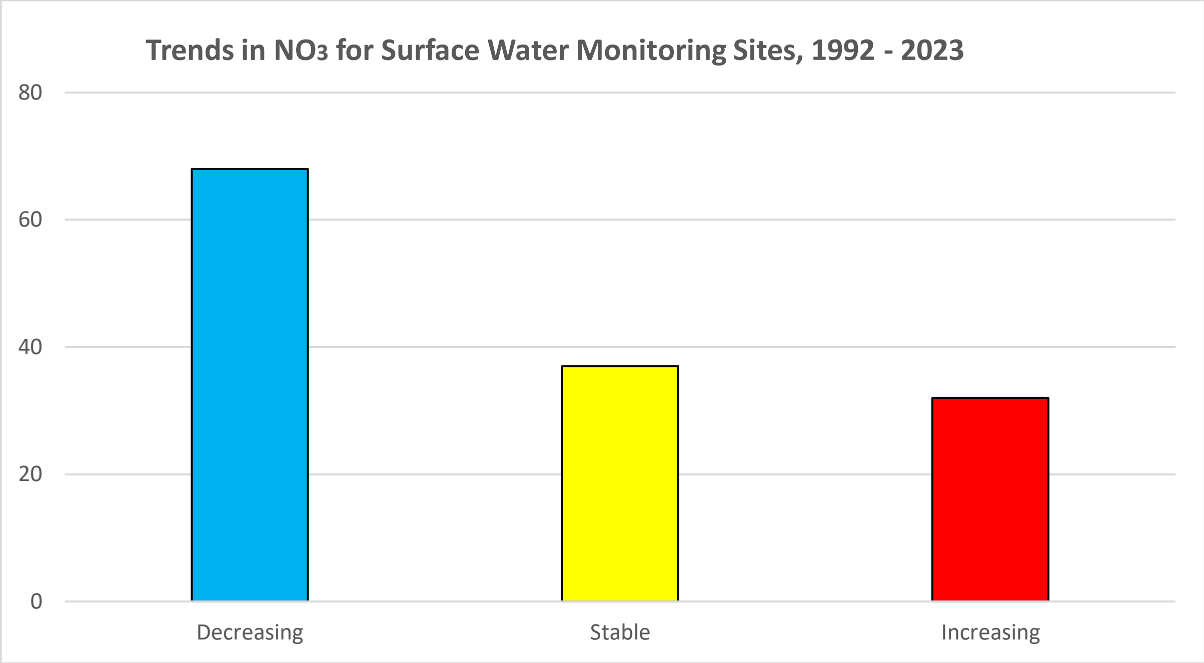

Figure 1.15: Numbers of monitoring sites showing increases, decreases or remaining stable, 1992-2023.

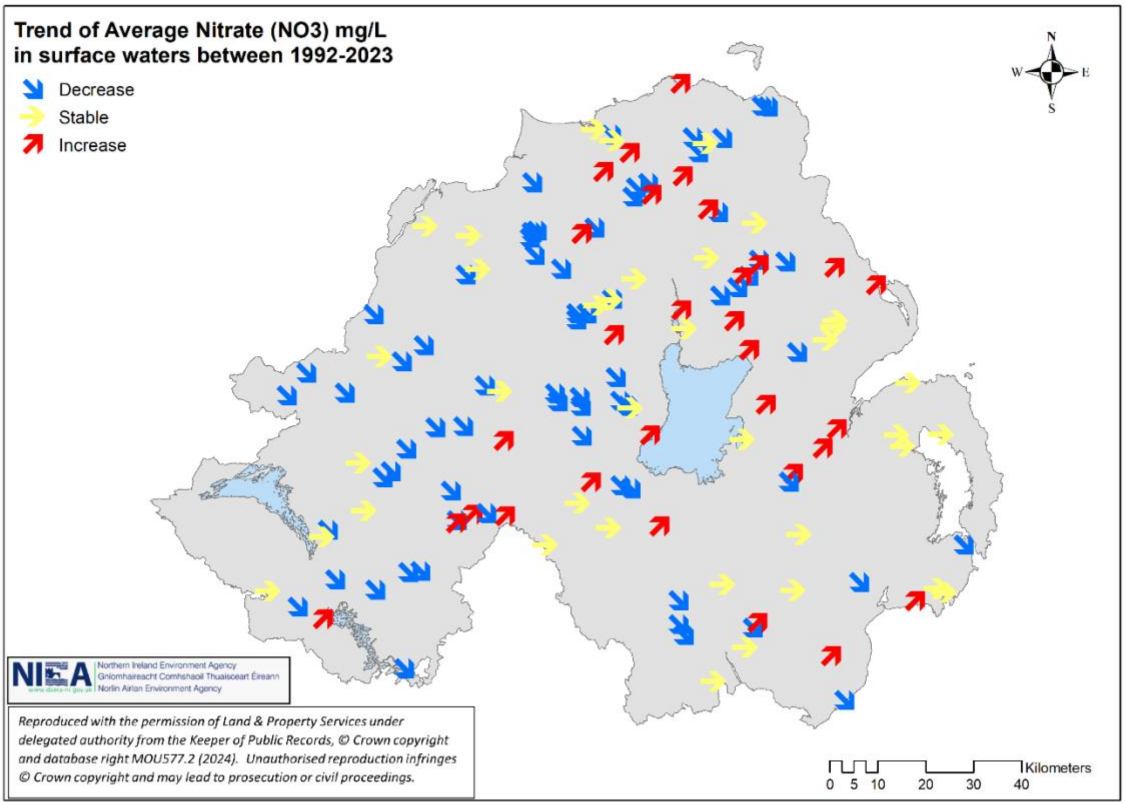

Figure 1.16: Overall trend of average nitrate (NO_3 mg/l) in surface waters across Northern Ireland in the period January 1992 to December 2023

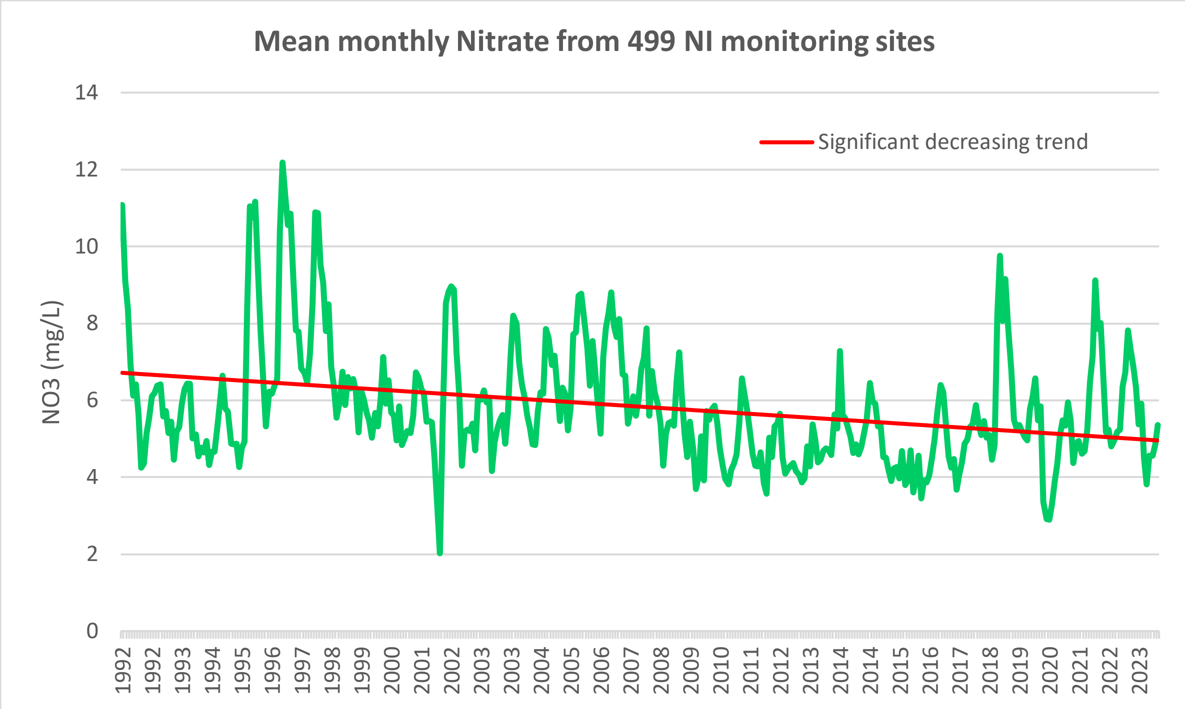

Figure 1.17: Nitrate (NO_3) concentrations in 499 monitoring sites summarized by month into annual mean values of the site population, 1992-2023.

Flow-weighted mean concentrations were used to calculate the trends in nitrate loadings from the river catchments flowing to Lough Neagh, 2009 to 2023 (Figure 1.18). The outflow concentration is representative of the lake condition. An increasing trend was evident from three of the inflowing rivers, the Upper Bann, the Glenavy and the Crumlin. Generally, nitrate export has increased since 2016. The outflow also showed an increasing trend over the period.

When compared on a normalised area basis annually, (Figure 1.19) there was a slight variation in the contribution of nitrate loading per river.

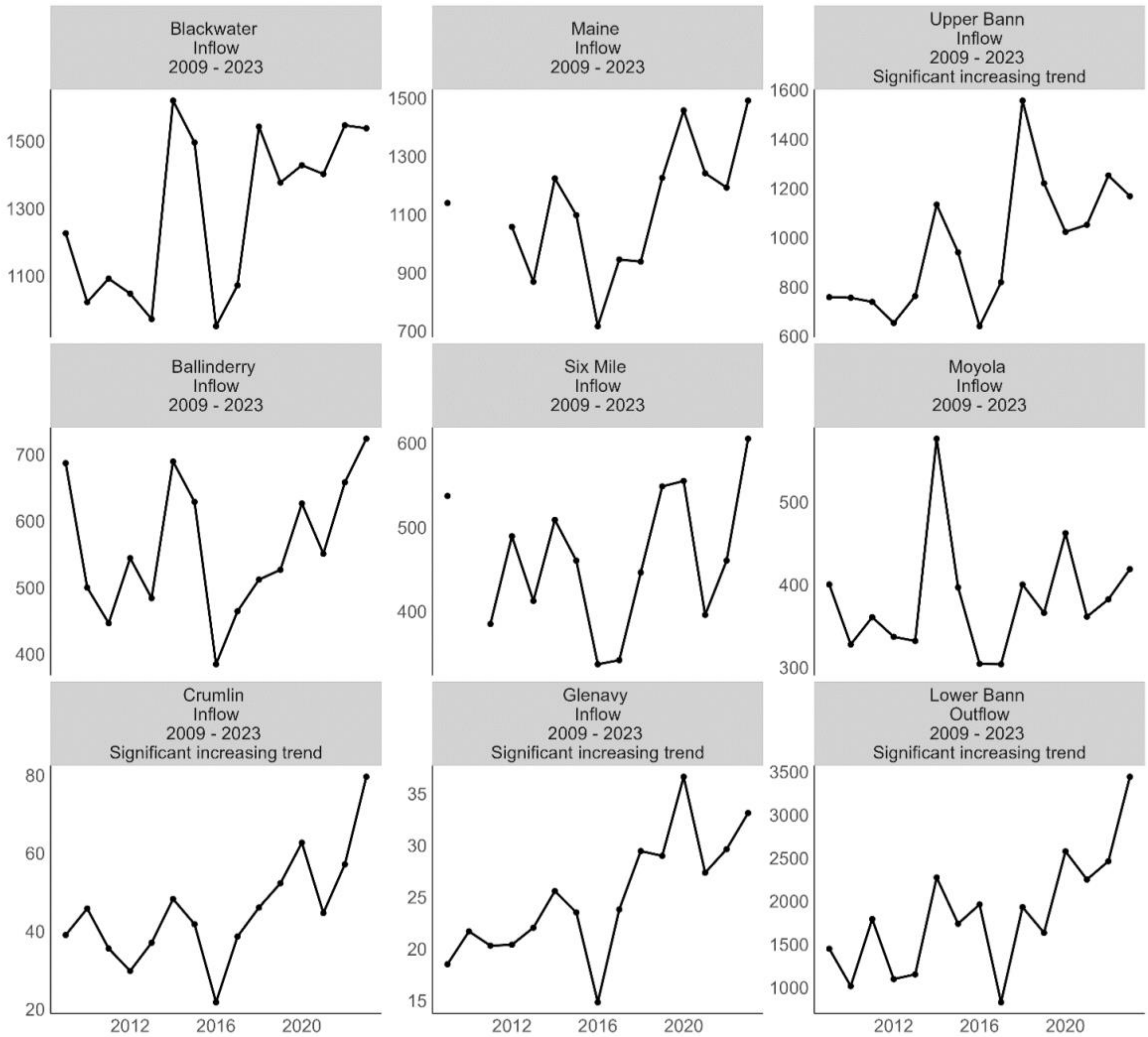

Figure 1.18: Nitrate (NO3) loading (T) from the rivers flowing into and out of Lough Neagh, 2009 to 2023. Trend determined by Mann-Kendall test.

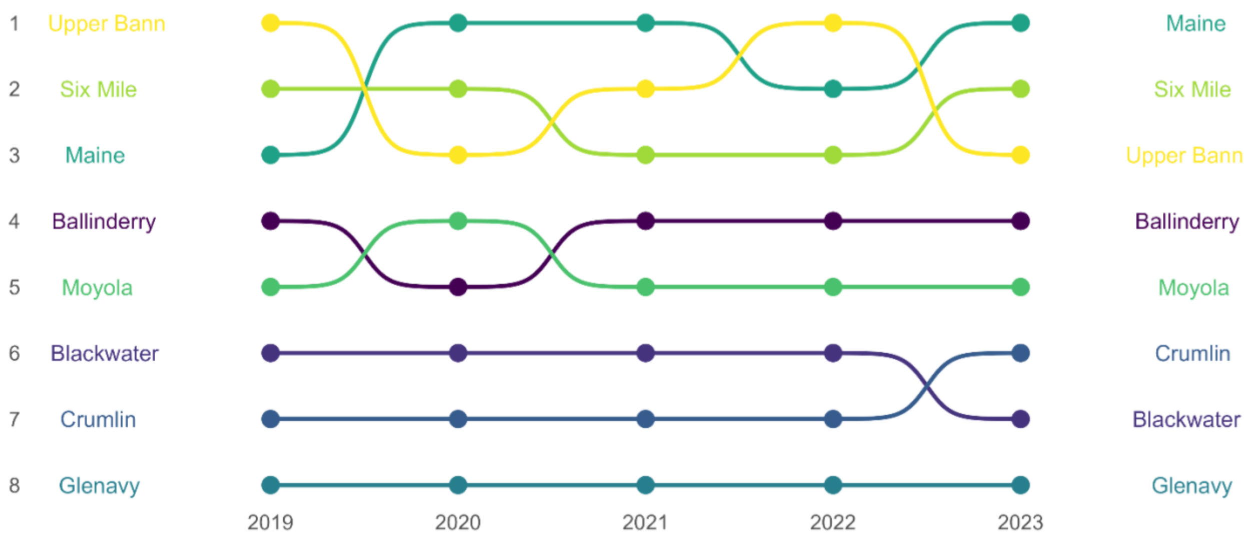

Figure 1.19: Lough Neagh inflowing rivers ranked according to nitrate (NO3) loading, T per km2 per year, 2009 to 2023. Trend determined by Mann-Kendall test. Position one is the greatest contributor and position 8 is the least.

In summary for Section 1.3 on nitrates in freshwaters, in recent years there has been an increase in the number of sites showing increasing levels of nitrate in freshwaters, particularly in the south and east of the region, which is a cause for concern. Over the long term, since 1992, levels continue to decline. Further analysis will be undertaken to establish the causative factors and any geospatial differences in the recent changes reported.

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

1.4.1 Transitional and coastal monitoring network

This assessment is based on a review and collation of all available records in transitional and coastal waters. Nutrient (NO_3) data from a variety of historical and current monitoring programmes, including investigative monitoring programmes, were collated to provide a comprehensive historical and contemporary dataset. Assessments of transitional and coastal waters, particularly under the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017, are undertaken at the water body level, which provides an integrated measure of environmental conditions. All data collected at each monitoring site were assessed in terms of quantity and frequency; although some sites had good long-term data, the data for many sites, particularly those in offshore coastal waters was somewhat limited. This is due to the complex and challenging nature of site-specific marine monitoring schemes. In order to ensure a robust and comprehensive analysis, the assessment of nitrate in transitional and coastal waters was undertaken at the water body level. All monitoring data were reviewed and collated into the 25 transitional and coastal water bodies identified under the Water Framework Directive Regulations (Figure 1.20).

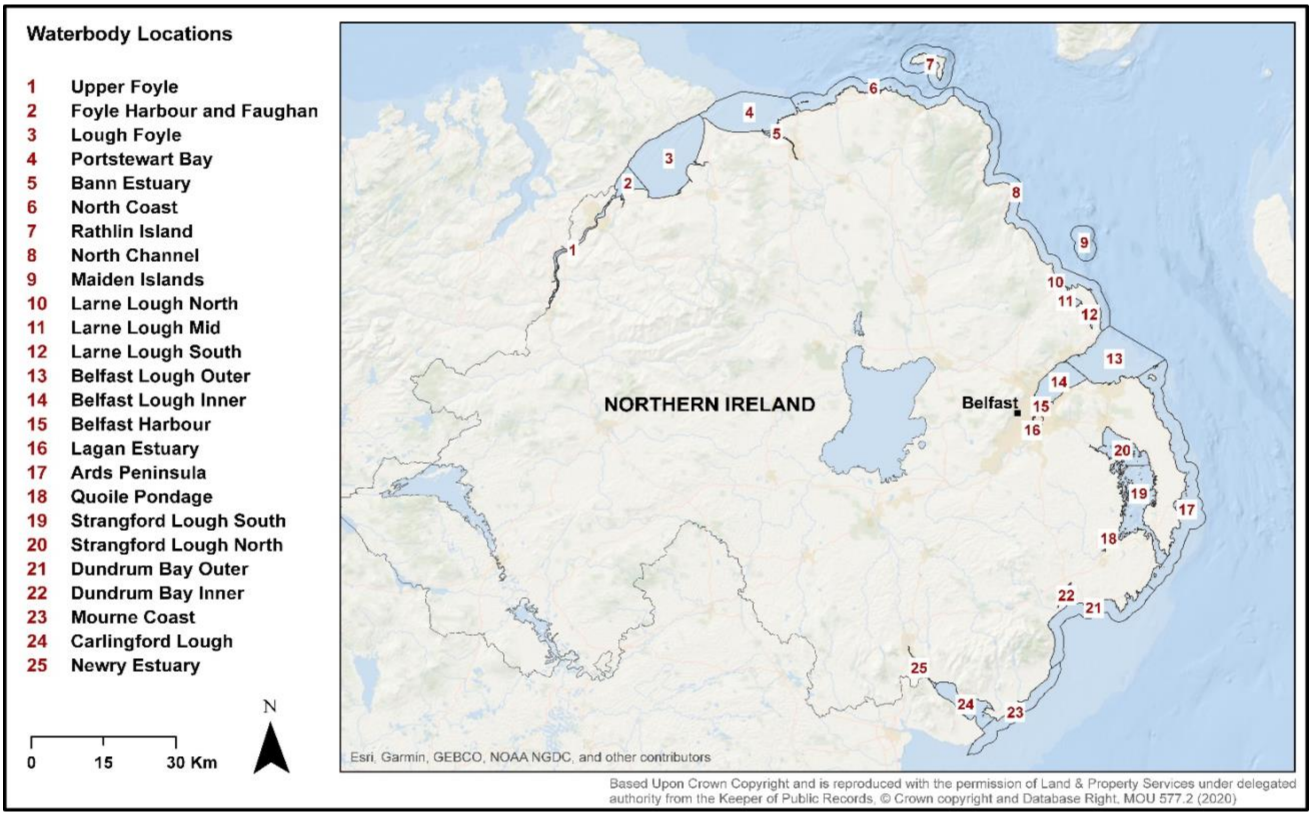

Figure 1.20: Transitional and coastal water bodies identified in Northern Ireland.

The data for each water body was divided to three reporting periods: 2012-2015, 2016-2019 and 2020-2023. For reporting purposes, the results are presented at a representative site for each water body (Figure 1.21).

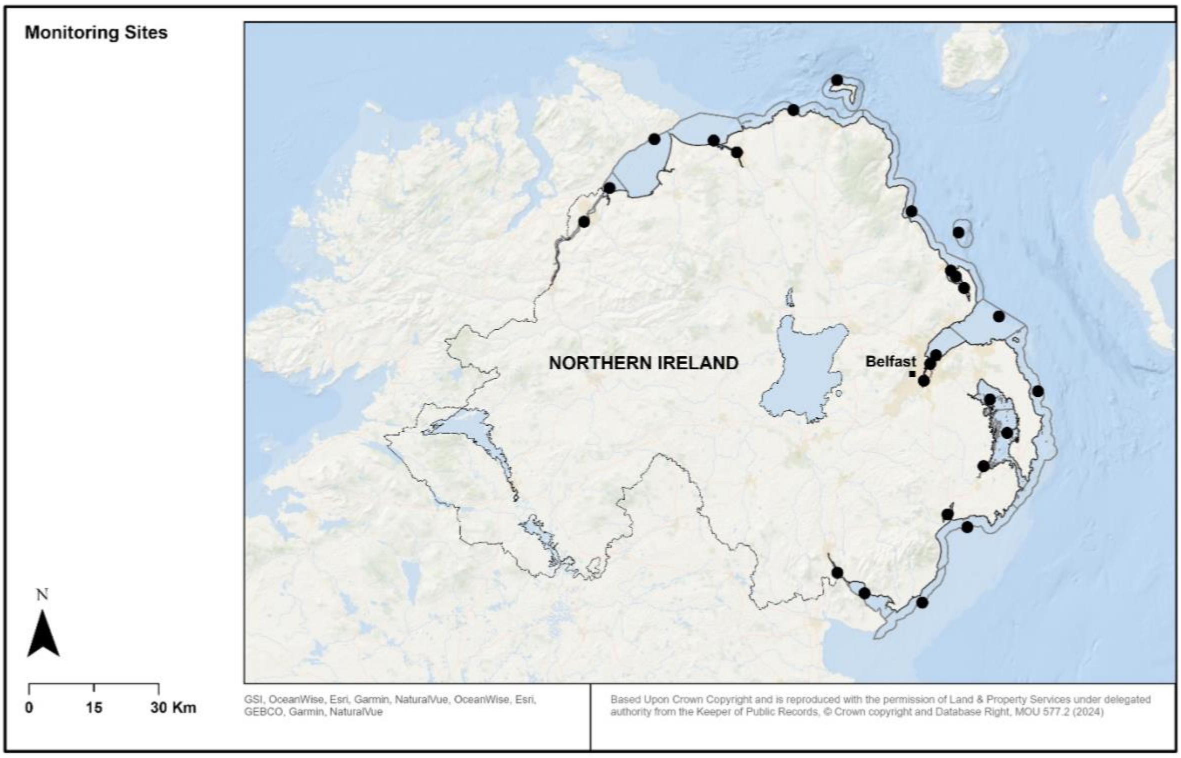

Figure 1.21: Transitional and coastal monitoring sites in Northern Ireland.

Nitrogen is the primary nutrient that limits plant growth in the marine environment and its uptake by phytoplankton, macroalgae and aquatic macrophytes is highest during the spring and summer growing period. Nutrient levels in marine waters are typically highest during the winter when plant growth is minimal. Nutrient levels in the marine environment are therefore monitored and assessed based on winter (November – February) values. Winter mean and winter maximum nitrate concentrations (NO_3 mgl^{-1}) were calculated for each water body for each of the assessment periods (2012-2015, 2016-2019 and 2020-2023).

1.4.2 *Nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters*

Mean winter nitrate concentrations over the 2020-2023 period ranged between 0.4 and 14.7 mgl^{-1}. Overall, 68% of transitional and coastal water bodies had nitrate concentrations of less than 2 mgl^{-1}. The remaining water bodies had nitrate concentrations below 25 mgl^{-1} (Table 1.16). Maximum winter nitrate concentrations measured between 0.6 and 21.4 mgl^{-1}. Nine (36%) water bodies had maximum winter nitrate values of less than 2 mgl^{-1} with 48% having values between 2 and 10 mgl^{-1}. The remaining 16% of water bodies had maximum nitrate values of between 10 and 25 mgl^{-1} (Table 1.17).

Table 1.17: Classification of mean and maximum winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters 2020-2023 (% of water bodies).

	% of water bodies (NO_3 mgl^{-1})					
	0-1.99	**2-9.99**	**10-24.99**	**25-39.99**	**40-50**	**>50**
Transitional and coastal winter mean	68.0	28.0	4.0	0.0	0.0	0.0
Transitional and coastal winter maximum	36.0	48.0	16.0	0.0	0.0	0.0

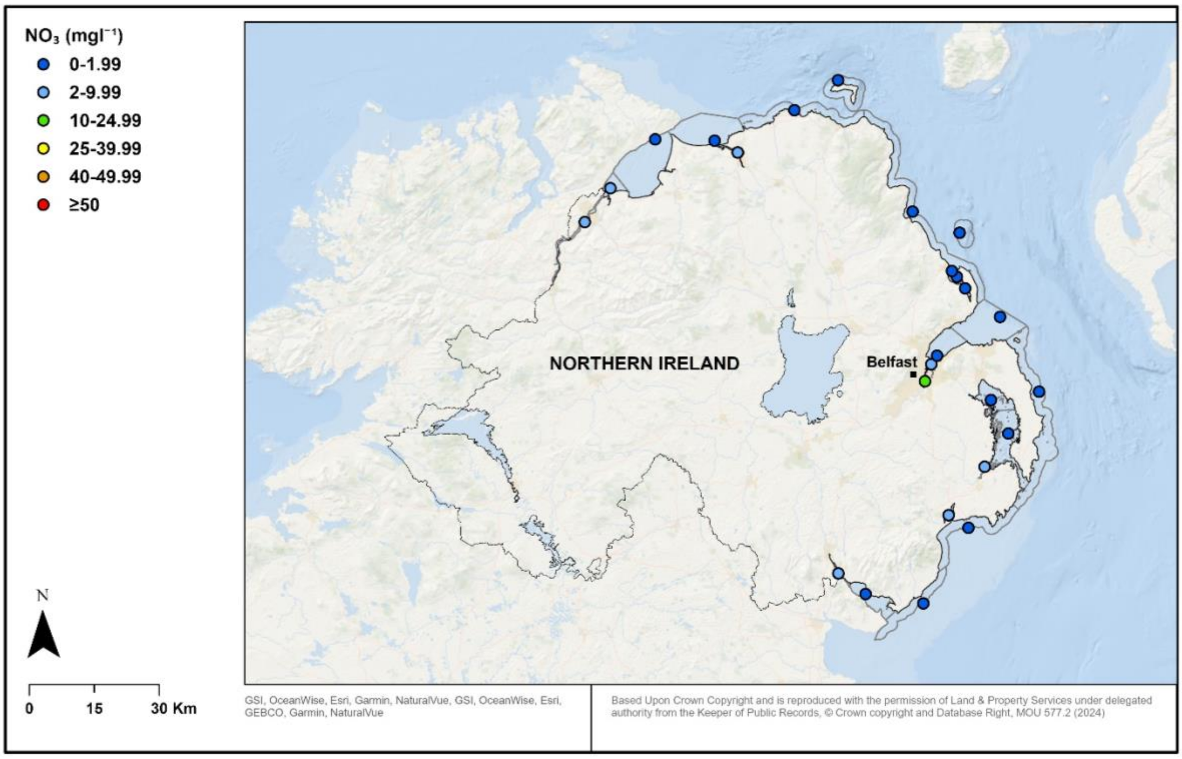

Figure 1.22: Mean winter nitrate concentrations in transitional and coastal water bodies, 2020-2023.

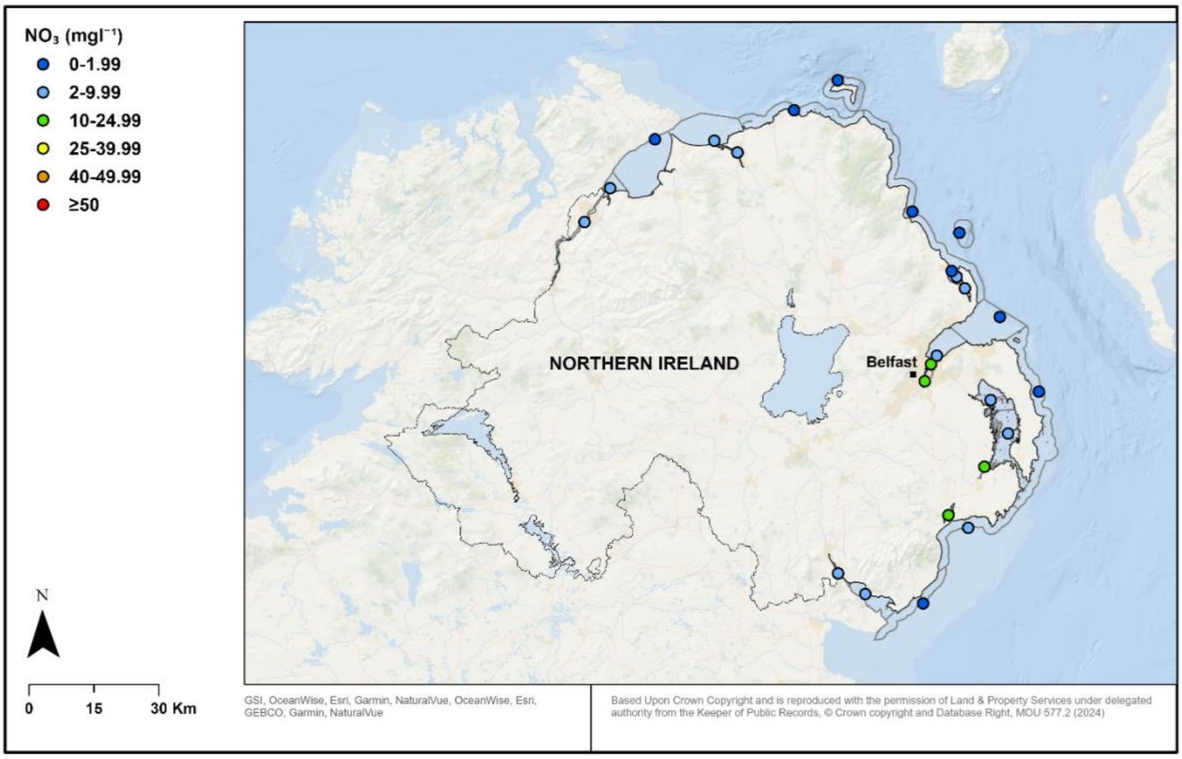

Figure 1.23: Maximum winter nitrate concentrations in transitional and coastal water bodies, 2020-2023.

While the mean and maximum nitrate levels in transitional of coastal water bodies did not exceed 25 mgl^{-1}, those water bodies with relatively high values (>10 mgl^{-1}) were either transitional (estuarine) waters or inshore coastal sea loughs (Figures 1.22 and 1.23). All offshore coastal waters had mean or maximum winter nitrate values below 10 mgl^{-1}. This indicates catchment-based inputs of nutrient to the marine environment and that this is most noticeable in inshore estuaries and sheltered sea loughs.

1.4.3 *Changes between previous and current reporting periods*

Winter nitrate concentrations in transitional and coastal waters for the current (2020-2023) reporting period were compared with data recorded during the previous two reporting cycles (2016-2019 and 2012-2015). A comparison between the 2020-2023 and 2016-2019 data showed that of the 24 water bodies included in this analysis, approximately 92% were considered stable based on winter mean values while 8% exhibited a weak increase (Table 1.18, Figure 1.24). Based on maximum nitrate values, 46% were classified as stable while 17% showed as strong to weak decrease and 35% showed a weak increase (Table 1.18, Figure 1.25).

Table 1.18: Changes in mean winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters between 2020-2023 and 2016-2019.

	% of sites (based on mgl^{-1} difference)				
	≤- 5 - Strong decrease	**>-5 to ≤ -1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Transitional and coastal winter mean (n=24)	0.0	0.0	91.7	8.3	0.0
Transitional and coastal winter maximum (n=24)	8.3	8.3	45.8	37.5	0.0

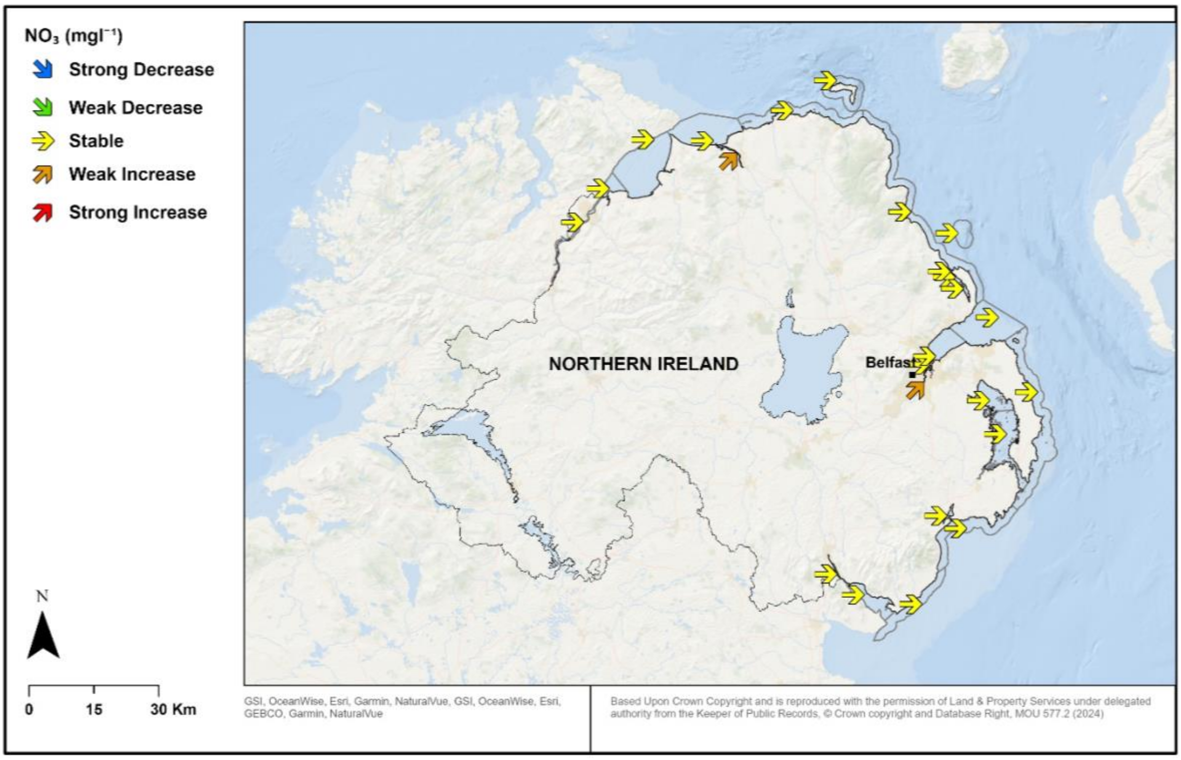

Figure 1.24: Change in mean winter nitrate concentrations in transitional and coastal water bodies between 2020-2023 and 2016-2019 reporting periods.

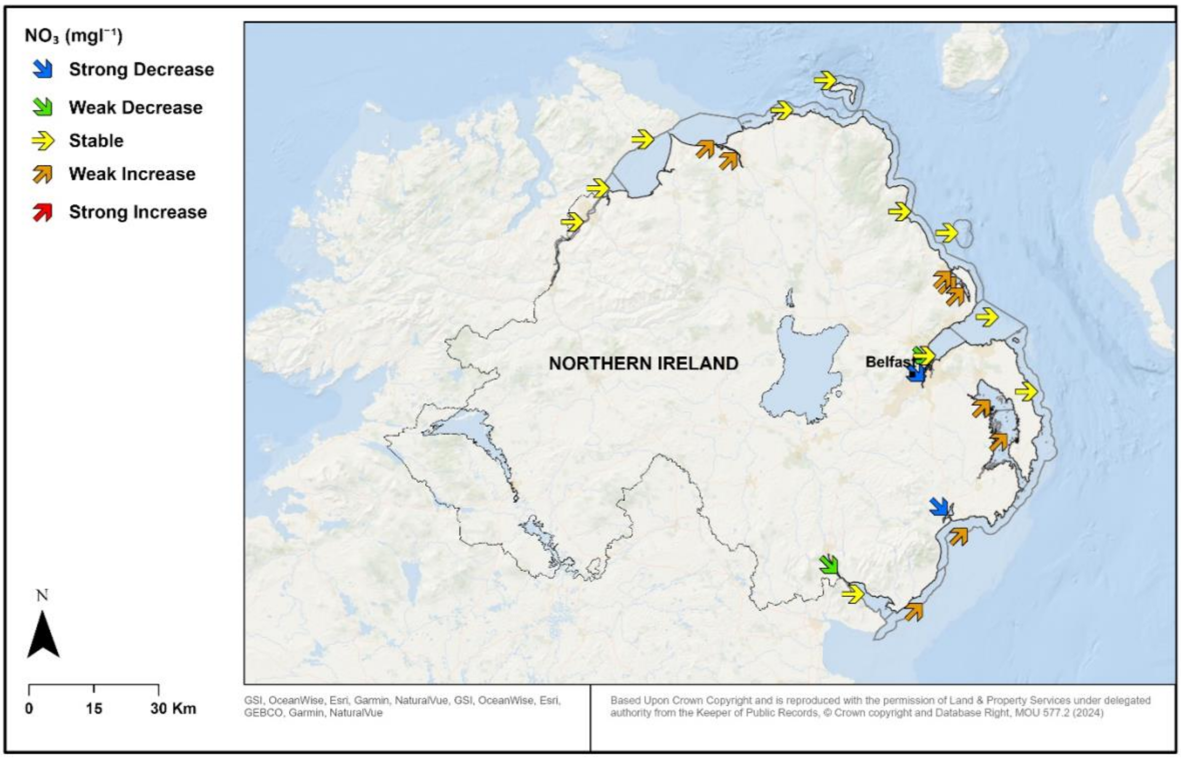

Figure 1.25: Change in maximum winter nitrate concentrations in transitional and coastal water bodies between 2020-2023 and 2016-2019 reporting periods.

Data for 24 water bodies were used to compare nitrate values between the 2020-2023 and 2012-2015 periods. Based on winter mean values, approximately 83% of water bodies were considered stable; the remaining 17% showed a strong to weak increase (Table 1.19, Figure 1.26). Winter maximum values showed that 54% of water bodies were stable, 4% exhibited a weak decrease, and 42% showed a weak to strong increase (Table 1.19, Figure 1.27).

Table 1.19: Changes in mean winter nitrate concentrations (NO_3 mgl^{-1}) in transitional and coastal waters between 2020-2023 and 2012-2015.

	% of sites (based on mgl^{-1} difference)				
	≤- 5 - Strong decrease	**>-5 to ≤ -1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Transitional and coastal winter mean (n=23)	0.0	0.0	83.3	12.5	4.2
Transitional and coastal winter maximum (n=23)	0.0	4.2	54.2	33.3	8.3

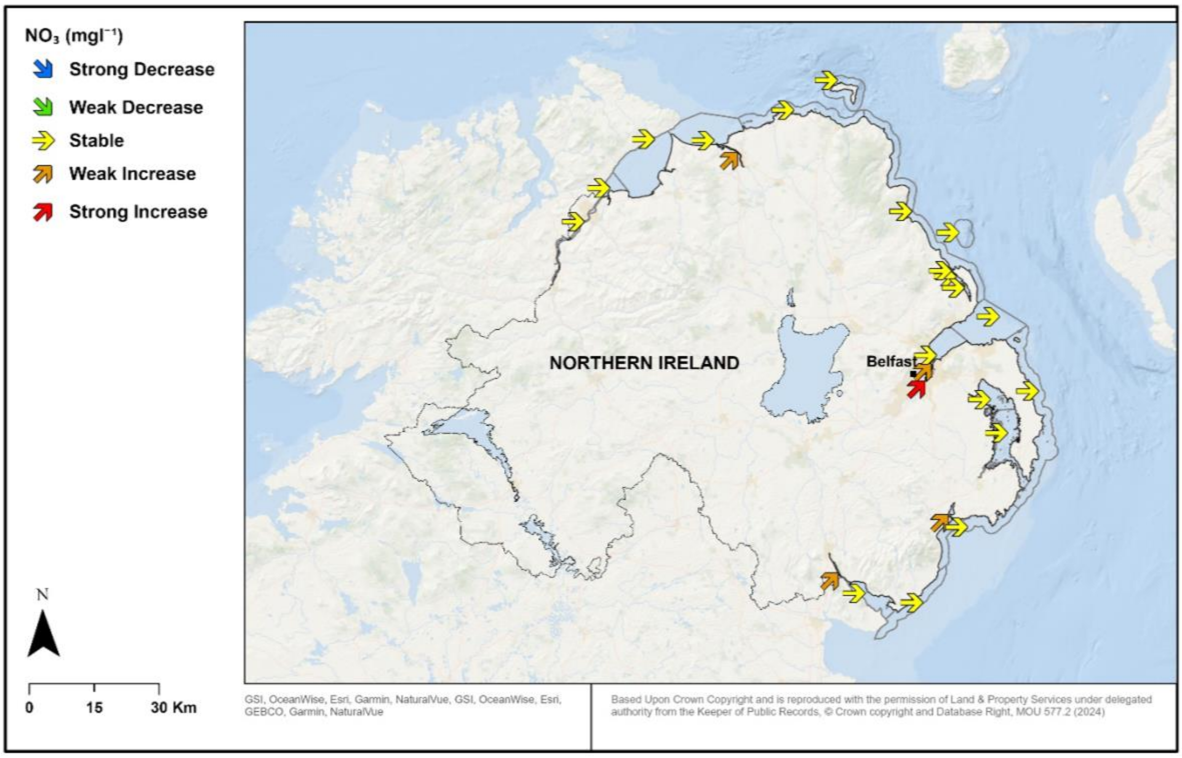

Figure 1.26: Change in mean winter nitrate concentrations in transitional and coastal water bodies between 2020-2023 and 2012-2015 reporting periods.

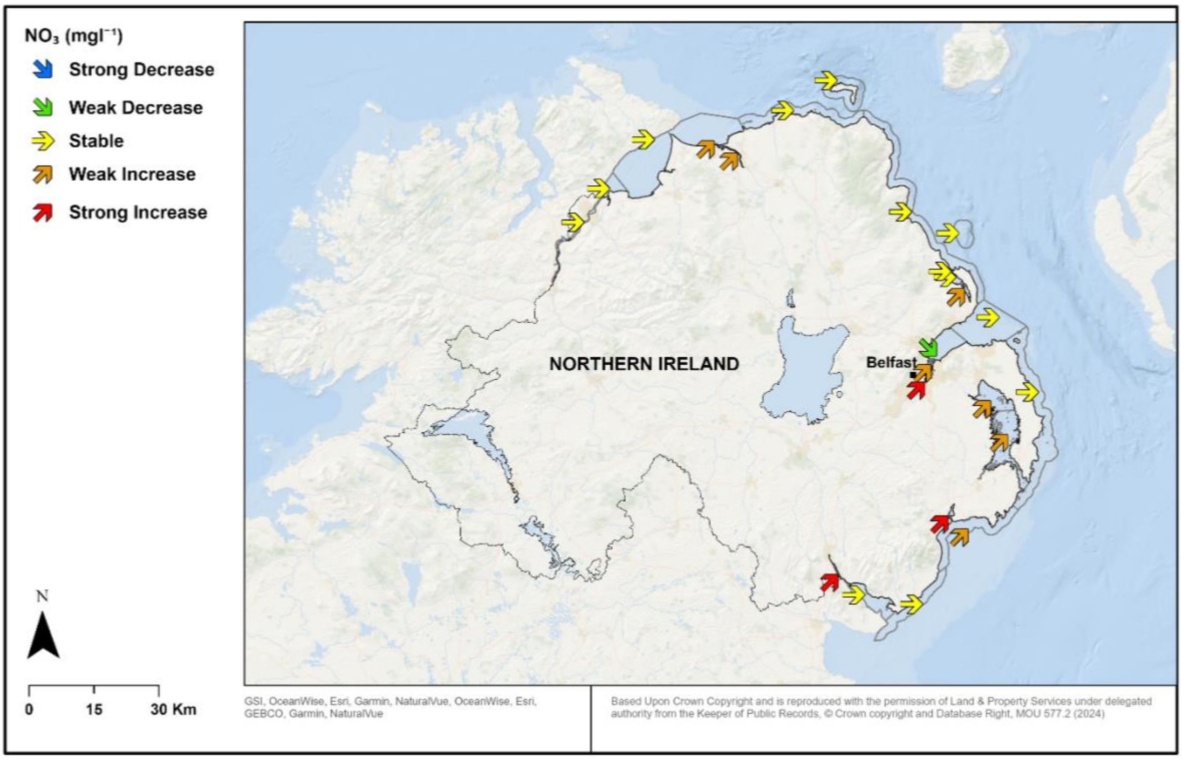

Figure 1.27: Change in maximum winter nitrate concentrations in transitional and coastal water bodies between 2020-2023 and 2012-2015 reporting periods.

Although most water bodies were classified as stable in terms of mean nitrate concentrations, when absolute values are considered, between 63% and 88% of water bodies exhibited an increase in mean nitrate values relative to the previous reporting periods. This pattern was also evident with maximum values where between 79% and 88% of water bodies exhibited higher maximum concentrations than those recorded during the previous reporting periods. A preliminary analysis of dissolved inorganic nitrogen (DIN), which includes ammonia (NH_3), nitrate (NO_3) and nitrite (NO_2) has also recorded an increase in DIN values in 92% of water bodies between 2021 and 2023. While the environmental standards for DIN have not been exceeded for most water bodies, these results suggest that inputs to the marine environment are increasing.

1.4.4 Long-term trend analysis of nitrate concentration

A long-term trend analysis was undertaken on individual water bodies. A four-year moving average value was calculated for each transitional and coastal water body extending over the last four assessment cycles from 2008 to 2023. Trends in nitrate values were then assessed using the non-parametric Mann-Kendall test. No statistically significant ($p>0.05$) trend was detected in 13 water bodies (54%). Nine water bodies (38%) exhibited a significant ($p<0.05$) increase while two water bodies (8%) exhibited a significant ($p<0.05$) decrease (Table 1.20).

Table 1.20: Summary results of the Mann-Kendall trend analysis of mean annual winter nitrate (NO_3) values in transitional and coastal water bodies over the period 2008-2023.

Time Period	Trend		
	Decrease (p<0.05)	**Stable (NS)**	**Increase (p<0.05)**
2008-2023	***2 (8.3%)***	***13 (54.2%)***	***9 (37.5 %)***

Long-term patterns in nitrate concentrations were also examined by grouping water bodies into coastal waters, sea loughs, and transitional waters and calculating an annual mean nitrate concentration for each water body type over the period 2008 to 2023. Nine coastal water bodies were identified; overall mean nitrate values for these water body types were typically low and did not exceed 0.6 mgl^{-1} (Figure 1.28). Nitrate values exhibited a steady decline from 2008 to 2012 before increasing again over the period 2012 to 2015. Apart from a relatively low value recorded in 2019, mean nitrate values appeared to remain relatively constant from 2015 to 2023 (Figure 1.28).

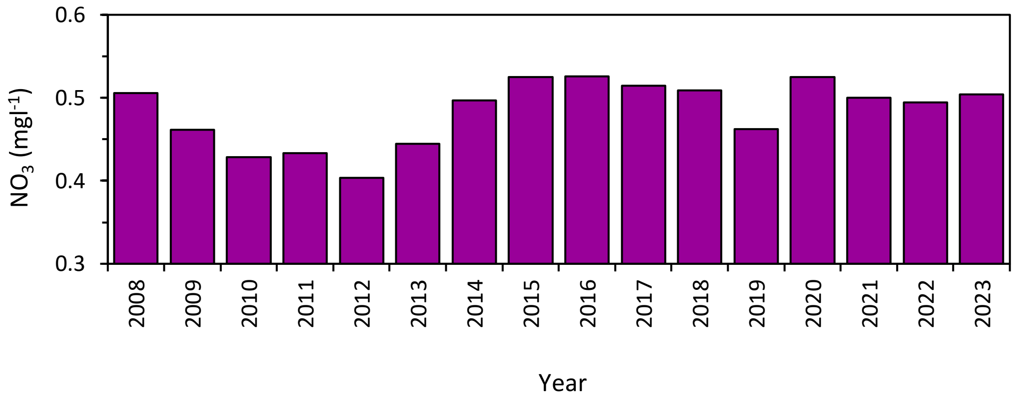

Figure 1.28: Mean winter nitrate concentrations recorded in coastal water bodies over the period 2008 to 2023.

Nine sea lough water bodies were included in this analysis; overall mean nitrate values for these water body types were higher than coastal water bodies but did not exceed 1.5 mgl^{-1}

(Figure 1.27). Nitrate values exhibited a decline from 2008 to 2009 and remained relatively constant over the period 2009 to 2014. Mean nitrate values then exhibited a steady increase from 2017 onwards, reaching a maximum in 2021; values have since remained relatively elevated up to 2023 (Figure 1.29).

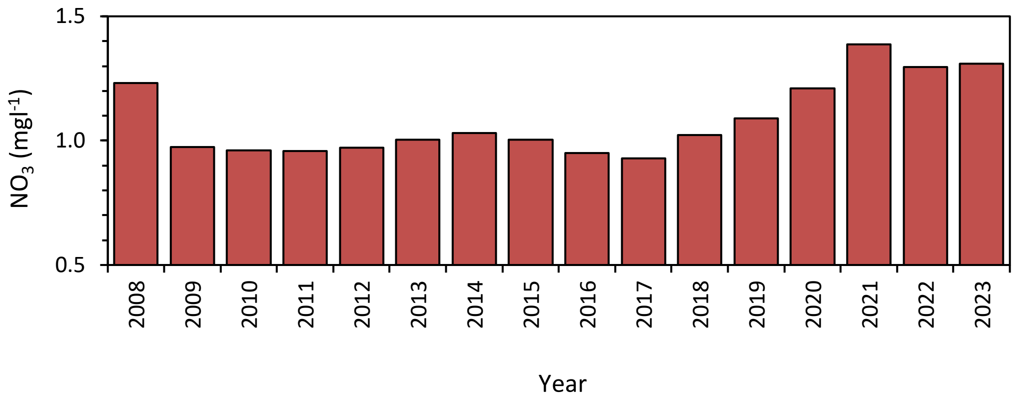

Figure 1.29: Mean winter nitrate concentrations recorded in sea lough water bodies over the period 2008 to 2023.

Transitional water bodies had the highest mean nitrate concentrations and typically exceeded 3.0 mgl^{-1} (Figure 1.30). Nitrate values exhibited a decline between 2008 and 2012 and remained relatively low over the period 2012 to 2017. Values then increased from 2017 onwards, reaching a peak in 2021 where they have remained relatively high (Figure 1.30).

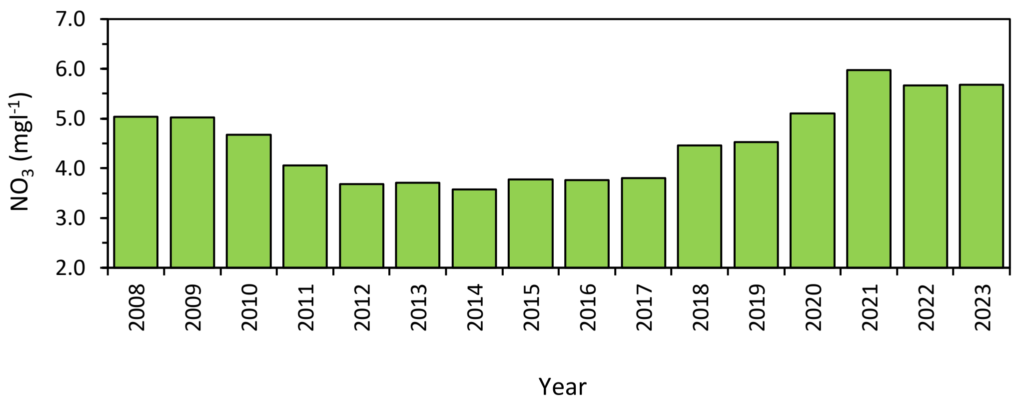

Figure 1.30: Mean winter nitrate concentrations recorded in transitional (estuarine) water bodies over the period 2008 to 2023.

These results indicate that nitrate levels, particularly in transitional waters (estuaries) and sea loughs, although exhibiting an initial decline over the period 2008 to 2017, have shown a steady increase from 2017 onwards. A similar pattern was observed for winter dissolved inorganic nitrogen (DIN) and winter dissolved inorganic phosphorous (DIP) where preliminary analyses indicated that, although there was an initial annual decline in these nutrients, there has been a steady increase over the last 3-5 years.

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

1.5.1 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 in all water body types, as outlined in Table 1.21. 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 1.21: WFD quality elements and parameters relevant to eutrophication in 2020-2023*****

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 1.20 are those current in 2023. 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 1.15). 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:

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

In the previous report, each of the WFD classes were evaluated against the European guidance issued in 2020 (Table 1.22). The same methodology will be followed in this report:

- High and Good status under WFD correspond with 'non-eutrophic' status under the ND.
- Moderate status can be thought of as a 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 lead to a classification of 'eutrophic' if the previous trophic status was Moderate, Poor or Bad under WFD. However, if the previous classification was High or Good under WFD,

the trophic status should be ‘may become eutrophic’. This corresponds to a negative eutrophication trend between the previous and current reporting periods. This is not applicable to a negative trend between High and Good status.

- Poor and Bad status under WFD correspond with ‘eutrophic’, relating to situations where undesirable disturbances are common or severe.

Table 1.22: WFD status in relation to trophic status

WFD Status	Trophic Status
High	Non- eutrophic
Good	Non- eutrophic
Moderate	Eutrophic or May become eutrophic
Poor	Eutrophic
Bad	Eutrophic

In 2023, DAERA carried out an assessment of the trophic status of surface freshwaters and transitional and coastal marine waters under the UWWTD Sensitive Area Review using the trophic parameters (i.e. chemical and biological) outlined in Table 1.21. The review used WFD 2021 classification data and focussed on areas previously identified as Sensitive (Eutrophic) under the UWWT Directive in Northern Ireland and considered if the remaining catchments not previously identified as sensitive should now be designated. The existing Sensitive Area (Eutrophic) designations were supported and no new Sensitive Area (Eutrophic) identifications were recommended. Further biological monitoring of surface freshwaters and transitional and coastal marine waters is required to continue to assess trends in eutrophic water quality, improve confidence in class and provide evidence for the next review period. The total existing area of land draining to water bodies which are sensitive to eutrophication is approximately 86 % of the Northern Ireland land area. The next SAR under the UWWTD will be carried out in 2027.

1.6 Assessment of eutrophic indicators in rivers

Comprehensive eutrophic parameter monitoring is essential for WFD, as well as ND and UWWTD reporting. Northern Ireland has identified 450 water bodies for WFD classification. Each trophic parameter is assessed for each monitoring site within all of the water bodies (where data is available). The results of each assessment were then combined using the Cycle 2 WFD 2021 overall classification criterion of deferring to the lowest class in each case to give an overall WFD trophic class for each monitoring site and river water body. *Note that these trophic status classifications do not include the full suite of WFD classification elements at all locations.*

For eutrophic pressures, macrophytes, diatoms and soluble reactive phosphorus (SRP) are considered in rivers. NIEA monitored phosphorus concentrations at 466 surface freshwater sites across NI over the period 2018-2020; macrophyte classification was based on surveys carried out at 478 river sites over the period 2010-2020 and benthic diatom classification was based on samples collected at 478 river sites over the period 2010-2020. The eutrophic water body status for this report is predominantly based on monitoring data for the period between 2015 and 2020. There are a very few exceptions where some older biological data have been included where the Covid pandemic prevented surveys being completed in 2020.

The distribution of WFD 2021 trophic classes for river monitoring sites across Northern Ireland is shown in Table 1.22. Data from the previous reporting periods using WFD 2015 and WFD 2018 classification data are also presented in Table 1.23 to allow comparison. The number of monitoring sites presented will differ during each reporting period.

Table 1.23: Overall WFD 2015, 2018 and 2021 classifications of the trophic indicator quality elements for river monitoring sites in Northern Ireland (based on SRP, macrophytes and diatoms)

		WFD Class					
		HIGH	GOOD	MODERATE	POOR	BAD	NO DATA
% of Sites	**WFD 2015** *(n=559)*	16	41	36	7	0	0
	WFD 2018 *(n=552)*	15	40	37	8	0	0
	WFD 2021 *(n=538)*	10	41	41	8	0	0

The WFD 2015 trophic classifications show that 57 % of river sites across Northern Ireland were considered to be of High/Good trophic status. No river sites were considered to be of Bad trophic status. However, 43 % of river sites were classed as Moderate or Poor status. The WFD 2018 trophic classifications show that 55 % 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, 45 % of river sites are classed as Moderate/Poor status which is indicative of eutrophic conditions. The WFD 2021 trophic classifications show that 51 % of river sites across Northern Ireland are considered to be of High/Good trophic status. This is decrease from the previous two reporting periods. Although no river monitoring sites are considered to be of Bad trophic status, 49 % of river sites are classed as Moderate/Poor status which is indicative of eutrophic conditions.

The distribution of WFD 2021 trophic classes for river water bodies across Northern Ireland is shown in Table 1.24 and Figure 1.31. Data from the previous reporting periods using WFD 2015 and WFD 2018 classification data is also presented in Table 1.24 to allow comparison. The number of river water bodies (450) remains consistent during all reporting periods.

Table 1.24: Overall WFD 2015, 2018 and 2021 classifications of the trophic indicator quality elements for river water bodies in Northern Ireland (based on SRP, macrophytes and diatoms)

		WFD Class					
		HIGH	GOOD	MODERATE	POOR	BAD	NO DATA
% of River Water Bodies	**WFD 2015** *(n=450)*	13.1	41.3	34.4	6.2	0.2	4.7
	WFD 2018 *(n=450)*	10.7	37.6	39.6	8.2	0.2	3.8
	WFD 2021 *(n=450)*	6.4	38.0	42.9	9.1	0.2	3.3

The WFD 2015 trophic classifications show that 54.4 % of river water bodies across Northern Ireland were considered to be of High/Good trophic status. 40.6% of river water bodies were classed as Moderate or Poor status. 0.2 % of river water bodies (Lough Neagh peripherals which was classified using Lough Neagh lake data) are considered to be of Bad trophic status. Data was not available for 4.7 % of river water bodies. The WFD 2018 trophic classifications show that 48.3 % of river water bodies across Northern Ireland are considered to be of High/Good trophic status. 47.8 % of river water bodies are classed as Moderate or worse status which is indicative of eutrophic conditions. Of these, 0.2 % of river water bodies (Lough Neagh peripherals which are classified using Lough Neagh lake data) are considered to be of Bad trophic status. Data was not available for 3.8 % of river water bodies. The WFD 2021 trophic classifications show that 44.4 % of river water bodies across Northern Ireland are considered to be of High/Good trophic status. This is decrease from the previous two reporting periods. 52.2% of river water bodies are classed as Moderate or worse status which is indicative of eutrophic conditions. Of these, 0.2 % of river water bodies (Lough Neagh peripherals which are classified using Lough Neagh lake data) are considered to be of Bad trophic status. Data was not available for 3.3 % of river water bodies.

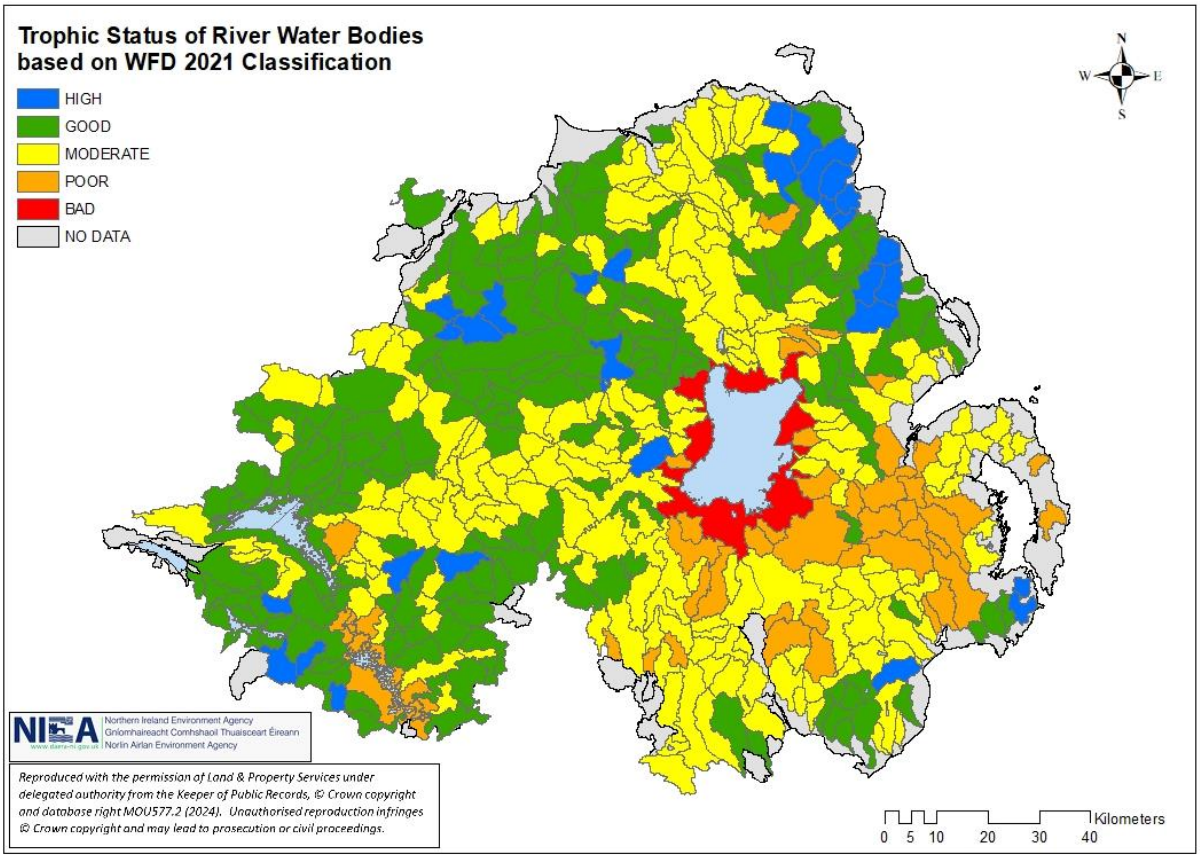

Figure 1.31: Distribution of the WFD 2021 trophic classes across Northern Ireland's 450 river water bodies

The WFD 2018 and 2021 trophic river water body classifications were assessed against the corresponding trophic state according to the guidance issued in 2020 as described in Table 1.22. In the previous reporting period (WFD 2018), data was compared against results from the previous reporting period where WFD 2015 water body classification data was used to report trophic status. The previous report interpreted Moderate WFD status as 'indicative of eutrophic conditions. It was not possible to determine if the Moderate status for the WFD 2015 trophic classifications were corresponding to a negative eutrophication trend as the data preceding the 2016 report was not available for comparison. The WFD 2021 trophic river water body classifications were compared against the results from WFD 2018 according to the same guidance. Table 1.25 shows the quality classes on the trophic state of river water bodies in Northern Ireland for the previous and current reporting periods.

Table 1.25: Quality classes on the trophic state for river water bodies based on WFD 2018 and 2021 classifications of the trophic indicator quality elements.

	% of Water Bodies			
	Non-Eutrophic	May Become Eutrophic	Eutrophic	No Data
WFD 2018	48.2	9.8	38.2	3.8
WFD 2021	44.4	8.0	43.8	3.8

Table 1.25 shows that in the previous reporting period (WFD 2018), 48.2 % of river water bodies across Northern Ireland are considered to be in a non-eutrophic state. 9.8% of the river water bodies may become eutrophic, i.e. the trophic class was Moderate according to WFD 2018 classification and was High or Good in the previous reporting period (WFD 2015). 38.2% of the river water bodies are considered to be eutrophic. Data was not available for 3.8% of the river water bodies. In the current reporting period (WFD 2021), 44.4 % of river water bodies across Northern Ireland are considered to be in a non-eutrophic state, a decline from the previous reporting period. 8% of the river water bodies may become eutrophic, i.e. the trophic class was Moderate according to WFD 2021 classification and was High or Good in the previous reporting period (WFD 2018). 43.8% of the river water bodies are considered to be eutrophic. Data was not available for 3.8% of the river water bodies (Figure 1.32).

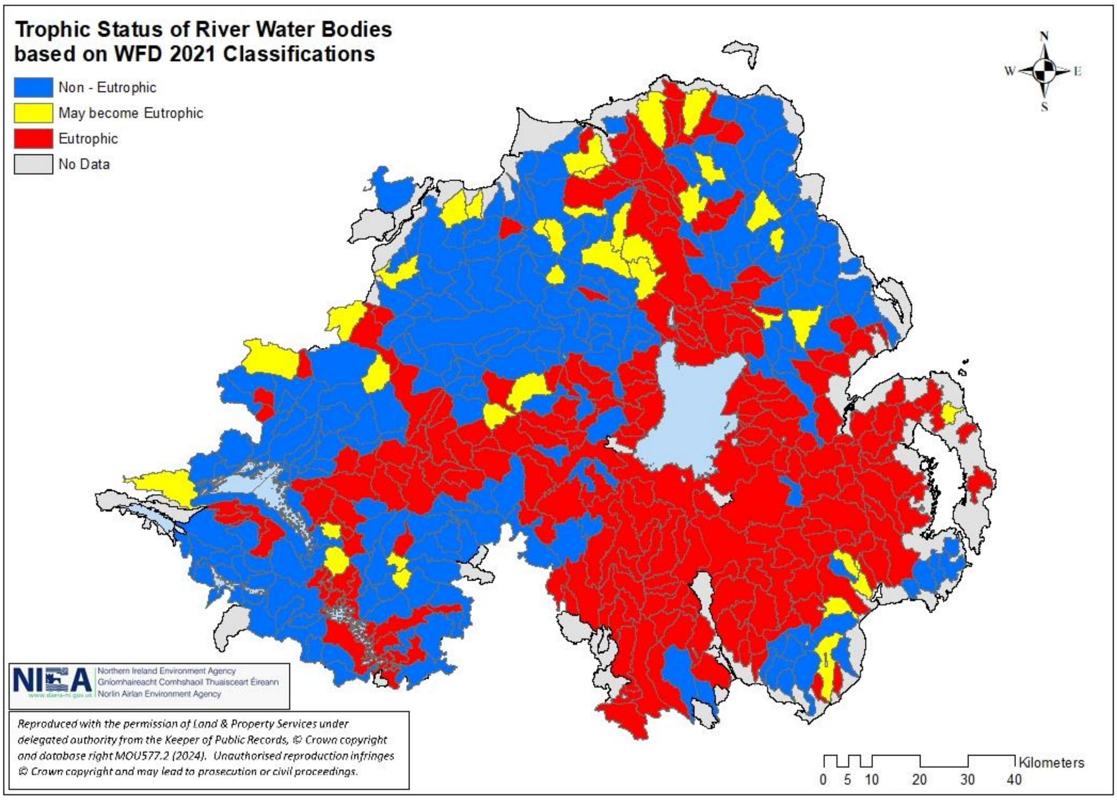

Figure 1.32: Distribution of the WFD 2021 trophic status across Northern Ireland's 450 river water bodies

1.6.1 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.

Northern Ireland has assessed annual average data from 2012-2015, 2016-2019 and 2020-2023 using the latest version of the SRP standards calculator (recommended by UKTAG) to obtain a SRP classification for each site. 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 'may become eutrophic'. 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*

NIEA monitored SRP concentrations at 391 surface freshwater stations in 2012-2015 and at 471 surface freshwater stations in 2016-2019. During the 2020-2023 reporting period 499 sites were monitored. Sufficient numbers of samples (i.e. >=20 samples) over four years were available at 467 sites. Of these sites, 466 are common with those sites monitored in the previous period.

Results in Table 1.26 show that in the 2012–2015 reporting period, 66.3 % of river sites were classified as High or Good for SRP status. The remaining 33.7 % of river sites had a WFD SRP classification of 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 1.26 shows that in the 2016–2019 reporting period, 57.1 % of river sites were classified as High or Good for SRP status. The remaining 42.9 % of river sites had a WFD SRP classification of less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 8.1 % were classified as Poor status for SRP, indicative of nutrient enrichment. No sites were classified as Bad status.

Table 1.26 and Figure 1.33 show that in the current reporting period 2020–2023, 58.5 % of river sites were classified as High or Good for SRP status. The remaining 41.5 % of river sites had a WFD SRP classification of less than Good status which is considered to be at risk from eutrophication or eutrophic. Of these sites, 9.2 % were classified as Poor status for SRP. No sites were classified as Bad status.

Table 1.26: WFD Soluble reactive phosphorus classification in rivers: 2012-2015, 2016-2019 and 2020-2023 (number and % of sites)

Rivers SRP WFD classification	Number and % of sites				
	High	**Good**	**Moderate**	**Poor**	**Bad**
2012-2015 *(n=391)*	127	132	110	22	0
	32.5 %	33.8 %	28.1 %	5.6 %	0
2016-2019 *(n=471)*	92	177	164	38	0
	19.5 %	37.6 %	34.8 %	8.1 %	0
2020-2023 *(n=467)*	99	174	151	43	0
	21.2 %	37.3 %	32.3 %	9.2 %	0

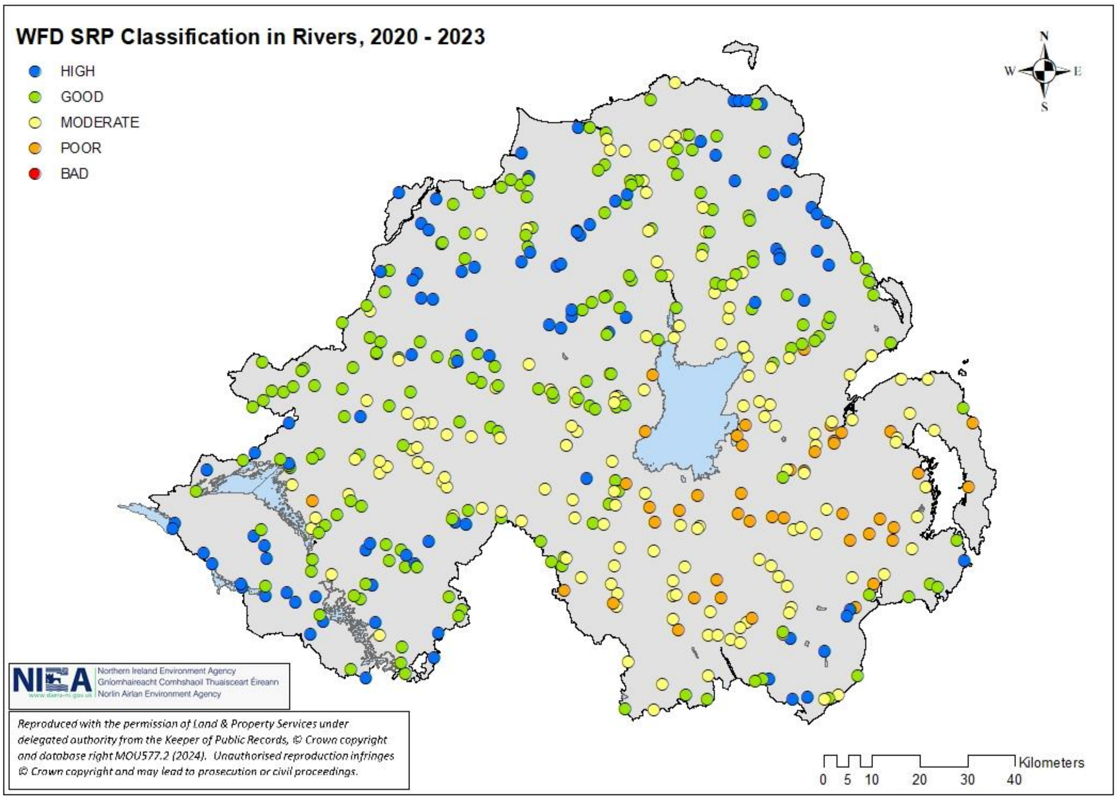

Figure 1.33: WFD soluble reactive phosphorus classification in river monitoring sites, 2020–2023

Overall changes in Table 1.27 and Figure 1.34 indicate that the majority (91.4 %) of river sites experienced a decrease or stabilisation in WFD SRP classification status between the previous and current reporting periods. 8.6 % of sites exhibited a weak increase in SRP between the two reporting periods as they deteriorated by one class. This an improvement from the trend noted between the 2015-2015 and 2016-2019 reporting periods when 73.8 % of river sites experienced a decrease or stabilisation, whilst 26.3 % exhibited an increase in WFD SRP classification status.

Table 1.27: 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=466)*	0	50	376	40	0
	0	10.7 %	80.7 %	8.6 %	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*

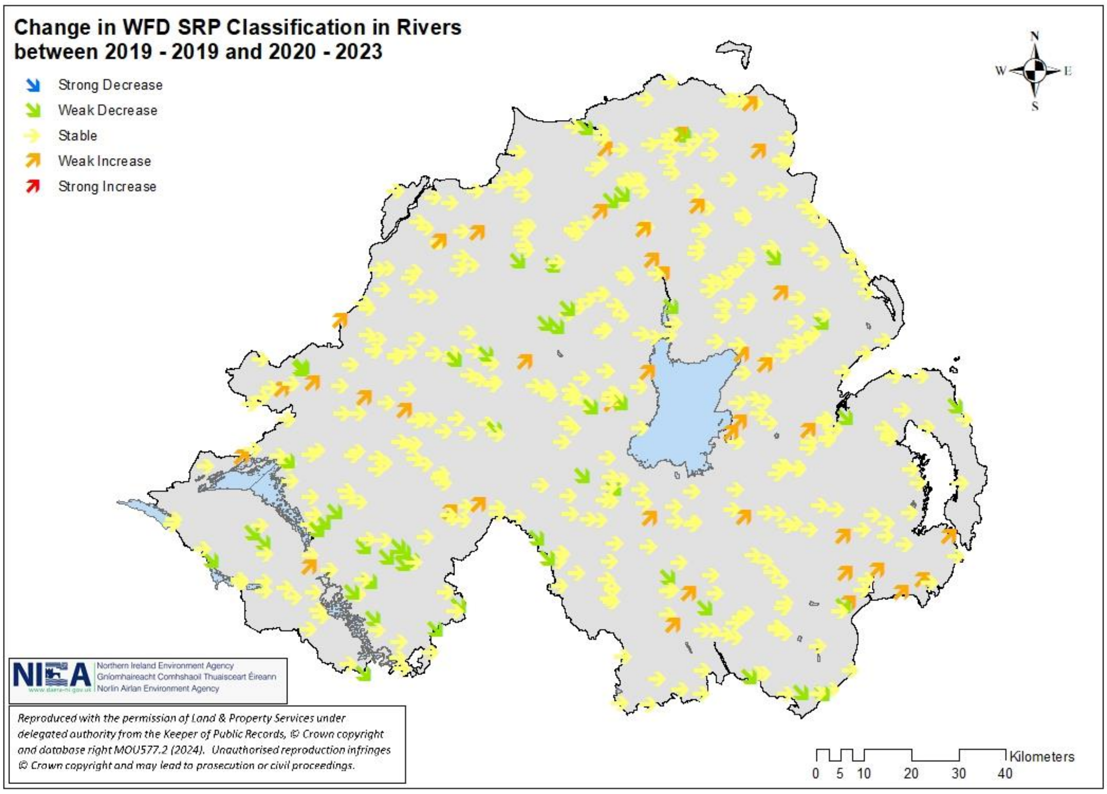

Figure: 1.34: Change in WFD soluble reactive phosphorus classification in river monitoring sites between previous and current reporting period, 2016-2019 and 2020-2023

1.6.2 Long-term trend analysis of Soluble Reactive Phosphorus concentration

As discussed in Section 1.3.4, 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 2023. The SRP dataset is for a shorter time period (1998-2023) 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 reporting limit.

A total of 499 monitoring sites (minimum >6 years data as recommended by UKTAG) were analysed and of these, 32 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 32 individual monitoring sites. Seasonal trend analysis showed that the monthly trends in average phosphorus concentrations in 28 river sites in Northern Ireland were decreasing or stable over the 25-year period, 1998-2023 (87.5 % of sites). Only 4 sites (12.5% of sites) showed a significant increasing trend (Tables 1.28 and Figure 1.35). Figure 1.36 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 499 rivers sites were calculated from the 25-year data set (Figure 1.37). Peak values tended to occur in the summer months. The SMK and Sen tests indicated a significant decreasing slope for this combined dataset.

Table 1.28: Summary of numbers of monitoring sites showing overall and seasonal significant decreases, increases or stable trends of phosphorus between 1998 and 2023.

Time Period	SRP (n=32): 1998-2023		
	Decrease (p=<0.05)*	Stable (NS)*	Increase (p=<0.05)*
Overall	*7(21.9%)*	*21(65.6%)*	*4(12.5%)*

**(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))*

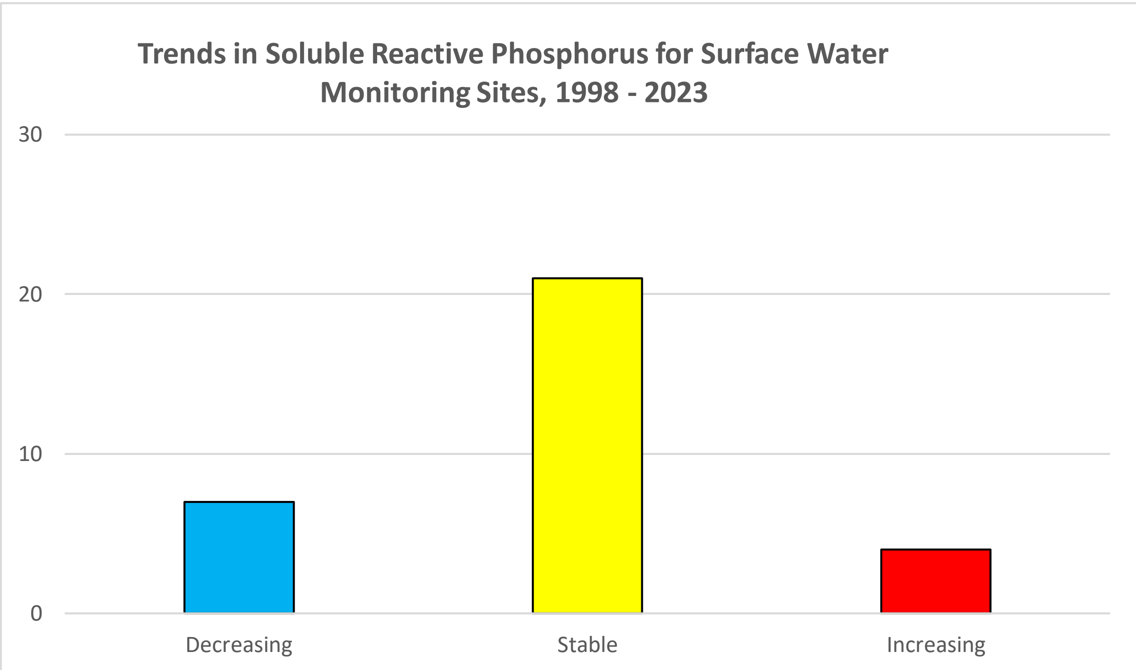

Figure 1.35: Numbers of monitoring sites showing increases, decreases or stability for soluble reactive phosphorus concentrations, 1998-2023.

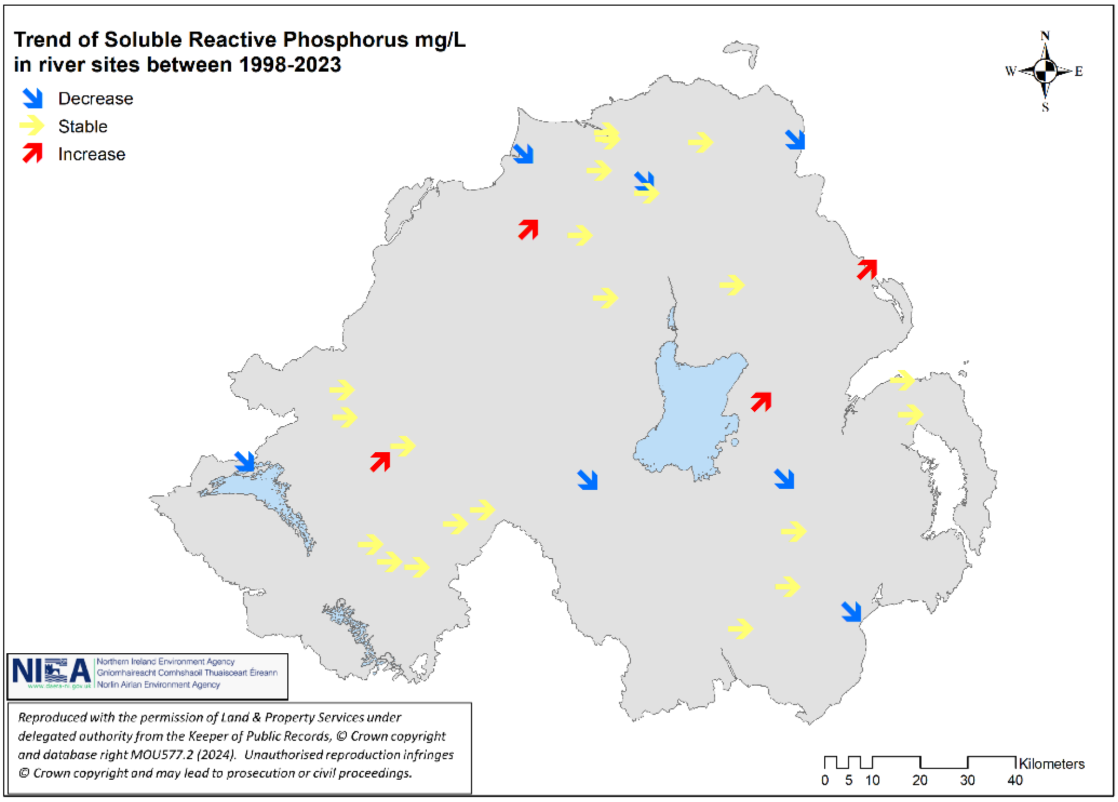

Figure 1.36: Trend of average soluble reactive phosphorus (SRP mg /l) in rivers across Northern Ireland: 1998–2023

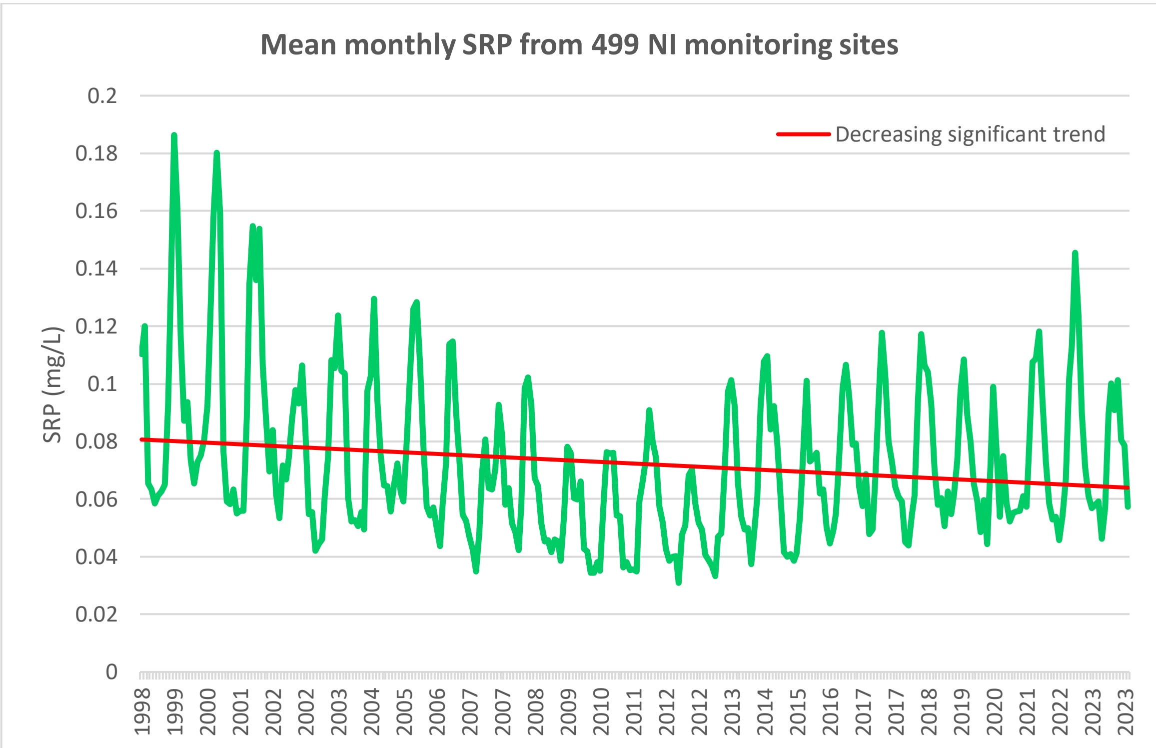

Figure 1.37: Soluble reactive phosphorus concentrations (SRP mg /l) in 499 monitoring sites summarized by month into annual mean values of the site population, 1998-2023.

Flow-weighted mean concentrations were used to calculate the trends in SRP loadings from the river catchments flowing to Lough Neagh, 2009 to 2023 (Figure 1.38). The outflow concentration is representative of the lake condition. No trend was evident in the time period for any river. When compared on a normalised area basis annually, (Figure 1.39) there was little variation in the contribution of SRP loading per river.

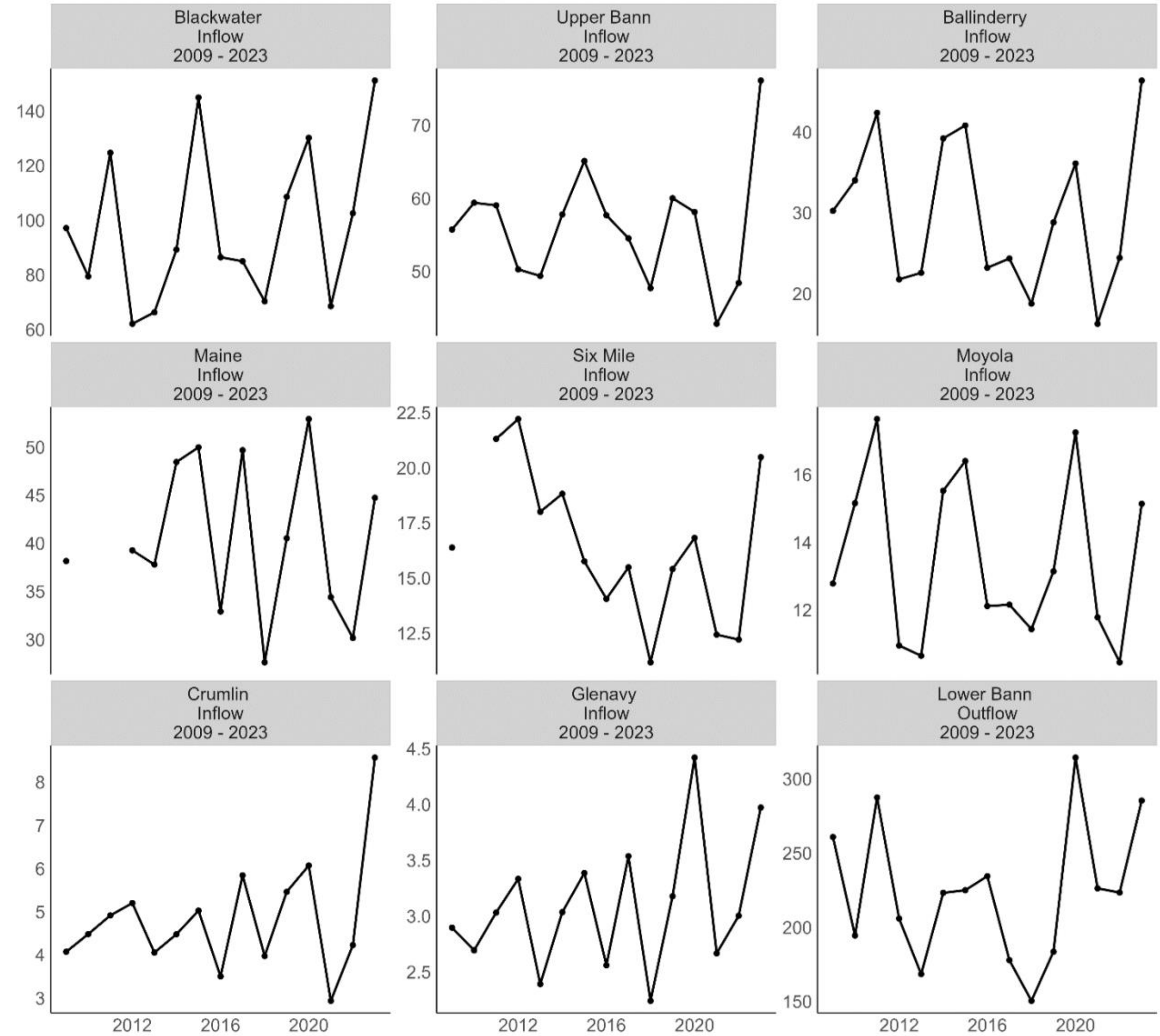

Figure 1.38: Soluble reactive P loading (T) from the rivers flowing into and out of Lough Neagh, 2009 to 2023. Trend determined by Mann-Kendall test.

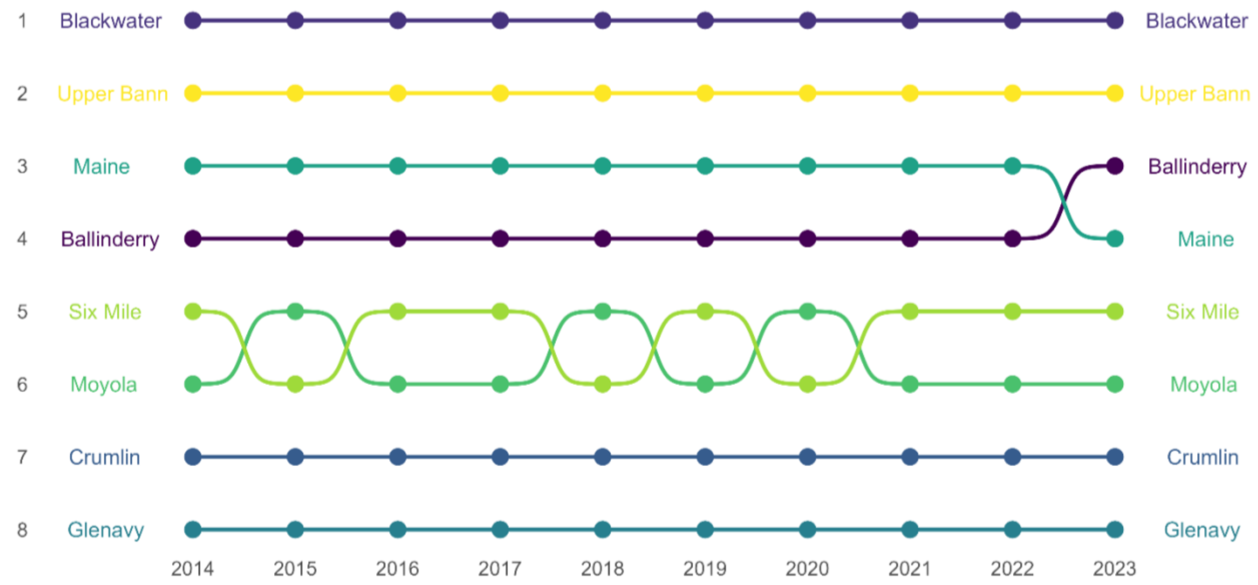

Figure 1.39: Lough Neagh inflowing rivers ranked according to soluble reactive P loading, T per km2 per year, 2009 to 2023. Trend determined by Mann-Kendall test. Position one is the greatest contributor and position 8 is the least.

In summary for section 1.5 on phosphorus in freshwaters, in recent years there has been an increase in the number of sites showing increasing levels of phosphorus in freshwaters, across Northern Ireland. In particular the period 2014-2016, during the industry-led Going for Growth strategy, had shown rates of increase that were a cause for concern. Over the long term, due to the very high baseline levels since 1998, trends across the full time period show an overall decline. This masks the recent increases in phosphorus. Further analysis will be undertaken to establish the causative factors and any geospatial differences in the recent changes reported.

1.7 Assessment of eutrophic indicators in lakes

Lakes over 50 hectares (ha) in size are water bodies in themselves, but lakes less than 50 ha are subsumed under river water bodies. The WFD has an implicit requirement to assess eutrophication when classifying the status of water bodies where nutrient enrichment affects biological and physiochemical quality elements (Table 1.20). 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 periods 2012-2014 (WFD 2015), 2015-2017 (WFD 2018) and 2018-2020 (WFD 2021), NIEA monitored total phosphorus (TP), phytoplankton, macrophytes and benthic diatoms at 21 lakes across Northern Ireland. Lakes with a surface area greater than 50 ha are known as surveillance lakes. Lower Lough Erne is divided into two water bodies and it should also be noted that the monitoring station located at Lower Bann at Toome Bridge is representative of the Lough Neagh water body and thus will be included in the assessment of water quality of Lough Neagh in the two reporting periods.

It is important to note that the trophic status classification does not include all WFD quality elements and is restricted only to those that reflect trophic status. Macrophytes and benthic diatoms were generally 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. Phytoplankton samples are collected in July, August and September for three consecutive years to give a total of nine samples.

The results of each parameter were then combined to give an overall trophic classification for each water body using the WFD criterion of defaulting to the lowest class in each case. 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 (hydrology class) 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 eleven HMWB lake designations in Northern Ireland: Lower Lough Erne at Kesh, Lower Lough Erne at Devenish, Upper Lough Erne, Lough Neagh, Stoneyford Reservoir, Cam Lough, Lough Fea, Lough Island Reavy, Lough Mourne, Silent Valley Reservoir and Spelga Dam. Of these, the first five named pass their hydrology standard and macrophytes are included in trophic assessment. The remaining six fail their hydrology and macrophytes are not used in trophic assessment.

In this report WFD trophic assessments will be made using data from the current reporting period, as well as data from the two previous reporting periods (WFD 2015 and WFD 2018) to allow comparison where possible. According to the European guidance issued in 2020, lakes which are not considered to be eutrophic are classed as High or Good. Poor and Bad status under WFD correspond with 'eutrophic', relating to situations where undesirable disturbances are common or severe. Moderate status may lead to a classification of 'eutrophic' if the previous trophic status was Moderate, Poor or Bad under WFD. However, if the previous classification was High or Good under WFD, the trophic status should be 'may become eutrophic'. This corresponds to a negative eutrophication trend between the previous and current reporting periods. This is not applicable to a negative trend between High and Good status (Table 1.22).

The distribution of WFD 2015, WFD 2018 and WFD 2021 trophic classes for lake water bodies in Northern Ireland is shown in Table 1.29. According to the WFD 2021 classification results, the trophic status of lake water bodies indicated that 14% of water bodies achieved either High or Good status. This represents a decline of 10% when compared with the both the WFD 2015 and WFD 2018 reporting periods. The remaining 86% were Moderate, Poor or Bad trophic status.

Table 1.29: Overall WFD 2015, WFD 2018 and WFD 2021 classification of trophic indicator quality elements for 21 lakes in Northern Ireland*

Reporting Period *(n=21)*	**Number and % of Lakes**				
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
WFD 2015	2	3	6	6	4
	10%	14%	29%	29%	19%
WFD 2018	3	2	5	8	3
	14%	10%	24%	38%	14%
WFD 2021	0	3	7	7	4
	0%	14%	33%	33%	19%

* based on Total Phosphorus (TP), phytoplankton, macrophytes and diatoms

The trophic assessment also showed the continuing decline in our High trophic status surface waters. High status surface waters decreased from 14% (3 lakes) in the WFD

2018 reporting period to zero lakes at High trophic status in the WFD 2021 current reporting period. Lough Fea and Silent Valley declined from High to Good trophic status between the reporting periods, whilst Spelga Dam deteriorated from High to Moderate trophic status. The main drivers for the deterioration in status in these three lakes being elevated TP concentrations resulting in disturbances to the diatom, planktonic and macrophyte communities. The number of Moderate trophic status waters also increased from 24% in the WFD 2018 reporting period to 33% in the WFD 2021 current reporting period. Overall the trophic status remained unchanged at 14 lakes. One lake, Lower Lough Erne at Kesh improved from Poor to Moderate trophic status due to an improvement in the diatom classification (Figure 1.40).

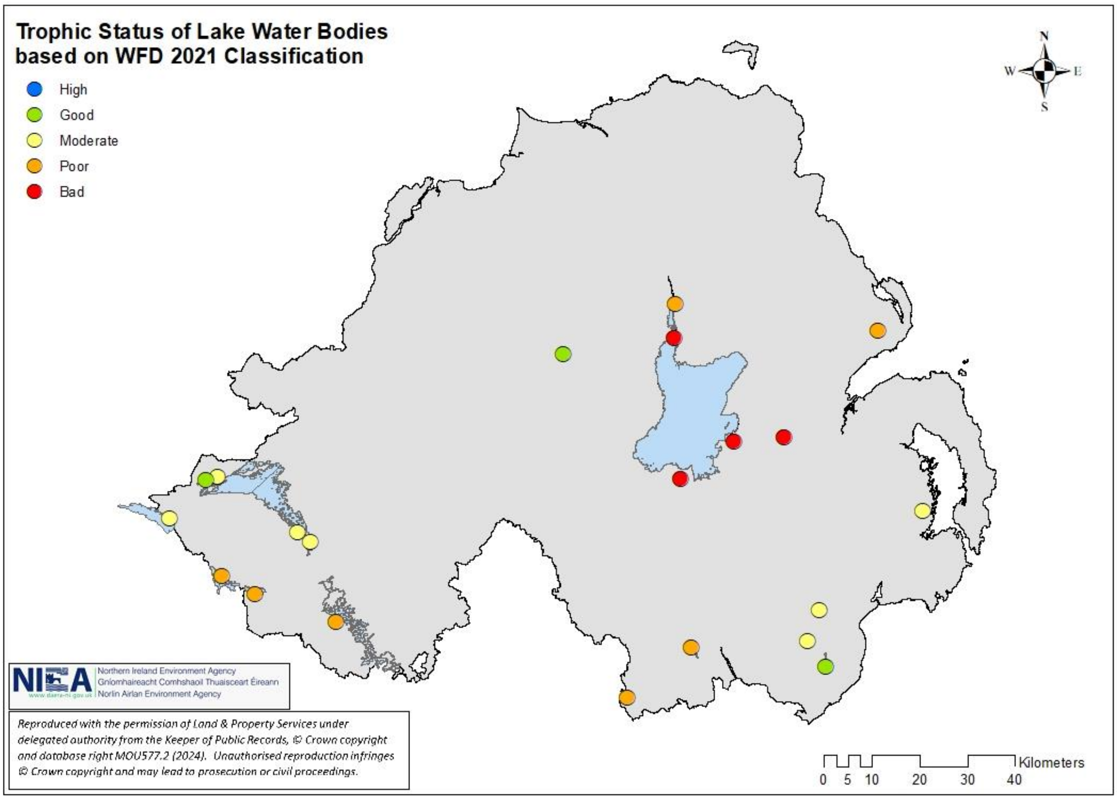

Figure 1.40: Overall WFD trophic classes across Northern Ireland 21 lake monitoring stations in the WFD 2021 reporting period *(based on TP, phytoplankton, macrophytes and diatoms)*

The WFD 2018 trophic lake classifications were compared against the results from WFD 2015 according to the guidance issued in 2020 as described in Table 1.22. In the previous reporting period (WFD 2018), five lakes in Northern Ireland were considered to be in a Non-Eutrophic state and 16 lakes were assessed as Eutrophic. As no lake water bodies had declined from High or Good to Moderate over the reporting period, no lakes are assessed as May become Eutrophic. It was not possible to determine if the Moderate status for the WFD 2015 trophic classifications were corresponding to a negative eutrophication trend as the data preceding the 2016 report was not available for comparison. Table 1.30 shows the quality classes on the trophic state of water bodies in Northern Ireland for the previous and current reporting periods.

Table 1.30: Quality classes on the trophic state of lakes based on WFD 2018 and 2021 classifications of the trophic indicator quality elements.

Reporting Period *(n=21)*	Number and % of Lakes		
	Non-Eutrophic	May Become Eutrophic	Eutrophic
WFD 2018	5	0	16
	24%	0%	76%
WFD 2021	3	2	16
	14%	10%	76%

The WFD 2021 trophic lake classifications were compared against the results from WFD 2018 according to the same guidance. Three lakes in Northern Ireland were considered to be in a Non-Eutrophic state and 16 lakes were assessed as Eutrophic. Two lake water bodies (Castlehume and Spelga Dam) had declined from High or Good to Moderate over the reporting period, and were assessed as May become Eutrophic.

1.7.1 Total phosphorus

Data from 2015-2017 (WFD 2018) and 2018-2020 (WFD 2021) was assessed using the latest version of the WFD Lake TP reference boundary calculator (v4) to obtain a TP classification. The data from 2012-14 which was presented in the previous report is shown in Table 1.31 below, thus allowing a three-period comparison. This review is based on 2015, 2018 and 2021 WFD lake TP classifications. Twenty-one lakes in Northern Ireland were routinely monitored on a monthly basis for TP for all classification periods. The same 21 lakes were monitored during all reporting periods.

Table 1.31: Total Phosphorus, classification in Northern Ireland, WFD 2015, 2018 and 2021

Reporting Period *(n=21)*	Number and % of Lakes				
	HIGH	GOOD	MODERATE	POOR	BAD
WFD 2015	5	4	3	7	2
	24%	19%	14%	33%	10%
WFD 2018	4	3	7	5	2
	19%	14%	33%	24%	10%
WFD 2021	0	4	10	4	3
	0%	19%	48%	19%	14%

Table 1.31 shows that of the 21 lakes monitored in the WFD 2015 reporting period (2012-2014), nine lakes were classed as High/Good. Twelve lakes had TP classifications less than Good. Of these, seven lakes were classified as Poor status for TP, which are considered to be eutrophic. Lough Neagh and Portmore Lough remained classified as Bad status for TP classification.

In the WFD 2018 reporting period 2015-2017, seven lakes were classed as High/Good. This is a slight deterioration from the previous reporting period as Lower Lough Erne at Kesh and Lough Melvin both deteriorated from Good to Moderate TP status. Fourteen lakes had TP classifications less than Good which is indicative of nutrient enrichment. Of these, five lakes were classified as Poor status for TP. Lough Neagh and Portmore Lough were classified as Bad status for TP classification (the same lakes as the in the previous reporting periods).

In the WFD 2020/21 reporting period 2018-2020, four lakes were classed as High/Good. This is a deterioration from the previous reporting period as. Castlehume Lough, Upper Lough MacNean and Spelga Dam all deteriorated from High/Good to Moderate TP status. No lakes were classed as High TP status in this reporting period. Seventeen lakes had TP classifications less than Good which is indicative of nutrient enrichment. Of these, four lakes were classified as Poor status for TP. Lough Neagh, Portmore Lough and Stoneyford were classified as Bad status for TP classification. Stoneyford deteriorated from Poor to Bad TP status. (Figure 1.41).

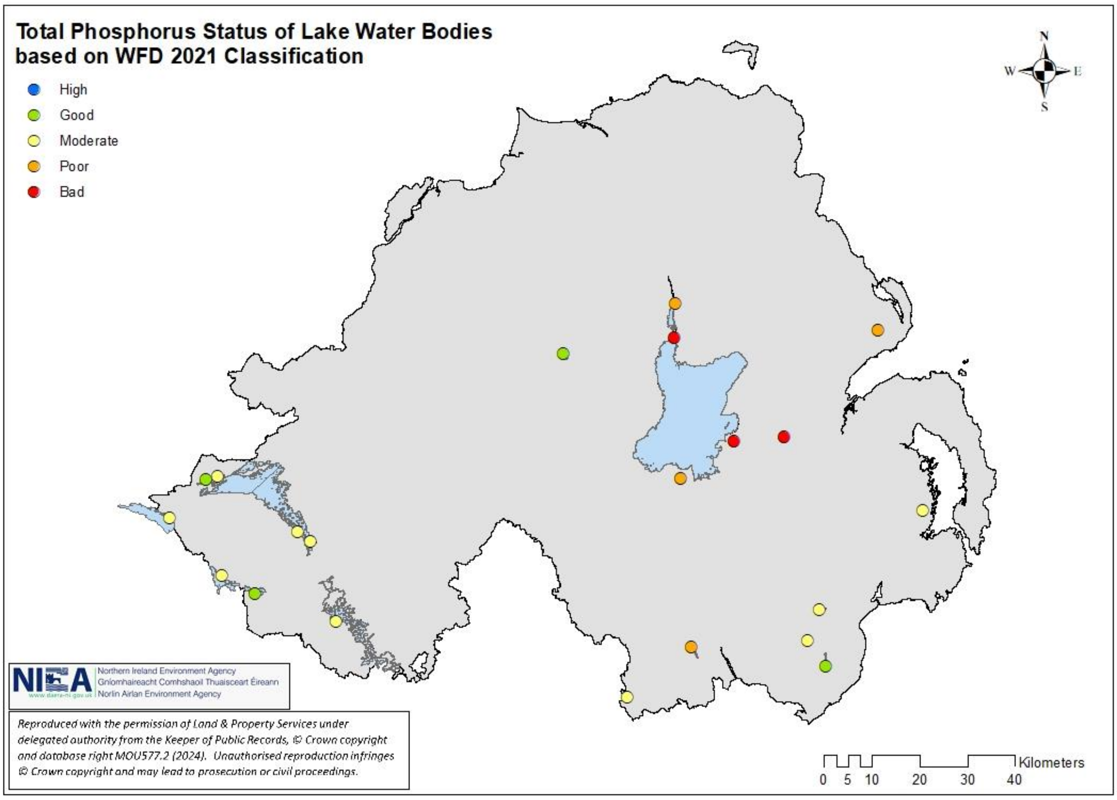

Figure 1.41: WFD Total Phosphorus classification in lakes, 2018-2020

Overall changes shown in Table 1.32 indicate that for the 21 common lake monitoring sites, no lakes have shown improvement in WFD TP classification between the reporting periods. Fourteen lakes remained stable between the reporting periods 2015-2017 and 2018-2020. (Figure 1.42). Six lakes deteriorated by one class. One lake (Spelga Dam) deteriorated by two classes from High to Moderate status. Further investigation of these lakes is planned as part of the third cycle River Basin Management Plans (RBMPs).

Table 1.32: Changes in WFD Total Phosphorus classification in lakes between former and current reporting periods (numbers and % of lake sampling points)

Reporting Period *(n=21)*	Number and % of points				
	Strong decrease[1]	Weak decrease[2]	Stable[3]	Weak increase[4]	Strong increase[5]
Lakes WFD TP classification	0	0	14	6	1
	0%	0%	66.7%	28.6%	4.8%

[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

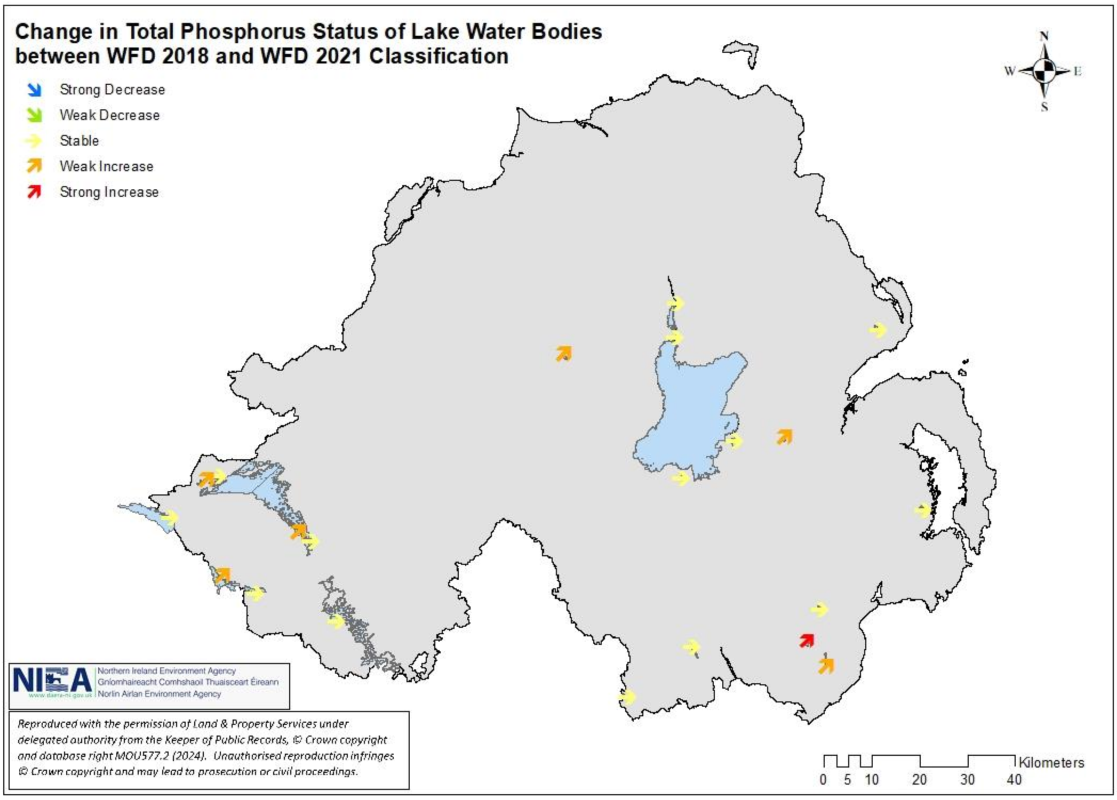

Figure 1.42: Change in WFD Total Phosphorus classification in lake sampling sites between previous and current reporting period, 2015-2017 and 2018-2020.

1.7.2 Chlorophyll-α

Data from 2016-2019 and 2020-2023 was assessed using the latest version of the WFD PLUTO Single Site Calculator (V4h). The data from 2012-15 which was presented in the previous report is shown in Table 1.33 below, thus allowing a three-period comparison. 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). Twenty-one lakes in Northern Ireland were routinely monitored on a monthly basis for chlorophyll-α for all classification periods. The same 21 lakes were monitored during all reporting periods.

Table 1.33: WFD chlorophyll-α classification in Northern Ireland, 2012-2015, 2016-2019 and 2020-2023

Reporting Period *(n=21)*	Number of Lakes				
	High	Good	Moderate	Poor	Bad
2012-2015	5	8	4	4	0
2016-2019	5	5	6	5	0
2020-2023	4	8	5	4	0

Table 1.33 shows that of the 21 lakes monitored for chlorophyll-α in the 2012-2015 reporting period, 13 lakes were classed as High/Good. Eight lakes had chlorophyll-α classifications less than Good with four lakes at Moderate status and for at Poor status. No lakes were classified as Bad status for chlorophyll-α.

In the reporting period 2016-2019, 10 lakes were classed as High/ Good. Eleven lakes had chlorophyll-α classifications less than Good with six lakes at Moderate status and five at Poor status. No lakes were classified as Bad status for chlorophyll-α.

In the current reporting period (2020-2023), 12 lakes were classed as High/ Good. Nine lakes had chlorophyll-α classifications less than Good, with six lakes classed as Moderate status and four lakes classed as Poor status. No lakes were classified as Bad status for chlorophyll-α in the current reporting period (Figure 1.43).

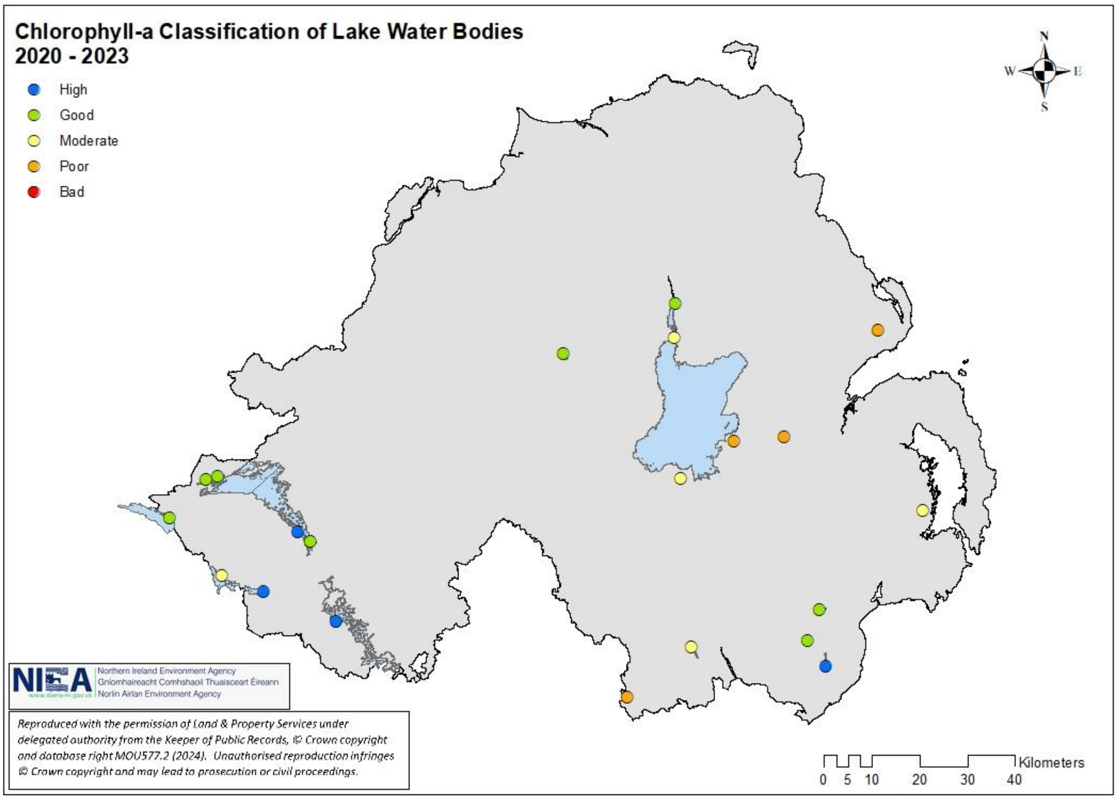

Figure 1.43: WFD chlorophyll-α classification in lakes, 2020–2023

Changes in lake WFD chlorophyll-α classification shown in Table 1.34 and Figure 1.44 indicate that overall, for the majority (57.1%) of the 21 lakes monitored in Northern Ireland, the trophic status has remained stable between the reporting periods. Four lakes have shown improvement in chlorophyll-α WFD classification between the reporting periods from Moderate to Good status and two have improved from Poor to Moderate status. Two lakes

(Lough Gullion and Lough Mourne) deteriorated by one class. One lake (Clea Lakes) deteriorated by two classes from High to Moderate status. Further investigation of these lakes is planned as part of the third cycle River Basin Management Plans (RBMPs).

Table 1.34: Changes in lake WFD chlorophyll-α classification between 2016-2019 and 2020-2023 periods (numbers and % of lake sites)

Reporting Period *(n=21)*	**Number and % of sites**				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Lakes WFD chlorophyll-α classification	0	6	12	2	1
	0.0	28.6%	57.1%	9.5%	4.8%

[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

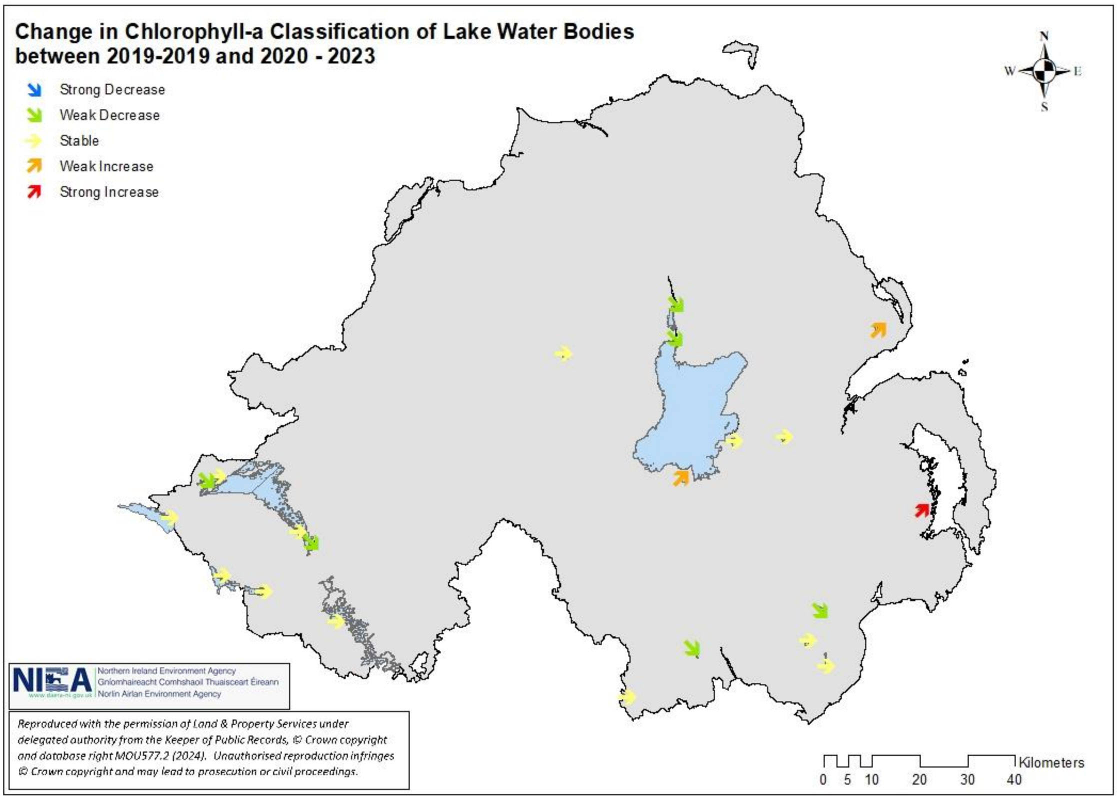

Figure 1.44: Change in WFD chlorophyll-α classification in lakes sites between previous and current reporting period.

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

Eutrophication in transitional, coastal, and marine waters is assessed based on selected quality elements monitored under the Water Framework Directive Regulations. These quality elements include parameters relating to nutrient enrichment (e.g. dissolved inorganic nitrogen), direct effects of nutrient enrichment (e.g. chlorophyll-a, phytoplankton, macroalgae), and indirect effects of nutrient enrichment (e.g. oxygen depletion). The trophic status of transitional and coastal waters was assessed using the results of the 2021 Water Framework Directive Regulations water body classification. This assessment was restricted only to the appropriate eutrophication quality elements. These included dissolved inorganic nitrogen (DIN), phytoplankton (including chlorophyll-a), macroalgae, angiosperms, and dissolved oxygen. It is important to note that the trophic status classification does not include all quality elements and is restricted only to those that reflect trophic status.

Based on the results of the 2021 classification results, the trophic status of transitional and coastal waters indicated that 56% of water bodies were high or good status, 20% were moderate status, and 24% were either poor or bad status (Table 1.35).

Table 1.35: Overall Water Framework Directive Regulations classification of eutrophication for transitional and coastal waters *(based on Dissolved Inorganic Nitrogen (DIN), phytoplankton, macroalgae, macrophytes and dissolved oxygen)*

CLASS	2021 Classification	
	Number of water bodies (n=24)	%
HIGH	7	28.0%
GOOD	7	28.0%
MODERATE	5	20.0%
POOR	2	8.0%
BAD	4	16.0%

The assessment also showed that eutrophication did not appear to be an issue in coastal waters; all coastal water bodies were either good or high status (Figure 1.45). All water bodies that were classified as moderate or worse were either transitional (estuarine) waters or nearshore sea loughs.

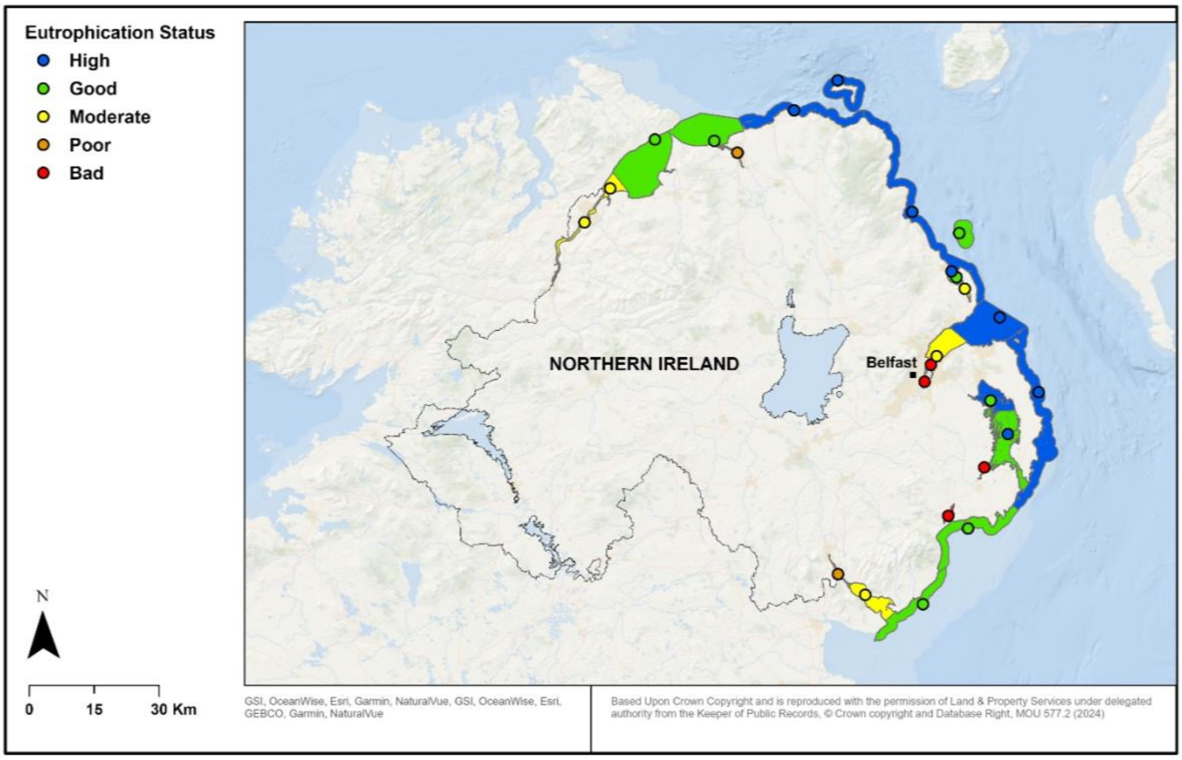

Figure 1.45: Northern Ireland water body classification based on the combination of all relevant direct and indirect eutrophication related parameters.

An analysis of individual quality elements monitored under the Water Framework Directive Regulations showed a marked decline in several components, particularly those related to eutrophication; an increase in nutrient (DIN) concentrations was observed in over 90% of water bodies with a decline in the quality of eutrophication response variables such as phytoplankton and dissolved oxygen in over 50% of water bodies. This suggests that, although water bodies may not exhibit signs of eutrophication at this stage, a high proportion are exhibiting a response to increased nutrient inputs. In addition to nutrients, a number of water bodies also failed to meet environmental standards for a number of pesticides and herbicides suggesting that that catchment-based agricultural activities are a contributing factor to the water quality status of transitional and coastal waters.

2. Action programmes

The Nutrients Action Programme (NAP) is required to be reviewed and, where necessary, revised, at least every four years. There have been four NAPs implemented in Northern Ireland since 2006. A scientific review of the fourth NAP is currently underway and a formal consultation on the proposals for the fifth NAP for the period 2025-2028 will be carried out later this year. Following completion of the review and consultation, revised NAP Regulations will be introduced in 2025.

A Nitrates Derogation for Northern Ireland for the period 2019-2022 was approved in Commission Decision EU 2019/1325 following a positive Member State vote at the Nitrates Regulatory Committee meeting in March 2019. This is the fourth derogation decision approved for Northern Ireland. Therefore the 2019 NAP Regulations were amended 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 the criteria set in the derogation decision. A summary of the measures contained in the 2019 NAP Regulations is provided at section 4.2.

The Derogation is important for some grassland cattle farms as it enables them to operate at a higher manure nitrogen loading, subject to additional nutrient management and environmental criteria. Previous NI derogations decisions were approved by the EU Nitrates Regulatory Committee under procedure in the ND. Since EU exit this EU approval process no longer applies and the position with respect to derogations is assessed as part of the NAP review process.

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 2021 it accounted for approximately 1.6 % of Gross Value Added (GVA) and supports 2.3 % of civil employment in Northern Ireland. It is, therefore, proportionately almost three 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 4.2 % and 3.7 % respectively.

There are currently 26,131 farm businesses in Northern Ireland in 2023, of which approximately 21 % are regarded as large enough to provide full-time employment for one or more persons (based on a standardised labour requirement). Farm numbers declined steadily from 1981 until 2010 and have been relatively stable over the past 13 years (Figure 3.1). Slight increases were observed in the years 2013, 2015, 2017, 2020 and 2021 (the latter 2 years as a result of methodological changes to the Farm Census[3]), In 2022 and 2023 there has been a stabilisation in farm numbers. It is estimated that 52,676 people were engaged in some form of agricultural activity in 2023, although the majority do so on a casual or part-time basis. The size of the agricultural labour force has remained relatively stable since 2004 (recent increases in figures are as a result of methodological changes to the Farm Census[4]).

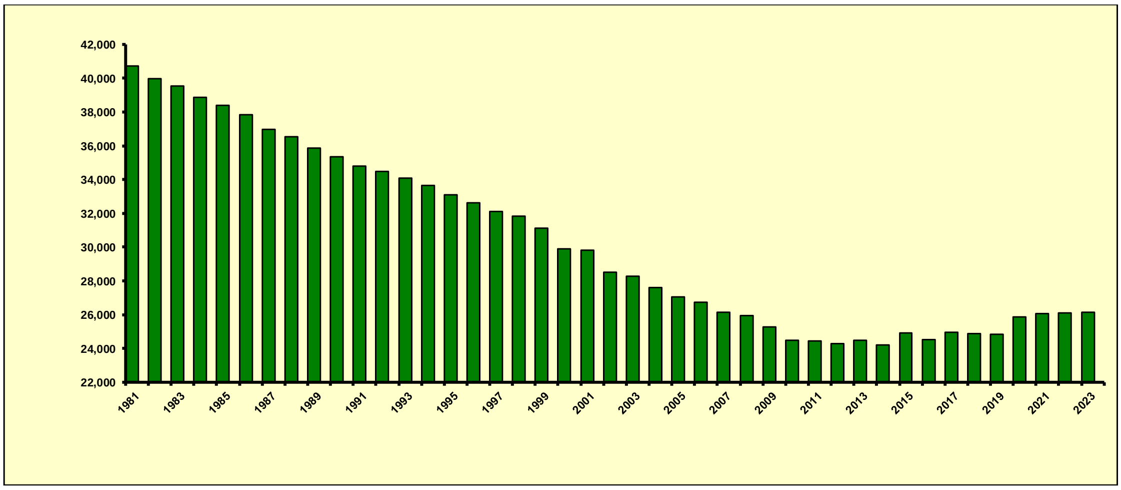

Figure 3.1 Trend in farm numbers in Northern Ireland (1981-2019)

Farms in Northern Ireland are almost entirely owner-occupied and are small by UK standards but the average area of farm businesses of 40 ha in 2023 is 2.5 times larger than the average size of EU-27 countries of 16.2 ha in 2013. Since 1990 average farm size increased b10 ha, from 2010 to 2019 the average area remained stable at 41ha, dropping to 40ha in 2020 and remaining stable since then. The area farmed (excluding common land) has remained relatively steady since 1984.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.

[3] Further information on Methodological changes avaialable at https://www.daera-ni.gov.uk/publications/agricultural-census-northern-ireland-methodology-and-quality-report

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 2023. 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. In 2023 rough grazing represented 14 % of the agricultural area and 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				
	2008-2011	**2012-2015**	**2016-2019**	**2022-2023**	**Units**
Total land area	13,600				km^2
Agricultural land	10,027	9,959	10,196	10,423	km^2
Agricultural land available for application of manure	8,409	8,395	8,516	8,666	km^2
Arable crops	565	504	461	477	km^2
Permanent grass	7,843	7,890	8,055	8,219	km^2
Perennial crops[a]	15	15	15	13	km^2
Agricultural land under Agri-environment Scheme[b]	4,545	3,780	518	630k	km^2
Annual use of organic N from livestock manure	96,666	97,864	102,862	99,393 [f]	tonnes N per year
Annual use of organic N other than livestock manure	273	91	90	333	tonnes N per year
Annual use of mineral N	68,276	71,042	77,733	71,787	tonnes N per year
Number of farms[c]	24,436	24,907	24,827	26,131	
Number of farms with livestock[c]	23,516	23,817	23,646	24,760	
Cattle[d]	1,590	1,609	1,612	1,673	Thousand
Sheep	1,886	1,990	1,987	2,073	Thousand
Pigs	421	570	675	682	Thousand
Poultry	19,623	21,246	24,780	25,585	Thousand
Other[e]	15	14	12	9	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 2011, 2015,2019 and 2023.*
[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/statistical-review-ni-agriculture-2007-onward).*
[e] *Horses (6,000) and goats (3,000).*
f Calculations for 2020-2023 use the updated N excretion rates per livestock category in the Nutrient Action Programme Regulations (Northern Ireland) 2019 which revised down estimates for a number of livestock categories compared to earlier iterations.

3.2. Nitrogen discharges to the environment

Table 3.2 summarises estimates of discharges of nitrate-N from land to the aquatic environment in Northern Ireland for the periods 2004-2007, 2008-2011, 2012-2015, 2016-2019 and 2020-2023. Estimates of the diffuse losses of nitrate from agriculture were based on mean annual nitrate-N export coefficients 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 (Northern Ireland Statistics and Research Agency) were used to estimate the average annual domestic sewage discharge of nitrate-N for each period.

Data provided in Section 4 provide a more detailed breakdown of the amount of N applied to land and, in particular, the residue of N that is unaccounted for by the difference between inputs via fertiliser and imported feedstuffs and outputs removed in agricultural products. Agriculture is computed to be the largest source of N discharges to surface waters. This reflects the large proportion of the land area of Northern Ireland devoted to agriculture (77%) and the current level of animal production within agriculture which can lead to loss rates in the region of 20 kg N ha/year or 2 tonnes N/km^2/year.

By comparison, the average human population density over the period 2020-2023 is approximately 141 persons/km^2 which, based on a per capita N loading of 2.45 kg N/person$^/$year (6.7 g N/person/day; Smith, 1976; Jordan & Smith, 2005), equates to an area-weighted loss of N from human population of 0.346 tonnes N km^{-2} year^{-1}.

There was an overall increase of 5% in the combined total N discharged resulting from a 6% increase in the agricultural N discharge and a 1.5% increase in the domestic sewage (human population) N discharge.

Table 3.2: Annual mean discharge of nitrate-N (tonnes NO_3-N year-1) to the aquatic environment by sector for 2004-2007, 2008–2011, 2012-2015, 2016-2019, and 2020-2023 (average value over the 4 years).

	Period					
	2004-2007	**2008-2011**	**2012-2015**	**2016-2019**	**2020-2023**	**2020-2023 vs 2016-2019**
	tonnes NO_3-N year-1					% change
Agricultural	19,199	16,177	17,148	18,116	18,484	+2.0
Domestic sewage	4,240	4,386	4,496	4,599	4,667	+1.5
Total	23,439	20,563	21,644	22,715	23,151	+1.9
	Period					

3.3. Code of Good Agricutural Practice (COGAP)

Table 3.3: Summary data on codes of good agricultural practice

Date of first publication – COGAP for the Prevention of Pollution of Water, Air and Soil	1999
Dates of revision	2002
	2008
Date of first publication – COGAP for Reducing Ammonia Emissions	2019

In Northern Ireland, the Code of Good Agricultural Practice (COGAP) for the Prevention of Pollution of Water, Air and Soil 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. It was first revised and updated in 2002, comprising two booklets, one of which applied specifically to water. DARD (now DAERA) issued this to all farmers in Northern Ireland in 2003.

Following extensive consultation within Government and a 12-week public consultation period in 2007, the COGAP for the Prevention of Pollution of Water, Air and Soil was fully revised and updated to take account of the NAP Regulations and other legislation changes at the time. The most recent version 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 COGAP for the Prevention of Pollution of Water, Air and Soil is scheduled in coming years to accommodate changes to future NAP Regulations and other relevant legislation. In the meantime, DAERA ensures that farmers are kept updated about any changes to the NAP requirements through updated NAP Guidance documents, knowledge transfer events, press articles, and via the DAERA website.

In addition to the COGAP for the Prevention of Pollution of Water, Air and Soil, the COGAP for Reducing Ammonia Emissions was published by DAERA in May 2019. Produced in collaboration with the farming industry, it provides farmers with a range of practical steps they can take to minimise emissions of this air pollutant. In particular, it outlines the legislative requirements of NAP in relation to the storage of organic manures, and how to apply organic manures effectively and efficiently through the use of Low Emission Slurry Spreading Equipment (LESSE).

3.4. Compliance with Code of Good Agricutural Practice

As a consequence of the total territory approach in Northern Ireland, the sections of the COGAP for the Prevention of Pollution of Water, Air and Soil relevant to livestock manure storage and nitrogen fertiliser application are incorporated into the 2019 NAP Regulations and compliance is a legal requirement for all farm businesses in Northern Ireland. In addition, the COGAP for the Reducing Ammonia Emissions section on spreading organic manure using LESSE is compulsory for farms which meet certain criteria. All NAP information literature will be reviewed, updated and re-published in 2025 to reflect the fifth NAP. 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 2020 to 2023, the DAERA College of Agriculture, Food and Rural Enterprise (CAFRE) held training workshops and webinars covering NAP Information, Nitrates Derogation improved Nutrient Use Efficiency, Soil Health 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’s current agri-environment climate scheme under the Northern Ireland Rural Development Programme 2014-2020 is the Environmental Farming Scheme (EFS). It was launched in 2017 and provides a range of voluntary options aimed at improving water quality, biodiversity, habitat condition and sequestering carbon.

A key feature of EFS development was the close engagement between colleagues across the Department for Agriculture, the Environment and Rural Affairs (DAERA) (the Department) (previously two 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 DAERA. Information from both the original Departments has been combined spatially and has enabled much more accurate targeting of measures impacting on water quality.

EFS has two main elements. EFS (Higher) aims to improve habitat condition and biodiversity with an outcome target of 60,000 ha of environmentally designated land and priority habitat under favourable management. EFS (Wider) aims to improve biodiversity and water quality, and sequester carbon, across the wider countryside with an outcome target of creating 7,400 ha of green infrastructure.

Six tranches of EFS Wider level have been rolled out up to 2022. After the six tranches some 5300 EFS agreements were in place, covering approximately 61,000 hectares of land. Some 70% of the EFS Wider level agreements have at least one water quality measure and some 203 km of riparian margin’s and 2,500 km of watercourse stabilisation fencing implemented. While there have been no further tranches of EFS Wider, EFS Higher has had a seventh intake tranche in 2023 and an eighth is planned for 2024. A successor agri-environment programme, the Farming with Nature package is currently under development.

Some farmers associate the environment with regulation, inspections and penalties. More of the focus around training and awareness aims to highlight that often what is good for the environment is also good for the farm business and managing the environment isn’t a negative cost to the business.

A Soil Testing and Training Initiative for farmers within targeted sub-catchments of the Colebrooke and Strule water bodies was implemented by DAERA in 2019. The Initiative was an extension of EU Exceptional Adjustment Aid (EAA) Soil Sampling and Analysis Scheme. This was a pilot programme to help inform the potential roll-out of the Sustainable Agriculture Land Management Strategy (SALMS) recommendation for a publicly funded soil sampling and analysis survey of all agricultural land in Northern Ireland.
Agri-Food and Biosciences Institute (AFBI) managed and delivered the initiative on behalf of DAERA, which provided participants with free soil sampling and analysis in order to apply nutrients in line with crop requirements. By applying organic and inorganic fertilisers as efficiently as possible, farmers can optimise crop yields and increase farm profitability, while also improving environmental performance and water quality in particular.

The success of this initiative has resulted in the development of the Soil Nutrient Health Scheme (SNHS) which aims to soil sample every field across Northern Ireland. This data will provide a baseline for scientific research but also provide information to further educate farmers to allow better decision making around nutrient applications and promote behavioural change. The SNHS is being implemented over 4 years on a zoned basis with Zone1 (south east) and Zone 2 (south west) opened fir applications in 2022 and 2023 respectively.

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

DAERA has produced numerous advisory articles to raise awareness of the Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil 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.

The Knowledge Advisory Service (KAS) within the College of Agriculture, Food and Rural Enterprise (CAFRE) published a wide range of press articles dealing with farm nutrient and manure management during the period. Using various methods of communication including local farming press, radio, DAERA & CAFRE websites and various social media platforms.

The DAERA Farm Advisory System Newsletter 'FAS News' published triannually, was discontinued in preparation for new future agricultural policy being developed. A reviewed format of this publication is being developed by policy with a proposed initial circulation commencing in Autumn 2024.

Advice

Advice is delivered through the Knowledge Advisory Service. This continues to provide the original advisory functions provided by CAFRE alongside the agri-environment advisory functions previously provided by the Departments Countryside Management Unit (CMU). This allows a much more holistic approach to be taken with farm advice, considering the environmental needs alongside production objectives.

The primary role of the Knowledge Advisory Service is the holistic development of farm and food businesses, where economic and environmental performance are inextricably linked. This ensures that the productivity, environmental sustainability and resilience agendas are the primary focus. From an environmental perspective, the new service represents an opportunity for DAERA to better integrate environmental advice into its support to the agri-food sector.

The service has been enhanced by the formation of a Sustainable Land Management Branch, based at Greenmount Campus. This environmental branch delivers Knowledge and Technology Transfer (KTT) across the key areas of air quality, biodiversity, land management and water quality. Central to this branch is the CAFRE Farm, which remains vital to the delivery of education, training and knowledge transfer to our farming industry.

Following engagement with key stakeholders, the new service encourages a partnership approach with external bodies. As the Knowledge Advisory Service develops, DAERA believes it will drive business practices and behaviours that will lead to improved productivity and profitability as well as enhanced environmental performance.

Guidance and training

Work has continued between 2019-2023 with CAFRE continuing to deliver nutrient management planning training to farmers across the Business Development Groups. These groups have delivered training and guidance on soil health, fertiliser planning, nutrient management planning and greater awareness on water quality. With the role out of the Soil Nutrient Training Scheme, CAFRE has developed a training package for online and Face to Face training which will be delivered to 24,500 farm businesses detailing the need for soil sampling, the interpretation of the results, an awareness of soil carbon and the application of a nutrient management plan. Face to Face training was developed by CAFRE and delivered through Family Farm Key Skills with the initial tender delivered by agents Countryside Services Ltd.

CAFRE has engaged with the Agricultural Consultants, industry farmer liaison staff and awareness events to ensure that the message is delivered to farmers of the need to undertake the training and make full use of the soil results to complete a nutrient management plan to help improve water quality through more efficient use of nutrients.

CAFRE continues to engage with farmers and landowners through press articles, online and social media content to deliver information on Nutrient Management Planning, Cross Compliance, and NAP. Webinar events were held promoting improved nutrient use efficiency, demonstrating the value of slurry and organic manures and how to best utilise them on farm. Slurry management events were held where farmers were able to attend to again promote responsible use of slurry on farms and how to better integrate organic manures within Nutrient Management Planning.

In addition, CAFRE Advisers and the Agri-Environment Team successfully dealt with numerous enquiries from farmers, Advisers and Consultants on NAP related issues including the closed period, manure exports (online record submission) and nitrates derogation (online record submission).

Training and support for Nutrient Management and Land Management is being delivered to farmers on a sectorial basis through the Business Development Group (BDG) Programme. Approximately 3,000 farmers have participated in BDG's since their initiation in 2016. In 2019/20 the BDG sectoral approach was extended to include Environmental Farming BDG's, under Tranche 5 of the BDG programme. This resulted in the initiation of 25 additional Environmental Farming BDG's supporting 570 farmers, focusing specifically on environmental issues including water quality and nutrient management planning.

Agri-environment schemes

Environmental Farming Scheme

The Environmental Farming Scheme (EFS) is the Department's current Agri-Environment Scheme. It was a key element of the NI Rural Development Programme 2014-2020.

EFS is a voluntary agri-environment scheme that supports farmers and land managers to carry out environmentally beneficial farming practices on agricultural land. The scheme is made up of three levels:

a. EFS Higher Level – aimed at site specific environmental improvements on environmentally designated sites and for other priority habitats and species.

b. EFS Wider Level – aimed at delivering environmental benefits across the wider countryside outside of the environmentally designated sites.

c. EFS Group Level – to provide advisory support and encourage co-operative work by farmers in specific areas, including water catchments and designated sites. The 10 Group Level projects are delivered by environmental non-government organisations (eNGOs).

There have been six annual intake tranches of EFS wider level and seven tranches of higher level.

EFS agreements last for five years. At its high point, over 5,500 farmers were participating in EFS. Agreement numbers are reducing as wider level agreements end. However, numbers in higher level have largely been maintained, as it has continued to open annually for applications and farmers have been able to re-apply after 5 years.

At present there are 10 EFS Group projects which are being facilitated by four eNGO's: RSPB, Lough Neagh Partnership (LNP), Ulster Wildlife (UW) and Rivers Trust (RT). Some 800 farm businesses are participating across these EFS Groups.

Future agri-environment support under the Farming with Nature package is currently under development and will in due course replace the EFS. Total support to farmers under EFS is projected to be £97 million, up to 2029.

<u>Sustainable Catchment Programme (SCP)</u>

The SCP follows a successful £550k pilot year during 2021-22 in which 54 farm holdings were engaged across the Dundrum, Upper Bann and Ballinderry catchments. The initial pilot year means that the delivery model and procedures have been tried and tested and shown to be effective.

The SCP delivers a variety of on-farm measures and interventions designed to improve and protect water quality in the Dundrum, Ballinderry, Salterstown (western Lough Neagh shore) and Upper Bann rivers' catchments. These measures are identified by non-regulatory farm advisors employed by The Rivers Trust, who will have identified the need, scope, and location of prescribed and bespoke measures, agreed with the landowner, for the protection and expected improvement of water quality and water dependent species and habitats. These will be detailed in farm Water Environment Management Plans (WEMPs) drawn up for each farm by The Rivers Trust advisors following farm assessment visits.

By looking at each farm on an individual basis, measures can be tailored to specific situations instead of using a set of prescribed measures which may not make as great an environmental difference or give as good value for money. This advisory work is delivered through projects supported under the Environmental Farming Scheme (EFS) Group measure.

The SCP funding covers grant aid for the capital costs of the on-farm measures only and the EFS Group funding covers the resource cost of The Rivers Trust farm advisors and group facilitation. The SCP measures identified will be in addition to those available in the EFS and will be completed to similar specifications.

The Rivers Trust administers the delivery of SCP funding to farmers, either directly or through partnership working with local rivers trusts. This is via an agreed application and administration process, ensuring financial diligence and best value for money in the implementation of measures. A multi-disciplinary SCP Steering Group oversees the governance of the project with financial and impact reporting being made quarterly.

Collectively, the SCP catchments represent a geographical spread across Northern Ireland, as well as a range of farming operation types, sizes, and landscape settings (i.e. Inland and coastal catchments, lowland and upland, highly productive and poorer productive areas).

In 2024 the SCP will be extended to the Owenkillew river catchment and may be expanded further in future.With the last tranche of EFS Wider level closing in September 2022 and no immediate successor scheme, the SCP provides an efficient and effective means of continuing to deliver measures on farms to help sustain, protect, and improve water quality. Learning from the SCP will also contribute to the formulation of the successor agri-environmental scheme for NI, Farming with Nature.

Soil Nutrient Health Scheme

The Soil Nutrient Health Scheme (SNHS) is a four-year project investing up to £37M into Northern Ireland's farming sector. The Scheme provides farmers with soil analysis results for all their fields, which will help improve on farm efficiency by assessing soil nutrient requirements and where that should be applied to maximise crop yields and avoid water pollution.

Every eligible farm business in Northern Ireland can apply for soil analysis through the Scheme and in the first two years of the Scheme, uptake by farm businesses was over 90%. Participation in the Scheme is a requirement for the incoming Farm Sustainability Payment.

Farm Businesses will also receive run off risk maps for their farm identifying areas at high risk of nutrient loss during rainfall events. This is a useful tool for farmers to identify sub-field areas, which may benefit from interventions, such as buffer strips to minimise nutrient run off into water courses.

Online training is provided by CAFRE for farm businesses that have received their results. This will help them interpret their soil nutrient results and runoff maps and demonstrate how they can develop a farm nutrient management plan, with the aim to improve nutrient use efficiency and reduce environmental impacts.

Another key area of the Scheme is for the Agri-Food and Biosciences Institute, in partnership with Ulster and Leeds University, to develop real-time water quality monitoring demonstrations for farmers showing directly how levels of nutrients in water vary over time as a result of different sources and pathways. In addition, research, using both detailed surveys and one to one interviews with participants in the Scheme, will be used to evaluate the impact participation has had on farmers' attitudes and actions with regard to both farm practices and environmental awareness.

Catchment initiatives

Work continues at a waterbody scale to bring about improvements in Water Framework Directive (WFD) status. Catchment investigations highlight the key pressures within the catchment, and a multiagency approach is applied to finding mitigations to the issues. Mitigations can range from public meetings, a planned awareness raising campaign and individual, business specific, advice to surrounding landowners.

In the second cycle of the Water Framework Directive (2015-2021) efforts were focused at a water body level. In the first half of the cycles 2015-2018 the focus was on water bodies failing to reach their WFD objective status by one element. The measures applied to these water bodies where bespoke to the failing element. Water bodies failing from nutrient related issues had an increase weighting for cross compliance visits. Additional sampling and survey work identified areas of increased nutrient loading. Where the additional loading was from an agriculture source this resulted in cross compliance visits to farm businesses known to be impacting on water quality. Where appropriate, the catchments or sub catchments where highlighted for agri-environmental training and guidance. Business within the catchment whare also encouraged to take on water quality improvement measures from DAERA's agri-environment scheme – Environmental Framing Scheme (EFS).

In the third cycle of the Water Framework Directive (2021-2027) efforts have returned focus to the Local Management Area (LMA) scale. The LMAs where identified for prioritization using a matrix consulted upon in the third cycle plan. The first LMA identified for prioritizations was the Roe catchment on Lough Foyle. The Roe was prioritized on account of being a designated site (SAC) and having waterbodies that have deteriorated in WFD status. An investigation was conducted for each waterbody within the LMA to identify the pressures impacting on the waterbody status. Once the pressures within the waterbody identified, mitigations were recommended to address the issue. Agricultural mitigations included farm advice for the Knowledge Advisory Service (KAS), promotion of water quality mitigations through the Environmental Farming Scheme (EFS) along with an increase weighting for cross compliance visits. Targeted cross compliance visits were directed to farm businesses known to be impacting on water quality.

The Roe investigation has been followed by a similar approach on the Strule. A desktop study and additional sampling highlighted critical source areas of nutrients. Measures are prescribed and applied to these areas. Agricultural measures again include Knowledge Advisory Service (KAS), the Environmental Farming Scheme (EFS) along with an increase weighting for cross compliance visits. Targeted cross compliance visits were directed to areas known to be impacting on water quality.

Future Priority Water Body investigations will be in the Lough Neagh catchment in an attempt to reduce nutrient loading on Lough Neagh to reduce the likelihood of future Blue Green Algal blooms such as those witnessed in 2023.

Additional catchment initiatives have been delivered through the Strategic Strand of the Environment Fund. This fund delivers projects within Northern Ireland aligned with the NIEA's objectives. There is one such project being delivered on the Ballinderry catchment, which is designated as a Special Area of Conservation, primarily for the Freshwater Pearl Mussel population. A key aspect of this project is to deliver agri-environment improvements within the catchment, above and beyond the measures available in the EFS. Things they would consider within these measures would be riparian buffers, pesticide handling areas, water gates, swales and means to intercept overland flow from farmyards, lanes, and areas of hard standing within the farm infrastructure.

The Trust works with farmers within the Ballinderry catchment providing advice and support drafting farm Water Environment Management Plans (WEMPs) which ensure water, slurry and manures are managed better, with no impact upon the Upper Ballinderry SAC. The project will also see the SAC conservation management plan complete; two focused water body improvement efforts; an invasive control plan created and implemented within the catchment; along with a breeding and re-introduction programme for the Freshwater Pearl Mussel.

NIEA fund a Rivers Trust Development Officer post to promote the development of River Trusts in Northern Ireland. River Trusts deliver practical river improvements in water quality and help to raise awareness and educate the wider public on river issues. There are six Rivers Trusts in Northern Ireland (Ballinderry, Erne, Six Mile, Lagan, Strule, and Blackwater). Engagement with the Trust allows access to the key stakeholders and an awareness of local water issues quality being raised by local partners.

The Rivers Trust are also working with DAERA to deliver the “Sustainable Catchment Programme” as detailed above.

The DAERA Environment Fund also includes a Water Quality Improvement Strand. This strand funds “not for profit” organizations and community groups to deliver water quality improvements and increase public awareness of water quality issues. It funds projects from £5000-£30000 over the course of one year. From 2020-2024 this fund has contributed £650k to deliver water quality projects.

This period saw Interreg Va projects completed. Catchment Care finished in 2023. This project focused on farm nutrient management practices within the Blackwater, Arney and Finn Catchments. Part of its legacy include a catalogue of water quality improvement tools via its website. The Source to Tap funding ended in 2022. This project focused on improving the raw water quality on the river Erne and Derg catchments with farms offered assistance in developing Water Environment Management Plans (WEMPS). Mitigations where also delivered on forestry sites and through bog restoration. Source to Tap will also leave a legacy of educational resources related to the management of the aquatic environment. Further Interreg projects are expected to be delivered via Peaceplus which will support projects within Northern Ireland and the border counties in the Republic of Ireland. PeacePlus includes a Catchment Management Programme looking at Cross-border catchments to act as sites to facilitate more sustainable solutions to water quality improvement.

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. An Implementation Working Group co-ordinated the activities of government departments and agencies to 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) the stakeholder engagement was developed further. With workshops for each River Basin District looking at specific themes, coupled with an biennial conference to build capacity and inform stakeholders.

Key stakeholder engagement continues through a number of sector specific working groups for the third cycle RBMP. The working groups are held biannually and oversee the implementation of the programme of measures. Stakeholder engagement also focuseson delivering water quality messages through events hosted by key partners. This has included delivering water quality messages through the Lough Erne Landscape Partnership, an angling event hosted by Derry and Strabane District Council and at agricultural shows. By attending events hosted by other organizations it is hoped that the stakeholder base is widened beyond the groups that have previously attended WFD stakeholder events. Future stakeholder engagement is likely to focus on the Neagh Bann catchment capatilizing on the increased interest on account of the Blue green algea blooms of 2023.

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 were three tranches of the Scheme between 2009 and 2014. 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.

Since 2016 DAERA has continued to provide financial support for Low Emission Slurry Spreading Equipment (LESSE) through the Farm Business Improvement Scheme (FBIS).
To date 1500 farm businesses have been supported through FBIS in the purchase of LESS equipment with £10.5m in grant aid being paid.

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, there is an on-going long-term project the '*UK Environmental Change Network: Freshwater*' which monitors conditions in Loughs Neagh and its inflowing rivers and also Lough Erne. The NAP/EFS E&I (18/4/03) '*Monitoring and modelling of nutrient losses to water in agricultural catchments to evaluate the effectiveness of the Nutrient Action Programme (NAP) and the Environmental Farming Scheme (EFS)*' (costing £4,027,407) which runs to October 2024 continues long-term evaluation of the imapct of agricultural practices on water quality across the Upper Bann, Colebrooke and Ballinderry catchments.

Other projects include: 21/5/03 NI Ammonia Monitoring; 19/4/16 LESS: Assessing the ammonia emission abatement potential of Low Emission Slurry Spreading technologies and treated slurries for Northern Ireland; PEAT-NI-SP-AEB; SUSTAIN - Building Resilience into Grassland and Delivering Ecosystem Services and 21/4/10 - Changing Behaviour: Real-time water quality data for stakeholder behavioural change and on-farm decision support (REAL-DATA).
The Soil Nutrient Health Scheme also includes a programme of research across water, soil, carbon and behavioural science to support deliverables from the Scheme to a value of ~£8M across AFBI Ulster and Leeds universities.

Water quality improvement schemes
DAERA continues to deliver the Environment Fund which is a dedicated competitive grant scheme to fund voluntary 'not for profit' bodies and local councils. Details are given above.

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 %. Analysis of samples by the Department indicates that the average P level in dairy compound feed is now approximately 0.51 %.

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 training is delivered and the best possible advice is provided to farmers and sprayer operators.

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 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 2020-2023 with the previous reporting period 2016-2019. For further comparison data for previous periods are also given.

4.1.1. Livestock manure N

Table 4.1 summarises estimates of livestock manure N production in Northern Ireland for the periods 2004-2007, 2008-2011, 2012-2015, 2016-2019 and 2020-2023. Livestock number (Agricultural Census in Northern Ireland) and N excretion rates (taken from the Nitrates Action Programme Regulations 2015 for calculations to 2019; and from the Nutrient Action Programme Regulations (Northern Ireland) 2019 thereafter) were used to estimate the total N production per livestock category for cattle, sheep, pigs and poultry.
Changes in livestock manure N production reflect both increasing/decreasing livestock numbers but also improved efficiency (due to breeding/housing/feed) and more accurate measurement across the systems.

Between the current (2020-2023) and the previous reporting period (2016-2019), the total estimate of the amount of manure N produced on farms in Northern Ireland has reduced by 4.8%. This reduction is due primarily to revisions to the excretion coefficients implemented from 2019 (NAP 2019-22, Schedule 2), which affect cattle and poultry classes, and also from changes in the numbers of cycles/year for some pig classes.

Table 4.1: Livestock manure nitrogen production (kg N ha-1) in Northern Ireland from cattle, sheep, pigs, and poultry for 2004-2007, 2008–2011, 2012-2015, 2016-2019, and 2020-2023 (average value over the 4 years).

	Period					
	kg N ha^{-1} yr^{-1}					
Animal category	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2020-2023**	**Change from 2016-2019**
Cattle	95.4	87.4	87.1	88.3	85.9	-2.7%
Sheep	16.4	15.1	15.5	15.8	15.8	0.0%
Pigs	2.0	2.2	2.5	3.1	4.5	45.2%
Poultry	9.0	9.5	10.6	12.9	8.1	-37.2%
Total manure N	**122.8**	**114.2**	**115.7**	**120.1**	**114.3**	**-4.8%**
Slurry/Manure from Housing (5 mths cattle; 1 mth sheep, all pig & poultry)	52.1	49.4	50.7	54.1	49.7	

Manure production has continued to be dominated by cattle, accounting for 74-77 % of total manure N production since 2004-2007 (75.2% in 2020-2023). While N produced from sheep has stabilised, excretions from pigs and poultry have changed most since the last reporting period. Census data indicate a reduction in poultry numbers from 24,780 million to 23,760 million head from 2016-2019 and this along with revised emissions factors due to improvements to housing/heating in the poultry industry has led to a reduction in estimated emissions of 37.2% over the period. For pigs (4% of overall livestock manure N production) estimates have increased by 45.2% due to an increase from 675,000 to 705,000 head between periods and as previous estimates did not allow for multiple cycles per year in growers and finishers.

Cattle and sheep are generally 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 (or for some poultry manures sent to AD) is estimated at 50 kg/ha/year for the period 2020-2023. In 2004-2007 this was 52 kg/ha/year N declining to 49 kg/ha/year N in 2008-2011 and increasing to 54 kg/ha/year in 2016-2019. Interannual variations in these emissions are likely, with winter weather conditions prolonging housing periods in some years (e.g. 2023/24), and with increasing numbers of fully housed cattle systems some farms will have considerably higher stored volumes.

4.1.2 Land use

Table 4.2 illustrates that the total agricultural area is 1.8 % higher in 2020-2023 than in 2016-2019. The results show that agricultural land use continues to be dominated by managed grassland, accounting for 79 % of the total agricultural area in 2020-2023.

The area of grass under 5 years old has decreased by 6,095 ha (-4.2 %) since the last reporting period whereas the area of older grass (5+ years) has increased by 20,204 ha (+3.1 %) over the same period. The area under arable cropping has slightly increased by 960 ha (+2.1 %) since the last reporting period. It illustrates that there has been a small increase (+3.9 %) in the total area of crops and grass available for manure applications. The rough grazing area slightly increased by +0.2 % compared to the previous reporting period, this area would not be expected to receive any fertiliser. The decrease in younger grass (<5 years) area observed since the previous reporting period may be related to the 2022 drought and the remarkably wet 2023 year that made reseeding, grass growth, and grazing difficult.

Table 4.2:

Composition of reported agricultural land area (ha) within Northern Ireland for 2004-2007, 2008-2011, 2012-2015, 2016-2019 and 2020-2023 (average value over the 4 years).

	Period					
Land use	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2020-2023**	**2020-2023 vs. 2016-2019**
	Area (ha)					% change
Grass <5 years old	131,509	121,537	142,300	146,475	140,380	-4.2
Grass 5+ years old	680,390	662,804	646,750	659,075	679,279	+3.1
Grass (total)	811,899	784,341	789,025	805,525	819,659	+1.8
Arable crops and horticulture	51,595	56,514	50,450	46,025	46,985	+2.1
Rough grazing	149,408	142,589	137,525	141,100	141,356	+0.2
Other land*	20,941	19,246	18,862	26,825	29,763	+11.0
Total agricultural area	**1,033,843**	**1,002,690**	**995,887**	**1,019,500**	**1,037,763**	**+1.8**

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

The area of *Other land* increased by 11% compared to the previous reporting period. A breakdown of components of this category in Table 4.3 shows that the increase in woodland area observed between the previous reporting periods is still ongoing; woodland area increased by 16.4 % between 2016-2019 and 2020-2023. While this increase is lower than the 46.8% increase observed between 2012-2015 and 2016-2019, it is still an encouraging trend for biodiversity protection/conservation and carbon storage/sequestration. The area of other land (e.g. buildings, roads…) slightly increased by +3% compared to the previous reporting period.

Table 4.3: Components of the Other land category of reported agricultural land (ha) within Northern Ireland for 2004-2007, 2008-2011, 2012-2015, 2016-2019 and 2020-2023 (average value over the 4 years).

	Period					
Land use	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2020-2023**	**2020-2023 vs. 2016-2019**
	ha					% change
Set-aside	2,496	400	0	0	0	0
Woodland	9,100	10,273	10,883	15,975	18,593	+16.4
Other (e.g. buildings, roads, ponds)	9,345	8,572	7,979	10,850	11,171	+3.0
Total other land	**20,941**	**19,246**	**18,862**	**26,825**	**29,763**	**+11.0**

It is not entirely clear why previously a trend of lower agricultural land area was evident between the 2008-2011 and 2012-2015 reporting periods as there was no evidence of significant land abandonment or compensating expansion in land use for non-agricultural purposes. The decline in reported agricultural area observed in 2012 may have been a consequence of changes in the way that some landowners reported short-term leasing relationships (conacre) 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 the 2016-2019 period supports this theory.

4.2 Action programme measures

The action programme measures contained in the 2019 NAP Regulations were detailed in the previous Article 10 report (2016-2019). As referred to in section 2.1, a revised action programme, applying to all farmers across Northern Ireland, came into operation on 11 April 2019. The 2019 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. However, it must only be spread when weather and soil conditions are suitable.

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 and including dirty water, 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 (with an average incline of 20% or more on grassland 15% or more on all other land) where other significant risks of water pollution exist. The risk factors to be considered include the proximity to waterways/lakes, type and amount of fertiliser to be applied, soil conditions, weather forecast and time to incorporation if applied to arable land.
  - On all other land (with an incline of less than 20% for grassland or less than 15% for all other land) where significant risks of water pollution exist. The risk factors to be considered include the proximity to waterways/lakes, amount to be applied, soil conditions, weather forecast and time to incorporation if applied to arable land.
- Prevent entry of fertilisers to waters and ensure application is accurate, uniform and not in a location or manner likely to cause entry to waters.
- All types of chemical fertiliser must not be applied within 2m of any waterway.
- Organic manures including dirty water must not be applied within:-
  - 20m of lakes;
  - 50m of a borehole, spring or well;
  - 250m of a borehole used for a public water supply;
  - 15m of exposed cavernous or karstified limestone features;
  - 10m of a waterway other than lakes; this distance may be reduced to 3m 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 50m in width and less than 15m3 in a single application.

- 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.
- From midnight 30 September - 15 October and during February:
  - The buffer zones for spreading slurry are increased:
    - from 10m to 15m of any waterway
    - from 20m to 30m for lakes
  - The maximum slurry application rate is reduced from 50m3 per ha (4500gal per ac) to 30m3 per ha (2700 gal per ac).
- 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.
- Low Emission Slurry Spreading Equipment (LESSE) includes bandspreading, dribble bar, trailing hose, trailing shoe, soil incorporation or soil injection methods. LESSE must be used: from 1 February 2020 for spreading anaerobic digestate, from 1 February 2021 by slurry spreading contractors and from 1 February 2022 on cattle farms with 200 or more cattle livestock units and pig farms with a total annual livestock manure nitrogen production of 20,000 kg or more from pigs.

- Where it is not practical to spread on a field using LESSE due to slope, slurry can be spread using an inverted splash plate on that field. A record of the field number and the reason for spreading using a splash plate must be kept for inspection.

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 specific additional criteria and conditions.

4.2.4 Nitrogen and Phosphorus Excretion Rates

- From 11 April 2019 revised nitrogen and phosphorus excretion rates for poultry production systems must be used.
- From 1 January 2020 revised nitrogen and phosphorus excretion rates for cattle must be used.

4.2.5 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.

4.2.6 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.

4.2.7 Phosphate Fertiliser Application Limits

- From 1 January 2020 new maximum phosphate fertiliser application rates (kg P2 O5 per ha) for extensively managed grassland (receiving under 60kg chemical N/ha/year or under 120kg manure N per ha per year loading) will apply.

4.2.8 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.
- When certain criteria are met there are allowances for out-wintering, animals on bedded accommodation, separated cattle slurry, renting additional tanks, poultry litter and anaerobic digestate fibre 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, poultry litter and anaerobic digestate fibre:
  - May be stored in middens with adequate effluent collection facilities.
  - May be stored in a field heap where they are to be applied, for a maximum of 120 days
  - Field storage of poultry litter and anaerobic digestate fibre must be notified to NIEA prior to placement in the field.
- FYM, poultry litter and anaerobic digestate fibre field heaps must not be stored:-
  - In the same location of the field year after year;
  - Within 50m of a borehole, spring or well;
  - Within 250m of a borehole used for a public water supply;
  - Within 50m of exposed cavernous or karstified limestone features;
  - On land that is waterlogged, flooded or likely to flood.
- FYM field heaps must not be stored within 20m of any waterway and 50m of lakes.
- Poultry litter and anaerobic digestate fibre field heaps must not be stored within 100m of lakes and 40m of any waterway.
- Poultry litter and anaerobic digestate fibre field heaps must be covered with an impermeable membrane as soon as possible and within 24 hours of placement in the field.
- Provide storage for dirty water during periods when conditions for land application are unsuitable.
- From 1 January 2020 new above ground slurry stores must be sited at least 50m from waterway and fitted with a cover.

4.2.9 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.
- From 1 January 2020 supplementary feeding sites must be a minimum of 20m from any waterway where there could be a significant risk of pollution occurring from their use.
- From 1 January 2022 supplementary livestock drinking points must be a minimum of 10m from any waterway where there could be a significant risk of pollution occurring from their use.

4.2.10 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.
- At least 50% of slurry produced on the holding must be applied by 15th June.
  After 15th June, slurry must be applied using Low Emission Slurry Spreading Equipment (LESSE).

4.2.11 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.
- From 1 January 2020 a fertilisation plan must be prepared and kept up to date by all grassland farms using chemical phosphorus fertiliser, and all farms using phosphorus rich manure e.g. some poultry manures, pig FYMs and anaerobic digestate. A soil analysis is required.
- From 1 January 2020 farms importing anaerobic digestate will require a nutrient content analysis.
- Storage capacity and, where applicable, details of rental agreements, authorisation to store poultry litter and or anaerobic digestate 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.

4.2.12 Cross-Compliance

All NAP measures are a Cross-Compliance requirement. This now includes the measures controlling the application of chemical phosphorus fertiliser to land.

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 limited the application of chemical P fertiliser to crop requirement, based upon a soil analysis, and introduced land application restrictions similar to those for N fertilisers. They also set values for P recommendations for grassland and P availabilities for organic manures. Following a review of the NAP 2015-2018, the decision was made to bring the Phosphorus Regulations under Cross Compliance to encourage farmers to make better use of P from organic manures generated on farm and only using chemical fertiliser containing P where there is a demonstrable agronomic need. Therefore the Phosphorus

Regulations were incorporated into the 2019–2022 Action Programme, and it was renamed from the 'Nitrates Action Programme' to the 'Nutrients Action Programme' to better reflect the nutrient management measures both on nitrogen and phosphorus, and its objectives.

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 2019 NAP Regulations which are published on the DAERA website.

The guidance documents include:-

- Summary of the changes to the Nutrients Action Programme 2019-2022
- NAP 2019-2022 Guidance Booklet
- NAP 2019-2022 Workbook
- NAP Derogation Guidance Booklet 2019 – 2022
- NAP Derogation fertilisation plan
- NAP Derogation fertilisation account

CAFRE also continue 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 Nutrient Action Programme Regulations (Northern Ireland) 2019 are 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.

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 NAP Regulations derogation are also inspected. Around 250 farm businesses are now selected for inspection each year. During the covid pandemic years of 2020 and 2021 theinspection rate wasreduced to 0.5%.

Tables 5.1 and 5.2 present data on compliance with the NAP Regulations from 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 the number of inspections, including referrals. The total number of inspections peaked in 2014 with 679 farms and was lowest (excepting the pandemic years of 2020 and 2021) in 2022 with 313 inspections being carried out representing 2.1% and 1.28% inspection rates respectively. In this reporting period 2020 - 2023 the total number of inspections leveled out with an annual average of 313 equating to 1.28%. The average number of referral inspections conducted in each year of this reporting period was 78, ranging from 93 in 2020 to 64 in 2022. All such referral reports are investigated by NIEA and enforcement action is taken when a breach of the 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 All inspections	2016 – 2019 All inspections	2020 - 2023 Scheduled inspections	2020 – 2023 All inspections
Number of farm businesses visited	2008 – 466 2009 – 453 2010 – 483 2011 – 648	2012 – 605 2013 – 598 2014 – 679 2015 – 402	2016 – 365 2017 – 336 2018 – 330 2019 – 352	2020 – 130 2021 – 133 2022 – 249 2023 – 247	2020 – 223 2021 – 220 2022 – 313 2023 – 314
Percentage of relevant farm businesses visited each year	2008 – 1.2 % 2009 – 1.2 % 2010 – 1.2 % 2011 – 1.7 %	2012 – 1.5 % 2013 – 1.6 % 2014 – 2.1 % 2015 – 1.3 %	2016 – 1.4% 2017 – 1.3% 2018 – 1.4% 2019 – 1.4%	2020 – 0.53% 2021 – 0.54% 2022 – 1.02% 2023 – 1.01%	2020 – 0.91% 2021 – 0.90% 2022 – 1.28% 2023 – 1.28%

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

Under the 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: Percentage of the inspected farm businesses compliant with the NAP Regulations

Reporting period	Compliance from all inspections: 2008 - 2011	Compliance from all inspections: 2012 - 2015	Compliance from all inspections: 2016 - 2019	Compliance from scheduled inspections: 2020 - 2023	Compliance from all inspections: 2020 - 2023
Closed spreading periods for chemical fertiliser	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%	2020 – 100% 2021 – 100% 2022 – 100% 2023 – 100%	2020 – 100% 2021 – 100% 2022 – 100% 2023 – 100%
Closed spreading periods for organic manures	2008 – 100 % 2009 – 98.5 % 2010 – 100 % 2011 – 100 %	2012 – 94.5 % 2013 – 99.5 % 2014 – 100 % 2015 – 99 %	2016 – 100% 2017 – 99.4% 2018 – 96.4% 2019 – 99.1%	2020 – 92.3% 2021 – 100% 2022 – 100% 2023 – 100%	2020 – 93.7% 2021 – 95.5% 2022 – 99.0% 2023 – 98.7%
Land Application Restrictions	2008 – 86 % 2009 – 90.5 % 2010 – 90 % 2011 – 90 %	2012 – 97 % 2013 – 95 % 2014 – 97 % 2015 – 94 %	2016 – 91% 2017 – 95.2% 2018 – 84.8% 2019 – 96.6%	2020 – 95.4% 2021 – 100% 2022 – 100% 2023 – 98.8%	2020 – 82.1% 2021 – 86.4% 2022 – 89.5% 2023 – 91.1%
Nitrogen fertilizer entering a waterway or water contained in underground strata	2008 – 89 % 2009 – 83 % 2010 – 80 % 2011 – 60 %	2012 – 75 % 2013 – 80 % 2014 – 72 % 2015 – 88 %	2016 – 78.6% 2017 – 83.9% 2018 – 79.7% 2019 – 77.8%	2020 – 90.8% 2021 – 94.7% 2022 – 97.6% 2023 – 91.1%	2020 – 61.9% 2021 – 70.0% 2022 – 83.7% 2023 – 77.7%
Nitrogen and Phosphate fertiliser crop requirement limits	2008 – 99.5 % 2009 – 98 % 2010 – 99 % 2011 – 98 %	2012 – 99 % 2013 – 99 % 2014 – 99 % 2015 – 99.5 %	2016 – 99.5% 2017 – 99.4% 2018 – 99.4% 2019 – 100%	2020 – N/A 2021 – N/A 2022 – 100% 2023 – 98.0%	2020 – N/A 2021 – N/A 2022 – 100% 2023 – 98.4%
Livestock manure nitrogen limits	2008 – 99 % 2009 – 89 % 2010 – 98 % 2011 – 97 %	2012 – 90 % 2013 – 95 % 2014 – 96 % 2015 – 97.5 %	2016 – 95.1% 2017 – 96.4% 2018 – 91.8% 2019 – 92%	2020 – 96.2% 2021 – 93.9% 2022 – 95.2% 2023 – 91.1%	2020 – 97.8% 2021 – 96.4% 2022 – 96.2% 2023 – 93.0%
Livestock manure storage requirements	2008 – 84 % 2009 – 84.5 % 2010 – 80.5 % 2011 – 62 %	2012 – 83 % 2013 – 82.5 % 2014 – 75 % 2015 – 87.5 %	2016 – 78.4% 2017 – 81% 2018 – 80% 2019 – 77%	2020 – 90.0% 2021 – 94.7% 2022 – 96.0% 2023 – 89.1%	2020 – 62.8% 2021 – 74.1% 2022 – 84.7% 2023 – 79.0%
Land management	2008 – 100 % 2009 – 100 % 2010 – 100 % 2011 – 100 %	2012 – 100 % 2013 – 100 % 2014 – 100 % 2015 – 100 %	2016 – 100% 2017 – 100% 2018 – 100% 2019 – 100%	2020 – 100% 2021 – 100% 2022 – 100% 2023 – 100%	2020 – 100% 2021 – 100% 2022 – 100% 2023 – 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 %	2016 – 98.1% 2017 – 92.6% 2018 – 94.8% 2019 – 96.6%	2020 – 95.4% 2021 – 94.7% 2022 – 93.9% 2023 – 73.7%	2020 – 97.3% 2021 – 95.5% 2022 – 87.2% 2023 – 79.3%

5.2. Commentary on points of difficulty regarding compliance

Table 5.2 shows the percentage of the inspected farm businesses compliant with NAP Regulations. A 100% compliance was recorded for both closed spreading periods for chemical fertiliser and land management in this and previous reporting periods. This is more likely to do with enforceability than compliance. Compliance with Nitrogen fertiliser crop requirement limits was also very high averaging 99.57% in this period.

The most frequent areas of non-compliance are related to water pollution and often associated with poorly managed or inadequate manure storage facilities, and exceeding livestock manure limits. A large increase in non-compliance in 2020 may have been due to lower maintenance in the first year of the pandemic. Nitrogen fertiliser entering a waterway or water contained in underground strata, resulting in pollution is the most common non-compliance issue found in referral inspections. This is not surprising as pollution impacts arising from discharges of farm effluents from poorly managed or inadequate manure storage facilities are recorded on a number of referral visits with pollution signs such as fungal growths being reported by members of the public.

There was an increase in non-compliance relating to record keeping in 2022 and 2023 which were mostly related to new requirements for fertilisation plans required from 2020. There was also an increase in those not submitting manure export records discovered at inspection when checking their N loading.

5.3. Measurable criteria for assessing the impact of the Nutrients 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 takes into account the livestock manure nitrogen that is produced on farms. Therefore, by setting 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 2019 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 DAERA (www.daera-ni.gov.uk/publications/statistical-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 2020-2023 with the previous reporting period 2016-2019. For further comparison data for 2000-2003, 2004-2007, 2008-2011, 2012-2015 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 (2022) are 77 kg/(ha/year) N, 8 kg/(ha/year) N less than in 2019.

Over the recent reporting period, the amount of nitrogen imported in feedstuffs has remained stable. As a consequence, the total amount of nitrogen entering the system has declined from 178 kg/(ha/year) N in 2019 to 168 kg/(ha/year) N in 2022, i.e. a 6 % decrease.

Alongside the decreased nitrogen inputs, outputs of nitrogen from agriculture, which are dominated by exports of meat and milk, increased from 43 kg/(ha/year) N in 2019 to 45 kg/(ha/year) N in 2022, and hence nitrogen efficiency within agriculture increased to 27%.

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 0.6 % in the current reporting period compared to the previous period causing a 1.1 % reduction in the N balance, which was driven by reduced N inputs and slightly higher feedstuff N inputs. However, outputs of nitrogen also increased by 1.7 % and as a result N efficiency increased slightly to 25 %.

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 decreased by 2.7% compared to the previous period, i.e. from about 139 to 135 kg/(ha/year), as a result of decline in N fertiliser inputs and a very small increase in feedstuff N inputs. However, it should be noted that this balance still remains substantially lower than previous peak N balances during the mid1990s which exceeded 165 kg/ha/year N.

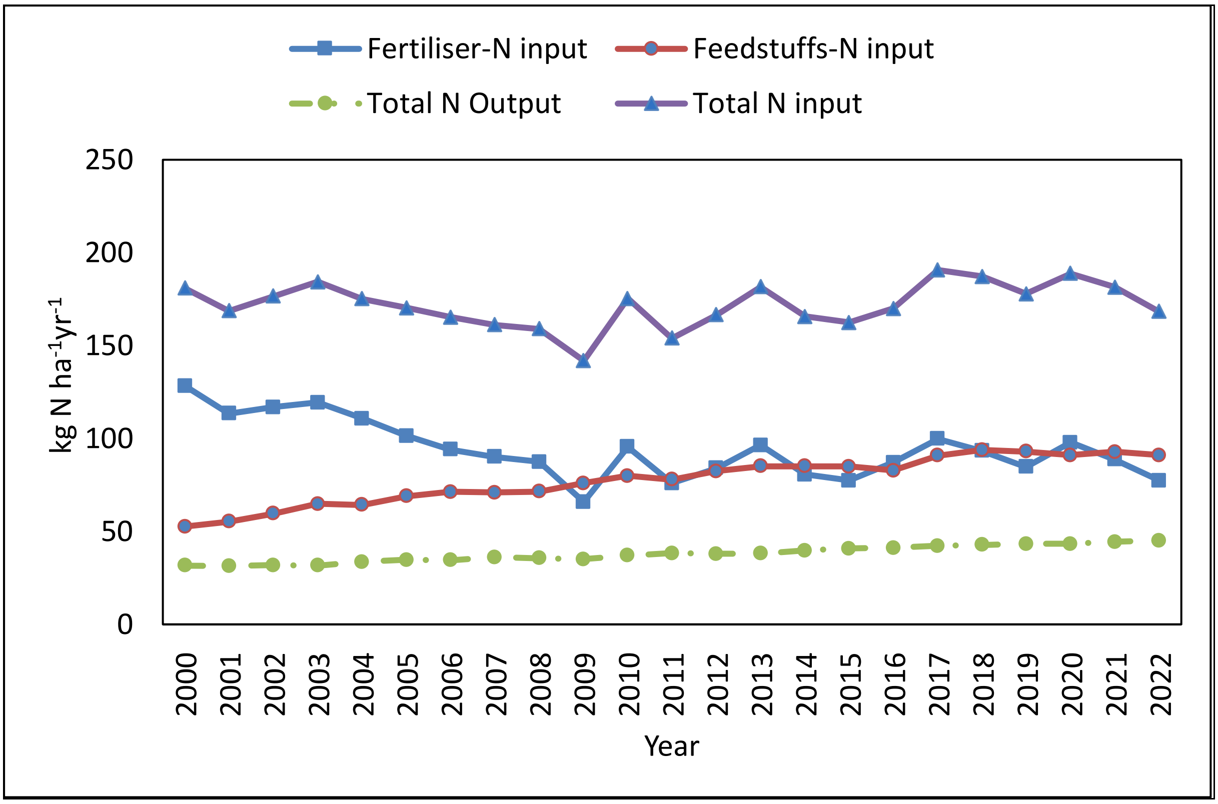

Figure 5.1 Time series of nitrogen (N) inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2022

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

Period	**2000-2003**	**2004-2007**	**2008-2011**	**2012-2015**	**2016-2019**	**2020-2022**	**2020-2022 vs. 2016-19**
	(tonnes N year^{-1})						(% change)
Input N							
Fertiliser N	107161	85827	68276	71042	77719	76086	2.1
Feed N	52136	59486	64152	70864	76764	79324	3.3
Total N inputs	159297	145313	132428	141905	154483	155410	0.6
N outputs	28378	30074	30635	32863	36081	38351	1.7
N balance	130919	115239	101792	109042	118403	117059	1.1
N effic' (%)	17.8	20.7	23.1	23.2	23.4	24.7	5.5

(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	2016-2019	2020-2022	2020-2022 vs. 2016-19
	(kg N ha^{-1} year-1)						(% change)
Input N							
Fertiliser N	119.5	99.1	81.2	85.1	91.3	87.9	3.7
Feed N	58.1	68.9	76.5	84.4	90.4	91.6	1.7
Total N inputs	177.6	168.0	157.7	169.0	181.6	179.6	1.0
N outputs	31.6	34.8	36.3	39.1	42.4	44.3	4.5
N balance	146.0	133.2	121.4	129.9	139.2	135.3	2.7
N efficiency (%)	17.8	20.8	23.1	23.2	23.4	24.7	5.6

Although nitrogen inputs have increased in recent years and caused dips in N efficiency in 2013 and 2017, as already noted, in the last couple of years, N inputs have begun to decline again (Figure 5.1), and N efficiency is currently 24.7 %, i.e. its highest level since 2015 (Figure 5.2).

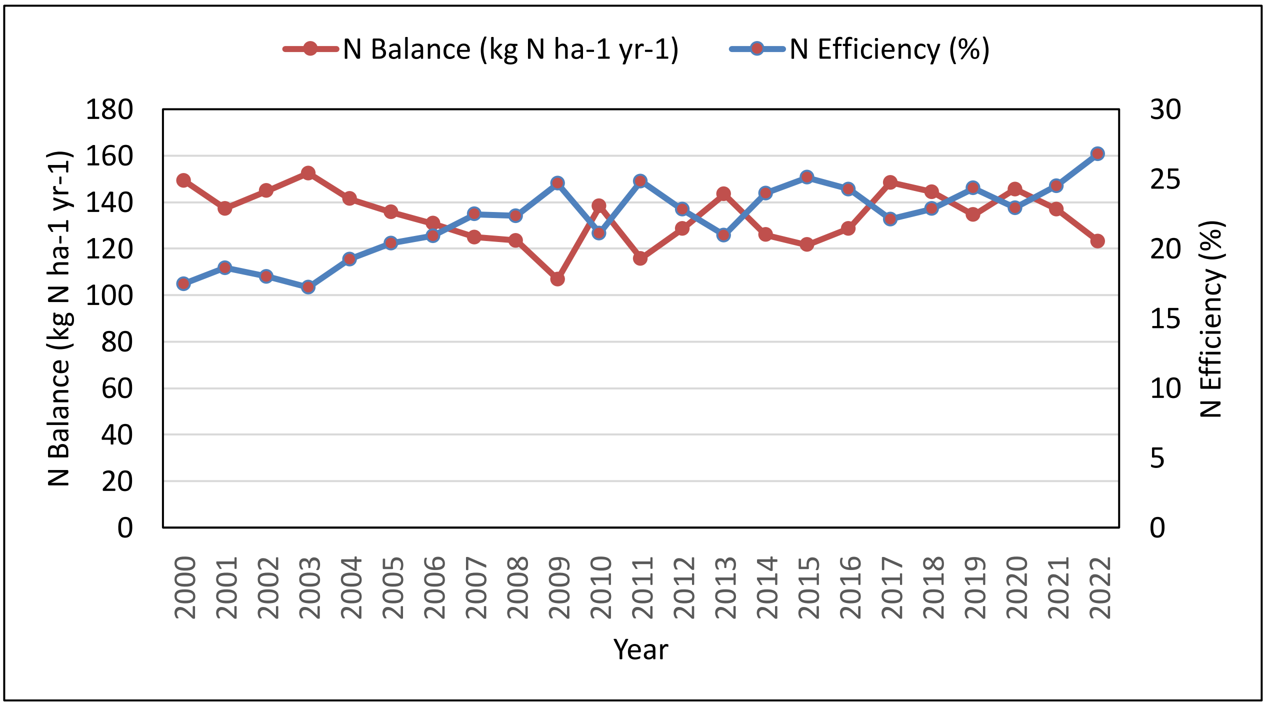

Figure 5.2 Time series of nitrogen (N) balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2022. (Data normalised to the area of crops and grass)

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 as means of lowering P inputs to farms. While this strategy, in theory, may lead to some increases in fertiliser N inputs, i.e. to produce more grass and forage of higher protein and energy content, the opposite has occurred with a notable decline in purchased N fertiliser. The main reason for this is the increase in fertiliser prices.

The need to control phosphorus (P) as well as nitrogen has also been a key message of advice, workshops and the consultative process. However, it is now being given greater emphasis to try to counteract a trend in increased feedstuff and fertiliser P inputs over the last few years which has resulted in increased levels of SRP in rivers and lakes.

Figure 5.3 shows the time series of inputs and outputs of P to Northern Ireland Agriculture from 2000 until 2022. 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 between 4.0 and 5.0 kg/(ha/year) P in 2014-2015 and 202-2022 (Figure 5.3). Feedstuffs P inputs which declined between 2006 and 2008 have been increasing since then and are currently at 17.2 kg/(ha/year) P in 2020-2022. As a result, total P inputs are currently about 21 kg/(ha/year) P.

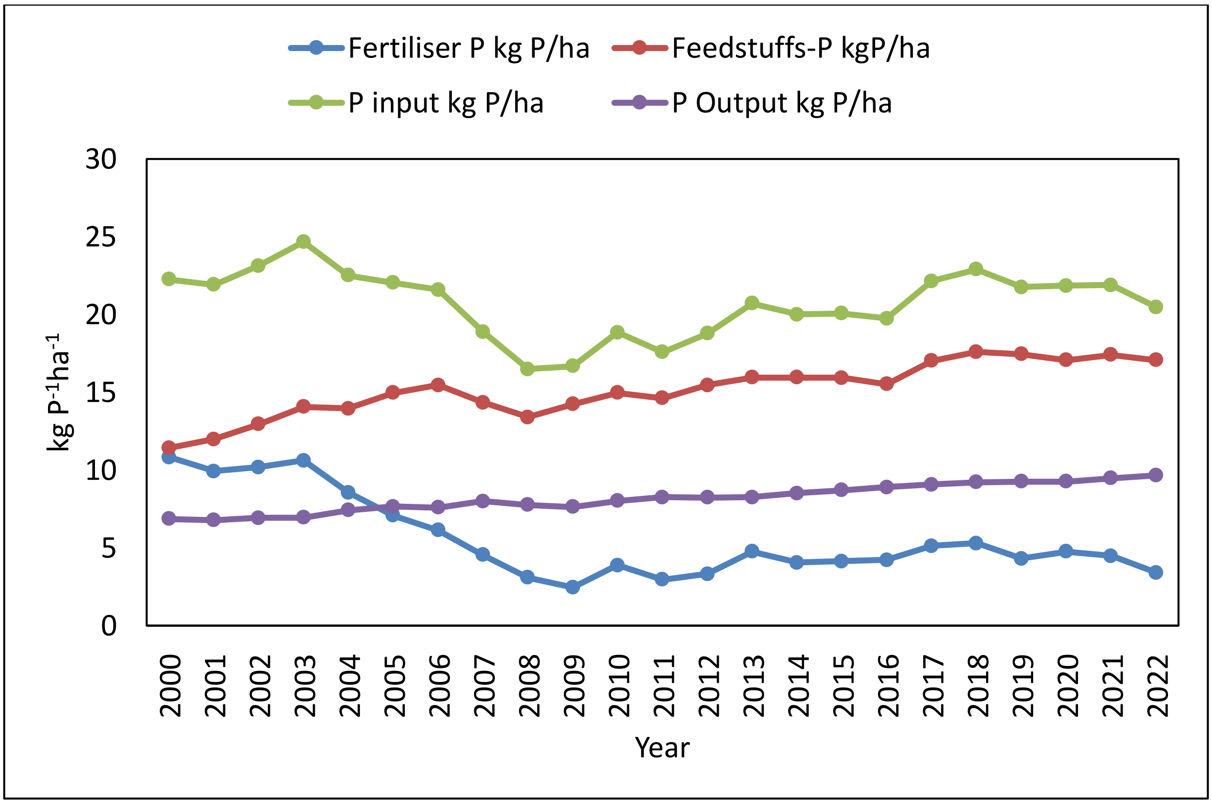

Figure 5.3 Time series of phosphorus inputs and outputs for agriculture in Northern Ireland for the years 2000 to 2022. (Data normalised to the area of crops and grass)

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 is now 47% in 2022, 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 a pressing need for significant reductions in the agricultural P surplus to improve water quality.

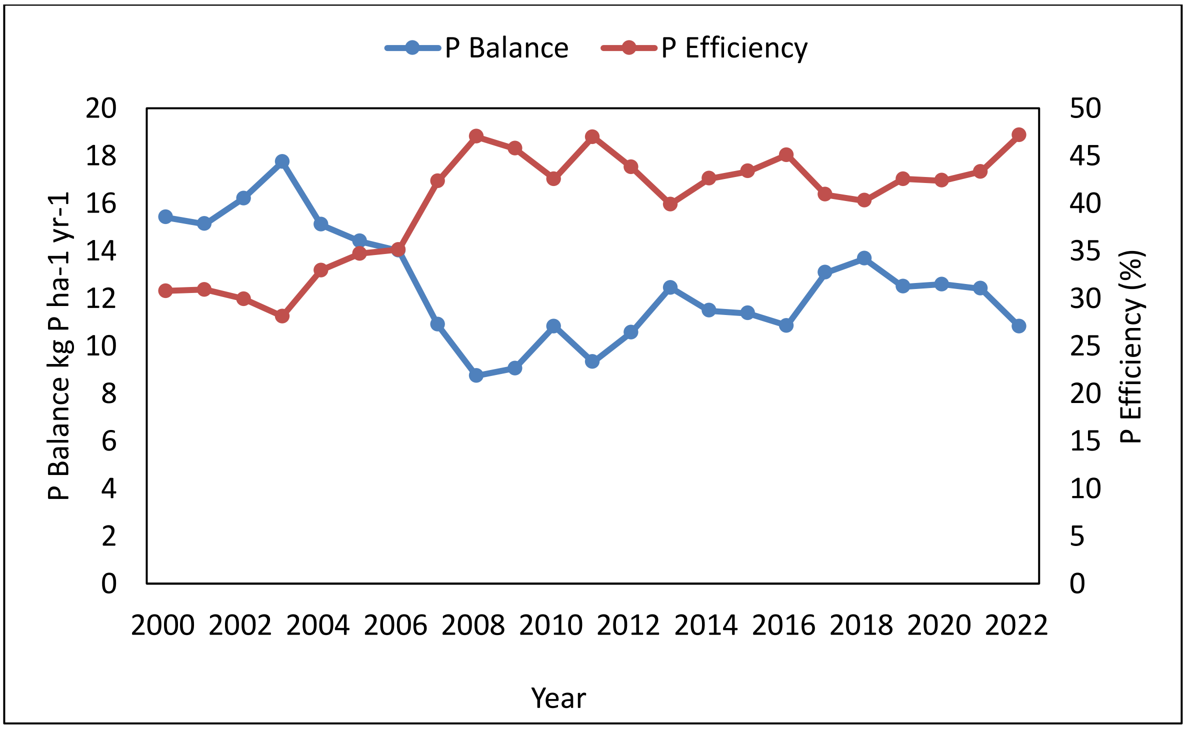

Figure 5.4 Time series of phosphorus balance and efficiency for agriculture in Northern Ireland for the years 2000 to 2022

5.5 Individual cost effectiveness studies

Some measures in the 2019 NAP Regulations go beyond the measures set out in Article 4(1) (a) and Annex III of the ND, such as the mandatory requirement for the use of Low Emission Slurry Spreading Equipment (LESSE) for farms that meet certain criteria. Therefore, studies on cost effectiveness of measures under Article 5(5) of the ND are part of the 2019 Regulatory Impact Assessment (RIA) listed below.

As part of the development of the 2019 NAP Regulations, a Regulatory Impact Assessment (RIA) was carried out. This examined different options for revisions to the 2019 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 at:-
http://www.legislation.gov.uk/ukia/2019/121/pdfs/ukia_20190121_en.pdf

In addition, the Northern Ireland 2019 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.

6. Forecasting future water quality

The ND requires an estimate of 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 2027. The latter depend on estimates of livestock numbers for 2027 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 2027.

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

In the previous 2020 Article 10 Report, the total area of agricultural land in Northern Ireland was predicted to increase by 260 km^2 between 2019 and 2023 and to increase the area available for manure application by 62 km^2 as most of the changes were projected in rough grazing or forestry. In reality, the agricultural area increased by 192 km^2, with the area available for manure application increasing by 161 km^2, with the remaining difference associated with a reduction in the area of rough grazing (-16 km^2), and expansion in woodland (+37 km^2) and other land (+10 km^2) (see summary in Table 6.1; based on data for 2019 and 2023 taken from DAERA Statistical Review of Northern Ireland Agriculture 2023).

From the implementation of the industry-led Going for Growth strategy in 2013 the total agricultural area has continued to increase (by ~0.6%/year) over the last decade. However, production-focussed strategies are unlikely to be the only driver going forward, with growing awareness of the impact and need for mitigation of the environmental impacts of agriculture on water, air quality, and GHG emissions. The Green Growth strategy which will focus on climate and environmental action is planned for submission to the NI Executive in autumn 2024. In addition, the shift from the area-based Basic Payment subsidy for farms to a number of schemes focussed on delivering biodiversity, carbon and environmental benefits may lead to a shift in focus from increasing production.

In the previous Article 10 Report, it was predicted that total Nitrogen (N) excretion by animals would decrease by 1.8 % by 2023, and in reality it increased by 2.5 %, with increases across the cattle, sheep, pig and poultry sectors. The biggest increase was in the poultry sector (+4.1%) and least in pigs (0.9%).

Looking forward to 2027, results from the Food and Agricultural Policy Research Institute (FAPRI) UK model are projecting a small 0.4% decrease in cattle numbers so it is likely that neither the total agricultural area nor the area of land available for manure application will increase (and may indeed decline). It is predicted that the total area of permanent grass will remain unchanged by 2027, but that the arable area will decline by 3.9% (for cereals and oil seed rape) to 459 km^2. Projected reductions in cattle numbers, if realised, will result in a relatively small 272 tonne N/year reduction in emissions from 75,017 tonnes N/year in 2023 to 74,744 tonne N/year (-0.36%). With an increase in sheep (+1.7% for ewes; +2.7% for other sheep) and only slight reductions in pig (-1.6%) and poultry (-1.24%) projected, the overall emissions change for all livestock will reduce by only 0.49%. It should be noted, however, that the FAPRI model assumes that there are no changes in policy and that weather remains relatively constant for the period.

Fertiliser N usage over the past decade has fluctuated interannually (range 77.3 - 99.9 over 2014 - 2022) but with no clear trend. Lowest annual usage was in 2022 (77.3 km N/ha) and was associated with the high prices in that year, which have since fallen. If more livestock products are to be produced from grass and less from imported N and P containing feedstuffs then it is possible that usage might increase. However, increasing integration of clover mix in swards, and in sowing multi-species swards should help to effect some reduction in dependency on chemical N. 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 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 2023

	2019 (Actual from Census 2023)	**2023 (Actual from Census 2023)**	**Prediction for 2027**	**Units**
Agricultural area	10,232	10,433	10,433	km^2
Agricultural area available for manure application	8,536	8,697	8,697	km^2
Change in farming practices				
Permanent pasture	8,087	8,219	8,219	km^2
Arable crops	449	478	459	km^2
	N excretion by livestock (from Census 2019, 2023)		**Predicted N excretion**	
Cattle	72,223	75,017	74,744	tonnes /yr
Sheep	13,271	13,682	13,969	tonnes /yr
Pigs	3,786	3,818	3,752	tonnes /yr
Poultry	7,342	7,644	7,549	tonnes /yr
Horses + Ponies	435	317	317	tonnes /yr
Goats	41	32	32	tonnes /yr
Total	98,098	100,510	100,363	tonnes /yr

6.3. Forecast of diffuse nutrient loss from agricultural land

Due to their contribution to freshwater and marine eutrophication, losses of nutrients (nitrate and phosphate) via drainage and surface runoff from agricultural sources potentially have a major detrimental impact on water quality within Northern Ireland. Efforts have been ongoing to control nutrient loss from agriculture and the NAP regulations apply to all farms within Northern Ireland.

Trends in nutrient concentration and load

AFBI fortnightly to weekly stream water nitrate-nitrogen (NO_3-N) and soluble reactive phosphorus (SRP) concentrations data were combined with public daily discharge data (UK National River Flow Archive) to analyse trends in nutrient concentration and loading over the period 2005-2022 (accounting for differences in runoff/precipitation between years; Hirsch et al. 2010). The analysis was conducted for the principal rivers draining to Lough Neagh, and the Colebrooke and Bush catchment rivers. Together these catchments are considered to provide a regionally representative picture of water quality trends. This trend analysis was used to determine periods that are distinct in terms of nutrient export, and for which nutrient export coefficients were then derived and compared. Following this methodology, nutrient export coefficients were reported in the preceding report for the periods 2005-2010 and 2010-2016. This trend analysis has been updated (**Figures 6.1** and **6.2**) for the current report to include a third period 2016-2022.

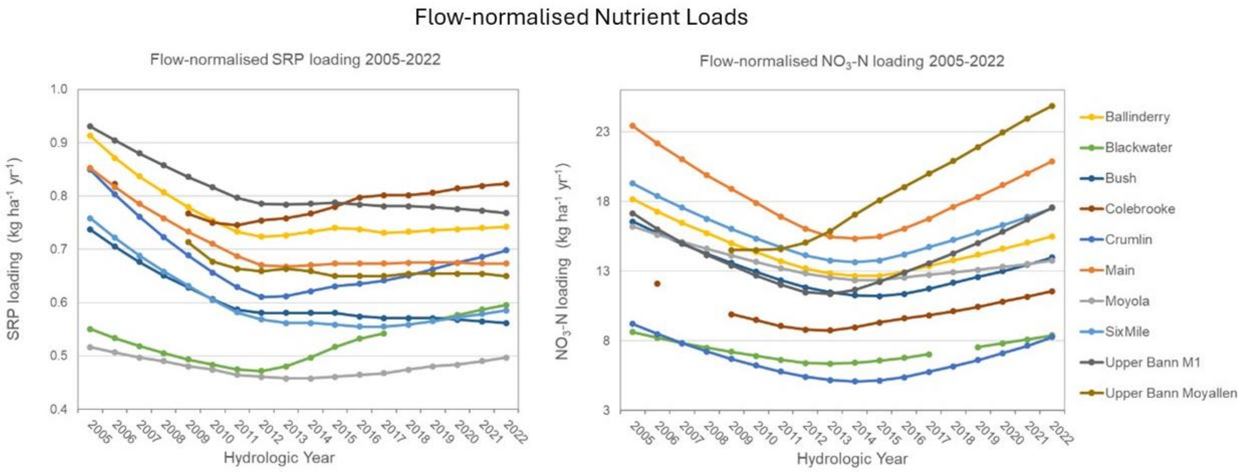

Figure 6.1 Time-series of flow-normalised SRP (left panel) and NO_3-N (right panel) load (kg/ha/year) for rivers draining to Lough Neagh, and the Colebrooke and Bush catchment rivers. Note: loadings include the contribution of wastewater.

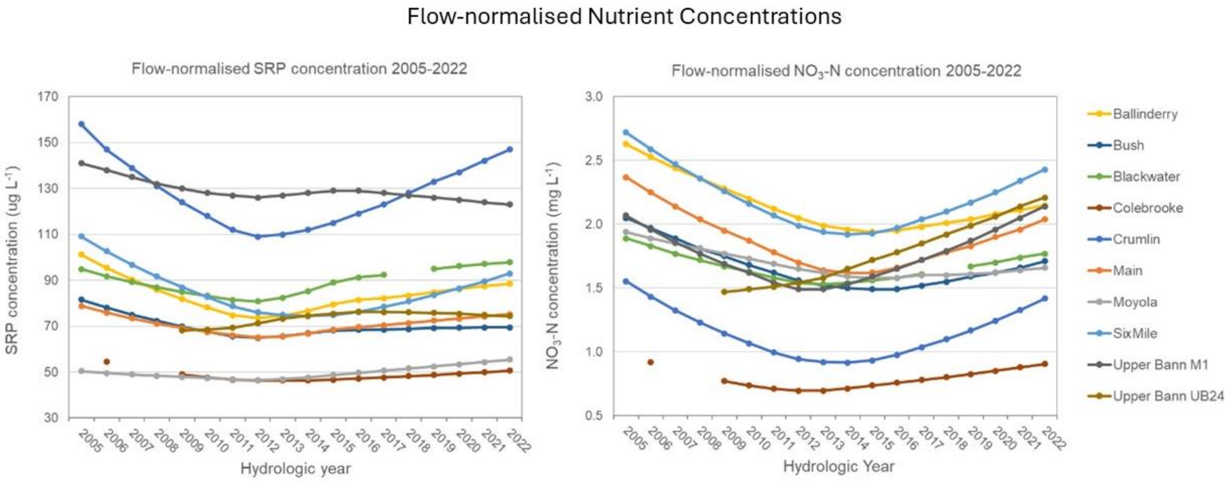

Figure 6.2 Time-series of flow-normalised average SRP (left panel) and NO_3-N (right panel) concentration (mg/L) for rivers draining to Lough Neagh, and the Colebrooke and Bush catchment rivers. Note: concentrations include the contribution of wastewater.

Nutrient Export Coefficients

For each period, the yearly average nutrient (SRP or NO_3-N) loading (kg year^{-1}) was computed for a set of 65 catchments covering the whole of the region and for which daily discharge and AFBI or NIEA monthly (or more frequent) nutrient concentration data were available. Flow-normalised loads were used to account for differences in runoff/precipitation and the contribution of wastewater as determined from postcode level census data for each catchment was removed to leave only the assumed contribution from land. The population census for 2011 was used for Period 1 and 2; and the 2021 Census for Period 3.
UK CEH 2021 land cover data for Northern Ireland (Marsden et al., 2022) were used to calculate the respective areas (ha) of the different land cover categories for each catchment. This higher resolution data set replaces the 1990 CORINE land cover that was used in previous modelling. For areas of catchments within the Republic of Ireland CORINE 2018 land cover data were used. Land cover is assumed to be static over the modelling period as examination of available land cover data sets (CEH 2007, 2015, 2018) indicated that differences in the resolution and classification methods brought in more variability than actual changes in land cover.

Multiple Linear Regression models were then developed for each period using the catchment areas (ha) of the land cover categories as predictors of the yearly average nutrient loading (kg/year) exiting the catchment. Different models were developed for SRP and NO_3-N, and only land cover categories showing a statistically significant effect on SRP/NO_3-N loadings were included in the models. The regression coefficients of the models were the SRP/NO_3-N Export Coefficients (kg/ha/year) and are given in **Table 6.2** below. The value of the export coefficient indicates the intensity of nutrient export from the land use category.

In the previous report, SRP and NO_3-N export coefficients for Periods 1 and 2 were derived using CORINE 1990 land cover data. These coefficients have been updated using the more accurate UK CEH 2021 land cover data. Land cover classes were grouped in line with the previous analysis with Broadleaf Woodland, Mountain, Heath and Bog in a single class representing land with no agricultural nutrient inputs.

Table 6.2: Nutrient Export Coefficients (kg/ha/year) (statistically significant only) for the periods 2005-2010, 2010-2016 and 2016-2022 and the percentage of change between Period 2 and Period 3.

NO_3-N Coefficients (kg/ha/year**)**

Land cover category	Period 1 2005-2010	Period 2 2010-2016	Period 3 2016-2022	% Change Period 3 vs. Period 2
Arable	48.62	72.13	69.07	-4.2
Improved Grassland	11.81	8.98	10.04	+11.8
Semi-natural Grassland	-	7.68	4.14	-46.1
Broadleaf Woodland, Mountain, Heath and Bog	4.65	-	-	-

SRP Coefficients (kg P/ha/year**)**

Land cover category	Period 1 2005-2010	Period 2 2010-2016	Period 3 2016-2022	% Change Period 3 vs. Period 2
Coniferous Woodland	0.40	-	0.59	-
Improved Grassland	0.52	0.63	0.52	-17.5

For all 3 periods,
Arable land generated the highest NO_3-N export, followed by Improved Grassland. The NO_3-N export from Arable land decreased slightly from Period 2 to Period 3 while the export from Improved Grassland increased over the same period. Semi-natural Grassland NO_3-N export decreased by 46.1% from Period 2 to Period 3. In Period 3, NO3-N export from Arable land was 7 times higher than the export from Improved Grassland.

For the 3 periods, Improved Grassland exported significant SRP load. SRP export from Improved Grassland decreased by 17.5% from Period 2 to Period 3 and was similar in Periods 1 and 3. In Period 3, Coniferous Woodland generated significant SRP load, the SRP export from Coniferous Woodland was slightly higher than the export from Improved Grassland.

Nutrient export across Northern Irish catchments

The export coefficients derived from the analysis were applied to 84 catchments covering all major river systems in NI and inflowing cross-border catchments (in the Foyle, Erne and Neagh-Bann systems). For each catchment the area (ha) of each land cover category was determined beforehand, and the export coefficients from the preceding analysis applied to provide modelled estimates of NO_3-N and SRP export (kg $year^{-1}$) As only nutrient export from land cover categories showing a statistically significant ($p<0.05$) effect on nutrient loading was accounted in the calculation, this likely underestimates the total nutrient export but still gives an overview of the spatial variations in nutrient export across the region. The area-normalised nutrient export (kg/ha/year) for each period and catchment is shown in **Figures 6.3** and **6.4**. The total nutrient export for the whole region over each period is shown in **Table 6.3**.

The maps shown in Figure 6.3, indicate that between Period 2 (2010-2016) and Period 3 (2016-2022) there was no noticeable change in NO_3-N export from the southeastern catchments in Co. Down. These catchments have a higher than typical percentage of arable land, and the minor change in the export coefficient associated with this land cover has led to this relative stability. Nitrate-nitrogen export in in Period 3 the other areas remained broadly the same as in Period 1 and decreased for catchments where Semi-natural Grassland was the dominant land cover (e.g. Roe, Moyola, Ballinamallard or Sillees catchments) and increased for catchments with a high proportion of Improved Grassland (e.g. Callan catchment).

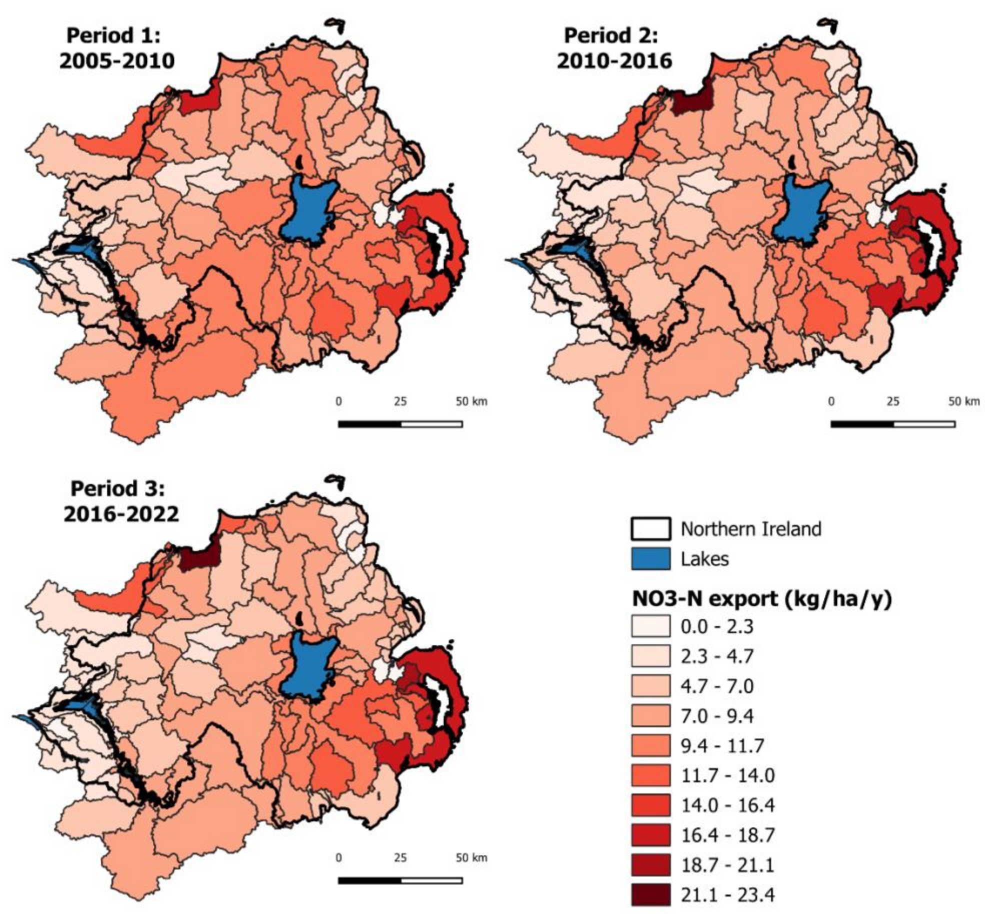

Figure 6.3 Maps showing NO_3-N export (kg/ha/year) in 84 river catchments in Northern Ireland (and inflowing cross-border catchments) over three consecutive periods – Period 1 (2005-2010), Period 2 (2010-2016) and Period 3 (2016-2022).

The maps shown in Figure 6.4 indicate that between Period 2 (2010-2016) and Period 3 (2016-2022) there was a slight decrease in SRP export from the southern and eastern catchments (e.g. Cusher, Crumlin, Main or Lower Bann catchments). These catchments are dominated by Improved Grassland, and the decrease in the export coefficient associated with this land cover has led to this reduction. The SRP export from the western catchments (e.g. Owenkillew, Colebrooke) increased in Period 3 compared to Period 2, it reflects the significant effect of the Coniferous Woodland area in these catchments on SRP export. Fertiliser is part of the commercial forestry process but generally in the early stages of development so further analysis should examine the age of plantations to confirm this.

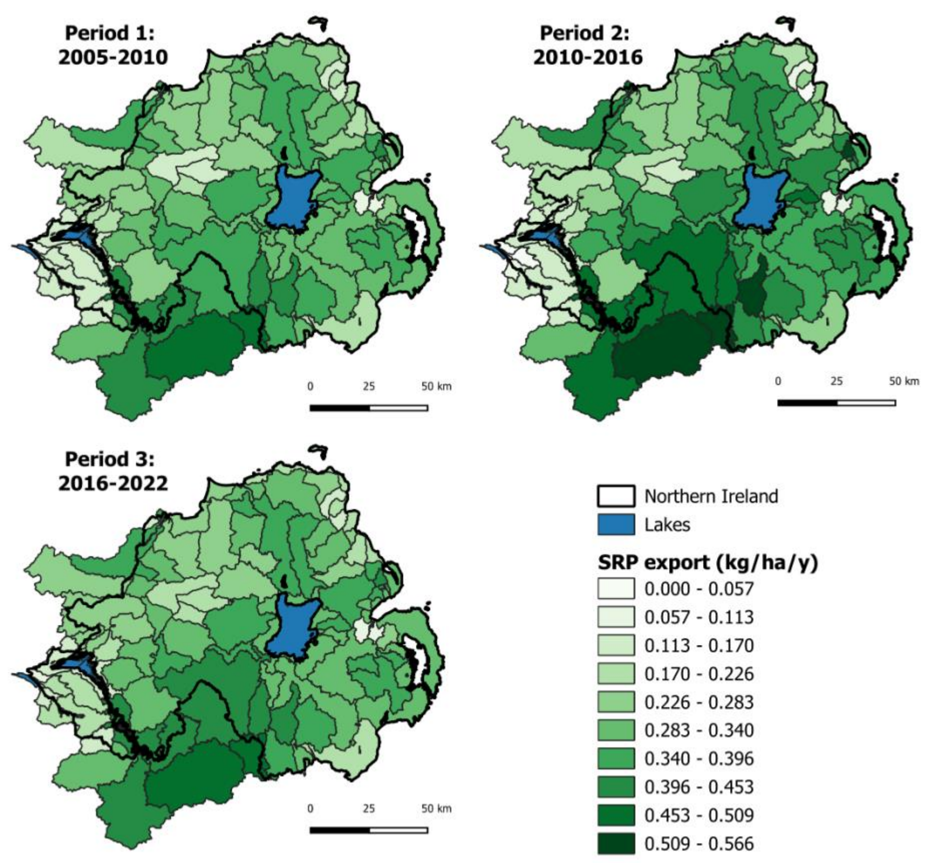

Figure 6.4 Maps showing SRP export (kg/ha/year) in 84 river catchments in Northern Ireland (and inflowing cross-border catchments) over three consecutive periods – Period 1 (2005-2010), Period 2 (2010-2016) and Period 3 (2016-2022).

Table 6.3: Total nutrient export (tonnes/yea^{-1}) from land across Northern Ireland (and inflowing RoI catchments) for the periods 2005-2010, 2010-2016 and 2016-2022 and the change between Period 2 and Period 3.

	Nutrient Export			**Change Period 3 vs. Period 2**		
	Period 1	Period 2	Period 3			
	tonnes/year			tonnes/year	**kg/ha/year**	%
NO_3-N	15,302	15,139	14,861	-278	-0.16	-2
SRP	539	527	503	-24	-0.01	-5

The accurate classification of land use is critical and in those catchment areas within RoI the reduction in resolution in the CORINE 2018 data sets may have over/underestimated the cover of different land cover types and thus the estimated loading. The ability to better classify fields according to management intensity and nutrient loading, providing sub-classes within the generic “Improved Grassland”, would also be an important development and may be facilitated by soil nutrient data available through the Soil Nutrient Health Scheme for NI, which concludes in 2026. There is also likely to be some underestimation of loads as a result of sampling at weekly or lower frequencies, given that the majority of annual loads in NI rivers are associated (particularly for P) with short duration storm events that have a low likelihood of being sampled. The interannual variability in loads due to weather and other short-term fluctuations such as fertiliser pricing is not captured using this approach.

Inter-annual variability in nutrient export

The average annual NO_3-N and SRP export modelled for Period 3 (2016-2022) from nutrient export coefficients for the Upper Bann catchment was compared with the annual nutrient export calculated from 7-hourly measurements of stream water NO_3-N and SRP concentrations in two Upper Bann sub-catchments (UB03 – an intensively farmed improved grassland catchment; and UB15a a less intensively farmed catchment with no land in derogation) monitored since 2018 to evaluate the effectiveness of the Nutrients Action Programme regulations (**Table 6.4**).

The modelled average nutrient export over 2016-2022 for the Upper Bann catchment coincides with the range of annual nutrient export observed between 2018 and 2022 for the Upper Bann sub-catchments. Nutrient export, however, is highly variable between years due to variations in weather conditions. Rainfall events can explain a large proportion of the total annual nutrient export, especially for phosphorus.

Table 6.4: Comparison of nutrient export (kg/ha/year) modelled for the Upper Bann catchment from nutrient export coefficients and calculated for two Upper Bann sub-catchments from 7-hourly NO3-N and SRP measurements.

	NO3-N load			SRP load		
	Upper Bann	UB03	UB15a	Upper Bann	UB03	UB15a
	kg/ha/year			kg/ha/year		
Period 3 2016-2022	11.1	-	-	0.33	-	-
2018-2019	-	23.4	17.4	-	0.47	0.39
2019-2020	-	14.2	14.9	-	0.63	0.52
2020-2021	-	12.9	12.6	-	0.53	0.44
2021-2022	-	9.2	11.6	-	0.17	0.14

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 2027 and 2031 using long term averages from 135 and 129 monitoring sites respectively between 1992 and 2023. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of nitrate in 2027 and 2031 is shown in the Technical Annex.

Table 6.5: Nitrate concentrations (NO_3 mg/l) in surface waters: Forecast for 2027 and 2031

	% of points (NO_3 mg/l)				
	0 – 9.99	**10 – 24.99**	**25 – 39.99**	**40 – 49.99**	**> 50**
Surface water annual average in 2027 (n=135)	77.0	19.3	2.2	0.7	0.7
Surface water annual average in 2031 (n=129)	75.2	21.7	1.6	0.8	0.8

Results from trend analysis shown in Table 6.5 indicate that in 2027 96.3% and in 2031, 96.9% of average nitrate concentrations are predicted to be below 25 mg/l NO_3.

Table 6.6: Predicted trends in annual average surface water Nitrate concentrations (NO_3 mg/l) in rivers (change between 2020-2023 and 2027 and 2031).

	% of points (based on mg/l difference)				
	Strong decrease	**Weak decrease**	**Stable**	**Weak increase**	**Strong increase**
Surface water annual average in 2027 (n=135)	0	26.7	53.3	14.1	5.9
Surface water annual average in 2031 (n=129)	0	34.1	42.6	15.5	7.8

Based on mg/l difference - Strong Decrease = < -5; Weak Decrease = ≥ -5 to < -1; Stable = ≥ -1 to ≤ +1; Weak Increase = > +1 to ≤+5; Strong Increase = > +5

Information on the trend of average concentrations in rivers between 2020-2023 and 2027 and 2031 (Table 6.6 and Figures 6.5 and 6.6) indicates that there will be a 26.7 % decrease and 53.3 % stabilisation across all sites in the next four years to 2027. Predictions of trend of nitrate concentrations for 2031 indicate that 76.7 % 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.

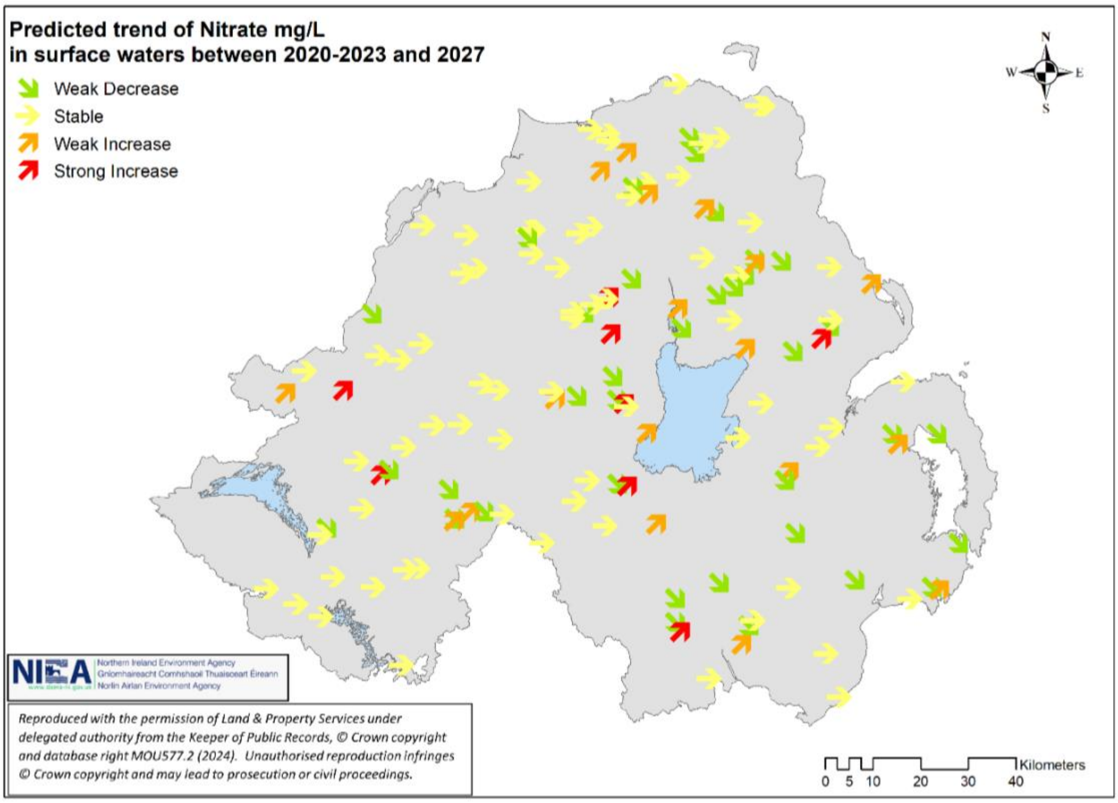

Figure 6.5: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2020-2023 and 2027

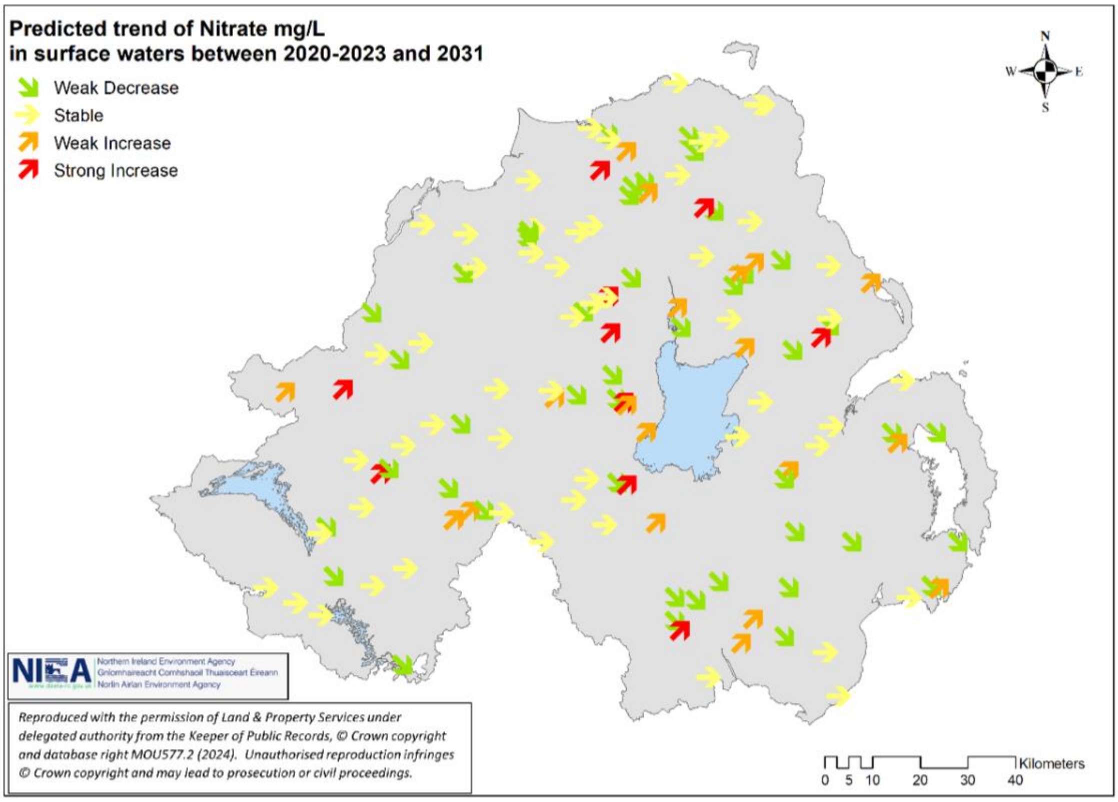

Figure 6.6: Trends of predicted Nitrate concentrations (NO_3 mg/l) in rivers between 2020-2023 and 2031

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 2027 and 2031 using long term averages between 1998 and 2023. Predictions for 2027 and 2031 are presented for 26 monitoring stations common with the

2020-2023 reporting period. The methodology describing how raw surface water monitoring data was analysed to predict the concentrations of phosphorus in 2027 and 2031 is shown in the Technical Annex.

Table 6.7: WFD phosphorus classification in rivers: Forecast for 2027 and 2031

	% of points				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Rivers SRP WFD classification 2027 (n=26)	15.4	42.3	42.3	0	0
Rivers SRP WFD classification 2031 (n=26)	15.4	42.3	42.3	0	0

Results from predicted trend analysis shown in Table 6.7 indicate that 57.7 % of river sites are predicted to be High or Good status for SRP classification in 2027 and 2031. 42.3 % of river sites are predicted to be less than Good status for SRP classification in 2027 and 2031.

Table 6.8: Predicted trends in WFD phosphorus classifications in rivers (change between 2020-2003 and 2027 and 2031)

	% of points				
	Strong decrease[1]	**Weak decrease[2]**	**Stable[3]**	**Weak increase[4]**	**Strong increase[5]**
Rivers SRP WFD classification 2027 (n=26)	0	11.5	84.6	3.8	0
Rivers SRP WFD classification 2031 (n=26)	0	11.5	84.6	3.8	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

The trend of WFD phosphorus classification in rivers between the current reporting period, 2020-2003 and 2027 and 2031 (Table 6.8 and Figures 6.7 and 6.8) indicates in the next four years to 2027, there will be an 11.5 % decrease and 84.6 % stabilisation across all sites. 3.8 % of sites are expected to deteriorate by one class. Predictions of trend of phosphorus concentrations for 2031 indicate that that there will be a 11.5 % decrease and 84.6 % stabilisation across all sites. 3.8 % of sites are expected to deteriorate by one class.

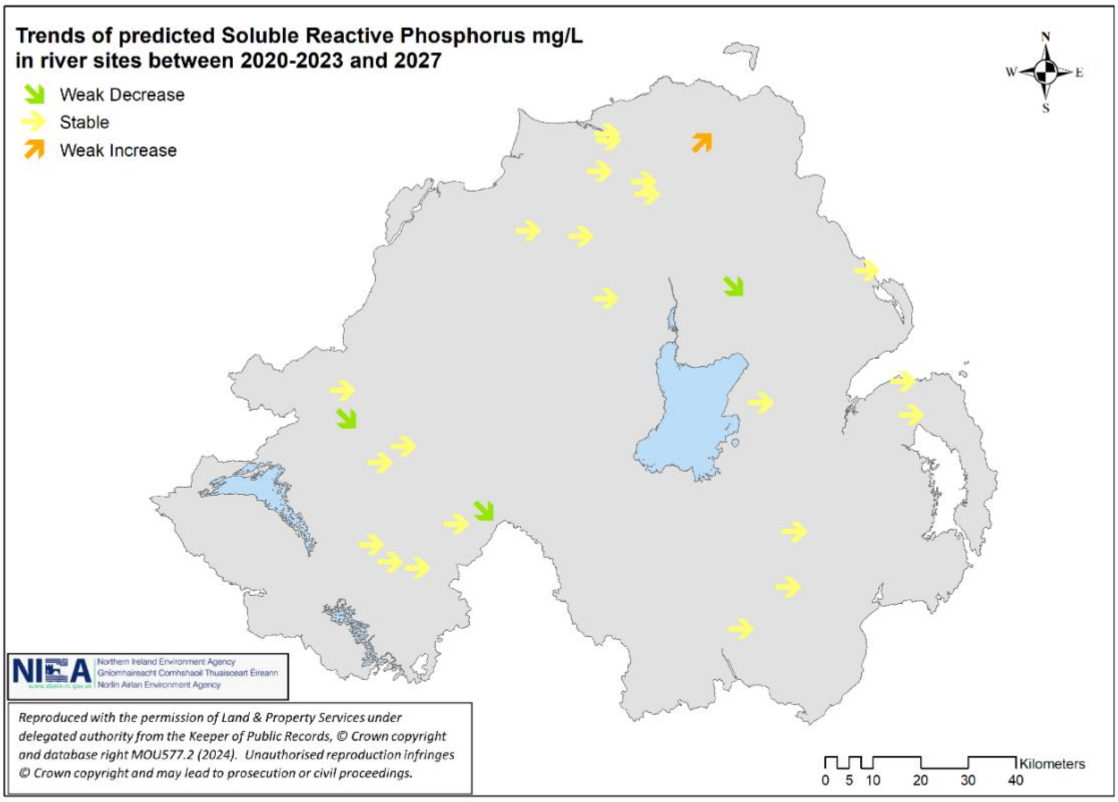

Figure 6.7: Trends of predicted Soluble Reactive Phosphorus (mg/l) in rivers between 2020-2023 and 2027.

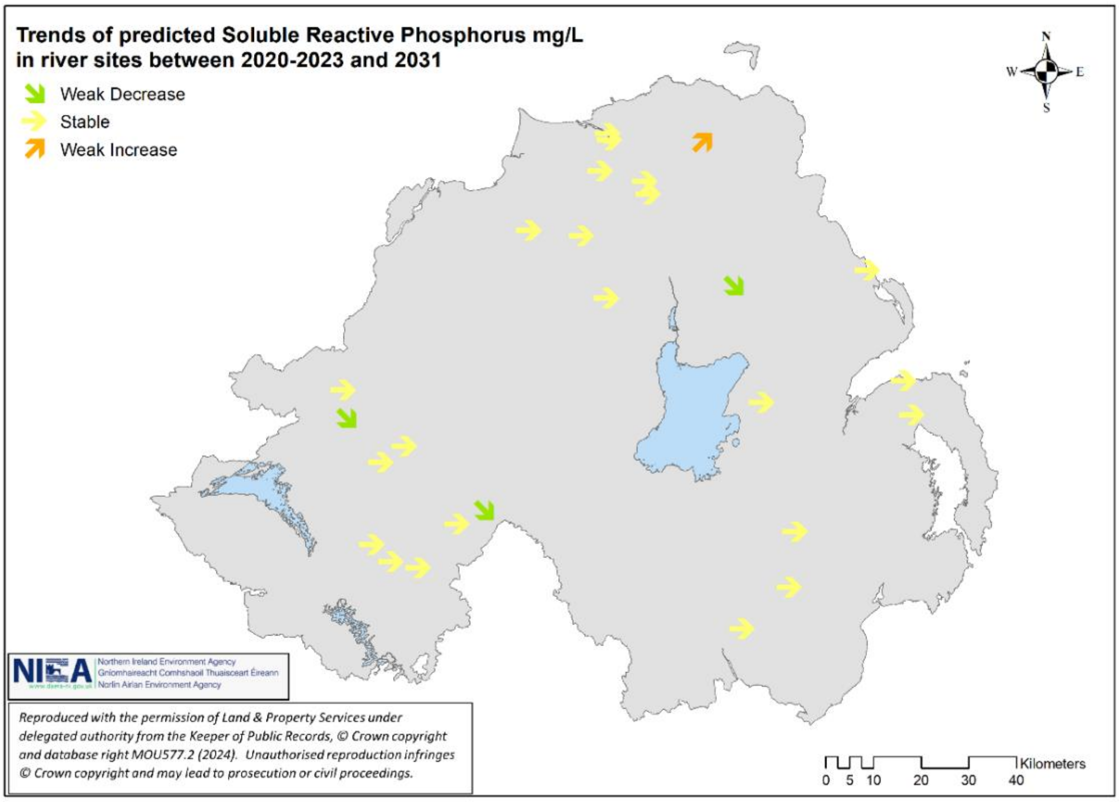

Figure 6.8: Trends of predicted Soluble Reactive Phosphorus (mg/l) in rivers between 2020-2023 and 2031.

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. 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 shows that one groundwater monitoring site has a statistically significant increasing trend. The site code is UKGBNIGWNE17-C. For the reporting period 2020-2023 the average nitrate concentration was 13.99mg/l for the period 2020-2023 and the maximum was 27.12mg/l. The predicted concentration for 2027/2031 are 28.8mg/l and 35.4mg/l respectively.

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APPENDIX – Modified Groundwater and Surface Water Monitoring Stations

Removed stations	
National station code (NationalStationCode)	UKGBNIGWNB06-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	20134
Longitude	305000
Latitude	404000
Last annual average nitrate concentrations	1.14
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[4]	1.29
Other (please specify)	Sampling Access Removed
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode) **groundwater (0-5m)**	None Identified
Station Type **(StationType)**	
National station name **(NationalStationName)**	
Longitude	
Latitude	
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	

[4] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed stations	
National station code (NationalStationCode)	UKGBNIGWNB08-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	20135
Longitude	313000
Latitude	404000
Last annual average nitrate concentrations	9.54
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[5]	9.31
Other (please specify)	Sampling Access Removed
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode) **groundwater (0-5m)**	None Identified
Station Type **(StationType)**	
National station name **(NationalStationName)**	
Longitude	
Latitude	
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	

[5] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed stations	
National station code (NationalStationCode)	UKGBNIGWNB27-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	20137
Longitude	313000
Latitude	345000
Last annual average nitrate concentrations	0.65
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[6]	0.65
Other (please specify)	Sampling Access Removed
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode) **groundwater (0-5m)**	None Identified
Station Type **(StationType)**	
National station name **(NationalStationName)**	
Longitude	
Latitude	
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	

[6] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed stations	
National station code (NationalStationCode)	UKGBNIGWNE22-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	20139
Longitude	331000
Latitude	314000
Last annual average nitrate concentrations	0.85
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[7]	0.93
Other (please specify)	Sampling Access Removed
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode) **groundwater (0-5m)**	UKGBNIGWNE101-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	Kilkeel Harbour
Longitude	331000
Latitude	314000
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	2.12

[7] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed stations	
National station code (NationalStationCode)	UKGBNIGWNB53-C
Station Type **(StationType)**	0
National station name **(NationalStationName)**	20162
Longitude	279000
Latitude	351000
Last annual average nitrate concentrations	0.85
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[8]	0.85
Other (please specify)	Sampling Access Removed
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode) **groundwater (0-5m)**	None Identified
Station Type **(StationType)**	
National station name **(NationalStationName)**	
Longitude	
Latitude	
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	

[8] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10398
Station Type **(StationType)**	4
National station name **(NationalStationName)**	TUNNY CUT AT TUNNY BRIDGE
Longitude	-6.3009303
Latitude	54.569689
Last annual average nitrate concentrations	2016 Annual Average Concentration = 1.20 mg NO_3/L 2017 Annual Average Concentration = 2.03 mg NO_3/L 2018 Annual Average Concentration = 2.52 mg NO_3/L 2019 Annual Average Concentration = 2.53 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[9]	Yes - Please note - This was not the reason for closure. The station was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[9] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10464
Station Type **(StationType)**	4
National station name **(NationalStationName)**	GLENDUN R AT CLOCKAN
Longitude	-6.1765252
Latitude	55.081107
Last annual average nitrate concentrations	2016 Annual Average Concentration = 0.13 mg NO_3/L 2017 Annual Average Concentration = 0.13 mg NO_3/L 2018 Annual Average Concentration = 0.13 mg NO_3/L 2019 Annual Average Concentration = 0.17 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[10]	Yes - Please note - This was not the reason for closure. The monitoring station was surplus to monitoring requirements under WFD. Monitoring station closed in April 2019.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[10] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10655
Station Type **(StationType)**	5
National station name **(NationalStationName)**	LOUGH MELVIN AT MUCKENAGH BAY
Longitude	-8.1292208
Latitude	54.436666
Last annual average nitrate concentrations	2016 Annual Average Concentration = 0.38 mg NO_3/L 2017 Annual Average Concentration = 0.52 mg NO_3/L 2018 Annual Average Concentration = 0.49 mg NO_3/L 2019 Annual Average Concentration = 0.38 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[11]	Yes - Please note - This was not the reason for closure. The monitoring station was closed in April 2021 due to Health and Safety concerns. It was replaced by monitoring station F11508 (see details below).
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	F11508
Station Type **(StationType)**	5
National station name **(NationalStationName)**	LOUGH MELVIN BESIDE ANGLING CLUBHOUSE 89 LOUGHSIDE RD GARRISON
Longitude	-8.1069373
Latitude	54.426140
First annual average nitrate concentrations (mg NO_3/L) - period 2020-2023	2020 Annual Average Concentration = N/A (Opened April 2021) 2021 Annual Average Concentration = 0.60 mg NO_3/L 2022 Annual Average Concentration = 0.55 mg NO_3/L

[11] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

	2023 Annual Average Concentration = 0.53 mg NO_3/L

Removed station	
National station code (NationalStationCode)	F10764
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BALLYMAGRORTY STREAM AT UPPER GALLIAGH ROAD
Longitude	-7.3450193
Latitude	55.029257
Last annual average nitrate concentrations	2016 Annual Average Concentration = 4.48 mg NO_3/L 2017 Annual Average Concentration = 3.57 mg NO_3/L 2018 Annual Average Concentration = 4.60 mg NO_3/L 2019 Annual Average Concentration = 3.87 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[12]	Yes - Please note - This was not the reason for closure. The monitoring station was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[12] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F10765
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BALLYMAGRORTY STREAM AT BALYMAGRORTY
Longitude	-7.3565658
Latitude	55.017263
Last annual average nitrate concentrations	2016 Annual Average Concentration = 4.05 mg NO_3/L 2017 Annual Average Concentration = 2.38 mg NO_3/L 2018 Annual Average Concentration = 3.26 mg NO_3/L 2019 Annual Average Concentration = 3.29 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[13]	Yes - Please note - This was not the reason for closure. The monitoring station was surplus to monitoring requirements under WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[13] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F11258
Station Type **(StationType)**	4
National station name **(NationalStationName)**	BLACK WATER AT PARK ROAD BRIDGE
Longitude	-6.0045169
Latitude	54.684515
Last annual average nitrate concentrations	2016 Annual Average Concentration = 6.06 mg NO_3/L 2017 Annual Average Concentration = 7.39 mg NO_3/L 2018 Annual Average Concentration = 7.84 mg NO_3/L 2019 Annual Average Concentration = 8.82 mg NO_3/L
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2012-2015 period[14]	Yes - Please note - This was not the reason for closure. The monitoring station was surplus to requirements for WFD.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[14] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

Removed station	
National station code (NationalStationCode)	F11329
Station Type **(StationType)**	4
National station name **(NationalStationName)**	RIVER ERNE AT BELLANALECK JETTY
Longitude	-7.6367231
Latitude	54.300332
Last annual average nitrate concentrations	2016 Annual Average Concentration = 0.91 mg NO_3/L 2017 Annual Average Concentration = 1.25 mg NO_3/L 2018 Annual Average Concentration = 1.42 mg NO_3/L 2019 Annual Average Concentration = N/A (Closed in December 2018)
Reason for removal	
Annual average nitrate concentrations < 25 mg/l for the 2016-2019 period[15]	Yes - Please note - This was not the reason for closure. The river water body is now classified by Upper Lough Erne lake class. Monitoring station closed in December 2018.
Other (please specify)	
Alternative station identified (only for removed stations for reason other than annual average nitrate concentrations < 25 mg/l for the 2016-2019 period)	
National station code (NationalStationCode)	N/A
Station Type **(StationType)**	N/A
National station name **(NationalStationName)**	N/A
Longitude	N/A
Latitude	N/A
First annual average nitrate concentrations (mg NO_3/L) - period 2016-2019	N/A

[15] Cf Article 6.1.b of the Nitrates Directive – condition for reporting every 8 years

TECHNICAL ANNEX - Water Quality Datasets

1. Groundwater nitrates

Water quality (raw) data for Northern Ireland is available through a Water Information Request - more information is available at: https://www.daera-ni.gov.uk/articles/information-requests

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 and transitional and coastal marine waters)

Northern Ireland Surface Water Monitoring Stations 2020-2023

Surface Water Monitoring Station information for Northern Ireland is available through a Water Information Request - more information is available at: https://www.daera-ni.gov.uk/articles/information-requests

Nitrate concentrations in Northern Ireland Surface Waters 2020-2023

Water quality (raw) data for Northern Ireland is available through a Water Information Request - more information is available at: https://www.daera-ni.gov.uk/articles/information-requests

Prior to calculation of summary values, raw data values which are less than the Reporting Limit have been reported as half the Reporting Limit.

3. Surface waters eutrophication parameters

Eutrophication parameter concentrations in Northern Ireland surface waters 2020-2023

Water quality (raw) data for Northern Ireland is available through a Water Information Request - more information is available at: https://www.daera-ni.gov.uk/articles/information-requests

Prior to calculation of summary values, raw data values which are less than the Reporting Limit have been reported as half the Reporting Limit.

4. Datasets supporting forecasting of water quality

Surface water data 1992-2023

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 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). An added check was done on the Sen's Test predictions to ensure readings did not exceed the expected max (NO3 set to 100mg/L and SRP set to 1mg/L)

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

Groundwater Data 2008 - 2023

Monitoring data for all 70 stations were imported into the Aquachem software in order to establish whether the data exhibit a statistically significant upward trend. Where available data were included from 2020 to 2023, but data records for some monitoring boreholes can be longer or shorter. The minimum record length was set to five data points and two years.

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

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 2027 and 31 December 2031 were calculated.