6. EUTROPHICATION

Algal bloom in the Quoile Pondage

Key messages

- Monitoring the trophic status of inshore and coastal waters of Northern Ireland has been undertaken by NIEA and AFBI over the last 20 years.
- There is evidence to show that inputs of nitrogen and phosphorus from human sources to our waters have generally declined over the last 10 years.
- Despite this, there is evidence of eutrophication in small areas of restricted water movement. These are the brackish and estuarine waters of inner Belfast Lough, the tidal Lagan Estuary, the north end of Strangford Lough and the Quoile Pondage.
- For the more open marine waters of the Irish Sea, there is evidence from AFBI's long-term monitoring programme to show that these waters are not eutrophic.
- Continued monitoring of all these waters is essential. The AFBI/NIEA/Loughs Agency Coastal Observatory and larger scale Western Shelf Observatory will provide invaluable information for the sustainable management of Northern Ireland's marine waters.
- Further work is needed to improve confidence in the plant monitoring (seaweed and phytoplankton assessment) and nutrient assessment techniques.

What is eutrophication?

Eutrophication is the term used to describe the enrichment by nutrients accompanied by a biological response and an undesirable disturbance to plant or animal life.

Eutrophication of waters has become increasingly common since the middle of the last century. It has been studied in great detail in freshwater since the 1960s, but it can also occur in the sea. More recently, the term has been refined from its original scientific meaning.

In legislative terms, a water is only deemed eutrophic if there is evidence of

1. nutrient enrichment (relative to 'natural' levels) that is linked to human activity
2. increased growth of algae and higher plants and
3. correlated undesirable disturbance to water quality and the balance of organisms.

Why does eutrophication matter?

Although at first sight making our waters more productive may seem beneficial, this interference in the natural balance can have undesirable consequences. Enrichment may promote the prolific growth of microscopic algae, freshwater weed and seaweeds which in turn can lead to surface scum, undesirable odours, the build up of organic sediment and ultimately the depletion of dissolved oxygen in the water.

How does eutrophication occur?

Eutrophication commonly occurs when nutrients enter the water from sewage treatment works, land drainage, agricultural effluents and septic tanks. Nutrients entering rivers may affect lakes, then further downstream estuaries, sea loughs and other coastal areas. Sewage treatment works discharging directly to the sea may also cause eutrophication.

Who is measuring the trophic or nutrient status of the coastal waters around Northern Ireland?

NIEA, AFBI and the Loughs Agency have a long history of monitoring trophic status in the estuarine and coastal waters around Northern Ireland. In addition, AFBI has developed and assessed nutrient budget information to tabulate the main sources of nutrients. This enables appropriate management action for the control of nutrient inputs to the aquatic environment.

How is trophic status measured?

Measurements to assess trophic status are linked to the 3 defining elements of eutrophication. These include:

- nutrient concentrations measured in winter, when algal growth is lowest
- micro-algal growth, measured as the plant pigment chlorophyll during the growing season of March-September
- seaweed growth, examining the balance of species
- dissolved oxygen concentrations in the water
- detection of nuisance algal species.

NIEA, AFBI and Loughs Agency collaborate on all trophic status monitoring through a number of linked monitoring programmes including the Coastal Observatory. This is a series of *in-situ* monitoring buoys measuring factors like salinity, temperature, dissolved oxygen and fluorescence. Fluorescence is a measure or microscopic algae. Locations are shown in Figure 6.1.

The results from the buoys are displayed in real time on the AFBI website www.afbini.gov.uk/coastal-monitoring.htm

Positioning a monitoring buoy

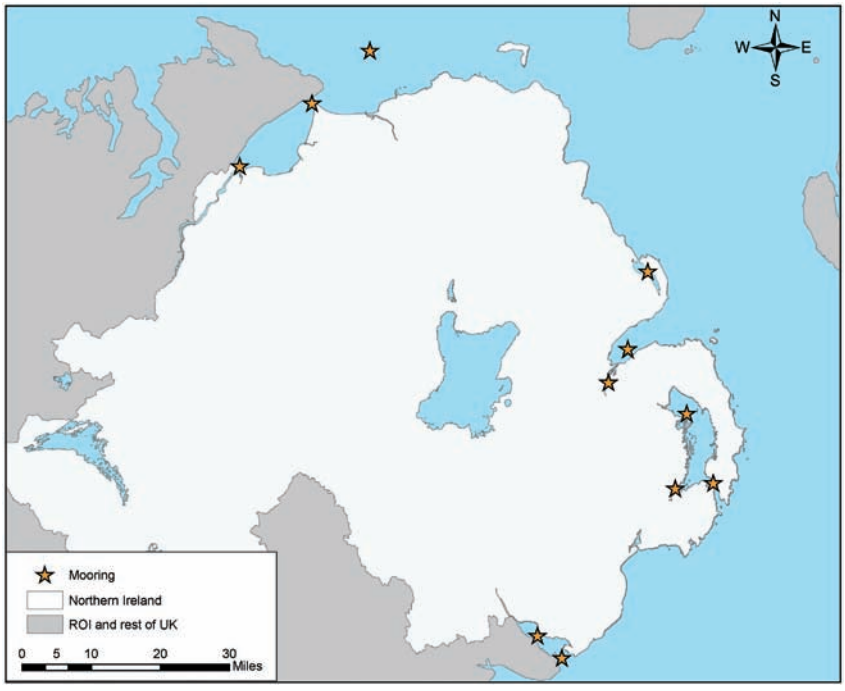

Figure 6.1 Locations of the coastal observatory monitoring buoys.

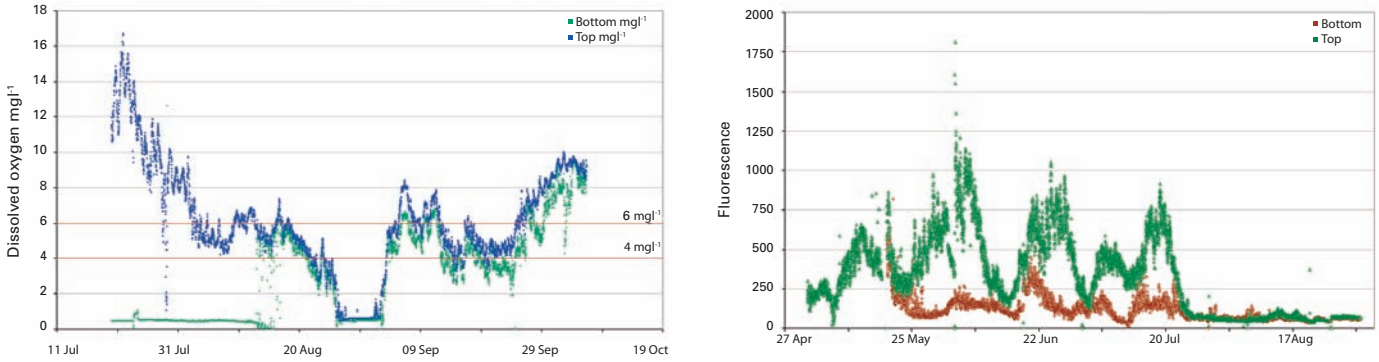

Figure 6.2 Low dissolved oxygen (left) and high fluorescence (right) in the Quoile Pondage.

The overall assessments are made by NIEA according to agreed UK protocols. The most recent assessments have been made using the classification tools developed for the Water Framework Directive. www.wfduk.org/ These incorporate nutrient and dissolved oxygen standards in addition to biological measurements for algae (as chlorophyll) and larger plants (the reduced species list tool and macroalgal blooming tool).

In the trophic status assessments, a 'weight of evidence' approach is used i.e. all the evidence gathered is considered before a designation is recommended. This is different to the Water Framework Directive approach where, should one element fail, the whole water body is downgraded. Although the new Water Framework Directive tools have been used, the overall assessment takes a weight of evidence approach.

What is the trophic status of the estuarine and coastal waters around Northern Ireland?

Some marine or brackish areas are designated as eutrophic or likely to become eutrophic because there is evidence of nutrient enrichment accompanied by a biological response and an undesirable disturbance. These are: inner Belfast Lough, tidal Lagan Estuary, the north end of Strangford Lough and the Quoile Pondage. The tidal Lagan and Quoile Pondage are impounded behind respectively a weir and a barrage, which restrict water exchange. They exhibit nutrient enrichment causing high levels of algal growth and low concentrations of dissolved oxygen (Figure 6.2). There are reports of occasional fish kills.

Inner Belfast Lough has demonstrated all the signs of eutrophication in the past. However, dramatic reductions in nutrient inputs to the inner Lough have resulted in water quality improvements. The north end of Strangford Lough is an area considered 'likely to become eutrophic' should management action not be taken. The area is subject to nutrient enrichment and a disturbance in the balance of macroalgae. This is because some fast growing seaweeds compete with the sensitive eel grass *Zostera* that is an important food for Brent Geese. A survey carried out for NIEA in 2003 reported that eel grass was being smothered by sea lettuce *Enteromorpha* [(1)].

In the western Irish Sea, AFBI's long-term monitoring and associated research projects show that current winter nutrient concentrations are only slightly elevated compared to historical concentrations. The seasonal cycle of phytoplankton production and biomass are typical of this type of coastal sea and there is no evidence of undesirable disturbance[(2),(3)].

What measures are being taken to reduce nutrient inputs to the water environment?

Although eutrophication is not a big problem in the coastal waters of Northern Ireland, it is considered to be an issue in the freshwater environment and of course, the water from our rivers enters the coastal zone.

By 2005, 85% of the total land area of Northern Ireland had been designated as sensitive under the Urban Waste Water Treatment Directive. This means that waters in these areas are either eutrophic or under threat of becoming eutrophic should management action not be taken. A sensitive area designation requires higher standards of sewage treatment at larger waste water treatment works to reduce nutrient inputs into the water environment.

Monitoring buoy off the North coast

The catchments covered by designations are shown in Figure 6.3.
These designations have been key in reducing nutrient inputs to areas like the Lagan and inner Belfast Lough. A further review of trophic status has just been completed and will be published on the NIEA website. No further designations are recommended at this stage. In addition to these measures to reduce nutrients from waste water treatment, a total territory approach has been adopted under the Nitrates Directive, placing controls on nutrient inputs from agriculture across all of Northern Ireland.

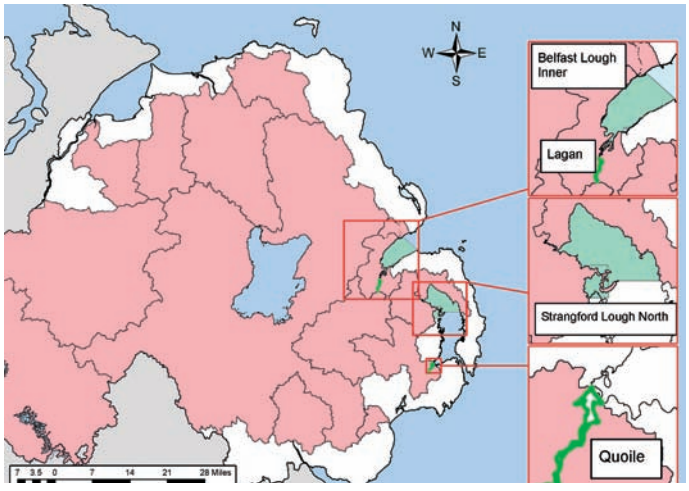

Figure 6.3 Nutrient sensitive areas (pink-catchment; green – coastal; bright green-transitional); under the Urban Waste Water Treatment Directive, 2005.

Are these measures effective?

There is evidence that the measures to control nutrient inputs to confined coastal waters like Belfast Lough are effective. Figure 6.4 shows that, in the last ten years, nitrogen inputs have decreased by almost 90% and phosphorus inputs by 78%.
Dramatic improvements in the seabed fauna of the inner Lough were also observed. Advanced statistical analysis of the data showed that between 1995 and 2001 there was a notable change in the types of animals found, probably linked to a reduction in organic inputs. Since 2002, the seabed community has become more stable, with little change from year to year.

What more needs to be done?

The evidence collected over the last 20 years has shown that, with the exception of 4 small regions with restricted water movement, the waters around the coast of Northern Ireland are not eutrophic.

A reduction in the inputs of human derived nutrients to fresh and marine waters is evident following the introduction of legislation to control inputs. This in turn has reduced the risk of coastal waters becoming eutrophic in the future. Nevertheless, it is important to continue monitoring the trophic status of our coastal

waters. In particular we need to focus on those with restricted water movement and as part of a broader integrated programme to monitor the ecological status of coastal waters with a view to achieving good environmental status by 2020. Many of the new plant monitoring tools developed for the Water Framework Directive have only been used for 2 sampling seasons. Further work is required to increase confidence in the overall assessment.

The AFBI/NIEA Coastal Observatory monitoring buoy network is a cost-effective way of producing high resolution observations. It is particularly useful as a management tool in areas like the tidal Lagan and the Quoile Pondage which suffer from low oxygen concentrations that can lead to fish kill events. The buoy network provides an excellent early warning system.

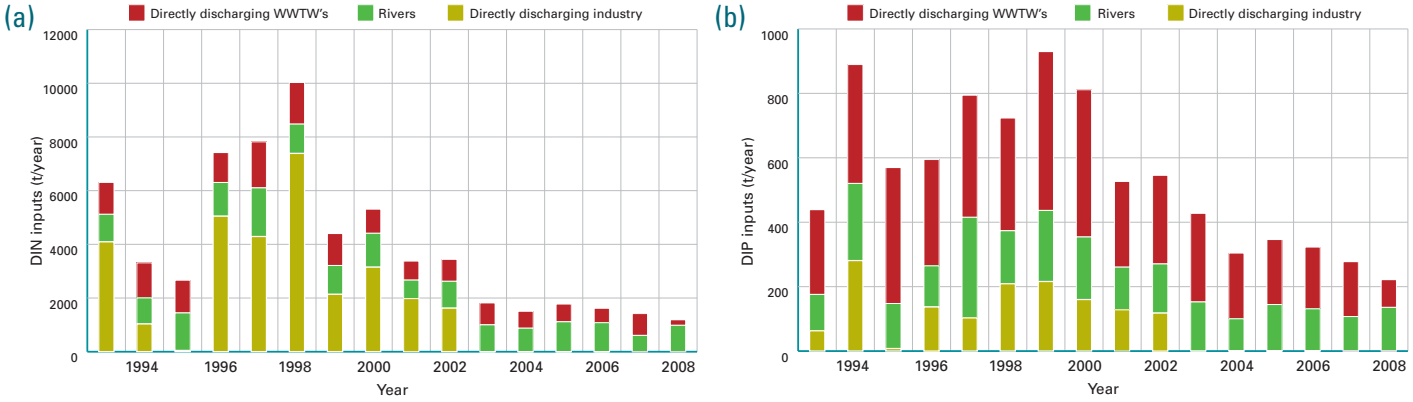

Figure 6.4 Dissolved inorganic Nitrogen (a) and Phosphorus (b) inputs to Belfast Lough

Legislation	
Marine Strategy Framework Directive Descriptor 5 Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters	
Other relevant EC Directives (full references and corresponding regulations – Appendix II)	
Urban Waste Water Treatment Directive	Driving tighter standards in sewage treatment & some industrial effluents
Nitrates Directive	Driving programmes to reduce nutrient losses from agriculture
Water Framework Directive	Driving overall improvements in water quality
International Agreements	
OSPAR Convention for the protection of the marine environment of the North-East Atlantic	Strategy to combat eutrophication
Local legislation	
Water (Northern Ireland) Order 1999	Allowing NIEA to set appropriate consent conditions for sewage and industrial effluent treatment

References

(1) Portig, A. 2006 The Distribution of intertidal *Zostera* spp. in Northern Ireland. Environment and Heritage Service Research and Development Series. No. 06/22.

(2) Gowen, R.J, D.J.Hydes, D.K. Mills, B.M. Stewart, J. Brown, C.E. Gibson, T.M. Shammon & S.J. Malcolm 2002 Assessing trends in nutrient concentrations in coastal shelf seas: A case study in the Irish sea. Estuarine, Coastal and Shelf Science, 54:927-939.

(3) Gowen R.J, P. Tett, K. Kennington, D.K. Mills, T.M. Shammon, B.M. Stewart, N. Greenwood, C. Flanagan, M. Devlin & A. Wither 2008 The Irish Sea: Is it eutrophic? Estuarine, Coastal and Shelf Science 76: 239-254