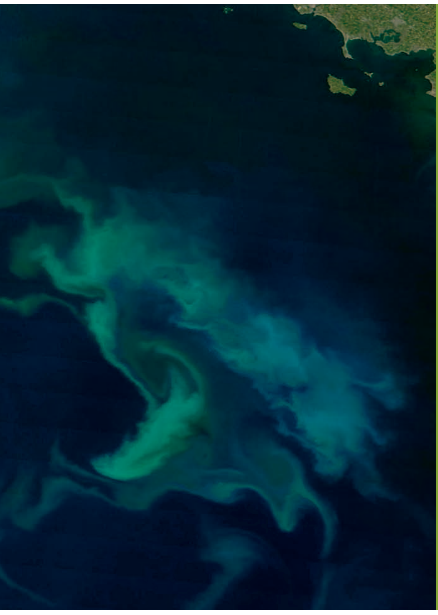
4 EUTROPHICATION



Eutrophication is still a problem in Regions II, III and IV and the objective of no eutrophication will only be partly achieved by 2010. Reductions in phosphorus discharges exceed the OSPAR target of 50 % compared to 1985, but nitrogen discharges are still the main problem, especially those from agriculture. Concern about atmospheric nitrogen inputs is increasing. It can take decades for reduction measures to have positive effects in the sea because nutrients are released from soils and sediments.

OSPAR Contracting Parties should cooperate

→ to implement with urgency OSPAR and EU measures to reduce nutrient inputs to eutrophication problem areas and take additional action if needed to eliminate eutrophication problems;
→ to set within OSPAR appropriate reduction targets for nutrient inputs to individual problem areas;
→ to promote consideration of marine eutrophication when implementing the EU Nitrates Directive and in the revision of international nitrogen air emission targets and standards, for example, those set by the EU, UNECE and IMO;
→ to refine OSPAR's assessment methodologies, including modelling of nutrient transports;
→ to improve OSPAR's monitoring framework through coordinated use of novel observation tools and coordination of data collection on sources, inputs and environmental status.

Key OSPAR assessments

→ Eutrophication status of the OSPAR maritime area
→ Towards the 50 % reduction target for nutrients
→ Trends in atmospheric concentrations and deposition
→ Trends in waterborne inputs

Nutrients, especially nitrogen and phosphorus, are essential for the growth of aquatic plants which form the basis of marine food webs. Natural processes regulate the balance between nutrient availability and the growth of marine plants and animals in ecosystems. Excess nutrients introduced into the sea by human activities can disturb this balance and may result in accelerated algal growth, leading to adverse effects on water quality and marine ecology. This process is known as eutrophication. OSPAR works under its Eutrophication Strategy to combat eutrophication and to achieve a healthy marine environment.

What are the problems?

Eutrophication affects marine ecosystems in many ways

Eutrophication is mainly a problem in coastal areas and in areas with restricted water exchange, such as enclosed estuaries and embayments. Eutrophication causes changes in the composition of plant and animal communities and generally favours growth of rapidly reproducing opportunistic algal and animal species → FIGURE 4.1. Opportunistic algal species do not always pose a threat but some species can adversely affect ecosystems. Mass occurrence of phytoplankton also reduces the depth at which light is available for long-lived seagrass species. Once the nutrients have been depleted, the algal blooms associated with nutrient enrichment decay, leading to oxygen deficiency and possibly kills of fish and benthic invertebrates, and to the formation of toxic hydrogen sulphide (H_2S).

OSPAR Strategy objectives for eutrophication

→ Combat eutrophication in the OSPAR maritime area in order to achieve and maintain, by 2010, a healthy marine environment where eutrophication does not occur.
→ Reduce inputs of nitrogen and phosphorus to areas affected by or likely to be affected by eutrophication in the order of 50 % compared to 1985.

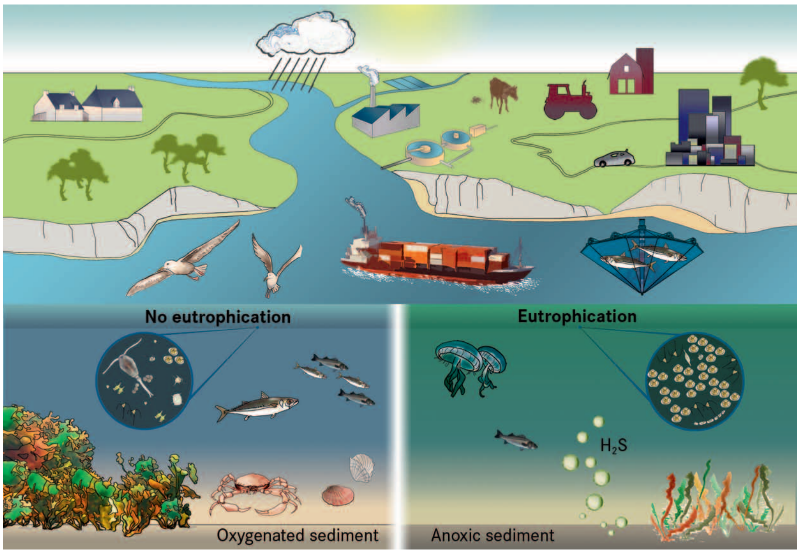


FIGURE 4.1 *Sources of nutrient input to the marine environment and simplified schemes showing eutrophication effects arising from nutrient enrichment.*

As well as causing impacts on the ecosystem, eutrophication can affect human activities. For example, algal blooms can clog fishing nets. Decaying blooms of some algae can create unsightly foam masses on beaches and unpleasant smells that interfere with tourism and recreation. Although some algae produce toxins that can harm humans through consumption of contaminated shellfish, the link to nutrient enrichment is uncertain.

Excess nutrients result from sources on land and at sea

Rivers are the main pathway for excess nutrients to Regions II, III and IV, collecting direct discharges from point sources, such as sewage treatment plants and industry, and inputs from land run-off and leaching, mainly as a result of agriculture. The amounts of nutrients released from land-based sources vary according to land use and population density. Point sources generally dominate in urban areas, while diffuse sources dominate in farming areas. Farmland covers about half the total land area in many OSPAR countries, reaching 60 % to 70 % for some countries bordering Regions II and III. The rate of turnover of nutrients in soils and sediments means they can be released to the marine environment for decades after releases from the original sources have been reduced. A further potential confounding factor is hazardous substances, some of which (e.g. certain anti-fouling agents) have the potential to influence algal growth and in turn eutrophication effects. Transboundary transport of nutrients by ocean currents is particularly important in Region II.

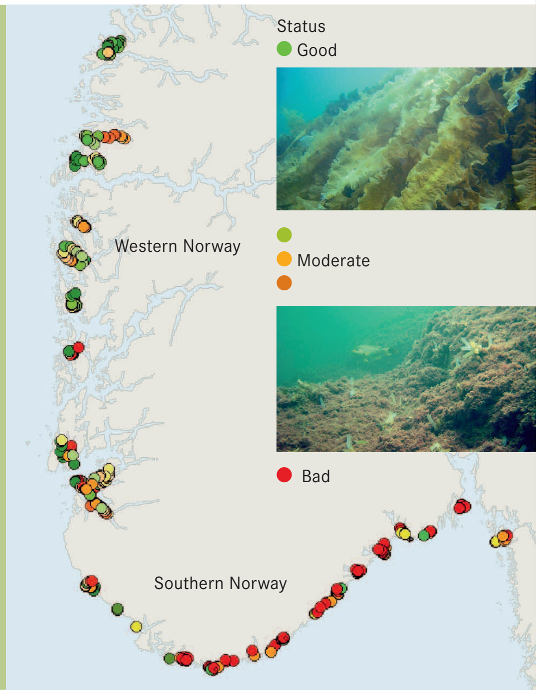
Atmospheric deposition is an important pathway for nitrogen to the sea and is usually greatest close to the source. Nitrogen is emitted to the atmosphere from agriculture and from combustion processes associated with industry and transport, including maritime shipping, and can be carried by winds to places far from the emission sources, where it is deposited. In Regions I and V, far from most point sources of pollution, atmospheric deposition is the main pathway for anthropogenic inputs of nitrogen.

BOX 4.1 Declining sugar kelp forests on the Norwegian coast

Surveys of sugar kelp forests between 1996 and 2006 by the Norwegian Institute for Water Research uncovered a dramatic decline in their abundance along the Norwegian coasts. Abundance of sugar kelp reduced by 40 % on the western coast and 80 % on the southern (Skagerrak) coast. The decline was most pronounced in sheltered waters, where the sugar kelp forests have been replaced over large areas by a silty turf community dominated by filamentous algae.

The shift in vegetation probably reflects a combination of long-term eutrophication (transboundary inputs as well as local nutrient inputs) and recent climatic events resulting in higher sea temperatures. The decline in sugar kelp followed exceptionally warm summers. Eutrophication may also have negatively affected recruitment of new plants on the Skagerrak coast.

The kelp forests are highly productive and diverse communities, providing habitat for many organisms, and are important feeding and nursery areas for many species of fish. In contrast, the turf communities provide much less food and shelter. The ecological and economic consequences of these changes within the coastal zone are uncertain. Estimates suggest that the lost sugar kelp forests mean a shortfall of 50 000 tonnes of fish biomass and CO_2 capture capacity worth 11 million Euro (based on 18 Euro per tonne CO_2).



BOX 4.2 **A Common Procedure to assess eutrophication**

The Common Procedure for the Identification of the Eutrophication Status of the Maritime Area ('Common Procedure') provides the framework for a comprehensive, harmonised characterisation of marine areas by OSPAR countries in terms of 'problem areas', 'potential problem areas' and 'non-problem areas' with regard to eutrophication. Its second application, relating to the period 2001–2005, was restricted to areas that had previously shown eutrophication problems or non-problem areas which gave concern that their quality status may have deteriorated.

The Common Procedure links ten indicators for nutrient enrichment and direct and indirect eutrophication effects in an integrated cause-effect scheme. Applications of the Common Procedure have so far focused on assessing eutrophication status and change in area status over time. Assessments of regional trends in individual indicators will need to receive more attention in future to make it possible to track improvements.

The indicators cover excessive nuisance algal blooms, loss and changes in biodiversity (for macrophytes, zoobenthos, fish) and oxygen deficiency. Differences in environmental characteristics, such as salinity, mean that not all parameters are relevant or robust indicators for eutrophication in each area. Indicators are elevated if they exceed the acceptable deviation from area-specific background conditions which OSPAR countries determine through regionally agreed methodologies, taking into account natural variability. As a result they are not applied in the same way across the OSPAR area. Data availability also contributes to differences in their use. An area is generally classified as a problem area if an indicator for nutrient enrichment and an indicator for eutrophication effect are elevated. Monitoring of the indicators is coordinated across the OSPAR area through agreed methodological standards covering sampling, analysis, reporting and quality assurance. The work supports judgement about the quality of coastal and marine waters under the EU Water Framework Directive and the EU Marine Strategy Framework Directive.

Climate change may alter impacts

More rain and increased flooding as a result of climate change are expected to enhance nutrient enrichment through increased freshwater input and run-off from land → **CHAPTER 3**. Rising sea temperature and prolonged stratification are likely to lead to increased incidence of harmful algal blooms and changing phytoplankton composition. Ocean acidification may also promote changes in the plankton. Recent observations of the decline in sugar kelp along the southern coast of Norway indicate possible interactions between climate change and eutrophication → **BOX 4.1**. Improved understanding of this interaction will be important in OSPAR's future work on eutrophication.

What has been done?

Reduction targets set to tackle eutrophication

The presence of serious eutrophication effects in parts of the maritime area during the 1970s led North Sea countries to agree on the need for a reduction of nitrogen and phosphorus inputs to areas affected, or likely to be affected, by eutrophication. Agreement was reached on a target for reduction of the order of 50 % between 1985 and 1995. This was endorsed by OSPAR in 1988 for its entire maritime area and has since formed an integral part of its Eutrophication Strategy.

Regular national reporting, supported by harmonised procedures for quantifying and reporting discharges and losses of nutrients, makes it possible to judge progress on reducing nutrient releases and achieving the 50 % reduction target.

Agreed methodologies track eutrophication problems

In response to the need for a collective approach for evaluating the eutrophication status of the maritime area, OSPAR developed the Common Procedure for use by all OSPAR countries → **BOX 4.2**. This was applied in 2002 for the period 1990–2000 and again in 2007 for the period 2001–2005 and has proved a good means for assessing the extent of marine eutrophication and for identifying problem areas, where the 50 % nutrient reduction target applies. Joint modelling exercises have been used to test the effectiveness of current and projected nutrient reduction scenarios and to estimate transboundary nutrient transport in the North Sea.

The Common Procedure also supports the application of the eutrophication-related Ecological Quality Objective (EcoQO) for the North Sea → **CHAPTER 11**.

Continued cooperation with other international bodies

To achieve OSPAR's targets, OSPAR countries have agreed to implement a coordinated programme for the reduction of nutrient inputs from point sources and agriculture where eutrophication problems are identified. This is mainly being delivered through implementing measures adopted in the EU, the European Economic Area and other international forums. A wide range of European and international instruments aim at combating nutrient releases to surface waters and air through controlling discharges, emissions and losses at source and by setting environmental targets → **TABLE 4.1**. Under EU legislation, stricter requirements apply to agriculture and urban

TABLE 4.1 *European and international instruments to combat eutrophication and their respective tools that have supported progress towards the OSPAR objective.*

EU Urban Waste Water Treatment Directive (91/271/EEC)
Connection of industry and households to waste water treatment Higher level treatment of waste water Designation of water areas sensitive to nutrient inputs
EU Nitrates Directive (91/676/EEC)
Good agricultural practice Designation of water zones vulnerable to nitrogen losses
EU Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC)
Industrial and agricultural point sources Best Available Techniques Emission and discharge limits
EU Water Framework Directive (2000/60/EC)
Normative definitions describing good ecological status of a water body River basin management plans
EU National Emissions Ceiling Directive (2001/81/EC)
Ceilings for air emissions of nitrogen
MARPOL Annex VI
Emission control standards for ships Emission control sea areas with stricter ship standards
UNECE Convention on Long-range Transboundary Air Pollution (Gothenburg Protocol)
Industrial and agricultural point sources Emission targets for nitrogen Transboundary air transport of nitrogen

waste water treatment plants discharging into areas designated as sensitive or vulnerable to nutrient inputs. These broadly coincide with OSPAR problem areas. EU legislation and OSPAR measures mutually support objectives to combat eutrophication.

Did it work?

The 50 % reduction target has mostly been met for phosphorus but not for nitrogen

Nutrient discharges and losses to water from point and diffuse sources to eutrophication problem areas have steadily decreased in Regions II and III over the past 20 to 25 years → FIGURE 4.2. By 1995, the initial timeframe agreed, most Region II countries had achieved a reduction of 50 % in phosphorus discharges compared to 1985. This was not the case for nitrogen and OSPAR countries committed themselves to the 50 % reduction target beyond 1995. Continued efforts have now resulted in further substantial decreases in phosphorus discharges in several countries of up to 85 % compared to 1985. By 2005, some progress had also been made on reducing nitrogen discharges and losses to the North Sea, with Denmark having achieved the 50 % reduction target and Germany and the Netherlands approaching it. More efforts are needed by OSPAR countries, especially to reduce nitrogen inputs to areas where eutrophication problems still exist. Differential reductions in nitrogen and phosphorus inputs can alter nitrogen/phosphorus ratios in seawater and this may cause shifts in algal species composition, for example from diatoms to flagellates.

Point source discharges are falling, but sewage is still a problem

Four countries have reported reductions in nitrogen and phosphorus discharges to eutrophication problem areas from industry of more than 80 % for the period 1985–2005, with Germany (nitrogen and phosphorus) and the Netherlands (phosphorus) reporting reductions of more than 90 %. Urban

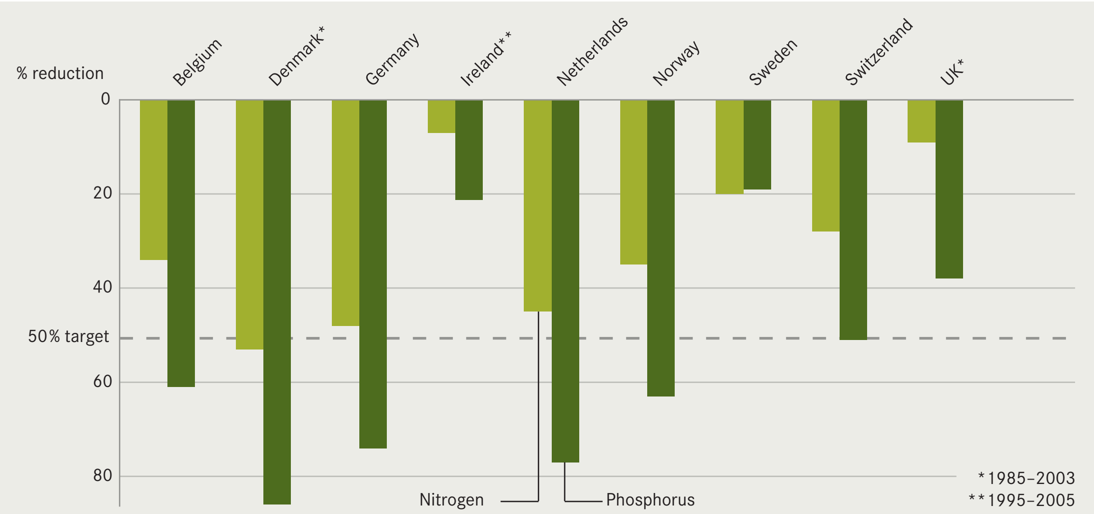


FIGURE 4.2 *Reduction of discharges and losses of nitrogen and phosphorus to problem areas reported for 2005 relative to 1985. Most countries in Regions II and III have met the target reduction of 50 % for phosphorus, but not for nitrogen. For France data on source-related discharges and losses to problem areas are not available. France reported, however, a 50 % reduction in riverine inputs of phosphorus to its coastal waters in the period 1990–2007, but no significant trend in nitrogen inputs. It is not possible to compare directly the reductions achieved by OSPAR countries owing to differences in the periods over which the reduction measures were applied and the different methods used to calculate reductions.*

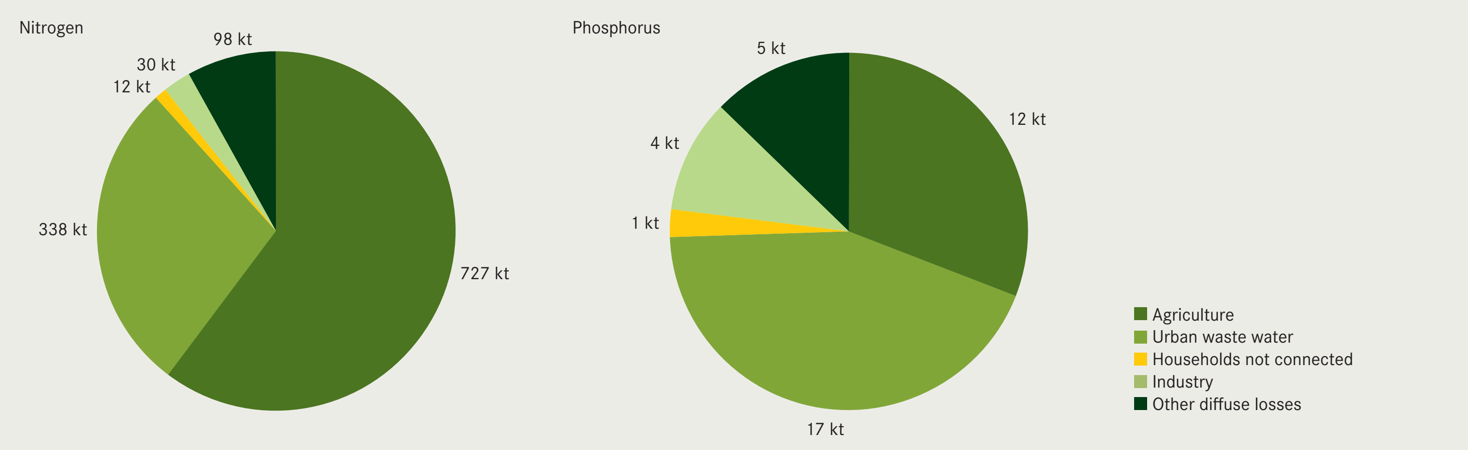


FIGURE 4.3 *Relative contribution of sources of discharges and losses of nitrogen and phosphorus to eutrophication problem areas in Regions II and III in 2005. Eight OSPAR countries reported combined totals of around 1200 kt nitrogen and 40 kt phosphorus for discharges and losses. Data on discharges to problem areas in Region IV are not available. The category 'other diffuse losses' includes background losses, atmospheric deposition on freshwater and some losses from agriculture. Releases from coastal and freshwater aquaculture are not shown in the chart as they are substantially smaller than those from other sources, amounting to around 260 t of nitrogen and 45 t of phosphorus.*

waste water is another major source of nutrient discharge and efforts to collect and treat waste water from households and industry are continuing. Most households in OSPAR countries are now connected to waste water treatment plants and many of these use biological and chemical treatment to remove nitrogen and phosphorus. Nevertheless, sewage effluents are still the main source of phosphorus to the marine environment and contribute a quarter of all nitrogen discharged to problem areas in Regions II and III → **FIGURE 4.3**. Full implementation of the EU Urban Waste Water Treatment Directive is key to achieving further reductions.

Nitrogen losses from agriculture must be tackled

Nearly two-thirds of the nitrogen and a third of the phosphorus discharged to eutrophication problem areas in Regions II and III in 2005 came from agricultural sources → **FIGURE 4.3**. The progress made since 1985 in reducing losses from agriculture varies between OSPAR countries and is more marked for phosphorus. Some countries have reduced nitrogen losses by roughly a quarter, while others have reported only minor progress or even small increases. While it is difficult to predict the future trend in fertiliser use and associated nitrogen releases from agriculture, the expansion in biofuel production to meet EU targets for renewable energy and the expected intensification of food crop production should be kept under review with regard to possible impacts on the eutrophication status of coastal areas. The reform of the Common Agricultural Policy provides an opportunity to promote agro-ecological schemes aimed at reducing nutrient losses to surface water. To reduce agricultural inputs to eutrophication problem areas it is essential for countries to fully implement the reduction measures under the EU Nitrates Directive, taking into account marine eutrophication, and the EU Water Framework Directive. OSPAR should assess, through modelling and in cooperation with the EU, whether these measures are sufficient to support the achievement of non-problem area status.

Trends in riverine and direct inputs are mostly downward

Rivers collect the nutrients discharged and lost from all land-based point and diffuse sources in the catchment and account for most of the waterborne inputs of nitrogen and phosphorus to Regions II, III and IV. Monitoring shows that nitrogen inputs from rivers and direct discharges to the sea have decreased to varying degrees since 1990 → **FIGURE 4.4**. Phosphorus inputs show similar regional patterns, although reductions are generally more pronounced than for nitrogen.

Large decreases in the nitrogen loads carried by the rivers Elbe and Rhine and the phosphorus loads carried by the rivers Seine, Elbe, Rhine and Meuse underlie the clear fall in river inputs to Region II since 1990. Direct discharges of phosphorus for this period were significantly reduced but discharges of nitrogen were not.

There is no clear trend for river inputs to Regions III and IV in the period 1990–2006, but there has been a significant downward trend in direct discharges for Region III, reaching 50 % for phosphorus. In Region I, total nutrient loads are small compared to the other Regions and remained unchanged in the period 2000–2006 because increasing discharges from mariculture offset reductions in riverine inputs.

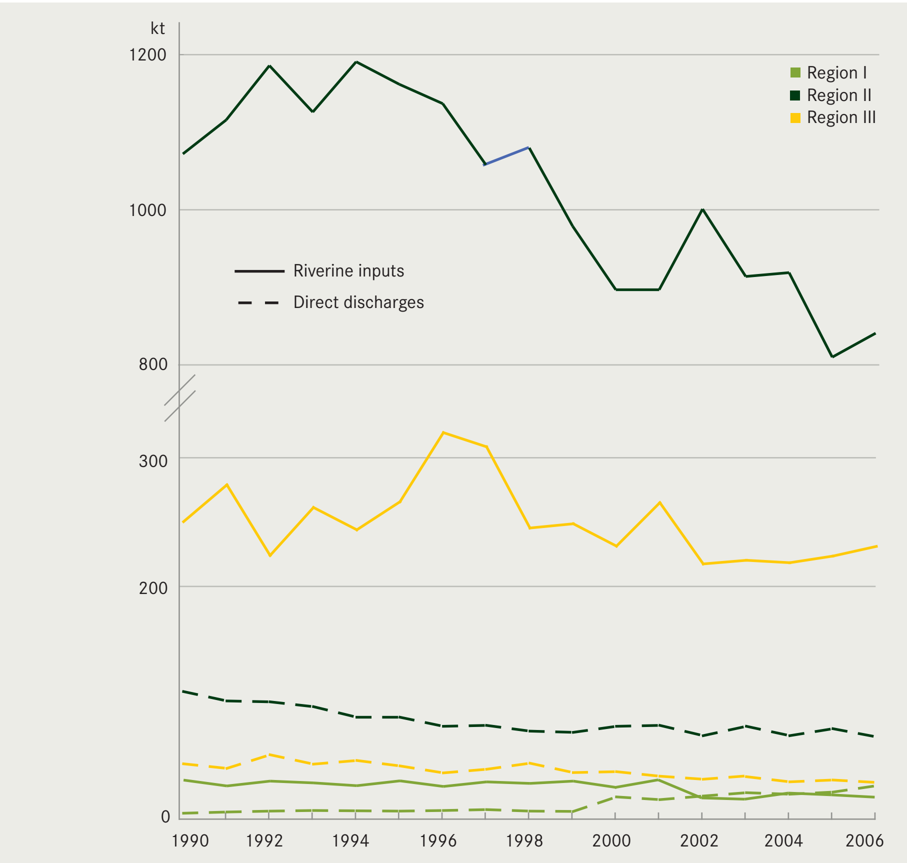


FIGURE 4.4 *Annual riverine inputs and direct discharges of nitrogen in the period 1990–2006. Statistical analysis of the monitoring data, taking into account annual changes in water flow, shows significant downward trends in riverine inputs in Region I (−50 %) and Region II (−25 %). There is no trend in riverine inputs in Region III. Direct discharges decreased in Region II (−35 %) and Region III (−30 %) over this period. In Region I, Norway first reported direct discharges from mariculture in 2000. Direct discharges have since increased and now account for the greater fraction of waterborne inputs in Region I. Data for Region IV are not included in this figure as they are incomplete and not fit for trend assessment.*

Reductions in nitrogen emissions to air are limited and atmospheric inputs remain high

More than 4600 kt of nitrogen were emitted to air across the OSPAR Convention area as a whole in 2006, with combustion in power plants, industry and industrial processes, agriculture and transport, including international shipping, the main contributing sectors → **FIGURE 4.5**. While emissions of oxidised nitrogen decreased by 20 % in the period 1998–2006, mainly as a result of pollution control in industry and stricter emission standards for motor vehicles, emissions of reduced nitrogen, which are almost entirely attributable to agriculture, decreased only by 10 %. Agriculture and combustion are estimated to have contributed most to atmospheric nitrogen deposition in the OSPAR area in 2006 → **TABLE 4.2**. Nitrogen emissions from growing international ship traffic on the North Sea and the Atlantic have increased by more than 20 % since 1998, to 560 kt in 2006, and accounted for 10 % of total atmospheric nitrogen deposition to the OSPAR area.

Models estimate that Region II receives most atmospheric nitrogen, as would be expected from the high levels of industry and agriculture in its coastal areas and its intense ship traffic → **FIGURE 4.6**. Models show no significant trends in atmospheric inputs between 1998 and 2006 in the OSPAR area. This is supported by coastal observations of nitrogen in precipitation in Region II which show little change in this period. Monitoring also shows an increase in ammonium and nitrate concentrations in air in Regions I and II and nitrate in rain in Region IV. Efforts are required to reduce emissions from agriculture, combustion processes and transport, and to tackle emissions from increasing levels of ship traffic.

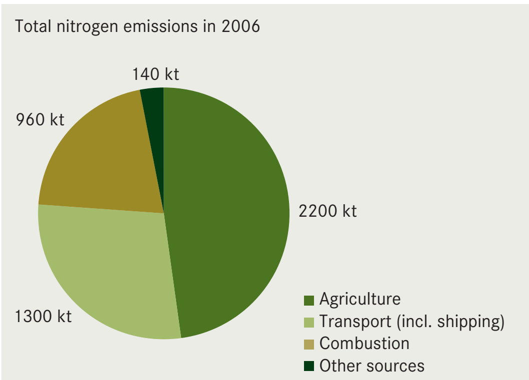


FIGURE 4.5 *Relative contributions of the main sectors in OSPAR countries to emissions of nitrogen to air in 2006. Data source: EMEP.*

TABLE 4.2 *Relative percentage contribution of emission sectors to modelled atmospheric nitrogen deposition to OSPAR Regions in 2006. Data source: EMEP.*

Percentage (%)	Region I	Region II	Region III	Region IV	Region V
Agriculture	26	42	44	37	28
Combustion	28	23	22	24	26
Transport	21	15	14	14	15
International shipping	7	7	8	10	14
Other sectors	18	13	12	15	17

How does this affect the quality status?

Eutrophication is still a problem in Regions II, III and IV

A healthy marine environment where no eutrophication occurs was not achieved over the assessment period (2001–2005) and will only be partially achieved by 2010. Anthropogenic nutrient enrichment of marine waters is still causing eutrophication in areas of Region II, and in some coastal embayments and estuaries within Regions III and IV. Regions I and V are not affected by eutrophication → FIGURE 4.7.

Many of the indicators taken into account when assessing eutrophication are above the acceptable deviation from background conditions. Nutrient, chlorophyll and oxygen concentrations are the most widely used indicators across the OSPAR area. Eutrophication problems are more apparent in coastal areas, that is, closer to the main nutrient sources and where environmental conditions (e.g. restricted circulation, resuspension of nutrients in shallow waters) make them susceptible to eutrophication. In offshore areas, dilution generally ensures lower nutrient concentrations, but the origin of the nutrients is less clear owing to transport by ocean currents.

Region II is most widely affected

The eutrophication status of Region II over the assessment period (2001–2005) was not significantly different to that during the first assessment period (1990–2000) under the Common Procedure. Region II is the most widely affected Region with large areas along the continental coast from France to Norway and Sweden and a number of estuarine areas on the UK North Sea coast still adversely affected by eutrophication → FIGURE 4.7.

In the period 2001–2005 severe eutrophication effects have occurred in various coastal areas with adverse impacts on ecosystems and society:

- In some estuaries in the Netherlands a die-off of cultured mussels and benthic animals has been linked to the decay of massive algal blooms.

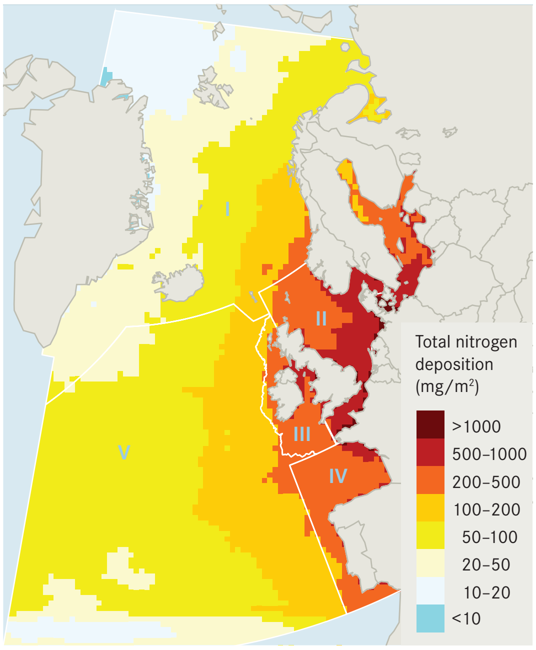


FIGURE 4.6 *Total atmospheric deposition of nitrogen calculated by EMEP models for 2006. Deposition levels are highest in the coastal areas of Region II and decrease towards the open sea. Regions II, III and IV receive high loads of atmospheric nitrogen. For Regions I and V, atmospheric deposition is the main input pathway for nitrogen.*

- Kills of fish and invertebrates due to extreme oxygen deficiency occurred in fjords and estuaries of Sweden and Denmark. Kills of benthic invertebrates also occurred in Norwegian fjords.
- Toxic hydrogen sulphide released from rotting sea lettuce, which is proliferating on Brittany's beaches, has resulted in serious health impacts for locals and tourists.
- Algal foam on beaches in Belgium has been estimated to cause an annual economic loss of around 0.5 % of revenue to the tourism industry.

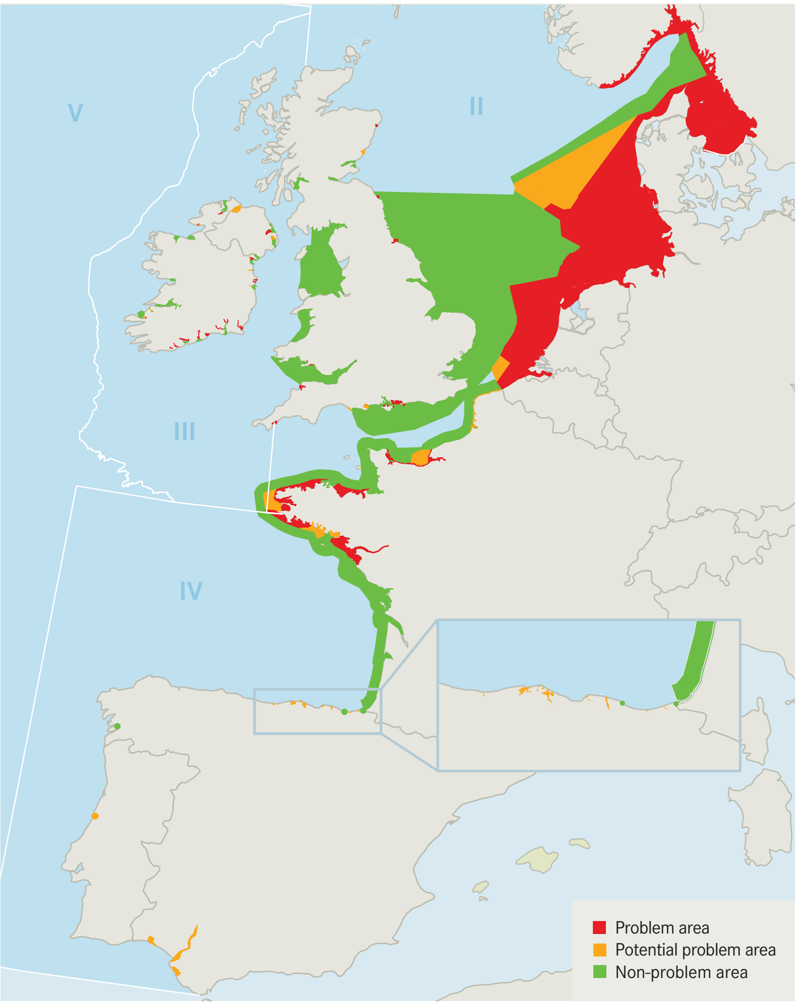


FIGURE 4.7 *Eutrophication status in the period 2001–2005. Large areas of the North-East Atlantic were screened in 2001 for obvious non-problem areas. The latest application of the Common Procedure relating to the period 2001–2005 assessed those areas of the North-East Atlantic which have shown eutrophication problems or which gave rise to concerns that their non-problem status might have changed.*

Although most non-problem areas occur offshore, several coastal areas have also been classified as non-problem areas. Despite high nutrient concentrations in these waters, for example, on the east coast of England, environmental factors, such as high turbidity, prevent the growth of algae and the development of undesirable disturbance to the balance of organisms and water quality.

Some changes in eutrophication status in Region II

The eutrophication status of several areas within Region II changed as a result of the latest classification (relating to the period 2001–2005) compared to their status following the first classification (relating to the period 1990–2000).

Some fjords along the southern Norwegian coast were reclassified in the latest assessment as problem areas, mainly due to the loss of sugar kelp forests → BOX 4.1 and oxygen depletion. In contrast, offshore areas in the Swedish and Danish Skagerrak, and the Netherlands' Oyster Ground are now considered non-problem areas, based on a better understanding of eutrophication induced biological effects and thus refined assessment criteria.

In other areas, indicators show improving trends which are not yet visible in the overall eutrophication status. For example, in coastal waters off the Netherlands, although chlorophyll concentrations decreased over the period 2001–2005, they were still elevated.

The fall in nutrient inputs via rivers since 1990 is now apparent in lower nitrogen and phosphorus concentrations in seawater. This decrease is particularly clear in nearshore waters compared to offshore areas, where the effects of falling inputs via rivers can be masked by the influx of nutrient-rich water from the Atlantic Ocean.

Transboundary transport is significant for Region II

Transport of nutrients between areas can contribute to eutrophication and offset the successful control of local sources. Nutrient-rich water enters the northern North Sea from the Atlantic and is transported with residual currents southward along the east coast of the UK and northward along the continental west European coast. Models have shown that the German Bight receives nutrients via coastal currents that originate in the Atlantic and which become progressively enriched by nutrients from river inputs and atmospheric deposition as they move through the Channel and the North Sea. From the German Bight, the Jutland current transports the nutrients along the west coast of Jutland to the Skagerrak and Kattegat. Together with the outflow from the Baltic Sea and local sources this contributes to the eutrophication apparent along the Swedish west coast and the Norwegian south coast. The onward transport of nitrate from the German Bight may contribute as much as 60% to 80% of the concentration along the southern coast of Norway. Effective assessment of transboundary effects of nutrient loads requires international cooperation.

Chlorophyll levels are still high in Region II

The Common Procedure uses chlorophyll concentration as an indicator of phytoplankton biomass. Overall there have been no significant trends in chlorophyll concentration between 2001 and 2005, despite the reduction in nutrient concentrations observed in coastal waters. The relationship between chlorophyll concentrations and nutrient concentrations is complex, showing natural year to year variability, and depending on factors such as nutrient release from sediments and changes in grazing pressure by zooplankton.

No change in eutrophication status in Region III

There have been no significant changes in the eutrophication status of Region III over the period 2001–2005 compared to the first classification relating to 1990–2000, and most of the coastal and offshore areas are still non-problem areas. Eutrophication resulting from human activities only occurs in semi-enclosed inshore waters such as estuaries, particularly those along the south-eastern coast of Ireland → FIGURE 4.7. In general, this reflects the larger coastal settlements and intense agricultural activities in these areas. Three estuaries in western England and Wales, which are variously affected by agricultural run-off and urban drainage, have also been classed as problem areas. While eutrophication problems occur in many locations in Region III, the total spatial extent of the affected areas is small.

Coastal ecosystems are less susceptible to eutrophication in Region IV

There are few eutrophication problems in Region IV and those that do exist are mainly limited to estuaries and bays with restricted circulation. Elevated levels of chlorophyll, nuisance phytoplankton species and algal toxins have been observed in a number of coastal and estuarine areas along the French coast → FIGURE 4.7. In Spain, many estuaries have been classified as 'potential problem areas', due to their high nutrient concentrations, but there are no observed biological effects (which is often due to a lack of data).

What happens next?

The OSPAR objective of no eutrophication will not be met by 2010

A healthy marine environment where no human-induced eutrophication occurs was not achieved in the period 2001–2005. While eutrophication is not a problem in Regions I and V, many areas of Region II, including areas in the Channel, Skagerrak and Kattegat, and some small coastal embayments and estuaries within Regions III and IV are still affected by eutrophication. Eutrophication is a more prominent problem in coastal areas than offshore waters.

Progress in improving the status has been slow:
- In many cases, measures targeting nutrient sources have been taken later than envisaged.
- It can take many years for ecosystems to respond to nutrient reductions at source, because nutrients in sediments and soil may contribute to local nutrient budgets over long periods.
- Transboundary transport of nutrients into and within Region II has been shown to contribute to eutrophication problems.

Further actions are needed to improve problem areas

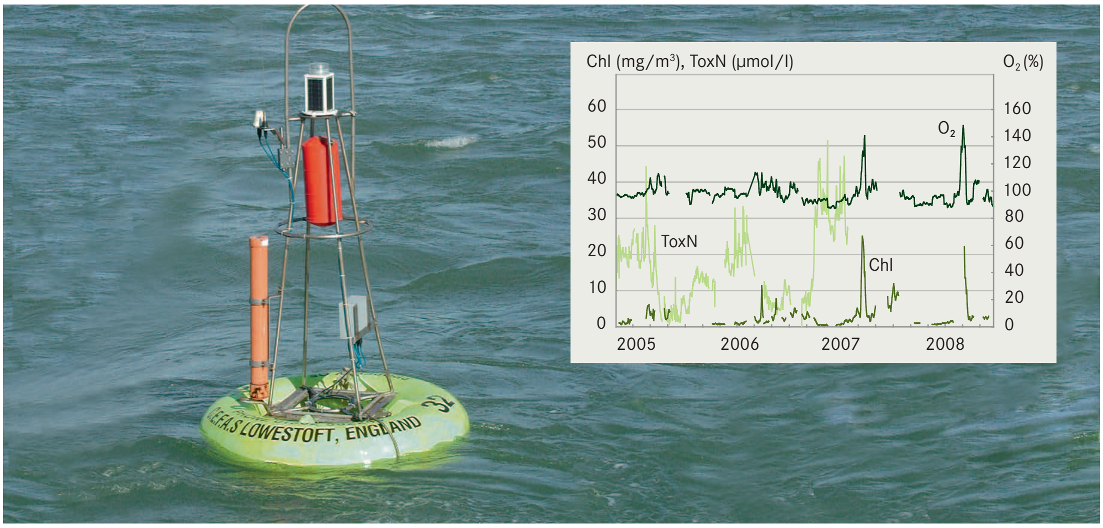
OSPAR countries with problem areas have made substantial progress towards the OSPAR target of 50% reductions in nutrient discharges and losses compared to 1985. Reductions of up to 85% have been achieved for phosphorus while progress for nitrogen has been less successful with only few reductions of up to 50%. Modelling studies suggest that significant further reductions of nutrient inputs, beyond 50% to some problem areas, will be required to eliminate eutrophication problems. The main contributions of nutrients to problem areas are discharges and losses from agriculture, urban waste water and industry, and from atmospheric deposition.

To achieve a status where eutrophication does not occur, OSPAR countries should take the following actions:
- Fully implement the relevant OSPAR and EU measures as soon as possible → TABLE 4.1 and promote consideration of marine eutrophication when implementing the EU Nitrates Directive.
- Take, if necessary, additional measures (e.g. via river basin management plans set up under the EU Water Framework Directive) to address sources contributing to problem areas.
- Cooperate to set appropriate reduction targets for nutrient inputs for individual problem areas.
- Improve monitoring and coordinate data collection on sources, inputs and environmental status in order to direct measures.

Atmospheric nutrient loads need to be addressed

There is concern about the level of atmospheric nitrogen deposition to the OSPAR area from agriculture, combustion processes and road transport, and about the increasing absolute and relative contribution from shipping to airborne inputs. Marine eutrophication has yet to be taken into account in international measures setting air emission targets and standards. OSPAR should take the following actions:
- Promote the recognition of marine eutrophication in the revision of air emission targets for nitrogen under the EU National Emission Ceilings Directive and the Gothenburg Protocol to the UNECE Convention on Long-range Transboundary Air Pollution.
- Evaluate the contribution of atmospheric nitrogen emissions, including those from ships, in eutrophication assessments and use these results to promote that marine eutrophication is taken into account in the revision of standards for ship emissions of oxidised nitrogen set by the International Maritime Organization (IMO).

FIGURE 4.8 *The strength of continuous measurement devices such as the Cefas SmartBuoy at Warp Anchorage (outer Thames estuary) is their capacity to detect day-to-day variability and peaks in concentrations of chlorophyll (Chl), total oxidisable nitrogen (ToxN) and oxygen (O_2), and to transmit data in real time.*



Assessment framework to support the EU Marine Strategy Framework Directive

The Common Procedure provides a good tool for a robust assessment of the eutrophication status of the North-East Atlantic. It also provides a good example of how countries can provide a common approach to determining good environmental status under the EU Marine Strategy Framework Directive and good ecological status under the EU Water Framework Directive.

New observational tools such as instrumented buoys → FIGURE 4.8, ferry boxes, airborne surveillance and remote sensing, have the potential to complement traditional sampling and to help in the design of cost-efficient monitoring programmes to enhance the evidence base for future eutrophication assessments through better spatial and temporal coverage. However, they do not yet offer the same guarantee of quality-assured biogeochemical observations as is achieved by monitoring water quality using scientific research vessels.

Future monitoring and assessment should be supported by the following actions:

- Refinement of the methodologies of the Common Procedure, including assessments of individual indicators at regional level.
- Coordinated use of new observational tools to complement the OSPAR eutrophication monitoring programme.
- Continued cooperation on evaluating transboundary nutrient transport and improved knowledge through modelling.

There is increasing evidence that climate change may alter eutrophication effects. OSPAR should continue to improve knowledge on the interactions of climate change and eutrophication and should take these interactions into account in future eutrophication-related monitoring and assessment.

Delivering OSPAR Strategy objectives for eutrophication

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	No eutrophication by 2010	Change in status[1]	Key factors and pressures	Outlook for pressures	Action needed
Region I	No problems *	←→ *	Atmospheric nitrogen inputs Aquaculture	↑	OSPAR
Region II	Many problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region III	Some problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region IV	Some problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region V	No problems *	←→ *	Atmospheric nitrogen inputs	↑	OSPAR

[1] *2001–2005 relative to 1990–2000.*