NORWEGIAN MINISTRY OF
CLIMATE AND ENVIRONMENT

Foto: Jo Halvard Halleraker

Summary report for Norway

WFD Article 8 and 15

Monitoring programmes

Table of contents

Introduction

Norway is implementing the Water Framework Directive (Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy) under a specific timetable agreed pursuant to the European Economic Area Joint Committee Decision No 12/2007 incorporating the Water Framework Directive (WFD) into the Agreement on the European Economic Area.

This document represents a preliminary, summary report of WFD-relevant monitoring programmes in Norway according to Articles 8 and 15 of the WFD. Norway aims to give a complete, electronic report of the monitoring programmes as part of the 2016 reporting of River Basin Management Plans, in accordance with the revised Reporting Guidance agreed by the Water Directors in 2014.

Monitoring of freshwater and coastal areas in Norway have focused on the ecological effects of anthropogenic impacts during the last 20 – 30 years. Examples are effects of acidification in rivers and lakes and effects of pollution from industry in fjords and coastal areas. In some cases, monitoring stations representing reference conditions have been included. However, the emphasis has been on waters impacted by human activity.

Monitoring in Norway has traditionally focused on physic-chemical quality elements rather than biological quality elements, and the geographical coverage has been insufficient. The portion of water bodies currently classified for ecological status based on monitoring data is very low, see figure 1. Biological quality elements constitutes only a small part of the basis for classification. Expert judgement has so far been the most common method to determine ecological status. For the determination of chemical status in rivers and lakes, lack of data is very evident as more than 95 % of the water bodies are set to “status unknown”. For coastal water bodies the portion set to “status unknown” is 88 %.

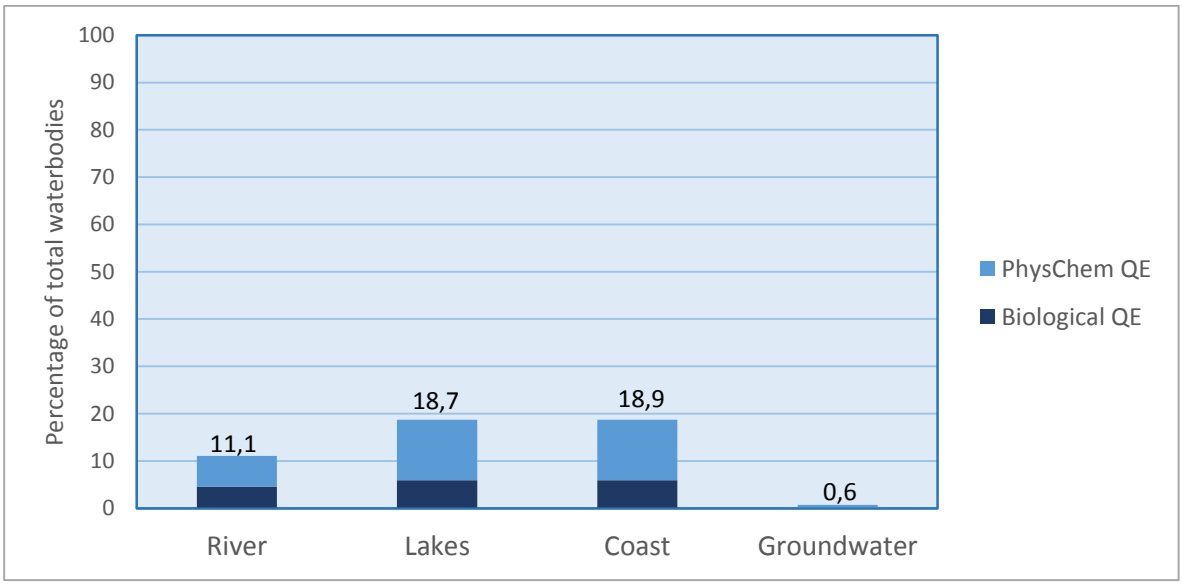

Figure 1: Portion of water bodies classified for ecological status based on monitoring data.

In order to bring the national monitoring programmes in accordance with the requirements of the WFD, monitoring of biological quality elements is increasingly being applied. More stations representing reference conditions have also been added to the surveillance monitoring since 2009. The programmes also cover all common water types. As a result, this provides a better basis for the ongoing development of the national classification system, with special emphasis on quality elements that have not yet been intercalibrated.

Many of the monitoring programmes have been expanded geographically to include all River Basin Districts. Further, more extensive use of grouping of water bodies (representative monitoring) has been introduced, i.e. monitoring of a single water body, which represents other water bodies of the same water type and pressure situation within a region. This will significantly improve the portion of water bodies classified on basis of monitoring data.

The following chapters' gives an overview of all WFD-relevant monitoring in Norway, both current monitoring and monitoring initiated in 2015.

Surveillance monitoring

The Norwegian Environment Agency is responsible for all surveillance monitoring at national level. The purpose is to monitor reference conditions in different water types and long-term changes resulting from widespread anthropogenic activity. The monitoring covers all biological quality elements, supporting physico-chemical quality elements and specific pollutants.

Surveillance monitoring consists currently of six national programmes:

- Ecosystem monitoring in coastal waters
- Ecosystem monitoring in freshwater, part 1 and 2
- Specific pollutants in coastal waters
- Riverine inputs to coastal waters
- Specific pollutants in large lakes
- Groundwater monitoring

Ecosystem monitoring in coastal waters

The programme started in 2013, and is a continuation of the former "Coastal monitoring programme" (1990 – 2012) covering Skagerrak and the North Sea. Data have been submitted annually since 1990 to OSPAR as part of the "Co-ordinated Environmental Monitoring Programme" (CEMP). Ecosystem monitoring in coastal waters is also a continuation of a four-year study (2009 – 2012) on sugar kelp status in southern Norway.

The programme has monitoring stations in most of the River Basin Districts as shown in table 1 and figure 2. About 50 percent of the stations represents reference conditions.

Table 1: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	3
NO1102	Trøndelag	7
NO1103	Nordland	12
NO1106	Norsk-Finsk	10
NO5101	Glomma	2
NO5102	Vest-Viken	8
NO5103	Agder	14

RBD Code	RBD Name	Number of stations
NO5104	Rogaland	5
NO5105	Hordaland	6

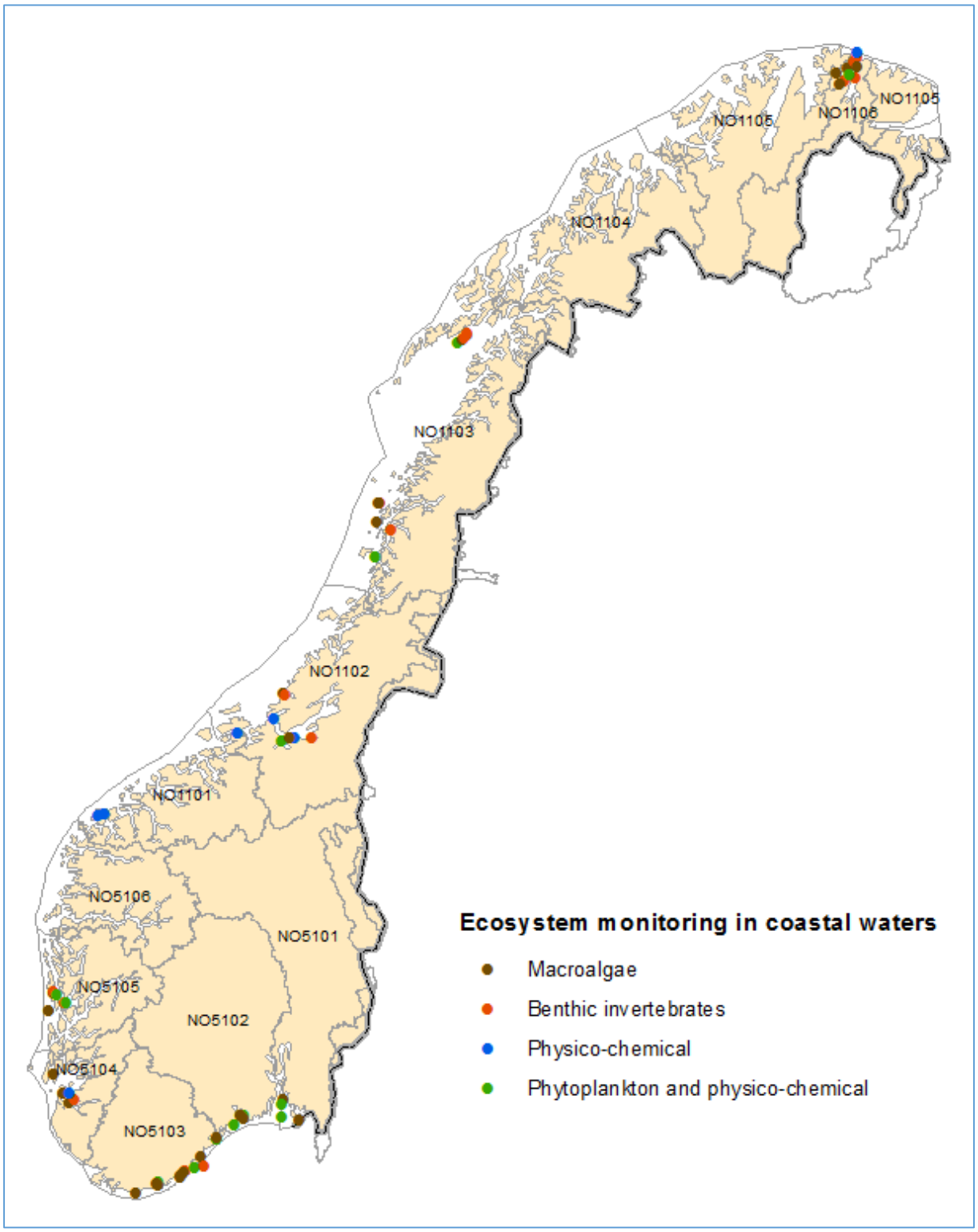

Figure 2: Ecosystem monitoring in coastal waters.

Phytoplankton and physic-chemical quality elements will be monitored on an annual basis, while macroalgae and benthic invertebrates will be monitored every third year. A more extensive monitoring of macroalgae will take place in Rogaland (North Sea south) in 2015 with the purpose to collect data as a basis for further development of the intercalibrated multimetric index RSLA.

Ecosystem monitoring in freshwater. Part 1: Baseline monitoring

The baseline-monitoring programme started in 2009 including lakes that represent reference conditions, as well as a few lakes impacted by acidification and eutrophication. The long-term objective of the programme is to cover all common water types in order to improve the basis for developing classification criteria, including reference conditions. This will also include the northern parts of Norway.

During 2009 – 2012, 24 lakes were sampled twice, i.e. 12 lakes each year. In the period 2013 – 2016, the programme continues with an additional seven lakes annually. We expect that minimum 40 lakes will be a part of this programme at the end of 2016. The programme complies with the monitoring requirements of WFD. All relevant biological quality elements are represented (i.e. phytoplankton, aquatic flora, benthic invertebrate fauna and fish fauna) along with physic-chemical quality elements.

The programme include all River Basin Districts in southern Norway as shown in the table 2.

Table 2: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	2
NO1102	Trøndelag	14
NO5101	Glomma	13
NO5102	Vest-Viken	15
NO5103	Agder	5
NO5104	Rogaland	2
NO5105	Hordaland	5
NO5106	Sogn og Fjordane	1
NOSE5	Västerhavet	2
NOSE2	Bottenhavet	1

A biological monitoring programme in large lakes is being initiated in 2015, i.e. lakes with surface area > 50 km^2. Six large lakes in southern Norway will be monitored in 2015 and another six lakes in 2016. The aim is to continue this monitoring on an annual basis, including all large lakes during a six-year cycle, and to select some lakes for annual monitoring.

Figure 3 shows all lakes, which will have been monitored by 2016, including the large lakes.

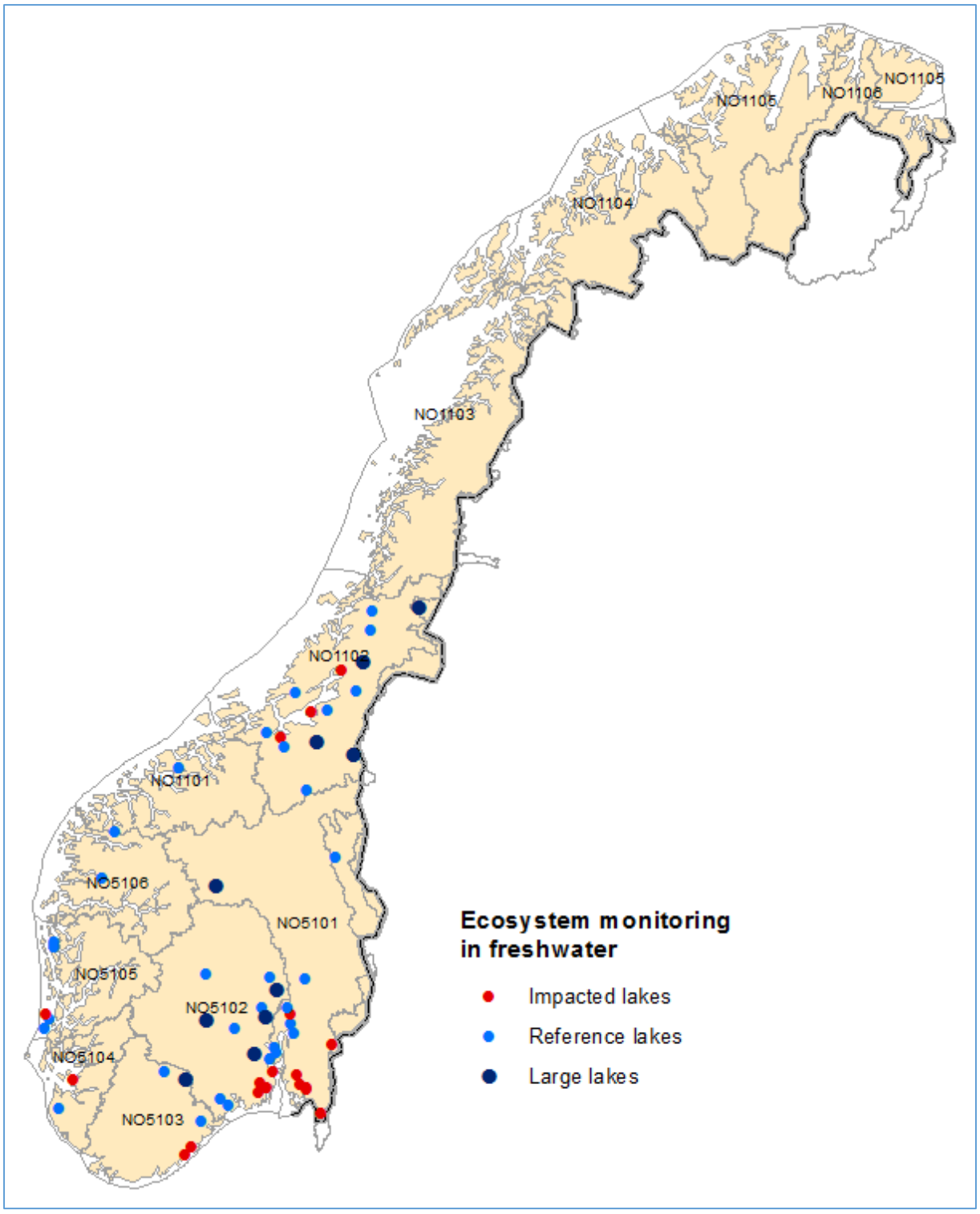

Figure 3: Ecosystem monitoring in lakes – baseline monitoring.

Ecosystem monitoring in freshwater. Part 2: Effects of acidification

The monitoring of ecological effects of acidification in freshwater covers 80 lakes. Most lakes in this programme are located in the acidified areas in southern Norway, and four lakes are located close to

the Russian border in the northeast. A few reference lakes are located in Mid-Norway and northern Norway, with a historical low-level of acidification pressure.

The lakes are monitored with respect to physic-chemical quality elements, but 28 of the lakes are also subject to sampling of the biological quality elements most sensitive to acidification. Another 17 lakes are monitored with respect to biological quality elements, which totals 45 lakes in this category.

This part of the surveillance monitoring is basically a continuation of a previous national monitoring programme on acidification, originally including more than 80 lakes. Several of the lakes have been monitored with respect to physic-chemical quality elements for nearly 30 years and biological quality elements for 20 years. Data on physic-chemical quality elements have been submitted annually to EEA (SoE-reporting).

The programme covers the River Basin Districts as shown in table 3 and figure 4.

Table 3: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	2
NO1105	Finnmark	1
NO1106	Norsk-Finsk	17
NO5101	Glomma	12
NO5102	Vest-Viken	7
NO5103	Agder	24
NO5104	Rogaland	6
NO5105	Hordaland	7
NO5106	Sogn og Fjordane	2
NOSE5	Västerhavet	2

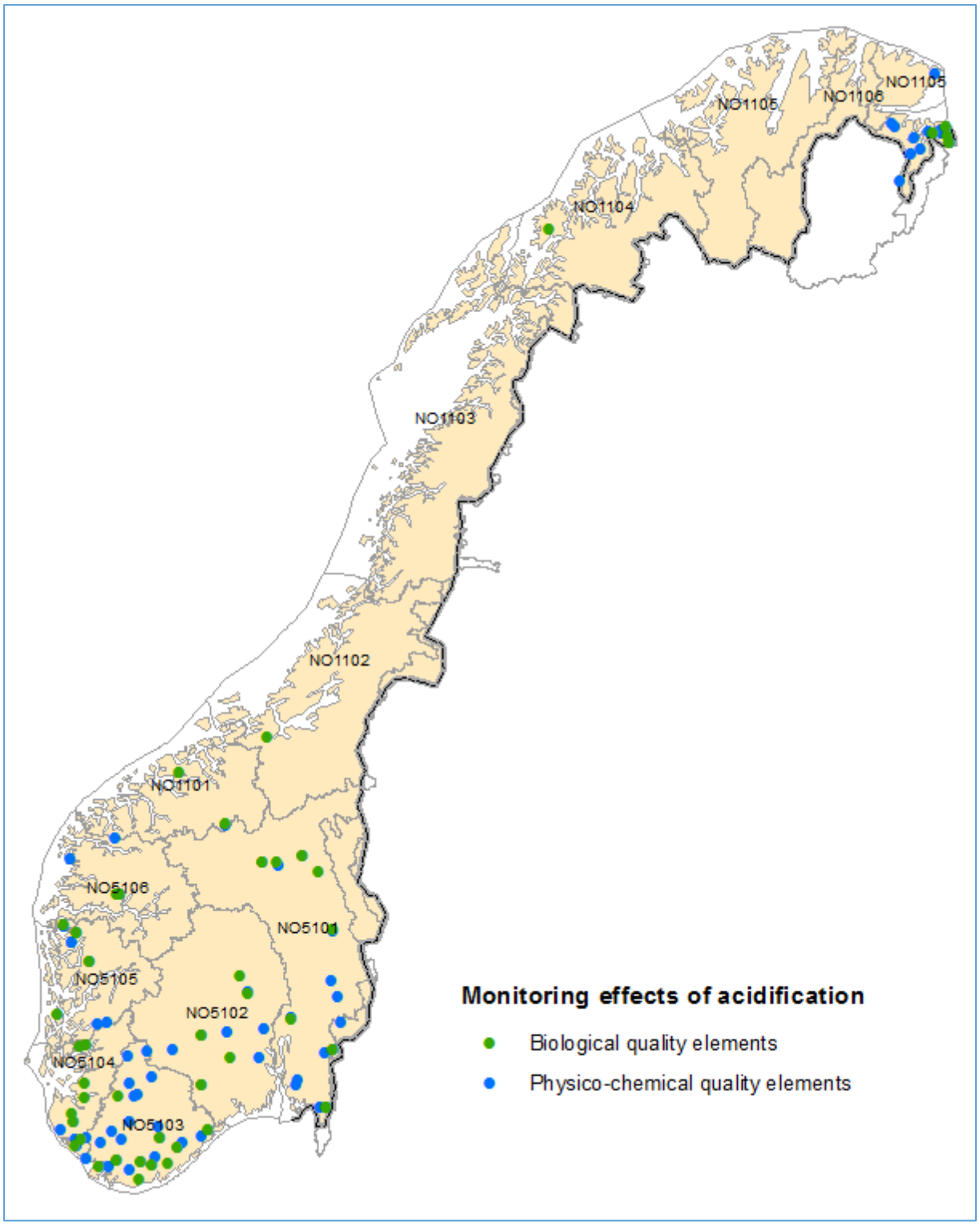

Figure 4: Ecosystem monitoring in lakes – monitoring effects of acidification.

Specific pollutants in coastal waters

The monitoring of specific pollutants along the Norwegian coast was initiated in 2012. It is a continuation of previous monitoring of contaminants in biota, which had been running since 1990. Data have been submitted annually to OSPAR as part of the "Co-ordinated Environmental Monitoring Programme" (CEMP).

The programme covers both priority substances and selected river basin specific substances. Table 4 shows the different substances groups.

Table 4: Number of substances monitored per substances group.

Group of substance	No. of substances	No. of priority substances
Heavy metals	11	4
Polychlorinated biphenyls (PCB)	7	-
DDT	3	1
Polybrominated diphenyl ethers (PBDE)	9	5
Polycyclic aromatic hydrocarbons (PAH)	16	8
Hexabromcyclododecane (HBCD)	3	-
Tetrabrombisphenol A (TBBPA)	1	-
Bisphenol A (BPA)	1	-
Perfluorinated alkylated substances (PFAS)	7	-
Chlorinated paraffins	2	1
Alkyl phenol	2	2
Organotin	4	1
Phosphorus flame retardants (PFR)	14	-
Phthalates	17	1

Samples are mainly collected from biota: fish (cod) and shellfish (blue mussel) in all RBDs, se table 5 and figure 5.

Table 5: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	1
NO1102	Trøndelag	2
NO1103	Nordland	6
NO1104	Troms	1
NO1105	Finnmark	2
NO1106	Norsk-Finsk	2
NO5101	Glomma	11
NO5102	Vest-Viken	8
NO5103	Agder	7
NO5104	Rogaland	1
NO5105	Hordaland	12
NO5106	Sogn og Fjordane	1

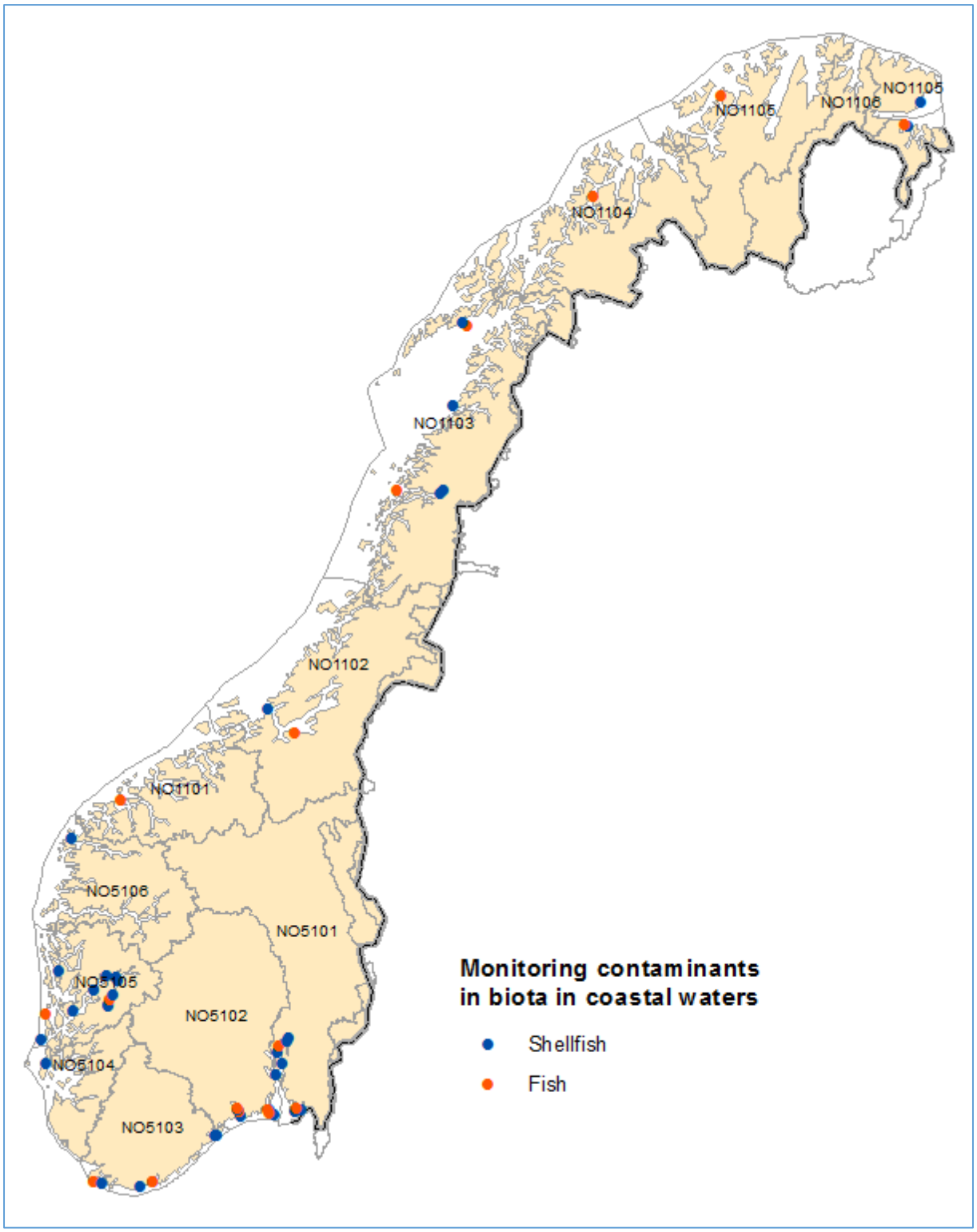

Figure 5: Monitoring of specific pollutants in biota (shellfish and fish) in coastal waters.

Riverine inputs to coastal waters

Riverine inputs to coastal waters have been monitored on an annual basis since 1990 in 10 main rivers and 36 tributary rivers. One additional main river was included in 2013. Data have been submitted annually to OSPAR as part of the "Comprehensive Study on Riverine Inputs and Direct Discharges" (RID). The programme continues in the same manner as previous years with respect to nutrient conditions and heavy metals. Extended sampling of selected organic hazardous substances takes place in three of the main rivers.

The programme focuses on physic-chemical quality elements (nutrient condition) and specific pollutants in water. The main purpose is to get a statistically valid estimate of the discharges of these substances to coastal waters, and to study long-term trends. Despite the fact that no biological quality elements are being monitored, the programme give a good representation of the overall status of whole catchments.

Table 6 shows the different specific pollutants groups included in three of the main rivers. Organic substances are monitored using two different techniques: passive sampling for sampling of freely dissolved contaminants, and continuous flow centrifugation (CFC) for sampling of suspended particulate matter-associated contaminants.

Table 6: Number of substances monitored per substances group.

Group of substance	No. of substances	No. of priority substances
Heavy metals	9	4
Polychlorinated biphenyls (PCB)	7	-
Lindane (γ-HCH)	1	-
Polybrominated diphenyl ethers (PBDE)	9	5
Polycyclic aromatic hydrocarbons (PAH)	16	8
Hexabromcyclododecane (HBCD)	3	-
Tetrabrombisphenol A (TBBPA)	1	-
Bisphenol A (BPA)	1	-
Perfluorinated alkylated substances (PFAS)	25	-
Chlorinated paraffins	2	1

Samples are collected in rivers in all RBDs, se table 7 and figure 6.

Table 7: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	2
NO1102	Trøndelag	7
NO1103	Nordland	4
NO1104	Troms	2
NO1105	Finnmark	1
NO1106	Norsk-Finsk	2
NO5101	Glomma	3
NO5102	Vest-Viken	4

RBD Code	RBD Name	Number of stations
NO5103	Agder	7
NO5104	Rogaland	9
NO5105	Hordaland	1
NO5106	Sogn og Fjordane	5

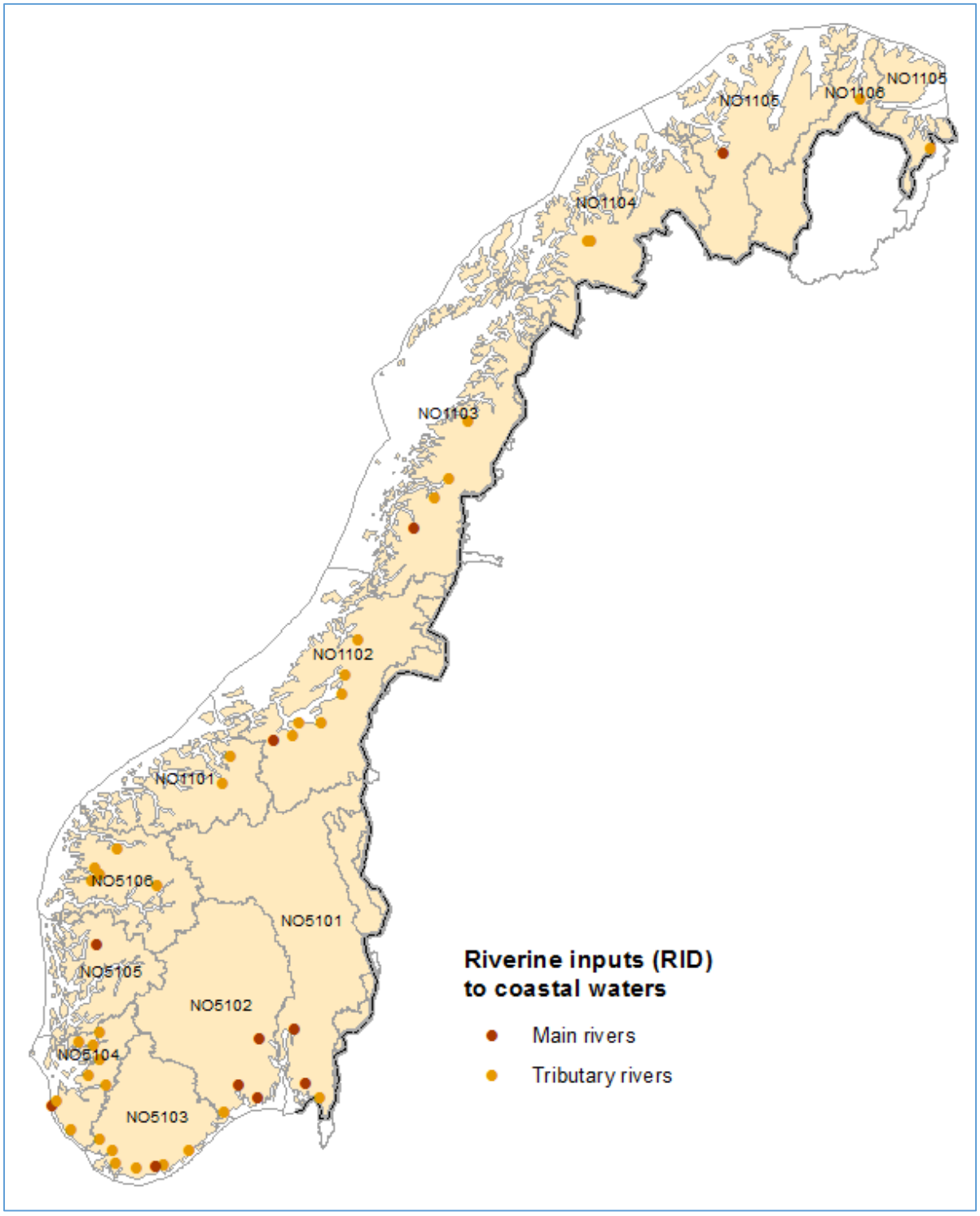

Figure 6: Monitoring of riverine inputs (RID) to coastal waters.

Specific pollutants in large lakes

Surveys of hazardous substances in freshwater fish populations have been conducted at different intervals in different parts of the country for the last 20 years. In 2014, long-term monitoring of hazardous substances in fish populations in large lakes in southeastern Norway was initiated. The main purpose is to study the bioaccumulation of selected substances in large fish populations and the distribution of these substances further down in the food chain. This includes annual sampling in both fish fauna and zooplankton.

Currently this programme cover five large lakes, se figure 7. Two of the lakes are also included in the ecosystem monitoring in freshwater.

Figure 7: Monitoring of specific pollutants in large lakes.

Groundwater monitoring

The Norwegian groundwater-monitoring network (LNG) was established in 1977 as a cooperative effort by the Geological Survey of Norway (NGU) and the Norwegian Water Resources and Energy Directorate (NVE). The purpose is to collect reference data on groundwater conditions represented by temperature, groundwater level and groundwater chemistry. The LNG-sites are located in catchments expected to be insignificantly affected by human activity and not significantly influenced by surface waters like rivers and lakes.

Since 1977, the number of LNG-sites have been increased to improve representation, i.e. different aquifer types, climate and geology. The number of chemical parameters have also increased, and the quality of measurements have improved in the recent years. Since 2003, the programme has also been adjusted to comply with the requirements and needs of WFD.

Today the LNG consists of 65 sites with measurements of groundwater level and temperature operated by the NVE, and 52 sites with measurements of groundwater chemistry operated by the NGU. Of the 52 sites operated by the NGU, 11 are located in bedrock aquifers and the rest in different types of unconsolidated aquifers, se figure 8.

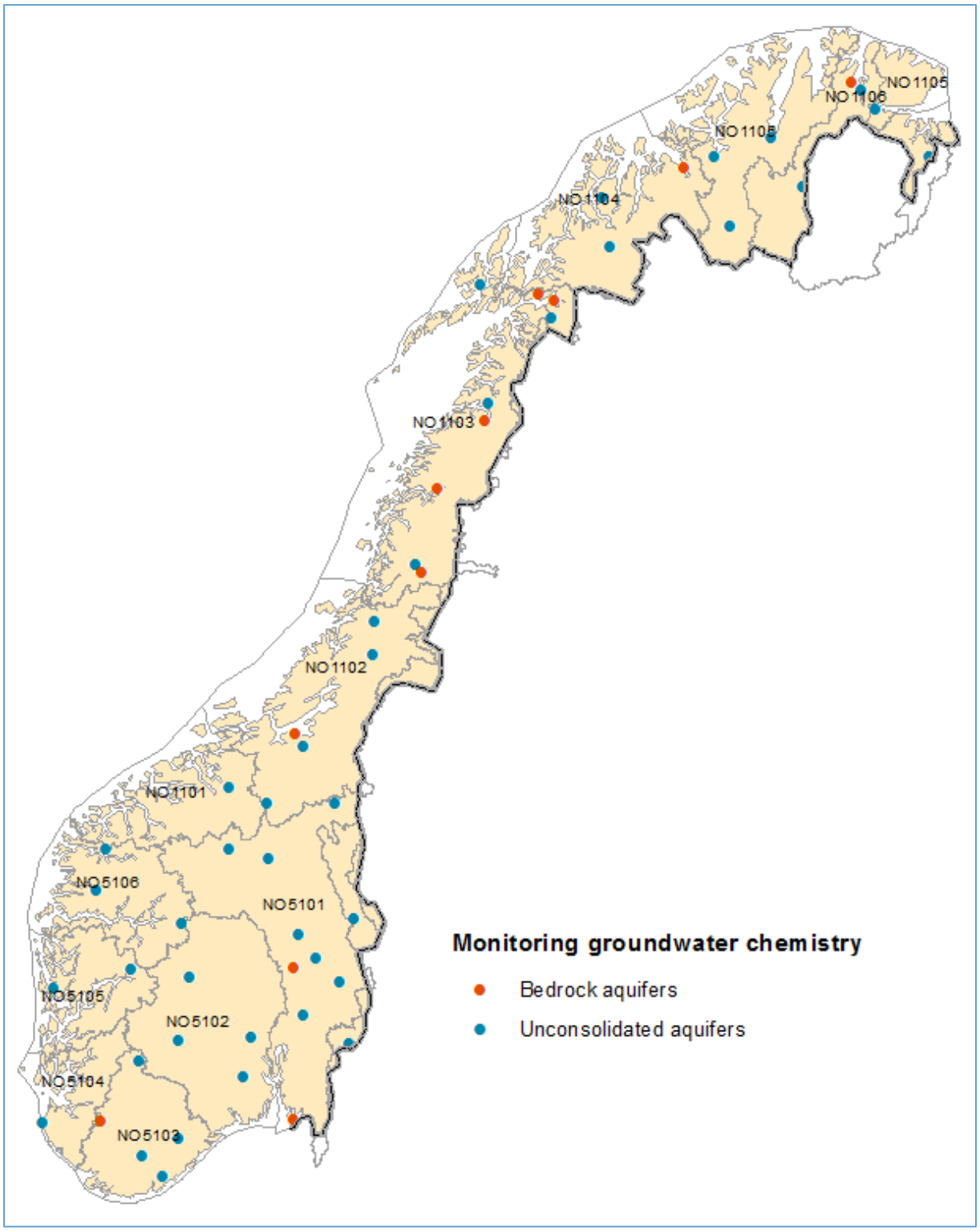

Figure 8: Chemical monitoring of groundwater.

The programme on groundwater chemistry covers the River Basin Districts as shown in Table 8.

Table 8: Monitoring stations per River Basin District.

RBD Code	RBD Name	Number of stations
NO1101	Møre og Romsdal	1
NO1102	Trøndelag	5
NO1103	Nordland	9
NO1104	Troms	3
NO1105	Finnmark	4
NO1106	Norsk-Finsk	4
NO5101	Glomma	9
NO5102	Vest-Viken	4
NO5103	Agder	5
NO5104	Rogaland	1
NO5105	Hordaland	2
NO5106	Sogn og Fjordane	3
NOSE5	Västerhavet	2

Operational monitoring

National regulations enables environmental authorities to apply the polluter-pay principle in order to establish operational monitoring. This is often the case for land-based and offshore industry and aquaculture made possible by strong regulation. In some cases however, it is common to share the cost between national/regional authorities and polluters due to a diversity and complexity of pressures. In special cases, such as liming of rivers and lakes as a measure to compensate acidification and restore fish population, environmental authorities finance all monitoring.

Operational monitoring at national level

Industrial sector

In 2014, the Norwegian Environment Agency ordered 134 of the largest industrial companies to develop and implement monitoring programmes during 2015. Some of these programmes are a continuation of previous monitoring, but most of them are new. The results of these programmes will be reported, and the need of further monitoring will be assessed early in 2016. The main purpose is to determine the ecological and chemical status of the water bodies influenced by the point sources and diffuse sources from these facilities, and if necessary implement measures to reduce the impact.

The monitoring programmes represents a variety of quality elements depending on the type of production and effluent composition. The primary concerns are contaminants in biota and sediment, but benthic invertebrate fauna and macro algae will also be a part of the investigation in some cases. Figure 9 shows the industrial facilities where monitoring will be implemented in 2015.

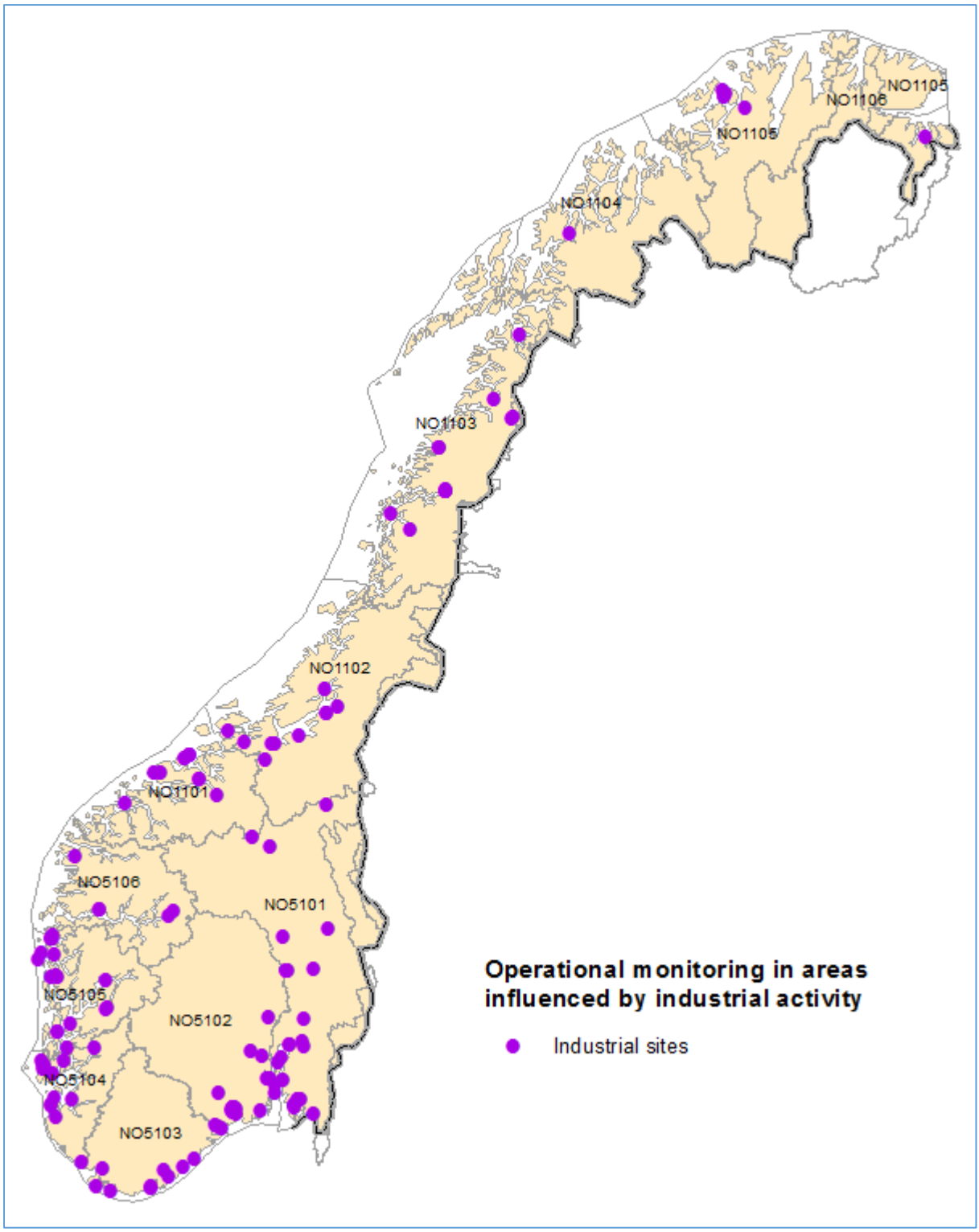

Figure 9: Operational monitoring in areas influenced by industrial activity.

Agricultural sector

The agricultural sector conduct a monitoring programme (The Norwegian Agricultural Environmental Monitoring Programme, JOVA), which covers relatively small catchments (< 10 km^2) dominated by agriculture. The catchments represent the most important agricultural areas in the country with regard to climate, soil and management practices, except from the coastal fjord districts of western and central Norway.

The purpose is to document the environmental effects of different farming systems and agricultural practices. The monitoring takes place at ten different locations, and is focusing on nutrient runoff, soil erosion and pesticide residues in streams and rivers. The programme has been running since 1992, and has established valuable long time-series on nutrient conditions and pesticide residues. However, it does not include biological quality elements.

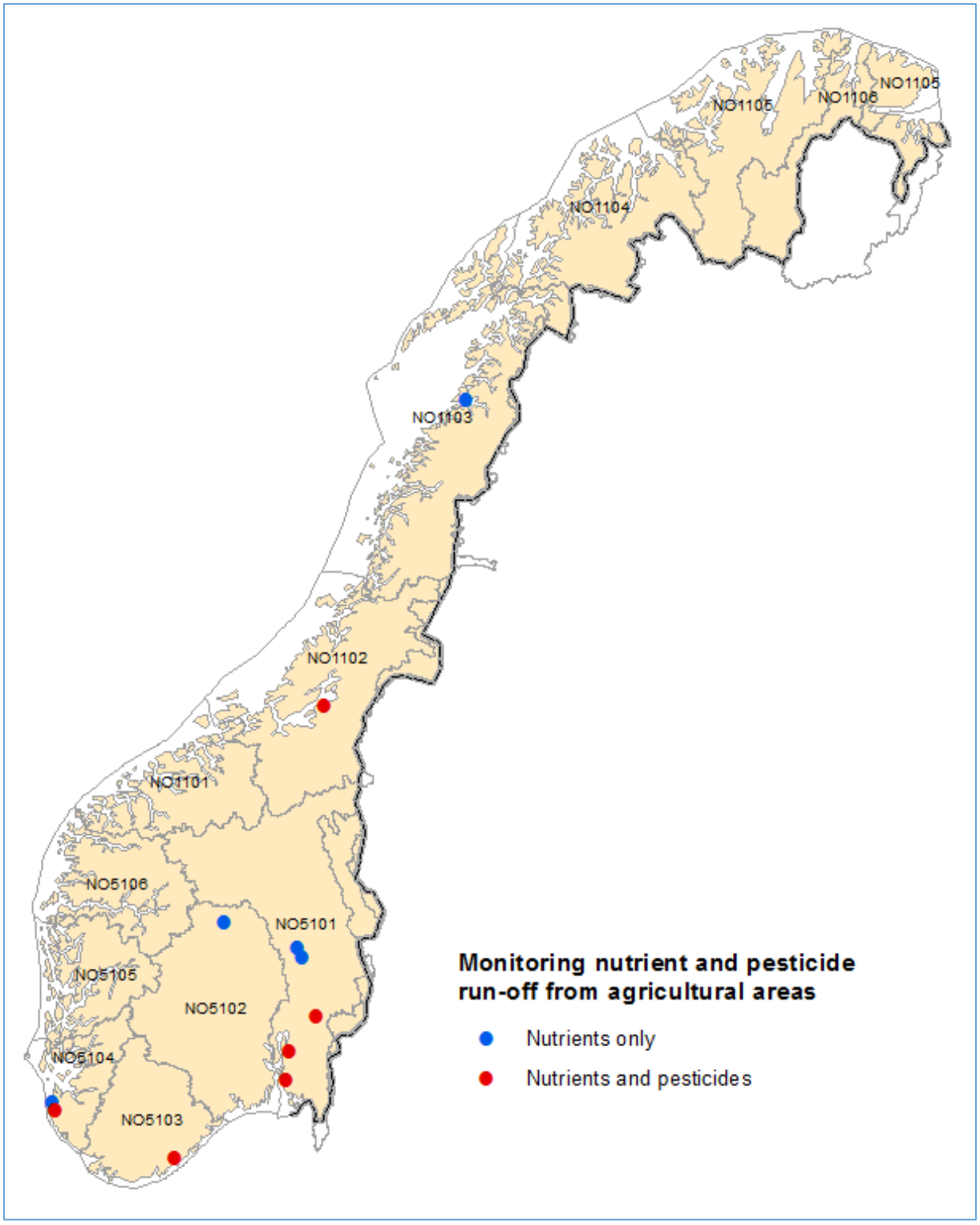

Figure 10: Operational monitoring in agricultural areas.

Aquaculture sector

According to the Aquaculture Act of 2005 and accompanying regulations, monitoring of environmental conditions is required at the sea bottom in the local impact zone, the intermediate impact zone and in the regional impact zone of aquaculture facilities. This applies for sites in seawater. Norwegian Standard NS-9410:2007, "Environmental monitoring of benthic impact from marine fish farms", gives a detailed description of the monitoring requirements, focusing on benthic invertebrate fauna. Monitoring of the local impact zone is required at least every second year depending on the environmental conditions (the B-investigation).

According to annual statistics, "Key figures from aquaculture industry 2013", published by Directorate of Fisheries, the number of sites in seawater for production of Atlantic salmon and rainbow trout was 991. Most of the sites are located between Rogaland (NO5104) in the south to Finnmark (NO1105) in the north. Very few sites are located along the southern coast of Skagerrak.

Monitoring of the regional impact zone of aquaculture facilities (the C-investigation) represents a valuable supplement to the classification of ecological status of coastal water bodies.

Energy sector

Many Norwegian rivers are impacted by hydropower production. All modern licenses for production of hydropower are given with a specific set of terms, under which environmental authorities can instruct the power companies to examine the environmental effects of such activity and implement compensatory measures. This is the basis for operational monitoring in these rivers.

The extent of the investigations is dependent on type of river and the significance of the impact. Fish fauna is considered the most sensitive quality element. The programmes therefore usually include studies of fish fauna, but macro invertebrates, macrophytes or physico-chemical elements may also be included. Table 9 gives an overview of investigative monitoring in salmon rivers impacted by hydropower production.

Table 9: Salmon rivers monitored per River Basin District.

RBD Code	RBD Name	Number of rivers
NO1101	Møre og Romsdal	5
NO1102	Trøndelag	5
NO1103	Nordland	8
NO1105	Finnmark	2
NO5101	Glomma	1
NO5102	Vest-Viken	1
NO5103	Agder	4
NO5104	Rogaland	4
NO5105	Hordaland	14
NO5106	Sogn og Fjordane	9

The Norwegian Water Resources and Energy Directorate (NVE) runs a network of 600 monitoring stations for measuring hydrological parameters, i.e. water flow and temperature in rivers and water level in lakes. About 200 of these stations are operated by NVE. The remaining 400 stations are operated by the power companies. These stations provide important data for the assessment of hydromorhological quality elements and the identification of heavily modified water bodies.

Liming of rivers and lakes

The monitoring of limed rivers and lakes started in 1985. Currently the programme covers 21 salmon rivers in southern Norway exposed to high deposition of sulphur and nitrogen and vulnerable to acidification, se figure 11. The main goal is to document responses to physic-chemical and biological quality elements, and to reach a quality of water required to safeguard the reproduction of salmon in the rivers.

The monitoring of biological quality elements in rivers focus on benthic invertebrate fauna, fish fauna, macrophytes and phytobenthos. In lakes, the biological quality elements of interest are phytoplankton and zooplankton. More than 400 stations are monitored each year, both upstream and downstream the liming facilities.

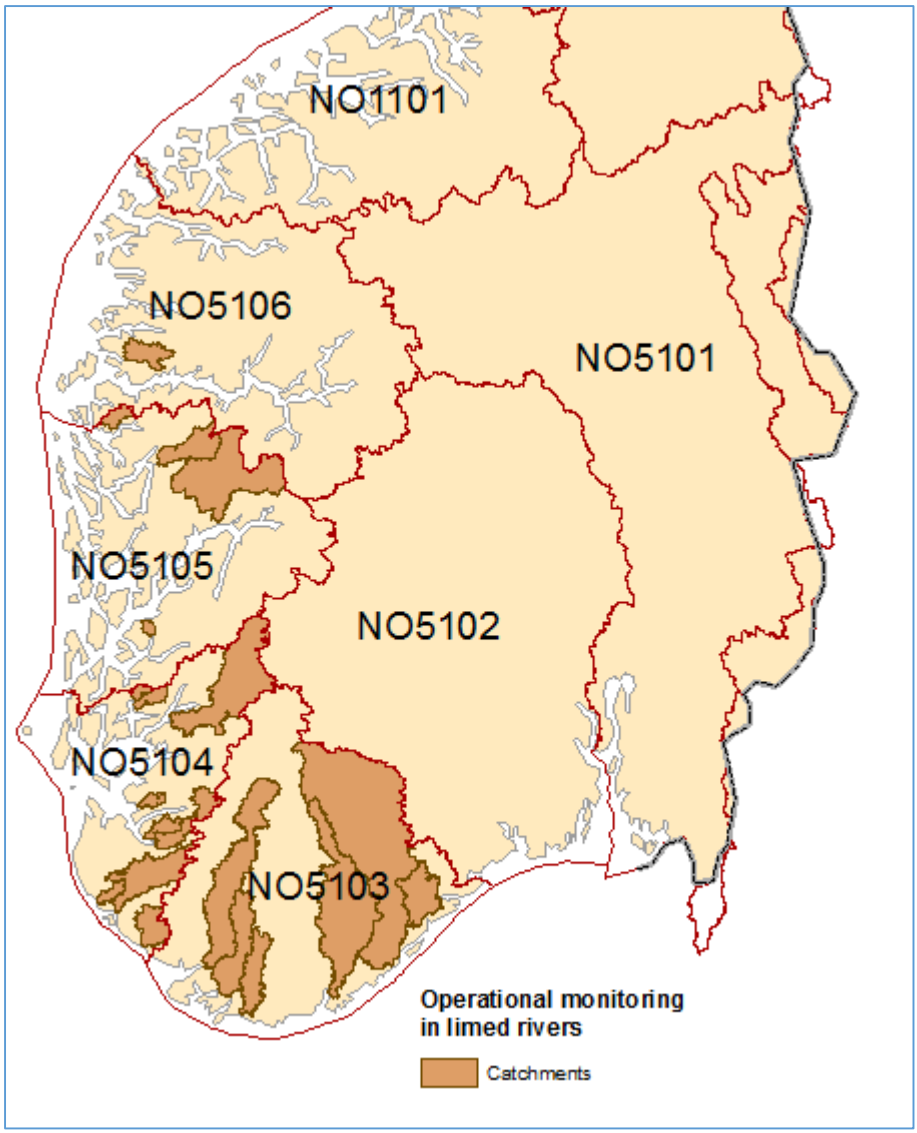

Figure 11: Operational monitoring in limed rivers.

Operational monitoring at regional level

The River Basin Districts authorities are responsible for operational monitoring at regional level, assisted by the County Governors. In many of the RBDs, operational monitoring has been conducted for several years, with emphasis on physico-chemical quality elements.

New programmes are now developed to comply with the requirements of the WFD, i.e. monitoring the biological quality elements most sensitive to the actual pressure. The programmes are being developed on a sub-regional scale and will be launched from 2015 and onwards, provided that the necessary funding becomes available.

Table 10 gives an overview of number of water bodies in each RBD to be monitored in 2015. Most of the water bodies are at risk of not achieving good status within 2021. The number of water bodies are not directly comparable between the RBDs, because some RBDs include representative

monitoring and others not. Besides, some of the RBDs report almost all monitoring at regional level as investigative monitoring, se next chapter.

Table 10: Water bodies monitored (operational) per River Basin District.

RBD Code	RBD Name	Number of WB
NO1101	Møre og Romsdal	181
NO1102	Trøndelag	81
NO1103	Nordland	0
NO1104	Troms	37
NO1105	Finnmark	7
NO5101	Glomma	560
NO5102	Vest-Viken	218
NO5103	Agder	194
NO5104	Rogaland	101
NO5105	Hordaland	55
NO5106	Sogn og Fjordane	24

Investigative monitoring

Investigative monitoring at national level

At national level, investigative monitoring is performed specifically in harbours and fjords to study levels and geographical distribution of pollutants in sediments. In 2007, the Government presented an action plan for polluted sediments in 17 prioritized areas. It was based on the findings from previous county action plans.

The Environmental Departments at the County Governor's offices have been responsible for working out the county action plans for polluted sediments. The Norwegian Environment Agency and the County Governors have a common responsibility to follow up the plans, and to make sure that the most polluted areas along the coast are cleaned up. Environmental authorities apply the polluter-pay principle to finance the adequate restoration measures.

Investigative monitoring in these areas is performed with very dense sampling in order to detect the sources of pollution and to define more exact the area where measures need to be applied. Figure 12 illustrates this for the harbor in the city of Harstad. Some of this monitoring may also be categorized as operational since the main goal is to monitor the effects of implemented measures.

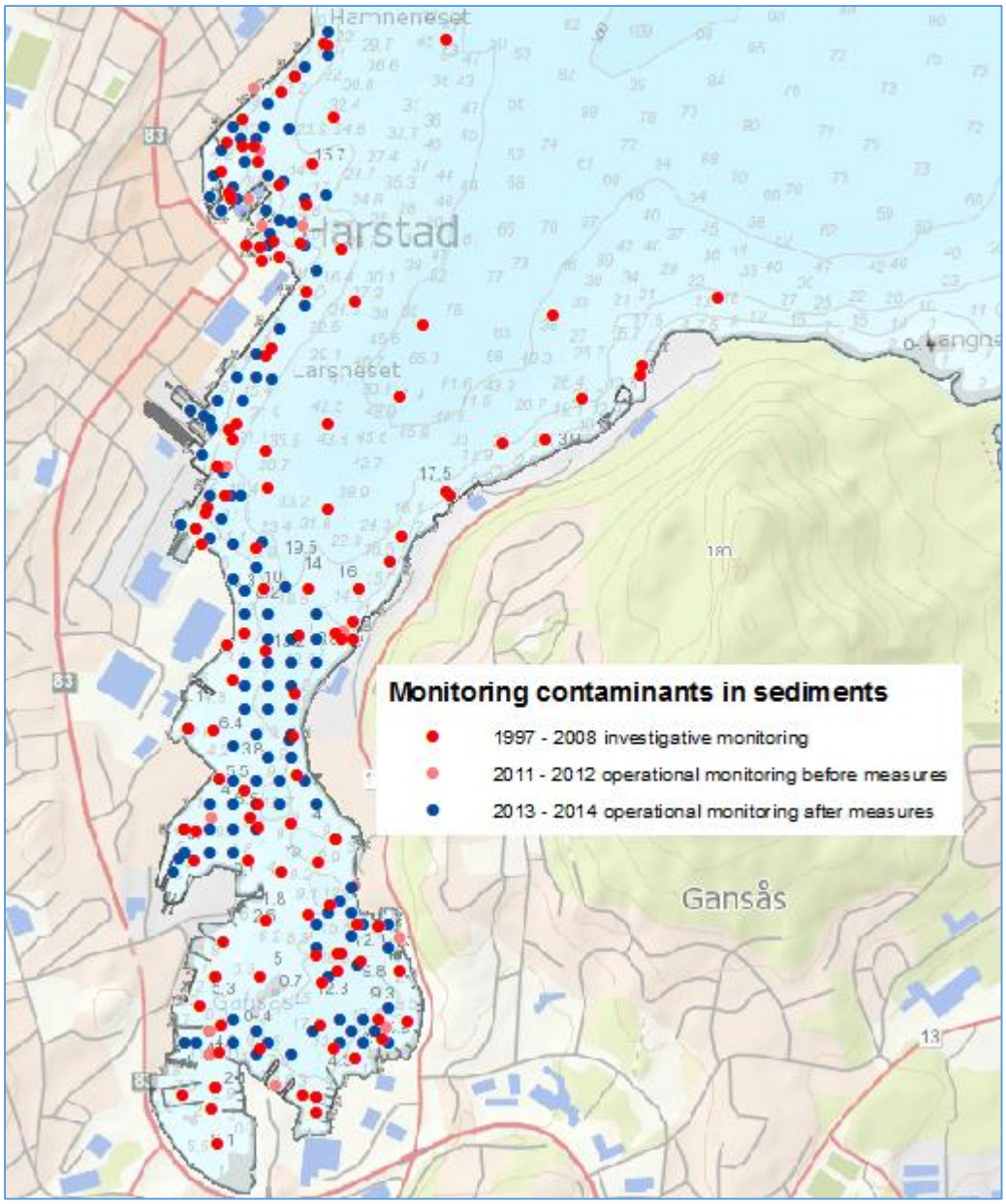

Figure 12: Investigative and operational monitoring of specific pollutants in sediments before and after implementation of measures.

Investigative monitoring at regional level

The River Basin Districts authorities are also responsible for investigative monitoring at regional level, assisted by the County Governors. Table 11 gives an overview of number of water bodies in each RBD to be monitored from 2015 and onwards, provided that the necessary funding becomes available. Most of the water bodies are at risk of not achieving good status within 2021.

Table 11: Water bodies monitored (investigative) per River Basin District.

RBD Code	RBD Name	Number of WB
NO1101	Møre og Romsdal	131
NO1102	Trøndelag	100
NO1103	Nordland	38
NO1104	Troms	35
NO1105	Finnmark	0
NO5101	Glomma	99
NO5102	Vest-Viken	200
NO5103	Agder	30
NO5104	Rogaland	56
NO5105	Hordaland	50
NO5106	Sogn og Fjordane	190

As with operational monitoring, the number of water bodies are not directly comparable between the RBDs, because some RBDs include representative monitoring and others not. Although some of the RBDs investigative monitoring is focusing on physic-chemical quality elements only, the results of the monitoring will increase the precision of characterization of the water bodies.

Protected Areas

Two categories of protected areas have a special relevance in this context: (1) areas designated for the abstraction of water intended for human consumption (Directive 98/83/EC – Drinking Water Directive) and (2) nutrient-sensitive areas, including areas designated as vulnerable zones (Directive 91/676/EEC – Nitrates Directive) and areas designated as sensitive areas (Directive 91/271/EEC – Urban Waste Water Treatment Directive).

About 1600 drinking water treatment plants report data annually to the Norwegian Food Safety Authority. Surface water is the main water source, supplying 57% of the drinking water treatment plants. The surface water based drinking water treatment plants serve 90% of the population, while groundwater waterworks serve the remaining 10%. Monitoring at the water source is carried out in accordance with national regulations with respect to both sampling frequency and parameters to be analysed.

Monitoring in nutrient-sensitive areas is generally undertaken by national programmes (surveillance monitoring) and monitoring at regional level (operational monitoring). In 2012, Norway reported data on water pollution by nitrates according to the Nitrates Directive. Data from 19 sampling stations within Glomma RBD were reported to WISE. Monitoring will continue at nearly all stations in order to compare with data reported in previous reporting periods.