KLIMA- OG FORURENSNINGS-DIREKTORATET

The petroleum sector on the Norwegian Continental Shelf

Guidelines for offshore environmental monitoring

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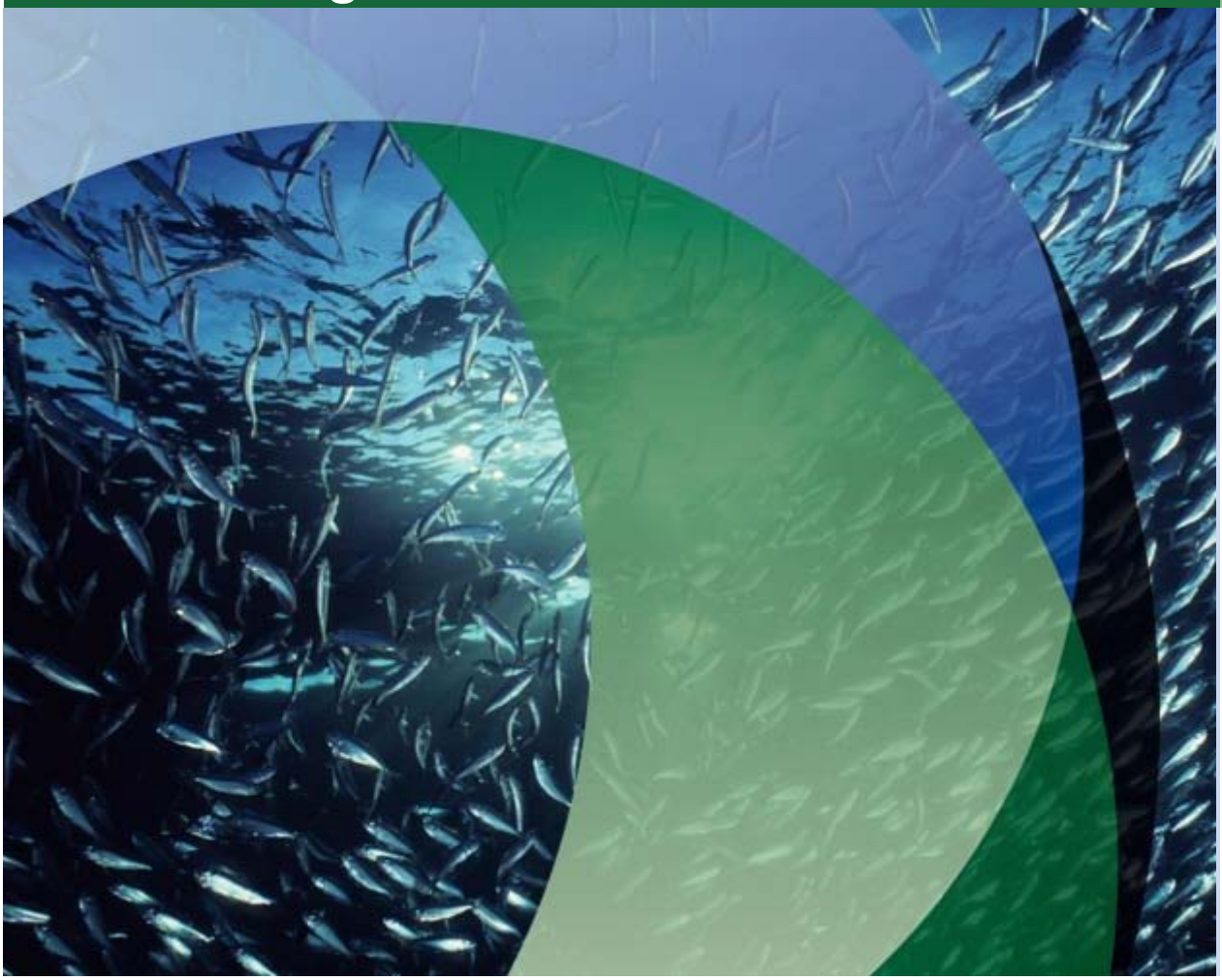

Foreword

Guidelines for offshore environmental monitoring were originally drawn up in 1990 and dealt with monitoring of discharges of oil-based drilling fluids. They were revised in 1997 (after oil-based drilling fluids were phased out) and 1999, and in 2002 were incorporated into the Regulations relating to conducting petroleum activities (the Activities Regulations). With effect from 1 January 2010, the detailed requirements for environmental monitoring have again been removed from the regulations and are set out in these guidelines.

Operating companies are required to carry out environmental monitoring to obtain information on the actual and potential environmental impacts of their activities and to give environmental authorities a better basis for regulating releases of pollutants. These guidelines are intended to provide more detailed instructions on how the general requirements of the regulations can be met.

Environmental monitoring must be carried out within a clear framework in order to provide good results. To be useful, the results must be comparable between years. In addition, monitoring surveys must generally be conducted in the same way across the whole continental shelf so that results from different fields and regions can be compared. The results are also reported internationally.

The changes in the structure of the regulations coincide with a need to make changes in the environmental monitoring regime so that it is more precisely adapted to actual discharges from the fields and their possible impacts. In addition, oil and gas activities have entered into new habitat types, such as areas with coral reefs or sponge communities, where different types of monitoring will be required. Requirements for sampling and analysis of naturally occurring radioactive substances have been included in the guidelines.

One of our goals in preparing these guidelines has been to simplify the methodology and reduce the frequency of monitoring surveys as a response to considerable changes in discharge patterns. In addition, we now know enough about environmental impacts on new fields under development, in order to be confident that under normal conditions, the spread of pollutants and environmental impacts will be limited to the immediate surroundings. In recent years, new field developments have largely used subsea installations.

The general conclusion that can be drawn is that operational discharges, the spread of pollutants and impacts on benthic habitats and the benthic fauna as a result of oil and gas activities have been substantially reduced from earlier levels over the past 10–15 years. However, water column monitoring needs to be further developed because discharges of produced water are continuing to increase.

These guidelines are a result of the cooperation between the Climate and Pollution Agency (Klif), an expert advisory group appointed by Klif, the Norwegian Radiation Protection Authority (NRPA), the Oil Industry association (OLF), oil and gas companies and consultancy firms.

Klif, Oslo, October 2011

Signe Nåmdal
Director, Department of Climate and Industry

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1. Introduction

1.1 Purpose of offshore environmental monitoring

The purpose of offshore environmental monitoring is to provide an overview of environmental status and trends over time as a result of oil and gas activities. Monitoring programmes are intended to show whether the environmental status on the Norwegian continental shelf is stable, deteriorating or improving as a result of the operators' activities. In addition to identifying trends, the results should as far as possible provide a basis for projections for future developments. Environmental monitoring of offshore oil and gas activities includes monitoring of the water column and of benthic habitats (sediments and soft- and hard-bottom fauna). The monitoring results are used by operators and authorities as a source of information and as basis for making decisions on new measures to be implemented offshore. The results will also be used to develop and report on national environmental indicators for the offshore oil and gas industry.

1.2 Requirements for monitoring

Under section 49 of the Act of 13 March 1981 No. 6 concerning protection against pollution and concerning waste (Pollution Control Act), any person that causes pollution has a duty "to provide the pollution control authority or other public bodies with any information necessary to enable them to carry out their tasks pursuant to this Act". Further, under section 51 of the Act, Klif and NRPA have the power to order investigations to "determine whether and to what extent the activity results in or may result in pollution". Specific requirements relating to environmental monitoring are set out in sections 52, 53, 54, 55 and 56 of the Activities Regulations for the oil and gas industry, which deal with environmental surveys of the water column and benthic habitats, and cooperation between operators within the same region.

Authorities can carry out inspection and control of environmental monitoring activities, in the same way they do for other activities regulated by environmental and radiation protection legislation. This applies to all stages, from planning of the surveys to the use of the results by individual operators to improve their environmental performance.

1.3 The purpose of these guidelines

Detailed requirements for environmental monitoring on the Norwegian continental shelf were previously incorporated in the Activities Regulations. As part of the legislation simplifying process and in order to provide more flexibility when changes are needed, the detailed descriptions of monitoring procedures have now been transferred from the regulations to the present guidelines. The regulations contain general requirements, while the guidelines provide more detailed instructions on how the requirements can best be met.

The guidelines deal with the required scope of the monitoring activities, the parameters that are to be analysed, the methods that should be used, necessary accreditation, and templates for reports.

The authorities intend these new guidelines to be a dynamic document that can be more easily adjusted according to shifting needs

1.4 Development of monitoring programmes and cooperation

Operators in a region where monitoring is planned are responsible for drawing up draft water column and benthic habitat monitoring programmes. OLF has its own environmental monitoring expert group which coordinates the planning, implementation and reporting of environmental surveys on behalf of the operators. Operators are required to base their environmental monitoring programmes on the requirements of the regulations and on the instructions given in these guidelines. The draft programmes are presented, discussed and assessed at annual planning meetings of Klif, an expert advisory group appointed by Klif, NRPA, OLF and relevant operators. Consultants also take part in these meetings as needed. The scope of the final programme is decided on the basis of the discussions at these meetings. The operators make the necessary corrections to the draft and send the final programme to Klif. This cooperation to determine the final content of environmental monitoring programmes makes it possible to review both positive and negative experiences gained from earlier surveys.

It may be appropriate to require additional monitoring surveys in certain areas, for example in nearshore waters or in areas where vulnerable species and habitats have been identified or there is reason to believe they may occur. The operators are responsible for identifying the need for additional surveys. For example, modified baseline surveys are being carried out in the Barents Sea in response to new rules governing discharges (2011). Plans for such surveys are drawn up by the operator(s) in consultation with Klif, NRPA and relevant working groups in the OLF.

A forum for offshore environmental monitoring is held annually. This is a working meeting where operators and consultants are invited to present both the most recent results (from the previous year's surveys) and future plans. The forum also provides an opportunity for lectures and discussions on current issues related to offshore environmental monitoring. The meetings are held alternately by Klif and OLF.

Final reports on conducted monitoring surveys are published on Klif's website (www.klif.no) after the Agency has approved them and they have been presented at the forum for offshore environmental monitoring.

1.5 Description of the environmental monitoring regime

1.5.1 Monitoring of the water column

According to section 55 of the Activities Regulations, monitoring of the water column consists of two main elements, **condition monitoring** and **impact monitoring**. Monitoring activities must be carried out in a way that makes it possible to verify the risk that pollutant discharges from oil and gas activities will impact the pelagic environment. The scope of the monitoring programme must be proportional to the expected risk. Samples for analysis of naturally occurring radioactivity in the water column will be taken in conjunction with regional sediment monitoring.

Condition monitoring applies to fish and surveys are required every three years. The monitoring is intended to document to what extent fish from Norwegian waters are affected by pollution from the oil and gas industry. The analyses are required to include measurements of hydrocarbons (NPD/PAHs) and selected biomarkers in fish. The scope of the surveys is determined by Klif, and surveys are to be carried out in eight regions as shown in Figure 3.1. However, priority will be given to those areas believed to be most heavily polluted and to attractive nursery areas for fish where there is also substantial oil and gas activity with consequently higher discharges.

Impact monitoring must as a minimum include fish and mussels. The scope of the surveys is determined by Klif each year. Impact monitoring surveys have so far been carried out in four regions (see Figure 3.1), but the inclusion of region 5 in the programme should be considered. As part of the environmental monitoring regime, the operators are required to take part in the development of methods for impact monitoring in the water column.

Impact monitoring is based on exposing organisms placed in cages to produced water. The positioning of the instrument rigs is determined on the basis of realistic dispersal models. Selected rigs should be equipped with flow meters and passive samplers. To obtain better information on dispersal a minimum number of cages should be placed in all directions from the discharge point. The preferred species is the blue mussel, but fish may also be appropriate in some cases. Biomarkers for assessing exposure and possible impacts are constantly being developed. A set of key methods should be included in the impact monitoring programmes, but adaptation of the methodology to take account of new knowledge should be taken into account during the planning process. Table 3.3 gives an overview of current methods.

1.5.2 Monitoring of benthic habitats (sediments and soft- and hard-bottom fauna)

According to sections 53 and 54 of the Activities Regulations, monitoring of benthic habitats consists of two main elements:

- **Baseline surveys**, which are required before exploration drilling in new areas and before production drilling.
- **Field-specific** and **regional monitoring programmes**, which normally begin after production has started. (Field-specific monitoring programmes form part of the regional programmes, and are carried out at the same time.)

The Norwegian continental shelf has been divided into eleven geographical regions for monitoring of benthic habitats (see Figure 4.1). As a general rule, each region should be surveyed every third year, and the surveys should alternate between regions. The scope of the monitoring programmes must be related to the level of offshore activity in the region. Monitoring of new activities is additional to and must be adapted to existing monitoring activities. If large variations in depth and/or type of sediment indicate that it is necessary, regions should be divided into subregions. The subregional divisions established in regions that have already been surveyed should not be changed without good reason.

Samples from the regional and field-specific stations in one region are to be taken during the same survey. The regional stations are intended to provide information on general background levels in the area for the parameters that are monitored and to function as reference stations for the expected normal situation. The field-specific stations are intended

to provide information on environmental status near the facilities in each region. Samples are primarily to be analysed for petroleum hydrocarbons, metals, naturally occurring radioactive substances and fauna composition.

In addition to investigating the horizontal extent of any impacts around oil and gas installations, vertical sectioning of the sediment samples should also provide an estimate of how deep into the sediment drill cuttings and drilling fluid are present and whether a natural recovery process is taking place.

As a general rule, an approved grab type sampler must be used to collect samples of sediments and the benthic fauna. However, in some cases, a grab may not be suitable:

- in areas where there are coral reefs or sponge communities;
- in areas where the seabed habitat is heterogeneous – a mixture of rock, stones and gravel with some soft-bottom areas;
- when monitoring discharges from the top-hole section after drilling; in such cases, there is so little dispersal that traditional sampling methods cannot convey the extent of the impacts.

In such areas, visual surveys will be needed, using remotely operated or towed observation gear. Remotely operated vehicles (ROV) are preferable because they provide more flexibility during a survey. In addition, visual surveys will be needed as a supplement to traditional methods of environmental monitoring in areas that are defined as vulnerable (e.g. the Barents Sea).

The overall purpose of environmental monitoring is to describe whether and to what extent releases from oil and gas activities have had impacts on a sampling station, a larger area around an installation, or a region. It is important that environmental monitoring results can be used to verify the predictions and conclusions of the environmental impact assessments (EIAs) for individual fields and the region as a whole.

1.6 Quality assurance

Documentation of the requirements below should be obtained before oil and gas companies award contracts in connection with environmental monitoring (the environmental survey programmes sent to Klif and NRPA must refer to such documentation, which must be produced on request).

- All suppliers of services for monitoring programmes (analyses, field work) must have ISO 17025 accreditation for the methods they use. The certification should be awarded by Norwegian Accreditation or an equivalent accreditation body in another country. If no official accreditation scheme is available in a particular area, Klif or NRPA, depending on the type of analyses involved, may make exemptions from this rule. This applies for example to new methodology for water column monitoring. Suppliers must also document their own quality assurance routines.

- The operating companies' reports to the authorities must confirm that the requirements above are fulfilled, with reference to the qualification system, certificates and approval date.

2. Definitions and abbreviations

Background levels:
Concentrations of selected parameters (hydrocarbons, metals, radioactive substances) at the regional stations in each region, which are meant to provide levels as close as possible to the natural concentrations in the area.

Baseline survey:
The first environmental survey of an area or locality to obtain information on its chemical and biological status before a new activity starts.

Biological impact: (OK)
This is indicated in an area if the fauna in a sample is significantly different from that at comparable regional stations in the same region. Calculations of biological impact are based on an overall evaluation of all the statistical analyses carried out on the biological material.

C_1-C_3 alkyl homologues:
A group of isomers in which the hydrogen atoms in the ring system of aromatic hydrocarbons are substituted with a methyl group (C_1), with two methyl groups or one ethyl group (C_2), and with three methyl groups or one methyl and one ethyl group or one propyl group (C3).

CEMP:
Coordinated Environmental Monitoring Programme, one of several OSPAR programmes under the JAMP. It includes monitoring of many of the contaminants that are included in Norway's offshore environmental monitoring. Analyses of sediments, mussels and several fish species from stations all along the Norwegian coast are carried out as part of the CEMP.

Chemical contamination:
Present in areas where the levels of the selected metals, radioactive substances and/or hydrocarbons are significantly higher than the expected background level (see the latter and LSC).

Concentration field:
A geographical area where the concentration of a contaminant exceeds a specific level

Condition monitoring:
Mapping of concentrations and/or effects of petroleum-related compounds in selected free-living/wild-caught fish species.

Ecologically sensitive area:
A geographically delimited area containing one or more natural resources (species and habitats) that are sensitive to a particular pressure and that at best will need a long recovery period to return to a normal state after significant damage.

Environmental Monitoring Database (MOD):
A database containing data from the environmental monitoring programmes for the Norwegian continental shelf. It can be accessed at:
http://projects.dnv.com/MOD/Default.aspx?TOOL=HJEM

Grid:
A grid design is used to determine locations for the sampling stations if the position of the oil/gas field has not yet been established or if obstacles on the seabed make it impossible to use a radial transect design.

Impact monitoring:
Mapping of pollutants or biological effects of pollutants using organisms placed in cages near selected installations.

JAMP:
Joint Assessment and Monitoring Programme: an international monitoring programme run by OSPAR, with joint guidelines for planning, implementation, analysis and reporting.

Kurtosis:
A measure of how peaked or flat the distribution of data is relative to a normal distribution. High kurtosis indicates that the data distribution has a narrower peak than expected for a normal distribution. Used in evaluating grain size distribution.

Limit of significant contamination (LSC)
A statistically calculated limit for chemical contamination, based on background levels from regional/subregional stations.

Macrofauna
Organisms larger than 1 mm (*i.e.* that are retained on a 1 mm sieve)

Megafauna
Organisms larger than 20cm

Meiofauna
Organisms in the size range of 0.063–1 mm. Generally refers to specific groups of organisms (foraminifera, nematodes, harpacticoid copepods, etc.)

Monitoring of benthic habitats
Physical, chemical and biological investigation of the seabed

Monitoring survey
A routine investigation of environmental conditions in a field or region conducted after production drilling has started.

Multivariate analyses
Statistical analyses that handle more than one variable in the same analysis and look for trends across several dimensions at once

NPD
The sum of naphthalene, phenanthrene, dibenzothiophene and their C_1-, C_2- and C_3 alkyl homologues

PAHs
Polycyclic aromatic hydrocarbons: all hydrocarbons in which the molecule contains three or more aromatic rings. Hydrocarbons with only two aromatic rings are often included as well.

Plankton
Organisms that spend all or part of their life cycle floating or drifting in the water and that have little or no independent mobility.

Radioactive substance
A substance that emits alpha, beta or gamma radiation

Radial transect
A radial transect design consists of two axes placed perpendicular to one another with the installation at the origin and the main axis in the prevailing direction of current flow.

Region
A delimited area of the continental shelf defined by geographical coordinates. The boundary towards the shore follows the coastal baseline.

ROV
Remotely operated underwater vehicle carrying a video camera, which can often be equipped with extra equipment such as sonar, sensors, a manipulator and sampling equipment.

THC
Total hydrocarbon content: content of all hydrocarbons in the material within a particular range of carbon chain lengths (n-C_{12} – n-C_{35}), both those formed biologically and those originating from oil and other sources of pollution.

TOM
Total organic matter (applies to sediment) – refers to all combustible material containing organic carbon.

Water column
The marine environment from the water surface to the surface of the sediment

Water column monitoring
Mapping of pollutants or biological effects of pollutants, using caged or wild-caught organisms

3. Water column monitoring

3.1 Deadlines

3.1.1 Programmes

Final programmes for condition monitoring of the water column must be sent to Klif by 1 April of the year in which the surveys are to be carried out, see section 55 of the Activities Regulations. For impact monitoring, the deadline for submitting programmes is agreed upon function of when the surveys are to be carried out. Condition monitoring must be carried out in autumn, and always outside the spawning period for the fish species in question, preferably in October (JAMP Guidelines for Monitoring Contaminants in Biota, 1997). The timing of field work for impact monitoring of the water column depends on the analyses that are to be carried out, and is decided for one year at a time. Table 3.1 shows deadlines for submitting programmes, carrying out field work and reporting.

3.1.2 Reporting

The deadline for delivering final reports on impact monitoring to Klif is 1 April of the year after the surveys. The deadline for delivering final reports on impact monitoring is agreed upon in relation to survey timing.

Table 3.1 *Deadlines for submission of programmes and reports for offshore water column monitoring*

Type of survey	Activity	Deadline
Condition monitoring	Submission of programmes	April 1st
	Field work	August-December
	Reporting	April 1st
Impact monitoring	Submission of programmes	April 1st or as agreed with Klif
	Field work	Depends on type of investigation
	Reporting	April 1st or as agreed with Klif

If during surveys or sample processing results are obtained that deviate substantially from the expected status or trend, this must be immediately reported to Klif.

3.2 Survey frequency and sampling pattern

3.2.1 Condition monitoring

As a general rule, condition monitoring surveys are required at three-year intervals. Grounds must be given for any modification of the monitoring frequency, which must be approved by Klif.

3.2.2 Impact monitoring

Impact monitoring is required in at least one region a year. So far, surveys have been carried out in three regions: Ekofisk, Sleipner and Tampen (see Figure 3.1 and Table 3.2). The number of regions included will increase as activities expand in new areas. Klif and the operators involved agree on which fields in the regions are to be monitored.

To improve the monitoring methodology and the basis for result interpretation, operators may in consultation with Klif be permitted to replace one year's water column monitoring programme with laboratory studies or literature studies on individual substances or groups of substances.

3.2.3 Sampling areas and station network

As a basis for **condition monitoring**, operators must obtain up-to-date information on the distribution and migratory patterns of the fish populations in the target area.
The choice of station network design for **impact monitoring** in each region must be based on knowledge of the physical conditions in the area and calculations of concentration fields for relevant pollutants.

There is no requirement for baseline surveys for water column monitoring.

The sampling pattern for **condition monitoring** must be such that it gives a representative picture of the most important fish species in the region. Figure 3.1 and Table 3.2 show the regions where condition monitoring should be conducted. There are reference stations in Egersundbanken and in the Barents Sea.

The number and location of the instrument rigs deployed for **impact monitoring** must be such as to provide the best possible picture of the situation of the selected field in the region. Any need for changes or an expansion of the station network must be discussed in the report following each survey.

Table 3.2 *Regions for possible condition and impact monitoring of the water column. The Tampen region corresponds to regions III (Oseberg) and IV (Statfjord) used in water column monitoring.*

Region/fields*	**Type of monitoring (C = condition, I = impact)**	**Area of region, thousand km^2**
North Sea		
1. **Ekofisk** *56-58 °N* ***Ekofisk**, Eldfisk, Embla, Tor, Valhall, Hod, Ula, Tambar, Tambar Øst, Gyda, Oselvar og Yme*	C & I	52
2. **Sleipner** *58-60 °N* ***Sleipner** Øst og Vest, Gungne, Glitne, Sigyn, Balder, Jotun, Grane, Alvheim, Heimdal, Skirne, Ringhorne Øst, Varg, Vale, Vilje, Volund, Volve og Gudrun*	C & I	49
3 and 4. **Tampen** *60-62 °N* ***Oseberg**, Oseberg Sør og Øst, Brage, Tune, Troll I og II, Fram, Huldra og Veslefrikk* ***Statfjord**, Statfjord Nord og Øst, Snorre, Tordis, Vigdis, Sygna, Kvitebjørn, Gullfaks, Gullfaks Sør, Gimle, Gjøa, Visund, Vega og Vega Sør*	C & I	35
Norwegian Sea		
5. **Møre** *62-64 °N* *Ormen Lange*	C	71
6. **Halten Bank** *64-66 °N* *Alve, Njord, Draugen, Åsgard, Heidrun, Mikkel, Morvin, Kristin, Skarv, Norne, Urd, Tyrihans, Yttergryta og Marulk*	C	96
7. **Nordland** *66-68 °N*	C	95
8. **Tromsø** *68-70 °N*	C	31
Barents Sea		
9. **Finnmark** *70-72 °N* *Snøhvit, Goliat*	C	85

* In accordance with *Facts: the Norwegian Petroleum Sector 2011*, published by the Ministry of Petroleum and Energy.

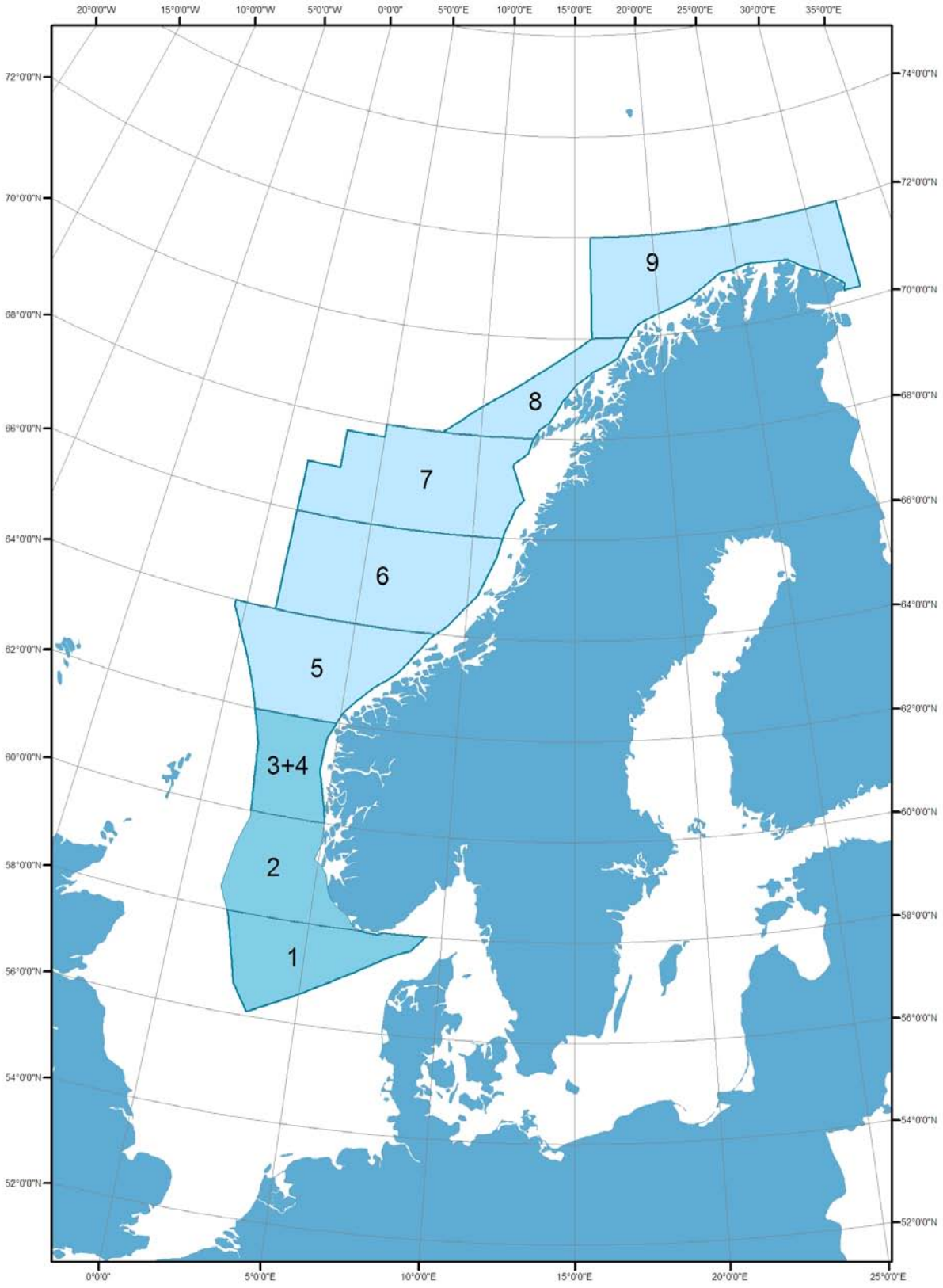

Figure 3.1 *Region divisions for condition and effect monitoring of the water column. Condition monitoring is carried out in all eight regions, while impact monitoring is currently carried out in the three southernmost regions (darker blue).*

3.3 Analytical parameters

3.3.1 Biological parameters

The fish species to be included in **condition monitoring** are determined in consultation with Klif and must be listed in the monitoring programme. Representative species from areas where there is oil and gas activity, for example cod and haddock, are to be collected and analysed. Other species may also be included in the surveys. In addition to the chemical parameters (see below), analyses should include a selection of biomarkers that are indicative of exposure to pollutants and any adverse effects on fish.

The organisms to be used for **impact monitoring** will be specified in the monitoring programme. Experience shows that blue mussels (*Mytilus edulis)* should be used. So far, the only fish species used has been cod. The monitoring programme must also specify which biomarkers and other biological parameters are to be included.

3.3.2 Chemical parameters

Condition monitoring must include analyses of the content of NPD/PAHs in fish fillet because of the food safety implications of these pollutants. Even though levels above the detection limit have seldom been found, analyses for these compounds are still required in areas where the impacts of oil and gas activities are believed to be greatest. Measurements of various biomarkers are also required to determine whether fish in areas where there is oil and gas activity have been exposed to pollutants released from these activities. Specifications are to be drawn up in the draft programme, discussed at the annual planning meeting and documented in the final monitoring programme.

The chemical parameters to be investigated under **impact monitoring** must be specified in the draft programme, discussed at the annual planning meeting and listed in the final monitoring programme.

3.3.3 Other investigations

If Klif considers it necessary, further water column investigations regarding environmental status and impact of pollutants may be required near oil and gas fields. Such investigations can be initiated through agreements between Klif and operators or consultants.

3.4 Sample collection and processing

3.4.1 Sample collection

Procedures for sample collection and processing for **condition monitoring** are described in the *JAMP Guidelines for Monitoring Contaminants in Biota* (1997).

Sample collection methodology for **impact monitoring** is described in the yearly updated requirements drawn up in the monitoring programmes.

3.4.2 Sample processing

Fish that are investigated as part of **condition monitoring** must be kept alive until samples are taken for biochemical analysis. Working surfaces used for sample processing must be clean, and the samples must be handled in a way that minimises the risk of sample

contamination on board the vessel. The procedures followed must be documented and reported. For general procedures, see the *JAMP Guidelines for Monitoring Contaminants in Biota* (1997). More specific procedures are described in the monitoring programme.

The methodology for sample processing together with the sample collection procedures for **impact monitoring** are described in the yearly updated requirements drawn up in the monitoring programmes.

3.4.3 Sample preservation

Samples taken for chemical analysis as part of **condition monitoring** surveys must be frozen to at least -20°C as soon as possible and stored at this temperature until analysis. All other samples for both **condition** and **impact monitoring** must be treated according to the specifications in the monitoring programmes.

3.5 Analytical methods

All analytical methods must be documented. The programmes for **condition** and **impact monitoring** must include detailed descriptions of the analytical design, methods and reporting format.

Table 3.3 *Overview of relevant methods for water column monitoring*

Method	Tissue type/ matrix	Substance/ group of substances	Organisms
PAH metabolites (FF/GCMS)	Bile	PAHs	Fish
Alkyl phenol (AP) Metabolites	Bile	APs	Fish
PAHs (body burden)	Soft tissue	PAHs	Mussels
Histology	Gills	Different sources of stress	Fish
DNA adducts	Liver	PAHs (+)	Fish
CYP 1A	Liver	PAHs (+)	Fish
Vitellogenin (VTG)	Blood plasma	Xenoestrogens	Fish
Pyrene hydroxylase	Digestive gland	PAHs	Mussels
Micronucleus formation	Cells	Genotoxic stress	Mussels
Lysosomal membrane stability	Haemocytes (blood cells)	Metals and organic contaminants	Mussels
Lipofuscin	Histological sections	Different sources of stress	Mussels
Neutral lipid	Histological sections	Different sources of stress	Mussels

4. Monitoring of benthic habitats

4.1 Deadlines

4.1.1 Programmes for baseline and monitoring surveys

The deadline for the submission of draft programmes for baseline surveys is established together with Klif and the Norwegian Radiation Protection Authority on a case-to-case basis.

Draft programmes for monitoring surveys of benthic habitats must be submitted to the authorities by 1 February of the year in which the surveys are to be carried out, see section 54 of the Activities Regulations.

4.1.2 Sample collection

Field work in connection with monitoring of sediments and soft-bottom fauna should be carried out in the period 1 May–15 June in regions I–VIII (58–70°N). For regions IX–XI (north of 70°N) the period is extended to 1 July. These time frames do not apply to monitoring of hard-bottom fauna. In special cases, operators may carry out sampling at other times, but this must be well justified in the programme submitted to the authorities.

4.1.3 Reporting

The deadline for delivering the final reports of baseline surveys and regional monitoring surveys to Klif and the Norwegian Radiation Protection Authority is 1 April of the year after the surveys. If results are obtained during the surveys or sample processing that deviate substantially from the expected status or trend, this must be immediately reported to Klif.

4.2 Survey frequency and sampling pattern

4.2.1 Baseline surveys

Baseline surveys are required in connection with exploration drilling in new areas. As soon as possible and latest by the time production drilling starts, regional stations must be established.

Section 53 of the Activities Regulations requires baseline surveys to be carried out:

- before exploration drilling in new and previously unsurveyed areas within established regions (depending on the distance from already surveyed areas);
- before exploration drilling in areas where particularly vulnerable environmental resources (species and habitats) have been shown to exist, or where their existence is probable;
- before production drilling.

The requirements above apply to all types of installations. A baseline survey is valid for six years or for as long as decided by the authorities after consulting relevant expert bodies.

4.2.2 Field-specific surveys

As a general rule, the same survey frequency is required for all types of fields and developments.

- Monitoring of a field starts with the first regional survey for the region in which it lies.
- After the first survey, field-specific monitoring surveys are as a general rule conducted every three years, as part of the regional monitoring surveys. Changes in the frequency of field-specific surveys must receive prior approval by the authorities.
- After the end of the production phase, two more field-specific surveys are required at three-year intervals.
- The need for further monitoring of a field after this is assessed by the competent authority.

The scope of field-specific surveys must reflect the results of previous surveys and the level of activity and discharges registered in the field in question. This means that certain stations or analyses may be omitted and new ones included in consultation with Klif. The final scope of these surveys is decided during annual planning meetings as described in chapter 1.4.

4.2.3 Regional surveys

The Norwegian continental shelf has been divided into eleven geographical regions for the regional monitoring of benthic habitats (see Figure 4.1). Table 4.1 provides further details on the location of each region, on which fields are included in each region and on the time schedule for regional surveys. As a general rule, benthic habitats in each region should be surveyed every three years. A regional survey includes both the regional and the field-specific stations in the region.

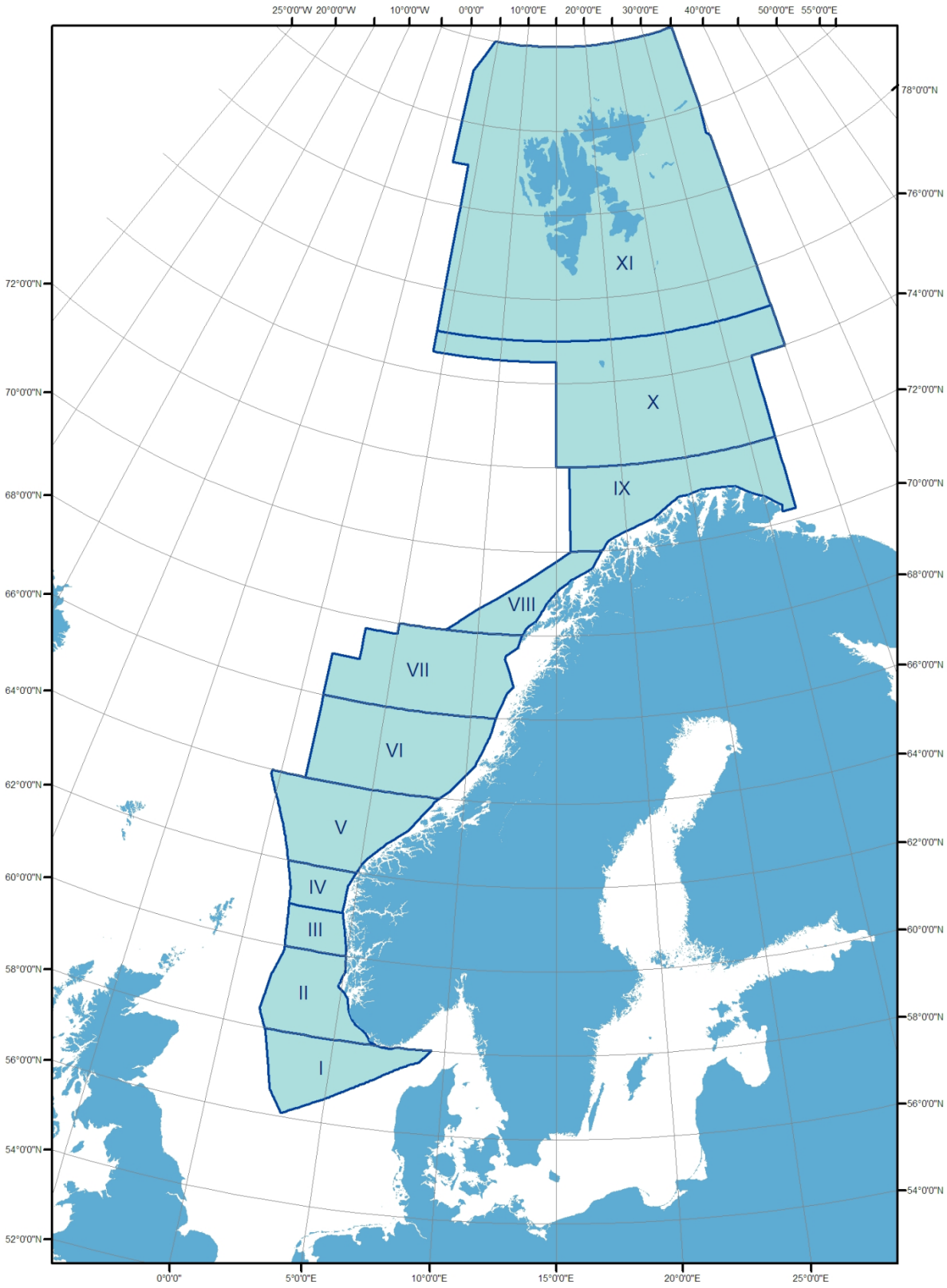

Figure 4.1 *Regions to be used for offshore environmental monitoring of benthic habitats*

Table 4.1 *Monitoring of benthic habitats in the different regions in the period 2012–2014*

	Region/fields		Area, thousand km^2	Year for planned regional survey		
North Sea						
I	**Ekofisk** *56–58 °N* *Ekofisk, Eldfisk, Embla, Tor, Valhall, Hod, Ula, Tambar, Tambar Øst, Gyda, Oselvar og Yme*		52			2014
II	**Sleipner** *58–60 °N* ***Sleipner** Øst og Vest, Gungne, Glitne, Sigyn, Balder, Jotun, Grane, Alvheim, Heimdal, Skirne, Ringhorne Øst, Varg, Vale, Vilje, Volund, Volve, Gaupe og Gudrun*		49	2012		
III	**Oseberg** *60–61 °N* ***Oseberg**, Oseberg Sør og Øst, Brage, Tune, Troll I og II, Fram, Huldra og Veslefrikk*		17		2013	
IV	**Statfjord** *61–62 °N* ***Statfjord**, Statfjord Nord og Øst, Snorre, Tordis, Vigdis, Sygna, Kvitebjørn, Gullfaks, Gullfaks Sør, Gimle, Gjøa, Visund, Vega og Vega Sør*		17			2014
Norwegian Sea						
V	**Møre** *62–64 °N* *Ormen Lange*		71	2012		
VI	**Halten Bank** *64–66 °N* *Alve, Njord, Draugen, Åsgard, Heidrun, Mikkel, Morvin, Kristin, Skarv, Norne, Urd, Tyrihans, Yttergryta og Marulk*		96	2012		
VII	**Nordland** *66–68 °N*		95			
VIII	**Troms** *68–70 °N*		31			
Barents Sea						
IX	**Finnmark** *70–72 °N* *Snøhvit, Goliat*		85		2013	
X	**Barents Sea South** *72–75 °N*		210		2013	
XI	**Barents Sea North** *North of 75 °N*		320			

* In accordance with *Facts: the Norwegian Petroleum Sector 2011*, published by the Ministry of Petroleum and Energy.

4.3 Station network

The monitoring of benthic habitats has both a local and a regional focus. Within each region, the objective of **field-specific** monitoring is to reveal any impacts of individual installations on the surrounding area, while a set of **regional** stations is intended to reflect normal benthic conditions in the region and make it possible to detect whether oil and gas activities have more widespread impacts in the region. Previously established reference stations where no impacts have yet been detected must from now on be classified as regional stations.

The locations of regional stations must be coordinated with the locations of the field-specific stations in the same region. The positioning of both types of stations must be based on information about:

- depth and topography;
- currents and dispersal patterns in the area in question;
- sediment conditions and sedimentation patterns;
- discharge history of the fields;
- pipelines and other installations on the fields.

It is the operators' responsibility to make use of this information to revise a station network or establish a new one. Data on currents must cover a range of depths and the different seasons of the year. It is particularly important to obtain data for the depths immediately above the seabed where discharges are planned/ expected. Further elements to be considered when selecting either field-specific or regional stations are described below.

4.3.1 Selection of stations for baseline surveys

Regional stations

When a first regional survey is to be carried out, a representative selection of at least 10 regional stations should be established to provide a general picture of background benthic conditions in the region. The regional stations should therefore be located in areas that are not expected to be affected by discharges from the offshore oil and gas industry, either at the time or later. If a regional station proves to be affected by a later field development, a new regional station must be established.

The following elements must be considered when positioning regional stations:

- they should cover all the main types of seabed (sand, clay, etc.), with main emphasis on sedimentation areas;
- if the water depth in the region varies, the stations should be located in such a way that typical depth intervals can be described;
- the stations should cover all parts of the region where there are field developments or where developments are expected.

When a baseline survey is carried out for a field, at least three of the regional stations should be associated with the field in question. They should be as representative as possible of background conditions on the field. They should be reasonably close to the oil or gas field in question and have similar sediment type and depth. If necessary, more regional stations can be established near the field for this purpose. The same regional stations must be used from year

to year both in the baseline survey and for later monitoring surveys of the field. Results from the regional stations are to be used as reference values for assessing possible effects observed at nearby field-specific stations.

Field-specific stations

When a baseline survey of a field is carried out, the field-specific stations should preferably be established using a radial transect design that is expected to be permanent for the monitoring surveys of the field. The stations are to be placed at increasing distances from the discharge point (according to the geometric series 250 m, 500 m, 1000 m, 2000 m, etc). Stations less than 250 m from the installations should be established if practicable and acceptable in terms of safety. If the final position of the oil or gas field has yet not been determined, a grid design may be used for station positioning across the field.

If the geographical characteristics of a field development indicate that a radial transect design will not be optimal, another design may be selected and used in the subsequent monitoring surveys. The operator must give grounds for doing this, and the station network must be agreed upon with Klif and the Norwegian Radiation Protection Authority. The stations must cover as much as possible of the entire area that will later be included in the monitoring programme. The orientation and surface of the station network should be determined based on the expected area of influence estimated with the help of likely discharge quantities and dispersal modelling (using the same assumptions as the EIA carried out for the field).

The operator must be able to document the grounds for the selected station positioning, based for example on water current patterns, depth intervals etc. The stations must be located so that it is possible to determine the degree to which benthic habitats are affected by discharges from the oil or gas field. Each station must be given a unique designation consisting of a maximum of four characters. The same designation must be used on maps, in tables and in the text. If a station is later moved by more than 50 m, it must receive a new designation. Any such changes must be specified in the report and the station history must be shown in a table.

During a baseline survey of a field, samples should be taken from a minimum of three regional stations, which are expected to become the regional stations associated with the field (see the last paragraph under ***Regional Stations*** above).

It can be difficult to maintain a radial transect or grid design of the stations when carrying out baseline surveys in deep water (>600 metres). In such cases, the stations should be positioned as optimally as possible in relation to the discharge pattern, expected dispersal patterns and benthic conditions.

4.3.2 Monitoring surveys

After drilling and discharges to the sea have started, the station network used for the first monitoring survey of a field should as a general rule be the same as that used for the baseline survey. However, depending on the overall monitoring activity in the region in question, certain stations may be omitted and new ones added in consultation with competent authorities. The monitoring programme must reflect the discharge pattern on the examined field. To make it possible to compare results between years, the positions of specific stations must not be changed. The deviation in position should not exceed ±50 metres.

If it is difficult to collect representative samples at a station, for example because of a high content of stones, the person responsible for the survey may decide to leave the station without taking samples. Any such deviations must be described as explained in Chapter 5.2 on reporting. If necessary, authorities may also require the establishment of new stations in transitional zones between oil and gas fields.

Field-specific stations

When a final decision has been made on the location of the installation(s) and of any discharge points, a permanent network of monitoring stations is established using the baseline survey as a starting point.

In the case of single installations, a radial transect design should preferably be used, with one axis along the prevailing direction of current flow just above the seabed and one perpendicular to this. This is the preferred design even in cases where a grid pattern was used for the baseline survey. In such cases, as many stations as possible from the grid should be retained. In the case of a complex field development (many subsea installations, for example) it may be necessary to deviate from this design, as stations must be located in a way that makes it possible to monitor the scale of the impacts of the installations. Most of the stations should be located downstream of the installations with respect to the prevailing current direction. If no prevailing current direction can be identified one of the two transects should run north-south.

Regardless of whether a grid or radial transect design is used, the station network should always include at least one station in each of the four main directions, even if there is no indication of chemical contamination or biological impact on the field. If the chemical contamination (for Ba 2xLSC is used as the boundary) or biological impact on a field extends beyond the outermost stations in the network, new stations must be established outside these for the next monitoring survey. New stations must be placed along the axes, at geometrically increasing distances. If later surveys (after the baseline survey and first monitoring survey) show elevated values for any of the parameters analysed at the first two stations downstream of the discharge point, chemical analyses must be carried out at all the innermost stations (along the other three radial transects). Analyses of THC and Ba (or an equivalent weighting agent) are required at all stations. A full metal analysis is to be carried out if this will not result in higher costs.

The scope of the monitoring surveys in each region and each field must reflect the level of activity, discharge history, and the results of the previous survey. If there is no measurable biological impact or chemical contamination, the station network can be reduced when the next benthic survey is carried out. As a general rule, the outermost stations sampled must always be unaffected (no biological impact or chemical contamination). If there are no measurable impacts, it may also be permissible to extend the time between surveys of a field to six years.

Regional stations

As a general rule, a regional monitoring survey must include all the established regional stations. In new regions where there are few fields to be monitored, regional surveys may in special cases be limited to the regional stations that are associated with fields. A gradual reduction of the number of stations originally established as reference stations may also be considered in areas where fields are being closed down.

In the case of regional stations, all chemical samples must be analyzed for calculating LSC. This is must be done during at least three surveys (ca. 10 samples). If the analyses indicate a stable level during several years, it is possible to only analyze one sample at a time. All samples must be however collected at all times and analyzed only if the one representative sample indicates variations compared to previous years.

4.3.3 Monitoring surveys – hard-bottom transects and coral reefs

Visual surveys of hard-bottom habitats are carried out using a remotely operated underwater vehicle (ROV) or a towed video system. Surveys should be carried out using either a radial transect design or a grid design, as described in the section on field-specific stations above. If possible, the two transects used in a baseline survey should also be used in later monitoring surveys.

In coral reef areas that have been investigated before production drilling started (for example where site surveys have been carried out), conducting ordinary monitoring surveys of the nearest reefs should be considered

4.4 Analytical parameters

This chapter describes the parameters or group of parameters required to be analysed for samples from benthic baseline and monitoring surveys. An overview of requirements regarding numbers of samples, analytical parameters, sample storage, etc. is given in table 4.2 below. Klif may request analysis of additional parameters (screening of new substances) on the basis of information on discharges in a region or an individual field.

Table 4.2 *Sediment samples, sample sizes and analyses*

Parameter	Sample depth	Benthic baseline and first monitoring surveys	Subsequent benthic monitoring surveys (2nd and 3rd etc.)[3]	Sample storage and size
TOM	0–1 cm	1 sample (from the mixed sample for grain size)	1 sample	-20° C 100 g
Grain size	0–5 cm	Mixed sample from 3 grab samples at the station	Mixed sample from 3 grab samples at the station	300 g
Hydrocarbons - THC -Synth. drilling fluid - NPD and PAHs[1]	0–1 cm 1–3 cm 3–6 cm	3 samples 1 sample [2] 1 sample [2]	3 samples	- 20° C 300 g
Metals -Ba[4], Cd, Cr, Cu, Pb, Zn, Hg	0–1 cm 1–3 cm 3–6 cm	3 samples 1 sample [2] 1 sample [2]	3 samples	- 20° C 50 g
Macrofauna[5]		5 samples	5 samples	10% formalin Bengal Red/ Eosin

[1] If THC exceeds 50 mg/kg, analyses of NPD and PAH are also required (in the upper 0–1 cm of the sediment only).
[2] Only the two downstream stations closest to the discharge point, if THC exceeded 50 mg/kg in the previous survey. Applies to NPD, PAHs and metals.
[3] The number of parameters to be analysed may vary depending on the degree of contamination and the level of activity on the field in question.
[4] Or an equivalent weighting agent (e.g. Ti).
[5] In the longer term, samples of the sediment **meiofauna** may be required in addition to the macrofauna, for example in areas that are inaccessible with conventional sampling equipment.

4.4.1 Sediment appearance on sampling

The characteristics of a sample should be described immediately after collection. These may include:

- the presence of drill cuttings, empty shells or other objects;
- the presence (or absence) of conspicuous fauna;
- smell (for example H_2S or oil).

In the case of visual surveys, classification of sediments must follow the specifications of NS 9435.

4.4.2 Physical and chemical sediment analysis

4.4.2.1 Total organic matter (TOM)

TOM is to be determined in samples from all stations in baseline surveys and first monitoring surveys. Subsequently TOM should be determined in samples from stations where biological analyses are carried out. Klif may require continued analysis of TOM if this is considered necessary.

4.4.2.2 Grain size distribution

Analysis of grain size distribution is required for all stations in baseline surveys and first monitoring surveys. Subsequently it is required at stations where biological analyses are carried out. As a minimum, the percentages of silt/clay (<63 µm), fine sand, medium sand and coarse sand are required for all biological surveys as a supporting parameter for interpretation of fauna data.

4.4.2.3 Hydrocarbons and synthetic drilling fluids

As a general rule, analyses must include the groups of substances specified below. Certain analyses may be omitted if the operator can document that there have been no discharges of the substances in question. The operator must also take into account the discharge status on the field and in the region and assess whether other parameters should be analysed.

The following analyses are required for samples from all stations in baseline surveys and first monitoring surveys:

- THC
- main components of synthetic drilling fluids (if used)
- NPD and PAHs (see appendix I).

Depending on the degree and extent of contamination, the analytical programme for field-specific stations can be reduced from the second monitoring survey onwards:

- THC (and possibly synthetic drilling fluids): all stations
- NPD and PAHs: all regional stations and as a minimum, the two downstream field-specific stations closest to the discharge point; also stations
    - where significantly high values were found in the previous survey
    - where the concentration of THC (mean value of three grab samples, including olefins) is higher than 50 mg/kg
    - where biological impacts have been registered.

If significantly high values for THC or NPD/PAHs are found at the two closest downstream stations in one monitoring survey, NPD/PAH analysis should be reintroduced in the next survey for all stations around the installation.

4.4.2.4 Metals

For baseline and first monitoring surveys, analyses of the following metals are required for all stations: Ba or an equivalent weighting agent, Cd, Cr, Cu, Pb, Zn and Hg. Depending on the degree and extent of contamination, the analytical programme can be reduced from the second monitoring survey onwards. Metals must be analysed in samples from all regional stations and as a minimum, samples from the two downstream stations closest to the discharge point. Metals must also be analysed in samples from stations:

- where significantly high values were found in the previous survey (2xLSC is used as the limit for Ba);
- where the concentration of THC (mean value of three grab samples, including olefins) is higher than 50 mg/kg;
- where biological impacts have been registered.

If significantly high values are found at the two closest downstream stations in one monitoring survey, all metals should be analysed in the next survey for all stations around the installation.

4.4.2.5 Radioactivity

Sediments

Two fields should be selected each year where samples are to be collected for analysis of radioactivity. These samples should be taken from around all installations with discharge of produced water on these fields.

Samples are to be taken at the following distances from the installations:

- 250 m, 500 m, 1000 m and 2000 m in the prevailing direction of current flow;
- 250 m, 500 m and 1000 m along the other axes.

In addition, a sample must be taken at a corresponding regional station.

Sample collection is required from three depths at each station: 0–1 cm, 1–3 cm and 3–6 cm.

Analysis of Ra-226, Ra-228 and Pb-210 is required for all samples. The Th-228 content must also be analysed in samples from platforms where mechanical or chemical removal of deposits from processing equipment was accompanied by discharged to sea.

Water column

Water samples are to be taken in the prevailing direction of the current flow, around the same platforms as the sediment samples.

Samples are to be taken at a distance of 250 m and 500 m from the installations. In addition, a sample must be taken at a corresponding regional station. Three samples are to be taken at each station, from the following depths: surface, 20 m and 40 m. Only surface samples are required from the regional station.

Analysis of Ra-226 and Ra-228 is required for all water samples from all stations.

The water masses at the regional station must be of the same type as those around the platforms where samples are taken (for example, all stations must be in coastal water or Atlantic water).

The recommended sample size for all water samples is 25 litres.

4.4.3 Biological analyses

A thorough analysis of the soft-bottom macrofauna is required, including taxonomical identification and number of specimens belonging to each species. The purpose of the investigation is to reveal potential impacts on the fauna as a result of discharges and contamination on the field. Calculations of biomass are not required.

Samples for biological analyses are taken at all stations during baseline surveys and first regional surveys. In subsequent surveys, biological analyses are required for the regional stations and the field-specific stations closest to each installation, preferably at a distance of 250 m. If a survey finds biological impacts or values of THC > 50 mg/kg at field-specific stations, the minimum requirement for the subsequent survey is to take samples at each station where a biological impact was found and the next station in the series (further out from the installation.

4.4.4 Analytical parameters for hard-bottom fauna

Visual surveys will only encompass megafauna. Hard-bottom fauna will be described in terms of the number per unit area. The coverage degree is required for colonial species. For coral reefs, a condition description is required in addition to coverage degree.

Klif will at a later date draw up guidelines concerning hard-bottom fauna, either as an appendix or as a chapter of these guidelines, as has been done for physical and chemical sediment analysis.

4.5 Sample collection and processing

For sample collection and processing in the field (including vessel requirements, keeping field logs, choice of sampling equipment, collection procedures, etc), please refer to NS-EN ISO 5667-19 for sediments, NS-EN ISO 16665 for soft-bottom fauna and NS 9435 for visual surveys of hard-bottom habitats.

If a laboratory is seeking approval of a new accredited method, it must provide documentation that the results achieved with the new method are as good as or better than those achieved with the old method.

4.5.1 Collection

For baseline surveys of soft-bottom habitats, there should be chosen appropriate quantitative sampling equipment that can be used for the collection of both biological and chemical samples. The equipment must sample a minimum area of $0.1m^2$. The use of a different type of sampling equipment in subsequent surveys is not permitted without approval from Klif.

Benthic samples must be taken with suitable equipment to avoid sediment compression. The equipment used to subtract subsamples for metal and hydrocarbon/drilling fluid analysis must not contaminate the samples (see NS-EN ISO 5667-19).

For analysis of metals and hydrocarbons/drilling fluid, separate samples are taken from the upper 0–1 cm of the sediment in each grab sample. Each sample must be packaged, stored and analysed separately.

For sieving of macrofauna samples in the field, see NS-EN ISO 16665. Sieves should have round openings and a mesh opening of 1mm.

A ROV or towed video system is to be used for visual surveys; see the procedures described in NS 9435.

In the case of hard-bottom habitats and in stony areas where conventional sampling is not possible, a ROV should be used to collect samples for physical and chemical analysis.

4.5.2 Sample storage and preservation

Sediment samples that are to analysed for TOM, grain size, hydrocarbons, synthetic drilling fluids and metals must be stored at a minimum temperature of -20°C until they are analysed.

For preservation of biological samples in the field and sample storage, see NS-EN ISO 16665.

4.5.3 Establishing and storing biological reference material

Accurate species identification is of fundamental importance for the reliability of the statistical analyses of the fauna. Experience has shown that quality control of species identification of the macrofauna needs to be improved.

One way of improving the situation is to build up a reference collection by retaining selected biological material from the surveys. It would be best to assign the responsibility for the storage and curation of the material to experts, for example within natural history museums. Klif encourages oil companies/consultants to enter into agreements with suitable museums to ensure that the same procedures for sample selection, storage and curation are used in all surveys.

4.6 Analytical methods

Analytical methods for which there are updated Norwegian or international standards should be used. All results of the chemical analyses of sediment are to be standardised against weight per kg dry weight of sediment.

4.6.1 Physical and chemical sediment analyses

Before chemical analysis, all stones larger than 5 mm should be removed from the subsamples.

4.6.1.1 Total organic matter (TOM)

TOM is determined according to NS 4764 as loss on ignition at a controlled temperature. However, the temperature should be 480 degrees Celsius to prevent loss of carbonate, which is a deviation from NS 4764.

4.6.1.2 Grain size distribution

The methodology for determining grain size distribution in the range 2000 to 63 µm is described in Bale & Kenny (2005). No further subdivision of the fraction < 63 µm is required.

The weight of each fraction is determined (to the nearest 0.01 g) and cumulative percentages by weight are calculated for each station. The calculated figures are further used to determine the median particle diameter and standard deviation, together with the skewness and kurtosis of the grain size distribution.

4.6.1.3 Hydrocarbon analyses

Hydrocarbon analyses of all samples from all stations are required, in accordance with Chapter 4.4.2.3. Methods with a high hydrocarbon extracting efficiency from sediment samples must be used. The analytical laboratory must be able to document this on request.

THC analyses should be performed using a gas chromatography/flame ionisation detector (GC/FID) in the retention window C_{12} to C_{35}. A reference oil sample will be used as an internal standard for the quantification. The reference oil in use is HDF 200. If this is replaced, intercalibration exercises using equivalent reference oils are required. NPD and PAHs should be determined by means of gas chromatography / mass spectroscopy (GC/MS), and results should be reported for individual components, sum NPD and sum PAH. If the drilling fluid used contains organic components (ethers/esters), the samples must also be analysed for these substances.

Detection limits should meet the following minimum requirements:

- THC: 1 mg/kg dry sediment (the quantification limit must be given in the report);
- NPD/PAHs, individual components: 1 µg/kg dry sediment.

Analyses of development trends over time of THC concentrations and the contaminated area must be carried out based on field-specific data. Similarly, analyses of development trends over time of the regional stations are required. These analyses are to be carried out using a suitable statistical tool. Data sets from earlier surveys can be found in the MOD database.

4.6.1.4 Synthetic drilling fluids

The sediment samples are to be analysed for the main component content in synthetic drilling fluids. The analytical method must be adapted to the relevant substances. Where appropriate, extraction and further processing of the sediment samples for these analyses can be combined with the hydrocarbon analyses.

4.6.1.5 Metal analyses

The samples will be analysed after digestion with nitric acid. The recommended method is described in NS-EN ISO 15587-2.

The following metals should be measured: Ba, Cd, Cr, Cu, Pb, Zn and Hg. If other weighting agent except Ba was used during drilling (e.g. Ti) the parameter must also be analysed. For

determination of Hg, the samples should be freeze-dried or dried at 40 ºC before sieving and digestion.

Different methods are generally used for analysis of different metals to achieve sufficient sensitivity:

- for Ba, Cu and Zn: inductively coupled plasma spectroscopy (ICP);
- for Cd, Cr and Pb: atomic absorption spectroscopy (AA), graphite furnace technique;
- for Hg: AA, cold vapour technique or high resolution ICP/mass spectrometry (HR-ICP/MS)

HR-ICP/MS provides sufficient sensitivity for all the parameters. Detection limits for metals are shown in appendix II. Analyses of development trends over time are required for any metals for which values exceeding the background level are measured. Metals with values below LSC are not to be included in the illustrations included in the report.

4.6.1.6 Analyses of naturally occurring radioactive substances

Suggested analytical methods for Ra-226, Ra-228, Pb-210 and Th-228 are listed in Table 4.3. The table also gives the approximate sample sizes needed to carry out an analysis. Activity levels that should be possible to detect using the methods in Table 4.3 are given in Table 4.4.

Table 4.2 *Estimated minimum sample sizes and examples of suitable analytical methods*

Sample	^{226}Ra	^{228}Ra	^{210}Pb	^{228}Th
Seawater	Ca 10 litres Alpha spectrometry/ Liquid scintillation	Ca 10 litres Alpha spectrometry via ^{228}Th	-	-
Sediment	Ca 100 g dry weight Gamma spectrometry (via daughter nuclides)	Ca 100 g dry weight Gamma spectrometry (via ^{228}Ac)	Ca 100 g dry weight Gamma spectrometry	Ca 100 g dry weight Gamma spectrometry (via daughter nuclides)

Table 4.3 *Activity levels that should be detectable using the analytical methods in Table 4.3*

Sample	^{226}Ra	^{228}Ra	^{210}Pb	^{228}Th
Seawater	0.5–1 Bq/m^3	0.5–1 Bq/m^3	-	-
Sediment	5 Bq/kg dry weight	5 Bq/kg dry weight	5 Bq/kg dry weight	5 Bq/kg dry weight

4.6.1.7 Limit of significant contamination and interpretation

Limits of significant contamination (LSC) are calculated based on the results for regional stations. Before LSC values are calculated, a principal component analysis (PCA) of the chemical data must be carried out, both for the current year alone and for all available data (from 1996 at the earliest and onwards). The results of the PCA will clarify whether it is necessary to split the region into subregions. If subregions are used, they must be the same for THC and for the weighting agent used (e.g. barite or ilmenite). LSC values are to be calculated both for the current year's data set alone and using the complete data set from all surveys in the region.

The values obtained with different calculation methods are compared and assessed to choose the relevant LSC (for the whole region or subregions).

LSC values are calculated from mean values, using a unilateral t-test and a significance level of 5 %. LSC values must contain a significant number of digits. The formula for calculating LSC values is given in the appendix III.

As a general rule, the LSC values obtained on the basis of all available data are quite robust and vary only slightly from one survey to another.

4.6.2 Biological analyses

Special requirements for the analysis of benthic fauna samples are set out below. Otherwise, species identification should follow NS-EN ISO 16665. As a general rule, taxonomic resolution should be at species level.

Organisms belonging to the following groups may be identified and recorded if wished, but they should be excluded from calculations of community indices and from multivariate analyses: Porifera, meiofaunal groups such as the harpactoida, planktonic organisms such as copepods and mysids, and fish.

For some groups (for example Oligochaeta, Cnidaria, Solenogastres and Phoronida), it may be necessary to operate with morphological forms only, since species identification requires special expertise and fixation techniques. This will fulfil the requirements for the subsequent numerical analyses. Solitary hydrozoans should be identified down to species level, but this is not necessary for colonial species. As an exception, larger species of Foraminifera may be identified. Statistical analyses are to be performed both with and without such species.

The taxonomic resolution should as a minimum be the same in the monitoring surveys as in the baseline survey.

Newly settled juveniles of benthic species should be identified and included in the data set, with the exception of newly settled larva of Echinoidea. If juveniles appear among the ten most abundant organisms in the data set, the statistical analyses should be performed both with and without these in order to illustrate their influence on the benthic community.

Species identification must be carried out by qualified personnel, and documentation of quality assurance routines must be available on request.

The following data is required for each station:

- complete lists of recorded species (species name and number of specimens of each species);
- total number of species;
- total number of specimens standardised to a sediment surface area of 0.5 m^2;
- table of the ten most abundant species (species name, number of specimens and percentage from the total number of specimens at the station), also showing the total number of species found at the station;
- species diversity as Shannon Wiener index on a $\log_2$ base (Shannon & Weaver 1963);
- evenness as Pielou's "J" (Pielou 1966);

- expected number of species per 100 individuals (ES_{100}).

The following analyses are required for all stations on a field, including the regional stations associated with the field, and in addition for all the regional stations as a group:

- cluster analyses based on the Bray-Curtis dissimilarity index (Bray & Curtis 1957), followed by group average sorting;
- ordination by non-metric multidimensional scaling (MDS).

All the results above are to be standardised to a sediment surface area of 0.5 m^2.

The multivariate analyses should be carried out based on the values obtained by summing up the five samples from each station. Other analytical methods than those specified above may be used, provided that they are supplementary. Multivariate analyses (for example correspondence analysis) should also be used to investigate the correlation between chemical and biological parameters.

4.6.3 Estimation of area affected

A conservative estimate of the areas with contaminated sediment and biological impacts is required, based on the assumptions that affected areas are elliptical, and that the entire area around the innermost uncontaminated station is contaminated. The calculation method is described in appendix IV. The calculated surface must be compared with those of previous surveys. This can be done provided that information is given on which wells and installations are used in the calculations, for example in a table. If stations are omitted from a survey, resulting in the impossibility to calculate the affected area, it is assumed that the results of the previous year's survey are still valid.

In order to correctly estimate the affected area, samples should be taken from all 250 m stations, as long as that is technically possible.

4.6.4 Visual surveys

Procedures for analysis and recording of photos and video from visual surveys are described in NS 9435.

4.6.5 Overall interpretation of the results

Similarities and differences in chemical status and community structure between field-specific and regional stations should be assessed on the basis of the biological results and the multivariate analyses. It is also recommended that the significance of differences between stations for the multivariate analyses is included. Relevant procedures have recently been developed (Clarke et al. 2008).

5. Requirements for reporting on the monitoring programmes

The purpose of offshore environmental monitoring is to provide an overview of environmental status and environmental trends over time as a result of oil and gas activities. Survey results must therefore be assessed in conjunction with the discharge history of the field or area in question. To that end, reports on both water column and benthic habitat monitoring must include assessments of current status and potential impacts on the environment.

5.1 Reporting on water column monitoring

Separate reports should be prepared for the condition and impact monitoring surveys.

The reports for both types of surveys should consist of a concise executive summary and a main report including a detailed scientific description of the survey.

Condition monitoring reports must describe the extent to which fish from the Norwegian continental shelf are contaminated by hydrocarbons or other petroleum-related substances, and whether they show any signs of exposure and/or stress as a result of discharges on the Norwegian continental shelf.

All raw data and results must be available for the authorities at all times, preferably in a central database and as appendices to the reports. Reports must specify where the data are stored and give the name of the contact person.

5.1.1 Data and processing of results

The raw data files must be provided as appendices to the reports, in Excel format. Further details on result processing can be found in the updated annual monitoring programmes.

5.1.2 Executive summary

The executive summary should not exceed 20 pages and must be produced in both Norwegian and English. The target group for this report includes the oil and gas companies, the public administration and the general public.

An executive summary should include the following elements:

- a brief description of the goals;
- a description of the field work;
- presentation and discussion of the most important results (illustrated with figures and tables);
- main trends and comparison with any earlier surveys;
- conclusions and recommendations.

Any additional elements required in impact monitoring reports will be established in the annually updated monitoring programme.

5.1.3 Main report

The target group for the main report includes the oil and gas companies, the environmental authorities, research bodies and consultancy firms. The main report is the final scientific report for a survey and should therefore include complete documentation of the survey, focusing on:

- analytical parameters;
- analytical methods and quality assurance;
- the results and conclusions of the survey;
- trends within the region or sampling area;
- issues that should be given priority in future surveys.

The main report must include the following elements:

Summary
A brief description of the goals of the survey. This should be identical to that given in the executive summary. Tables or figures showing environmental status and trends in the studied area should also be included.

Introduction
The following should be described for the region or area sampled:

- discharge history and other activities that may have affected chemical and biological conditions at the time of the survey;
- earlier surveys (table);
- main trends up to the time of the current survey;
- goals and priorities for the survey in question.

Methods
The methods section should include the following:

For condition and impact monitoring:
- brief description of the completed field programme, including the time frame for conducting the survey, number of stations, test chambers or sampling areas, positioning system, sampling programme at each station or each sampling area and any deviations from the programme, with reasons (complete field log in the appendix);
- brief description of the laboratory procedures for physical, chemical and biological analyses, including description of any deviations, with reasons, and an evaluation of how results are affected;
- principles for quality assurance routines in the field and in the lab (only briefly if the consultancy firm is accredited for the analysis in question);
- accreditation status and proof, together with documentation of control of results (chemical analyses) should be included in an appendix;
- formulae for any indices used, statistical methods used, etc;
- where and how the processed material (samples, reference collections, databases) is stored, responsibility for the material and results and their availability.

In addition, for impact monitoring:
- map showing coordinates, scale, depth contours, installations;
- reasons for the choice of stations (at the time of establishment) or sampling area;

- origin and condition of test organisms and handling before placement in test chambers.

Results and discussion
This chapter presents and discusses the results of the survey.

In the case of impact monitoring, the results for each station or sampling area should as far as possible be presented in the form of tables and figures. The observations and average results obtained for all the parameters analysed are to be described. Other characteristics of the station or sampling area that are of significance for the discussion should also be presented.

If the information is possible to obtain, geographical trends, time trends and changes should be presented. The questions listed below should/must be discussed:

- Which responses can be detected and at what distance from the source?
- How do biological responses correspond with exposure parameters and with gradients in natural and anthropogenic environmental variables?
- How do the results correspond with those of earlier surveys?
- How do the results correspond with relevant surveys of nearby areas?
- Are the effects correlated with the discharge history?

Overall evaluation and conclusions
This chapter should include final remarks on environmental status and trends for the individual fields and in the region.

Recommendations
Recommendations for the next survey should be made based on the results of the current survey.

Appendices
The following must be included:

- complete field logs with date, time, position (GMS and UTM, which reference grid is used; grid zone must be specified), depth, number of samples and weather conditions presented in table form for each station or sampling area;
- analysis report including tables of analytical data.

If the data appendices are too large, they should only be provided in electronic format (CD accompanying the report).

Unless special instructions are given, five is the number of printed copies of the report to be sent to Klif.

5.2 Reporting on benthic habitat monitoring

A report must be drawn up for each regional survey, providing an overview of the most important environmental trends in the region and individual fields. All raw data and results must be available to the authorities at all times in the MOD database and as electronic appendices to the report. Reports must specify where the data are stored, and give the name of the contact person.

Each report must be divided into an executive summary in Norwegian and English and a main report in Norwegian. Data such as matrix files must be included as electronic appendices to the report, and the field log as a printed appendix to the main report.

5.2.1 Executive summary

The executive summary should not exceed 20 pages, and must be produced in both Norwegian and English. The target group for executive summaries includes the oil and gas companies, the public administration and the general public.

An executive summary should include the following elements:

- a brief description of the goals, with tables or figures showing environmental status and trends in the region; should be identical in the executive summary and the main report;
- a description of the field work, including actual sampling locations (geographical station coordinates ±50m) and the navigation system used;
- presentation and discussion of the most important results (illustrated with figures and tables);
- main trends and comparison with earlier surveys;
- maps of seabed areas where contaminated sediments and biological impacts have been found should be included for each field and for the region as a whole;
- conclusions and recommendations.

5.2.2 Main report

The target group for the main report includes the oil and gas companies, the environmental and radiation protection authorities, research institutions and consultancy firms. This is the final scientific report on a survey, and should therefore include complete documentation of the conducted survey, focusing on:

- the results and conclusions of the survey;
- development trends within individual fields and the region as a whole;
- issues that should be given priority in future surveys.

A main report must include the following elements:

Summary
A brief description of the goals (no longer than one page), with tables or figures showing environmental status and trends in the studied region. This should be identical in the executive summary and the main report.

Introduction
The following should be described for each field, and if relevant for the region as a whole:

- area projected to be affected by discharges from oil and gas activities, according to the EIA;

- drilling and discharge history[1] and other activities that may have affected chemical and biological conditions up to the time of the survey;
- earlier surveys (table);
- main trends in pollution levels up to the moment of the current survey;
- specific goals and priorities for the current survey.

Methods
The methods section is to include the following:

- map of stations showing coordinates, map scale, depth contours, existing installations;
- reasons for the choice of stations (in the event of any changes from earlier surveys);
- table with overview of any station changes;
- brief description of the completed field programme, including time frame for conducting the survey, number of stations, positioning system, sampling programme at each station and any problems or deviations from the programme, with reasons (complete field log in the appendix);
- if sampling is not performed at a station or samples are rejected because the stone content in the sediment is too high, the reasons must be specified;
- if there is a high stone content in the sediment samples, this must be specified in the report together with a description of how results are affected;
- brief description of the laboratory procedures (physical, chemical and biological analyses): description of any deviations, with reasons, and an evaluation of how they affect the results;
- detection limits, quantification limits and LSC must be reported for chemical analysis methods;
- principles for quality assurance routines in the field and laboratory (brief if the consultancy firm is accredited for the analysis in question);
- accreditation status and proof, together with documentation of control of results (chemical analyses) should be included in an appendix;
- formulae for any indices used, which statistical methods were used, etc;
- reasons for any supplementary analyses;
- where and how the processed material (samples, reference collections, databases) is stored, responsibility for the material and results and their availability.

Results and discussion
This chapter presents and discusses the results of the survey.

<u>Description of individual stations</u>
Observations and the average results obtained for all physical, chemical and biological parameters analysed and all indices required should be presented, as far as possible in the form of tables and figures. Any classification should be explained and reasons for its use given. Other characteristics of the station that are of significance for the discussion should also be presented.

[1] As a minimum, the following information is required: number of wells drilled, discharges of barite or similar weight material, drill cuttings, oil-based, synthetic and water-based drilling fluids, cementing and completion chemicals, oil and radioactive substances in produced water; acute discharges. All discharges except for radioactive substances should be given in tonnes. Discharges of radioactive substances should be given in GBq. In addition, any recent excavating or dredging activities are to be specified.

Description of individual fields

- mean values, range (min.–max. and SD or SE), geographical gradients in concentrations, and biological indices across the field;
- comparison with corresponding characteristics for the associated regional stations;
- results of multivariate analyses on the similarity between groups of stations;
- correlations between physical/chemical characteristics and biological characteristics;
- specification of the areas where chemical contamination and biological impacts have been recorded;
- trends over time on the specific field concerning the characteristics listed in the bullet points above.

Description of the region

- mean values, range (min.–max. and SD or SE), geographical gradients in concentrations, and biological indices across all regional stations;
- results of multivariate analyses on the similarity between groups of stations, installations, etc;
- correlations between physical/chemical characteristics and biological characteristics;
- specification of the total areas in the region where chemical contamination and biological impacts have been recorded;
- changes in any of the points above since the previous survey.

Table 5.1 lists the points to be included in the results and discussion chapter which should provide the starting point for answering the questions listed below.

- Can a geographical or other pattern be identified to group stations across the field or region?
- If there is a pattern, how can it be described?
- How far from the discharge point are chemical contamination and biological impacts statistically detectable?
- Which area can be described as a “grey zone” where pollution levels are elevated but not significantly different from background levels?
- Which biological effects can be detected (including effects on individual species), and at what distance from the discharge point?
- How do the responses correspond with gradients in natural and anthropogenic environmental variables?
- How do the results correspond with those of earlier surveys?
- How do the results correspond with those of relevant surveys of nearby areas?
- Are the effects correlated with the discharge history of the field or region?

Information about the area where chemically contaminated sediments and effects on the benthic fauna were recorded should be given both in table form (km^2 for chemical contamination and biological effects) and in map form for the region in question. The regions’ surface bounded by the baseline towards the coast, are shown in Table 4.1.

Table 5.1 *Physical-chemical and biological parameters that must be included in reports*

Physical-chemical characterisation	Biological characterisation
• grain size distribution: divided as a minimum in silt/clay (< 63µm) and sand (63-2000µm), and percentage of fine, medium and coarse sand is provided for each station • for grain size, median particle diameter and standard deviation must be provided • colour, smell, appearance • total organic matter (TOM) • table listing all chemical data (and selected average values from previous years) • graphs showing relevant chemical data against year, presented with mean values and standard deviations • background levels based on the current year's data set alone and for the entire data set (from 1996 onward) in order of priority, for one of the following: - the whole region (all regional stations) - subregions, if used (based on selected regional stations) - a selection of the regional stations associated with each field in the region. • concentrations that are significantly different from background levels • contaminated area (for metals, radioactive substances and hydro-carbons) for fields and the region • variations in concentrations over time • distribution gradients (patterns) for selected parameters • table with results from measurements of radioactive substances in water samples from individual stations on each field and corresponding regional stations.	• number of species and specimens standardised to a sediment surface area of 0.5 m^2 (per station) • community indices • the 10 dominant species (density and percentage of total number) • distribution gradients (patterns) for selected species and community indices (figures) • similarity between stations, grouping by means of multivariate analysis • geographical distribution of station groups • description of station groups on the basis of: - depth - benthic conditions - content of organic matter - content of hydrocarbons - content of metals - biological parameters • analysis of correlation between community indices, density of selected species, physical properties of the sediment, and hydrocarbon and metal content. If significant correlations are found, further analysis of causal relationships is required. • area with recorded fauna disturbance.

Overall evaluation and conclusions
This chapter should contain concluding remarks on environmental status and trends for individual fields and the region, discussed in relation to the projections of the EIA and the results of previous surveys. The most important benthic habitat trends must be described, both for the region and for individual fields. The chapter must also identify areas where there are particular problems.

If visual surveys were carried out at the same time as or shortly before the benthic habitat survey, the results of these are to be taken into account in the evaluation and conclusions.

Recommendations
Recommendations for the next survey based on the results obtained during the current survey.

5.2.3 Appendices

The appendices to the report should be delivered on a CD and as a minimum include the following:

- complete field logs: date, time, position (GMS and UTM, which reference grid is used; grid zone must be specified), depth, number of grab samples and weather conditions presented in table format for each station;
- analysis report;
- tables of all analytical data ;
- raw data files in Excel format.

The same CD should also contain the executive summary and the main report in Word or PDF format.

Unless special instructions on the number of printed copies required, five printed copies of each report should be sent to Klif and three to the Norwegian Radiation Protection Authority.

5.3 Reporting on visual monitoring

Visual monitoring is a recent development. Guidelines and requirements for reporting may change as more surveys are carried out and more experience of this method is gained. Some points that should be included in the reports are listed below, but these are to be considered as suggestions since the method is still being tested.

5.3.1 Executive summary

An executive summary must be produced in both Norwegian and English. The target group for executive summaries includes the oil and gas companies, the public administration and the general public. An executive summary should include the following elements:

- a brief description of the goals;
- a description of the methodology and field work;
- presentation and discussion of the most important results (illustrated with figures and tables if necessary);
- main trends and comparison with any earlier surveys;
- conclusions and recommendations.

5.3.2 Main report

The target group for the main report (in Norwegian or English) includes the oil and gas companies, environmental authorities, research institutions and consultancy firms. This is the final scientific report on a survey and should therefore include complete documentation of the survey, focusing on:

- field methodology and implementation;
- analytical parameters;
- analytical methods and quality assurance;
- results and conclusions of the survey;
- issues that should be given priority in future surveys;
- (assessment of the analytical methods and proposals for improvements).

The main report must include the following elements:

Summary
A brief description of the goals, identical to that in the executive summary. Tables or figures must be used to illustrate the environmental status and trends in the studied area.

Introduction
The following should be described for the region or area sampled:

- projected area to be affected by discharges from oil and gas activities, according to the EIA;
- drilling and discharge history and other activities that may have affected the biological conditions as investigated in the survey;
- earlier surveys (table);
- goals and priorities for the current survey.

Methods
The method section should include the following:

- map showing coordinates, scale, depth contours, installations;
- reasons for the choice of stations and transects (in the event of any changes from earlier surveys);
- brief description of the completed field programme, including time frame for conducting the survey, number of stations or survey areas, equipment, positioning system, the sampling programme at each station and any problems or deviations from the programme, with reasons (complete field log in the appendix);
- brief description of the visual analytical procedures for the benthic substrate and the megafauna, together with a description of any deviations, with reasons and an assessment of how results are affected;
- principles for the quality assurance routines used in the field (brief if the consultancy firm is accredited for the analysis in question);
- documentation of any accreditation should be included in an appendix;
- where and how the processed material (video transects, still imagess, databases) is stored, responsibility for the material and results and their availability.

Results and discussion
This chapter presents and discusses the results of the survey.

Description of individual fields

- depth gradients, sediment characteristics, characteristics of the fauna, and anthropogenic impacts throughout the field;
- comparison with corresponding characteristics recorded at the associated regional stations;
- (estimated area where biological impacts have been recorded).

Overall evaluation and conclusions
This chapter should contain concluding remarks on environmental status and trends for the individual fields and the region.

Recommendations
Recommendations for the next survey based on the results of the current survey.

Evaluation
An evaluation of the survey and the analytical methods used is required, with comments and proposals for improvements.

Unless special instructions on the number of printed copies are given, five printed copies of each report should be sent to Klif.

5.3.3 Appendices

The appendices to the report should be delivered on a CD and as a minimum include the following:

- complete field logs: date, time, position (GMS and UTM, which reference grid is used; grid zone must be specified), depth, transect length and weather conditions presented in table form for each station;
- edited video presentations from each field showing transects, benthic habitat type, fauna and conclusions;
- tables with all the analytical data;
- still images;
- (results in GIS format);
- (raw data files in Excel format).

The same CD should also contain the executive summary and the main report in Word or PDF format.

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7. Appendices

Appendix I – Analysis parameters: main PAH compounds

Table 7.1 *US Environmental Protection Agency (EPA) list of 16 main PAH compounds identified in relation to the presence of pollution*

PARAMETER	STORET No[1]	CAS No[2]
Acenaphthene	34205	83-32-9
Acenaphthylene	34200	208-95-8
Anthracene	34220	120-12-7
Benzo (a) anthracene	34526	56-55-3
Benzo (a) pyrene	34247	50-32-8
Benzo (b) fluoranthene*	34230	205-99-2
Benzo (ghi) perylene	34521	191-24-2
Benzo (k) fluoranthene*	34242	207-08-9
Chrysene**	34320	218-01-9
Dibenzo (a, h) anthracene	34556	53-70-3
Fluoranthene	34376	206-44-0
Fluorene	34381	86-73-7
Indeno (1,2,3-cd) pyrene	34403	193-39-5
Naphthalene	34696	91-20-3
Phenanthrene	34461	85-01-8
Pyrene	34469	129-00-0

[1] Storage and Retrieval number (EPA)
[2] Chemical Abstract Service registry number (American Chemical Society)
* Figures for benzo (b, j, k) fluoranthenes are reported together
** Chrysene is reported together with triphenlyene

Appendix II – Detection limits for metals

The detection limits are established with regard to both the sensitivity of the measuring instruments and the background values registered in the sediments in the North Sea. These detection limits (mg/kg dry sediment) depend on the quantities of sediment that are weighted. The values provided in the table below are valid for a quantity of weighted sediment of minimum 1 g.

Table 7.2 *Detection limits for different metals*

Element	Detection limit mg/kg (dry sediment)
Ba	1.0
Cd	0.03
Cr	0.5
Cu	0.6
Hg	0.01
Pb	0.5
Zn	2.0

Appendix III – Formula for calculating LSC

$$LSC > \overline{R}_{\bullet\bullet} + t_{\alpha(1),\nu} \cdot s \cdot \sqrt{1 + \frac{1}{N_r}}$$

$\overline{R}_{\bullet\bullet}$ = average of the station mean values for the regional stations

$t_{\alpha(1),\nu}$ = critical value from the t-distribution with one-sided t-test with level of significance α (=0.05) and $\nu = N_r$ -1 degrees of freedom

s = standard deviation of sedimentation between station averages

N_r = number of regional stations

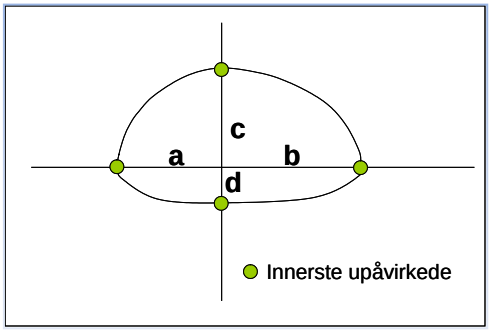
The standard deviation s is calculated as $s = \sqrt{\frac{\sum_{i=1}^{N_r} \left(\overline{R}_{i\bullet} - \overline{R}_{\bullet\bullet}\right)^2}{N_r - 1}}$

where $\overline{R}_{i\bullet}$ = mean values on the parallels of regional station nr. *i.*

Appendix IV – Methods for delimitating affected areas

Two affected areas are to be calculated for each field: one where there is significant chemical contamination (as defined by LSC values, to be calculated for THC and Ba as a minimum), and one where there are impacts on the benthic fauna. The areas should be given in km^2. The calculations are based on the assumption that the affected areas are approximately elliptical. The radii of the ellipse depend on the distance along each transect where effects can be detected. The calculations are conservative, i.e. they give an estimate of the maximum area affected. The radii must therefore be calculated as the distance from the centre of the ellipse to the innermost station where no effect is found. In many cases, this will result in an asymmetrical ellipse (see the figure below). The area is calculated in the same way in both cases:

Area = π * (a+b)*(c+d)/4



If no stations have been sampled along a transect, the radius is defined as the distance from the centre to the nearest station where no effects were found in the most recent survey that covered the transect in question.

If a transect has never been surveyed, the radius is defined as the average of the other radii.

On complex fields where there are many installations and overlapping station networks, such as Gullfaks, one common elliptical area should be defined for the entire field. The radii should normally be the distance from the centre to the nearest station where no effect is found, but in most cases some assessment will also be needed to define the most suitable area.

The calculation method (chosen ellipse and how the axes are defined) must be documented in the report.

KLIMA- OG FORURENSNINGS-DIREKTORATET

Climate and Pollution Agency (Klif)
P.O. Box 8100 Dep
Visiting address: Strømsveien 96, Helsfyr, Oslo
Tel: +47 22 57 34 00
Fax: +47 22 67 67 06
E-mail: postmottak@klif.no
Website: www.klif.no

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Author (s)
Per Erik Iversen, Ann Mari Vik Green, Mathilde Juel Lind, Mikkel Rønn Hedegaard Petersen, Torgeir Bakke, Rainer Lichtenthaler, Jarle Klungsøyr, Torbjørn Grafert, Henning Natvig and Mihaela Ersvik.

Title – Norwegian and English

Retningslinjer for miljøovervåking av petroleumsvirksonheten på norsk kontinentalsokkel

Guidelines for offshore environmental monitoring on the Norwegian continental shelf

Sammendrag – summary

Retningslinjene dekker omfang, gjennomføring og rapportering av miljøundersøkelsene som operatørselskapene skal gjennomføre som et av vilkårene for å drive petroleumsaktiviteten til havs.

These guidelines contain instructions for carrying out and reporting on the environmental monitoring required as one of the conditions in discharge permits issued to offshore operating companies. .

4 emneord	4 subject words
Miljøovervåking	Environmental monitoring
Petroleumsvirksomheten	Oil and gas activity
Til havs	Offshore
Norsk kontinentalsokkel	Norwegian continental shelf

Climate and Pollution Agency
P.O. Box 8100 Dep
N-0032 Oslo
Visiting address: Strømsveien 96, Helsfyr, Oslo

Tel: +47 22 57 34 00
Fax: +47 22 67 67 06
E-mail: postmottak@klif.no
Website: www.klif.no/english

About the Climate and Pollution Agency

The Climate and Pollution Agency reports to the Ministry of the Environment and has 325 employees, based mainly in Oslo. We implement government policy on pollution. We act as advisers, guardians and stewards for the environment. Our most important fields of work include climate change, chemicals, marine and freshwater environment, waste management, air quality and noise. Our vision is a future without pollution.
We are working to

- reduce greenhouse gas emissions
- reduce the spread of hazardous substances harmful to health and the environment
- achieve integrated and ecosystem-based management of the marine and freshwater environment
- increase waste recovery and reduce emissions from waste
- reduce the harmful effects of air pollution and noise

TA- 2849/2011