11 TOWARDS ECOSYSTEM ASSESSMENT

OSPAR has a well-established set of monitoring and assessment tools which support the implementation of its thematic strategies. Tools for assessing ecosystem health have been tested, but overarching ecosystem assessments remain a major challenge.

OSPAR Contracting Parties should cooperate

- → to develop an integrated monitoring and assessment programme based around an improved and comprehensive set of indicators that describe a clean, healthy and biologically diverse sea;
- → to draw current strands of OSPAR work into this context;
- → to extend the development and application of ecosystem assessment methodologies;
- → to seek consistency with developments under the EU Marine Strategy Framework Directive;
- → to research into impacts of pressures and biological changes that are insufficiently understood.

Key OSPAR assessments

- → Evaluation of the OSPAR system of Ecological Quality Objectives for the North Sea
- → Utrecht workshop report

The sustainable use of ecosystem goods and services through the application of the ecosystem approach is a core aspiration that is reflected in OSPAR's vision of a clean, healthy and biologically diverse North-East Atlantic ecosystem and expressed in the EU Marine Strategy Framework Directive as *... maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive*. Delivering the objectives of the OSPAR Strategies will contribute to achieving this aspiration.

The ecosystem approach requires the comprehensive integrated management of human activities based on the best available scientific knowledge about ecosystems and their dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems. This presents a challenge to existing methods for the assessment of the marine environment by requiring consideration of the wider implications of human activities on the quality, structure and functioning of marine ecosystems. Yet, understanding of the functioning of marine ecosystems and their interactions with human activities, and the availability of data supporting an ecosystem assessment are – and are likely to remain – limited. Assessment methodologies that support the ecosystem approach must accommodate these limitations and evolve with developments in knowledge.

A key starting point for developing methodologies to assess ecosystem health is an assessment of the overall status of biodiversity of the OSPAR area. Species and habitats that occur in the marine environment interact in complex and dynamic spatial and temporal patterns. Assessment methodologies need to link knowledge of the biology, chemistry and physics of the ecosystem. The basic challenge comprises three main steps: (1) to assess the status of species and habitats; (2) to assess the pressures from human activities; (3) to link the status and the impacts from pressures and take into account cumulative effects arising from multiple pressures and the interactions among species and habitats in the ecosystem. Knowledge from OSPAR's established assessment work → **CHAPTERS 4–10** needs to be brought into the context of what is known about the North-East Atlantic's biodiversity. This is important for those parts of the ecosystem that are subject to multiple pressures, especially those that play a key role in ecosystem functioning.

During the reporting period covered by the QSR 2010, OSPAR has made important steps toward supporting the ecosystem approach through the concept of Ecological Quality Objectives (EcoQOs) which provide a link between human activities and impacts on biodiversity and collectively provide a means of expressing a clean, healthy and biologically diverse sea. OSPAR has also progressed the development of approaches to assess the cumulative impact of pressures on specific species groups and habitat types as well as to rank the various pressures specific to each OSPAR Region. OSPAR has noted complementary approaches to ecosystem assessment, such as those developed by the ICES (International Council for the Exploration of the Sea) Study Group for the Regional Integrated

Sponges in waters off Ireland

Assessment of the North Sea. These approaches are clearly part of an evolving field of work, which needs to incorporate new knowledge as it becomes available. This chapter outlines some of these OSPAR developments and illustrates their contribution to ecosystem assessments.

Methods established to evaluate progress towards some OSPAR objectives

OSPAR's Joint Assessment and Monitoring Programme includes well-developed approaches for assessing eutrophication, hazardous substances and radioactive substances → TABLE 11.1. Commonly agreed tools, methodological standards and guidelines provide the basis for a coordinated and quality assured evidence base across much of the OSPAR maritime area and have delivered OSPAR-wide assessments, for example, of contaminant concentrations. At the same time there has been a need to evolve the assessment of contaminant concentrations on the basis of their biological effects. Such developments have proved extremely challenging and, for the time being, the capacity to associate observed biological effects in the marine environment with specific contaminant concentrations is generally limited. Furthermore, understanding the cumulative effects of hazardous substances on populations of marine organisms remains an area of development. In support of this, OSPAR, in cooperation with ICES, is exploring techniques to evaluate toxic and genetic effects in organisms which are representative of marine ecosystems.

OSPAR assessment work is founded in sound science and supported by exchange with ongoing marine research, particularly on underlying processes in the marine environment and on cause and effect relationships. It has taken considerable debate and scientific research to develop these assessment frameworks → TABLE 11.1. The experience gained in this process contributes to their continuing evolution. There is important complementary

TABLE 11.1 *Overview of well-established OSPAR assessment frameworks.*

Eutrophication	→ CHAPTER 4
Target	A healthy marine environment where no eutrophication occurs
Parameters	*Pressure:* Atmospheric and waterborne inputs *Environment:* Ten indicators of nutrient enrichment, algal blooms, loss and changes in biodiversity (macrophytes, zoobenthos, fish), oxygen deficiency
Geographical scope	OSPAR area
Assessment reference point	Area-specific assessment levels which may show a maximum deviation of 50 % of the natural background levels
Hazardous substances	→ CHAPTER 5
Target	Preventing pollution from hazardous substances listed on the OSPAR List of Chemicals for Priority Action with the ultimate aim of achieving concentrations near background values for naturally occurring substances or close to zero for man-made substances
Parameters	*Pressure:* Atmospheric and waterborne inputs *Environment:* Environmental concentrations in marine sediments and biota and biological effects
Geographical scope	OSPAR area
Assessment reference point	Natural background concentrations or zero for man-made substances Assessment levels where no adverse effects on the ecosystem can be assumed
Radioactive substances	→ CHAPTER 6
Target	Concentrations of radionuclides near background values for naturally occurring radioactive substances or close to zero for artificial radioactive substances
Parameters	*Pressure:* Discharge rates from nuclear and non-nuclear sources (total α-activity, total β-activity and specified indicator radionuclides) *Environment:* Levels of indicator radionuclides for the nuclear and non-nuclear sectors in seawater, seaweeds, molluscs and fish
Geographical scope	OSPAR area
Assessment reference point	*Discharges:* Baseline for trend assessment (1995–2001) established for certain indicator radionuclides discharged from the nuclear sector; baseline for the non-nuclear sector not yet established *Concentrations in the environment:* Baseline for trend assessment (1995–2001) established for certain indicator radionuclides for the nuclear sector in many areas. Baseline for indicator radionuclides for the non-nuclear sector not yet established

assessment work carried out by other bodies in relation to commercial fish stocks and oceanographic parameters which needs to be incorporated into OSPAR assessments and methodologies. Monitoring and assessment of biodiversity is still a challenge as it requires significant information not only in relation to priority species and habitats, but also ecosystem structure and functioning, and needs to be linked with the existing OSPAR assessment work.

EcoQOs provide an indicator-based assessment approach in Region II

The system of EcoQOs for the North Sea, developed by OSPAR in collaboration with ICES, defines the desired qualities of selected components of marine ecosystems in relation to human pressures. The EcoQOs set objectives for specified indicators and provide a means to measure progress. Collectively, EcoQOs are intended to provide comprehensive coverage of ecosystems and the pressures acting upon them, such that meeting all EcoQOs should provide the evidence that the ecosystem is in a good state. Where EcoQOs are not met, OSPAR should investigate the reasons for this and, where appropriate, should consider measures to regulate the relevant human activities.

Evaluation of the initial set of EcoQOs used in the North Sea shows that the objectives set have mostly not yet been achieved and that continued efforts are needed to improve the quality of the North Sea → TABLE 11.2. There are, however, signs that the impacts of tributyltin (TBT) and oil on marine life and the contamination of seabird eggs with chemicals have been decreasing. Some important commercial fish stocks for which reference levels have been set continue to be beyond safe limits, but the size composition of demersal fish communities has been improving, although the desired objective has not yet been reached. Litter in the marine environment is still a concern as indicated by the amount of plastic found in fulmar stomachs. By-catch of harbour porpoises is still high and the data are insufficient to assess whether the EcoQO is met.

The set of EcoQOs, developed for the North Sea, is not yet considered comprehensive. Most EcoQOs link to specific human activities, such as shipping (oil at sea), litter and fishing, and some link with established assessment approaches by evaluating adverse effects from hazardous substances and excess nutrients. Some EcoQOs indicate the health status of ecosystem components more generally, such as the EcoQO for seal populations. The experience from applying EcoQOs points to the need for consistent implementation across Region II and the need for improvements in quality assurance and data management. The EcoQOs have also provided a focus for discussions with stakeholders

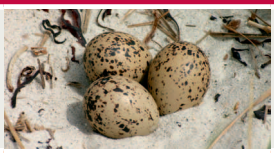
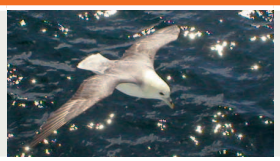
Benthic communities off southern England

on the management of the North Sea. Examples include the EcoQO on oiled guillemots which was a focus for governmental cooperation with coastal communities, bird rescue centres and volunteers in handling oiled birds in the case of oil spills. In the Netherlands, the EcoQO on plastic particles in seabird stomachs has been used to evaluate efficiency of port waste reception facilities.

OSPAR needs to develop the EcoQO system further to provide more comprehensive coverage of ecosystem components and pressures. Additional EcoQOs are already under development on seabird populations, threatened and/or declining habitats and marine beach litter. A more complete system would strengthen overall assessments of the North Sea status. Development of EcoQOs that can be applied in other OSPAR Regions may require the adaptation of the North Sea EcoQOs (e.g. use of more regionally appropriate species). Experience in expanding the application of EcoQOs to other OSPAR Regions has already been gained for TBT and eutrophication, through the development of assessment criteria which can be applied in all OSPAR Regions. The indicator on which the large fish EcoQO is based has also been trialled in other OSPAR Regions in addition to the North Sea.

OSPAR's concept of EcoQOs has supported the selection of indicators for measuring progress toward good environmental status under the EU Marine Strategy Framework Directive and should continue to support the development of a comprehensive set of criteria for good environmental status under the Directive. The aim must be to have a common set of indicators, regionally bespoke where appropriate (e.g. regionally appropriate species or assessment criteria), enabling a comparable judgement of good environmental status across the OSPAR area.

TABLE 11.2 *Summary of current status of the North Sea in relation to Ecological Quality Objectives (EcoQOs) based on assessments in Chapters 4 to 10. Further EcoQOs are under development on seabird populations, threatened and/or declining habitats and marine beach litter. Confidence: *** High; ** Moderate; * Low.* **?** *Status not known*

	Ecological Quality Objective		Status for the North Sea	
Biological diversity	**Healthy seal populations** → CHAPTER 10			
	No decline of greater than 10 % in grey seal pup populations or harbour seal populations over a five-year running mean, taking into account natural population dynamics and trends		Some problems ★ ★ ★	Harbour seals: EcoQO not met: Shetland; Orkney; North and East Scotland; South-East Scotland; Greater Wash to Scroby Sands; Limfjorden; west coast of Norway south of 62 ° N EcoQO met: the Netherlands Delta area; the Wadden Sea; Heligoland; the Kattegat, Skagerrak and Oslofjord Grey seals: EcoQO met in all areas
	Reduce by-catch of harbour porpoises → CHAPTER 8			
	By-catch rates should be no more than 1.7 % of the population		?	Unknown status in absence of reliable by-catch information
Commercial fish stocks/Food webs	**Increase proportion of large fish in the fish community** → CHAPTER 8			
	More than 30 % of fish should be longer than 40 cm		Many problems ★ ★ ★	EcoQO not met, but movement towards the objective detected
	Fish stocks at biologically safe levels → CHAPTER 8			
	All commercial stocks should be at or above safe levels		Some problems ★ ★ ★	EcoQO met for 9 stocks EcoQO not met for 3 stocks Unknown status for 13 stocks
Eutrophication	**Eliminate eutrophication** → CHAPTER 4			
	Dissolved inorganic nitrogen and phosphorus, chlorophyll a, phytoplankton, oxygen and benthic species should not exceed assessment levels		Many problems ★ ★ ★	EcoQO not met in coastal areas along the continental coast of the North Sea, some offshore areas in the southern North Sea and some UK estuaries
Contaminants	**Reduce level of imposex in dogwhelks and other gastropods** → CHAPTER 5			
	Imposex should be below levels indicating negative effects from exposure to TBT		Many problems ★ ★ ★	EcoQO not met at most locations, but levels of imposex are decreasing
	Reduce number of oiled guillemots → CHAPTER 9			
	There should be less than 10 % of birds found dead or dying which are oiled		Many problems ★ ★ ★	EcoQO met: Shetland, Orkney. Percentage of oiled guillemots is decreasing EcoQO not met: Belgium, Netherlands, Germany No information: East Scotland, East England, Denmark, Sweden, Norway
	Reduce levels of hazardous substances in seabird eggs			
	Mercury should not exceed reference levels Organochlorines should not exceed set values		Some problems ★ ★ ★	EcoQO not met for organohalogens and mostly not met for mercury. Concentrations are decreasing
Marine litter	**Reduce levels of litter (plastic particles) in fulmar stomachs** → CHAPTER 9			
	There should be less than 10 % of fulmars with more than 0.1 g of plastic in their stomach		Many problems ★ ★ ★	EcoQO not met: Current levels still well above the objective

Pilot of a new assessment approach

OSPAR has piloted one approach that aims to determine the status of ecosystems building on the identification and quantification of the main pressures and their cumulative impacts on species groups and habitat types. At a workshop held in Utrecht (the Netherlands) in February 2009, over 70 experts in marine science drawn from all OSPAR Regions participated in a trial assessment. The pilot provided important insight into the complexity of assessing ecosystems, and the lessons learnt are an essential contribution to the further development of assessment methodologies. In many cases the results of the Utrecht workshop concur with the findings of the thematic assessments prepared through regular OSPAR work, but there are also many gaps and short-comings, as would be expected when applying a new method to such a complex assessment for the first time. The results are presented in the Utrecht workshop report and Table 11.3 illustrates a possible outcome of impact assessments against pressures to support an overall assessment of quality status per region. The main messages drawn from the Utrecht workshop concern the method itself, the learning process and the way forward.

The Utrecht workshop followed a systematic analytical methodology described by Robinson *et al*. (2009). The workshop focused on assessing, at the scale of OSPAR Regions, the impact of pressures from human activities, as listed in the EU Marine Strategy Framework Directive, and those driven by climate change, on a selection of four species groups (fish, cetaceans, seals, seabirds) and four habitat types (rock and biogenic reef habitats, shallow sediment habitats, shelf sediment habitats, deep-sea habitats). The assessment process followed a series of steps:

- The first step was to map the geographic distribution of human activities and to describe the spatial and temporal extent, intensity and frequency of the pressures resulting from these activities.
- The second step was to define the geographic distribution of species groups and habitat types that are sensitive to these pressures.
- The third step was to estimate the degree of impact, where pressures and ecosystem elements overlap in space and in time. For this purpose, generic criteria and associated threshold values were developed for geographic range, population size and condition for species groups, and on range, extent and condition for habitats. The threshold values were based on those given in EU guidance for assessing favourable conservation status of species and habitats under the Habitats Directive. The degree of impact, following these criteria, was assessed against a reference status (based on an absence of the pressure). The percentage deviation from this reference status was used to classify the outcome as 'low', 'moderate' or 'high' impact.
- The fourth step was to summarise the different impacts from human activities in order to derive an overall status assessment per species group and habitat type (→ **TABLE 11.3** for example output).
- Finally, the impacts on all species groups and habitat types were summarised to assess the total impact per pressure → **TABLE 11.3** and consequently their relative contribution to the total impact in each Region.

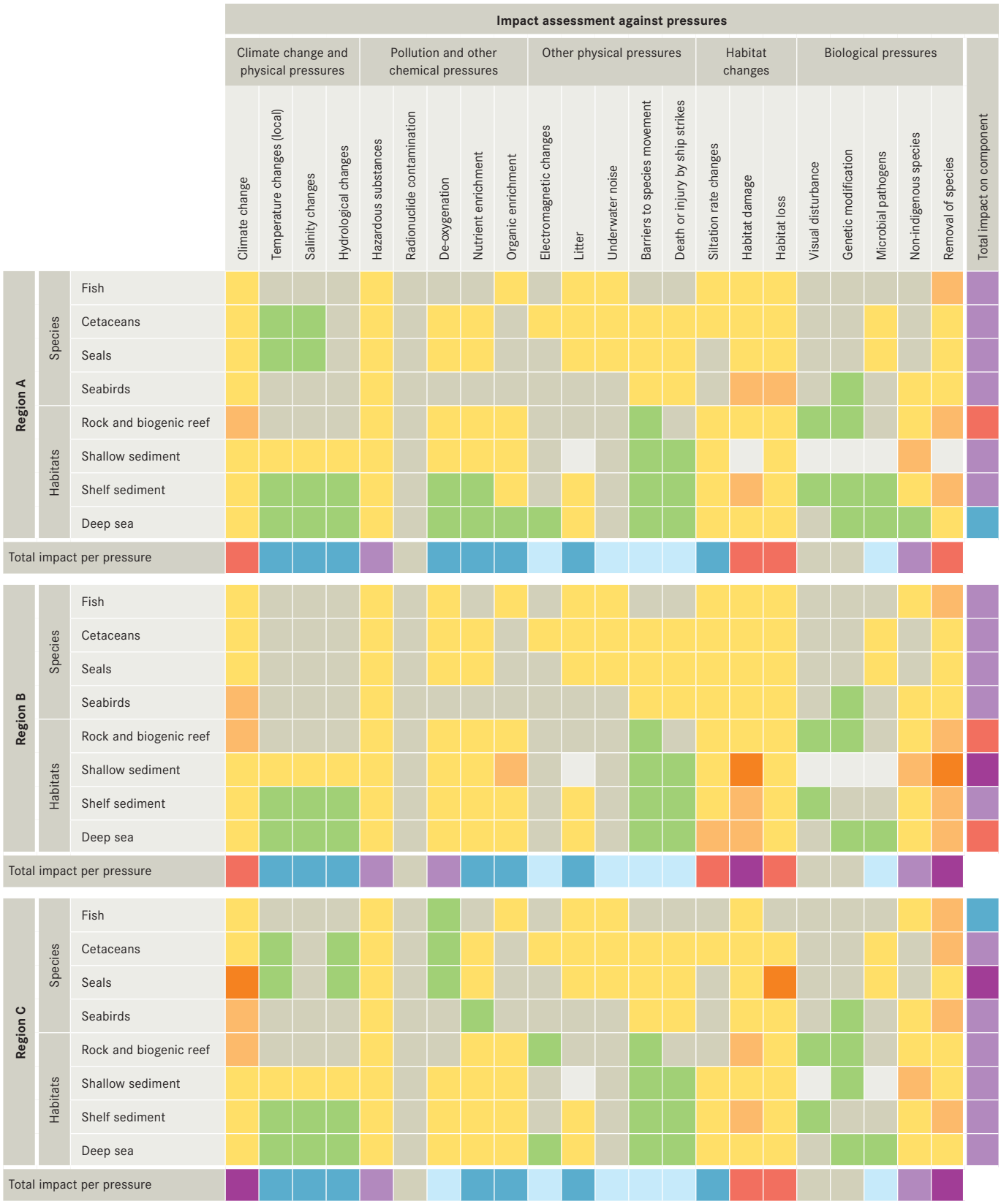
The assessment drew upon data and information on the distribution of the range of human activities presented in Chapters 8 and 9 and the supporting thematic assessments. In some cases, information on impacts from these activities and the status of species and habitats for all OSPAR Regions is very limited. These gaps were filled by collective expert knowledge which was also limited for some Regions and pressures. The level of confidence was determined for each assessment of impact. Lack of consensus among experts was addressed, but could not always be resolved. A review of the method and results of the workshop by ICES recognised that there were shortcomings in the performance of the method which needed to be addressed in its further development. However, the diverse range of experts engaged in the process had clearly added credibility to the expert opinion process.

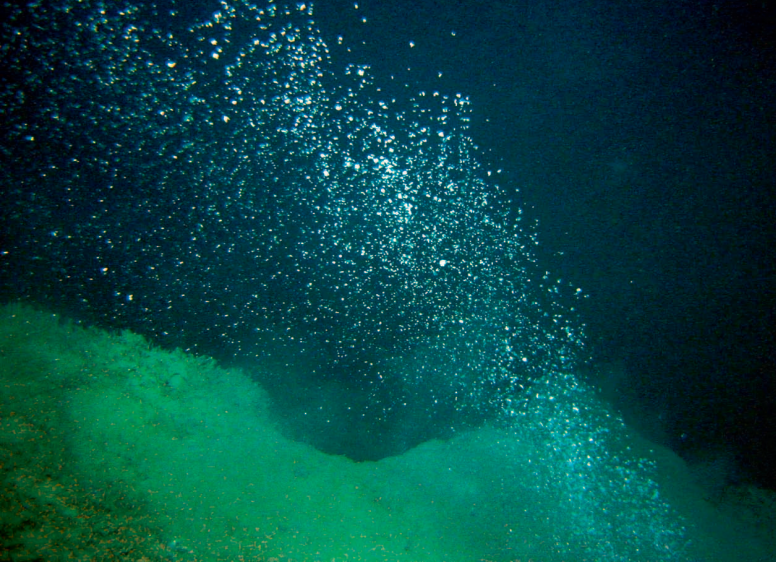
The Utrecht workshop provided good experience in linking human activities and their associated pressures to the assessment of the selected ecosystem components and trialled a generic, large-scale approach to ecosystem assessment. There are several lessons learnt which inform future work.

- Mapping of human activities and ecosystem components is promising for the assessment of separate and cumulative impacts on habitats and related sessile species (which are bound to a particular area). It seems less applicable to mobile species.

Fan worm near Cabo Peñas, northern Spain

TABLE 11.3 *Illustration of results from a pilot assessment of four species groups and four habitat types. A total impact assessment was made per region from the sum of the individual impacts per ecosystem component (last column) and per pressure (last row).*





Methane bubbles, Håkon Mosby mud volcano, Barents Sea

Brittle star on Lophelia pertusa corals, Porcupine Bank

- Assessments at the scale of OSPAR Regions are too coarse to identify properly the often area-specific impacts of human activities. Many habitats also occur at a smaller geographical scale. It is therefore important that assessments of human impacts are undertaken at the appropriate scale, which may vary on a case by case basis.
- Generic assessment criteria and thresholds do not take into account the variation in life history characteristics for some species groups. The assessment criteria should be refined to allow for more differentiation in species and also habitat groups.
- The pilot assessment yields a first indication of cumulative effects. Further development of the method is needed to improve the assessment of cumulative effects.
- Judgement by a designated group of experts following well-defined procedures can complement limited datasets. The credibility of the outcome is enhanced by recording the confidence level and by describing how gaps in data were treated and how issues were addressed for which there was insufficient consensus.

Next steps towards ecosystem assessment

OSPAR's existing thematic assessment approaches have been extended by the development of EcoQOs as a North Sea pilot project. Through the Utrecht workshop, OSPAR has also piloted a new approach for assessing additional aspects of ecosystem status at a broader scale. This pilot assessment has provided important lessons for future integrated assessments, such as those that may be needed for the EU Marine Strategy Framework Directive.

Further development of OSPAR's monitoring and assessment capabilities to address wider ecosystem functioning and biodiversity status must build on, and seek compatibility with, assessment methods developed under the Marine Strategy Framework Directive as well as other EU Directives (Water Framework Directive, Habitats Directive, Birds Directive) and other regional marine conventions (e.g. HELCOM). OSPAR Contracting Parties should cooperate to address the following priorities for action:

- To develop an improved and comprehensive set of indicators building on the current EcoQOs to enable assessment against OSPAR's objectives of a clean, healthy and biologically diverse sea. These indicators should cover the main ecosystem components, the range of relevant pressures and should be suitable for assessing ecosystem functioning and cumulative effects.
- To identify information needs to enable a move from expert judgement to a more evidence-based assessment. Improvements in the accessibility of all marine data will support this.
- To extend the development of ecosystem assessment methodologies which bring together and build upon OSPAR's existing approaches for thematic assessments. This should include a consideration of appropriate ecosystem components and their interactions as part of ecosystem functioning. There is a need for assessment criteria (especially for species) that take into account regional differences and for agreement on the most appropriate geographic divisions. Aggregation and integration techniques need to be developed.
- To develop integrated monitoring programmes, which take into account monitoring being undertaken in other forums and draw together current strands of OSPAR's work (e.g. EcoQOs, species and habitats on the OSPAR list of threatened and/or declining species and habitats) and which integrate across physical, chemical and biological systems.
- To further research both the impact of pressures that are insufficiently understood (e.g. litter, noise, electromagnetic radiation) and biological changes that cannot presently be explained (e.g. declines in seabird populations).
- To develop methodologies to judge whether the North-East Atlantic is being used sustainably.