International practices on setting criteria for favourable conservation status and baseline status of marine habitats

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1. Introduction

Members of the European Union have a commitment under the Habitats Directive to contribute to European nature conservation. For habitats, including marine, this is achieved through the designation of Natura 2000 sites, which contribute to an EU wide network of nature protection areas. These areas are required to be managed with an emphasis on sustainability, both ecological and economic. As soon as possible upon designation and within 6 years at most, member states must take the necessary management or restoration measures to ensure the favourable conservation status of those sites.

The Habitats Directive[1] is a European Union directive adopted in 1992 as an EU response to the Berne Convention. It is one of the EU's two directives in relation to wildlife and nature conservation, the other being the Birds Directive. The aim of the Directive is to protect 220 habitats and approximately 1,000 species listed in the directive's Annexes. These species and habitats are considered to be of European interest, following criteria given in the directive.

The directive led to the setting up of a network of Special Areas of Conservation, which form a network of protected sites across the European Union called Natura 2000, together with the existing Special Protection Areas.

Annex I of the directive contains a list of habitats of European interest, including marine habitats. A guideline is available for interpretation of these habitats (DG Environment 2013). For Estonia, the following Natura 2000 habitats are relevant:

- **1110 Sandbanks which are slightly covered by sea water all the time:** Character species for Estonia: charophytes, higher plants (*Zostera marina*, Ceratophyllum, *M. spicatum*, *N. marina*, *Potamogeton perfoliatus*, *S. pectinata*, ranunculus, *Ruppia*, *Z. palustris*), infauna (*M. balthica*, *M. arenaria*, *C. glaucum*), loose lying *F. lumbricalis* (only from Kassari Bay)
- **1130 Estuaries:** Downstream part of a river valley, subject to the tide and extending from the limit of brackish waters. River estuaries are coastal inlets where, unlike 'large shallow inlets and bays' there is generally a substantial freshwater influence
- **1140 Mudflats and sandflats not covered by seawater at low tide:** The Habitat Directive defines this as intertidal areas. In Estonia there are no tides, but water level can fluctuate due to the wind. Definition of this habitat in Estonia: muddy and sandy flat coastal area, occasionally not covered by seawater due to the low water level
- **1160 Large shallow inlets and bays:** Bays with diameter large than 1 km, depth generally below 2 m
- **1170 Reefs:** Character species: *Fucus vesiculosus*, *Fucus radicans*, *Furcellaria lumbricalis*, filamentous algae, *M. trossulus, A. improvisus*, *D. polymorpha*

Article 17 of the directive contains information on reporting requirements of EU Member States towards the EC on the status of the designated habitats. The main requirements are summarized here:

- Member states are required to report on the state of the sites and implementation of measures taken under this Directive. The report is required to include information on conservation measures, impact of those measures on the conservation status of habitats and main results of surveillance (Article 11)

[1] Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

- The Commission creates a composite report based upon the site reports. These reports include an appropriate evaluation of progress achieved. A draft version is forwarded to the Member State for verification. The final versions of the member state reports are published within 2 years for consideration by the Member States, the European Parliament, the Council and the Economic and Social Committee

The aim of the report is to provide information about benthic habitat classifications and condition assessment of marine habitats used in the Baltic, EU and worldwide. The report brings together information on the methods and approaches commonly used in classifying marine benthic habitats and assessing their extent and condition as a way of determining their favourable conservation status. The report will be used to inform the development of methods for monitoring and reporting habitat condition and trend in Estonian waters to fulfil their obligations under the EU Habitats Directive and their national conservation objectives.

2. Benthic habitat classifications

Benthic habitat classification systems allow the seafloor to be partitioned into discrete units that have similar physical and/or ecological characteristics. Among the several advantages of using standardized classification schemes is that they enable comparisons to be made between different studies, by providing a standard framework and terminology (Harris and Baker 2012). The classification facilitates reporting of habitat data in a comparable manner, for use in nature conservation (e.g. inventories, monitoring and assessments), habitat mapping and environmental management (Moss 2008). There are many different habitat classification schemes that have been developed for the coastal and marine environments. These schemes range from site/topic specific to broad approaches that cover large geographic regions (Reynolds and Greene 2008). The benefits of a site- or topic-specific classification scheme is that they can be tailored to a locations specific suite of habitats, whilst broad approaches allow habitats to be compared across large geographic regions.

Table 1. Comparison of benthic habitat classification systems.

Classification System	Reference	Target Area	Marine	Terrestrial	Hierarchical
A Classification scheme for deep seafloor habitats	Greene *et al.* 1999	USA	✓		✓
NOAA Marine and Estuarine Ecosystem and Habitat Classification	Allee *et al.* 2000	USA	✓	✓*	✓
International Hydrographic Organisation standardization of undersea feature names	IHO 2013	International	✓		
European Nature Information System	EEA 2013	Europe	✓	✓	✓
Marine Habitat Classification for Britain & Ireland	Connor *et al.* 2004	UK and Ireland	✓		✓
Baltic Marine Landscapes	Al Hamdani and Reker 2007	Baltic	✓		
HELCOM HUB - underwater biotope and habitat classification	HELCOM 2013a	Baltic	✓		✓

*partially covered

Some of the more commonly used habitat classification schemes include that of Greene *et al.* (1999) for deep sea habitats, the European Nature Information System (EUNIS) (EEA 2013), the Marine Habitat Classification for Britain & Ireland (Connor *et al.* 2004), the International Hydrographic Organisation standardization of undersea feature names (IHO 2013), the NOAA Marine and Estuarine Ecosystem and Habitat Classification (CMECS) (Allee *et al.* 2000) (Table 1). Within the Baltic region there are also a number of region specific classification systems/approaches that have been employed, including marine landscapes (Al-Hamdani and Reker 2007) and the HELCOM underwater Biotope and habitat classification (HELCOM 2013a).

2.1. A classification system for deep seafloor habitats (Greene *et al.* 1999)

The system of Greene *et al.* (1999) was one of the first published habitat classification systems that attempted to develop a standard, universally useful classification system for deepwater habitats. Among its features is a focus on capturing habitats at a variety of scales, from Megahabitats (features from kilometres to tens of kilometres), through Mesohabitats (tens of metres to kilometres), Macrohabitats (one to tens of meters) and Microhabitats (features centimetres in size). This classification system describes different habitat types in a hierarchical structure reflecting the scale of the features using systems, subsystems, class and subclass as the main groupings going from large to small features. The classification is predominantly based on physical and morphological parameters to define these features. Modifiers form the base level of the classification, which are used to describe the bottom morphology, bottom deposition, bottom texture, physical processes, chemical processes and biological processes that may help differentiate different habitats.

2.2. NOAA marine and estuarine ecosystem and habitat classification

The NOAA Marine and Estuarine Ecosystem and Habitat Classification system is a hierarchical system that was specifically designed for the USA. This system consists of 13 hierarchical levels. The upper 10 levels in the hierarchy describe the large scale physical setting of a habitat, including the climate zone, terrestrial vs water, marine/estuarine vs freshwater etc. Level 11 describes the geomorphic type and level 12 describes the substratum and eco-type. The bottom level, level 13, as for the Greene *et al.* classification system above, is for local modifiers and eco-unit. The NOAA classification system has been designed with similar aims to the EUNIS system (see below). It has additional hierarchical levels, not present in the EUNIS system, that can be used to additionally describe the physical setting and at the modifier level.

2.3. IHO - standardization of undersea feature names

The International Hydrographic Organization – standardization of undersea feature names differs from the previous classification systems in that it is not a hierarchical system designed to classify features at a range of scales. It is simply a list of geomorphic feature types and broad generic descriptions, rather than an actual classification scheme with decision rules, etc. (Harris and Baker 2012). It is included here as it provides definitions of many of the large scale features included in other classification systems.

2.4. European Nature Information System (EUNIS)

The European Union Nature Information System (EUNIS) habitat classification system aims to provide a common European reference set of habitat types within a hierarchical classification, and to cover all terrestrial, freshwater and marine habitats of Europe (Moss 2008). The EUNIS classification system is unique in that is covers both marine and terrestrial habitats and provides a

European wide system. The basis for the marine part of EUNIS is a classification of marine habitats of Britain and Ireland (Connor *et al.* 2004), developed by the British Joint Nature Conservation Committee (JNCC), see below. The top level of the hierarchy divides the habitats into eleven groupings which pull together habitat of similar types such as Marine habitats

2.5. Marine habitat classification for Britain & Ireland

The marine habitat classification for Britain and Ireland provides a tool to aid the management and conservation of marine habitats. It is one of the most comprehensive marine benthic classification systems currently in use, and has been developed through the analysis of empirical data sets, the review of other classifications and scientific literature, and in collaboration with a wide range of marine scientists and conservation managers (Connor *et al.* 2004). The classification system focusses on marine habitats, with particular focus on the near shore habitats (within 3 miles and less than 50 m water depth), with the deep water habitats less well described. It is hierarchical in nature and is fully compatible with and contributes to the European EUNIS habitat classification system.

2.6. Baltic marine landscapes

The Baltic marine landscapes scheme is not a prescribed classification system as such, but rather an attempt to use available geological, physical, chemical and hydrographic data to identify and map broad-scale marine landscapes for the Baltic Sea, based upon trans-national and cross-sectoral cooperation (Al-Hamdani and Reker 2007). The marine landscapes were developed to be individually distinct and reflect broad-scale species assemblages within the Baltic Sea. Three main types of marine landscapes were identified, coastal marine features (such as fjords and estuaries), seabed features (including benthic ecological features) and water column marine landscapes (pelagic).

2.7. HELCOM HUB - underwater biotope and habitat classification

The development of the HELCOM Underwater Biotope and habitat classification (HELCOM HUB) has been carried out with the aim to create a common understanding of the Baltic Sea biotopes, habitats and communities (HELCOM 2013a). The classification system has been constructed to be compatible with the European Nature Information System (EUNIS), but specific to the habitats and biotopes of the Baltic Sea Region. HELCOM HUB was developed by the HELCOM Red List project, as part of an effort to produce a comprehensive Red List of Baltic Sea species and to update the Red Lists of Baltic habitats/biotopes and biotope complexes for the HELCOM area. The system is a hierarchical system, with 6 levels and is primarily focussed on marine and not terrestrial habitats. Although HELCOM HUB retains the basic EUNIS structure, the substrate type is divided into finer levels (Wikström *et al.* 2010); it defines 328 underwater biotopes and ten biotope complexes.

3. Status assessment of marine habitats

3.1. Status criteria

Article 1 of the EU Habitat Directive contains the definition of the conservation status of habitats.

Article 1 (e) conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

The conservation status of a natural habitat will be taken as favourable when:

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

The conservation objectives are defined based upon the favourable conservation status. This favourable conservation status is based upon historical data and information, information from reference locations or best expert's judgement. In the case that the state of a habitat in an area is assessed to be in a favourable state of conservation, the objective is to conserve the current state. If the current state is assessed to be in an unfavourable state of conservation, then recovery objectives need to be defined. Similar principles have been embedded in regional policy frameworks, for example the OSPAR Convention uses Ecological Quality Objectives (EcoQOs) to help set management objectives for threatened or declining habitats (OSPAR 2011). The general EcoQOs for threatened or declining habitats are:

- restore and/or maintain the areal extent and distribution of the habitat,
- restore and/or maintain the quality of the habitat (e.g. water and sediment quality, condition of dominant or defining (e.g. habitat-forming) species, species composition, ecological functions).

ICES (2002) recommended a four-step process for the evaluation of the usefulness of habitats on the OSPAR List of threatened and/or declining habitats in developing EcoQOs.

Step 1: Determine whether a habitat on the List occurred in the North Sea.

Step 2: Can the threatened or declining status of the habitat be quantified accurately?

Step 3: Can we establish why a habitat is threatened or declining?

Step 4: Can trends in habitat status be detected reliably on short timeframes (about five years) relevant to management?

The formulation of the favourable conservation status is a scientific exercise, driven by available data and expert knowledge. However, the final choice of the conservation status and conservation objectives is a policy decision (Article 2 Habitat Directive), with the condition that the Habitat Directive defines that member states have to maintain or restore the favourable status of conservation for those Habitats and Species reported under the Habitat Directive. Stakeholder participation is possible in this process, as the Habitat Directive states that the measures can take into account socio-economic considerations.

The following framework for assessment of the status of habitats is required by the EC (DG Environment 2007) (Table 2). The assessment itself is based upon expert judgment and the current scientific knowledge of marine ecosystems.

Table 2. Framework for assessment of the status of habitats (DG Environment 2007).

Aspect	Favourable	Moderately unfavourable	Very unfavourable	Unknown
Distribution	Area stable or increasing AND not smaller than the 'favourable reference state'	Between 'favourable' and 'unfavourable'	Loss of area of more than 1 % per year OR area more than 10 % less than the 'favourable reference state'	No or insufficient information
Surface (Extent)	Area stable or increasing AND not smaller than the 'favourable reference state' AND no substantial change in the distribution pattern within the area	Between 'favourable' and 'unfavourable'	Loss of surface of more than 1 % per year AND surface less than the favourable reference state OR substantial change within the area OR surface more than 10 % less than the 'favourable reference state'	No or insufficient information
Quality	Structure and function (including typical species) in a good state AND no substantial deterioration	No or insufficient information	Structure and function is unfavourable in more than 25 % of the surface	No or insufficient information
Future perspectives	Perspectives are excellent or good. Major threats are not substantial. The habitat type is viable on a long term	No or insufficient information	Strong negative influence of threats for the habitat type; Negative perspectives ; viability of the habitat on the long term is in danger	No or insufficient information
Global evaluation Status of conservation	All 'green' or 3x 'green' and 1 'unknown'	One or more 'orange' but no 'red'	One or more red	Two or more unknown, with only green.

3.2. Physical and biological features used in status classification

In order to determine the favourable conservation status of a habitat, measures of both the physical and biological features that define that habitat are needed. These measures help to establish the extent and the quality of a habitat. The range of physical and biological features measured and the techniques used to measure these will depend largely on the habitat types being measured and the location of these habitats. In general monitoring protocols are usually site specific, with little information readily available on the surveys and methods of analysis available. The United Kingdom has, however, developed a monitoring protocol for marine habitats which provides guidance on methodologies and sampling techniques appropriate for each habitat (Davies *et al.* 2001).

The UK Marine monitoring handbook (Davies *et al.* 2001) outlines suitable approaches to monitoring the UKs marine special areas of conservation (SACs). The handbook covers the monitoring of seven Annex 1 habitat types including the five found in Estonian waters. Procedural guidelines are provided for 23 sampling methods including acoustic systems (AGDS, side scan sonar), photography and videography (viewpoint photography, sediment profile imagery, drop down video, subtidal hand held video, etc.), grab and suction sampling, towed sledge and fish sampling to name a few. Additionally procedural guidelines are presented on differential GPS, site relocation and specimen collection. Overall the UK marine monitoring handbook covers the methods used in the UK to assess the favourable conservation status of Annex 1 habitats (Figure 1).

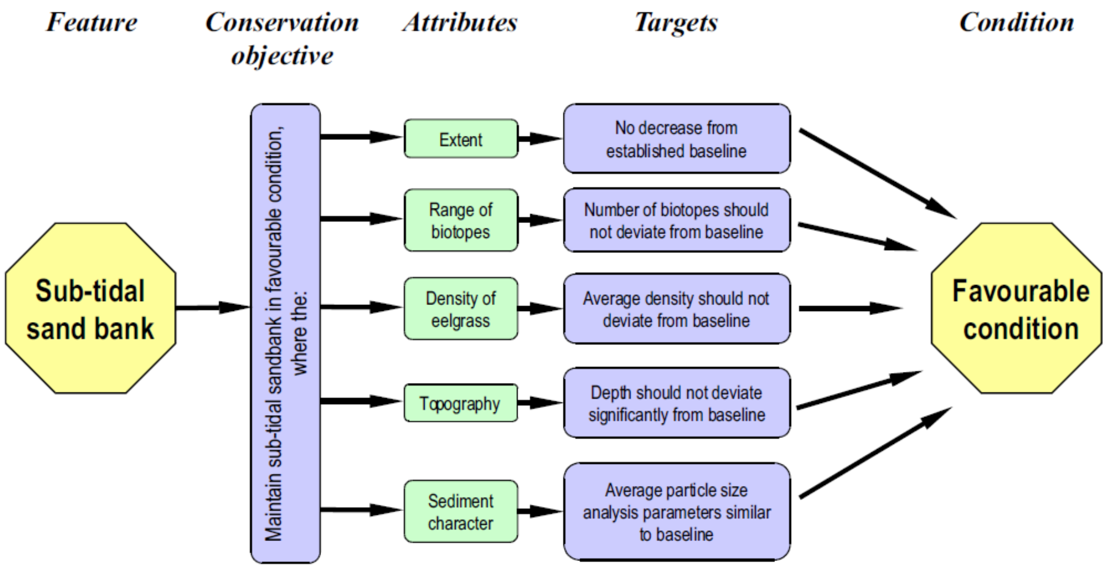

Figure 1.Diagrammatic representation of the UK's approach to setting a conservation objective for a marine SAC feature (Davies *et al.* 2001).

In assessing the conservation status of an Annex 1 habitat the condition of a range of features will need to be assessed. The following general features have been used in France, United Kingdom, the Netherlands, Germany and Belgium to assess the status of estuaries, mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, sandbanks and reef habitats (Table 3 - Table 7). These are described in a general way below. For species, this is area specific and this can be different in the Baltic compared to the North Sea.

Table 3. General features used to assess the status of Natura 2000 Estuaries (1130)

Group	Feature	Assessment
Physical	Area	Surface of the habitat, based upon the geomorphological characteristics of estuaries
	Structure/function	Hydrodynamic characteristics of estuaries Modelling data
Biological	Species communities	Macrobenthos communities Fish communities Other fauna Plants

Monitoring of the physical and biological characteristics of Estuaries requires a range of techniques and approaches. For example, the area or extent of an Estuary is a largely cartographic exercise which can be supported by remote sensing such as aerial photography and GIS (Davies *et al.* 2001). Additional sampling may be required to determine the extent of habitat types within an estuary, for example using acoustic or aerial remote sensing to determine the extent of seagrass beds. Other physical characteristics of an estuary may include sediment structure (sediment particle size or sediment profile imagery), water clarity (secchi disk), chemistry (water chemistry data loggers) and nutrient status (water quality samples). Sampling for such physical characteristics is commonly undertaken on a defined grid or other sampling pattern.

Sampling of the biological features of an estuary may be based on a range of sampling techniques which will depend on the physical setting (intertidal, subtidal) and the types of organisms being sampled (infauna, sessile organisms and mobile species). These techniques include quadrat sampling, towed video, grab samples, photography, epibenthic trawling, acoustic surveys and aerial photography. A description of these techniques can be found in the UK marine monitoring handbook (Davies *et al.* 2001). It is important to select relevant indicators to monitor to ensure that the conservation status of the habitat can be determined.

A series of 128 indicators were analysed in the UK relating to condition assessment of sedimentary ecosystems (Mazik *et al.* 2010). The 128 indicators included primary and derived indicators and covered zoobenthos, indicators of the status of saltmarsh, seagrass and macroalgae (opportunistic algae and fucoids), indicators of the status, spatial extent and distribution of key habitats and species (characterising, of conservation importance, indicator species and non-indigenous species) and a number of biomarkers. 100 of these indicators were accepted as valuable indicators which could be used in routine monitoring; these can be accessed through the UK Government Joint Nature Conservation Committee website (http://jncc.defra.gov.uk/page-5500). Sedimentary indicators are applicable for all soft sediment Natura 2000 habitat types including estuaries, mudflats and sand flats not covered by seawater at low tide, large shallow inlets and bays, and sandbanks.

In establishing a monitoring protocol for estuaries several factors must be taken into consideration. Firstly, an estuary may contain other Annex 1 habitats such as mudflats and sandflats, subtidal sandbanks and reefs which may require their own condition assessment (Davies *et al.* 2001). Despite this the condition of the entire estuary should be assessed. Additionally, seasonal and meteorological variation may have an impact on the condition (positive or negative) within an estuary.

Table 4.General features used to assess the status of Natura 2000 Mudflats and sandflats not covered by seawater at low tide (1140)

Group	Feature	Assessment
Physical	Area	Surface of the habitat, based upon the geomorphological characteristics of the habitat
	Structure/function	
Biological	Species communities	Macrobenthos communities Fish communities Other fauna Plants

As for estuaries, monitoring the extent of mudflats and sand flats can be done through remote sensing techniques such as aerial photography. The physical characteristics of such habitats include sediment character (sediment particle size, sediment chemical analyses), topography (LIDAR, shore profiling), water chemistry (measuring water quality, water chemistry data loggers), and nutrient status (measuring water quality, water chemistry data loggers) (Davies *et al.* 2001).

The biotic factors to be monitored can include biotic and or species composition/richness (Intertidal core sampling, intertidal *ACE* Surveys (Connor and Hiscock 1996)), characteristic species (Intertidal core sampling, intertidal *ACE* Surveys etc.) and spatial patterns of biotypes (remote sensing, transect surveys etc.) (Davies *et al.* 2001). As for Estuaries both seasonal and meteorological conditions must be taken into account when developing survey methodologies, especially with regards to timing of surveys.

Table 5. General features used to assess the status of Natura 2000 Large shallow inlets and bays (1160)

Group	Feature	Assessment
Physical	Area	Surface of the habitat, based upon the geomorphological characteristics of the habitat
	Structure/function	
Biological	Species communities	Macrobenthos communities Fish communities Other fauna Plants

The extent of large shallow inlets and bays again requires a remote sensing approach such as aerial photography. As with estuaries, these habitats may contain other Annex 1 habitats, whose extent may be defined using a number of different techniques, including aerial and acoustic remote sensing and point sample mapping. The physical characteristics of large shallow bays and inlets include sediment characteristics, water clarity, water chemistry and nutrient status, with appropriate monitoring methods similar to those identified for these characteristics above.

The biotic characteristics of large shallow inlets and bays can include both the intertidal and subtidal biotope and species richness/composition and characteristic species, again with methods identified as above. Both seasonal and meteorological conditions must be taken into account when developing survey methodologies, especially with regards to timing of surveys.

Table 6. General features used to assess the status of Natura 2000 sandbanks (1110)

Group	Feature	Assessment
Physical	Surface	Surface of the habitat within the area, based upon geomorphological characteristics of sandbanks
	Distribution	Occurrence of the habitat within the area
	Geomorphology	Topography of sandbank habitats
	Substrate	Sediment characteristics (grain size)
	Transparency	Transparency of water column Suspended solids Algal biomass
	Morphodynamics	Sediment transport Erosion Sedimentation
	Hydrodynamics	Currents, waves etc.
Biological	Species communities	Macrobenthos communities Fish communities Other fauna

The extent of subtidal sand banks may be determined by a combination of acoustic remote sensing, point sampling and for shallower areas aerial remote sensing (Davies et al. 2001). The physical properties of sand banks that may be measured include sediment character, topography, tidal regime (current meters and tide gauges), water clarity, water chemistry and nutrient status. The biotic properties include biotope and species composition/richness and characteristic species. The spatial pattern of subtidal biotopes is also an important indicator of habitat condition and can be determined using grab samples, video (including ROV) and acoustic systems.

Table 7. General features used to assess the status of Natura 2000 habitat reefs (1170)

Group	Feature	Assessment
Physical	Surface	Surface of the habitat within the area, based upon geomorphological characteristics of reefs
	Distribution	Occurrence of the habitat within the area
	Substrate	Substrate characteristics Stability
	Transparency	Transparency of water column Suspended solids Algal biomass
	Morphodynamics	Sediment transport Erosion Sedimentation
	Hydrodynamics	Currents, waves etc.
Biological	Species communities	Macrobenthos communities Fish communities Other fauna

Reefs are the final Natura 2000 habitat type that occurs in Estonian waters. The extent of reefs can be identified using a combination of aerial and acoustic remote sensing and point sampling. The extent of reefs can be further divided into intertidal subtidal and subtidal biogenic reefs (Davies *et al.* 2001). The physical properties of reefs that can be used in assessing the condition of reefs include water clarity, water chemistry and substratum (video and acoustic remote sensing). Reefs commonly support a large range of organisms. As such the monitoring of biotic properties is especially important in assessing the conservation status of these habitats. Typical biotic properties that can be monitored on reefs include biotope and species composition/richness using a range of techniques including dive and video surveys, quadrat sampling, suction sampling and fish sampling (Davies *et al.* 2001). It is vital that a standardised approach is adopted when measuring attributes of the number of species (species richness) or biotopes (biotope richness) because the number recorded is directly linked to the sampling effort (Sanderson *et al.* 2000).

Reef habitats may also contain a large range of species body sizes, as such sampling may be required at a range of scales in order to quantify the numbers of both large and small organisms. In the case of quadrat sampling this may be achieved by using a large quadrat size for enumerating the number of large organisms, and subsampling with a small quadrat size for smaller organisms (Davies et al 2001).

Biological zonation and spatial patterns of biotopes can also be important indicators of condition on reef habitats. As reefs are structurally complex and may contain many biotopes, a suite of techniques may be required to survey the full range of reef biotopes, for example intertidal and subtidal zones. Stratified surveys may also be used to ensure adequate sampling of the range of biotopes that occur in reef habitats (Davies *et al.* 2001).

A series of 215 indicators were analysed in the UK relating to condition assessment of reef and biogenic reef ecosystems (Mieszkowska and Langmead 2010). These indicators covered both pressures on these ecosystems or components of these ecosystems, and indicators of ecosystem structure and function. 185 of these indicators were accepted as valuable indicators which could be used in routine monitoring; these can be accessed through the UK Government Joint Nature Conservation Committee website (http://jncc.defra.gov.uk/page-5496).

As with the other habitat types seasonal and meteorological effects must be considered in monitoring reef habitats.

3.3. Spatial and temporal aggregation principles

In order to assess the favourable conservation status of a habitat both spatial and temporal information on its extent and quality are required. The first step is often to determine the distribution/extent of the habitat to be assessed. One of the major challenges in this is determining an appropriate scale at which to map and the methods to map. Benthic ecosystem features (reflected in habitat classification) are patchy on many scales (Davies *et al.* 2001). Habitats may be broadly distributed or occur in confined narrow bands. Further, the boundary of a habitat for the purpose of determining extent can be difficult to define.

Habitats may also be patchy in distribution which will affect the mapping and monitoring approaches. For example, in the OSPAR region, beds of mussels can be composed of isolated clumps, in ribbon like reefs with superimposed wave-like undulations, or in sheets. OSPAR guidance indicated that patches extending over >10 m^2 with >30% cover by mussels and the epibiota attached to them should be classified as “beds”, while scattered populations of isolated full grown individuals or of spat at quite high densities should not be classified as “beds” (OSPAR 2011).

There is a lack of information available on setting an appropriate scale for sampling patchy habitats and how to aggregate this information together when assessing the condition of a habitat. It is generally indicated that these decisions will depend largely on a combination of the extent, distribution and patchiness of a habitat as well as other physical parameters. For example reef habitats are known to support different suites of species at different depths and different exposure regimes (Davies *et al.* 2001).

The aim of a monitoring programme is to assess the condition of a whole habitat, and therefore the sampling programme must ensure samples are recorded throughout the entire extent. A stratified approach may be adopted for extensive sites where the available resources only permit a few locations to be investigated in detail, and the results must be extrapolated to the whole site (Davies *et al.* 2001). Nevertheless, the sampling strategy should include a series of ‘spot checks’ throughout the site to ensure that the extrapolated results are in fact representative of the condition of the entire site.

Temporal aggregation of monitoring data is also an important consideration when establishing a monitoring programme. Marine communities show seasonal patterns that could significantly affect a monitoring programme. In estuaries, for example, algal communities show some of the most obvious seasonal trends (Davies *et al.* 2001). Similarly many marine organisms have seasonal reproductive patterns which will significantly alter the number of individuals at different times of the year (Davies *et al.* 2001). As such, monitoring of habitat extent and condition should be conducted across similar seasonal conditions, with environmental conditions at the time of the survey also recorded.

In assessing the temporal trends in the condition of a habitat, it is also important to consider how these can be linked to both environmental changes and human use impacts. For example, in the North Sea, Zostera beds have been identified as a threatened or declining habitat. However, there are insufficient data on the recovery rates, and a lack of clear causative links with a manageable human activity to be able to establish Ecological Quality Objectives (OSPAR 2011).

At the regional and European-wide level, national site reports are aggregated both spatially and temporally, and are available on the European Environment Information and Observation Network website[2]. Aggregation of these reports is carried out at the national scale and at the

[2] http://bd.eionet.europa.eu/article17/reports2012/

biogeographical level. The assessments, both by countries and for the biogeographical regions, are available to the public using a dedicated website designed by the European Topic Centre on Biological Diversity and co-developed by the European Environment Agency. The reports describe the status of the habitat within the reporting period (e.g. 2007-2012).

3.4. Reference conditions or baseline status

Assessing the favourable condition of a habitat requires a reference condition or baseline state against which to assess the current condition. As was observed in the comparison of methods in the five studied countries (Degraer *et al.* 2010), it is often impossible to determine the reference condition of a given marine habitat because there is an absence or lack of monitoring information, an absence of historical reference situations and undisturbed reference sites and/or a large natural variability of the marine habitats. Determining thresholds values for the favourable state of conservation should therefore be done using other methods such as:

- Experiments with exclusion of physical disturbances of the habitats
- Modelling based upon stressor-response data
- Research on the naturalness of the habitat
- Literature research on sensitive species

In the UK, in developing a baseline for the 2008 Species and Habitat Action Plans, previous assessments from 2002 and 2005 were considered. The 2002 survey covered a limited number of species and habitats, and thus a full comparison could not be made, while the 2005 survey covered a similar suite of species to the 2008 survey. Three options were considered, using the earlier 2002 survey as the baseline and only reporting on the species and habitats common in the 2008 survey; using the 2005 survey as the baseline and only reporting on common species and habitats; or using a hybrid of the 2002 and 2005 status and reporting on the broadest suite of species and habitats across the longest timeframe possible. The last option of a hybrid approach of using 2002 data, where available, and supplementing with 2005 data to form a baseline was recommended (Hall 2010).

In effect establishing a baseline for a given habitat requires a pragmatic approach, combining the available historical data on the habitat distribution, extent and condition. Ideally the baseline would represent a time when the habitat was in a favourable conservation status with little evidence of degradation or human impact. In many cases this is not possible, as such, determining the favourable conservation status might require additional information to be collected.

3.5. Boundary setting principles (between favourable and not favourable conservation status)

In order to determine whether a habitat is in a favourable or unfavourable condition compared to an established favourable reference condition or baseline, information on aspects of the habitat's condition needs to be collated and assessed. DG Environment has developed a framework for assessment of the status of habitats (Table 2, DG Environment 2007) which uses available scientific information to score four aspects of habitat status; distribution, surface (extent), quality and future perspective. Each of these four aspects of habitat status may be scored as favourable, moderately unfavourable, very unfavourable, or unknown based on the available scientific information (indicators) and expert knowledge.

The distribution aspect of a habitat relates to where it occurs within a region. For many of the Annex 1 habitats, aerial remote sensing can be used to provide an estimate of distribution. For deeper habitats, including reef or submerged sand banks, additional information from acoustic remote sensing and/or point sampling may also be required to determine the distribution. Typical habitat distribution indicators include range and spatial pattern of a habitat (OSPAR 2011). A habitat's distribution would be considered to be in a favourable status if it was stable or increasing, and not smaller than a favourable reference state. It should be noted that an increasing distribution of one Annex 1 habitat may negatively impact on the distribution of adjacent Annex 1 habitats. A very unfavourable reference state would be where the distribution loss was greater than 1% per year (consistent over several years) or where more than 10% of the distribution is considered to be in a degraded condition (DG Environment 2007). If habitat distribution status falls between the favourable and very unfavourable, then it may be scored moderately unfavourable. In the case that there is insufficient information to determine the status of the distribution, the status is scored as unknown.

The surface (extent) aspect of a habitat relates to its aerial coverage or biomass. Surface (extent) can be measured using remote sensing (aerial and/or acoustic) and supplemented with underwater video, dive surveys and point sampling. Typical surface (extent) indicators include area and volume of the habitat or key habitat forming species (e.g. seagrass) (OSPAR 2011). The surface (extent) is considered to be in a favourable status when the area is stable or increasing and not smaller than a favourable reference area, further it will be considered favourable if there has been no substantial change in the distribution pattern within the area. The surface (extent) will be considered very unfavourable when any of the following criteria are met; there has been a loss of more than 1% per year and the area is less than a favourable reference state, the has been a substantial change in distribution within the area, or if more than 10% of the area is considered to be in a degraded condition (DG Environment 2007). If habitat surface (extent) status falls between the favourable and very unfavourable, then it may be scored moderately unfavourable. In the case that there is insufficient information to determine the status of the distribution, the status is scored as unknown.

The quality aspect of a habitat relates to the structure and function (including of typical species) required to maintain its integrity. Typical indicators of habitat quality include the condition of the typical species and communities; relative abundance and/or biomass, as appropriate; physical, hydrological and chemical conditions; physical damage; condition of benthic community; type, abundance, biomass and areal extent of relevant biogenic substrate; extent of seabed significantly affected by human activities for different substrate types; presence of sensitive and/or tolerant species, multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species; proportion of biomass or number of individuals in the macrobenthos above some specified length/size; and parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community (OSPAR 2011).

The quality aspect of a habitat would be considered favourable when the structure and function (including typical species) are in a good state and there is no substantial deterioration. The quality of a habitat would be considered very unfavourable where the structure and function is unfavourable in more than 25% of the area (DG Environment 2007). If habitat condition status falls between the favourable and very unfavourable, then it may be scored moderately unfavourable. In the case that there is insufficient information to determine the status of the distribution, the status is scored as unknown.

The final habitat aspect, future perspectives, incorporates the pressures and impacts that will shape a habitat condition into the future. Indicators for future perspectives include anthropogenic factors such as pollution, fishing pressure, dredging and extraction activities, or environmental changes such as changes in current regime, temperature and severity of storms. The future perspective of a habitat is considered to be in a favourable status where the perspectives are excellent or good, major threats are not substantial, and the habitat type is viable on a long term. The future perspective is very unfavourable when there is a strong negative influence of threats for the habitat type, or the viability of the habitat in the long term is in danger (DG Environment 2007). If habitat future perspective status falls between the favourable and very unfavourable, then it may be scored moderately unfavourable. In the case that there is insufficient information to determine the status of the distribution, the status is scored as unknown.

Once the four aspects of habitat condition are assessed, these can be used to determine the overall conservation status of the habitat. Under the DG Environment framework a habitat would be considered in a favourable conservation status if either all four aspects are favourable or at least three of the four aspects of habitat status are favourable, and the remaining aspect is unknown. In the case where one or more of the aspects of habitat status is moderately unfavourable, but none of the aspects are very unfavourable then the habitat would be considered to have a moderately unfavourable conservation status, while if one or more of the aspects of habitat status were very unfavourable, then the habitat would be considered to have a very unfavourable conservation status. It must be noted that determining the conservation status of a habitat is a policy decision that is underpinned by the available scientific data.

3.6. Assessment of marine habitats in the Southern North Sea

In order to examine how other European states are approaching the assessment of habitat condition, case studies from the literature were examined. Where possible these were related back to the relevant Natura 2000 habitats found in Estonia. The report from Degraer *et al.* (2010) contains a bench marking study of methodologies to assess favourable status of conservation for marine habitats and species protected under the Habitat Directive. The bench marking study included a comparison of methodologies that are being used in France, the UK, the Netherlands and Germany.

The following habitats[3], discussed in this study, are relevant for Estonia.

- 1110 Sandbanks which are slightly covered by sea water all the time
- 1170 Reefs

These main habitat types occur in Estonia as well as the southern part of the North Sea. However, regional differences occur in species composition, salinity, geomorphological characteristics etc.

The study from Degraer *et al.* (2010) concluded that the methods for determination of the conservation status and the criteria for the favourable status of conservation in the four studied countries were quite heterogeneous. Each country has an individual interpretation and process to determine the conservation objectives and favourable status of conservation. The eventual results (objectives, criteria) show much agreement with 2 levels of objectives; the objectives for marine habitats on a national scale have a general and abstract nature and are refined for each site separately. The operational conservation objectives have not been reached in any of the countries so far.

3.6.1. France

The Natura 2000 areas in France each have a steering committee (COPIL), containing members from socio-economic sectors. Management documents (DOCOB) with specific measures for the marine habitats are developed by the COPIL. There are specific guideline documents that describe how the DOCOB management documents have to be developed. There is no overarching national vision in France in relation to marine conservation objectives, but a number or general guidelines have been put forward, with participation of stakeholder groups:

- The restoration and conservation of marine habitats, with the objectives to ensure a sustainable management, to avoid direct and indirect pollution and to improve scientific knowledge

[3] The habitats '1160 Large shallow inlets and bays' are relevant for Estonia but where not part of the study of Degraer *et al.* (2010), as these are not characteristic for the Belgian part of the North Sea.

- Avoiding changes in marine habitats due to accidental introduction of non-indigenous species
- The restoration and conservation of marine habitats of species mentioned under the Habitat directive
- The management of access to the areas in accordance with the conservation of habitats and species
- Information and awareness raising of users

For each habitat and relevant specie, the DOCOB documents describe the initial state (ecological, biological), the use, the relationship between use and the habitats, objectives for sustainable management, financial consequences and methods for evaluation and assessment of the measures.

3.6.2. United Kingdom

Guidelines for the determination of conservation objectives for marine habitats were developed in a LIFE-Nature project. Amongst others, these conservation objectives should describe what is necessary (physical and biological) to maintain or recover habitats and species on the specific reported sites under the Habitat Directive. More specifically, the conservation objectives are being based upon characteristic elements of the definition, for each site separately, of the favourable state of conservation, with amongst others:

- Abiotic structures and processes
- Biological relationships (e.g. condition of biogenic structures, density of habitat-structuring species, etc).
- Presence and density of typical species

Each Nature 2000 site in the UK has a local project manager who is responsible for the development of management plans, in cooperation with local cultural and socio-economic stakeholders. These management plans contain the conservation objectives for the sites with Habitat Directive – habitats and species. More detailed objectives are developed for the individual sites, as explained above.

3.6.3. The Netherlands

Conservation objectives have been developed for the Dutch marine Natura 2000 areas (Jak *et al.* 2009), including the habitat types 1170 and 1110, and for each species and habitat type. These are workable, controllable and realistic in relation to user functions. These form the starting point for further negotiations with stakeholders when measures are defined. More detailed objectives are being made on a site specific basis.

In the Netherlands the habitat '1170 – Reefs' is determined based upon geomorphological features. Biogenic reefs belong to the habitats 1110 and 1140, as these only occur in these habitat types.

3.6.4. Germany

The federal states are responsible for the Habitat Directive in the territorial sea zone of Germany, while the federal government is responsible for Habitat Directive areas in the EEZ. The protection and conservation objectives are formulated in a general way (Table 8 and Table 9).

Table 8. Comparison of objectives for assessing the favourable conservation status of reefs in France, United Kingdom, the Netherlands and Germany.

1170 Reefs	France	United Kingdom	The Netherlands	Germany
Area	No general objectives, objectives are being developed which are site specific.	No change in area of the habitat	No change in area of the habitat	No change in area of the habitat
Distribution		No change in distribution of the habitat	No change in distribution of the habitat	No change in distribution of the habitat
Variety of habitats		Conservation of variety of reef habitats, as identified for each site		
Topography		No changes in topography		
Geomorphology		No changes of the sediment characteristics	Conservation of hard substrates Conservation and recovery of stability of hard substrates Conservation of the variety of sediment types (mosaic structure)	Conservation of the natural morphology and ecological functions (e.g. stepping stone for dispersion) Conservation of the variety of sediment types (mosaic structure)
Natural changes		Consideration of natural changes		
General and other			Guaranteeing rest to ensure colonization of smaller stones by sessile organisms Maintaining the transparency of the water column by low levels of suspended matter and limited eutrophication	Maintaining the ecological quality Maintaining the habitat quality Maintaining the characteristic morpho- and hydrodynamics of the habitat, and associated population dynamics
Positive indicator species			Maintaining the occurrence of typical reef species in sufficient numbers	Conservation of typical benthic communities, within the natural population dynamics (e.g. bivalves, fishes) Maintaining benthic communities with typical long-living species
Negative indicator species				

Table 9. Comparison of objectives for assessing the favourable conservation status of sandbanks in France, United Kingdom, the Netherlands and Germany.

1110 Sandbanks	France	United Kingdom	The Netherlands	Germany
Area	No general information, objectives are being developed which are site specific.	No change in area of the habitat, and its sub-habitats	No change in area of the habitat, and its sub-habitats	No change in area of the habitat
Distribution		No change in distribution of the habitat		No change in distribution of the habitat
Variety of habitats				
Topography		No change in topography		
Sediment characteristics		No changes of the sediment characteristics , and the associated habitats		
Natural changes		Consideration of natural changes		
General and other			Maintaining the transparency of the water column Maintaining structure and functions of the sandbanks Maintaining the ecological quality	Conservation of the natural morphology and ecological functions (e.g. stepping stone for dispersion) Maintaining the characteristic morpho- and hydrodynamics of the habitat, and associated population dynamics Reaching of an abiotic and biotic state of the environment that allow recovery of benthic communities in a favourable state of conservation
Positive indicator species			Maintaining the stable occurrence of typical species in sufficient numbers Maintaining the habitats of typical species and protected species Decrease of disturbance of sensitive species	Maintaining the stable occurrence of typical species in sufficient numbers
Negative indicator species		No increase of negative indicator species with an invasive character (e.g. *Ensis directus, Crassostrea gigas, Crepidula fornicata*.)	No increase of negative indicator species	

3.6.5. Norway

Norway has adopted most EU environmental policies and legislation through the EEA Agreement. This does not, however, include policies relating to the protection of nature, such as the bird directive, the directive on habitats and Natura 2000. But there are signals that the Norwegian protection policy should develop towards Natura 2000, including establishment of areas and accompanying reports to EEA. As such, Norway is not included in this above analysis.

3.6.6. Conclusions

There is diversity in approaches to determine the state of conservation, as well as criteria for the favourable state of conservation and conservation objectives among the studied EU member states. Each member state has its own interpretation of the conservation objectives, and conservation objectives are usually abstract and general. Operational conservation objectives have not been reached in many cases.

In general, the following steps are used to determine the objectives for Habitats of the Habitat Directive:

- Identification of general objectives (favourable state of conservation) for habitats and species, based upon an independent scientific process
- Site-specific objectives, based upon input from administrations and stakeholders, with consideration of site specific characteristics

Often the distinction is made between conservation objectives and recovery objectives. Recovery objectives are based upon knowledge of the reference state. Knowledge of the reference state is based upon best expert judgment, historical data, historical reference collections, comparison with undisturbed habitats, degradation data or a combination of all these.

It is recommended to involve stakeholders is in the process of describing site-specific objectives, as this is essential to acquire the necessary support for site-specific measures, which are based upon the assessment of the state of conservation.

3.7. Assessment of habitat condition and status in Australia – State of the Environment Reporting

Assessment of marine habitat condition and status in Australia is largely done through the state of the environment (SoE) reporting which is a requirement under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999. Every five years the minister for Environment Protection, Heritage and the Arts is required under this act to table a report in Parliament on the state of the environment. The intent of this report is to capture and present, in as accurate and useful a format as practicable, key information on the state of the 'environment' in terms of: its current condition; the pressures on it and the drivers of those pressures; and management initiatives in place to address environmental concerns, and the impacts of those initiatives.

The Commonwealth marine area (between 3 and 200 nautical miles), as a matter of national environmental significance under the Act, is specifically addressed in the State of the Environment reporting. Similarly, the states of Australia, which have jurisdiction over the waters inside 3 nautical miles, conduct parallel SoE processes.

While there has been considerable development of information sources relating to regional and national scale drivers of the marine environment (such as aspects of climate change) and pressures (such as fishing and the distribution and activities of oil/gas exploration), there has been only limited advancement in data/knowledge about the condition of ecosystems (particularly the biodiversity aspects). Many indicators have been previously proposed as suitable for reporting on the condition of Australia's marine environments and ecosystems, but only a few have been operationalised into the mainstream of data collection and synthesis at the local, regional or national scales. As a result, SoE Reports have previously been derived from limited and ad hoc assessments of the available data and examples.

In the absence of strong regional or national indicator datasets, and to limit the bias inherent in a narrow information base, the SoE 2011 process consulted experts to gauge their professional opinion about the condition of Australia's marine ecosystems.

The methodology used is based on *expert elicitation*[4], essentially a scientific consensus methodology, which is a process that synthesises existing assessments, data and information in conjunction with the subjective judgment of experts across a broad base of evidence. The method has the advantages that it is cost- and time-effective, it utilizes the existing knowledge of marine experts from the target region and it can incorporate non-conventional knowledge and information. In addition to Australia, the expert elicitation approach has been used in capacity building exercises in southeast Asia (Ward *et al.*, 2012; Feary *et al.*, 2014) and more recently in west Africa by GRID-Arendal.

The State of Marine Environment Expert Elicitation (SOME-EE) process uses consultation with national and regional experts to gauge expert opinion about the condition of the marine and coastal ecosystems and dependent socio-economic sectors. There are commonly datasets from local areas, and there are many sub-regional scale studies and short-term datasets about various aspects of marine ecosystems, but these have often a too coarse resolution and are not part of a systematic collection of data and knowledge routinely synthesised for reporting purposes. The SOME-EE process draws upon these disparate datasets and the knowledge-base dispersed across a range of sources and institutions to capture a representative sample of existing expert knowledge about the condition of the environment in a manner that can be used for reporting purposes.

The Australian SOME carried out in 2011 was reported by the Department of Environment (2011) and the expert elicitation process that was used is described by Ward (2014) and by Ward *et al.* (2014). Here we present a summary of the overall process needed to produce a SOME report using the expert elicitation process. In the case of Australia, the Department of Environment had decided to conduct a SOME assessment and had concluded that the SOME-EE approach would deliver the optimum quality product within the available budget. It was acknowledged that Australia's 5 major biogeographical provinces should be assessed separately, requiring a separate workshop for each bioregion. Approximately 1 year was allowed for the procedure according to the following steps (Figure 2):

[4] Expert elicitation is the synthesis of opinions of experts on a subject where there is uncertainty due to insufficient data.

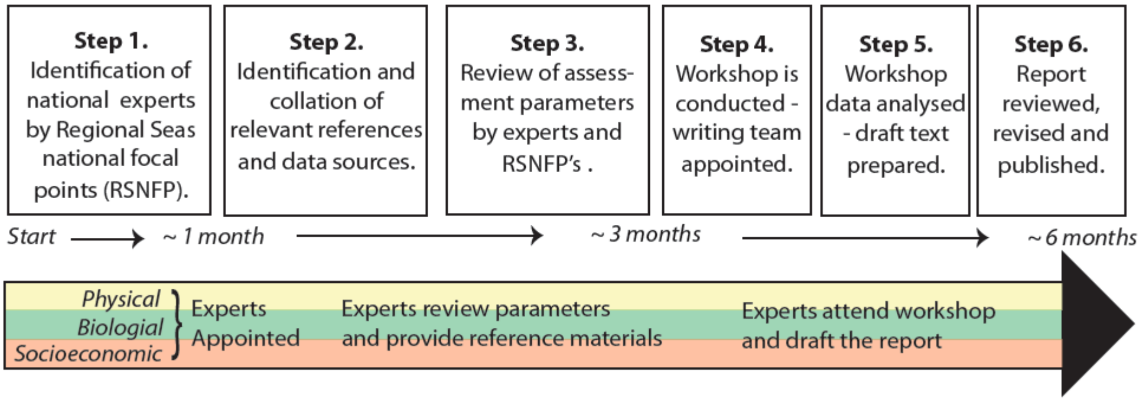

Figure 2. Diagram illustrating the time-line for one complete cycle of the SOME-EE process. Approximately four to six months is needed to plan and execute the process.

Step 1: Prospective experts were identified by the workshop organisers and invited to participate. An announcement was made by the Department of Environment and publicised in the Australian marine science community to ensure broad participation. This step is critical because if the experts invited are not representative of all aspects of the marine environment, or if they are skewed in number towards one particular sector (eg. fisheries), then the assessment will be biased. Experts should at the very least be invited from each of the key discipline areas (fisheries and biology, physical sciences and socioeconomics). Upon acceptance, each participant was provided with a detailed background paper on the assessment process.

Step 2: Workshop organisers identified and collated relevant information and made it available to experts via a web site. At this time, the nominated experts were sent a list of the parameters to be scored and were asked to identify and add important reference data and publications.

Step 3: All experts are provided with the initial pro-forma assessment. Experts were requested to review and make suggestions on the parameters for condition, threats and risk, and the elicitation procedures. They also reviewed the collated relevant information and suggested further additions.

Step 4: The workshops were held, attended by the appointed experts, and scores recorded for 196 separate parameters (examples listed in Table 10). During the workshop, experts were encouraged to volunteer to participate in the subsequent report-writing phase of the process.

Step 5: Post-workshop, the data on condition and risk assessment was compiled and interpreted by the workshop organisers. An editorial committee was selected among the national experts and they added introductory and discussion text as needed. The report was then submitted to the Department of Environment.

Step 6: The report was reviewed internally at the Department of Environment for final checking, updating and corrections as necessary. After revision the report was published on the Department of Environment web site.

Table 10. List of selected parameters assessed in the Australian 2011 SoE report (marine section; Department of Environment, 2011).

Habitats	Species	Ecosystem processes	Physiochemical processes
Estuaries	Sharks and rays (exploited and significant bycatch)	Spatial/physical disjunctions	Ocean currents, structure and dynamics
Small bays	Sharks and rays (non-targeted)	Migration, flyways	Storms, cyclones, wind patterns
Coastal lagoons	Whale shark	Recruitment, settlement	Sediment inputs
Beaches	Great white shark	Genome structures, genetic adaptation	Sediment transportation
Rocky coasts, including islands (intertidal and subtidal)	Tuna and billfish	Nesting, roosting, spawning and nursery sites	Coastal/shoreline erosion
Seabed inner shelf (0-50m)	Southern Bluefin tuna	Feeding grounds	Inshore water turbidity, transparency and colour
Seabed outer shelf (50-200m)	Outer shelf - demersal and benthopelagic fish species (50-200m)	Trophic structures and relationships	Sea temperature, including SST
Seabed shelf break and upper slope	Inner shelf - demersal fish species (0-50m)	Water column, pelagic productivity	Sea level change
Slope (700-1500m)	Slope - demersal fish species (>200m)	Benthic productivity-inshore	Nutrient supply and cycling: land-based (nutrients supplied by river or stream)
Seabed abyss (>1500m)	Meso-pelagic fish species	Benthic productivity-offshore	Nutrient supply and cycling: ocean-based
Coral reefs	Inner shelf small pelagic fish species	Predation	Freshwater inflow, surface and groundwater runoff
Water column shoreline (0-20m)	Inner-shelf reef fish species	Herbivory	Toxins, pesticides, herbicides
Water column inner shelf (20-50m)	Inner shelf - invertebrate species	Filter feeding	Dumped wastes
Water column outer shelf (50-200m)	Outer shelf and inner slope - invertebrates	Microbial processes	Radionuclides
Water column offshore (>200m)	Shoreline and intertidal species	Epiphytism	Ocean acidity
Mangroves	Seabirds—resident	Succession	Ocean salinity
Seagrass beds	Seabirds—migratory	Turnover	Low oxygen-dead zones
Submarine canyons	Hard coral species	Source-Sink relationships	Groundwater salinity
Bryozoan reefs	Mangrove species		Coastal land salinity/acidity
Seamounts	Seagrass species		Seaweed/seagrass wracks
	Dune and saltmarsh plant species		Marine debris wracks
	Dugongs		major currents
	Turtles		major upwellings
	Sea snakes		oceanic fronts
	Crocodiles		air-sea nutrient fluxes, air-sea gas exchange
	Seabirds		air-sea chemical, pollutants
	Dolphins and porpoises		atmospheric forcing via rainfall, wind, air temperature
	Whales baleen (not humpbacks)		extreme climate events
	Humpback whales		
	Whales toothed		

3.7.1. Grading Scores

Scores on condition provided as part of the assessment process were discussed and agreed during the workshop and assigned to quartile grades of Very Poor (0 to 2.5), Poor (>2.5-5), Good (>5 to 7.5) and Very Good (>7.5 to 10), for reporting on condition.

3.7.2. Grading statements

A key part of the process is understanding and applying a set of *Grading Statements* that have been uniquely derived for each major aspect of the assessment to represent the four grades of condition (Very Poor, Poor, Good, Very Good). Grading Statements provide guidance to inform the expert about the thresholds they should use in determining a score. They also explain the spatial context of how to assess a particular parameter (i.e. how to assess pressures, socioeconomic benefits, habitats, species, ecosystem processes, physical and chemical processes both in terms of condition and spatially).

3.7.3. Confidence estimates

Each score is also assigned a confidence estimate (High, Medium or Low) based on the expert's current state of knowledge and judgement. In general terms, a high level of confidence implies that there are published peer-reviewed papers or government reports that support the scores attributed to the parameter in question. A medium level of confidence may be based on one or more expert's knowledge of unpublished data, un-refereed reports or other information; a low confidence score is given where the experts agree to assign a score based mainly on expert opinion and inference.

3.7.4. Benchmarks

In forming judgements about condition of any parameter, a "benchmark" (a point of reference for the condition) is needed. Ideally, the benchmark is the condition of the parameter prior to the time when human impacts started to occur. In practice, benchmarks are mainly chosen for their convenience and to include times when data are available.

The reason is because "ideal" benchmarks will vary greatly from one part of the world to another; it may be the time of European settlement in one place, or before the Roman Empire in another. Humans may have had significant impacts on some ecosystems prior to the "benchmark" time and impacts may have accumulated gradually over a long time period afterwards. In the case of Australia, the time of European settlement was selected as the benchmark (Ward, 2014).

The use of a benchmark should not be confused with an objective for management; it is not the purpose of the SOME-EE process to make recommendations on national marine environmental goals or policies. The establishment of a benchmark is only for the purpose of quantifying environmental change relative to the present time.

3.7.5. Workshop procedures

Three expert elicitation workshops were conducted during 2011, each over a 3-day period in Perth (Western Australia), Brisbane (Queensland) and Hobart (Tasmania). The locations were chosen to most effectively draw upon local knowledge of experts about the nearby regions, and to maximise the prospects of full attendance by the experts at workshops. These workshops were attended by 40 invited experts from a range of backgrounds, disciplines and institutions

In the workshops, scores were given for three aspects of each parameter: 1) the condition in the worst-impacted 10% of the region under consideration; 2) the condition in the least-impacted 10% of the region under consideration; and 3) the condition in most (the remaining 80%) of the region under consideration. Each score is also assigned a confidence estimate (High, Medium or Low) as defined above.

The logic of selecting "10%" of an area for best and worst scores is justified for several reasons. Firstly, an area of 10% of the region under consideration has a higher predictive power than extreme examples of small spatial extent for detecting and/or resolving significant changes created by human activities. By looking at the worst and the best 10% of the region, both ends of the gradient are assessed, providing two independent measures and thereby constraining the "most" (80%) to a score within the identified range.

The scores are given based on *grading statements* that have been developed; these are general descriptive terms of the spatial extent, temporal extent, and magnitude of decline in condition of the parameters in relation to the selected benchmark. Each statement is associated with a range of numeric scores to guide the experts in reaching an agreed score for the parameter in question.

In addition to giving scores and confidence estimates, the experts will next judge the recent trend in each parameter as declining, stable or improving. The trends were assessed only for the last 5 years (and not in relation to the benchmark). The reason for this is to provide policy- and decision-makers with feedback on how policy responses have or have not had the desired effect. The choice of 5 years is based on the typical recurrence interval of SOME reporting in many countries and also because it is unlikely that measurable differences in condition could be detected in less than 5 years following policy changes implemented by government. A confidence estimate is also assigned to trends agreed by the experts (High, Medium, Low).

3.7.6. Data presentation

An important aspect of the Australian SOME-EE model is that the outputs are designed to optimise their communication to policy- and decisions-makers. The graphics used provide a simple summary of conclusions made by the experts that are easy to understand and convey a clear message regarding the status and trend of specified parameters. Examples are shown in Figure 3 below.

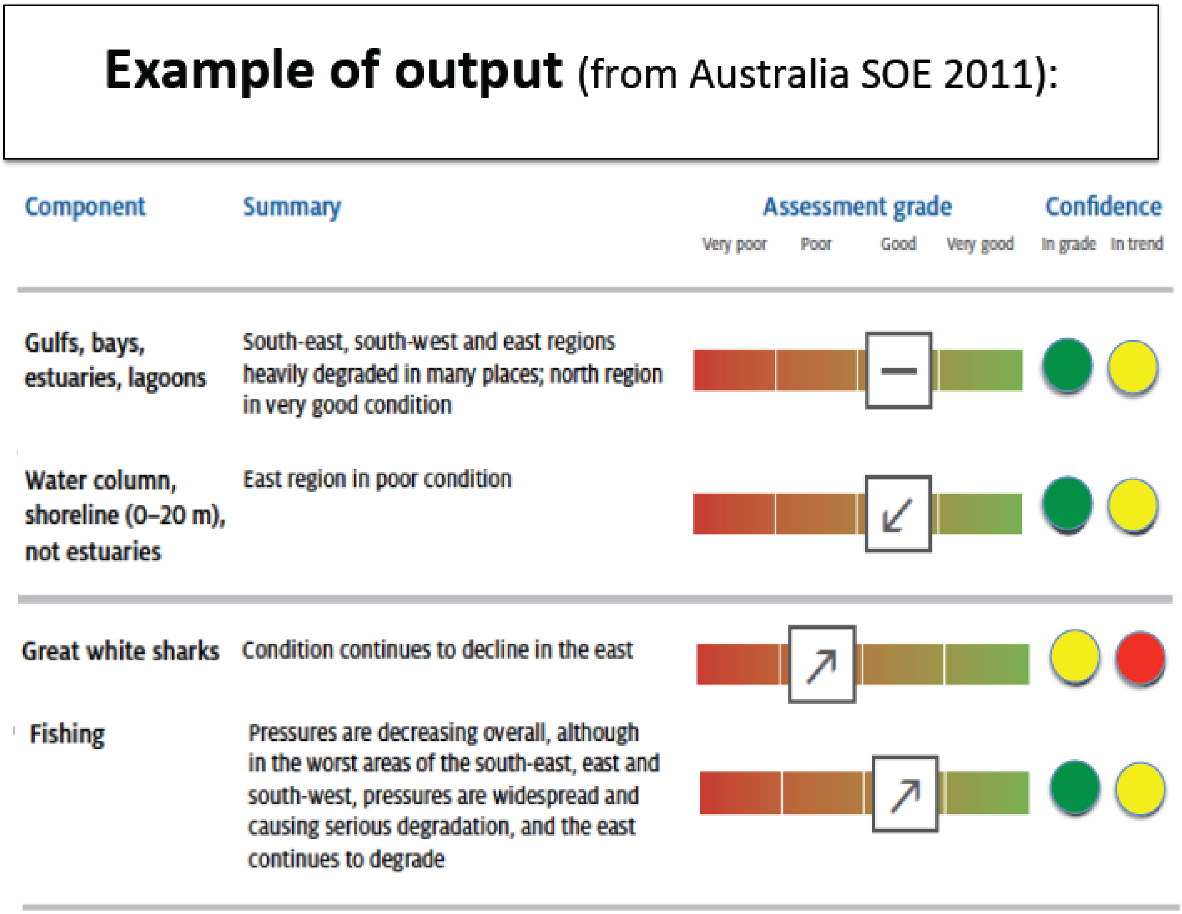

Figure 3. Example of outputs from Australian 2011 SOME-EE workshop process for gulfs, bays, estuaries and lagoons (habitat type), water column from the shoreline to 20 m water depth (habitat type), Great White Sharks (species type) and fishing (pressure) (Department of Environment, 2011). The location of squares indicates overall status of the parameter from very poor to very good. A horizontal line within the square indicates a stable condition, upward pointing arrow indicates improving condition and downward arrow indicates declining condition. Red, yellow and green circles on the right indicate low, medium and high confidence (respectively) for confidence in the grade given for status and the trend.

3.8. Habitat condition assessment in the United States of America

There are several mechanisms by which habitat condition is assessed in the United States of America. The most relevant is the US EPA Report on the Environment (ROE). Other mechanisms include the Marine Fisheries Habitat Assessment Improvement Plan (HAIP) and National Marine Sanctuary Program Condition Reports. This section will primarily focus on the ROE, but will also touch on elements of the other two mechanisms.

3.8.1. The US EPA Report on the Environment (ROE)

The US EPA (2008) Report on the Environment (ROE) presents the best available indicators of information on national conditions and trends in air, water, land, human health, and ecological systems that address 23 questions EPA considers mission critical to protecting our environment and human health (EPA 2008). Of the 23 questions addressed in the ROE, one is specifically focussed on the coastal waters.

> *What are the trends in the extent and condition of coastal waters and their effects on human health and the environment?*

Extent and condition are two key variables in assessing coastal waters and their ability to serve ecological and human needs. The extent of coastal waters—i.e., the spatial area—is particularly important in terms of the extent of specific types of coastal waters, such as coastal wetlands or coral reefs. The condition of coastal waters reflects a group of interrelated physical, chemical, biological, and ecological attributes. For example, nutrient levels should be sufficient to support the food web but not so high as to cause eutrophication, while toxic chemical contaminants in water and sediment may pose a threat to aquatic organisms or accumulate in the food web (EPA 2008).

Five national indicators and two regional indicators are addressed for coastal waters within the ROE, with the above question addressed in each case.

National Indicators

- Wetland Extent, Change, and Sources of Change
- Trophic State of Coastal Waters
- Coastal Sediment Quality
- Coastal Benthic Communities
- Coastal Fisheries Tissue Contaminants

Regional Indicators

- Submerged Aquatic Vegetation in the Chesapeake Bay
- Hypoxia in the Gulf of Mexico and Long Island Sound

In the EPA's 2008 Report on the Environment, an indicator is a numerical value derived from actual measurements of a stressor, state or ambient condition, exposure, or human health or ecological condition over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment (EPA 2008).

The national indicators wetland extent, change, and source of change; coastal benthic communities; and the regional indicator submerged aquatic vegetation in the Chesapeake Bay are most relevant to the assessment of habitat status, although the other indicators will also influence habitat quality. For example the coastal sediment indicator is based on measurements of contaminants in the sediment which can pose a risk to benthic organisms. While this indicator is usually assessed in terms of toxicity to specific organisms in bioassays, or in terms of the levels of contaminants that are present, sediment quality also can be inferred by assessing the condition of benthic communities, which largely reflect the quality of the sediments in which they live (although other stressors may be reflected as well) (EPA 2008).

The wetland extent, change, and sources of change indicator is based on data from the U.S. Fish and Wildlife Service's Wetlands Status and Trends survey. Conducted approximately every 10 years, this survey provides an estimate of the extent of all wetlands in the contiguous U.S., regardless of land ownership. The survey uses aerial imagery to examine sample plots in a stratified survey to determine the extent of wetlands. Field verification is conducted to address questions of image interpretation, land use coding, and attribution of wetland gains or losses.

The coastal benthic communities indicator is based on a multi-metric benthic communities index that reflects overall species diversity in estuarine areas throughout the contiguous United States (adjusted for salinity, if necessary) and, for some regions, the presence of pollution-tolerant and pollution-sensitive species (EPA 2008). The benthic community condition at each sample site is given a high score if the index exceeds a particular threshold (e.g., has high diversity or populations of many pollution-sensitive species), a low score if it falls below the threshold conditions, and a moderate score if it falls within the threshold range. The exact structure of the index and the threshold values vary from one biogeographic region to another, but comparisons between predicted and observed scores based on expert judgment are used to ensure that the classifications of sites from one region to another are consistent (EPA, 2004).

The submerged aquatic vegetation in the Chesapeake Bay indicator presents the distribution of SAV in the Chesapeake Bay and its tributaries from 1978 to 2006, as mapped from black and white aerial photographs (EPA 2008). The surveys follow fixed flight routes to comprehensively survey all shallow water areas of the Bay and its tidal tributaries. This indicator primarily relies on the extent of the submerged aquatic vegetation as an indicator of the condition. This information is linked to other environmental variables, such as turbidity related to rainfall. Extent is just one of the variables that can be used to measure the condition of submerged aquatic vegetation communities and does not necessarily provide a direct indicator of vegetation health, density, and species diversity.

Within the ROE several limitations of the indicator methodology have been highlighted. These limitations relate to continuity of monitoring data sets, lack of coverage, lack of resolution, changes in technologies and changes in methodologies. For example, for the coastal benthic communities it was identified that trend data are not yet available for this indicator in the 2008 ROE. Because of differences in methodology, the data presented were not comparable with data that appeared in EPA's first National Coastal Condition Report (EPA 2004). Thus the 2008 data were determined to serve as a baseline for future surveys. This also highlights one of the biggest challenges of any environmental reporting, and that is setting an appropriate base line to assess condition against.

3.8.2. National marine sanctuary program condition reports

In the United States of America the National Marine Sanctuaries Act (NMSA) authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities as national marine sanctuaries. The National Marine Sanctuary Program Condition Reports provide a summary of resources in each sanctuary, pressures on those resources, the current condition and trends, and management responses to the pressures that threaten the integrity of the marine environment. Specifically, the reports include information on the status and trends of water quality, habitat, living resources and maritime archaeological resources and the human activities that affect them. The methodology is outlined in the National Marine Sanctuaries: A Monitoring Framework for the National Marine Sanctuary System (NOAA 2004).

The Condition Reports use a set of 17 questions as a tool to report on the status and trends of sanctuary resources. These questions relate to water, habitat, living resources, and maritime archaeological resources. There are four questions that relate to the assessment of habitat condition.

- What is the distribution of major habitat types and how is it changing?
- What is the physiological condition of biologically-structured habitats and how is it changing?
- What are the contaminant concentrations in sanctuary habitats and how are they changing?
- What are the levels of human activities that may influence habitat quality and how are they changing?

The questions are general in nature so that they can be asked within any marine ecosystem and at any spatial scale. Each question will be answered using a “status and trends” reporting system which is defined in the monitoring framework (NOAA 2004). Each question will be assigned a colour to denote status and a symbol to denote the trend (Figure 4). Within each condition report a rating scheme is defined, which clarifies the above questions and the possible responses. For each question statements are presented that are used to judge the status and assign a corresponding colour code. These statements are customized for each question and provide a way to standardize judgments across all marine sanctuaries (NOAA 2004).

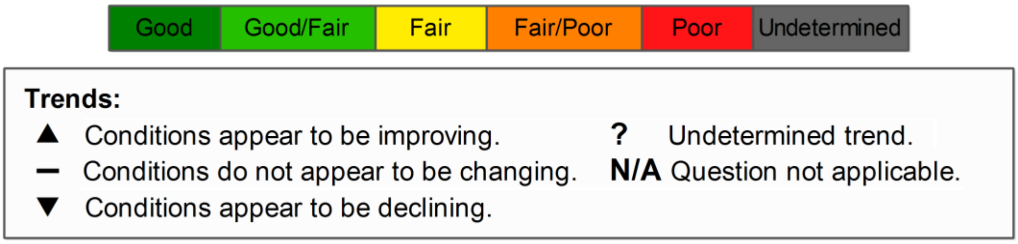

Figure 4. Status and trends for habitat condition assessment in the US.

In order to inform the rating of status and trends for habitats, a System-Wide Monitoring (SWiM) approach is used to monitor each of the U.S. National Marine Sanctuaries. SWiM begins with tailored monitoring at the local (sanctuary) level to track the status and trends of natural resources and human uses (allowable and prohibited) as they affect water, habitat, and living resource quality (NOAA 2004).

The design process for SWiM has three phases (NOAA 2004). The first, Requirements, uses a sanctuary’s management objectives to generate specific questions based on existing threats to resources. The second phase, Protocols, has experts consider temporal and spatial aspects of existing programmes, as well as resolving capabilities, as required by resource managers. The outcome of this phase is a requirements matrix that lists priority resources and specific assessments that must be made for each. The third phase, Observing, involves field sampling, analysis, and reporting. This phase collects the information that the status and trends assessment will be based upon. The marine habitats variables used to assess the condition of a habitat are outlined in Table 11.

Table 11. Variables used to assess the condition of habitat.

Category		Common Measures
Habitats	Status and Trends	Sediment Contamination Structure/distribution Biogenic Aspects Storm frequency/intensity/impacts Climatic events Seasonality
	Human Activity	Mechanical Disturbance Extraction levels Debris accumulation

3.8.3. Marine fisheries Habitat Assessment Improvement Plan (HAIP)

The final main mechanism for the assessment of habitat condition and status in the U.S.A. relates to the assessment of habitat which supports commercial fisheries production. The role of marine habitats in supporting fishery production and in providing other critical ecosystem services is poorly understood. The Marine Fisheries Habitat Assessment Improvement Plan (HAIP) defines the

National Marine Fisheries Service's (NMFS) unique role in pursuing habitat science and in developing habitat assessments to meet its mandated responsibility to sustain marine fisheries and associated habitats (NMFS 2010). While the HAIP has several goals, the most relevant to habitat condition assessment are to improve the ability to identify essential fish habitat (EFH) and habitat areas of particular concern (HAPC) and provide information needed to assess impacts to EFH.

Of particular relevance to the assessment of habitat condition and status are the delineation of habitat type and extent and the assessment of habitat quality. The first is primarily based upon the mapping and characterisation of habitats using physical, chemical, and biological data. These data are collected using a variety of survey instruments and methods, collated, analysed, and translated into maps for use in habitat or stock assessments. Due to limitations of the surveys, data, and analyses, most habitat maps are usually not explicit and often are derived from a reasonable environmental proxy (e.g. depth, grain size, rugosity, and water temperature) (NMFS 2010).

The assessment of the condition of habitats is based on a range of approaches. Typically visual methods to monitor the status or condition of benthic habitats include SCUBA, manned submersibles, towed and drop cameras, laser line scanners, AUVs, ROVs and aerial/satellite sensors (NMFS 2010). Typically, the data products from these tools require a large amount of effort and expertise to compile and thus are dependent on substantial funding (NMFS 2010). Additional information on habitat quality can be inferred from water quality monitoring data. The NMFS is done on a case by case basis, and as such does not provide as detailed framework for reporting as the other examples above.

3.9. Habitat condition assessment in the Baltic Sea Area

Within the Baltic Sea Area, the Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM) is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, known as the Helsinki Convention. HELCOM's vision for the future is a healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities. The Baltic Sea Action Plan (HELCOM 2007), one of the main instruments of Helsinki Convention, outlines an ambitious programme to restore the good ecological status of the Baltic Marine environment by 2021. One of its four goals is the favourable status of Baltic Sea biodiversity.

Environmental assessments and periodic assessments have been conducted since the 1980s within HELCOM. Since the 2000s these have evolved into regular and holistic assessments covering Baltic Sea themes. The HELCOM Monitoring and Assessment Strategy (HELCOM 2013b) was developed as a common plan to monitor and assess the health of the Baltic Sea in a coordinated and cost efficient way between all HELCOM Contracting Parties. It was first adopted in 2005 and revised in 2013 in order to:

- Support regionally coordinated activities of the HELCOM Contracting Parties regarding monitoring and assessment of the Baltic Sea. This supports the implementation of the BSAP and the requirements of the EU Marine Strategy Framework Directive (MSFD).
- Adjust the cooperation on monitoring to the latest technical and scientific developments.
- Enlarge and strengthen the monitoring component of the Strategy.
- Provide a hierarchy of possible sub-divisions of the Baltic Sea that should be used in monitoring and assessment purposes.

A major part of the Monitoring and Assessment Strategy is the principle of the Joint Monitoring System, which is designed to achieve coordination, cooperation, sharing and harmonisation of national monitoring programmes. Information from the Joint Monitoring System feeds into the Data Pool, which can be then used by all countries as the basis of Assessment (Figure 5).

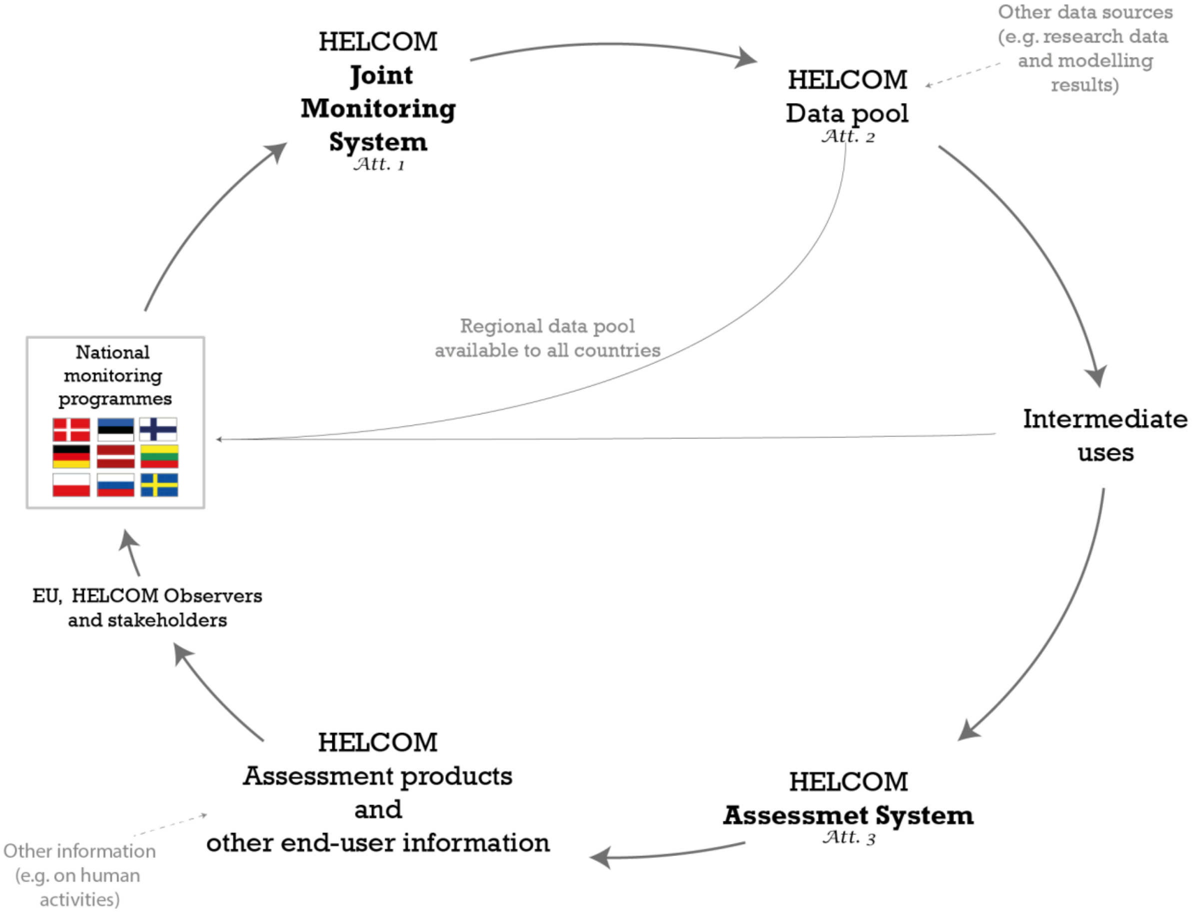

Figure 5. The structure and relationship between the HELCOM Monitoring and Assessment Strategy (HELCOM 2013b) and National monitoring programmes. (source http://helcom.fi/action-areas/monitoring-and-assessment/monitoring-and-assessment-strategy/)

The HELCOM Monitoring Manual has been developed to support the implementation of the HELCOM Monitoring and Assessment Strategy and to follow-up commitments made under Baltic Sea Action Plan (BSAP) and the Marine Strategy Framework Directive (MSFD) for those Contracting Parties of HELCOM that are also EU Member States (HELCOM 2014a). The manual brings together the existing monitoring programmes and the indicators developed. Their monitoring is grouped under 12 main monitoring programmes which cover 17 programme topics (Figure 6). In all, there are 40 sub-programmes which fall under this structure and provide the detailed information about monitoring.

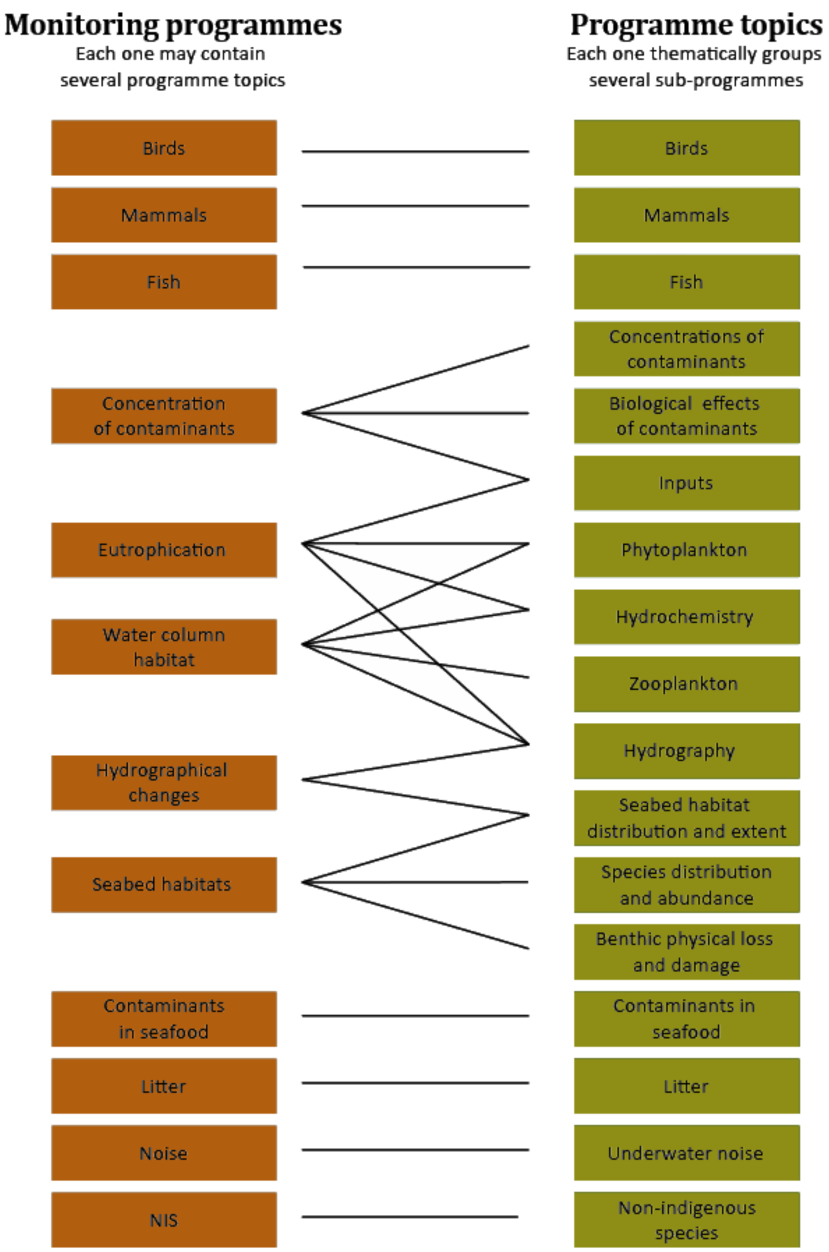

Figure 6. Monitoring programmes and Programme topics from the HELCOM Monitoring Manual (HELCOM 2014a)

Within the seabed habitat monitoring programme there are three programme topics and five sub-programmes (Table 12).

Table 12. Seabed habitats monitoring programme structure from the HELCOM Monitoring Manual (HELCOM 2014a).

Monitoring Programme	Programme Topic	Sub-Programme	MFD Descriptors
Seabed Habitats	Seabed habitat distribution and extent	Habitat-forming species and substrates Seabed habitat physical characteristics	D1, 4, 6
	Benthic community species distribution and abundance	Hard bottom species Soft bottom fauna Soft bottom flora	D1, 4, 6
	Benthic physical loss and damage		D1, 4, 6

The seabed habitat distribution and extent programme topic focusses on the assessment of the state of habitats and biotopes and pressures acting on them. Habitats and biotopes are defined through the HELCOM HUB classification (see 2.7 above). The monitoring includes assessment of both the physical characteristics and the biological parameters. This monitoring can be carried out through routine mapping; however information on benthic habitats and biotopes can also be gained by combining spatial layers of physical and biological parameters from other programmes. The monitoring manual sets out the indicators to be monitored under each of the sub-programmes, including the scale and frequency of monitoring in a monitoring concepts table. The HELCOM core indicators 'Red-listed benthic biotopes' and the pre-core indicators 'Cumulative impact on benthic habitats' and 'Distribution pattern and extent of benthic biotopes' are related to the programme topic. Very little areal monitoring data on the distribution of habitat-forming species is available at the moment, however station and transect-based monitoring of the specific species is done in all the Baltic Sea countries. In many cases common methods/monitoring guidelines are still to be developed for monitoring under this programme topic.

The benthic community species distribution and abundance monitoring programme topic includes the monitoring of both hard and soft bottom flora and fauna. While primarily focussed on the biological aspects of selected species, information on physical and chemical parameters are also included. Monitoring of hard bottom species is predominantly done in coastal waters, and includes macroalgae and in some areas the blue mussel. The HELCOM core indicator 'Population structure of long-lived macrozoobenthic species' is linked to this sub-programme as it includes size distribution of hard bottom dwelling blue mussels. The pre-core indicator 'Lower depth distribution limit of macrophyte species' is also linked, as macroalgae are an essential part of photic hard bottoms.

The soft bottom fauna sub-programme uses the HELCOM COMBINE methods in offshore areas, and modified methods for coastal waters (HELCOM 2014b). The HELCOM core indicators 'State of the soft-bottom macrofauna communities', measuring Benthic Quality Indices (BQIs), and Population structure of long-lived macrozoobenthic species', measuring size distribution of species of burrowing bivalves, are linked to monitoring being carried out under this sub-programme.

The final sub-programme under the benthic community species distribution and abundance monitoring programme is the soft-bottom vegetation monitoring sub-programme. This monitoring includes eelgrass, charophytes and some freshwater plants such as *Potamogeton spp*. The HELCOM pre-core indicator 'Lower depth distribution limit of macrophyte species' is linked to monitoring under this sub-programme as representative soft bottom species might become included.

The final programme topic under the seabed habitats monitoring programme, the benthic physical loss and damage programme topic, is under development.

4. Pressures and status of marine habitats

The drivers, pressures, state, impact, response (DPSIR) framework (Figure 7; UNEP and IOC-UNESCO 2009) is an effective way of illustrating the role of habitat mapping in deriving indicators to describe the state of the environment within the EBM context. The “state” (Figure 7) is defined as the condition of the system at a specific time and is represented by a set of descriptors of system attributes that are affected by pressures. Examples of state descriptors could be sediment quality, species composition, habitat structure, and the like. The DPSIR framework relates large-scale drivers of change (e.g., overinvestment in fishing fleet) to the pressures they exert (e.g., increased bottom trawling), which cause changes in the state of the environment (e.g., an increase in the area of modified habitat), resulting in impacts on biodiversity and human well-being (e.g., loss of fisheries income), thereby leading to institutional responses, policy development, and target setting (e.g., establishment of an MPA or other zoning framework). The fundamental concept is that the species abundance and composition of any ecosystem are determined by the physical environment in combination with impacts from human management.

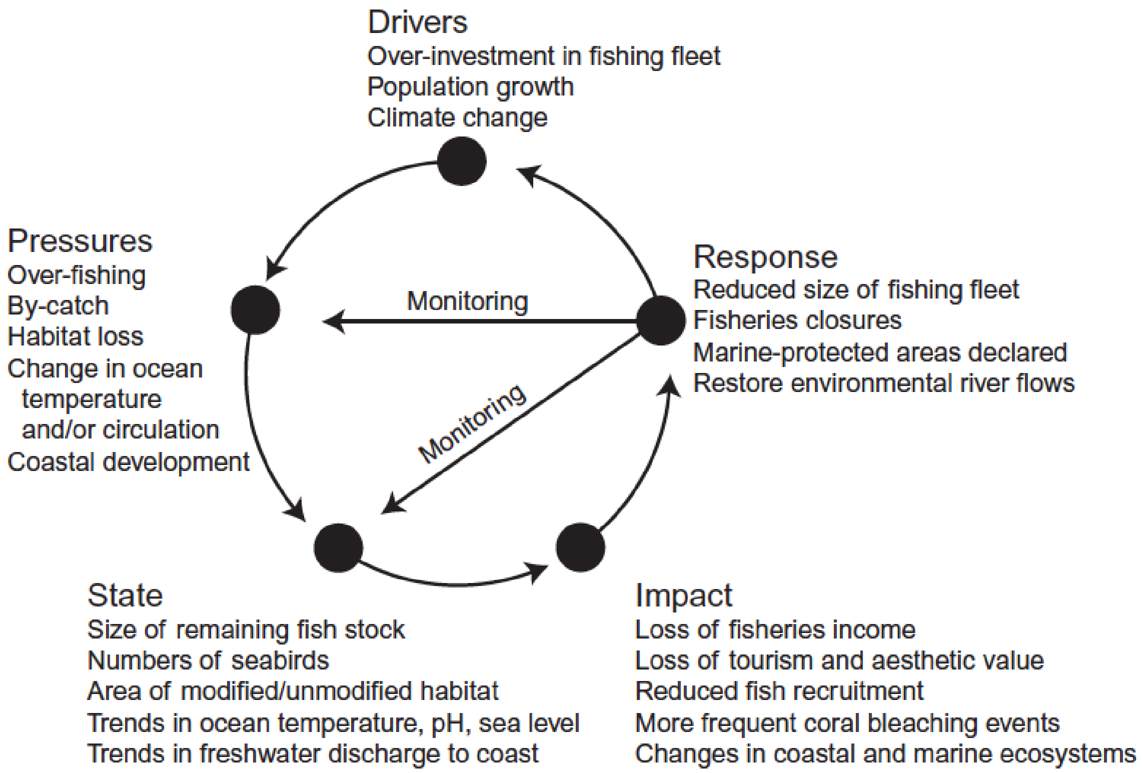

Figure 7. The DPSIR tool is used for organizing information about the state of the environment and describing interactions between society and environment. The figure illustrates where habitat mapping can fit into this process (i.e., assessment of the "state" of the habitat/ecosystem and predicting impacts (adapted from UNEP and IOC-UNESCO, 2009).

Viewing the pressures, state, and response components of the DPSIR diagram as three separate limbs of a triangle (Figure 8) illustrates some important aspects of how these components interact. The pressures located along the base of the triangle are cumulative, as summarized by Halpern *et al.*'s (2008) global study. The pressures also summarize the social and economic aspects of human interactions with the marine environment, as many of the pressures relate to an industry sector (fishing, tourism, mining, etc.). The right-hand limb of the triangle refers to the state of the environment, which is measured and observed by scientists in relation to one or all of the anthropogenic pressures. The reduction of data collected is illustrated by progressing up the side of the triangle, so that observations can be analysed to create maps or time series showing trends in condition. Such analyses can sometimes reveal new insights into ecosystem processes and habitats. Habitat mapping is included explicitly within the scope of marine environmental condition assessments and is useful for monitoring changes in ecosystem health. Habitat mapping can identify indicators that are also useful for environmental monitoring, which is a crucial component of the DPSIR framework (Figure 8).

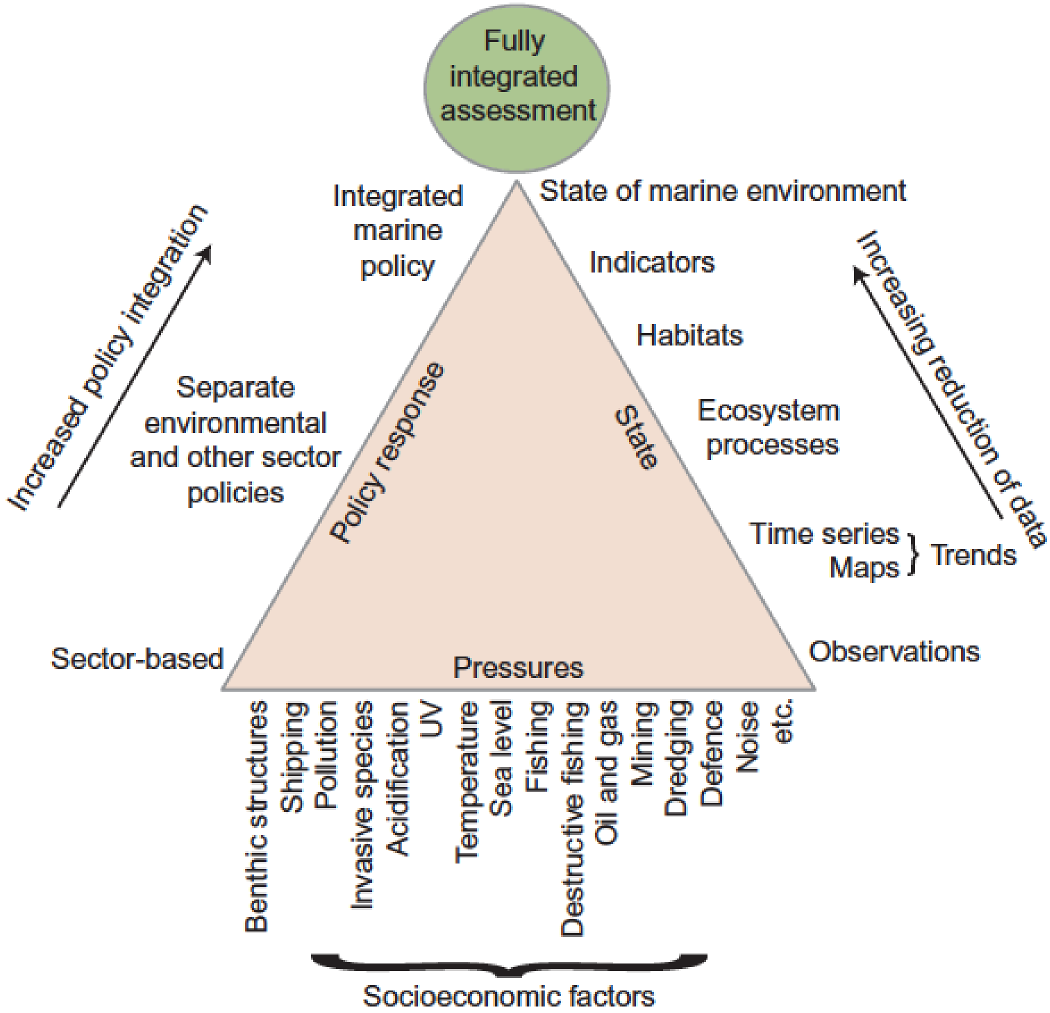

Figure 8. The relationships between anthropogenic pressures on the marine environment, state, and policy response as a subset of the DPSIR framework (from Baker and Harris, 2012). See text for explanation.

The left side of the triangle includes the response of governments in terms of developing policies (and implementing legislation), taking into account and informed by both the pressures (including social–economic aspects) and the state of the environment. The growth and development of policies are represented by a vertical progression toward the apex of the triangle. Policies may simply be based on sectors (e.g., separate policies on fisheries, tourism, oil, and gas) or integrated across broad groups of pressures (e.g. polices applied to resource-based industries). Development of a fully integrated marine environmental policy remains a challenge for most countries.

It is important to emphasize that human impacts are cumulative; overfishing, pollution, noise, mining, and so on often affect the same areas, and individual species are simultaneously affected by more than one stressor (Halpern *et al.*, 2008). The cumulative impacts of human activities have affected all parts of the oceans to greater or lesser degrees, but the greatest impacts have been in the coastal and shelf environments. Separate impacts ranked in order of priority for percentage of species affected, for example, shows that a simple list of threats does not predict the combined effect of multiple stressors.

In order to detect anthropogenic impacts, measurements must first account for the natural variability that affects any signal. Baseline observations of dynamic systems must be referenced to a long time series of measurements in order to account for natural fluctuations that occur in many cases. Perhaps one of the greatest challenges facing the management of shelf and coastal marine environments is that pristine, benchmark sites are rare or absent, making the assessment of human impacts difficult. The goals for shelf and coastal conservation efforts therefore frequently deal with restoration of previously existing ecosystems, rather than with maintenance of current status. A corollary of this observation is that the identification of remaining pristine sites is a priority for conservation, in order to help establish benchmarks and control sites for condition assessments and monitoring the performance of conservation measures.

In a survey of experts who contributed 57 case studies to an assessment of benthic habitats, respondents were asked to rank the importance of different pressures relevant to the habitat studied; the experts were asked to describe the naturalness of their study areas (Harris and Baker, 2012). In several cases, habitat mapping was specifically undertaken in order to manage specific pressures from one or more human uses. The experts identified the impacts of fishing as the most significant threat to benthic habitats. Fishing has four times the number of citations as the second most perceived threat (pollution). Pollution includes the effects of marine debris, which was the most commonly cited form of pollution. Oil and gas development, aggregate mining, and coastal development are perceived as also being among the more significant threats.

Anthropogenic climate change is viewed as an immediate threat to benthic habitats by only three of the 57 case studies (Harris and Baker, 2012). This is not necessarily evidence that climate change is not a significant threat to the marine environment in the longer term, but it does indicate that the experts working in the field of habitat mapping are currently documenting the immediate harmful consequences of other human pressures (particularly fishing and pollution) on the condition and status of the marine environment. Future impacts of anthropogenic climate change will be in addition to damage already suffered by marine habitats due to the cumulative impacts of pressures (fishing, pollution, mining, etc.) that have occurred over the past century.

5. Recommendations for Estonian case

Estonia has commitments under the EU Habitats Directive to ensure the favourable conservation status of its Natura 2000 conservation sites. As such there is a need to be able to assess the extent and condition of these sites. This report has presented an overview of the varying approaches both in terms of habitat classification and habitat condition assessment that have been adopted around the globe. Based on this overview the following general recommendations can be made.

5.1. Habitat Classification System

Due to its Baltic setting, Estonia requires a habitat classification system that will be able to relate to both the types of habitats occurring within its waters, but also allow comparison and harmonisation with other Baltic states. There is therefore a need for a well-defined and regionally relevant classification system. The capacity to classify habitats and biotopes at different levels and spatial scales also necessitates the use of a hierarchical classification system. There is also a need to be able to relate these habitats back to the EU Habitats Directive. There are two choices for Estonia in regards to adopting a habitat classification system, either the EUNIS system or the HELCOM HUB.

The EUNIS system is directly linked to the EU Habitat Directive and the definition of Natura 2000 sites, while the HELCOM HUB is the Baltic regional framework for habitat classification and has been designed to be EUNIS compatible. Both systems, at the habitat and biotope level, share a similar structure. Despite some inconsistencies in terminology, reflecting the Baltic specific setting, these two classification systems can generally be cross mapped against each other with minimal inconsistencies.

5.2. Habitat condition assessment

The review of habitat condition assessment methods from several different countries and regions highlighted the range of approaches that can be used. There are many differences, but also some common elements to each and also some common challenges that need to be addressed.

In many cases monitoring programmes, while having a general overarching national or regional framework, were adapted to be site specific. This was a reflection on the differences in habitat but more importantly the difference in pressures between sites. It was highlighted that it was important to have well defined questions that were being addressed through the monitoring. For example in the US marine sanctuary condition reporting framework a series of 17 questions were asked. Four of these related to the assessment of marine habitats, with additional site specific guidance on how to assess the status and trends of habitats in relation to these questions.

The Australian state of the environment reporting also highlights the need to define a benchmark or baseline against which to measure habitat condition. The benchmark is the condition of the parameter prior to the time when human impacts started to occur. In practice, benchmarks are mainly chosen for their convenience and to include times when data are available. For example in the 2008 EPA report on the environment, there was no comparable baseline data for the benthic communities monitoring, thus the 2008 data was set as a baseline for future monitoring.

This also highlights the next challenge with assessing the condition of marine habitats, and that is the lack of data available. Typically monitoring is based on a set of indicators that can be measured and a reported against. While this approach provides a good objective method for assessing habitat condition, without a dedicated monitoring program there is often only patchy data availability. For this reason Australia has adopted an expert elicitation approach to assess habitat condition as part of its broader State of the Environment reporting. This approach uses a defined methodology to match the available data with expert knowledge to try to fill in the gaps and make informed decisions about habitat status and trends.

The final consideration is to ensure adequate stakeholder engagement in any monitoring programme. This is especially the case when assessing the pressures on a habitat, which are often anthropogenic. Strong stakeholder engagement allows a multiple of perspectives to be considered and often results in a more robust and transparent outcome.

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