1.5.6.3 **Special request, Advice June 2013**

ECOREGION General advice

SUBJECT OSPAR special request on review of the technical specification and application of common indicators under D1, D2, D4, and D6

Advice summary

ICES undertook a simulation benchmarking exercise on the 35 common indicators whose technical specifications had been supplied by OSPAR. ICES advises that 17 of the indicators in the Greater North Sea can be considered high-performing; 14 are close to being fully operational and 19 are adequately monitored throughout the North Sea.

ICES did not assess the performance of the indicators in regions other than the Greater North Sea, but considers that analysis of this region will help in the understanding and further development of indicators in other regions.

ICES cannot define the precise nature of good environmental status (GES) as this is an EU Member State issue, but advises that in order to better understand GES, it would be helpful to develop further indicators, so that a more holistic ecosystem view can be achieved and potential additional monitoring needs can be identified.

A technical review of the two OSPAR common indicators on non-indigenous species is provided.

Request

ICES is requested to undertake an independent peer review of the technical specifications and proposed operational implementation of the indicators (COBAM draft indicators) presented. The review should consider, from the perspective of producing a set of common indicators for the OSPAR Region:

1. *whether the indicators put forwards are appropriate to implement at a regional scale;*
2. *whether the set of indicators is sufficient as a set to understand GES;*
3. *identify any gaps;*
4. *identify where there are difficulties in the operationalization of the indicators, with proposals for how to overcome these.*
   Based on the outcomes of Request regarding maximising efficiencies for monitoring of biodiversity:
5. *identify where there are opportunities to cluster indicators that can benefit from shared monitoring/ data collection.*

(OSPAR request 3/2013)

ICES has addressed consideration 5 in its response to the request on maximizing the use of available sources of data for monitoring of biodiversity (ICES Advice 2013, Section 1.5.5.2).

ICES advice

<u>Overall review</u>

Based on 16 criteria, 35 indicators were reviewed based on the information available in the Technical Specifications provided by OSPAR ICG–COBAM (for four indicators no technical specifications were made available). The criteria approach used here can help to guide future selection for currently underdeveloped indicators, providing a method for selecting one indicator over the other. The results of the assessment for the Greater North Sea are summarized below for three ecosystem aspects of the indicators.

Overall performance

A simulation benchmarking exercise was conducted on the 35 common indicators whose technical specifications had been supplied by OSPAR. Based on the scoring of the criteria and the thresholds set for the analysis ICES found that 17 of the indicators in the Greater North Sea can be considered high-performing; 14 are close to being fully operational, and 19 are adequately monitored throughout the North Sea. The interpretation of the indicator scores depends largely on the benchmarking procedure used and the resulting thresholds. The outcome of the assessment is affected by both the knowledge of the performance of the indicator and by the level of detail provided in the technical specifications.

Operational implementation

To improve the 21 indicators that are identified as less operational, in particular those that are currently categorized as core indicators, ICES recommends focussing further work on (1) integrating surveys and improving the current cost effectiveness of data collection (see reply to OSPAR request 4/2013 in ICES Advice 2013, Section 1.5.5.2) and (2) extending the spatial scale of the existing monitoring. Benthic and pelagic habitat indicators will need improvement in terms of monitoring and ability to understand how the metric can vary, whereas for species indicators, particularly for birds and mammals, improvements should be directed towards the spatial extent of monitoring. The results of the evaluation presented here only apply to the Greater North Sea (OSPAR Region II).

Regional coverage

ICES was unsure as to the meaning of "*appropriate to implement at a regional scale*" as this could mean at an sub-regional scale, or it might imply 'appropriate for all OSPAR regions'. An analytical evaluation exercise was undertaken to assess the adequacy of current monitoring (as described in the technical specifications) for the Greater North Sea. Seventeen indicators have inadequate geographical monitoring within the North Sea (i.e. monitoring is undertaken across a limited fraction of the sub-region). Considering the Greater North Sea as a relatively data-rich region, the results are likely to be lower in other OSPAR regions. For many indicators, however, information on relevant monitoring programmes was limited in the technical specifications and this may have biased the results presented here.

Understanding GES and gap analysis

Identification of the critical ecosystem components and the most effective indicators to monitor these is essential to understand GES. Three of these ecosystem aspects were reviewed by ICES: 1) whether there are gaps in the list of OSPAR indicators compared to the indicators defined by the European Commission (Decision 2010/477/EU); 2) whether there are gaps in the list of indicators for important parts of the marine ecosystem; and finally 3) whether any of the present indicators are redundant.

Gaps in OSPAR's list of common indicators related to MSFD

The 35 OSPAR common indicators do not address fully the Marine Strategy Framework Directive (MSFD) indicators listed in the EU Decision (2010/477/EU). ICES notes that it is not essential for all ecosystem aspects to be covered by OSPAR common indicators, as further indicators may be implemented individually by EU Member States to help in defining GES.

- Within the three species-level ecosystem components (birds, mammals, and fish), no OSPAR common indicator addresses the requirement for indicators of 'population genetic structure' (MSFD indicator 1.3.2).
- No seabird or mammal OSPAR common indicator addresses the requirement for indicators of 'composition and relative proportions of ecosystem components' (MSFD indicator 1.7.1).
- None of the OSPAR common indicators addressing foodweb (MSFD indicators 4.1.1 and 4.3.1) use benthic invertebrate metrics.
- MSFD indicator 1.1.3 applies specifically to benthic species and habitats, yet none of the OSPAR common indicators address the requirements for this indicator.
- No OSPAR common indicator for fish and cephalopods is linked to the distribution range and distribution pattern (MSFD indicators 1.1.1 and 1.1.2), or to the population demographics (MSFD indicator 1.3.1). ICES notes that two distribution indicators (FC-7 and FC-8) and a proportion of mature fish (FC-6) indicator were listed in part B of ICG–COBAM's report as potential candidate indicators, but no details were provided in the technical specifications.
- None of the benthic habitat OSPAR common indicators addressed the habitat-level MSFD indicator requirements for distributional range (1.4.1), distributional pattern (1.4.2), or volume (1.5.2).
- None of the OSPAR common indicators address the impact of non-indigenous species (MSFD indicators 2.2.1 and 2.2.2).

In addition ICES found four major issues relevant to poor linkages between MSFD Decision indicators and OSPAR common indicators as specified in the ICG–COBAM document (Table 1.5.5.1.1).

Table 1.5.5.1.1 Problems with linkages between MSFD Decision indicators and OSPAR common indicators as specified in the ICG–COBAM document. The issues (left hand column) are: (1) The OSPAR common indicator does not seem to relate to the MSFD indicator; (2) This multimetric indicator does not fit the definition of the MSFD indicator, but is implicitly part of it; (3) This OSPAR indicator is considered relevant by OSPAR, but is not a MSFD indicator specified in the Decision document; (4) This linkage is tenuous, with insufficient detail provided in the ICG–COBAM Technical Specifications document to be convincing.

No. of issue	MSFD Decision indicator	OSPAR ICG–COBAM indicator
1	1.2.1 (Population abundance and/or biomass)	FC-4 (Bycatch rates of Chondrichthyes)
1	1.3.1 (Population demographic characteristics)	M-6 (Proportion of bycaught individuals within a species population)
1	1.3.1 (Population demographic characteristics)	B-4 (Non-native/invasive mammal presence in island seabird colonies)
1	1.3.1 (Population demographic characteristics)	B-5 (Mortality of marine birds from fishing (bycatch) and aquaculture)
1	1.6.1 (Condition of the typical species and communities)	FC-3 (Mean maximum length of demersal fish and elasmobranchs)
1	1.6.2 (Relative abundance and/or biomass)	FC-2 (OSPAR EcoQO for proportion of large fish (LFI))
2	1.6.1 (Condition of the typical species and communities)	BH-2 (Multi-metric indices)
2	1.6.2 (Relative abundance and/or biomass)	BH-2 (Multi-metric indices)
2	6.2.1 (Presence of particularly sensitive and/or tolerant species)	BH-2 (Multi-metric indices)
3	4.3.1 (Abundance trends of functionally important selected groups/species)	FW-9 (Ecological network analysis indicator (e.g. trophic efficiency, flow diversity)
4	6.2.2 (Multi-metric indices assessing benthic community condition and functionality)	PH-1 (Changes in plankton functional types (life form) index ratio)
4	6.2.2 (Multi-metric indices assessing benthic community condition and functionality)	FW-5 (Change in plankton functional types (life form) index ratio between: gelatinous zooplankton and fish larvae; copepods and phytoplankton; holoplankton and meroplankton

Ecological gaps

The proposed OSPAR common indicators reflect the seven OSPAR ecosystem components (seabirds, marine mammals and reptiles, fish and cephalopods, benthic and pelagic habitats, foodwebs, and non-indigenous species). However, focus on such broad groups may mean that other ecosystem components are ignored, and some of these may indeed have a bearing on determining whether GES at the whole ecosystem level has actually been achieved in any given OSPAR region. ICES therefore listed potential ecological gaps (Table 1.5.5.1.2), which may aid the further development of new indicators and identify potential additional monitoring needs.

Table 1.5.5.1.2 Gaps in the OSPAR common indicators that may need to be filled to fully define GES.

OSPAR ecosystem component	Identified gaps
Rocky and mixed benthic habitats	There is little sampling of rocky and mixed benthic habitats for the status assessment of benthic fauna and fish species, partly due to the risk of sustaining damage to the trawl. Rocky habitats often host sensitive species and may provide refuge from fishing.
Deep-water habitats and species	The majority of surveys operate in coastal shelf seas and not in deeper waters, including those within the North Sea, Skagerrak, and Kattegat.
Microplankton and microbenthos	For PH-1 and FW-5 (Table 1.5.5.1.1), OSPAR identified micro-, pico-, nano-phytoplankton and bacteria and micro-zooplankton including ciliates as being undersampled. These groups are essential components of the microbial loop of marine food webs but ICES notes that substantial effort would be required to obtain reasonably precise estimates given the extremepatchiness of such organisms in space and time.
Cephalopods	Cephalopods are caught in fisheries research surveys (e.g. IBTS) and hence data for the assessment of status of at least some species under FC-1, FC-7, and FC-8 (Table 1.5.5.1.1) should be available.
Coastal and inshore fish communities	Coastal fish communities are not required to be monitored under the Water Framework Directive. Existing surveys do not sample in shallower coastal zone waters. Shallow coastal waters are important during the juvenile phase of the life-history of many fish species.
Highly migratory fish and reptiles	Sharks, tunas, and other highly migratory fish are only partly addressed by the OSPAR common indicators and none consider the status of reptiles.
Non-indigenous species	The importance of different pathways and associated vectors for each country should be assessed, after which a final decision on common indicators should be made. In addition to invasion vectors and pathways, the monitoring strategy should also depend on the taxa to be sampled. Impacts caused by non-indigenous species should be assessed.

Redundant indicators

In some cases, correlations between the health of different ecosystem components and/or indicators could be used to reduce the number of indicators needed. Potential correlation between indicators should be recognised in order to avoid misleading impressions of actual progress towards GES. ICES suggests a criterion "Indicators making up a suite of indicators should reflect variation in different attributes of the ecosystem component and thus be complementary" to identify situations where indicator redundancy could be an issue. Since the indicators are at varying stages of development and/or the information necessary to assess each OSPAR common indicator against this criterion was not provided in the ICG–COBAM Technical Specifications document, ICES was not able to assess whether any of the currently listed indicators contain elements of redundancy.

Background

ICES evaluated each indicator (based on the technical specifications supplied by OSPAR) using a standardized framework (ICES, 2013a). It is important to note the distinction between the indicator and its technical specification, as a poor specification could devalue a good indicator. ICES could only work with the specifications that had been provided and could not make assumptions about what was not in the specification.

Table 1.5.5.1.3 lists the criteria used to evaluate the performance of OSPAR's proposed common indicators and provides the *importance* weightings assigned to each criterion, their associated scores, and the guidelines for assessing the *compliance* of each indicator against each criterion. These criteria were essentially devised to assess the performance of 'state' indicators. However, the OSPAR common indicators also include 'pressure' indicators. It is inappropriate to evaluate such indicators against criteria for assessing the state indicators to variation in pressure. A pressure indicator should be, by definition, extremely sensitive and responsive to variation in the ecological pressure it purports to measure. Each indicator was therefore first assessed against criterion 1, which distinguished state indicators from pressure indicators. If the indicator was considered to be a pressure indicator, then it was automatically given a *compliance* score of zero against criteria 6, 8, 12, and 13 (highlighted in Table 1.5.5.1.3), as these are relevant only to state indicators.

The *importance* weightings assigned to each criterion were given scores of Essential = 3, Desirable = 2, and Informative = 1, and the *compliance* fits were assigned scores of Fully met = 1, Partially met = 0.5, and Not met = 0. Multiplying these two values together provided a score for the performance of each indicator against each criterion. Summing these scores across all criteria then generated an overall score for the general performance of the indicator against all the criteria.

The decision to give pressure indicators a compliance score of 0 introduces a bias in the assessment process in favour of state indicators. ICES notes the need for both "state" and "pressure" indicators so that the "pressure–state" relationship can be adequately defined, and pressure indicators are essential in providing the scientific basis for advice regarding the most appropriate management measures required to achieve GES. Pressure indicators are also required for Descriptor 6.

Criterion 16 considers correlations between indicators and was not used in the evaluation of the performance of the OSPAR common indicators. This criterion is intended to select metrics that measure different attributes of an ecosystem component's condition, and to discourage selection of metrics that essentially perform similar functions. Therefore, this criterion should be applied after the main assessment process, to aid further selection between high performing indicators.

Table 1.5.5.1.3 Criteria used to evaluate the performance of common indicators proposed by OSPAR to support implementation of the MSFD at the sub-regional and regional scales. The 16 criteria are grouped into five main categories, and the principle characteristic of each indicator's performance examined by each criterion is given. The *importance* weightings, and their associated scores, are shown, as are the guidelines for assessing the level of *compliance* of each indicator against each criterion. Pale blue cells indicate criteria that were not used in the evaluation. In the *compliance* guidelines column, criteria are given a zero *compliance* score if the indicator relates to a 'pressure' (Criterion 1).

Criterion No.	Category	Characteristic	Criterion	*Importance* Weighting	*Importance* Score A	Guidelines for *Compliance* Assessment Score B
1	Type of Indicator	State or pressure	Is a "pressure" indicator being used for want of an appropriate "state" indicator?			Fully met (1): indicator is a "state" indicator. Not met (0): indicator is actually a "pressure" indicator. Although scoring 0 in this criterion, and linked criterion further on in this table, ICES recognises that pressure indicators are essential in management decision making and in indicators for D6.
2	Quality of underlying data	Existing and ongoing data	Indicators must be supported by current or planned monitoring programmes that provide the data necessary to derive the indicator. Ideal monitoring programmes should have a time series capable of supporting baselines and reference point setting. Data should be collected on multiple sequential occasions using consistent protocols, which account for spatial and temporal heterogeneity.	Essential	3	Fully met (1): long-term and ongoing data from which historical reference levels can be derived and past and future trends determined. Partially met (0.5): no baseline information, ongoing monitoring or historical data available, but monitoring programme discontinued; however, potential to re-establish the programme exists. Not met (0): data sources are fragmented, no planned monitoring programme in the future.
3	Quality of underlying data	Indicators should be concrete	Indicators should ideally be easily and accurately determined using technically feasible and quality assured methods, and have a high signal-to-noise ratio.	Essential	3	Fully met (1): data and methods are technically feasible, widely adopted, and quality assured in all aspects, signal-to-noise ration is high. Partially met (0.5): potential issues with quality assurance, or methods not widely adopted, poor signal-to-noise ratio. Not met (0): indicator is not concrete or doubtful; noise excessively high due either to poor data quality or the indicator is unduly sensitive to environmental drivers.
4	Quality of underlying data	Quantitative versus qualitative	Quantitative measurements are preferred over qualitative, categorical measurements, which in turn are preferred over expert opinions and professional judgments.	Desirable	2	Fully met (1): all data for the indicator are quantitative. Partially met (0.5): data for the indicator are semi-quantitative or largely qualitative. Not met (0): the indicator is largely based on expert judgement.
5	Quality of underlying data	Relevant spatial coverage	Data should be derived from a large proportion of the MSFD sub-region, at appropriate spatial resolution and sampling design, to which the indicator will apply.	Essential	3	Fully met (1): spatially extensive monitoring is undertaken across the sub-region. Partially met (0.5): monitoring does not cover the full sub-region, but is considered adequate to assess status at the sub-regional scale. Not met (0): monitoring is undertaken across a limited fraction of the sub-region and considered inadequate to assess status at the sub-regional scale.

Criterion No.	Category	Characteristic	Criterion	*Importance* Weighting	*Importance* Score A	Guidelines for *Compliance* Assessment Score B
6	Quality of underlying data	Reflects changes in ecosystem component that are caused by variation in any specified manageable pressures	The indicator reflects change in the state of an ecological component, caused by specific significant manageable pressures (e.g. fishing mortality, habitat destruction). The indicator should therefore respond sensitively to particular changes in pressure. The response should be unambiguous and in a predictable direction, based on theoretical or empirical knowledge, thus reflecting the effect of change in pressure on the ecosystem component in question. Ideally the pressure–state relationship should be defined under both the disturbance and recovery phases.	Essential	3	**IF CRITERION 1 IS SCORED 0 THEN THE COMPLIANCE SCORE B MUST BE 0**. Otherwise: Fully met (1): the indicator is primarily responsive to a single or multiple pressures and all the pressure–state[1] relationships are fully understood and defined, both under the disturbance and recovery phases of the relationship. Partially met (0.5): the indicator's response to one or more pressures are understood, but the indicator is also likely to be significantly influenced by other non-anthropogenic (e.g. environmental) drivers, and perhaps additional pressures, in a way that is not clearly defined. Response under recovery conditions may not be well understood. Not met (0): no clear pressure–state relationship is evident.
7	Management	Relevant to MSFD management targets	Clear targets that meet appropriate target criteria (absolute values or trend directions) for the indicator can be specified that reflect management objectives, such as achieving GES.	Desirable	2	Fully met (1): an absolute target value for the indicator is set. Partially met (0.5): no absolute target is set for the indicator, but a target trend direction for the indicator is established. Not met (0): targets or trends unknown.
8	Management	Relevant to management measures	Indicator links directly to management response. The relationship between human activity and resulting pressure on the ecological component is clearly understood.	Desirable	2	**IF CRITERION 1 IS SCORED 0 THEN THE COMPLIANCE SCORE B MUST BE 0**. Otherwise: Fully met (1): both response-activity and activity–pressure relationships[2] are well defined – advice can be provided on both the direction AND the extent of any change in human activity required, and the precise management measures required to achieve this. Partially met (0.5): response–activity and activity–pressure relationships are not well understood, or only one of the relationships is defined, but not the other, so that the precise changes in pressure resulting from particular management actions cannot be predicted with certainty. Not met (0): no clear understanding of either relationship, so that the link between management response and pressure is completely obscure.
9	Management	Comprehensible	Indicators should be interpretable in a way that is easily understandable by policy-makers and other non-scientists (e.g. stakeholders) alike, and the	Desirable	2	Fully met (1): the indicator is easy to understand and communicate. Partially met (0.5): a more complex and difficult to understand indicator, but one for which the

[1] The term "pressure–state relationship" is used here in the sense described by Piet *et al*. (2007): e.g. fishing ***pressure*** (fishing mortality rate [*F*]) – ***state*** of the stock (stock biomass [*B*]).

[2] Here the terms response–activity relationship and activity–pressure relationship are used in the sense described by Piet *et al*. (2007); e.g. management ***response*** (total allowable catch) – fishing ***activity*** (days-at-sea), and fishing ***activity*** (days-at-sea) – fishing ***pressure*** (fishing mortality rate [*F*]).

Criterion No.	Category	Characteristic	Criterion	*Importance* Weighting	*Importance* Score A	Guidelines for *Compliance* Assessment Score B
			consequences of variation in the indicator should be easy to communicate.			meaning of change in the indicator value is easy to communicate. Not met (0): the indicator is neither easy to understand nor communicable.
10	Management	Established indicator	Indicators used in established management frameworks (e.g. EcoQO indicators) are preferred over novel indicators that perform the same role. Internationally used indicators should have preference over indicators used only at a national level.	Desirable	2	Fully met (1): the indicator is established and used in international policy frameworks. Partially met (0.5): the indicator is established as a national indicator. Not met (0): the indicator has not previously been used in a management framework.
11	Management	Cost-effectiveness	Sampling, measuring, processing, analysing indicator data, and reporting assessment outcomes, should make effective use of limited financial resources.	Desirable	2	Fully met (1): little additional costs (no additional sampling is needed). Partially met (0.5): new sampling on already existing programmes is required. Not met (0): new sampling on new monitoring programmes are necessary.
12	Management	Early warning	Indicators that signal potential future change in an ecosystem attribute before actual harm is indicated are advantageous. These could facilitate preventive management, which could be less costly than restorative management.	Informative	1	**IF CRITERION 1 IS SCORED 0 THEN THE COMPLIANCE SCORE B MUST BE 0**. Otherwise: Fully met (1): indicator provides early warning because of its high sensitivity to a pressure or environmental driver with short response time; Not met (0): relatively insensitive indicator that is slow to respond.
13	Conceptual	Scientific credibility	Scientific, peer-reviewed findings should underpin the assertion that the indicator provides a true representation of variation in the ecosystem attribute in question.	Desirable	2	**IF CRITERION 1 IS SCORED 0 THEN THE COMPLIANCE SCORE B MUST BE 0**. Otherwise: Fully met (1): peer-reviewed literature. Partially met (0.5): documented, but not peer-reviewed. Not met (0): not documented, or peer-reviewed literature is contradictory.
14	Conceptual	Metrics relevance to MSFD indicator	For descriptors D1 and D6, metrics should fit the indicator function stated in the 2010 MSFD Decision document. This requirement can be relaxed for D4 indicators because the Decision document stipulates the need for indicator development in respect of this Descriptor (but any newly proposed D4 indicators must still fulfil the overall goals stated for D4).	Essential	3	Fully met (1): the metric complies with indicator function. Not met (0): the metric does not comply with indicator function.
15	Conceptual	Cross-application	Metrics that are applicable to more than one MSFD indicator are preferable.	Desirable	2	Fully met (1): metric is applicable across several MSFD indicators. Not met (0): no cross-application.
16	Indicator suites	Indicator correlation	Different indicators making up a suite of indicators should each reflect variation in different attributes of the ecosystem component and thus be complementary. Potential correlation between indicators should be avoided.	Desirable	2	Fully met (1): the indicators are uncorrelated. Partially met (0.5): correlation between some indicators. Not met (0): all indicators are correlated.

The analytical evaluation exercise was undertaken only for the Greater North Sea due to there being insufficient data and expertise on the other MSFD-relevant OSPAR sub-regions present at the relevant ICES expert group meetings. ICES considers that the process could be readily applied to the remaining OSPAR sub-regions. Evaluation of each of the OSPAR common indicators against criteria 2 to 15 was undertaken independently by at least three separate experts and the mean overall assessment scores, along with the range of overall scores, was determined (Figure 1.5.5.1.1).[3]

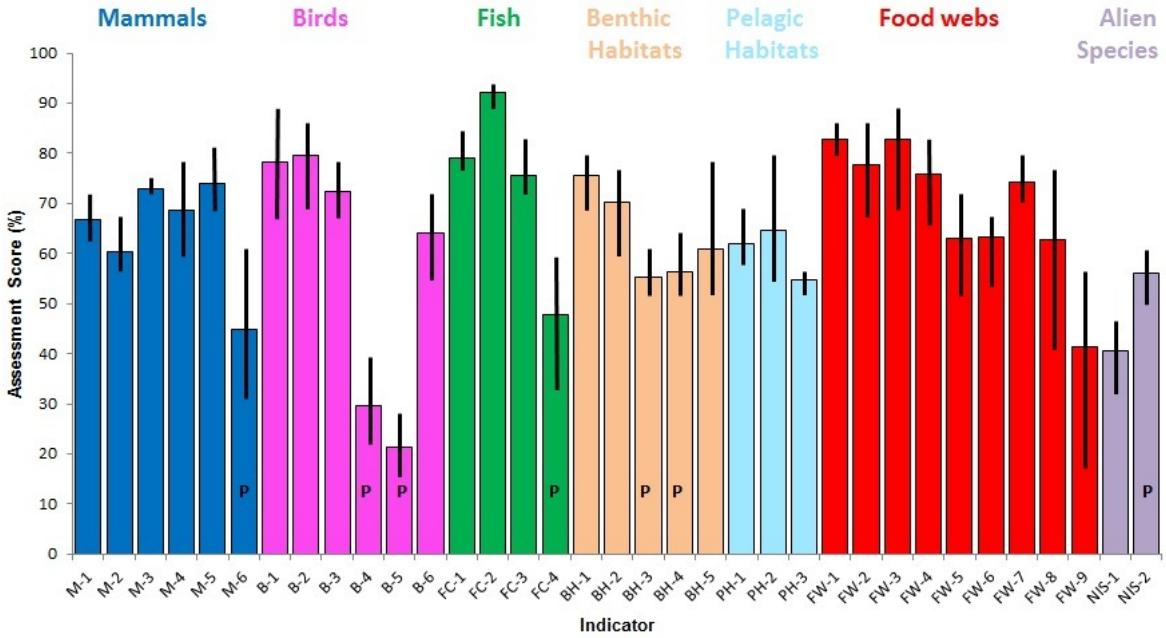

Figure 1.5.5.1.1 Mean and range of three independent evaluations (four in the case of the foodweb (FW) indicators) of the performance of 35 OSPAR common indicators against criteria 2 to 15 listed in Table 1.5.5.1.3. Pressure (P) indicators were automatically assigned a zero *compliance* score against four criteria deemed not applicable to pressure indicators (see text and Table 1.5.5.1.3). For abbreviation of indicators see Table 1.5.5.1.4.

The OSPAR common indicators are intended to enhance cooperation between Member States sharing marine regions so that status assessment can be made across whole MSFD sub-regions and regions. The mean scores given to each OSPAR common indicator against criterion 5 (relevant spatial coverage) was therefore determined to identify the most useful OSPAR common indicators in this respect (Figure 1.5.5.1.2). ICES assessed the degree to which each of the proposed OSPAR common indicators could be readily used, based on each indicator's performance against criteria 2, 3, 4, 5, 10, and 11. The mean score given to each OSPAR common indicator against these criteria was determined (Figure 1.5.5.1.3).

[3] It should be noted that ICES assessed the performance of 35 OSPAR common indicators. ICES is aware that several more common indicators are under consideration, but the version of the document "Report by ICG–COBAM on the development of an OSPAR common set of biodiversity indicators: Part C: Technical Specifications" available to expert groups only provided details for 35 indicators.

Table 1.5.5.1.4 Abbreviations and categories of the 35 proposed biodiversity OSPAR common indicators as described in the ICG–COBAM Part C: Technical Specifications document.

Code	Indicator	Category
Mammals		
M-1	Distributional range and pattern of grey and harbour seal haul-out sites and breeding colonies	Core
M-2	Distributional range and pattern of cetaceans species regularly present	Core
M-3	Abundance of grey and harbour seal at haul-out sites	
M-4	Abundance at the relevant temporal scale of cetacean species regularly present	Core
M-5	Harbour seal and Grey seal pup production	Core
M-6	Numbers of individuals within species being bycaught in relation to population	Core
Marine birds		
B-1	Species-specific trends in relative abundance of non-breeding and breeding marine bird species	Core
B-2	Annual breeding success of kittiwake	Core
B-3	Breeding success/failure of marine birds	Core
B-4	Non-native/invasive mammal presence on island seabird colonies	Core
B-5	Mortality of marine birds from fishing (bycatch) and aquaculture	Candidate
B-6	Distributional pattern of breeding and non-breeding marine birds	Core
Fish and cephalopods		
FC-1	Population abundance/ biomass of a suite of selected species	Core
FC-2	OSPAR EcoQO for proportion of large fish (LFI)	Core
FC-3	Mean maximum length of demersal fish and elasmobranchs	Core
FC-4	Bycatch rates of Chondrichthyes	Candidate
Benthic habitat		
BH-1	Typical species composition	Core
BH-2	Multi-metric indices	Core
BH-3	Physical damage of predominant and special habitats	Candidate
BH-4	Area of habitat loss	Candidate
BH-5	Size–frequency distribution of bivalve or other sensitive/indicator species	Candidate
Pelagic habitat		
PH-1	Changes of plankton functional types (life form) index ratio	Core
PH-2	Plankton biomass and/or abundance	Core
PH-3	Changes in biodiversity index (s)	Core
Food webs		
FW-1	Reproductive success of marine birds in relation to food availability	Core
FW-2	Production of phytoplankton	Core
FW-3	Size composition in fish communities (LFI)	Core
FW-4	Changes in average trophic level of marine predators	Core
FW-5	Change of plankton functional types (life form) index ratio	Core
FW-6	Biomass, species composition, and spatial distribution of zooplankton	Candidate
FW-7	Fish biomass and abundance of dietary functional groups	Candidate
FW-8	Changes in average faunal biomass per trophic level	Candidate
FW-9	Ecological network analysis indicator (e.g. trophic efficiency, flow diversity)	Candidate
Non-indigenous species		
NIS-1	Pathways management measures	Candidate
NIS-2	Rate of new introductions of NIS (per defined period)	Candidate

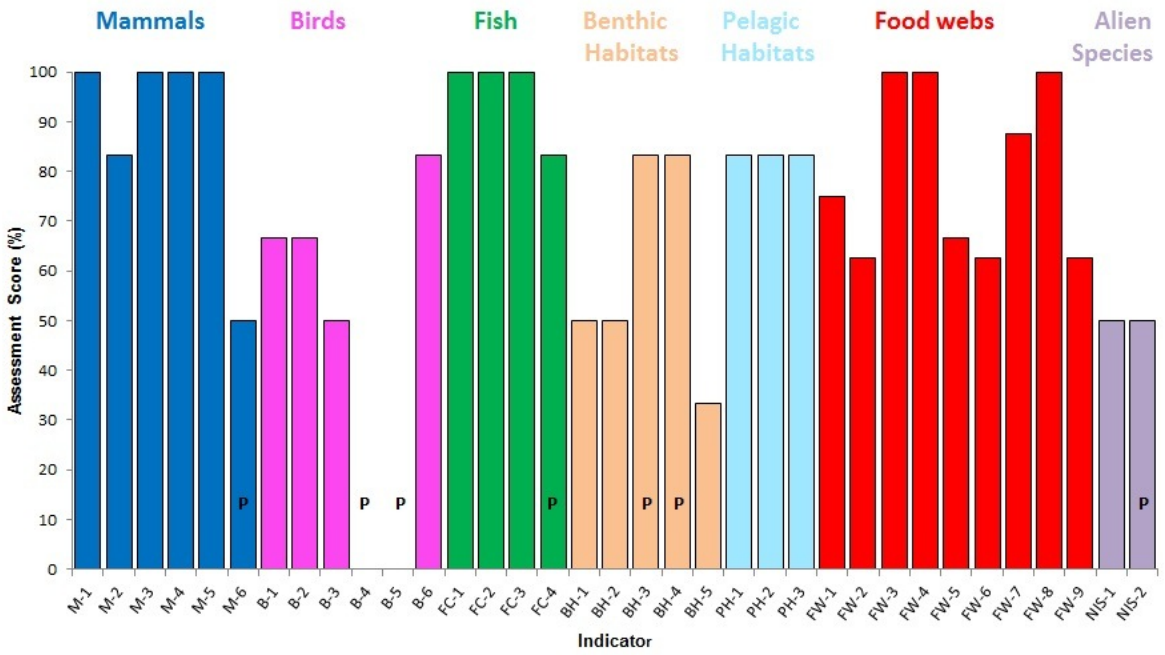

Figure 1.5.5.1.2 Spatial coverage. Evaluation of the performance of 35 OSPAR common indicators (abbreviations in Table 1.5.5.1.4) against criterion 5 (relevant spatial coverage) listed in Table 1.5.5.1.3. Indicators B-4 and B-5 received zero scores. P indicates a "pressure" indicator.

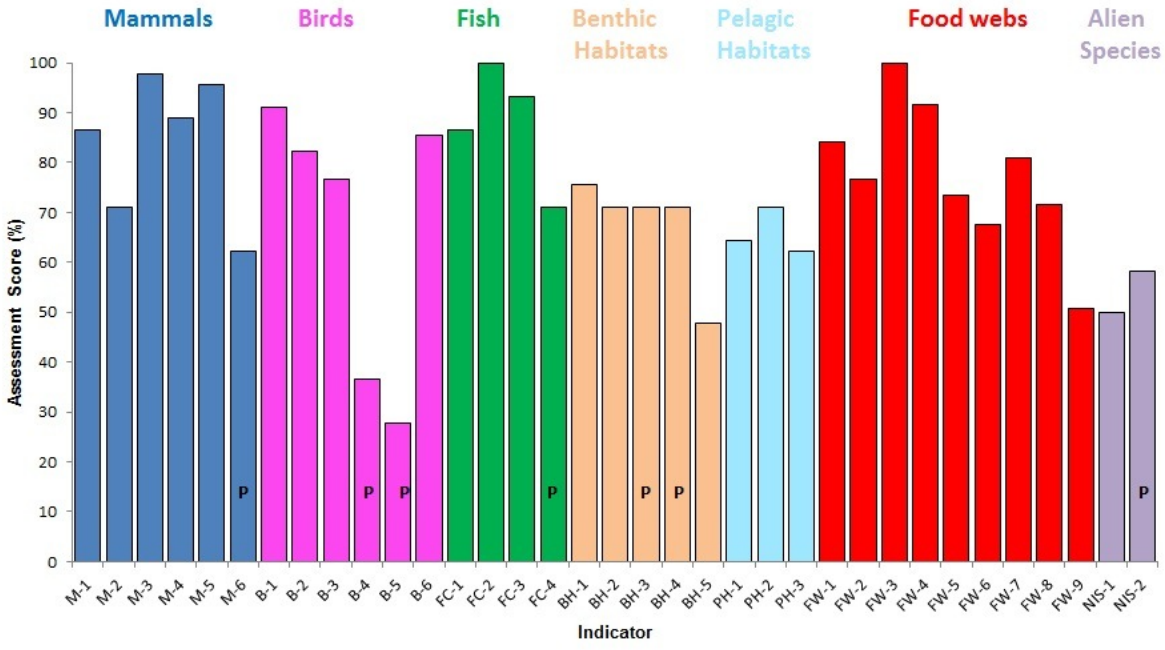

Figure 1.5.5.1.3 Useability. Evaluation of the performance of 35 OSPAR common indicators (abbreviations in Table 1.5.5.1.4) against criteria 2, 3, 4, 5, 10, and 11 (related to the ability to use the indicators immediately) listed in Table 1.5.5.1.3. P indicates a "pressure" indicator.

Comparing between categories of indicators

The process undertaken by ICES means that it is not possible to directly compare pressure and state indicators, nor their readiness for immediate use. It would be possible for experts to chose thresholds, but these would be partly arbitrary and would reflect the opinions (and possible biases) of experts involved in any given indicator assessment exercise; different groups of experts might therefore set different benchmark threshold scores, thus generally compromising the repeatability and consistency of such objective indicator assessment exercises. A simulation exercise was therefore undertaken (ICES, 2013b) in order to understand the significance of scores in each of these categories (Figure 1.5.5.1.4,

Table 1.5.5.1.5). ICES has based the advice on the performance of indicators on the thresholds that derive from this process.

In Figure 1.5.5.1.4 is shown the simulated distribution of scores that will likely be generated when a very large set of virtual "state" and "pressure" indicators are put through the scoring system. Figure 1.5.5.1.4 indicates the mean score and the upper 25-percentile, upper 10-percentile, and upper 5-percentile benchmark scores on each distribution. For overall assessment against all 15 criteria, "pressure" indicators could not score as highly as "state" indicators because scores against four criteria were all automatically set to zero; hence the different distributions and benchmark thresholds illustrated in Figure 1.5.5.1.4. When considering the operational implementation of each indicator, only data from six criteria were used, giving the third distribution and set of benchmark scores. In this latter case all six criteria applied to both "state" and "pressure" indicators, so both indicator types had the same distribution and benchmark thresholds. The precise benchmark score thresholds are shown in Table 1.5.5.1.3. ICES considers that assessment scores falling above the upper 5-percentile benchmark threshold identify statistically significant high-performing indicators.

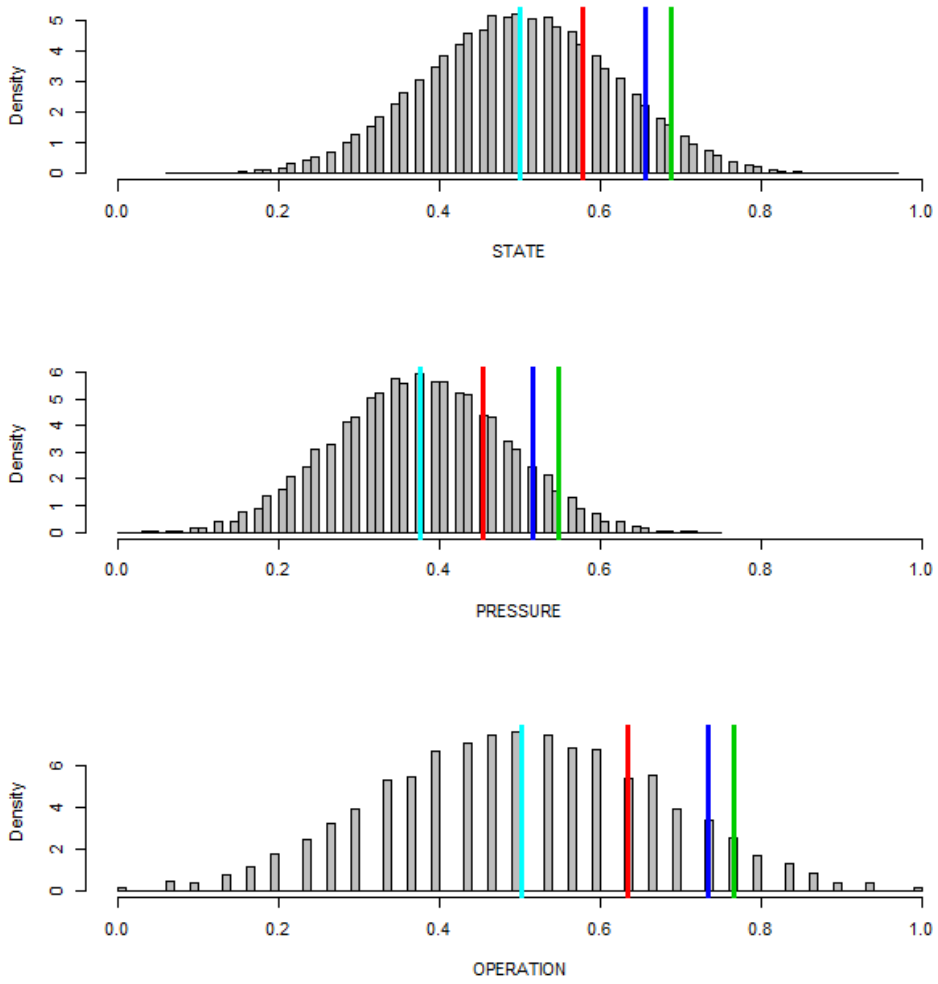

Figure 1.5.5.1.4 Score distributions for 100 000 virtual indicators (for details see ICES, 2013b), showing mean (light blue), upper 25-percentile (red), upper 10-percentile (blue), and upper 5-percentile (green) scores, computed using randomly sampled categories (for score B) for state indicators (top), pressure indicators (middle), and for the subset of categories that were considered to reflect the operational implementation of each indicator (bottom).

Table 1.5.5.1.5 Summary of simulated indicators: mean and upper percentiles for the distribution of randomized indicator scores.

Summary statistic	State	Pressure	Operation
Mean	0.500	0.375	0.501
Upper 25 percentile	0.578	0.453	0.633
Upper 10 percentile	0.656	0.516	0.733
Upper 5 percentile	**0.688**	**0.547**	**0.767**

Table 1.5.5.1.6 shows the performance of the 35 common indicators against the benchmark thresholds for overall performance, adequate coverage of the Greater North Sea MSFD sub-region, and for how close each is to becoming fully operational. The analysis reflects the greater availability of appropriate fish community data and the relatively long history of developing and using ecological indicators based on these data.

Table 1.5.5.1.6 Evaluation of the performance of the OSPAR common indicators against criteria 2 to 15; against the six criteria related to the ability to use the indicators, and against the criterion related to spatial coverage of the indicators. Green cells show where indicators meet the benchmark thresholds and red cells show where indicators do not meet the benchmark thresholds. For abbreviation of indicators see Table 1.5.5.1.4.

Common Indicator	Overall	Operational	Spatial Coverage
M-1			
M-2			
M-3			
M-4			
M-5			
M-6			
B-1			
B-2			
B-3			
B-4			
B-5			
B-6			
FC-1			
FC-2			
FC-3			
FC-4			
BH-1			
BH-2			
BH-3			
BH-4			
BH-5			
PH-1			
PH-2			
PH-3			
FW-1			
FW-2			
FW-3			
FW-4			
FW-5			
FW-6			
FW-7			
FW-8			
FW-9			
NIS-1			
NIS-2			
TOTAL	17	14	19

MSFD indicators 1.4.1, 1.4.2, 1.5.1, 1.5.2, 1.6.1, 1.6.2, and 1.6.3 all relate to 'habitat-level of biodiversity', and so are pertinent to both the benthic habitats and pelagic habitats ecosystem components, but not to birds, mammals, or fish. Despite this, the ICG–COBAM Technical Specification document links two fish component indicators, the large fish indicator (FC-2) and the mean maximum length (FC-3), to MSFD indicators 1.6.2 and 1.6.1, respectively. ICES considers that it would be more appropriate for these OSPAR common indicators to be linked to the ecosystem/community level of biodiversity covered by MSFD indicator 1.7.1 (a linkage is also specified in the ICG–COBAM Technical Specification document).

Comments on indicators for non-indigenous species

- The technical description of the proposed NIS-1 indicator is insufficiently detailed and is incomplete. ICES considers that both the indicator and the description need further development.
- The OSPAR common indicators for non-indigenous species (NIS) do not provide information to support decisions on bioinvasion management options other than prevention. These include control, confinement, and mitigation of invasive species (Lodge *at al.*, 2006; Olenin *et al.*, 2011).
- It may be that country-specific indicators are more relevant to this issue than common indicators. The importance of different pathways and vectors differ between countries and this should be considered when deciding on appropriate common indicators (and in designing sampling, analysis, and assessments). An analysis should be carried out, taking into account the importance of different pathways and associated vectors for each country (see Olenin *et al.*, 2010, 2011).
- Sampling methodology should be designed in relation to the organism groups to be monitored. It is unclear from the technical description for which organism groups/taxa/species monitoring will be planned, and therefore it is at this stage impossible to review the proposed methodology. In general, a sampling frequency of once per year is insufficient to obtain representative information for several organism groups, and is particularly poor for planktonic organisms with a reproduction cycle merely ranging a few days.
- The proposed site selection of two sites per country is likely to be insufficient. The site selection should be country-specific and rather depend on the analysis of the presence and importance of different pathways/vectors. ICES further suggests that the choice of monitoring location be based on likely entry points into regional seas. To assess impacts caused by NIS, distribution, abundance, and biomass data are also needed. For this reason also, more than two sites will need to be monitored.
- A possible way to decide which invasion pathways and habitats should be monitored is preparing a pathway/habitat matrix and leave the selection to individual countries based on their priorities and capabilities.
- Species identification is likely to pose serious problems, particularly for smaller organisms such as the micro-zooplankton or meio-benthos.
- The target setting should be redefined; a three-year period is likely to be too short, a longer assessment period is more appropriate (e.g. six years, as stated in the MSFD Directive (EU, 2008)).

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