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EU request for guidance on an appropriate method to integrate criteria, species, species group to higher groups of birds, mammals, reptiles, fish and cephalopods for a Good Environmental Status assessment

Advice summary

ICES advises that for integration for

a) criteria to species, a set of conditional rules should be applied that reflect the difference in importance between primary and secondary criteria;
b) species to species groups, a proportional integration rule is appropriate; and
c) species groups to ecosystem component, a proportional integration rule is appropriate. However for ecosystem components, integrating species directly to ecosystem component is recommended.

ICES advises that regionally established thresholds of fixed proportions of species in the order of 60–80% (to be decided by managers/decision makers) be used to describe the extent to which Good Environmental Status (GES) has been achieved when integrating to species group and ecosystem component; the thresholds should balance the sensitivity to false alarms and missed alarms.

ICES suggests that an additional mechanism should be developed to alert of a potential extinction risk.

Request

Request from the European Commission, DG ENV, for guidance on an appropriate method(s):

a) to integrate across criteria for each species of bird, fish and cephalopod (excepting commercial species and species on Habitats Directive annexes).
b) to aggregate species within species groups for an overall assessment of status per species group for MSFD Descriptor 1.
c) to aggregate from species group to the level of birds, mammals, reptiles, fish and cephalopods for an overall presentation of the extent to which GES has been achieved for these higher groups

In addition to comment on any likely failure to alert of a potential extinction risk to a species from applying the aggregation approaches proposed.

Elaboration on the advice

This advice has been prepared in light of the revised MFSD Commission Decision EU/2017/848 (EU, 2017) and as such differs from ICES advice on guidance on the most appropriate method to aggregate species within species groups for the assessment of good environmental status for MSFD Descriptor 1 issued in 2016 (ICES, 2016) which referred to Commission Decision 2010/477 (EU, 2010).

a) integration of criteria to species

ICES advises that conditional rules should be used for assessing status at the species level (Table 1). The rules account for cases where a criterion fails or achieves GES as well as cases where the criterion is not relevant to a species or cannot be assessed due to lack of data or knowledge (indicator or reference levels not defined). Further, the rules can be applied both to data rich species where indicator measurements include estimates of uncertainty and to data limited species, where indicators are categorical (GES achieved/not achieved). The conditional rules are based on the division in the Commission Decision between primary criteria (D1C1 and D1C2) and secondary criteria (D1C3, D1C4 and D1C5) under the assumption that a secondary criterion status cannot overrule a primary criterion status.

The secondary criteria for data rich species are integrated by averaging the standardised criteria. A criterion is standardised by dividing it by the threshold and the standard deviation of the criterion.

In the case where one or more of the secondary indicators are categorical, they are integrated by the following rules:

- All criteria are at GES: combined criterion C3–C5 is at GES
- Two criteria are at GES, one criterion not at GES, missing or not applicable: combined criterion C3–C5 is at GES
- One criteria is at GES, two criteria are missing or NA: combined criterion C3–C5 is at GES
- All other combinations: combined criterion C3–C5 is not at GES

Table 1 Proposed decision guide for GES decision for integrating criteria to species. N – Criterion fails GES, Y – Criterion in GES, O – Missing data or reference level but criterion relevant to assessment, NA –Not Applicaple, criterion result irrelevant to assessment.

Criterion	GES									
C1 Bycatch	Y	Y	Y	N	N	N	NA	NA	O	O
C2 Abundance	Y	N	N	N	Y	Y	Y	N	Y	N
C3 – C5	Y, N, O or NA	Y	N, O or NA	Y, N or NA	Y	N, O or NA	Y, N, O or NA	Y, N, O or NA	Y, N, O or NA	Y, N, O or NA
At GES?	Yes	Yes[1]	No	No	Yes[2]	No	Yes[3]	No	Yes[4]	No

[1] This instance may be the case for example for recovering populations where management measures or natural influences on populations are likely to result in recovery to good status within the assessment cycle, and instances where population abundance is low for natural reasons (e.g disease) and there is evidence from other secondary criteria(e.g demographic characteristics) that suggest no management action is required.

[2] A likely contradictory outcome where evidence from secondary criterion on demographics is required to be in good status and to explain the outcome. This instance suggests that the threshold for bycatch assessment needs to be reassessed.

[3]It should be noted that population demographic characteristics may be an early warning indicator of future population abundance. Prolonged low status is likely to result in low abundance in the future and hence not maintaining GES for the species.

[4] Development of an indicator for D1C1 Bycatch and acquiring sufficient data to estimate the temporal development and the reference level of this indicator should be given high priority as this is a primary criterion.

b) and c) integration of species to species group and species group to ecosystem component

ICES advises the use of following integration methods:

b) Proportion of species in good status to species group level
c) Proportion of all species in good status above agreed level (across species groups) for the species group to ecosystem component level

Proportional rules are considered most appropriate when integrating between species and species groups and from species groups to ecosystem components. There will often be many species to integrate and the use of a conditional rule such as OOAO (one out all out) will likely result in numerous false alarms[1].

For integration from species groups to ecosystem components, ICES recommends that integration should be from species level to ecosystem component directly rather than from species group level to ecosystem component. This will decrease the risk of false alarms caused by species groups with low number of species.

When considering the proportion of species required to achieve GES in order for the species group (or ecosystem component) level to be at GES, probabilistic methods would provide a statistically robust proportional threshold. At present, however, the methodology is incomplete and requires further development. ICES advices that a proportional threshold of 60–80% is chosen to represent the majority of species. The proportional threshold should be low enough to avoid frequent false alarms from uncertain or data–limited species assessments. A very low proportional threshold should also be avoided to ensure that GES is not achieved with a substantial proportion of the species outside GES.

[1] False alarms record a poor status where the actual status is good; missed alarms record a good status where the actual status is poor.

Accounting for risk to extinction in the MSFD

ICES suggests that an additional mechanism should be developed to alert of potential extinction risk in the MSFD.

There is a well-developed globally accepted framework for alerting risk to extinction, the IUCN red list. The MSFD criteria for selecting species suitable for assessment under D1 are different from this framework – *i.e*. the species chosen to form indicators for D1 species must respond in some manner to key anthropogenic pressures and be present in sufficient numbers or to a significant enough extent in the assessment area to construct a suitable indicator. The MSFD criteria do not provide a good tool to assess risk of extinction.

In addition, there is an inconsistency in information between common and rare taxa. This is due to the difficulty in monitoring rare species. Existing monitoring schemes for fish are not designed to monitor rare species and frequently monitoring is lethal. For offshore birds, systematic surveys are expensive and, for rare species, often need unrealistic levels of sampling. Insufficient monitoring and paucity of data leads to an increased probability of false alarms.

If species that are listed as threatened by IUCN are included in the species groups, the only integration approach that can possibly affect assessment outcomes is the conditional rule, "one-out, all-out" (OOAO), throughout the entire hierarchy of integration. ICES advises against the use of the conditional rule OOAO at some levels of the integration hierarchy as a threatened species will likely cause species groups and ecosystem components to be consistently outside of GES.

In the context of the MSFD, ICES suggests that the IUCN global assessments be used by Member States (MS) and Regional Seas Conventions (RSCs) to highlight taxa at risk of extinction. This will ensure consistency in the approach across the MSFD regions and account for boundary issues. ICES acknowledges that national and regional lists exist to highlight national and regional priorities. However, for the purpose of the MSFD, the advantage of the IUCN global listing is the consistency of assessment across taxonomic groups, the formalized assessment cycle and the transparency and documentation of guidelines and results.

For each MS or RSC area, the presence of taxa of birds, fish, and cephalopods that are listed as threatened by IUCN and not covered by the Habitats Directive, should be reported. The presence of these taxa could either create an alert or be used to create a separate threatened species indicator (perhaps the so-called RedList Indicator). Incorporating an alert or a threatened species indicator into the GES integration process present different challenges. Nevertheless, providing the list acts as an alert in itself.

Suggestions

ICES notes that Criterion D1C1 applies to *Species of birds, mammals, reptiles and non-commercially-exploited species of fish and cephalopods, which are at risk from incidental by-catch in the region or subregion*. In the MSFD bycatch is explained as "*The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long-term viability is ensured*". However, for many species, bycatch mortality may form only a small proportion of total anthropogenic mortality, e.g. from hunting or pollution. The long-term viability of a species subject to excessive mortality may not be ensured by D1C1. ICES suggests that a future decision might consider using a criterion applying to total anthropogenic mortality rather than to bycatch alone.

ICES suggests that integration methods should be tested on observed or simulated data to determine the risk of false and missed alarms, conclude on advantages and disadvantages of each method and to agree on a recommended option. The utility of probabilistic methods for integration should also be further explored

This advice assumes that sufficient monitoring programmes and data collation exist for biodiversity. This is not the case in some MSFD regions. ICES recommends that sufficient monitoring should be undertaken in all regions to assess the two primary criteria.

Basis of the advice

Background

The request further stated:

The revised Commission Decision on criteria and methodological standards for Good Environmental Status ((EU) 2017/848) has clarified that the assessment process for birds, mammals, turtles, fish and cephalopods under biodiversity descriptor 1 of MSFD should be based on integration of the criteria used in order to derive a status assessment for each species, followed by an overall status assessment per species group. The status per species is to follow the Habitats Directive integration method (for Habitats Directive-listed species of mammal, turtle and fish) and the Descriptor 3 method for commercial fish and cephalopod species. For other species a suitable method is to be agreed at EU level, taking into account regional or subregional specificities.

ICES is requested to re-evaluate the previous ICES guidance (http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/Special_Requests/EU_Guidance_on_method_to_aggregate_species_within_species_groups_D1.pdf) in light of the requirements of the new Decision.

Based on these considerations, ICES is to provide an operational recommendation for consideration by the Marine Strategy Coordination Group on:

1. *a suitable method to integrate D1 criteria to derive the status for each species (for species other than those under the Habitats Directive and assessed for D3), when suitable following the method used for Habitats Directive or commercial species, so as to minimise the range of methods followed. ICES should also advise whether there is justification to adopt a different method for a specific region or subregion.*
2. *a suitable method to derive the overall status of each species group, based on integrating the status assessments of all the species assessed within the group. The number of methods recommended for use across the 16 species groups should be minimised, taking into account the likely number of species assessed per group and region or subregion.*
3. *bearing in mind the GES Decision requirement to conclude on overall status only at species group level, and the draft Article 8 guidance which shows a further level of aggregation from species group to the level of birds, mammals, reptiles, fish and cephalopods, provide guidance on the overall presentation of the extent to which GES has been achieved for these higher groups.*

On the development of these methodological standards, considerations should be given to the risk of extinction of species within a species group. For example, if the threshold value for GES is set at 75% of species within the group, but there is significant risk of extinction of other species within the group, how should this affect the application of the aggregation rules.

The approaches/methods proposed should be tested using the results of current Regional Sea Convention assessments (i.e. HOLAS II and OSPAR intermediate assessment), taking account that further indicators may be necessary.

Rationale for the advice

Integration from criteria to species level has to account for a varying number of criteria within each species. Each criteria has different attributes. The number of criteria per species can also vary with the number of indicators applied to this species, whether that species is listed in the Habitat Directive, is a commercial fish or shellfish (an MSFD D3 species), or is at risk from incidental by-catch at the regional or sub-regional level. Moreover, some of criteria listed by the Commission Decision EU/2017/848 (EU,2017) are primary for some groups of species and secondary for the others. Accounting for all this complexity led ICES to advise a conditional rule, which is shown in a decision table (Table 1). The suggested method works well with the low number of criteria per species and accounts for situations with insufficient information on some criteria even when this information is considered mandatory.

Proportional rules were considered more appropriate than the conditional rules when integrating between species and species groups and from species groups to ecosystem components. There will often be many species to integrate and the use of conditional rules will likely result in many false alarms. For integration to ecosystem components, integration should

be at the species (rather than species group) level because there are too few species groups to integrate to the ecosystem component without high risk of false alarms.

Choice of threshold value for proportional method

The choice of threshold for the application of the proportional method is a management decision. ICES suggests that it involves consideration of the tradeoff between the risk of false and missed alarms and recommends a threshold between 60–80% and that the final choice of threshold should be selected by the parties completing the assessment. ICES advises against the setting of a very high threshold (> 80%) as it will result in multiple false alarms from uncertain or data-limited species assessments. A low threshold (< 60 %) would be more prone to missed alarms. Member States should collaborate either at a regional or European level to ensure consistency of approach to thresholds. At the present time scientific rationale for a more definitive proportional threshold is lacking. There is a potential for probabilistic methods to be used to determine thresholds for the proportion of species which should be required to achieve GES for the species group or ecosystem component. Probabilistic approaches would provide a statistically robust proportional threshold identification, but currently the methodology is incomplete and requires further development. They may also result in the high likelihood for false alarms.

Robustness of indicators and propagation of signals through the process of integration

The conclusions below are based on the assumption that indicators are unbiased, representative, accurate and integrated to criteria level using scientific methods (e.g. in accordance with current knowledge, based on quality assured data series, documented, peer reviewed). Further, if the indicators differ greatly in precision, this may lead to indicators with high variability or variance having a substantially greater effect on the outcome than indicators with low variability or variance. Hence, including many imprecise indicators may substantially increase the variability of the GES assessment at species group level, effectively masking the effect of the more precise indicators. If the principles for applying precaution when defining thresholds differ between indicators, the risk of false alarms and missed true alarms will differ, and the resulting risk at the species group level will not be readily evident.

Three aspects require careful consideration when integrating GES assessments between different levels: i) the treatment and propagation of false alarms raised due to random measurement error; ii) the importance of persistence or trends in status; and iii) the issue of data-limited species.

A species for which an indicator is measured with low precision will be particularly prone to false alarms (recording a poor status where the actual status is good) and missed alarms (recording a good status where the actual status is poor). In cases where precision is known, this could be incorporated in weighting procedures when determining the status at criteria level, but in many cases, the precision of the indicator is unknown and no correction can be made. As the MSFD is aiming for GES while enabling the sustainable use of marine goods and services, an integration process must incorporate some tolerance to false alarms, so that human use is not unnecessarily impeded. Alarms should be investigated to determine if they are signals that require action.

Persistence or trends in status convey important information. For example, having a poor status for a species in one year may not be a concern, but a series of poor status years will be. Regardless of the integration method used, a persistent low species abundance or a decreasing trend in D1C2 should lead to raising an alert.

The amount of data supporting the status assessment differs greatly between species, both in terms of quality and the length of available time-series. The methods advised are applicable in data-limited situations. ICES advises that as GES cannot be assessed, GES should not be able to be achieved in the absence of information,. ICES therefore advises that conditional rules for assessment of whether GES is being achieved or not should provide incentives to collect information, and not provide perverse incentives that might inhibit data collection. Thus, if information is missing on a primary criterion (e.g. bycatch), and no other compensatory information on a secondary criterion (e.g. demographics) is available, collecting further information should be of high priority.

Advantages and risks of integrating

ICES considers that there are a number of advantages to integrating decisions through a hierarchy but that there are also a number of risks (Table 2). The influence of individual indicators ranges from high in OOAO to low in averaging methods.

In general, OOAO is most prone to false alarms and least prone to missing alarms, whereas averages are least prone to false alarms and most prone to missing alarms. The other methods fall between these two extremes.

Table 2 The potential advantages and risks of integrating.

Topic	Advantage	Risks
Reduce noise	Filtering, exclude random variability (addressing point i) above)	Signal and details could be lost.
Summarize	Summarize, alert and promote action where appropriate (related to point ii) above)	Reacting to false alarms might decrease scientific credibility and reduce future response to alarms.
Balance	Balance different species groups and ecosystem components, reflecting where species groups are considered of equal importance	Species in species poor groups have more impact on the integrated indicators than those in species rich groups.
Communication	Simplified, comprehensible results for decision makers and the general public	Oversimplifying and losing details and perhaps stimulating inappropriate actions
Comparison	To allow broad-scale comparisons of results between Member States and marine regions to identify relevant scales of management (local/regional/global)	Depending on the methods, the systems are not comparable, simply because they have different levels of complexity and species numbers

In the future, integration methods should be tested on observed or simulated data to determine the risk of false and missed alarms, conclude on advantages and disadvantages of each and to agree on a recommended option.

Approaches used in Regional Sea Convention assessments

It was not possible to test the integration methods directly on OSPAR and HELCOM data as the underlying data used for the indicator assessments were not available to ICES. However the methods were qualitatively reviewed.

The method of integration currently applied within the HELCOM HOLAS II process is based on a normalisation where the indicator threshold is rescaled to 0.6. Values below this are rescaled to fall between 0 and 0.6 and values above are rescaled to fall between 0.6 and 1 (generally equal to the historical maximum). This integration method addresses the issue of larger means and historical variability in some indicators than in others. However, the difference in measurement error between different indicators is not taken into account. The inherent asymmetry of the method means that two indicators, one of which is 10% above and the other 10% below the threshold, do not average to a value of 0.6 (equal to the threshold). The statistical consequences of this normalisation are not well known nor are the impacts on transparency of the resulting integration results.

Integration rules are not widely applied in OSPAR assessments, such as the Intermediate Assessment 2017, except for cases where this is an element of a specific indicator definition, e.g. the OSPAR common indicator on marine bird abundance. The status of marine bird communities was assessed by calculating the proportion of species exceeding the lower assessment values according to the following integration rule: changes in abundance of marine birds should exceed species-specific assessment values in 75% or more of species that are assessed (within the 60-80% bounds as advised by ICES).

Challenges when considering extinction risk

ICES used the IUCN guidelines (IUCN, 2017) to inform its advice on assessing extinction risk. There are some challenges when exploring extinction risk. The IUCN approach considers predominately trends, habitat and scarcity. Taxa at persistently low but stable abundance across large areas are usually considered non-threatened by IUCN, even if this low abundance has been caused by anthropogenic pressures.

The basis for IUCN assessments of decline in number (IUCN criterion A which is mostly used for fish) is the longer of three generations or ten years which may be inadequate for some long-lived species or taxa for which gradual declines or range contractions have already been observed for a longer period. The frequency of IUCN assessments may not match with the MSFD assessment cycle and is variable. Longer assessment and variable cycles may affect the effectiveness of assessments

in alerting on taxa at risk. However, shorter cycles, such as the MSFD cycle, may not be the most effective tool to create alerts of extinction risk as a longer time-series might be necessary to discern changes due to measurement error (noise) from actual decreases (signal).

Methods

Potential methods for integration

To construct this advice ICES considered the following methods for integration: one-out all-out (OOAO), conditional, proportional (the percentage of indicators within limits), probabilistic methods, arithmetic averages, geometric average, weighted averages, and risk-based (Table 3).

Table 3 Integration methods with their advantages and disadvantages, as well as information on when the method is considered appropriate.

Integration method	Advantages	Disadvantages	Appropriate when
One out all out (OOAO)	• Easy to apply, explain and understand • No masking of failure	• Sensitive to false alarms • Loss of information	Suitable for the integration of few (up to five), equally weighted groups/criteria
Conditional	• Tailor made to reflect relevance and number of elements • Flexible	• Disadvantages differ between implementations • Prone to differences in implementation	Suitable for integration if following common guidelines
Proportional (percentage of indicators within limits)	• Simple • Reduces the occurrence of false alarms	• Threshold may be subjective • Sensitive to missed alarms	Suitable for the integration of a large (> 5) number of elements. Threshold setting is iterative process between experts and policy-makers.
Probabilistic methods	• Considers estimated uncertainty in data	• Method development for threshold setting requires further elaboration and testing	Currently not applicable
Arithmetic averages	• Provides a measure of distance to target • Lower risk of propagating false alarms	• One or more poor status indicators may be masked by one good status indicator • Higher risk of missing alarms	Suitable when indicator values are normalized to account for differences in measurement error and mean prior to integration.
Geometric average	• Provides a measure of distance to target • Lower risk of propagating false alarms • More resilient to outliers than averages	• One or more poor status indicators may be masked by one good status indicator • Higher risk of missing alarms	Suitable when indicator values are normalised to account for differences in measurement error and mean prior to integration.
Weighted averages	• Allows including elements considered crucial to be given more importance • Allows weighting by data availability and confidence	• One or more poor status indicators may be masked by one good status indicator • Higher risk of missing alarms • Weighting of elements is subjective	Suitable when some elements are considered more important or more certain than the others
Risk based	Allows objective and transparent decision-making	Require development of non-fisheries related applications	Currently not applicable

Sources and references

EU. 2010: Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956). No 2010/477/EU. 11 pp/

EU. 2017. Commission Decision 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardized methods foronitoring and assessment, and repealing Decision 2010/477/EU. No 2017/8948. 32 pp.

ICES. 2016. EU request to provide guidance on the most appropriate method to aggregate species within species groups for the assessment of good environmental status for MSFD Descriptor 1. *In* Report of ICES Advisory Committee, 2016. ICES. Advice 2016, Book 1, Section 1.6.2.3

ICES. 2018a. Report of the Workshop on MSFD biodiversity of species D1 aggregation (WKDIVAGG). 1–4 May 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:47. 49 pp.

ICES. 2018b. Report of the Workshop on extinction risk of MSFD biodiversity approach (WKDIVExtinct). 12–15 June 2018. Copenhagen, Denmark. ICES CM 2018/ACOM48 39 pp.

IUCN. 2017. IUCN standard and petitions subcommittee. 2017. Guidelines for using the IUCN red list categories and criteria. Version 13. http://cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf 108pp