RASS scoring guidance

Version 2, revised April 2024

1.1 RASS overview

Advice on 'which fish to eat or avoid' is currently available from many sources (notably from the NGO sector) allied with scoring systems. This advice can be inconsistent and be at differing levels of detail. Varying or conflicting advice has created confusion for the supply chain and consumers alike. There is a need from seafood buyers for robust, up-to-date, and structured information on the environmental risks when sourcing seafood. Depending on a buyer's needs this may encompass the risks to the health of a particular stock, or the risks associated with the wider environmental impacts of different fisheries.

The UK Sea Fish Industry Authority's Risk Assessment for Sourcing Seafood (RASS) will provide UK seafood buyers and processors with information on the biological status of fish stocks from which fish are either landed or imported into the UK, and the environmental impacts of fisheries catching these stocks. A key feature of RASS is that it will present risk scores for four themes: 1) stock status, 2) stock management, 3) habitat impact, and 4) bycatch impact (hereafter referred to as mechanisms).

Seafish has developed the RASS scoring mechanisms and a tool for disseminating this information to our key stakeholders. In addition to informing the UK seafood industry's sourcing policies, it is envisaged that RASS would facilitate dialogue between the scientific community and industry, allowing prioritisation of future research to address high-risk uncertainties.

1.2 Scoring

The rationale behind scoring is that many seafood buyers who use RASS will not have the knowledge (or time) to make sense of quantitative and qualitative information from scientific, technical and legal sources. Seafish has developed a risk assessment method for translating information gathered from management advice and the broader scientific literature into five risk categories (see Table 1). Supporting evidence in the form of a referenced narrative (and graphs where appropriate) will also be provided in addition to the score to provide context.

Scoring is normally carried out under the following headings:

- Stock status: fish stocks are the assessment unit used.
- Stock management: the process by which fisheries are managed to control their impacts on the stock.
- Bycatch impact: fisheries can have unintended consequences for other species and this aspect is scored together with mitigating measures.
- Habitat: the scoring of this aspect concerns seabed habitat effects of the fishery

Table 1 Risk categories for RASS as scores and as symbolised on the profiles. Only five risk categories will be presented in the profiles. The risk category is described in words in column 1, as a numerical score (1 to 5) in column 2 and symbolised in column 3 as the number of solid blue discs out of 5.

Risk	Score	Symbol
Very low	1	●○○○○
Low	2	●●○○○
Moderate	3	●●●○○
High	4	●●●●○
Very high	5	●●●●●

Scoring is perhaps least contentious for scoring stock status in fully assessed stocks, as the goal is relatively easy to define (i.e. to minimise the risk of a stock being outside safe biological limits), and there are a limited number of criteria to score against this goal. Scoring stock management is trickier as it is more difficult to define what constitutes 'good management', and the criteria used to assess good management are much more subjective, entailing some degree of judgement from the scorer. For bycatch and habitat risk, expert judgement will have to be excised on a patchy evidence base, and in some cases a generalisation will have to be made on the potential risk of impact of a given gear category.

We define a stock at the biological stock level as used by scientists for assessment. The stock status and stock management will be assessed together throughout the stock's range. There will be scope in RASS to make assessments of nested fisheries that catch the same stock but may have a different spatial extent or be defined by a different gear type. In these fisheries management, bycatch and habitat risks will be assessed separately, although management risks will also be assessed across the stock's range. See Section 6.3. Figure 9.

2 Scoring mechanisms

2.1 Stock status

The goal for this component is that seafood is sourced from a stock that is harvested sustainably and within safe biological limits. Our definition of a stock is the unit used by managers for regulatory purposes. A "stock" may not always match the biological unit of a population which can pose problems for management (see Section 3).

Essentially the scoring scheme had to be developed to take into account different types of stock assessment including Data-limited methods for stocks where there is some information but not enough to enable a full stock assessment. Although the stock assessment methods differ between the different scientific institutions and management bodies, in most cases maximum sustainable yield (MSY) and /or safe biological limits are defined and the advice given is based around these reference points. The scoring scheme is based around these reference points. For those stocks that are not assessed in any way we resort to using the resilience of the species to fishing which is defined on Fish Base (Cheung et al 2005).

There will be no room for manoeuvre in decreasing the risk score for stock status for nested fisheries, as this information will be treated independently regardless of the catch from a particular fishery.

2.1.1 Quantitatively assessed stocks

These are assessed against quantitatively defined reference points using the matrix in Figure 1. Definitions:

- Maximum Sustainable Yield (MSY) is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technological characteristics.

- Overfishing; A stock that is subject to overfishing has a fishing mortality (harvest rate) that is higher than the rate that produces MSY

- Overfished; A stock that is overfished has a biomass level reduced to a degree that the stock's capacity to produce MSY is jeopardized. A stock can be overfished but be managed under a rebuilding plan that over time returns the population to a level that can support the MSY. Stocks can be overfished but not depleted to the point where there is insufficient spawning stock biomass to enable sufficient breeding and hence recruitment into the stock (see Seafish 2022a)

- Safe Biological Limits (SBL) When the stock is outside safe biological limits the spawning stock biomass is below levels which enable sufficient breeding and hence recruitment of young fish into the stock to support a fishery. When this occurs, managers would be expected to take action to recover the stock.

Typically, the commercially most important fish stocks are fully assessed through statistical models that quantify the biomass of the stock and fishing mortality in relation to a target and/ or limit reference point. Generally speaking, a target reference point refers to the Maximum Sustainable Yield (B_{MSY} and F_{MSY}) or proxies. Trigger reference points, (example MSY $B_{trigger}$) are levels below which action should be taken to conserve the stock, aimed at bringing it back to levels which can sustain MSY.

Precautionary (pa) and limit (lim) reference points, relate to the likelihood that stock recruitment is being impaired. When a stock is outside pa reference points it is at risk (5-10 percent) of being outside the limit reference points and hence SBL. The risk can be assessed according to how stock biomass and fishing mortality reference points fall in relation to one another in the matrix shown in Figure 2.

The above is only an outline. For more information see Seafish Guides to Fish Stock assessment and ICES reference points (Seafish 2022a) and Fishing at Maximum Sustainable Yield (MSY) (Seafish 2022b).

Figure 1 Matrix for scoring quantitatively assessed stocks, the risk score is shown below the symbolised blue discs. The matrix shows increasing fishing mortality along the horizontal axis and increasing stock biomass along the vertical axis. Note that for some stocks, biomass (B) reference points may be explicitly defined, whereas fishing mortality (F) may be described as a range, or be described more broadly in terms of where it lies in relation to a long-term average.

Stock biomass (B)

Underfished (B= >B_{MSY} [if MSY defined])	●○○○○ 1	●○○○○ 1	●●○○○ 2	●●○○○ 2
Stock within safe biological limits (B= >$B_{trigger}$/ B_{pa})	●●○○○ 2	●●○○○ 2	●●●○○ 3	●●●●○ 4
Overfished and at risk of impaired recruitment (B= <$B_{trigger}$/ B_{pa})	●●●○○ 3	●●●○○ 3	●●●●○ 4	●●●●● 5
Impaired recruitment (B= <B_{lim})	●●●●○ 4	●●●●○ 4	●●●●● 5	●●●●● 5
	Underfishing (<F_{MSY} [if MSY defined])	F within precautionary levels **OR** F below long-term average	F outside precautionary levels **OR** F is >F_{MSY} and no precautionary level defined **OR** F around long-term average	Overfishing (F> F_{lim})

Fishing mortality (F)

Reference points can differ between different assessment areas (i.e. ICES vs NOAA) (Table 2). In the USA, stock biomass reference points relate to B_{MSY} or a proportion (usually 30, 35 or 40%) of the un-fished biomass with average long-term recruitment. Limit reference points for biomass are undefined. Advice on sustainable exploitation is given as fishing mortality rates calculated to move stock status towards B_{MSY}, which are in turn used to determine the corresponding acceptable harvest (or range of harvests) for a given stock, the Allowable Biological Catch (ABC), and also the overfishing level (OFL – defined as any amount of fishing in excess of a prescribed maximum allowable rate).

Table 2 Table showing how scoring criteria for stock biomass and fishing mortality approximately relate to reference points in the ICES and North American systems. There are five tiers used to determine ABC for US ground fish stocks, based upon the status and dynamics of the stock, the quality of available information, environmental conditions and other ecological factors, and prevailing technological characteristics of the fishery

Scoring criteria	**Assessment system**	
Stock biomass	**ICES**	**USA (NOAA)**
Underfished	>B_{MSY}	>$B_{35\%}$ (for Tier 3 stocks)
Stock at levels where it can be safely harvested at F_{MSY}, reaching long term equilibrium at B_{MSY}	>MSY $B_{trigger}$ Analytical models >0.5 B_{MSY} Production models. However, note that where used in an ICES data limited context using SPiCT production models the catch is advised at around 70% of MSY see Seafish (2022c)	
Stock requires reduction in fishing mortality from F_{MSY} to enable long term equilibrium at B_{MSY}	Between MSY $B_{trigger}$ and B_{pa}	
Stock within safe biological limits	Above B_{pa}	
Overfished and at risk of impaired recruitment	Between B_{pa} and Blim	
Impaired recruitment	<B_{lim}	

Scoring criteria	Assessment system	
Fishing mortality		
Underfishing	>F_{MSY}	
Fishing mortality within precautionary limits	Between F_{MSY} and F_{pa}	F_{ABC} is set equivalent to the mean of F_{MSY}
Fishing mortality outside precautionary limits	Between F_{pa} and F_{lim}	
Overfishing, long-term risk of impaired recruitment	>F_{lim}	

2.2 Tuna assessment models

Tuna assessments are generally carried out using models for which it is difficult to define reference points other than F_{MSY} and B_{MSY}, because there is less information on risk of reduced recruitment of young fish into the stock, which is the basis for the precautionary approach reference points discussed above.

The tuna assessment community is beginning to define F_{lim} and B_{lim} for some stocks, especially for those which are overfished. Although these reference points are not always based on stock-recruitment relationships they are used as reference points for these stocks and forward projections are made based on them. However, precautionary levels (B_{pa} and F_{pa}) are not usually defined as the ICES stocks.

So for tuna stocks the scoring should proceed as follows;

1. First consult the International Seafood Sustainability Foundation's status of the stocks report. This will give a summary of the latest assessment for all the tuna stocks and it also contains information on management and bycatch, and summarises scores relating to MSC[1] criteria. For a historical perspective back to 2011 ISS foundation's Interactive stock status and catch tool is useful. For stocks which are under fished ($F<F_{MSY}$, $B>B_{MSY}$), this should be sufficient information to make a RASS risk assessment.

[1] Marine Stewardship Council

2. For stocks which have limit reference points, and the range of assessment results crosses either the biomass or fishing mortality limit reference points, should be scored as being outside precautionary levels and scored accordingly.

3. Stocks outside limit reference points that is outside SBL for fishing mortality and/or biomass should be treated as for ICES stocks and scored accordingly.

It is also worth checking the assessment to see the relevant science section on the RFMO[2] site reached through Tuna-org. It is also important to read what the assessment has to say on the forward projection of stock status at current levels of catch. This will inform any caveats attached to the assessment and the management risk score, see Section 3.1.

2.2.1 Data limited stocks

ICES WKLIFE X (ICES, 2020) has developed 'proxy' reference points for stock status. The derivation of these reference points are further described in Seafish (2022c). These methods use estimation of abundance trends, based on research vessel survey catch-per-unit-effort, as biomass indices and length-based indicators, for fishing mortality, derived from commercial catches and the matrix used for scoring these stocks is given in Figure 2. Although the use of these indicators has been tested in simulations and found to be precautionary, they are not full stock assessments. Hence there is a requirement for a different scoring matrix for these stocks, and for non-ICES stocks using proxy reference points. Note that this scoring matrix cannot score very low risk, because of the level of uncertainty concerning the stock status.

[2] Regional Fisheries Management Organisation

Figure 2. Matrix for scoring data limited stocks which use proxy reference points, the risk score is shown below the symbolised blue discs. In ICES assessments proxy Stock Biomass reference points are related to the lowest observed level of the biomass index which is effectively used as B_{lim}, and $B_{trigger}$ is estimated as 1.4 x the lowest observed index. This may result in the advice being too precautionary when the stock is lightly exploited. The Fishing mortality reference point F_{MSY} proxy is based on stocks being at F_{MSY} when fishing and natural mortality are equal. Other proxy frameworks use other reference points.

Stock biomass (B)	Stock Biomass index above $B_{trigger}$	●●○○○ 2	●●○○○ 2	●●●○○ 3
	Stock Biomass index below $B_{trigger}$	●●●○○ 3	●●●○○ 3	●●●●○ 4
	Stock Biomass index below lowest observed level	●●●○○ 3	●●●●○ 4	●●●●○ 4
		Fishing mortality (F) estimated to be below F_{MSY} proxy	Fishing mortality (F) estimated to be at F_{MSY} proxy	Fishing mortality (F) estimated to be above F_{MSY} proxy
		Fishing mortality (F)		

Where data-limited stocks have biomass index (B) and harvest rate (F) defined, but only presented in relation to a long-term average, Figure 3 may be used. The various possibilities for the status of B and F (see first column) will be weighted by a species biological resilience defined in Fish Base, or Sea Life Base (Cheung et al 2005). If B and F are not defined, the default position would be to use species resilience only to score (i.e. High 3, Medium 4, Low/ very low resilience 5). For some species (e.g. brown crab, lobster etc) only their vulnerability has been defined in Fish base or Sealife Base, therefore this metric will be used in the absence of information on resilience.

Figure 3 Matrix for scoring data-limited stocks where information on biomass (B) and fishing mortality (F) is presented in relation to long term average scenarios, using species resilience or vulnerability as a weighting factor, risk score is shown below the symbolised blue discs. *No index for B and F is to be used as the default score in the absence of any information on B and F

Biomass and fishing mortality information	B>long-term average **AND** F< long-term average	●●○○○ 2	●●○○○ 2	●●○○○ 2	●●●○○ 3
	B>long-term average **AND** no index for F	●●○○○ 2	●●●○○ 3	●●●○○ 3	●●●○○ 3
	B around long-term average **AND** F around long-term average B around long-term average **AND** no index for F	●●●○○ 3	●●●○○ 3	●●●○○ 3	●●●○○ 3
	B<long-term average **AND** F around long-term average **or** no index for F B around long-term average **AND** F>long-term average *No index for both B **AND** F	●●●○○ 3	●●●●○ 4	●●●●● 5	●●●●● 5
	B< long-term average **AND** F>long-term average	●●●●○ 4	●●●●● 5	●●●●● 5	●●●●● 5
	Resilience[3]	**High**	**Moderate**	**Low**	**Very low**
	or (if resilience not defined) Vulnerability[3]	**0-24**	**25-49**	**50-74**	**75-100**

If only a population trend is known, then Figure 4 will be used to score. In certain circumstances the ICES advice will state the direction of the trend, however if not, this can be inferred visually from the time-series.

[3]Some species may be cited as bordering two categories, we suggest being conservative in this case, and assume the lower resilience score, or higher vulnerability score.

Figure 4 Matrix for scoring data-limited stocks if only a population trend is known with species resilience as a weighting factor. [1]Some species may be cited as bordering two categories, we suggest being conservative in this case, and assume the lower resilience score, or higher vulnerability score.

Population trend					
	Increasing	●●○○○ 2	●●○○○ 2	●●●○○ 3	●●●○○ 3
	Stable	●●○○○ 2	●●●○○ 3	●●●●○ 4	●●●●○ 4
	Decreasing	●●●○○ 3	●●●●○ 4	●●●●● 5	●●●●● 5
	Resilience[3]	**High**	**Moderate**	**Low**	**Very low**
	or (if resilience not defined)				
	Vulnerability[3]	**0-24**	**25-49**	**50-74**	**75-100**

3 Stock management.

The goal for this component is that seafood is sourced from a stock that is responsibly managed. Here we define responsible management as reflecting the extent to which the stock harvest strategy (Figure 5, see row headers) is known to be precautionary, and secondly, what is known about the general surveillance and enforcement of the law within the fishery and extent of infringements (Figure 5, see column headers). In contrast to scoring stock status, descriptors of these two dimensions can be difficult to define objectively. Scoring management is inherently subjective as different assessors may have divergence in opinion on the choice of scoring criteria that best describe the same fishery. Special attention will need to be spent on quality assurance to mitigate this subjectivity and ensure consistency in scoring.

Assessments of management will initially be made for the stock area. However, for some species (i.e. scallops, nephrops) management will typically be assessed at the scale that the main capture fishery operates (e.g. scallop dredging in the Celtic Sea), and not individual beds/ grounds. See Section 6 for discussion of 'nested fisheries', that is fisheries defined by spatial extent and/or operating procedures.

Generally, fisheries management in the developed world has improved considerably over the past fifty years (Hilborn & Ovando 2014). Fisheries operating in the jurisdiction of developing countries, where there is no agreed harvest strategy, limited surveillance, and limited law enforcement, there will be more risk associated with management. Clearly, this situation makes risk assessments more uncertain, and this aspect should be included in the commentary.

3.1 Stock harvest strategy

This dimension captures the quality of information that underpins the Management Controls (MCs) and their implementation. MCs can take a variety of forms as is appropriate to the stock.
Management controls used include:

- Total allowable catches (TAC)
- Limiting general fishing effort e.g. Licences
- Limiting the spatial-temporal distribution of fishing for example closed seasons
- Technical measures e.g. specifying gear types and selectivity devices.

Although in fisheries management emphasis is put on the collection of data to inform the setting of the TAC, there are also some fisheries that are not TAC managed. For example, the Faroe Islands effort based management system (Hegland & Hopkins 2014). Spatial and size-based limits also play a part in controlling harvesting strategy, our scheme recognises this, so that a wide range of strategies can be scored.

The evidence used to score this dimension will be found in fisheries management plans and stock assessment advice or inferred from the rules set out by the management body. Many commercially important stocks will have an agreed management plan, and it will often be explicitly stated in the stock assessment advice whether this is assessed as precautionary. However, for most fish stocks an inference will have to be made to score against the criteria shown in first column of Figure 5. In the commentary it is useful to include reference to the principles being used for the advice:

1. Maximum Sustainable Yield (MSY) and/or Precautionary Approach (PA), Data Limited, or is the advice following a management plan agreed by the parties fishing the stock?

2. Is there mixed fisheries advice and does it have implications for the stock?

3. How does the science advice translate into management; are there management plans and harvest control rules? There may be an agreed management plan, but because it is not assessed as precautionary the scientific advice does not give it as headline advice, but advice on catch may be given in the options table of the advice.

4. Is there an international dimension to the stock; transboundary (across more than one nation's EEZ) or straddling (includes High Seas). Are there any international co-operation agreements and management plans?

When providing a management score, consideration should be given to how closely the management has followed the scientific advice, and the risk levels associated with the management's action. For stocks with forward projections this can be assessed by reference to the probability of the stock being outside safe biological limits as a consequence of a given management action. This type of information is available from the ICES advice, options table, although probabilities are usually only given when the stock is close to or outside Safe Biological Limits. Forward projections, with estimates of the probabilities of stocks being overexploited in subsequent years are also given in many of the tuna assessments. There is also ICES technical service standing request for advice on zero TAC stocks. Reference should be made to the EU TACs and quotas regulations for European stocks; Fishing quotas – European Commission (europa.eu). When interpreting this information, it is important to check that all nations are included in the TAC ie EU, UK and Norway for shared stocks. Also, it is best to carry out the assessments of European stocks once the TACs and quotas have been set in January, so they can be related to the previous year's advice.

3.2 Surveillance and enforcement

This dimension captures the extent to which there is surveillance of a fishery to ensure compliance and impacts of infringements. Through technological advances (i.e. satellite monitoring, electronic logbooks etc) the capacity of most developed countries to carry out surveillance of their fleets has increased since the turn of the century. However, infringements will continue to happen, therefore expert judgement should be made on the extent to which infringements such as misreporting catch (Hentati-Sundberg et al. 2014) are likely to compromise the objectives of the harvest strategy. Compliance with the Landing Obligation in EU and UK fisheries should only be considered where the issue is mentioned in the stock advice. See column 3 of Figure 5.

Figure 5 Matrix for scoring management. Note MC are Management Controls

<table>
<tr><th></th><th></th><th colspan="3">Surveillance and enforcement</th></tr>
<tr><td></td><td></td><td>MCs are routinely enforced and independently verified through surveillance of fishing activities (e.g. VMS, logbooks, dockside monitoring, vessel inspections etc). Infringements happen only very occasionally and unlikely to compromise harvest objectives.</td><td>Compliance can be patchy (i.e. misreporting of catches or issues concerning the Landing Obligation officially stated to be a problem), and infringements may compromise harvest objectives.</td><td>Lack of surveillance prevents confirmation of whether fishing vessels are complying with MCs; OR there is widespread non-compliance and no capacity to enforce infringements. Harvest objectives (if they exist) will likely be compromised.</td></tr>
<tr><td rowspan="9">Stock harvest strategy.
Decreasing monitoring of stock, and more risky harvest strategy</td><td>MCs are derived from analytical stock assessments and known to be precautionary; AND Actual MCs within range specified by science advice.</td><td>●○○○○
1</td><td>●●●○○
3</td><td>●●●●○
4</td></tr>
<tr><td>MCs are advised using analytical stock assessments though found not to be precautionary (OR tested without implementation error); OR Simpler data-limited approaches (e.g. ICES data-limited methods) are used for setting MCs, and which are based on knowledge of the fisheries and the biology of the stock, but unknown whether they are precautionary; AND A fishery has implemented MCs for the stock, and these are consistent with science advice.</td><td>●●○○○
2</td><td>●●●○○
3</td><td>●●●●●
5</td></tr>
<tr><td>MCs are derived from data, though compromised by mismatching scale of assessment unit and management (e.g. some Nephrops functional units, and where there is a combined TAC for overlapping stocks); OR catches or effort too high to be optimal (i.e. outside range specified by science advice for MSY) and may not lead to an optimal pattern of exploitation although within precautionary approach levels.</td><td rowspan="2">●●●○○
3</td><td rowspan="2">●●●●○
4</td><td rowspan="2">●●●●●
5</td></tr>
<tr><td>A fishery has implemented MCs that are rational in relation to the life-history of the species/ stock, but lack of monitoring means efficacy is not verifiable.</td></tr>
<tr><td>Data are too limited to develop any form of MCs to adjust fishing opportunities on the stock BUT there are management measures in place to control effort in the fishery.</td><td rowspan="4">●●●●○
4</td><td rowspan="4">●●●●●
5</td><td rowspan="4">●●●●●
5</td></tr>
<tr><td>The managers choice of MC is consistent with the stock forecast to be outside SBL is greater than 5% in the next year, and therefore not precautionary.</td></tr>
<tr><td>Although there is clear scientific advice on catch levels managers persistently set catch or effort levels higher than advised by science</td></tr>
<tr><td>The catch is trending upward without agreement on effective MCs</td></tr>
<tr><td>Data are too limited to develop any form of MCs to adjust fishing opportunities on the stock AND no effort control.</td><td>●●●●●
5</td><td>●●●●●
5</td><td>●●●●●
5</td></tr>
</table>

4 Bycatch impacts

The goal for this component is that seafood is sourced from a fishery that minimises the impact on stocks of vulnerable resource species and populations of Endangered, Threatened and Protected (ETP) species

Many fisheries are described as mixed fisheries; where the fishers would describe several named species as target species and the catch (and revenue) is made up of a wide variety of species. Target and bycatch species in many fisheries are not clearcut. The risk assessment method intends to distil out of the information available on which stocks of vulnerable resource species and populations of ETP species and are caught in significant quantities by the fishery, and how these catches may be affecting these populations. Bait used in trapping (potting) and hook and line fisheries to be treated as bycatch for wild caught bait stocks. However, for aquaculture waste example salmon farm waste, just mention that this is the origin of the bait, but do not try to do a risk assessment on it.

4.1 Resource species

Impacts of fisheries on vulnerable resource species are usually well documented, because in many mixed fisheries re-building of these stocks is dependent on managing all catches and not just the main fisheries targeting these stocks. Information is available from ICES advice on zero TAC stocks is available under ICES technical advice and there is also annual mixed fisheries advice which is a source of information on potential choke species. Scoring is as in Figure 6a, intended to be equivalent to the ETP species scoring in Figure 6b.

4.2 Endangered, Threatened and Protected species

A species will be categorised as ETP if;

- it is legally protected in conservation law,
- their populations are considered vulnerable as assessed by the International Union for Conservation of Nature (IUCN) Red List; or
- may be considered vulnerable to the effects of fishing activities because of low abundance or their life history characteristics mean a population can withstand limited additional mortality.

More information is available on these species in the Seafish (2022d) Guide to protected species. Preferably, a judgement on risk will consider evidence on the potential biological removal (PBR) rate, defined as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population, or other evidence on the population status of the ETP species. If there is no information on this, an inference will be made on whether there is mitigation in place across the fishery that will likely reduce the impact of the fishery on the ETP species/ population in question. If there is ambiguity over the extent to which mitigation is taking place in the fishery, a precautionary stance will be taken, with this dimension being scored a high risk (Figure 6b).

Figure 6 Risk to bycatch of resource species (a) and to ETP species (b). The risk scored in RASS will be the dimension that is scored the highest.

a) Resource species within a mixed fishery	Risk
Fishery targets and catches a single stock	●○○○○ 1
Capture of resource species which are inside safe biological limits occurs, but fisheries are managed to maintain stocks at these levels	●●○○○ 2
Capture of vulnerable resource species (at risk of being outside safe biological limits) occurs but are not at levels sufficient to affect recovery of populations. Mitigation measures are in place that are demonstrated to be effective.	●●●○○ 3
Capture of vulnerable resource species, which are outside safe biological limits, occurs at levels sufficient to affect recovery of populations. Mitigation measures are in place but there some uncertainty as to their effectiveness.	●●●●○ 4
Capture of vulnerable resource species which are outside safe biological limits occurs. Fisheries have a significant impact on these stocks, inhibiting their recovery	●●●●● 5

b) ETP species	Risk
Capture of ETP species over the course of a fishing season is very unlikely.	●○○○○ 1
Capture of ETP species is likely (≥1 per year). Impact on the population is unlikely to be significant because: Population status of ETP species is healthy **OR** Removal < PBR rate.	●●○○○ 2
Capture of ETP species is likely and population status is unknown or declining. However, mitigation (including high post-release survival) in fishery is likely to significantly reduce impact.	●●●○○ 3
Capture of ETP species is likely. Impact on the population may be significant because: Population status of ETP species is declining **OR** Removal > PBR[1] rate **AND** Effect of any mitigation is questionable or not well documented.	●●●●○ 4
Capture of ETP species likely and population status is critical. Removals very likely to be having a significant impact on the population.	●●●●● 5

5 Habitat impacts

The goal for this component is that seafood is sourced from a fishery whose seafloor habitats impact is reversible within five years. Typically, it is going to be mobile bottom gears that have the greatest impact on the seafloor; however, effects can vary considerably between gear types and according to the environmental context in which they are fished. The effects of disturbance can be relatively minor and last a few days in some habitats, though in others, severe and much longer-lasting, especially in biogenic habitats. The latter we define as vulnerable habitats and Figure 7 may be used to score these.

Over the past 10 years substantial advances have been made in assessing the seabed habitat effects of fishing, some of it co-ordinated by the group Trawling Best Practices. Methods for deriving benthic effects of fishing have been advanced, using the concept of Relative Benthic Status (RBS). This uses an assessment of the relative rates of depletion after trawling and recovery of benthic habitats to assess the level of depletion of the fauna relative to the unfished state. See Appendix for further details.

When assessing the risk score for demersal trawl gear there should be an initial review of information on habitats and fishing effort, Marine Protected Areas and any habitat assessments which have been made. The assessor should choose, based on the amount of information available, which set of criteria from Figure 8 Revised scale of risk for habitats assessed using the MSC benthic impact tool; may be used for vulnerable and commonly encountered habitats. The MSC Benthic Impacts Tool and Figure 8 should be used to make the assessment. In some cases, the assessment will have been made using an amalgamation of gears, that is for example all towed gears within a region. In these cases, there should be clarity as to which unit of assessment is being used. Where appropriate, nested fisheries can be assessed.

There have been several assessments using the RBS method. The overall footprints of trawling and the relative status of biotic communities on sedimentary habitats have been mapped in 24 regions worldwide (Pitcher, et al 2021) and also widely in the ICES region by ICES WGFBIT. The Marine Stewardship Council (MSC), in collaboration with Bangor University have developed the Benthic Impact Tool, which uses the RBS framework and information on recovery times of the benthic communities to derive recovery times for benthic habitats affected by the gear footprint (by footprint we mean area and depth of penetration of the gear into the seabed). This can be used to score the seabed impacts of the fishery in relation to the time the benthos takes to recover to 80% of its unimpacted level within the MSC's scoring scheme. If information is available from the benthic impact tool then use the scheme shown in Figure 8.

Figure 7 Habitat scoring criteria for vulnerable habitats. [1] Use these statements when high resolution mapping data are present

Impact criteria	Risk
No interaction of the gear with seafloor habitats (e.g. pelagic seining longlines and handlines, pelagic gillnets, pelagic trawling [e.g. mackerel, herring])	●○○○○ 1
Gear touches the seafloor, though significant interaction with vulnerable habitats is very unlikely. IF mapping data to assess[1]: Gear touches the seafloor, but there is no significant overlap with the habitat feature of interest. IF data poor: Pelagic trawling [e.g. Alaska pollock], demersal longlines, pots and traps, demersal gillnets (though see caveat for moderate risk category where static gear is used over biogenic habitats)	●●○○○ 2
Potential interaction with vulnerable habitats (marginal overlap of the fishery's footprint with vulnerable habitats) IF mapping data to assess[1] : The fishing pressure (FP) impact interval is likely < longevity of the longest lived species, but > half the longevity of the longest lived species. This assumes that the organism will have reached reproductive maturity before successive FP impacts occur. IF data poor: An argument can be made that the footprint of mobile bottom gears is adequately managed to significantly reduce damage to vulnerable habitats. I.e. MPAs limit the interaction of a mobile bottom gear with vulnerable marine habitats, such as deep-water mud. **OR** Static bottom gears/ demersal longlines are being used over biogenic reef habitats where possible entanglement can occur **OR** Bottom trawling/ dredging/ seining known known to occur mainly on habitats resilient to disturbance, such as mobile sediments.	●●●○○ **3**
Likely interaction with vulnerable habitats (significant overlap of the fishery's footprint with vulnerable habitats) Bottom trawling/ dredging/ seining known to occur on vulnerable marine habitats, such as deep-water muds.	●●●●○ **4**
Highly likely interaction with vulnerable habitats over a large proportion of the fishery's footprint. Bottom trawling off continental shelf/ deep-sea areas that may be previously un-trawled.	●●●●● 5

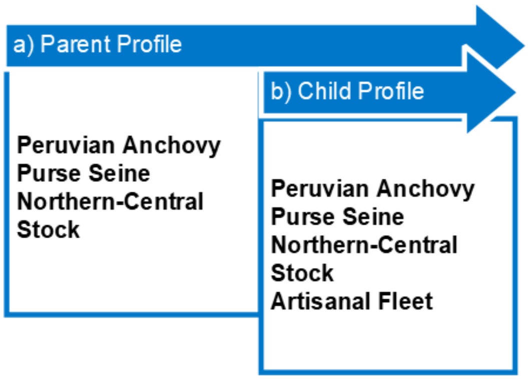
Figure 8 Revised scale of risk for habitats assessed using the MSC benthic impact tool; may be used for vulnerable and commonly encountered habitats. MSC Benthic Impacts Tool | Marine Stewardship Council

Impact criteria	Risk
No interaction of the gear with seafloor habitats (e.g. pelagic seining longlines and handlines, pelagic gillnets, pelagic trawling [e.g. mackerel, herring]	●○○○○ 1
The probability of the habitat failing to recover to 80% of its unimpacted level within 20 years is less than 20%.	●●○○○ 2
The probability of the habitat failing to recover to 80% of its unimpacted level within 20 years is less than 30%.	●●●○○ 3
The probability of the habitat failing to recover to 80% of its unimpacted level within 20 years is less than 40%.	●●●●○ 4
The probability of the habitat failing to recover to 80% of its unimpacted level within 20 years is greater than 40%.	●●●●● 5

6 Scoring of nested fisheries

There will be scope for down-scoring risks of nested fisheries for management, bycatch and habitat, although status and management of the overall stock will always be assessed see Figure 9. This is because management of a stock over the whole of its range would be expected to have an effect on all the fisheries exploiting the stock. Bycatch and habitat risk for nested fisheries can be scored, if they can evidence that they would have less of a negative impact than the broad-scale fishery profile to which they belong. Such down-scoring will have to be evidenced by data, or sound argument that can be scrutinised by peer-review.

Figure 9 RASS fisheries assessments will initially be broadly defined at the scale of the stock (a). Though there will be scope to define nested fisheries at varying spatial scales (b) and/ or operating procedures.



6.1 Scoring management of nested fisheries

A stock may have scored a ≥moderate risk for management either because of an ineffective stock harvest strategy and/or surveillance and enforcement. In certain circumstances a nested fishery (see Section above for definition) may be implementing local management measures that are contributing to the conservation of the stock and/ or is better managed than the parent fisheries profile in terms of surveillance and enforcement (e.g. fully documented fisheries).

There will be scope in RASS to recognise best practice in such fisheries by creating tailored profiles, and potentially down-score risk if management of the stock is deemed less risky in these fisheries compared to the parent, with an assessment made against the same criteria in Figure 5. To do this in a way that is defensible, the nested fishery would have to provide evidence of local stock management measures that distinguish it from the general parent fishery. Management would need to be consistent with a precautionary harvest strategy. Such profiles would also need to be quality assured to ensure that there is a reasoned argument for down scoring the risk.

The score for overall stock management of the parent fishery would be included in the RASS assessment, with the revised score given for the nested fishery where appropriate.

6.2 Scoring bycatch of nested fisheries

In certain circumstances an argument may be made by a nested fishery (see Figure 1) that the incidence and impact of bycatch is significantly less compared to the parent fishery which may have been scored a ≥ moderate risk. For example, vessels in the nested fishery may have universally adopted a code of practice and or gear modifications to reduce either the quantity of bycatch of vulnerable resource species, or impact on ETP species when compared to the parent fishery. The same criteria defined in there is ambiguity over the extent to which mitigation is taking place in the fishery, a precautionary stance will be taken, with this dimension being scored a high risk (Figure 6b). will be used to assess the bycatch risk in such fisheries; and any down-scoring will have to be evidenced by data or sound argument that can be scrutinised by peer-review.

6.3 Scoring habitat impact of nested fisheries

As with management and bycatch, an argument could be made that habitat impact is significantly less compared to the parent fishery which may have been scored a ≥moderate risk. For example, the fishing footprint of the nested fishery may have been comprehensively mapped and found not to overlap with vulnerable marine habitats. Or in the absence of comprehensive spatial data, an argument can be made that the footprint of mobile bottom gears is adequately managed to significantly reduce damage to vulnerable habitats. Use Figure 8 Revised scale of risk for habitats assessed using the MSC benthic impact tool; may be used for vulnerable and commonly encountered habitats. MSC Benthic Impacts Tool | Marine Stewardship Council and Figure 8 as appropriate.

7 References

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Glossary of terms

Term	Definition
B_{lim} Biomass limit:	Biomass limit reference point; stocks with spawning stock biomass below this level are considered to suffer from impaired recruitment (recruit overfished) and hence may not be able to sustain a fishery.
B_{MSY} Biomass at MSY	This is defined as the estimated level of biomass of a stock which produces MSY at long term equilibrium. B_{MSY} can also be defined as the level of biomass that results from fishing at F_{MSY} for a long time. B_{MSY} is not normally used as a reference point for ICES stocks that are assessed using analytical models. However, it is widely used in North American stock assessment.
B_{pa}: Precautionary Biomass level	Precautionary biomass level; stocks with spawning stock biomass below this level are at risk (around 5-10%) of being below the Biomass limit reference point (B_{lim}).
Fishing Mortality: F	The rate of mortality due to fishing which is often expressed as an instantaneous rate. In some texts it is referred to as "Fishing pressure"
F_{lim}	Fishing mortality limit reference point; stocks fishing stocks at above this rate in the long-term will result in the spawning stock biomass being below the Biomass limit reference point (Blim).
F_{MSY}	Rate of Fishing mortality consistent with achieving Maximum Sustainable Yield (MSY).
F_{pa}	Precautionary fishing mortality level; stocks fished at this rate have a risk (around 5-10%) of being exploited at above the Fishing mortality limit reference level (Flim) and hence a long-term risk of being below the Biomass limit reference point (Blim)
Harvest Control Rule: HCR	A Harvest Control Rule is a set of well-defined management actions that are taken in response to changes in stock status.
International Council for Exploration of the Sea: ICES	International scientific body responsible for carrying out fish stock assessments in the ICES Area: the Northeast Atlantic and Baltic Seas. Also advises governments on other scientific issues concerning the marine environment www.ices.dk
Maximum Sustainable Yield: MSY	Catching the maximum quantity that can safely be removed from the stock while maintaining its capacity to produce sustainable yields in the long term under

Term	Definition
	prevailing ecological, environmental conditions and fishery technological characteristics.
MSY $B_{trigger}$	MSY Biomass trigger level; When the stock is above this level the stock it is considered capable of being sustainably harvested at F_{MSY} with a 95% probability that the stock will be within safe biological limits (above Blim) in any one year. It is used as a trigger reference level, when the stock is below this level the ICES approach is to reduce fishing mortality
National Oceanic and Atmospheric Administration (NOAA); (United States)	NOAA Fisheries provides science-based conservation and management for sustainable fisheries and aquaculture, marine mammals, endangered species and their habitats. Fisheries | National Oceanic and Atmospheric Administration (noaa.gov)
Recruitment	This is the term given to the process by which young fish enter the stock.
Safe Biological Limits: SBL	When a stock is inside safe biological limits there is considered to be sufficient reproductive capacity to support a fishery.
Target reference point	Target reference points are levels of fishing mortality and/or Biomass of a stock which managers aim for in the long term
Total Allowable Catch: TAC	The Total Allowable Catch (TAC) is a catch limit (expressed in tonnes or numbers) set for a fishery generally for a year or a fishing season.
Trigger reference levels	Trigger reference levels are levels of fishing mortality and/or Biomass of a stock which should trigger management action to bring the stock back towards the target

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Appendix; Relative Benthic Status

The Relative Benthic Status (RBS) model is a calculation of the relative rates of depletion and recovery of benthic habitats after trawling. The RBS value describes the status of the seabed ranging from 0 to 1, it is expressed as B/K (biomass (B) divided by carrying capacity (K)) to determine the state of the biomass in relation to the habitat carrying capacity (Eqn.1). For example, an RBS value of 1 indicates no depletion, depletion and an RBS of 0.7 represents 70% of possible biomass remaining post-trawling (i.e. possible 30% depletion of total biomass). However, this does not necessarily mean that the areas trawled are devoid of life, the biota may adapt to the level of trawling occurring.

$$\mathbf{RBS = B/K = 1 - Fd/r}$$

Equation 1. Relative Benthic Status model.

Within the RBS model (Eqn.1), biomass divided by carrying capacity (B/K) is equivalent to a habitat's carrying capacity (1) minus the fishing effort (*F*) multiplied by depletion rate (*d*) over the recovery rate (*r*) of the habitat.

The impact of fishing is assessed by spatial analysis of fishing effort and the estimation of depletion rates, i.e. the fraction of mortality per trawl pass. The rates of recovery are assessed by reference to information available on benthic fauna available from surveys. Essentially, the RBS model incorporates the relationship between fishing effort, associated depletion rates and habitats' ability to recover to assess the sensitivity of habitats to fishing.