North Pacific Fisheries Commission

NPFC-2023-SSC BFME04-WP06

A review of the basis by which RFMOs have determined VME encounter thresholds by taxa and gear-types

Dr Keith Reid, Ross Analytics Pty Ltd, 1 Lynden Road, Bonnet Hill, Tasmania 7053. Australia

Report prepared in accordance with a consultancy agreement dated 30 May 2023 between the North Pacific Fisheries Commission and Dr Keith Reid of Ross Analytics.

Summary

The detection of a VME during fishing operations is typically based on the presence of an unusually high catch of VME indicator taxa in the catch that exceeds an agreed threshold level.

Different objectives, such as determining if a VME is present or determining whether a significant adverse impact has occurred, are likely to require quite different encounter thresholds.

Relative differences in thresholds are likely for evidence of the existence of a VME (low), evidence of a significant adverse impact at a local scale (medium) and evidence of a significant adverse impact at the scale of the total area of VME habitat (high).

Encounter thresholds are part of an overall management approach to VMEs, including closed areas and gear restrictions, this means that it is essential that the context and objectives of individual thresholds are clearly articulated.

An important challenge in setting thresholds is the management decision on the level of precaution that should be applied to protecting VMEs from significant adverse impacts compared to the need to obtain sufficient information to conclude that such an impact has occurred.

Thresholds for bottom trawl, agreed in NAFO, and for demersal longline, agreed by CCAMLR, have been widely incorporated by other RFMO/As.

When considering threshold values adopted by other RFMOS it may be more appropriate to leverage the science on determining the distribution and abundance of VMEs rather than inherit the negotiated outcomes that are reflected in the prevailing regulations.

NOTE: Links to relevant reports and measures of RFMOs have been included in the text where possible and were verified at the time of writing.

Introduction

UNGA Resolution 61/105 was adopted in 2006 and calls upon Regional Fisheries Management Organizations or Arrangements (RFMO/As) to close areas to bottom fisheries until appropriate measures have been put in place to prevent significant adverse impacts (SAI) on vulnerable marine ecosystems (VMEs). It also requires RFMO/As to require vessels to cease bottom fishing activities in areas where vulnerable marine ecosystems are encountered in the course of fishing operations and to report the encounter so that appropriate measures can be adopted in respect of the relevant site.

The FAO Deep-Sea Fisheries Guidelines (FAO 2010, hereafter referred to as the DSF Guidelines) defines significant adverse impacts are those impacts that compromise ecosystem integrity (i.e. ecosystem structure or function) and suggest that such impacts should be evaluated individually, in combination and cumulatively, FAO (2010) also list six factors that should be considered when determining the scale and significance of an impact:

i. the intensity or severity of the impact at the specific site being affected,
ii. the spatial extent of the impact relative to the availability of the habitat type affected,
iii. the sensitivity/vulnerability of the ecosystem to the impact,
iv. the ability of an ecosystem to recover from harm, and the rate of such recovery,
v. the extent to which ecosystem functions may be altered by the impact, and
vi. the timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life-history stages.

The DSF Guidelines do not specify whether all or some of these factors should be considered and there are a range of management approaches taken to address the interactions of bottom fisheries on VMEs and the measures in place in RFMO/As to avoid significant adverse impacts (SAI). The DSF Guidelines also recommends that States and RFMO/As have an appropriate protocol for how fishing should respond to encounters with a VME in the course of fishing operations with a VME and that these protocols should include a definition of what constitutes evidence of an encounter. The DSF Guidelines do not provide any specific advice on developing a definition of an encounter but highlight that detailed seabed surveys and

mapping and other relevant information available for the site or area, should be taken into account when doing so.

Managing potential fisheries impacts on VMEs is further complicated by the difficulty to define the point at which adverse impacts become 'significant', either as one-off events or as cumulative effects and whether the significance of the impacts are considered at local or regional scales. The RFMOs that manage deep sea fisheries have introduced a range of measures to determine the presence of VMEs and to avoid SAI. There have been several reviews of those measures, for example by Kiyota (2018) and Cryer and Soffker (2019) that provide an overview of the suite of measures taken by RFMOs. Included in these measures are the quantity of VME indicator taxa in the catch that would trigger a management action (either a move on and/or a closure) based on the evidence of the existence of a VME or an identification of the risk of SAI to a VME. Typically RFMOs view thresholds and encounter protocols within the context of an overall approach to delineating the extent, and avoiding SAI on, VMEs. This means that the actual thresholds are influenced by the implementation of other measures, such as area closures, which will in turn influence the relative importance placed on the six factors highlighted by the DSF Guidelines. The general concept underlying the setting of threshold levels using catch data is outlined in Box 1.

Box 1. VME thresholds and cumulative catch curves

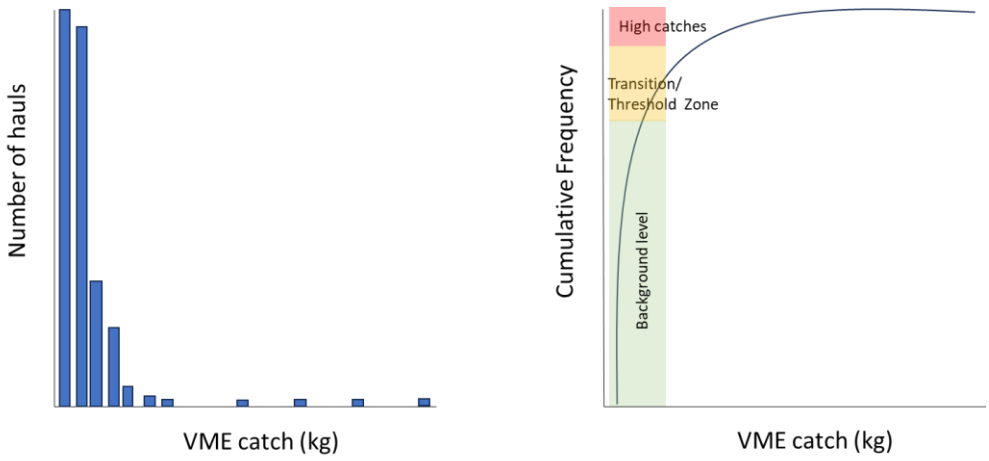

Figure 1. Example of a typical frequency distribution of the quantity of VME taxa (kg) in the catch (left panel) and the resulting cumulative frequency distribution (right panel).

Consistent with UNGA Resolution 61/105 the primary objective for RFMOs is the avoidance of SAI on a VME. As a first step in achieving this objective is determining where a VME might be present. The detection of a VME is typically based on the presence of an unusually high catch of VME indicator taxa and so deciding what constitutes an 'unusually high' level, and how that might be reflected in catches, is central to identifying thresholds. The typical distribution of VME catches is highly left-hand skewed, as there are mostly small catches and infrequent large catch. The resulting shape of the cumulative catch curve can be used to identify the transition from background levels of small catches to the less frequent large catches (See Figure 1). While this general process is applied in many scenarios the shape of the cumulative frequency curve above the 'background level' means that even small differences in the choice of a percentile threshold result in large differences in the consequential VME catch (kg) threshold.

Determining if a VME is present in an area, and determining if SAI has (or is likely to have) occurred, are quite different things. Although this distinction is not always apparent in the setting of thresholds, this difference in objectives can require quite different threshold levels. Cryer and Nicol (2017) observed that thresholds should be considered as a temporary measure when other information was 'almost non-existent' and that once information on the overall distribution of VMEs became available then the thresholds should become an insurance against an unexpected level of VME in a catch in the context of the overall

management approach. The premise being that fishing would not be allowed in areas where a high density of VME taxa would be expected to be encountered.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has agreed to a threshold with the aim of determining when a VME might have been encountered during fishing in order to implement a temporary closure until the existence of that VME can be confirmed. Whereas The Northwest Atlantic Fisheries Organisation (NAFO) and South Pacific Regional Fisheries Management Organisation (SPRFMO) view the threshold as a mechanism to indicate a level of catch of VMEs that is greater than expected based on an understanding of the spatial distribution of all VME in the management area; they view the threshold as a safety "backstop" to the overall spatial management approach rather than a primary tool to detect VMEs and avoid significantly adverse impacts. Implicit in these different approaches to setting thresholds is a consideration of whether the avoidance of SAI is viewed at the local scale, i.e. is an individual VME likely to be subject to SAI, or whether this impact is viewed at a regional scale across all of the VMEs, including in fished and unfished areas. In the latter approach the threshold might well be higher as there is an assessment that even with some level of local adverse impact this would not be significant at the regional scale. It follows that the thresholds that would trigger a management action would be lower for the detection of a potential VME, where the avoidance of any impact is the desired outcome, compared to a situation where a local impact is considered acceptable as it is assumed not to be significant at the larger scale. It is apparent that the application of the latter approach requires a much more complete understanding of the spatial distribution of VMEs in the management area. In both scenarios an important challenge in setting thresholds is the management decision on the level of precaution that should be applied in protecting VMEs from significant adverse impacts rather than obtaining the information that indicates that such an impact has arisen.

Gear specific thresholds

Longline

The development of thresholds for longline gear has largely been led by the measures agreed in the CCAMLR that have been adopted wholly or in part by RFMOs. For this reason it is

sensible to review the origin and chronology of the measures and thresholds adopted by CCAMLR as they relate to the timing of uptake by other organisations

In 2007, CCAMLR agreed to CM 22-06 that required Members notifying to fish in CCAMLR exploratory longline fisheries to complete a preliminary assessment of the known and anticipated impacts of proposed bottom fishing activities on VMEs (see https://cm.ccamlr.org/en/measure-22-06-2019). In 2008 those preliminary assessments included analyses of the frequency distribution of the CPUE of VME indicator taxa (number of bits of VME indicator taxa per number of hooks). These frequency distributions are highly skewed to the left by virtue of having a large number of longline hauls with only a small number of items and a few with much large amounts of VME indicator taxa. Based on these distributions a 'background level' of benthic items in catch data was determined, although there were no specific criteria agreed to determine a threshold level that would represent a transition from background levels of benthos to an indication of the presence of a VME.

In 2008, CCAMLR agreed to CM 22-07 (see https://cm.ccamlr.org/en/measure-22-07-2013) that provided practical guidance on recording and reporting requirements for the quantity of VME material brought aboard on longlines as well as providing clear terminology and definitions for VME indicators and when there was evidence of a VME present.

In the preliminary assessments of the known and anticipated impacts of proposed bottom fishing activities on VMEs, CCAMLR Members provided qualitative estimates of an appropriate threshold CPUE of VME indicator taxa that varied between 20- 25 items per 1000 hooks, with the suggestion that additional observer data be collected in cases of 5-24 items per 1000 hooks. Consideration of this issue by the CCAMLR Scientific Committee was based on the collection of benthic bycatch data from the longline fishery and the content of draft preliminary assessments of the known and anticipated impacts of proposed bottom fishing activities on VMEs by Members in the development of an implementable approach to measuring VME 'abundance' in defining a threshold. To do this CCAMLR agreed on the definition of a specific quantity of VME indicator taxa (VME-indicator-unit) and the scientifically and operationally appropriate threshold values (VME-evidence).

(i) VME-indicator-unit

> Either one litre of sessile taxa (paragraph 4.254(ii)) that can be placed in a bucket, or, for taxa covered under paragraph 4.254(iii) (branching species that may not easily fit into a volume measurement), one kilogram.
>
> (ii) VME-evidence
> In the interim of further advice on such evidence, a combined measure of at least 10 VME-indicator-units of sessile taxa (paragraph 4.254(ii)) recovered over a given section of line would be evidence of a possible encounter with a VME.
>
> Note: Paragraph 4.254(ii) referred to the sessile invertebrates as described on the New Zealand poster (WG-FSA-08/19) that was later replaced by the CCAMLR VME Taxa Classification Guide (https://www.ccamlr.org/en/document/publications/vme-taxa-classification-guide).

The advice from the CCAMLR Scientific Committee that the quantity of 10 VME-indicator-units to be used as VME-evidence was derived from the data and experience from fishing in the Ross Sea and the Indian Ocean. The discussions leading to these agreed definitions included benthic ecologists, scientific observers and fishing industry experts, although, as is often the case, the detail of those discussions is not included in the report of the meeting (KR pers. obs.).

When 10 or more VME indicator units (either one litre or one kilogram of VME indicator organisms, depending on the morphology of those organisms) are recovered in one line segment (defined as 1.2km of longline gear or 1000 hooks on longline gear, whichever is shorter), an area of 1 nautical mile radius from the mid-point of the segment is considered a 'VME risk area'. Vessels are then required to complete hauling any lines in that risk area and to immediately communicate the location at which the VME indicator units were recovered to the flag state and to the CCAMLR Secretariat who then communicate the notice of closure to all Members.

In addition to requiring reporting of observed VME encounters, CCAMLR has adopted a secondary trigger level of 'possible encounters' (currently >5 and<10 VME indicator units recovered within one line segment). In other words, there is some evidence of the VME

presence, but this is not sufficient to trigger the management action (i.e., VME area closure) outlined above.

To further support the measures outlined above CCAMLR also implemented an improved data collection process including mandatory reporting of all VME indictor units per segment of line as part of the catch reporting requirements for all vessels. Vessels engaged in CCAMLR longline fisheries are also required to carry at least one scientific observer (two in exploratory fisheries) who provide vessel-independent data on the occurrence and quantity of VME indicator taxa as well as feedback on practical implementation of related management measures.

The unit of measurement for VME indicator units, the threshold for evidence of an "encounter" with a VME during fishing and the resulting course of action to be taken by a vessel that were developed for longline fishing by CCAMLR have been adopted for demersal longline fishing in the South East Atlantic Fisheries Organisation (SEAFO), Southern Indian Ocean Fisheries Agreement (SIOFA), and SPRFMO. The North-East Atlantic Fisheries Commission (NEAFC) has adopted a somewhat similar approach but has simplified the 'VME indicator unit' to simply be the presence of any VME taxa on 10 hooks per 1000 hooks or per 1200 m line, whichever is shorter.

Trawl

The development of thresholds for bottom trawl gear has largely been led by the measures agreed in Northwest Atlantic Fisheries Organisation (NAFO) that have been adopted wholly or in part by other RFMOs (noting that CCAMLR has a prohibition on bottom trawling so does not require thresholds). For this reason it is sensible to review the origin and chronology of the measures and thresholds adopted by NAFO as they relate to the timing of uptake by other organisations.

In 2008, Annex 5 of the report of NAFO's ad hoc Working Group of Fishery Managers and Scientists (WGFMS see https://www.nafo.int/Library/Commission/Meeting-Proceedings-of-GC-FC/meeting-proceedings-sep-2008aug-2009) included a Norwegian Proposal for "Operational Procedures in Existing and New Fishing Areas" in which an encounter

threshold of more than [50] kg of coral [and/or 200kg of sponge] per set was proposed (the proposal included the square brackets around the threshold values). The proposal was agreed by WGFMS and when their recommendation was considered by in September 2008 by the Fisheries Commission of NAFO the Commission agreed to "remove the square brackets" in the original proposal and adopted the following:

> "For both existing and new fishing areas, an encounter with primary VME indicator species is defined as a catch per set (e.g. trawl tow, longline set, or gillnet set) of more than 100 kg of live coral and/or 1000kg of live sponge. These thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure."

The discussion that led to the proposed thresholds of 50 kg of coral and/or 200kg of sponge being revised and adopted as 100 kg of live coral and/or 1000kg of live sponge is not reflected in the Report of the Fisheries Commission, 30th Annual Meeting (see https://www.nafo.int/Library/Fisheries/2008-fisheries-commission-documents); it is assumed that his reflects the customary process of negotiated outcomes in multi-lateral organisations.

In 2009 the cumulative catch curve method and a GIS-based method were applied to research survey data to derive a weight threshold criterion of 75 kg to identify areas of significant sponge concentrations (Kenchington et al. 2009). At this time data on the catches of coral and sponge in commercial fisheries were not available to the NAFO Scientific Council and its Working Groups and there was no agreement to use the threshold from research trawls as an encounter threshold for commercial fisheries. The NAFO Scientific Council agreed to scale-up the research catches of corals and sponges in the Kenchington et al. (2009) analysis (4 kg/tow and 75 kg/tow respectively) based on the larger size and longer duration of commercial hauls, and derived estimates of an equivalent catch of 60 kg/tow coral and 1200 kg/tow of sponges. It then agreed that threshold level of 60 kg/tow and a level of 800 kg/tow, for corals and sponges respectively, provided a more "conservative and precautionary" level.

It is apparent that the advances in understanding of the distribution and catchability of VME indicator taxa since 2009 would provide the basis for a more informed translation of contemporary research thresholds to commercial catches. The original scaling adopted by

NAFO reflects the lack of satisfactory information at the time and implicitly assumes that the catches of patchily distributed sponges would be continuous throughout a circa 4-hour commercial trawl. Kenchington et al (2009) found that when the locations of high concentration of coral were mapped, they most commonly were grouped together forming "key locations" with a discontinuity between large catches and smaller catches caught outside the main concentration. Furthermore, the shape of the typical cumulative catch curves for VMEs would caution against a linear scaling of catch by haul duration. In the light of this underlying distribution a more appropriate scaling could simply be to compare the catches from a research trawl (19m wide) and a commercial trawl (40m wide) that passed through the same area of high sponge concentration (i.e. scaling on net size alone); this would yield a commercial catch equivalent of 158 kg for a 75 kg catch in the research trawl. Although even this comparative scaling based on net size alone does not take into account the low catchability of commercial trawls compared to research trawls as described in Kenchington et al. (2011).

Following the original NAFO agreement in 2009 the thresholds have been reviewed and revised, most substantively in 2012 (see Table 1), after the NAFO Fisheries Commission requested the Scientific Council to make recommendations for encounter thresholds and move on rules for groups of VME indicators including sea pens, small gorgonian corals, large gorgonian corals, sponge grounds and any other VME indicator species that meet the DSF Guidelines for VME and SAI. This request was addressed using a spatial kernel density model to map the data on catches of sponges from the Spanish/EU research vessel surveys to simulate commercial catches with a 13.8 nm bottom trawl. This analysis showed that a polygon based on a threshold of 300 kg would encompass most of the high concentration sponge grounds. NAFO subsequently adopted new thresholds of 7kg of sea pens, 60 kg of other live coral and 300 kg of sponges per tow or set. (NAFO FC, 2012). The current measure used in NAFO (CEM 2015-2023 Article 22 see https://www.nafo.int/Fisheries/Conservation), retains the same thresholds such that an encounter with a VME indicator species is defined as catch per set and there are no gear-specific thresholds.

Table 1. Timeline of VME catch thresholds adopted in NAFO.

Year(s) when threshold applied	Threshold levels (Catch per set).
2009	100 kg coral 1000 kg sponges
2010-2011	60 kg coral 800 kg sponges
2012	60 kg coral 400 kg sponges (new fishing area) 600 kg sponges (existing fishing area)
2013-2015	7 kg of sea pens 60 kg of other live coral 300 kg of sponges

NEAFC

In 2009 NEAFC discussed the harmonisation between NAFO and NEAFC with respect to VME thresholds and adopted the Rec. 11/2009 that included the thresholds of 100 kg of live coral and 1000 kg of live sponges (see https://www.neafc.org/neafcmeeting/722 and Table 2). The commentary from NEAFC Parties at that time included the suggestion that following NAFO would be "in line with the ICES comment to use more precautionary threshold levels" and also that while "NEAFC levels were not based on science, the NAFO levels had some scientific basis". The subsequent revisions of the threshold levels broadly followed the changes agreed in NAFO.

Table 2. Timeline of VME catch thresholds adopted in NEAFC.

Year(s) when threshold applied	Threshold levels (Catch per set).
2009	Corals: 100 kg live; Sponges: [1000 kg live]
2010-2012	Corals: 60 kg live; Sponges: 800 kg live
2013	Corals: 30 kg live; Sponges: 400 kg live
2014-present	Corals: 30 kg live; Sponges: 400 kg live

SEAFO

In 2008 SEAFO adopted Conservation Measure 12/08 On Bottom Fishing Activities in the SEAFO Convention Area (see http://www.seafo.org/Management/Conservation-Measures) that included threshold of 100 kg coral and 1000 kg sponges. In 2009 the SEAFO Commission considered development within NAFO regarding the reduction of encounter threshold levels for VMEs and adopted the revised threshold levels of 800 kg sponges and 60 kg corals in the SEAFO Convention Area. These thresholds were further refined in 2014 when SEAFO agreed to create different thresholds for established/existing and exploratory fisheries with thresholds of 600 kg of live sponges and/or 60 kg of live coral in existing fishing areas and 400 kg of live sponges and/or 60 kg of live coral in new fishing areas.

SIOFA

Prior to 2019 SIOFA required the implementation of thresholds determined by individual Parties, which were broadly consistent with those in place in other RFMOs. In 2019 these were incorporated into SIOFA's CMM 01 as 60 kg live coral and 300 kg live sponges consistent with the prevailing NAFO measure (see https://siofa.org/management/CMM/01/(2023))

SPRFMO

The approach used in SPRFMO to prevent SAIs on VMEs uses a spatial management approach, informed by the habitat suitability models, to define management area boundaries in which areas of high predicted VME abundance are closed to fishing. This is complemented by an encounter protocol that determines the threshold for a management action where a VME is encountered in area that is open to fishing. In the approach taken in SPRMFO the underlying assumption is that small amounts of VME taxa could be caught by many trawls but, as areas of high VME density have been closed to fishing, there is an assumed low likelihood of a VME encounter in the areas open to fishing. This approach places a very large emphasis on the outcomes of the habitat suitability models used to map predicted distributions of VMEs over a very large area with relatively limited data, especially as the modelling uses data from a subset of vessels in SPRFMO trawl fisheries.

There has been extensive discussion in SPRFMO around whether the thresholds should be set lower to indicate a possible encounter with a VMEs (that might trigger some precautionary management action) or whether the threshold should be set high so that it is triggered by only rare and large catches of VME indicator taxa that suggest the models used to predict the distribution of VME taxa are incorrect. Within those discussions is a recognition of the need for a management regime that is robust to model uncertainties and the need to reflect these uncertainties when using the model outcomes that suggest that the VME thresholds should be high. SPRFMO has very clearly articulated the distinction between the scientific processes used to derive candidate VME thresholds, and the policy and management choices of selecting from those candidate VME thresholds. The different candidate thresholds proposed in SPRFMO are based on the percentiles in the cumulative distribution of the weight of catch of VME taxa and therefore the choice of percentile reflects the Commission's approach to risk and the level of precaution to avoid SAIs.

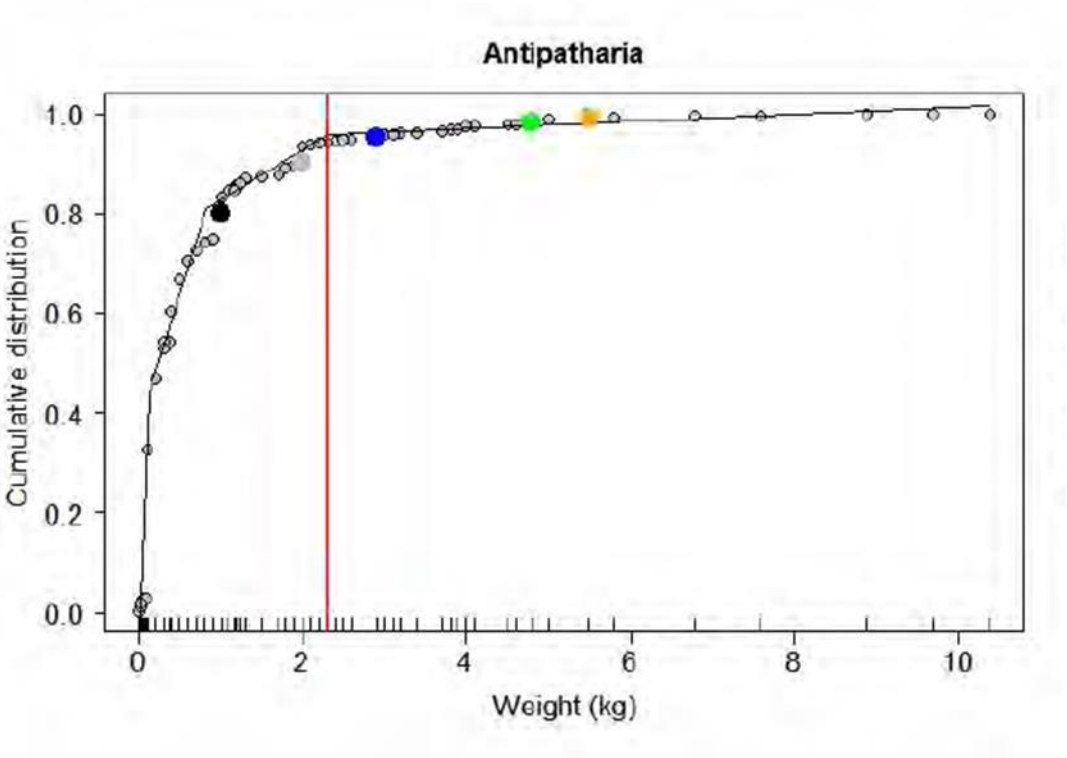

Figure 2. Example of the cumulative distribution of bottom trawl catch weights (kg) from Cryer et al. (2018) for Antipatharia showing the point where the line flattens towards an asymptote (red vertical line), and coloured points that indicate the 80th (black point), 90th (grey point), 95th (blue point), 98th (green point) and 99th percentiles (orange point).

In 2018 Cryer et al. (2018) described the process to develop VME move-on rules that used the 99th percentiles of the cumulative catch weight distribution to derive single-taxon threshold weights (kg) and the 80th percentiles of the cumulative catch weight distribution to derive individual taxa thresholds for inclusion in a multi-species, biodiversity threshold (see example for Antipatharia in Figure 2). The use of a biodiversity thresholds recognises that the presence of several VME indicator taxa in a single tow, each of which are below their individual weight thresholds, may indicate the presence of diverse benthic biodiversity and potential evidence of a VME. A move-on action is triggered when the biodiversity threshold for three of more different VME indicator taxa is recorded on a single tow. The choice of threshold weights at the 99th and 80th percentiles was informed by the advice of the SPRFMO Scientific Committee that the threshold for triggering the move-on rule should be high and triggered only by large catches (i.e. using the 99th percentile) of VME taxa that suggest the models used to predict the distribution of VME taxa are incorrect (because areas with such high VME densities would not be expected in areas open to fishing).

Table 3. VME indicator taxa weight thresholds for the biodiversity component and single-taxon threshold used in SPRFMO (see https://www.sprfmo.int/fisheries/conservation-and-management-measures/bottom-fishing/ for current and superseded version of CMM 03.

VME indicator taxa	Threshold for biodiversity component (kg)	2018 Single-taxon threshold weight (kg)	2023 Single-taxon threshold weight (kg) CMM 03 2023
Porifera (Phylum) *Sponges*	5	50	25
Gorgonacea (Order) *Sea fans*	1	15	15*
Scleractinia (Order) *Stony corals*	5	250	60
Antipatharia (Order) *Black corals*	1	5	5
Actiniaria (Order) *Anemones*	5	30	35
Alcyonacea (Order) *Soft corals*	1	60	*
Stylasteridae	1	–	

(Family) Hydrocorals			
Pennatulacea (Order) Sea pens	1	–	
Crinoidea (Class) Sea lilies	1	–	
Brisingida (Order) 'Armless' stars	1	–	

* The single taxon thresholds in CMM 03 Annex 6 originally included thresholds for Alcyonacea (Order) Soft corals and Gorgonacea (Order) Sea fans, however, following a recommendation by the Scientific Committee in 2020 that Gorgonian Alcyonacea were differentiated from other Alcyonacea because of their structure-forming characteristics the Commission revised the taxa list to include the Gorgonian Alcyonacea and remove the other taxa in the Alcyonacea.

In 2019 the SPRFMO SC (SC7 https://www.sprfmo.int/meetings/scientific-committee/7th-sc-2019/) noted that uncertainties in the predictions of the habitat suitability models for VMEs may mean that the previously adopted approach may offer less protection than previously thought and agreed that lower encounter thresholds for VME indicator taxa would help to mitigate risks of significant adverse impacts on VMEs. In response, the EU proposed that the single-taxon weight thresholds for triggering the VME encounter protocol should be based on the 95th percentile rather than the 99th percentile. Subsequent discussion of this proposal resulted in SPRFMO agreeing to the current single-taxon weight thresholds that represent a reduction (compared to the 2018 values) from 50 kg to 25 kg for Porifera and from 250 kg to 60 kg or Scleractinia (Table 3). These changes are approximately equivalent to a change from using the 99th to the 98th percentile of the cumulative catch curves for taxa included in Cryer et al. (2018).

Most RFMOs have, to some extent, agreed a list of VME indicator taxa, however, many of the thresholds adopted refer simply to corals and sponges. This grouping probably reflected expectations of the identification of VME taxa on commercial vessels. However, the focus on research and management of VMEs over past decade has brought an increased knowledge and availability of identification materials that allow for much better identification of taxa. An example of this is the development of the biodiversity threshold in SPRFMO that reflects the expectation of greater taxonomic definition in the identification of VME indicator taxa.

General Fisheries Commission for the Mediterranean (GFCM)

The GFCM does not have any threshold levels for encounters with VMEs (Res. 2019-06, see https://www.fao.org/gfcm/decisions/es/) although they have defined an encounter as "any catch of VME indicator taxa by any deep-sea fisheries" and have encouraged parties to undertake research projects on the presence, distribution, catch and bycatch of VME indicator taxa.

Other gear types

Pots

The small size and static nature of pot/ trap fishing gear means that they are generally assumed to cause less physical damage to the benthic environment compared to mobile gear, e.g., trawl gear. However, as with longline (hook and line) there can be little doubt that fragile benthic organisms present would be damaged when they come into contact with any fishing gear.

Comparing the potential impacts of different gear types is confounded by differences in gear selectivity or gear efficiency (often referred to as catchability (q), which is the fraction of the species present that is actually landed on deck. While it is assumed that for a given amount of VME on the seafloor the catchability with bottom trawls will be greater than with longlines which itself will be greater than pots, there remains no way to quantify the impact of VMEs of a catch of 100kg in a trawl net or 10kg from a longline. The catchability of VME organisms is known to be low, of the order of 1-2% for trawl gear (Kenchington et al. 2011) and is also likely to be highly variable between species. In the case of trap/pot gear used the catchability is likely to be so small as to be negligible This is reflected in the conclusions of DFO (2010) that this gear type does not retain sessile organisms. However, while the assumed low impact of static gear may be lower than trawl gear Gauthier (2017 and 2018) reported that between 59 and 80 % of pots were observed dragging, rolling, or bouncing on the seafloor. This movement indicates the potential for an approximate footprint per trap/pot set of 2000 m^2.

In the experimental lobster trap fishery in SPRFMO conducted by the Cook Islands there is a requirement to "collect all data necessary to assess encounters with VMEs" with the aim of assessing the distribution of vulnerable marine ecosystems in the areas fished (see https://www.sprfmo.int/fisheries/conservation-and-management-measures/cmm-14-potting-exploratory-fishery/). This requires the reporting of the occurrence of all VME indicator taxa, noting that the objective is to assess the distribution of VME taxa. While there are no thresholds in place in the experimental fishery, if evidence for the existence of a VME is found the vessel implements a voluntary move-on action in respect of fishing gear but may deploy deep-sea camera gear to further investigate the potential presence of a VME in the fished area.

Summary of Different approaches

A threshold to trigger a management action, such as a move on or an area closure, based on evidence of the existence of a VME or evidence of a significant adverse impact on that VME, are quite different things. Furthermore, according to para 18 of the DSF Guidelines determining the scale and significance of an impact should include consideration of:

i. the intensity or severity of the impact at the specific site being affected;
ii. the spatial extent of the impact relative to the availability of the habitat type affected;

Implicitly an emphasis on the (i) will take a smaller scale view of the actual impact on a site whereas the (ii) considers that impact in a regional context of the total impact on a VME taxa or the habitat type. This difference is likely to create a lower threshold for action if there is a local impact, whereas the same local impact, when viewed in the context of the total extent of that habitat type, may not be considered significant. This means that the threshold required to indicate the evidence of the existence of a VME may very well be lower than a threshold to indicate evidence of a significant adverse impact at a local scale while evidence of a significant adverse impact at the scale of the total area of VME habitat may be much greater again. Given these distinct differences in the objectives for setting thresholds it is essential that the context and objective of individual thresholds is clearly described.

CCAMLR uses the threshold to determine when a VME might have been encountered in order to implement a temporary closure until the existence of a VME can be established. This is the basis of the longline threshold adopted by some RFMOs for their longline fisheries. A number of the RFMOs have adopted the NAFO thresholds for trawl fisheries with the differences in the adopted thresholds between RFMOs reflecting when they were adopted relative to the situation in NAFO, rather than a regional specific assessment.
Despite the similarity in the conceptual approaches taken by NAFO and SPRFMO there are considerable differences in the analytical methods used that reflect the differences in the availability of data on the distribution of VMEs. In NAFO there are annual research surveys that provide data on VMEs whereas in SPRFMO there is paucity of empirical data and a reliance on habitat proxies for VME distribution. In both NAFO and SPRFMO the initial science advice was for lower thresholds but the negotiated outcomes produced higher thresholds. In both RFMOs there has been an iterative lowering of the thresholds as a result of either additional data (NAFO) or recognition of the influence of model uncertainty and policy decision on the level of precaution (SPRFMO).

Cryer et al. (2018) described the general outcomes of discussions at the NPFC VME workshop (https://www.npfc.int/meetings/npfcfao-workshop-protection-vulnerable-marine-ecosystems-north-pacific-fisheries) on the approach to setting thresholds as taking one of four approaches:

1. Completely arbitrary based on what "feels about right"

2. Arbitrary but based on actual historical catch records:
    a. catch records could come from the fisheries for which a threshold is required, or from similar fisheries, and
    b. thresholds could be based on medians, percentiles, or other metrics.

3. Combination of observed densities of VME indicator taxa, trawl tow distances, and estimated or imputed trawl catchabilities to estimate likely (or some precautionary percentile of) catch of given taxa within a VME

4. Comparison of observed catches with model predictions of (in order of preference) biomass, density, or habitat suitability for VME indicator taxa

One option that was not included by Cryer et al. (2018) is the option to adopt the threshold that has already been adopted by another RFMO/A. This is an example of regulatory diffusion, where the adoption of regulation by one agency increases the likelihood of the adoption of that regulation by another agency (Nou and Nyarko 2022). It is apparent that there has been a diffusion of the trawl thresholds adopted by NAFO and the longline thresholds adopted by CCAMLR across other organisation because of the need to implement precautionary measures in the absence of data. In the case of the RFMOs that have adopted the NAFO trawl thresholds, the differences in thresholds in place between those organisations tend to reflect when they were adopted relative to the situation in NAFO at that time, rather than any individual regional assessment.

Recognising the origins of adopted thresholds is important in the review process especially noting that in both NAFO and SPRFMO the initial science advice was for lower thresholds but the negotiated outcomes produced considerably higher thresholds. In both RFMOs there has been an iterative lowering of the thresholds as a result of either additional data (NAFO) or recognition of the influence of model uncertainty (SPRFMO) as well as policy decision on the level of precaution.

Regulatory diffusion is recognised as an important consideration in the development of policy across many disciplines as it can deliver efficiencies in relation to drafting, negotiation and implementation of a new legal text (see Nou and Nyarko 2022). However, such an approach can lead to an impression of a more robust approach, where there was a convergence on values through independent processes within an organisation, rather than a more linear approach where outcomes are directly inherited. In the case of thresholds for VME encounters it may be more appropriate to leverage the science approaches and outcomes on the distribution and abundance of VMEs rather than the negotiated outcomes that are reflected in the prevailing regulations. The simple adoption of the NAFO thresholds for trawl fisheries in other RFMOs may create a false sense of the applicability and robustness of the science foundation for those threshold values.

References

Cryer, M.; Nicol, S. (2017). The utility of move on rules in Conservation and Management Measures to prevent Significant Adverse Impacts of bottom fisheries on VMEs in the SPRFMO Area. SC5-DW08. SPRFMO, Wellington, NZ.

Cryer, M., Geange, S., Nicol, S. (2018) Methods for deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries. SC6-DW09. SPRFMO, Wellington, NZ.

Cryer, M and Soeffker, M. (2019) Approaches used by other RFMOs and CCAMLR to avoid significant adverse impacts on Vulnerable Marine Ecosystems. SPRFMO SC7-DW18. SPRFMO, Wellington, NZ.

Gauthier (2017) Canadian Data Report of Fisheries and Aquatic Sciences 1279

Gauthier, M. 2018. Trap camera videos from SGaan Kinghlas – Bowie Seamount: Overview of data obtained during sablefish bottom longline trap fishing in 2017. Can. Dat. Rep. Fish. Aquat. Sci. 1289

Kenchington, E., Cogswell, A., Lirette, C. and Murillo-Perez, F.J. (2009). The Use of Density Analyses to Delineate Sponge Grounds and Other Benthic VMEs from Trawl Survey Data. NAFO SCR Doc. 09/6

Kenchington, E., Murillo, F.J., Cogswell, A., Lirette, C. (2011). Development of encounter protocols and assessment of Significant Adverse Impact by bottom trawling for sponge grounds and sea pen fields in the NAFO Regulatory Area. SC Working Group on the Ecosystem approach to fisheries management – December 2011. Serial No. N6005, NAFO SCR Doc. 11/75.

Masashi Kiyota, M. (2018) Updated summary comparison of VME encounter protocols in bottom fish RFMO/As. NPFC-2018-WS VME01-WP02. NPFC, Tokyo

Nou, J. and Nyarko, J. (2022). Regulatory Diffusion. Stanford Law Review, 74(5),897-968.