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Setting Thresholds of Sessile Benthos Bycatch from Bentho-Pelagic Trawling

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Delegation of SIODFA

Abstract

Southern Indian Ocean Deepsea Fishers Association
南インド洋深海漁業組合
SIODFA Technical Paper 22/01

Setting Thresholds of Sessile Benthos Bycatch from Bentho-Pelagic Trawling

SIODFA

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1. INTRODUCTION

This document is an industry perspective as to the amount of bycatch of sessile benthos from bentho-pelagic trawling that 'constitute evidence of an encounter with a vulnerable marine ecosystem' (VME) (FAO 2009b) and thus provides the basis for setting the threshold value at which the respective fishing vessel must 'move on' to another location to continue fishing. The threshold value of bycatch and the distance of displacement required by a 'move-on' rule are directly linked by the, usually unknown, spatial ecology of the benthos in the area of fishing operation. Thus, an effective decision on a threshold should be informed by the appropriateness of the value of the 'move-on' distance applied – something that is, as yet, impossible, at least in the Southern Indian Ocean.

The note focuses on a review of Cryer, Geange & Nicol (2018) because it was cited by PAEWG (2021), para 21:

> "suggested that the PAEWG consider the South Pacific Regional Fisheries Management Organisation (SPRFMO) working paper SC5-DW09[1], which describes methods for deriving thresholds for VME encounter protocols …. Based on the options presented in that paper, Australia recommended setting VME indicator taxa weight thresholds using medians, percentiles, or other metrics based on historical SIOFA catch data."

But also notes the perceptive comments and recommendations of Cryer & Nicol (2017).

A large literature exists on the topic of VME bycatch thresholds and vessel 'move-ons'. Industry well know that contact between fishing gear and the seafloor may damage or destroy benthos if it is present depending on their structure. Little of the literature addresses, or reports on the relative spatial impact on the ecosystem of concern, perhaps because the ecosystem of concern is never explicitly defined, not least because of the difficulties of doing so. FAO (2008, p3) address this critical issue noting that it is the survival of the ecosystem that is rendered vulnerable, not survival of an individual or taxa in a particular location that is the concern. We assume that the ecosystem is bounded by the areal extent of the respective population, community or habitat of concern and not by the area of gear interaction.

Cryer *et al.'s* 2018 paper, "Methods for deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries" addresses several aspects of this issue including:

i. The international origins of for measures to protect high seas VMEs
ii. A proposal for a VME encounter protocol and

[1] SPRFMO SC6-DW09 is the paper of Cryer, Geanager & Nicol 2018.

iii. Evidence to inform a VME encounter protocol
iv. Reference points for selecting threshold and biodiversity weigh
v. Weight thresholds for VME indicator taxa and a biodiversity component of a 'move-on' rule.

2. FACTORS DETERMINING THE BYCATCH OF SESSILE BENTHOS FROM BENTHO-PELAGIC TRAWLING

If 'VME' populations exist on the seafloor in areas where bentho-pelagic trawling occurs, their presence in the recorded benthic bycatch depends on many factors. For a given overall areal density of benthic species, an important factor determining if a threshold amount of benthic bycatch occurs is the nature of the spatial distribution of the benthos. Characterizing the spatial ecology of benthos is difficult as it is a two-dimensional process (one might argue, three dimensional). The best sampling at present possible, using an appropriately equipped research vessel (swath mapping not withstanding) is by video linear transect sampling, a one-dimensional sample across a two-dimensional space. Inferences about the two-dimensional distribution might be drawn but any number solutions for parameter values are possible to whatever is observed. Clusters of benthos would be expected that in turn could comprise an unknown spatial structure at a larger scale.

In reality, tows are point or very short transect observations repeated non-randomly, determined by the distribution and behaviour of the fish being pursued. The critical consequence is that, independent of the overall average density of benthos for the area, samples with no bycatch could occur next to tows with high bycatches as a consequence of the spatial ecology of the benthos with little if any relation to the presence (or absence) of a vulnerable marine ecosystem based on observations of the bycatch from a tow.

This aspect of spatial ecology was addressed in the 2008 FAO publication in the Section on Deep-sea habitats (p6). FAO explicitly note (2009a, p52 and 2009b, p4, para 18):

> *18. When determining the scale and significance of an impact, the following six factors should be considered:*
> *…*
> *ii. the spatial extent of the impact relative to the availability of the habitat type affected.*

This is explicitly discussed in MMR (2017).

To be measured, benthos in the path of a trawl must be retained in the net. Their entry into the net will depend in part on the nature of the seafloor. When demersal trawls fish smooth seafloors, to be retained in the net the benthos height must be above the footrope which threads the ground bobbins. When tickler chains are used (as in fishing orange roughy), presumably the tickler chains will hit benthos, ejecting some up and into the net. In either case it is reasonable to expect some benthos will pass under the foot rope and bobbins and not be retained.

On rough bottoms, the gear will follow a saltatory trajectory. Where the footrope contacts the seafloor, benthos, if present, may be retained: when the foot rope is off-bottom between 'jumps', the net will pass over the benthos without foot-rope contactcontact. In this case, repeating a tow along exactly the same path may result in a very different bycatch. Benthos passing into the trawl may, either whole or

following disintegration, pass through the 110 mm mesh net. The retention of such benthos will be, in part, dependent on chance, i.e., an unknown stochastic process.

A further determinant of the bycatch by a tow will be the distance over which the net contacts the sea floor. Tows that cover a short distance would be expected to have less bycatch than tows covering a greater distance, though no relation ($R^2 = 0.014$) was found by Parker, Penny & Clark (2009). This may be because there is no relation between the tow duration that is recorded and the distance over which the trawl is in contact with the sea floor. The distance a tow is in contact with the bottom may depend on how successful the bridge officer is in corralling the aggregation of fish that is being pursued. The start time of gear contact with the sea floor has only a general relation with the time that is recorded as the time of the tow start. This is usually the time when the trawl has reached a pre-determined depth as it is being set. These potential variables depend on the bridge officers' practice, the nature of the seafloor topography, oceanographic variables and the characteristics of the individual tows as they develop. Successful bridge officers may have different average/median times of net bottom time contact than those who are less skilled. It is conceivable that if there was a problematic threshold value, the bridge officer could simply adjust the length of the tow to reduce possible bycatch and compensate by making more tows. Consequence? No gain and only cost.

Thus, the benthic bycatch that is recorded will depend on several unknown stochastic processes:

i. The spatial ecology of the respective benthic species whose nature and parameters should vary depending on the characteristics of the feature being fished
ii. The probability of the various benthic species being retained in the cod-end of the trawl as it is towed along the sea floor, itself a function of the nature of the bottom (i.e., the sea floor feature), tide, the particular rigging of the gear and bridge officers' fishing tactics.
iii. The distance the tow is on the bottom, related to, but less than, the period of time recorded for the duration of the tow.

These stochastic processes will form a composite density function describing the distribution of bycatch by species for a given density of benthos. An area of any average density of benthos, as a consequence of the spatial scale of sampling, the arbitrary scale being used to determine the distribution of the species of interest and standard sampling theory, could produce high, low or zero bycatches and all for the same ecosystem under consideration.

An introduction to these issues is given by FAO (2008, p6) that would benefit from development.

3. THE INTERNATIONAL ORIGINS OF MEASURES TO PROTECT HIGH SEAS VMES

Cryer *et al.* (2018) refer to resolutions of the UNGA, starting with UNGA 61/105 "calling"upon regional fisheries management organizations (RFMOs) to adopt conservation measures to protect vulnerable marine ecosystems (VMEs) from significant adverse impacts of bottom fishing activities, or to cease bottom fishing activities in areas where VMEs are likely to occur unless conservation and management measures have been established to prevent significant adverse impacts on VMEs". The Resolution did not define a VME but included seamounts, hydrothermal vents and cold-water corals. Nor, did it elaborate on the term 'likely' in relation to the occurrence of VMEs.

It is unfair to criticize UNGA Res 61/105, now 16 years past, for its lack of scientific rigor. The resolution has 26 preambular paragraphs covering most fisheries management concerns. One hundred and eight

paragraphs follow addressing twelve areas of fisheries governance. Of these, Section X, "Responsible fisheries in the marine ecosystem", deals with environmental issues in 19 articles, six of which refer to VMEs and in detail in two sections from one paragraph. These texts, debated on the Assembly floor, and as with all negotiated compromises, reflect wording pursued by different members according to their interests and acceptable compromises.

Two important sub-sections are:

> 83 (*c*) In respect of areas where vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold-water corals, are known to occur or are likely to occur based on the best available scientific information, to close such areas to bottom fishing and ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems;
>
> 83 (*d*) To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom fishing activities in areas where, in the course of fishing operations, vulnerable marine ecosystems[2] are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site.

UNGA 61/105 does not provide a useable definition of a *vulnerable marine ecosystem.* Cryer *et al*.(2018) conclude "This leaves RFMOs to develop their own interim definitions of VMEs and their own criteria for detecting encounters with VMEs". Cryer *et al.* note "actions were needed to strengthen the implementation of UNGA Resolution 61/105 and called upon RFMOs to establish and implement **science-based** [our emphasis] protocols, including "*threshold levels and indicator species*", **that would define** evidence of an encounter with a VME.

FAO (2009a), i.e., the Technical Consultation that addressed International Guidelines for the Management of Deep-sea Fisheries in the High Seas, in section 3.2 titled "Vulnerable marine ecosystems", defined 'vulnerability' but in the context of "population, community, or habitat", i.e. not the ecosystem – in paragraphs 14 and 15, but then returns to the term ecosystem – an unwelcome source of potential confusion. This diversification of descriptors is extended in Section 5 by reference to 'areas' and 'species groups'.

4. EVIDENCE TO INFORM A VME ENCOUNTER PROTOCOL

Cry *et al.* (2018) note that "the FAO has not, as yet, provided any advice or technical guidance on what constitutes evidence on an encounter with a VME during bottom fishing operations. Participants in deep-sea fisheries in the high seas are therefore currently still in the position of having to determine for themselves, based on best available scientific information, what constitutes evidence of an encounter with a VME,…". As the original FAO guidelines can be attributed to the FAO Committee of Fisheries (COFI), presumably it is this FAO body who would update the present advice but this may require another FAO Technical Consultation.

[2] At this point, undefined.

The SPRFMO (2013) Scientific Committee "endorsed" a number of characteristics of move on rules. They note that: "Encounter thresholds indicating evidence of a VME should be based on analyses of historical bycatch data, taking account of the different retention rates of species by each gear type. Multiple species can be used to indicate higher biodiversity" No elaboration was given as to their understanding of ' biodiversity'. Left unasked is *do threshold values of bycatch of species concluded to, or asserted to, provide evidence of vulnerable marine ecosystems, actually identify vulnerable marine ecosystems*?

Cryer *et al.* (2018) (p7) note that a SPRFMO threshold value specified in 2018 was derived from the 2012 – 2017 catch records of New Zealand ' bottom' trawlers fishing in the SPRFMO zone. The top 2% of vessel catches were pooled across all areas. It is unclear if the pooled catch referred to sessile bycatch or retained catch. Cryer *et al.* (2018) further note that there was agreement that "*should a move-on rule be implemented as part of the revised CMM for bottom fisheries, the threshold for triggering such a rule should be high. Ideally a move-on response should follow* ***more than one encounter*** [our emphasis] *involving weights of bycatch of benthic fauna that would indicate the models used to predict the distribution of VME taxa are misleading."*

More complex methods were tabled, but there was little chance these methods could be parameterized and were not considered feasible. Thus, a method that was necessarily arbitrary and used descriptive statistics of catch results was used to indicate evidence of the existence of vulnerable marine ecosystems.

Cryer *et al.* (2018) (p8) also note that subsequent to a 2018 workshop of the North Pacific Fisheries Commission, a meeting of Australians and New Zealanders concluded that of threshold options considered the most feasible option would be:

"*2. Arbitrary but based on actual historical catch records*

a. [VME?] *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*".

Cryer *et al.* (2018) describe a "more pragmatic "data-informed" method based on historical catch records from the fishery" to trigger the bottom trawl 'move-on' rule after concluding that it was not possible to use methods based on VME abundance and trawl catchability. They note that the choice of threshold weights should be high and triggered by rare and large catches of VME taxa. "To inform the choice of potential threshold weights," Cryer *et al.* (2018) (p14) calculate percentiles ranging from the 80^{th} to the 99.5^{th} taxon-specific percentiles of the VME bycatch indicator taxa and plotted cumulative distributions.

5. COMPLICATIONS FROM CONFOUNDING GEAR TYPES

SIOFA defines "Bottom Fishing"[3] as any type of fishing in which the gear may contact the sea floor". With bentho-pelagic trawling this confounds two different fishing methods. Fishing targeting alfonsino

[3] 'bottom fishing' means fishing using any gear type ***likely*** to come in contact with the seafloor or benthic organisms during the normal course of operations. General provisions and definitions, p2 - CMM 2020/011 Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area

has constituted about 71% of all recent tows undertaken by Cook Island-flagged vessels. For this they use a midwater trawl though it accords with the SIOFA definition of bottom fishing. They usually catch little or no benthos. Trawls targeting orange roughy are designed for sustained bottom contact, but are not deployed where gear damage or fastenings is expected. This type of fishing catches far more benthos.

This complicates the use of a single threshold value for 'bottom fishing'. If the threshold value is based on a percentile chosen for all "bottom tows" – SIOFA definition, inclusion of the large number of zero-bycatch tows when targeting alfonsino will markedly lower the size of any percentile threshold based on all bottom tows combined. Such a threshold will disproportionately affect trawling for orange roughy as including the low-benthic bycatches from alfonsino "bottom fishing", i.e. mid-water trawling, will lower threshold values for all percentiles.

FAO (2008b p39), in considering *Scope and Principles* notes that the guidelines are intended to apply to fisheries where "the fishing gear is likely to contact the seafloor during the normal course of fishing operations." "Likely" is not defined but logic indicates that it means a probability greater than 0.5, or 50% of tows. This does not seem to be so for mid-water trawling targeting alfonsino. FAO (2008b, para 15) recognize the potential for gear effects and note "the vulnerability of some populations, communities and habitats may vary greatly depending on the type of fishing gear used.

A complication arises depending on the historical from which bycatch values are chosen to determine the percentile values. Bycatch of benthos will decline as it is removed by fishing. Values from the early phase of the fishery will be high, but this is usually when data are scarce and/or of doubtful reliability. Later, threshold values will be lower and data more reliable. For a stable ecosystem situation and fishing footprint, operators could face dynamic and downward threshold values.

These considerations emphasize the complications and implicit terminological conundrums that characterize the unavoidable subjective process of choosing a threshold value.

6. A BIODIVERSITY COMPONENT OF AN ENCOUNTER PROTOCOL

Cryer *et al.*(2018) believe that "the presence of several VME indicator taxa in a single tow may indicate that the fishing event has encountered an area with a diverse seabed fauna, *potentially constituting evidence* [our emphasis] of a VME" citing Parker (2008) and Penny (2014) so introducing the concept of protection of biodiversity[4] through reference to Parker (2008) and Penny (2012). But, these citations simply note what Cryer *et al.* repeats, but this does not validate them. No empirical grounds to justify the claim are given.

Parker's (2008) rationale (in Penny 2014) for the incorporation a measure of biodiversity, was: "... the assessment of "Evidence of a VME" should ideally also incorporate other information available from the catch, such as the diversity of taxa encountered ... ". The "Evidence of a VME" developed uses an additional presence / absence score to capture diversity among broad taxonomic groups by assigning a single point to any listed taxon present in the catch, but below the threshold level. Summing those points

(Interim Management of Bottom Fishing). *An argument exists that bottom contact by mid-water bentho-pelagic trawls targeting alfonsino is* ***not likely.***

[4] No elaboration is given on what is understood by biodiversity and it use implies a non-technical sense. The interested reader is referred, as a start, to Cochrane *et al.* 2016.

provides a weighting factor that slowly increases the total VME score, even where threshold weights are not exceeded." Parker *et al*. (2009) do not provide an explanation for the choice of three species to trigger a 'move-on' as a result of an indication of biodiversity.

What is now referred to as the 'biodiversity component' then evolved: 1 – low, 2 – medium, 3 – high.. It was considered that no taxon could be confidently ranked a level 2 as this resolution could not be justified using the FAO (2009b) criteria for VME taxa. This reduced the taxonomic importance options to either High (3) for the already designated taxa and Low (1) for all other taxa chosen as indicator taxa. The 50% cumulative weight frequency values for the secondary taxa were typically less than 1 kg and weight thresholds at such low values could not be rapidly and reliably determined at sea, thus the presence of these lower importance species be used rather than attempting to determine weights of less than 1 kg at sea. The total score constituting evidence of a VME and triggering a move on was retained at a score of three (based on the initial decision to trigger a 'move on' if the weight of the primary species exceeded the score (of three). Thus, three taxa would trigger a 'move-on'.

7. CRYER AND NICOL (2017)'S CONCLUSIONS

There is now an abundance of papers reviewing and re-reviewing the issue of when to decide that a VME has been encountered and what should then happen. One of the most perceptive is Cryer and Nicol (2017) who report on 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. They conclude:

- Move-on rules provide a rapid response to *evidence* of vulnerable marine ecosystems (VMEs) in bottom fisheries
- they can be used to develop protective measures for VMEs in the early stages of a fishery when information is scarce
- once ... spatial management measures have been implemented to *prevent significant adverse* impacts on VMEs, move-on rules provide little additional benefit for VMEs
- they have significant costs in terms of monitoring requirements and operational uncertainty for fishers
- the potential information gathering benefits of move-on rules can be better met using structured and mandatory collection and review of benthic bycatch in bottom fisheries.

8. CRYER AND NICOL'S RECOMMENDATIONS

Cryer & Nicol (2017) recommend that:

- move-on rules should be viewed only as "back-stop" measures (if required) to complement spatial closures developed using decision-support software and designed to prevent significant adverse impacts on VMEs;
- the potential information gathering benefits of move-on rules can be better met using structured and mandatory collection and review of benthic bycatch in bottom fisheries;
- should a move-on rule be implemented as part of the revised CMM for bottom fisheries, the threshold for triggering such a rule should be high. Ideally a move-on response should follow more than one encounter involving weights of bycatch of benthic fauna that might be expected in an area predicted to have very high habitat suitability for structural VME taxa and a high state of naturalness.

Cryer *et al*.(2018) further provide a number of recommendations. These provide a point-form distillation of the many interrelated factors involved, which are reviewed on that basis in the following table.

	Recommendation	Comment
1	that a pragmatic, data-informed approach has been used to develop thresholds to support a proposed move-on rule for bottom trawls that can work as a "back stop" together with spatial management areas to prevent SAIs on VMEs;	Threshold values '*based on medians, percentiles, or other metrics'* are pragmatic if a decision is required for administrative purposes. It does not guarantee the protection of benthic communities, populations or habitats. Indeed, the most sensitive, and thus vulnerable, benthic ecosystems could well be those with relatively low densities of animals that generate low bycatch values .
2	insufficient data on VME distribution and density and on trawl catchability exist to apply more sophisticated methods	The SPRFMO situation relies on possibly the most comprehensive set of existing benthic trawl bycatch data, in terms of the number of observations, temporal extent and taxonomic resolution – THE NZ database. This is a complete contrast to the SIO bentho-pelagic fishery situation.
3	insufficient data from bottom longline fisheries exists to develop a data-informed move-on rule for that method	This would appear to also be the case for the bentho-pelagic fishery in the SIO.
4	that it is proposed that a move-on rule for bottom trawl would include two thresholds, exceeding either of which would require the vessel to move away from the location: ○ a catch of any one of the six most commonly-caught VME taxa over a taxon-specific threshold weight (based on the 99th percentile of the distribution of historical positive catch weights); OR ○ a catch of three or more VME taxa over a taxon-specific qualifying weight (based on the 80th percentile of the distribution of historical positive catch weights);	The taxonomic detail in the SIOFA benthic bycatch record for the bentho-pelagic trawl fishery is insufficient to inform decisions on an appropriate two-level threshold decision process. – evident from the available information. While specification of 99th and 80th percentiles may be pragmatic/data informed, Parker *et al*. (2009) and Penny (2014) note that making such decisions is not for scientific workers, **but for management** because measures based on catch metrics **do not provide a scientific basis for decisions on what threshold levels will protect benthic populations, communities and habitats.** These decisions involve consideration of precaution, which in turn requires the decision makers specify their attitude to risk and that a risk function is exists. Such a risk function would be informed by knowledge of the relative amount of habitat that is affected by bentho-pelagic trawling. Using empirical percentiles for decision making is arbitrary: they are not scientific but an operational response to a difficult administrative problem.
5	Agree that the scientific methods used to develop thresholds for the proposed move-on rule for bottom trawl to work as a "back stop" together with spatial management	Cryer *et al.* (2018) agree as to the treatment of this topic but the methods are only 'scientific' in the sense that they are systematic and methodical. No scientific inference is involved. SIODFA strongly endorses the recommendation to develop spatial management and have been proactive in this view since 2006.

	areas to prevent SAIs on VMEs are appropriate;	
6	benthic bycatch data and all move-on events should be reviewed annually by SC	This happens in the SIOFA SC (SIOFA 2020, p8, Table 4, *Weight of benthic bycatch reported, 2019*, Section 5.1. Benthos organisms bycatch summary.
7	models underpinning spatial management approaches should be reviewed periodically (perhaps every 5 years) or when evidence suggests those models are misleading, and to include these in suggested SC workplans for consideration by the Commission.	Such models have not yet been proposed for the SIO. When available they should be subject to appropriate peer review.

8. SUMMARY

SIODFA members strongly endorse the need to protect sessile benthos in the SIOFA area first recognized through their proposal to implement 10 Benthic Protected Areas first discussed in February 2006. Two additional sea floor features – Banana and MOW - were subsequently proposed - a total of 12 areas. These remain closed to fishing as a requirement of membership in SIODFA. Their protection is required by the fishing permits of two SIODFA-member vessels and are voluntarily recognized by the other members. Our view has been that the most effective method to protect sessile benthos is spatial management cognizant of the objectives/requirements of UNGA resolution A61/105.

The SIODFA bentho-pelagic trawl fishery has now a 23-year history. Three of the four existing vessels in the current fishery have prosecuted this fishery from before 2000. All skippers who have been asked expressed the view that the exploration of potential sites in the SIO for bentho-pelagic trawling was complete: none believed that new fishing grounds would be found (for the species they target). Trawlers typically fish up to 50 features in a year and possibly 75 over a five-year period. SIODFA data records list over 350 named features that have been explored for possible viable commercial fishing operations. Other reports refer to over 10,000 seamounts in the SIOFA area.

Current fishing operations, almost without exception, are undertaken on carefully mapped tow lanes. Some sea floor features have only one tow lane where fishing is possible. To deviate from these is to risk gear damage and possible trawl loss. The exact locations of the tow lanes are proprietary information. This method of fishing has direct implications to the concept of what is a *significant adverse impact*. This concept has received much attention at various management levels. FAO (2009b, para. 19) notes that to avoid significant adverse impacts the benthos should recover within 5 – 10 years. As many benthic animals grow slowly, some over a period of hundreds of years, such a concept would seem in need of review. Our view is that the most desirable trawl fishery from the perspective of protecting sessile benthos is one that has a stable footprint in terms of potential bottom impact and which is relatively small compared with the area over which benthic communities, populations and habitats, etc. are expected to occur[5].

[5] The interested reader is referred to p25, Section 4.2, Fished Area 4.2.1 Spatial Extent Processing (MMR 2017). — http://apsoi.org/sites/default/files/documents/meetings/SC-03-06.2%2804%29%20BFIA%20-%20Cook%20Islands.pdf

SIODFA already restricts the area of its fishing operations: they are more restricted than those required by SIOFA CMMs (nine of the benthic protected areas observed by SIODFA vessels were rejected by the SC as appropriate for conservation; one then became the area of a new fishery. However, SIODFA agrees that fishing should cease in an area if bycatch indicates that substantial sessile benthos exists. . However, a single record of bycatch is uninformative as to whether this was the outcome of an unusual, though possible, stochastic processes resulting in the observed bycatch or whether benthos density is in fact greater than was expected. From a scientific perspective, the requirement is clear – seize the opportunity to collect more information – it is unlikely there will be a follow up by a scientific research vessel! This principle was recognized in the earlier Cook Islands benthic bycatch move-on protocol where following a threshold catch of benthos, fishing could continue but with 50% reduction in the bycatch 'move-on' threshold value. SIODA believes a compelling scientific case exists for even insisting that a second tow following a threshold event is undertaken, even if the skipper prefers to change grounds.

These points are synthesized as follows.

- Trawl ground-rope contact will impact sessile benthos if it is present.
- Current bentho-pelagic fishing is along well-defined tow lanes: on rare occasions currents may displace the trawl from the intended tow path.
- A sustainable fishery can have a fixed benthic fishing footprint. There would be little or no recovery of benthos on such well-defined tow lanes.
- The areal distribution of benthos is expected to follow a multi- cluster process, i.e., clusters of clusters of species specific conditioned by the bottom features and currents.
- The sessile bycatch would follow a stochastic process depending on the nature of the specific sea floor feature, the distribution of benthos, the trajectory of the foot rope's contact with the sea floor and the skipper's skill and fishing tactics.
- Thus, for a given benthos density, the benthic bycatch would vary along a cumulative distribution process
- Benthic thresholds at which a move-on is required can be based on descriptive distribution statistics but these values have no scientific relation to the nature of the feature, population, community, habitat, skipper's skill and fishing practices: it is a 'management', not a 'scientific' decision depending on attitudes to precaution and thus risk.
- Repeated towing in an area may result in many sub-threshold values until finally a threshold value is encountered —Russian roulette.
- Confounding gear types with different benthic impacts when specifying a threshold (assuming the data exist) will penalize one gear sector relative to another: to avoid this the results from the higher impact gear should cover the lower impact gear.
- SIODFA strongly endorses using spatial management to affect conservation of benthic populations, communities and habitats and that they be urgently undertaken through an appropriate working group(s) – the footprint method?
- SIODFA notes its earlier, partially successful, efforts to close areas to fishing. This issue should be revisited.
- Because setting thresholds values is necessarily subjective, it should be done in a manner consistent with the various objectives of the UNGA resolution 61/105.

As noted, threshold values and move-on-rules are different sides of the same coin. It makes no sense to discuss one without the other. Time has passed: thresholds and move-on protocols do not have the

relevance to conservation issues in 2022 that may have been the case in 2006. For example, Cryer & Nicol (2017) conclude:

- • Move-on rules are best viewed as an interim data collection and protection measure until evidence-based and comprehensive measures are in place;
- • Move-on rules may have some utility within a spatial management regime designed to provide these joint outcomes if new and highly unexpected insights into the distribution or density of VME indicator taxa arose from the benthic bycatch in a particular trawl or a sequence of two or more trawls.

9. WHERE TO NOW?

These points provide excellent direction for future Scientific Committee endeavours regarding protection of (all) sessile benthos.

i. Undertake a synthesis of existing sessile benthos bycatch information documenting the quality and fidelity of this information (Done?). This should not be a major task and should not require the services of a consultant – relevant flag state biologists could address this need. Such a synthesis would provide a context for the PAEWG to evaluate the urgency of actions relating to "VMEs".

ii. Continue to document annually bycatch data of sessile benthos with summary statistics drawing on the reporting in SIOFA (2021).

iii. The Scientific Committee should review this information to determine if any conservation action should be recommended to the Meeting of the Parties.

10. LITERATURE CITED

FAO 2008. Report of the FAO Workshop on Vulnerable Marine Ecosystems and Destructive Fishing in Deep-sea Fisheries. FAO Fisheries Report No. 829. 18pp.

FAO 2009a Technical Consultation on International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome, 4–8 February and 25–29 August 2008. FAO Fisheries and Aquaculture Report No. 881. 98pp

FAO 2009b. International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome. 73pp.

Cryer, M. & S. Nicol 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. 5th Meeting of the Scientific Committee Shanghai, China, 23 - 28 September 2017. SC5-DW08. 19pp.

Cryer, M., S. Geange & S. Nicol 2018. Methods for deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries. 6th Meeting of the Scientific Committee, Puerto Varas, Chile, 9 - 14 September 2018. SC6-DW09 33pp.

MMR 2017. 3rd Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA) Scientific Committee 20-24 March 2017, Saint Denis, La Reunion Bottom Fishing Impact Assessment – Cook Islands. SC-03-06.2(04). 52pp. http://apsoi.org/sites/default/files/documents/meetings/SC-03-06.2%2804%29%20BFIA%20-%20Cook%20Islands.pdf

PAEWG 2021. Report of the Third Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA) Scientific Committee (SC) Protected Areas and Ecosystems Working Group (PAEWG). 21pp.

Parker S.J., A.J. Penney & M.R. Clark 2009). Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. *Marine Ecology Progress Series*, 397: 309–317. doi:10.3354/meps08115

Penney, A.J. 2014. Review of the biodiversity component of the New Zealand Vulnerable Marine Ecosystem Evidence Process. New Zealand Aquatic Environment and Biodiversity Report No. 135. Ministry for Primary Industries, Wellington, 44 p.

SIOFA 2021. Report of the Sixth Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA)Held via Online Forum and ZoomVideo conferences on 22-26 March 2021. 86pp.

UNGA 2007. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments. A/RES/61/105. 21pp.