New Zealand Implementation of the SPRFMO Interim Measures for High Seas Bottom Trawl Fisheries in the SPRFMO Area

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1. Introduction

The purpose of this paper is to outline New Zealand's intended approach to implementation of the interim measures for bottom fisheries, adopted in Reñaca, Chile in April/May 2007 by the Participants in the negotiations to establish a South Pacific Regional Fisheries Management Organisation (SPRFMO). The approach has been developed over a number of consultation meetings between New Zealand Government agencies (the Ministry of Fisheries; the Department for Conservation; the Ministry for Foreign Affairs and Trade) and the New Zealand fishing industry and NGOs over May 2007 – February 2008.

New Zealand is implementing the interim measures through a series of sequential implementation steps. A number of the requirements of the interim measures are already satisfied through existing management systems for New Zealand fisheries (such as VMS requirements), while other measures have required further implementation of existing systems (such as increased observer coverage). Other substantial and immediate requirements (such as spatial restrictions and the 'move-on' rule) are initially being implemented through conditions imposed on New Zealand high seas fishing permits, which are required by all vessels wishing to fish the high seas under New Zealand flag. These are planned to come into effect during March 2008, in time for the New Zealand 2008 high-seas bottom trawling season, which peaks between March - May. It is anticipated that permit conditions will be followed later by regulations, once these have been developed, to strengthen the legal framework, and to improve implementation of the interim measures.

The bottom trawl fishery is the primary focus of initial implementation steps because of the higher impact that this gear has on the seabed compared with other forms of bottom fishing (SPRFMO 2007a), and the fact that bottom trawling is the dominant fishing method by New Zealand flagged vessels in this fishery. The process adopted to define and map the New Zealand high seas bottom fishing footprints, and to detect evidence of encounters with vulnerable marine ecosystems (VMEs) during fishing, are described. Current implementation progress and planned future implementation are then reported in this paper against each of the bottom fishing related paragraphs of the SPRFMO interim measures.

2. Development of New Zealand Bottom Fishing Footprint Maps

2.1 Definition of the Bottom Fishing 'Footprint'

The SPRFMO Interim Measures for Bottom Fisheries require that participants "*Not expand bottom fishing activities into new regions of the Area where such fishing is not currently occurring."* (SPRFMO Bottom Fishing Interim Measure paragraph 2). No definition is provided in the interim measures themselves for areas 'where fishing is not currently occurring'. However, the Benthic Assessment Framework adopted at the 4th SPRFMO meeting in 2007 defined the '*currently fished*' footprint for bottom fisheries in the SPRFMO area as follows:

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"This joint footprint map is to be expressed as grid blocks of 20 minute resolution, with a 'fished' block being defined as any grid block partially crossed by at least one trawl track. The period 2002 - 2006 is to be used as the reference period for developing this joint trawl footprint map."

2.2 Development of the New Zealand Bottom Fishing Footprint Maps

Maps of the New Zealand bottom fishing footprint over 2002 - 2006 were prepared using high seas catch and effort data reported to the Ministry of Fisheries for all bottom fishing methods over the calendar years 2002 - 2006, as reported on compulsory catch and effort returns for those fisheries. These returns report all trawl tows as start and end position, and all bottom line (longline, drop-line and dahn-line) fishing start position, in latitude / longitude to the nearest minute.

All detectable position errors in these data were corrected during a standardised data grooming process, during which no data records were deleted from the data set. The resulting error-corrected data set is the same one used to generate the overview of New Zealand catch and effort and initial exploration of footprint mapping options presented at the 4th meeting of the SPRFMO Science Working Group, and a more detailed description of the data and grooming process are provided in that paper (Penney *et al*. 2007). These groomed data were also used to prepare New Zealand's catch and effort data submission to the SPRFMO Interim Secretariat.

This same data set was used to generate the footprint maps for New Zealand bottom fishing operations for 2002 - 2006. All tow start and end positions were imported into MapInfo® GIS mapping software, which was used to plot all trawl tows as straight lines between the reported start and end positions. These were then covered with a grid of blocks at 20 minute resolution and any block touched by at least one tow was retained, to constitute the trawl footprint map, which consists of 200 x 20 minute blocks. In a final data grooming step, the original catch / effort return for any individual tow which was particularly influential in causing an extra block to be added to the footprint (as a result of being isolated from other tows, or particularly long, extending across many blocks) was checked, to correct data capture errors. All tows included in the final footprint have therefore been through a rigorous error checking and validation process.

Three -Tier Classification of Fishing Effort

Tows which crossed adjacent block boundaries were split by the footprint block boundaries into tow segments within each block. These tow segments were then summed to provide an effort index (the number of tows which impacted each block), as recommended in the report of the 4th SPRFMO SWG meeting. An analysis of these effort indices per block indicated that three broad classes of trawled blocks can conceptually be recognised within the New Zealand trawl footprint:

1. There are a significant number of blocks (62) which have been lightly-trawled, which, with an average number of trawls / year over 2002 – 2006 of 0 (only 1 or 2 trawls over the 5 year period), can essentially be considered to be 'unfished'.

2. At the other end of the scale, there are many blocks which have clearly been targeted, and heavily trawled, over the period. In these blocks:
   - Most of the trawling effort has been focussed.
   - Most of the orange roughy catch has been made.
   - It is known that a significant of trawling is conducted on seamount features.

- Seabed impacts will have been most concentrated.

3. In-between these extremes, there are a number of moderately trawled blocks in which:
   - Effort and catch have been low compared to the heavily trawled blocks.
   - There is less likelihood that fishing was conducted on seamounts.
   - Seabed impacts have been low.

The moderately to heavily trawled blocks were divided to allocate equal numbers of blocks to the two effort tiers, to create a three-tier effort classification system, with 62 lightly trawled blocks, and 69 each 'moderately' and 'heavily' trawled blocks, or approximately one-third in each effort category. A diagrammatic representation of this three-tier effort classification is provided in Figure 1, which also provides descriptive information and a summary of specific management approaches adopted per effort tier. These management approaches are explained in more detail in section 4.

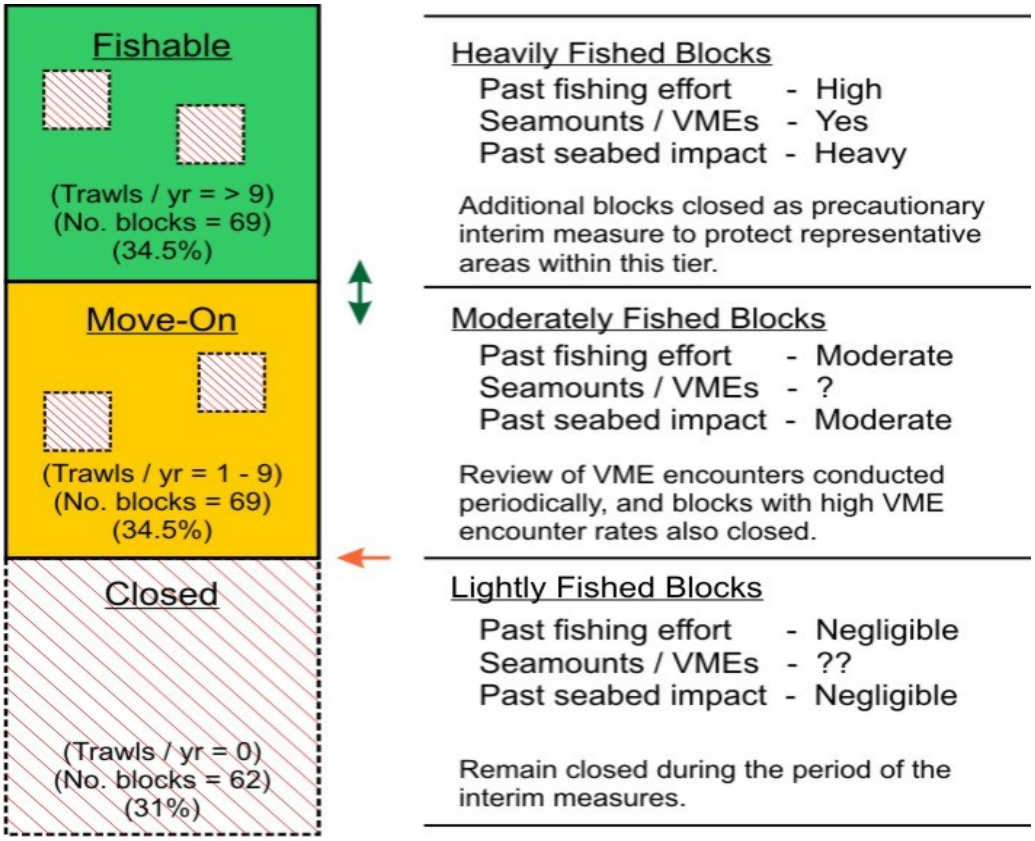

Figure 1. The three-tier classification system adopted by New Zealand as a basis for adaptive management of bottom trawl fishing in the various blocks constituting the New Zealand trawl footprint.

The trawl footprint blocks were then colour-coded by these three effort tiers to generate the maps of the New Zealand bottom trawling footprint shown in Figures 2 and 3, which show the footprint in the areas west and east of New Zealand, shaded by effort category. This footprint map can also be viewed on the New Zealand Ministry of Fisheries *National Aquatic Biodiversity Information System* (https://www.nabis.govt.nz/nabis_prd/index.jsp).

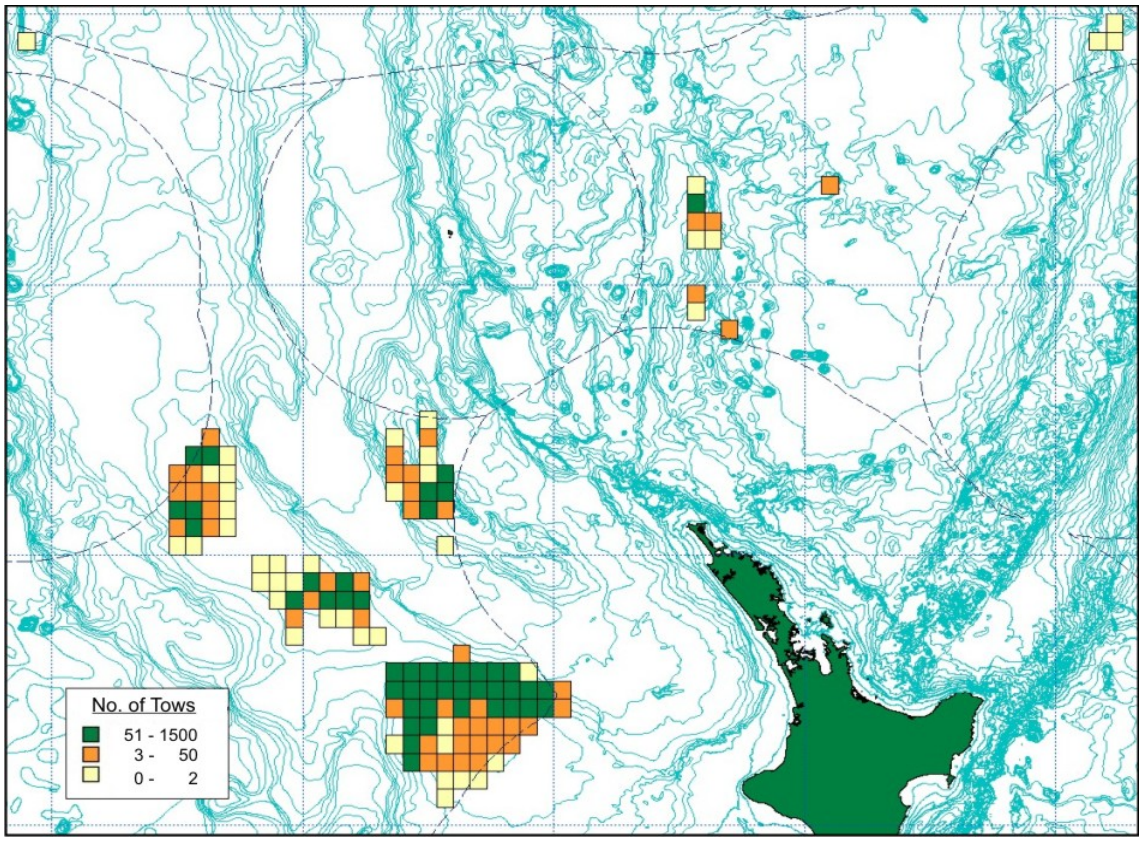

Figure 2. New Zealand trawl footprint in the Challenger Plateau, Lord Howe Rise, West Norfolk Ridge and areas east of Norfolk Island, shaded by effort index.

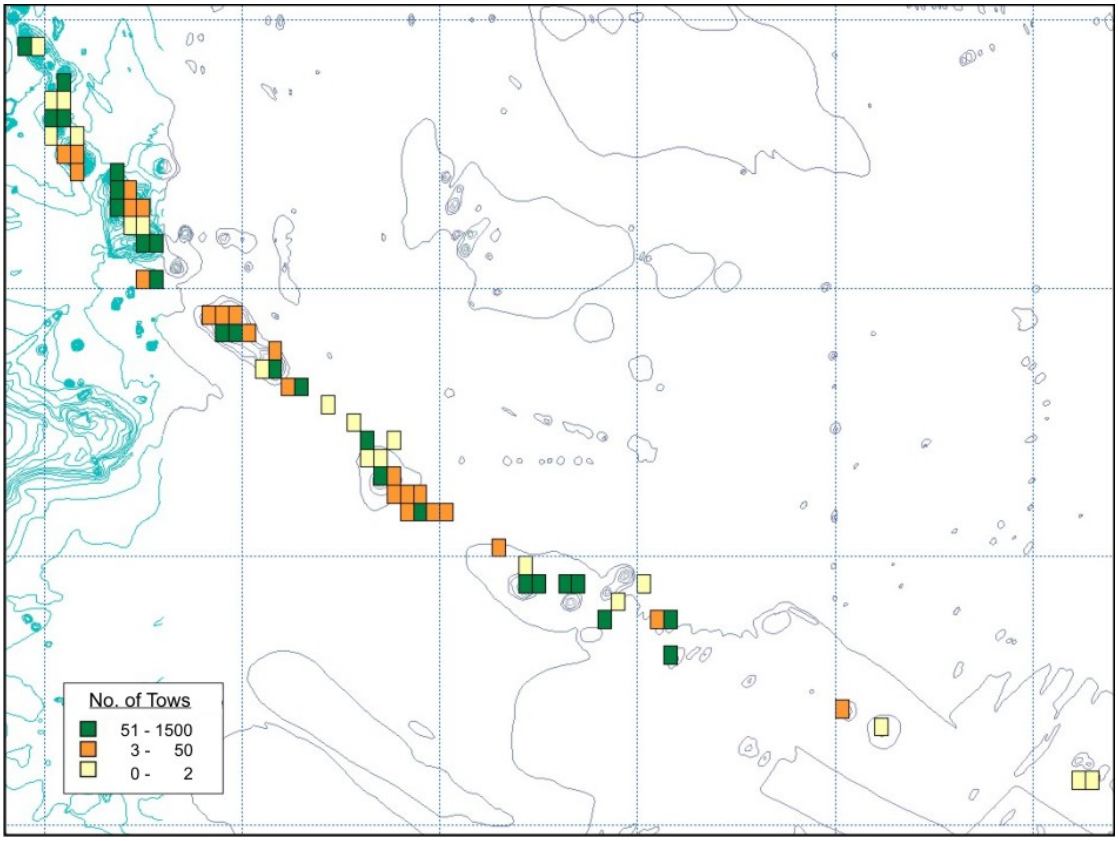

Figure 3. New Zealand trawl footprint in the Louisville Ridge area, shaded by effort index.

2.3 New Zealand Bottom Line Footprint

Footprint maps for New Zealand bottom lining (longlining, drop-lining and dahn-lining) were produced using the same groomed data set and mapping process, except that bottom line catch / effort returns report only start position of set, so there was no need to split sets between footprint blocks. The resultant footprint maps for the areas west, south and east of New Zealand are shown in Figures 4, 5 and 6.

The New Zealand bottom line footprint is far smaller than the trawl footprint, occupying only 40 x 20 minute blocks. As with trawling, the main bottom lining areas have been west of New Zealand, on the Challenger Plateau, West Norfolk and Other areas. However, in marked contrast to trawling, over 2002 - 2006, New Zealand conducted no longlining on the northern or southern Lord Howe Rise areas, nor anywhere on the Louisville Ridge. Also in contrast to trawling, a small amount of bottom lining was conducted south of Macquarie Island (Figure 5) and south of the southeast tip of the Louisville Ridge (Figure 6).

2.4 Separate Method Footprints

Bottom lining has therefore tended to occur in quite different areas from trawling over the 2002 - 2006 period, with very little overlap between trawling and bottom lining positions. The only area where the bottom lining footprint completely overlaps with the trawling footprint is in the Challenger Plateau area. Even there, however, bottom lining has been conducted in a small, central area of the Challenger Plateau (compare Figures 2 and 4), which is only moderately trawled. At individual set / tow level, there is virtually no overlap between the two methods, even on the Challenger. In areas such as the West Norfolk area, or the 'Other' area east of Norfolk Island, bottom lining has been conducted in areas adjacent to trawled areas, but with virtually no overlap between the actual set positions of the two methods. In these two areas, the bottom line footprint extends substantially beyond the trawl footprint.

In terms of the requirement in the SPRFMO interim measures to ensure that fishing does not expand beyond areas 'currently fished', and in recognition of the different levels of seabed impact expected from bottom trawling and lining (SPRFMO 2007b), there is therefore clearly a need to develop separate footprint maps for these different fishing methods. In terms of limiting impacts, and adapting management and mitigation methods within blocks to the specific fishing methods being used within each block, there would certainly be a need to restrict trawling to within a specific trawling footprint. There may be less of an imperative to prevent bottom lining in trawl footprint areas but, if the interim measure requirement to prevent expansion of fishing to areas 'not currently fished' is interpreted at a fishing method level, there would also be a requirement to prevent bottom lining from expanding beyond its own footprint.

3. Definition and Detection of Evidence of Vulnerable Marine Ecosystems

The SPRFMO Interim Measures for bottom fisheries "*Require that vessels flying their flag cease bottom fishing activities within five (5) nautical miles of any site in the Area where, in the course of fishing operations, evidence of vulnerable marine ecosystems is encountered*" (SPRFMO Bottom Fishing Interim Measure 7). Effective implementation of this measure therefore requires development of a definition of 'evidence of a VME' encountered during bottom fishing operations, and the development of a protocol and process for evaluating, documenting, reporting and responding to such evidence.

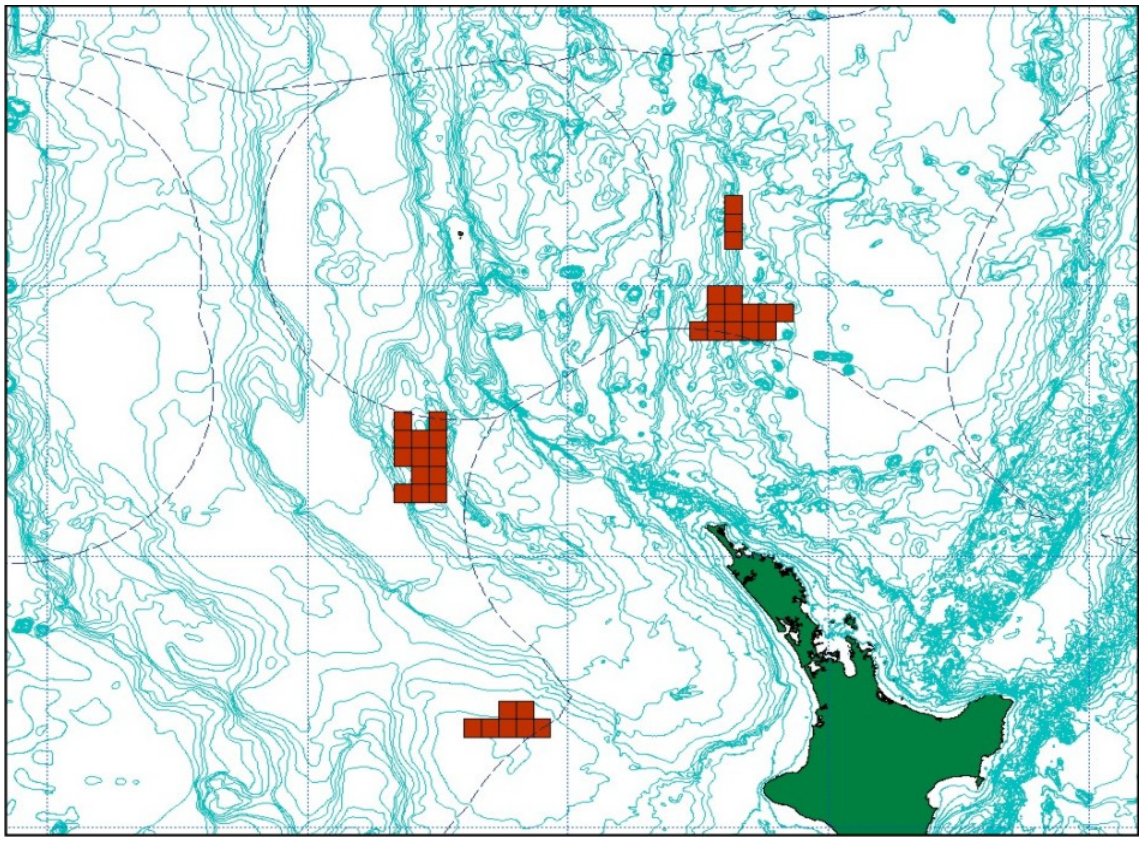

Figure 4. New Zealand bottom longline and drop-line footprint on the Challenger Plateau, southern Lord Howe Rise and area east of Norfolk Island.

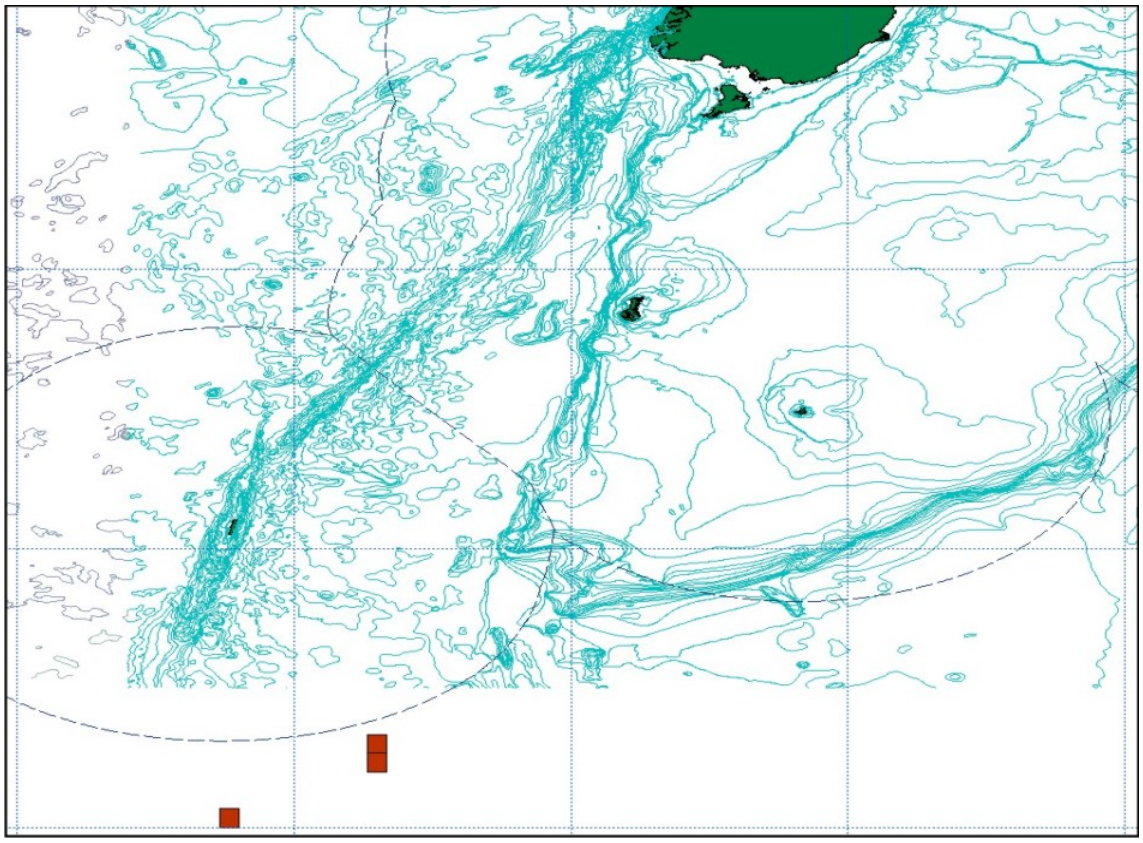

Figure 5. New Zealand bottom longline and drop-line footprint south of Macquarie Island.

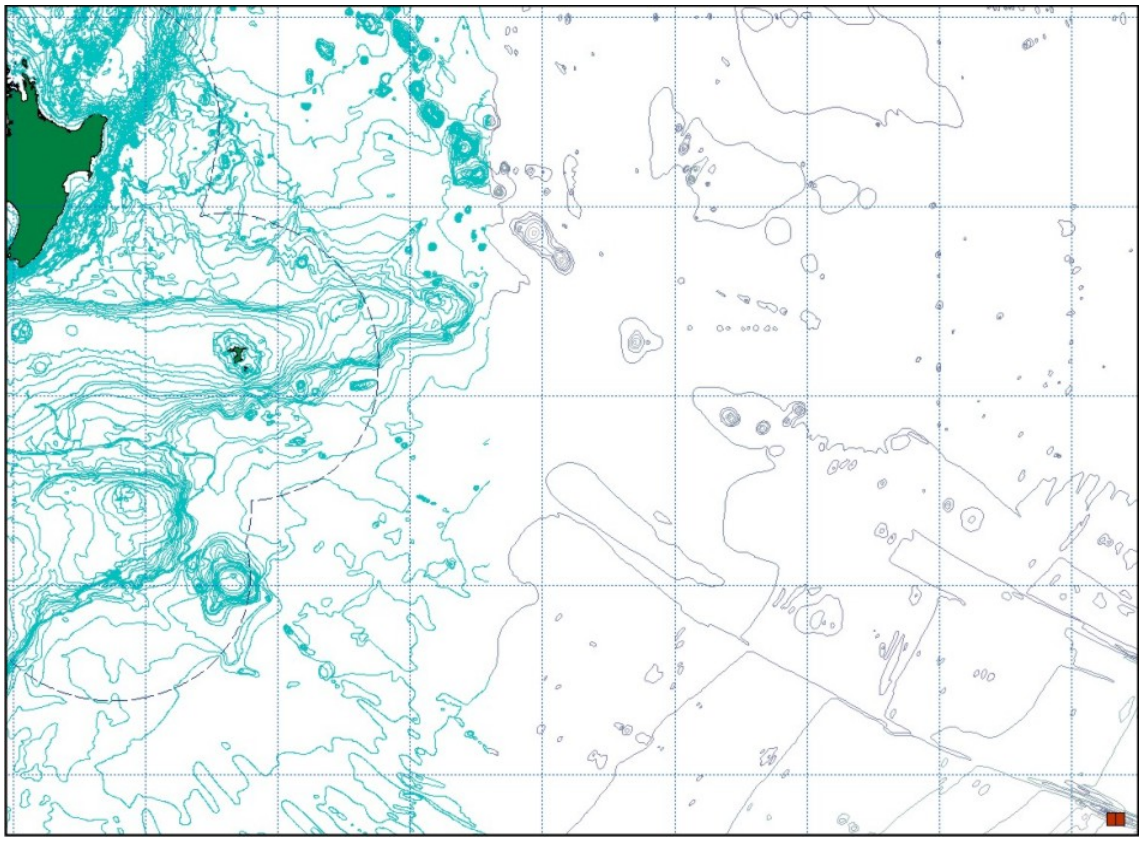

Figure 6. New Zealand bottom longline and drop-line footprint in the south-central Pacific area.

Given that such evidence, for a bottom trawling operation, can only consist of the by-catch of 'vulnerable' species in a particular tow, a protocol and process is required to define what would be considered to be vulnerable species or taxonomic groups, how much of any taxonomic group might be considered to actually constitute 'evidence of a VME' (as opposed to an insignificant encounter), and how to evaluate, document and respond to such evidence of an encounter with a VME.

3.1 Selection of Taxonomic Groups to Constitute 'Evidence of a VME'

The SPRFMO Interim Measures define 'vulnerable marine ecosystems ' (VMEs) as including seamounts, hydrothermal vents, cold water corals and sponge fields, based on the original definition in UN General Assembly Resolution 61/105. In terms of biological components of VMEs, the Draft Guidelines for Management of Deep-Sea Fisheries produced by the September 2007 FAO Deepwater Fisheries Expert Consultation (FAO 2007) provide an expanded list of example species considered sensitive and potentially vulnerable to deep-sea fisheries:

Examples of vulnerable species and habitat-forming species that are documented or considered sensitive and potentially vulnerable to deep-sea fisheries in the high seas (FAO 2007)

a) Coldwater corals of various types e.g., reef builders and coral forest including: stony corals (scleractinia), alcyonaceans and gorgonians (octocorallia), black corals (antipatharia), and hydrocorals (stylasteridae);

b) Sponge grounds (e.g. sponge dominated communities);

c) Communities composed of dense emergent fauna where large sessile protozoans (xenophyophores) and invertebrates (e.g. hydroids and bryozoans) form an important structural component of habitat; and

d) Seep and vent communities comprised of invertebrate and microbial species found nowhere else (i.e. endemic).

The above list of example species from the FAO Expert Consultation was used as a starting point for selecting species to use as evidence of fishing on a VME, when encountered as by-catch in a bottom trawl net. The general rationale used to determine whether taxa were to be included in the list defining 'evidence of a VME' was as follows:

- Any taxonomic group specifically listed by FAO as examples of VME inhabitants is included if retained in trawl gear and identifiable to group. Some groups mentioned by FAO are not included because they are not encountered in deep sea fisheries, retained by fishing gear, or are difficult to identify (e.g. shallow water sponges, xenophyophores). However, poor retention by trawl gear means that low weight thresholds can still indicate higher benthic impacts.
- Additional taxonomic groupings that are associated with hard substrate in deep water are included, but only as indicators of suitable habitat.
- Vent / seep taxa should be included at some point in future revisions, but no observer guidance or ID guides are presently available, and New Zealand vessels currently do not fish on such features. This aspect should be developed further in future revisions.

Using this overall rationale, the taxonomic groups listed in Appendix A were evaluated to determine whether each should be included in the protocol and form to identify evidence of fishing on a vulnerable marine ecosystem. Appendix A provides the specific rationale for each taxonomic group considered, including why each taxonomic group was included, how a threshold weight that would constitute 'evidence of a VME' was chosen and why each group is considered to be important as a VME indicator.

3.2 Threshold Weight Determination

Having determined which taxonomic groups should be considered to constitute evidence of a VME, available data on past trawl by-catches of these species recorded by scientific observers on New Zealand bottom trawl vessels fishing within the New Zealand EEZ, and on the high seas, were analysed to determine cumulative catch weight curves for each taxonomic group

The data used for this analysis were scientific observer data primarily from the 1998 - 2002 period, for fishing deeper than 200m for which any catch of corals or sponges was reported by observers. This selection resulted in 1,603 observer data records being analysed, which constituted about 5% of the total number of tows recorded in those areas over that time period, the remaining tows having reported no corals or sponges. This period was chosen as coral and sponge catches were higher than in recent years, although many species codes were not yet in use, and many corals were listed as 'unidentified'. For this analysis, the COU

(unidentified coral) code was interpreted to indicate stony corals (SIA), this being the most likely component of any significant 'unidentified coral' by-catch. The 1998 - 2002 observer data included tows targeting mainly hoki (49%), orange roughy (32%) and oreos (13%). Most tows came from the New Zealand South East Chatham Rise area (23%), then Sub-Antarctic (21%), High Seas (19%), and Southeast Coast (18%). Data from all these tows were analysed together, as the 305 tows from the high-seas were not considered sufficient to support a separate analysis of high-seas by-catches.

Catch weights of the individual vulnerable taxonomic groups were ranked in order of increasing catch weight per tow, and plotted as cumulative catch weights against percentage of tows catching increasing cumulative weights. Plots of the results are shown in Figure 7. The distribution of cumulative catch weights is highly skewed, with most tows catching small quantities, and quickly decreasing numbers of tows with larger catches. The objective of this analysis was to identify weight thresholds which could be considered to be 'evidence of a VME', by exceeding a chosen threshold weight for each taxon.

Any VME score based on exceeding some threshold weight for each vulnerable taxonomic group will obviously be sensitive to the weight percentile chosen as a threshold. Essentially, the percentile chosen equates to the percentage of tows that would not be above the threshold for that taxon code. Most of the observed tows had a reported catch of only one VME indicator taxon, so typically only a single code generates the VME score. The threshold weights from the analyses shown in Figure 7 for various cumulative % of tows are summarised in Table 1 below.

Table 1. Threshold percentile weights (in kg) for each taxonomic code. Data are from observed bottom trawl tows, >200 m depth from 1998-2002 except Gorgonacea (GOC) and Alcyonacea (SOC), which had so few observations that 1998-2007 observations were used. (Example: 75% of by-catch observations of ANT were below 100 kg.)

Taxon / Code	50th %	75th %	80th %	90th %
Actiniaria / Anemones - ANT	5	100	120	171
Antipatharia / Black corals - COB	1	2	2	3
Unidentified coral - COU	30	100	200	1000
Alcyonacea / Soft corals - SOC	1	2	2	5
Gorgonacea / Sea fans - GOC	1	2	4	20
Hydrozoa / Hydrocorals - HDR	6	80	118	193
Porifera / Sponges - ONG	50	200	300	705

The choice of what weight percentile to use as a threshold for determining evidence of a VME is essentially a management choice, amounting to choosing what percent of tows should qualify as VMEs, based on the data analysed. This choice needs to be made between the extremes of presence / absence (any occurrence of a vulnerable species in a catch would be considered to be evidence of a VME) and high weight thresholds (only the largest recorded vulnerable species by-catch weights would qualify as evidence of VMEs). It was notable that only about 5% of the tows considered for analysis were found to contain any corals or sponges; a surprisingly low percentage, given that a significant amount of the fishing effort targets seabed features likely to support VMEs. It is known that bottom trawls do not retain these taxa efficiently, and trawls on seamounts with dense and diverse structural fauna have been observed to arrive on deck with little or no coral by-catch.

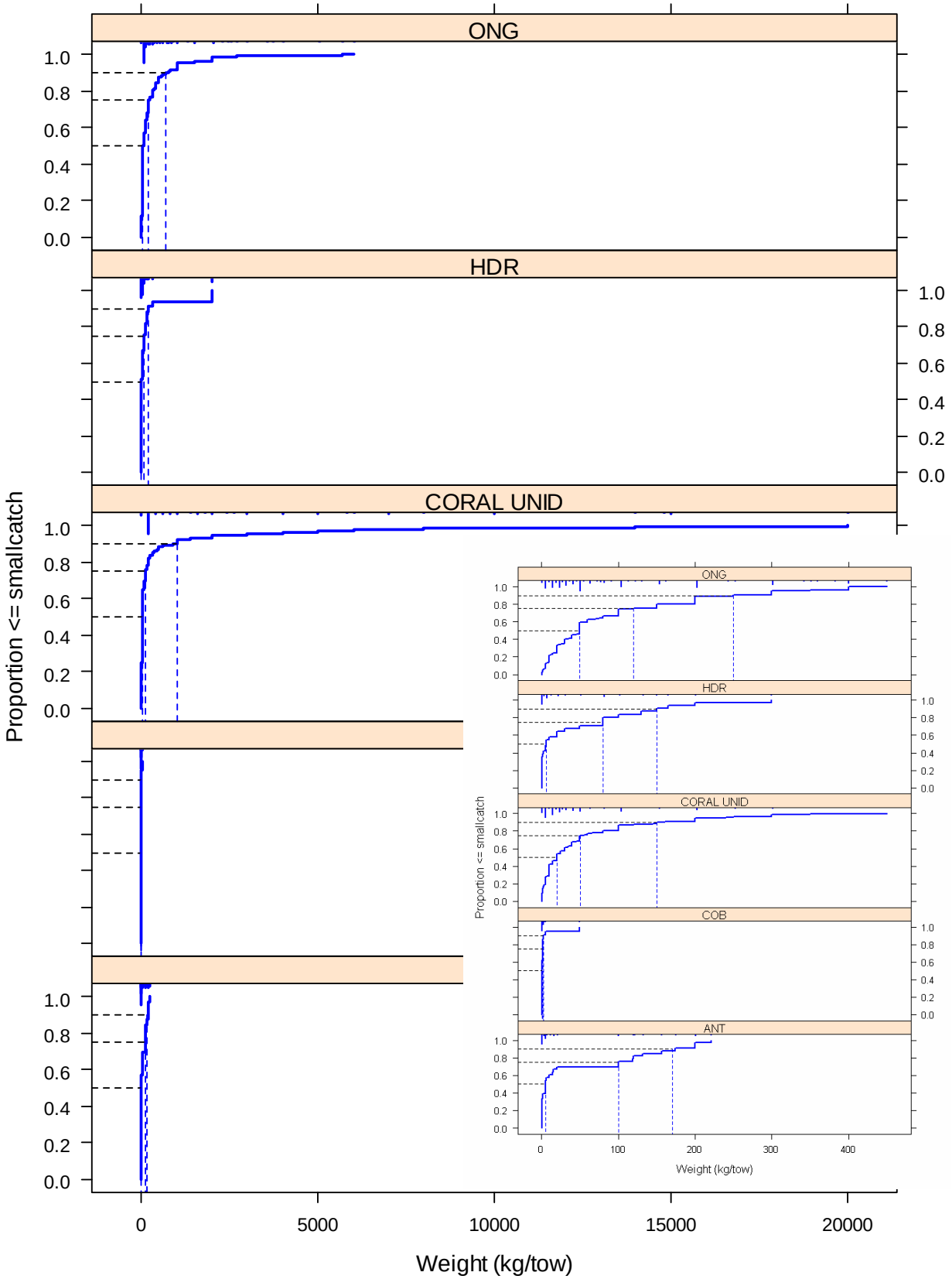

Figure 7. Cumulative catch distributions of VME indicator species codes used to determine threshold weights. Dashed lines indicate the 50th, 75th, and 90th percentile values. Inset shows same data truncated at 500kg for more detail.

The overall objective of this analysis was to develop a protocol for detecting *evidence* of VMEs. Such evidence would not necessarily constitute proof of actual *existence* of VMEs, and would also not provide adequate evidence of *significant adverse impacts* on such VMEs. Additional review and comprehensive scientific analysis of all available data, including data from frequent repeated encounters with VME species, together with additional information indicating likelihood of existence of VMEs in specific areas, would be required to properly identify and map VMEs. So, while the intention is to use the protocol to determine evidence of VMEs to require vessels to move-on, away from such areas, as required in SPRFMO interim measure paragraph 7, it is not intended to use such evidence as a basis for immediate area closures, until further overview analysis has been conducted to identify areas with a high likelihood of supporting VMEs, some proportion of which might be suitable for protection using spatial closures.

In the absence of any specified definition, or management objective, for 'evidence of a VME', and in recognition of the generally poor performance of trawl nets in sampling corals, the approach taken was that, while weight thresholds may need to be high enough to exclude insignificant encounters which might not actually provide evidence of VMEs, the thresholds would need to be low, and probably below the median of the dataset, to avoid excluding tows that, in all likelihood, had fished areas supporting VMEs. From Table 1 it can be seen that the weight thresholds for taxa such as black corals, soft corals and sea fans are particularly low, being only 1 kg at the 50% cumulative weight level based on the data analysed. While recognising that different sectors have widely differing views on what would constitute the most appropriate weight threshold to use, it was decided to use the median of the weight distributions.

Analysis incorporating the scale of catch (the actual weight of catch of each taxon above the threshold) showed that, because the VME identification would often be triggered by a significant catch of single taxon, adding emphasis on large catches does not change the classification of the tow, and is therefore superfluous. Nonetheless, all information on total catch weights would be recorded and would be available during a subsequent benthic impacts review process to use in determining if areas qualify as actual existence of a VME.

3.3 Rationale for the Proposed VME ID Form

The VME Evidence Process Form developed using the above rationale and analyses is shown in Appendix B. The VME form contains a checklist of vulnerable categories, organized to quickly categorize by-catch specimens with regard to the possibility that the by-catch provides evidence of a VME. The approach is to use a simple, fast procedure to determine if a particular catch was likely to be from a VME so that the vessel skipper can utilize the information in choosing the next fishing location. A detailed species identification procedure cannot be completed in this timeframe, nor is it necessary, as evidence of a VME is based on the presence of broad taxonomic groupings. Detailed species identification is done afterwards as part of the normal benthic materials sampling process to be conducted by scientific observers aboard New Zealand bottom trawling vessels. Determination of actual *existence* of a VME, or of significant adverse impacts on a VME, requires a more thorough scientific analysis of all benthic by-catch data collected by observers over the areas fished, together with other data which might indicate presence areas likely to support VMEs.

Only certain taxa were chosen to provide evidence of a VME. The form contains 11 taxa considered to be useful as indicators. Note that there are a myriad other sessile invertebrates observed in trawl gears that are not included here, so the abbreviated list already focuses attention on vulnerable species, and groups these in broad taxonomic groups to speed up the identification process. Once a 'significant' amount of a taxon is encountered (the

threshold weight for that taxon is exceeded) in a tow, a VME indicator score is allocated. These scores are based on a 3-level importance score to the presence of that taxon, based on its apparent sensitivity to impact (Low=1, Medium=2, High=3). The importance levels chosen for each taxonomic group are based on the conclusions of the FAO expert consultation on vulnerability of those taxa to disturbance and their life history characteristics (FAO 2007, and Appendix A). Summing all the individual taxon VME scores provides a score for taxa that exceed their weight thresholds. Currently, all taxa are allocated a sensitivity of 1 or 3, and no taxa score 2. However, splitting groups such as sponges and stony corals would create categories where a medium score is warranted. Future data collection is needed to inform such refinements.

3.4 Incorporating Species Diversity

The assessment of 'evidence of a VME' should incorporate other information available from the catch beyond the weights of the key taxa listed above, particularly the overall diversity of taxa encountered. The VME ID form developed uses a presence / absence score to capture diversity among groups by assigning a single point to any listed taxa present in the catch, but below the threshold weight levels. With a proposed total VME Evidence score threshold of 3, at least 3 groups would need to be present in a single haul to constitute evidence of a VME.

3.5 Performance of the VME Protocol Using Existing Observer Data

Analysis of the 1,603 observer data records from 1998 - 2002 with the present scoring system leads to 49% of tows catching corals or sponges to be categorized as 'Evidence of a VME' (Table 2). As only about 5% of all observed tows deeper than 200 m caught corals or sponges at all, this would translate to about 2.5% of total observed tows deeper than 200 m during the period. Very few tows score 2 and most qualifying tows score only 3, indicating the tows are not qualifying based on diversity, but based on exceeding the threshold weight for a single category.

Table 2. The VME indicator score distribution of observed tows 1998-2002 >200m showing the number of tows at each VME score using the 50th percentile threshold weights. Bold numbers indicate the number of tows qualifying as evidence for a VME.

Score:	1	2	**3**	**4**	**5**	**6**	**7**	**8**
#Tows:	780	33	**770**	**18**	**1**	**1**	**0**	**0**
%Tows	49%	2%	**48%**	**1%**	**<1%**	**<1%**	**0%**	**0%**

Because the dataset includes tows targeting species such as hoki within the EEZ, threshold weights were compared using only orange roughy target tows. Using only orange roughy target tows decreases the sample size to only 530 observations. In general, orange roughy target tows tended to catch less ANT, HYD and ONG and about the same COU and COB. For contrast, using 2002 - 2007 data as the basis for performance analysis results in lower coral and sponge catches but more codes, which would tend to emphasize diversity. However, the percent qualifying, using the weight thresholds determined above, expectedly decreases from 49% to 27% as a result of lower weights caught in recent years, with the decrease in catch weights during the later period is more influential than having more taxon codes and the diversity aspect of the scoring does not result in many more tows exceeding

the threshold (Figure 8). Of course, re-doing the weight threshold analysis using this more recent data would result in lower weight thresholds for ANT, HYD and ONG.

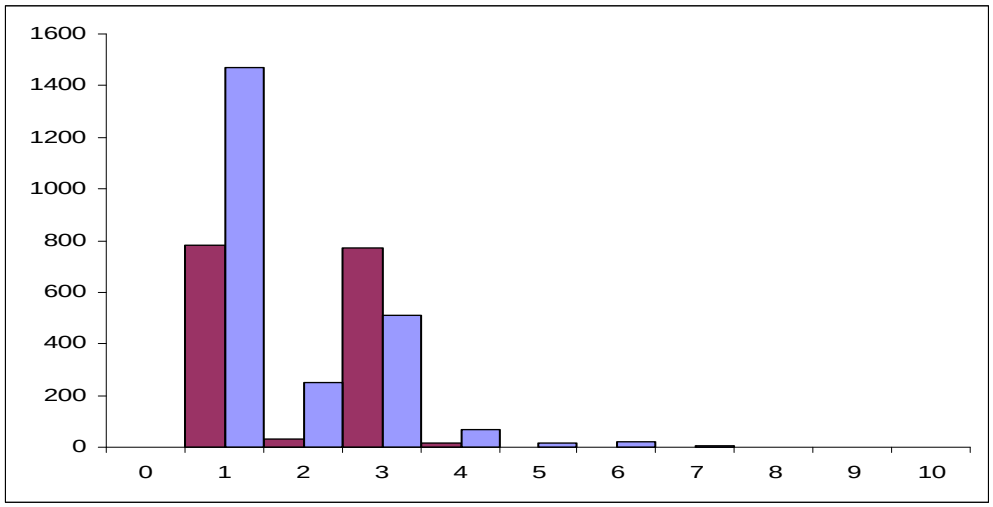

Figure 8. Comparison of total VME score distributions using 1998 - 2002 (magenta bars) versus 2002 - 2007 (blue bars) data.

Some hypothetical examples of application of the proposed VME ID protocol are provided below, showing hypothetical invertebrate catches and their resulting VME scores (where >=3 indicates evidence of a VME). Bold items are over the threshold, others count as 1 point.

Example 1	***Example 2***	***Example 3***
Catch composition: **Porifera 70 kg** **Gorgonian (2 species) 2 kg** Actiniaria 3kg Crinoidea 1kg VME score = 6+2 = **8**	Catch composition: Porifera 40kg Scleractinia 10 kg Unidentified Coral 3 kg Actiniaria 10kg VME score = 0+4 = **4**	Catch composition: **Scleractinia 200kg** Unidentified coral 3 kg VME score = 3+1 = **4**

Example 4	***Example 5***	***Example 6***
Catch composition: Scleractinia 10 kg Hydrozoa 4 kg VME score = 0+2 = 2	Catch composition: Unidentified Coral 40 kg VME score = 1+0 = 1	Catch composition: Unidentified Coral 40 kg Actiniaria 2 kg VME score = 0 +2 = 2

3.6 Comparison with Known Seamounts with Various Invertebrate Densities

Few datasets exist to investigate the relationship between what benthic invertebrates are actually on the bottom and what comes up in a trawl. The Graveyard Complex of seamounts within the New Zealand EEZ have a mixed of fished and un-fished seamounts, have some towed camera frame imagery, some tows with an epi-benthic sled and some experimental trawl fishing. However, when combined, only 1 tow from research cruise AEX9901 in overlapping areas with sled tows and camera tows caught coral, and this was on Graveyard,

a highly fished area. The other 8 tows did not return corals, highlighting the poor ability of these trawls to retain benthic materials, assuming the same areas were fished. Although research cruise TAN0604 also has camera and sled tows, the research cruise AMA0501 fished 1 tow on Graveyard, and 2 on Zombie, so any comparison would be minimal.

3.7 Potential Bias in Identification of Evidence of VMEs

Because several of the VME ID protocol design features and choices are somewhat arbitrary, or based on an existing dataset that is limited in scope and may not be representative of how the form will be used in the future, a list of potential biases and assumptions may be useful in assessing performance.

Design May Overestimate Evidence of a VME

- Observer data from 1998-2002 mainly categorized corals as COU. Available observer data from early / exploratory phases of the fishery, when coral catches are typically higher, did not identify individual identified coral orders. The form and current practice will generate more taxonomic categories than occur in past data, generating more diversity points and resulting in somewhat higher scores.
- Using a total VME score threshold equal to the score of a single important taxonomic group over the threshold weight protects vulnerable groups individually.

Design May Underestimate Evidence of a VME

- Using the 50th percentile leaves 51% of tows catching corals as not reaching the threshold for evidence of a VME. Although catch weights may appear small, trawl selectivity for many taxa is poor, so small individuals are not retained and large individuals are broken and not well retained. Comparisons of video with sled and trawl tows demonstrate the low selectivity and the small weights typically encountered.
- Several large groups of organisms are not included because they are poorly retained, rare, or not reliably identifiable. For example, Bryozoans, Xenophyophores, hydroids.
- The number of families and species within each order (or species code) listed are not equal, so the form down-weights the importance of true species-level biodiversity.
- The form uses data from high coral catch years, tending to set threshold weights high if fishing practices change or target species and effort remain in previously fished areas. This would tend to generate future catches with weights lower than the thresholds.

3.8 Analytical Process to Identify Existence of VMEs

While the proposed VME Evidence protocol and form described above is designed to provide initial evidence of the possible existence of a VME in the area where a trawl encountered sufficient evidence to trigger the move-on rule, this does not constitute adequate evidence of existence of a significant VME in the area, nor of significant adverse impact on a VME. The intention is to review all evidence gathered using the VME ID form, all additional data collected by observers doing detailed benthic by-catch analyses for all high seas tows (including outside the moderately trawled 'move-on' blocks), as well as any other relevant information which might be useful in determining the likelihood of presence of VMEs, at periodic intervals. All evidence and data would certainly need to be fully reviewed in 2010, when the interim measures, and resultant implementation options, are to be reviewed.

Using a similar by-catch weight threshold approach to the protocol described in this paper, the IUCN have proposed an example of how repeated encounters showing evidence of a

VME, either over time or space, could be periodically analysed to identify areas with a high likelihood of actual existence of VMEs, based on these repeated encounters (Rogers *et al*. 2008):

IUCN Criteria for Existence of VMEs:
Corals

- Two or more consecutive hauls containing > 2 kgs each of live corals on the same trawl track or setting area for fishing gear or where consecutive trawling tracks or sets intersect.
- > 4 encounters of corals > 2 kgs within an area (1 km^2) within one year.
- > 4 corals per 1,000 hooks in a long line fishery within one year within an area (10 km^2).
- > 15% of hauls of any gear within an area (10 - 100 km^2) containing corals.

Sponges or other Habitat-Forming Epifauna

- Two or more consecutive hauls containing >5kg sponges or other habitat-forming epifauna on the same trawl track or setting area for fishing gear or where consecutive trawling tracks or sets intersect.
- > 10 encounters of > 2 kg sponges or other habitat-forming epifauna in an area (1 km^2) within one year.
- > 15% of hauls of any gear within an area (10 - 100 km^2) containing sponges or other habitat forming epifaunal taxa.

In addition to benthic by-catch data collected by observers on VME ID forms and detailed benthic by-catch analysis forms, a range of other information could be useful in predicting likelihood of the presence of VMEs, and selecting representative areas for protection by means of spatial closures. In the absence of actual benthic biodiversity data, the most important additional information relates to physical characteristics of seabed topography and overlying oceanography:

Physical Characteristics Indicative of VMEs:
Bio-Geographic Zone

- This reflects oceanographic conditions (water mass). Various zonation systems could be applied.

Separation / Connectivity

- Distance between seamounts (~ 200 – 500 km), and the relationship of seamount direction to current flow will affect the dispersal abilities of fauna:
  - Isolated seamount; part of a cluster; or part of a linear chain (includes ridge peak system).

Summit Depth

- Depth is a major determinant of species composition. As the seamounts by definition arise from abyssal depths (in most cases), elevation is also a relative measure of seamount size:
  - 0–200 m; 201–1000 m; 1001–2000 m; >2000 m.

Substratum Type

- Sediment type will affect what fauna can occur (although most areas may have a wide range of substrate types):
  - Predominantly hard substrate (basalt, rocky); Predominantly soft substrate (mud, sand).

Seabed Topography

- This will be partially determined by substratum geology. Important features would include:
  - Guyot (flat-topped area); conical (small summit area); canyons and steep cliff features.

Oxygen Concentration & Nutrient Levels

- Oxygen levels can also be important for survival of certain groups of species:
  - 0–1 ml/l; 1–3 ml/l; >3 ml/l.
- Elevated seabed topographic features are often associated with localised increases in nutrient cycling and productivity.

Regarding the need to identify and protect areas representative of different bio-geographic zones, within the New Zealand trawl footprint area, it is probably adequate to consider the Tasman Sea area and the Louisville Ridge area to each represent single bio-geographic zones, for the purposes of stratification. With regard to extent of separation or connectivity, in the New Zealand trawl footprint, the clearly distinguishable fishery areas shown on the footprint maps are probably small enough to be considered as suitable and separate strata, in terms of connectivity.

The most important remaining characteristics to consider in any broader analysis to detect and map distribution of VMEs are therefore summit depth, substratum type (hardness) and seabed topography, all of which can be reasonably evaluated using high resolution bathymetric data. Such data are therefore the most important additional information required, after actual benthic biodiversity data.

In recognition of the importance of seabed topography as indicative of likely presence of VMEs, and the general paucity of biodiversity data, the 2007 FAO Expert Consultation on deepwater fisheries (FAO 2007) defined a number of seabed topographic or geological features which would be highly likely to support VMEs:

Examples of areas (mega-habitats) which are topographical, hydrophysical or geological features (including fragile geologic structures) known to support vulnerable species, communities, or habitats (FAO 2007):

a. Edges and slopes of oceanic islands and continental shelves (e.g., corals and sponges),

b. Summits and flanks of seamounts, guyots, banks, knolls, and hills (e.g., corals, sponges, xenophyphores),

c. Canyons and trenches (e.g., burrowed clay outcrops, corals),

d. Hydrothermal vents (e.g., microbial communities and endemic invertebrates), and

e. Cold seeps (e.g., mud volcanoes, microbes, hard substrates for sessile invertebrates).

When developing proposals for spatial closures to protect areas likely to contain VMEs based on analyses of benthic by-catch and the above ancillary information, consideration should also be given to the scale of fishing impact in relation to the spatial extent of the ecosystems concerned, and to distinguish between an impact on a particular habitat or ecosystem feature, and a significant adverse impact on such ecosystem.

4. Implementation of the Interim Measures for Bottom Fisheries

New Zealand's proposed process for implementation of the SPRFMO Interim Measures for Bottom Fisheries is described below against each of the interim measure paragraphs:

IM 1. Limit bottom fishing effort or catch in the Area to existing levels3 in terms of the number of fishing vessels and other parameters that reflect the level of catch, fishing effort, and fishing capacity.

Total bottom trawling fishing effort and catch have declined steadily over the 2002-2006 period (Penney *et al.*, 2007). Coupled with the other elements of these interim measures and prevailing economic conditions (e.g. rising fuel prices and US$/NZ$ exchange rate), it is anticipated that total catch and effort in the near future will not exceed existing levels. However, to ensure compliance with catch/effort limitations set out in the interim measures, effort limits are planned to be included in future regulations, as these represent a more suitable framework for such controls.

IM 2. Not expand bottom fishing activities into new regions of the Area where such fishing is not currently occurring.

The New Zealand high seas bottom trawl footprint in the SPRFMO Area consists of 200 20' x 20' (WGS84) blocks, as defined in the Interim Benthic Assessment Framework agreed by participants at the fourth SPRFMO consultation meeting. These are distributed across the various fishing areas as shown in the table below.

Fishing Area	**Total**
Other	14
Lord Howe North	22
Lord Howe South	23
West Norfolk	17
Challenger	58
Louisville North	24
Louisville Central	26
Louisville South	16
Total	**200**

Bottom trawling will not be permitted within the footprint of other bottom fishing methods (e.g. bottom longlining) in order to limit the impacts of bottom trawling to existing areas.

IM 3. Starting in 2010, before opening new regions of the Area or expanding fishing effort or catch beyond existing levels, establish conservation and management measures to prevent significant adverse impacts on vulnerable marine ecosystems4 and the long-term sustainability of deep sea fish stocks from individual bottom fishing activities or determine that such activities will not have adverse impacts, based on an assessment undertaken in accordance with paragraphs 11 and 12 below.

Not applicable until 2010 when new regions may be opened or fishing effort expanded. However, implementation of this element of the interim measures will be considered in the drafting of future regulations.

[3] Existing levels of fishing effort or catch means is defined in the SPRFMO Interim Measures as being the average annual levels over the period 1 January 2002 to 31 December 2006.

[4] For the purposes of these interim measures, 'vulnerable marine ecosystems' includes seamounts, hydrothermal vents, cold water corals and sponge fields (SPRFMO 2007).

IM 4. Cooperate through coastal States adjacent to the Area informing the Interim Secretariat of their own conservation and management measures in respect of deep sea fish stocks.

In developing its approach to implementing the interim measures, and in particular paragraphs 6 and 7, New Zealand has consulted several coastal States. This report has also been submitted to the Interim Secretariat.

IM 5. Cooperate to identify, on the basis of the best available scientific information, vulnerable marine ecosystems in the Area and to map sites where these ecosystems are located, and provide such data and information to the Interim Secretariat for circulation to all Participants.

New Zealand reported VME maps to the fourth SPRFMO consultation meeting (Penney *et al*., 2007) and is working to refine these maps in cooperation with its fishing industry. This process will be supported through the reports produced by the observers who are to be placed on all bottom trawl vessels and the approach taken to implement paragraphs 6 and 7 below.

IM 6. In respect of areas where vulnerable marine ecosystems are known to occur or are likely to occur based on the best available scientific information, close such areas to bottom fishing unless, based on an assessment undertaken in accordance with paragraphs 11 and 12 below, conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems and the long-term sustainability of deep sea fish stocks or it has been determined that such bottom fishing will not have significant adverse impacts on vulnerable marine ecosystems or the long term sustainability of deep sea fish stocks.

IM 7. Require that vessels flying their flag cease bottom fishing activities within five (5) nautical miles of any site in the Area where, in the course of fishing operations, evidence of vulnerable marine ecosystems is encountered, and report the encounter, including the location, and the type of ecosystem in question, to the Interim Secretariat so that appropriate measures can be adopted in respect of the relevant site. Such sites will then be treated in accordance with paragraph 6 above.

There is some uncertainty about the interrelationship of these paragraphs and, in particular, about whether the 'move on' rule set out in paragraph 7 applies to all parts of the SPRFMO Area, or only to areas in where conservation and management measures have <u>not</u> been established in accordance with paragraph 6. New Zealand's interpretation of paragraph 6 is that once adequate conservation and management measures have been established to prevent significant adverse impacts on VMEs and the long-term sustainability of deep sea fish stocks, it was not intended that any encounter with evidence of a VME would require a halt to fishing. It has to be expected that some evidence of VMEs will be encountered when bottom trawling takes place, even after conservation and management measures have been established. In New Zealand's view, the move on rule in paragraph 7 applies in areas where adequate conservation and management measures have not yet been established. In such cases, paragraph 7 requires fishing to stop until conservation and management measures have been established for those areas in accordance with paragraph 6.

New Zealand considers this approach to be consistent with the interim measures and with UNGA Resolution 61/105. It is also consistent with the approach proposed by the European

Commission for European Community flagged vessels operating on the high seas where there is no RFMO or interim measures in place (CEC, 2007).

Taking into account the above interpretation, a three-tier approach to implementing paragraphs 6 and 7 has been developed. This approach also takes into account the precautionary approach. The footprint blocks have been classified into three levels, being 'lightly' trawled blocks, with < 3 trawls over the 2002 - 2006 period, 'moderately' trawled, with 3 - 50 trawls over the period, and 'heavily' trawled blocks, with > 50 trawls over the period. (As detailed in section 2, the division between moderately and heavily trawled blocks has simply been chosen mid-way along the range of trawled blocks, to place equal numbers of blocks into these two tiers.) This is illustrated in the table below and Appendix A:

Fishing Area	Lightly Trawled	Moderately Trawled	Heavily Trawled	Total
Other	8	5	1	14
Lord Howe North	8	9	5	22
Lord Howe South	12	5	6	23
West Norfolk	6	7	4	17
Challenger	9	20	29	58
Louisville North	7	7	10	24
Louisville Central	6	13	7	26
Louisville South	6	3	7	16
Total	**62**	**69**	**69**	**200**

Tier 1: Lightly Trawled Blocks

Sixty two of the 200 blocks comprising the New Zealand component of the bottom trawl footprint have essentially been unfished, with only 1 - 2 tows over 2002 - 2006. These will be closed to further fishing. This reduces the footprint to a better approximation of the actual area 'currently fished', and protects these lightly trawled areas from further impact, while ensuring that effort is limited primarily to areas already impacted by previous fishing.

This approach is essentially the same as the 'open areas' approach recently proposed by the U.S.A. National Marine Fisheries Service for benthic habitat protection in the Aleutian Islands / Bering Sea groundfish trawl fishery (NMFS, 2007). The primary purpose of the NMFS proposal is to ensure that fishing effort remains focused on seabed areas already impacted by past fishing, and prevent effort from expanding onto adjacent un-trawled, or lightly trawled, areas. NMFS is proposing a similar approach, where any area with < 3 trawls per 100 km^2 will be closed to further fishing, with any area with > 2 trawls being designated the 'open' area for fishing. For comparison, the 20 minute blocks comprising the New Zealand trawl footprint range in area from 1,243 km^2 in the north to 898 km^2 in the south .

Tier 2: Moderately Trawled Blocks

Sixty nine of the 200 blocks comprising the New Zealand component of the bottom trawl footprint have been impacted by 3 - 50 tows over 2002 - 2006. Much of this appears to have been exploratory fishing in areas adjacent to targeted seamount features, and it is largely not known whether VMEs occur in these blocks.

The 'move on' rule has been applied in these blocks, using the definitions and VME Evidence form shown in Appendix B. Vessels bringing up evidence of a VME are required to move 5nm away from the position that hauling of the gear commenced for any particular tow, and not fish within 5nm of that position for the remainder of that fishing trip.

Data generated by trawls encountering 'evidence of a VME' will be reviewed annually together with other observer data on benthic by-catch, and additional closures of moderately trawled 20 x 20 minute blocks will be considered if consistent and significant evidence of VMEs is found within such blocks.

Tier 3: Heavily Trawled Blocks

Sixty nine of the 200 blocks comprising the New Zealand component of the bottom trawl footprint have been impacted by > 50 tows over 2002 - 2006. Much of this fishing effort has been targeted on seamount features, and these heavily trawled blocks account for most of the effort and catch over this period. Given the existing evidence about the substantial impact of bottom trawling, it is likely that most pre-existing VMEs in these areas have already been significantly impacted.

These blocks are considered, in principle, to be 'open' fishing areas, in which seamounts and VMEs are 'known' to occur. Bottom trawling will be subject to conservation and management measures adopted in accordance with interim measure paragraph 6. The 'move on' rule will not be applied, as these areas are treated in accordance with interim measure paragraph 6, with substantial block closures being implemented to protect a substantial proportion of the footprint area.

Additional Block Closures

While the heavily trawled blocks are, in principle, 'open' fishing areas in terms of interim measure paragraph 6, to afford protection to seamount features in heavily or moderately trawled areas, it is intended to close an additional 10% of total footprint blocks to protect representative areas in the moderately and heavily trawled areas. The 20 additional block closures will be selected based on the physical features listed in section 3.8 above, based on detailed bathymetry of the areas. Adequate and representative area closures have been recognized as probably the most suitable long-term VME protection measure by the SPRFMO Science Working Group meeting (SPRFMO, 2007) and the FAO (FAO, 2008). Recent IUCN recommendations on protection of seamounts and deep-sea VMEs recommend a minimum closure of 30% - 40% of such areas (Rogers *et al*. 2008).

These closures, implemented from the outset, are also consistent with the precautionary approach required by the interim measures. In order to ensure that the closures are representative of fishing areas, they will be distributed proportionally across the various fishing areas. Closing an additional 10% of blocks by fishing area will result in the additional closure of the following numbers of heavily or moderately trawled blocks in each fishing area:

Fishing Area	Heavily Trawled Blocks	Block Closures
Other	1	1
Lord Howe N	5	2
Lord Howe S	6	2
West Norfolk	4	2
Challenger	29	6
Louisville N	10	3
Louisville C	7	2
Louisville S	7	2
Total	69	20

(20 blocks = 10% of entire 2002 - 2006 footprint)

The mitigation measures to prevent significant adverse impacts from bottom trawling in the footprint (as required under SPRFMO interim measure paragraph 6) is therefore the combination of closure of all lightly trawled blocks; the application of the move on rule in all

moderately trawled blocks with the potential progressive closure of moderately trawled blocks found to contain significant evidence of VMEs; and additional precautionary closures of representative blocks in the moderately and heavily trawled areas.

Key advantages of this approach are that representative trawled areas and un-impacted areas are closed to provide protection to known or likely VMEs from the outset. The clear definition of open and closed areas provides certainty to industry and facilitates compliance. The approach also supports data collection as information on fishing impacts and regeneration rates can be monitored. New Zealand will review its implementation of the interim measures in 2010 more fully. This ties into the provision to open new regions of the SPRFMO Area in 2010 on the basis of an assessment (interim measure paragraph 3).

The application of the VME Evidence form and move on rule in the moderately trawled blocks will provide information on, and future protection to, unknown VMEs. The move on rule is considered secondary to the closed areas for protecting VMEs due to practical and scientific limitations. In particular, trawls are very poor sampling tools of VME evidence, and trawling may have a significant adverse impact on VMEs while providing very little evidence thereof in a specific tow. How the evidence will be measured and compared against the thresholds set out in the VME Evidence form is also currently un-tested and it is likely that there will be lessons to learn and changes to make to the form and its application based on experience and data accumulated during its implementation. Furthermore, there will be inevitable time lags in applying area closures in response to VME evidence to all vessels, both under New Zealand's and under other States' flags, due to the time needed for data review, administrative and legal processes.

In terms of the impact assessment requirements, in the longer term, individual high seas fishing permit holders are likely to be required by regulations to undertake assessments of their planned fishing activities, once further details of the Benthic Assessment Standard have been developed by the SPRFMO consultations. In the meantime, New Zealand will gather information on fishing plans as part of the annual high seas permitting process, and to compile and submit to the Interim Secretariat, an impact assessment for intended bottom fishing activities based on the implementation approach outlined in this paper, once this information has been provided..

IM 8. Not withstanding paragraph 2, in regions of the Area where bottom fishing is not currently occurring, undertake, as appropriate, scientific research activities for stock assessment purposes in identified parts of such regions and only in accordance with a research plan that has been provided to the Interim Secretariat for forwarding to the interim Science Working Group and all Participants, preferably 60 days prior to the commencement of that activity. Participants will provide promptly a report of the results of such scientific research activities to the Interim Secretariat for circulation to all Participants.

For the present, New Zealand is restricting bottom trawling, including for research purposes, to the current footprint. However, consideration will be given to including in future regulations a requirement that any scientific research activities for stock assessment purposes to be undertaken by New Zealand flagged vessels in new areas can only take place in accordance with a research plan approved by the Ministry of Fisheries. The Ministry will provide any approved plan to the Interim Secretariat for forwarding to the Science Working Group as required by paragraph 8.

IM 9. Appoint observers to each vessel flying their flag and undertaking or proposing to undertake bottom trawling activities in the Area and ensure an appropriate level of observer coverage on vessels flying their flag and undertaking other bottom fishing activities in the Area.

A Notification was issued to all New Zealand high seas bottom trawlers in December 2007 requiring all vessels to carry up to two observers. This initiative will be strengthened with the introduction of new high seas fishing permit conditions that require all New Zealand high seas bottom trawlers to carry up to two observers. Observers will be provided by the Ministry of Fisheries and will be fully cost recovered.

The number of observers (one or two) required on each vessel will be reviewed when high seas fishing permit holders approach the Ministry of Fisheries for observer coverage to ensure complete monitoring of the impacts of bottom trawling on VMEs, full and effective observing of the move on rule, and the accurate reporting of evidence of VMEs. Primary factors that will be considered include the crewing configuration and physical capacity of vessels. For example, those vessels crewed for fishing on a 24 hour a day basis will be required to carry two observers, while vessels physically unable to accommodate two observers and crewed for shift work will generally be required to carry only one observer. Accordingly, permit holders will need to demonstrate how they will operate in consideration of the working hours of the observers to ensure one hundred per cent observer coverage of all bottom trawling activities.

IM 10. To strengthen its control over bottom fishing vessels flying its flag, each participant will ensure that all such vessels operating in the Area be equipped with an operational vessel monitoring system no later then 31 December 2007, or earlier if so decided by the flag State.

Vessel monitoring systems are already in place for all New Zealand high seas vessels in accordance with the SPRFMO VMS Standard adopted at the fourth SPRFMO consultation meeting.

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Appendix A

Rationale for Inclusion of Taxa Used to Detect Evidence of Vulnerable Marine Ecosystems

The table below provides the specific rationale for including each taxonomic group in the protocol and form to identify evidence of fishing on a vulnerable marine ecosystem, including why each taxonomic group was included, how a threshold weight was chosen and why each group is important as a VME indicator.

	Rationale		
Taxon	**Include/exclude**	**Threshold Weight**	**VME score**
Porifera	Both classes (Demospongia and Hexactinellida) found in the deep sea can form complex structures and are vulnerable to disturbance by fishing gears.	No data on individual classes are available to scale catches for each code, but the vulnerability of glass sponges is likely higher. Data from new collections will aid in splitting this taxon into appropriate groups.	High densities of sponges in field and large colonies form complex structures and may provide habitat for many species. Longevity is unknown.
Cnidaria	Excluded as a taxon because we exclude classes such as jellyfish. However, it is listed to show the structure of taxa included in the evaluation.		
Anthozoa	Excluded because all Anthozoa should be classified to the appropriate order for the purposes of the form		
Alcyonacea	Soft corals may provide structural habitat in the deep sea. Some species can become large.	These are usually small organisms, but some deep sea species may be large . Only 11 observations of SOC exist since 1998, so this code should not be a main indicator, but when present it is useful.	Level 3- Specifically listed by FAO, so given high importance based on life history, but likely not a functional taxon for assessment. If found in high densities though, they would be vulnerable to fishing gear.
Gorgonacea	Specifically listed by FAO. These organisms may be large and form complex biogenic structure. Although several species are identifiable by observers, actions would be the same, so they are pooled for rapid VME assessment.	This code was not used until recently, so may not represent high catch areas (98-07). The distribution of catch weights decrease very quickly, with 50% of catches having weights of 1 kg or less. As a 1 kg sample could still contain several species from this order, this method does not provide a separate abundance from diversity within the taxon.	Level 3- Gorgonians are specifically listed in the FAO guidelines as examples of vulnerable ecosystem components to protect. This group includes several large and high profile species. Gorgonians are prime examples of large, complex, low-productivity cold water corals these measures are designed to protect.
Pennatulacea	Sea pens are not included in the NZ EEZ benthic materials listing, but are specifically listed by FAO guidelines for international waters. They are typical of softer substrates but do provide complex structure and have been associated with habitat for fish and invertebrate species and are vulnerable to trawl gear, both because they can be tall and because they live in mud/sand areas where trawling is common.	Although sea pens can occur in dense patches, previous observer data has only recorded very low weights for individual tows leading to a low threshold of only 1 kg, but this is likely an underestimate due to limited distribution deeper than 200m or retention in the net after dumping catch. A presence / absence indicator is all that is necessary.	Level 1- Sea pens are specifically listed as VME examples by FAO guidelines, but do not indicate hard substrate or stony corals. They do, however, suggest a different type of VME. They are scored here as in indicator of habitat containing vertical structure but do not qualify as evidence of a VME alone.
Actiniaria	Anemones are not listed by FAO guidelines, but are	Anemones are variable in size, but can be heavy and	Level 1- As an indicator of other VME components, a low

	indicators of hard substrate and conditions which may support corals, so are included here as an indicator group. They can also be endemic, large, species with unknown longevity and productivity and may be associated with other species.	abundant. As an indicator of habitat suitable for corals, a presence / absence indicator is all the is necessary	importance of 1 effectively utilizes anemones as an indicator group.
Scleractinia	Stony corals, especially complex branching taxa, are specifically listed by FAO guidelines as one of the main target taxonomic groups of the VME definition..	As various size organisms exist in different subtaxa, they are fragile, may be small bodied and not well retained in trawl gear, a low threshold is expected. However, these were often coded as COU, which for the period 98-02 had a 50th percentile of 30kg. No data exists to separate catches of cup corals from branching corals, but these will be collected in the future.	Level 3- These are slow growing species vulnerable to disturbance by fishing gear, with unknown recovery rates and a high importance is given.
Antipatharia	Black corals are structure-forming, complex, and vulnerable to fishing gear.	The organisms are light and fragile in structure, so a low weight is expected. This is supported by observer data showing 50% of samples are less than 1 kg.	Level 3- These are low productivity, structure-forming species vulnerable to fishing gears and are also specifically protected in NZ waters.
Hydrozoa	This taxon includes hydrocorals, which are specifically listed by FAO. It also includes smaller hydroids, but we have no species codes to split these two apart. Further, most hydroids are much smaller, so they may not fit biologically with the characteristics of hydrocorals, such as *Errina* spp, which can be very large. If only hydrocorals are considered important as complex structure, then leaving hydroids as a default provides a good index for larger species; but would effectively ignore the smaller, hydroid groups.	Some of these individuals can be very large, and they are found at high densities, so picking a threshold weight is not straight forward. 50% of tows catching corals catch less than 6 kg, but as these also occur as smaller individuals that may be colonizing impacted areas, many could be impacted before 6 kg is retained. Lowering the threshold weight for this taxon should be discussed.	Level 3- This class contains several high-profile species such as *Errina*. If the threshold weight is exceeded, then either many smaller individuals or significant large individuals were caught, either one indicating diverse coral are present.
Unidentified Coral	Specimens that cannot be placed in an order (likely dead or crushed segments) still provide information that the area either recently or still does support structure forming corals. So it is included here as a separate indicator of coral habitat and is a complex structure by itself.	These are likely dead but are indicators of habitat suitability for live corals and may even be part of the base of a live coral specimen. However, large quantities are not recorded in the database. It is likely not well retained by trawl gear.	Scored as level 1. Unidentified Coral is only considered as a suitable habitat indicator and taxa of live corals would need to be present to consider the specimens as evidence of a VME.
Echinodermata-Crinoids	Of all the echinoderms, this group is associated with hard substrates and often with corals. They are not however, specifically listed by	As crinoids are relatively small and light, and infrequently observed in the catch, 50% of catches are less than 1 kg. Crinoids are	Level 1-Once detected, crinoids would still only be an indicator hard substrate, so a low VME score of 1 is given.

	FAO, and do not possess the life history traits that FAO considered vulnerable when defining VMEs.	only recorded 9 times since 1998, so may not provide much of an effect.	
Diversity Index	The VME assessment form needs a way to incorporate taxonomic diversity, especially if several taxa are observed below the threshold weight.	A diversity index is accomplished simply by identifying groups that were observed but not over their weight threshold.	Importance is scaled by adding 1 point per group observed but below the threshold. Therefore, if 3 groups were observed all below threshold, that would be a strong suggestion that the fishing site contained a VME. Some groups get 1 point regardless of weight- they are just indicators.

Vulnerable Marine Ecosystem Evidence Process (Version 1.0 - Feb 08)

1. Trip, tow, and vessel information

Trip number	Tow number	Observer/s		Name of vessel master

2. Date, time, and position that hauling of the gear commenced

Date dd/mm/yy	Time 24-hr clock	Latitude Degrees Minutes	Longitude Degrees Minutes E/W
/ /	:	° . ' S	° . '

3. Instructions

Assess the total weights of all organisms whether dead or alive in each of the relevant taxonomic groups and record in Section 4.

If the Observed Weight of a taxonomic group is **greater than** (not equal to) the Threshold Weight, write the VME Indicator Score for that group in the "Score" Column.

If a taxonomic group is present, but the Observed Weight is **not** greater than the Threshold Weight, tick in the "Tick" column.

Sum the scores and count the ticks. Record these totals at the bottom of the columns. Add the Sum of scores to the Count of ticks and record it as the Total VME Indicator Score.

If the Total VME Indicator Score is 3 or greater, the area is considered to have Evidence of a Vulnerable Marine Ecosystem.

4. Relevant taxonomic groups, weights, and scores

Taxonomic Group	Code	Method of Analysis	Observed Weight (kg)	Threshold Weight (kg)	VME Indicator Score	Score if Threshold Weight exceeded	Tick if not scored but present
PORIFERA	ONG		.	50	3		✓
CNIDARIA							
Anthozoa (class)							
Actiniaria (order)	ATR		.	0	1		✓
Scleractinia (order)	SIA		.	30	3		✓
Antipatharia (order)	COB		.	1	3		✓
Alcyonacea (order)	SOC		.	1	3		✓
Gorgonacea (order)	GOC		.	1	3		✓
Pennatulacea (order)	PTU		.	0	1		✓
Hydrozoa (class)	HDR		.	6	3		✓
Unidentified Coral	COU		.	0	1		✓
ECHINODERMATA							
Crinoidea (class)	CRI		.	0	1		✓
Brisingida (order)	BRG		.	0	1		✓

Sum these scores

Count these ticks

Total VME Indicator Score → Sum of scores + count of ticks =

5. Vessel notification

As soon as the form is completed for any tow provide a copy to the person in charge of the vessel.

Name (if not vessel master)	Received by person in charge (signature)	Date received (dd/mm/yy)	Time received (24-hr clock)
		/ /	: