International Consultations on the Establishment of the
South Pacific Regional Fisheries Management Organisation

Eighth International Meeting: Science Working Group

SP-08-SWG-DW-01

Revised Draft Bottom Fishery Impact Assessment Standard

Contents

1. Introduction

Fishing with gears that make contact with the seabed (bottom fishing) has the potential to significantly impact the abundance and diversity of benthic species (Kaiser 1998, Koslow *et al*. 2001, Clark and Koslow 2007). The most fragile and vulnerable species are those that form complex biogenic structures which other species use as habitat, food or shelter from predation (Auster 2005). Deepwater habitat-forming species are often rare or endemic to isolated seamounts, creating areas of high biodiversity which are vulnerable to disturbance (Koslow *et al*. 2001, Richer de Forges *et al*. 2000, FAO 2008). These structure-forming organisms are typically slow growing and long lived, making them slow to recover and vulnerable to cumulative impacts from fishing (Clark *et al*. 2006). Benthic ecosystems that include organisms with these characteristics are referred to as 'vulnerable marine ecosystems' (VMEs) (UNGA 2007, FAO 2008, Rogers *et al*. 2008).

Many deep sea fish stocks have biological characteristics that result in low productivity, including: maturing at relatively old age, have slow growth, long life expectancies, low natural mortality rates, intermittent recruitment success and may not spawn every year. Their low productivity means that they are not able to sustain high exploitation rates and if depleted their populations are likely to recover very slowly. There is also limited data and information available to support management and so they pose a challenge for ensuring their sustainable utilization and exploitation (FAO 2008).

In response to the 2006 United Nationals General Assembly (UNGA) Resolution 61/105, the participants in the negotiations to establish a South Pacific Regional Fisheries Management Organization (SPRFMO) adopted interim measures for bottom fisheries, these require participants to:

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

In line with this participants are required to prepare impact assessments for bottom fishing activities:

11. Assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorized to proceed. (SPRFMO 2007a)

The interim measures also require the Science Working Group (SWG) to:

12. b) "*design a preliminary interim standard for reviewing the benthic impact assessments and develop a process to ensure comments are provided to the submitting Participant and all other Participants*" (SPRFMO 2007a).

Pending development of a more detailed standard, an interim Benthic Assessment Framework was developed by the SWG and adopted by the 6th Meeting of SPRFMO Negotiations (September 2007).

This document provides the draft interim *SPRFMO Bottom Fishery Impact Assessment Standard*, for consideration at the 8th meeting of the SWG. It has been developed using a broad range of currently available information, in particular the general principles developed internationally in response to UNGA Resolution 61/105, particularly the FAO *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* (FAO 2008)- referred to as the FAO Guidelines.

2. Purpose of the Standard

This Bottom Fishery Impact Assessment Standard (BFIAS) replaces the interim Benthic Assessment Framework. The purpose of the BFIAS is to provide a minimum standard for assessing the potential impacts of proposed bottom fishing activities on VMEs and deep-sea fish stocks. This standard will guide SPRFMO Participants in preparing the required bottom fishery impact assessments, and the SWG when reviewing these assessments. It is intended to constitute the standardised approach to be taken by all participants when preparing risk and impact assessments for high seas bottom fishing activities in the SPRFMO area.

The definitions and process in the BFIAS aim to be consistent with international principals and contribute to achieving the main objectives articulated in the FAO guidelines:

> 11. The main objectives of the management of DSFs are to promote responsible fisheries that provide economic opportunities while ensuring the conservation of marine living resources and the protection of marine biodiversity, by:
>
> i. ensuring the long-term conservation and sustainable use of marine living resources in the deep seas; and
>
> ii. preventing significant adverse impacts on VMEs (FAO 2008)

The BFIAS standard has been designed to ensure that areas containing VMEs and low productivity deep-sea resources are protected from significant adverse impacts due to bottom fishing, by ensuring management decisions are informed by robust impact assessments using the best data available.

As SPRFMO management measures for bottom fisheries are revised, and as information on distribution of VMEs and low productivity deep-sea resources and the impacts of bottom fisheries in the SPRFMO Area improves, this standard should be amended accordingly.

3. Area of Application

The BFIAS applies to all bottom fishing operations within the SPRFMO Area. While the SPRFMO Area is still under negotiation, for the purposes of the interim measures and this standard, the Area is considered to be the high seas area south of the Equator, north of the CCAMLR Convention area, east of the SIOFA Convention Area and west of the areas of fisheries jurisdictions of South American States (Figure 1).

Within regard to bottom fisheries, SPRFMO is primarily concerned with managing the *fishable area of the deep sea*, defined for the purposes of this BFIAS as bottom depths between 200 m and 2,000 m depth (Figure 1). This extends slightly beyond the range of current significant fishing (200 m to ~1,500 m) (Clark *et al.* 2006) to incorporate deeper areas of experimental fishing, and to ensure that potential risks to deeper areas from current fishing activities are assessed (Bailey *et al.* 2009).

Areas shallower than 200 m occur on continental shelf areas within EEZs of bordering nations and are not included in this definition. Areas deeper than 2,000 m are expected to remain beyond the reach of bottom fishing technology for some time.

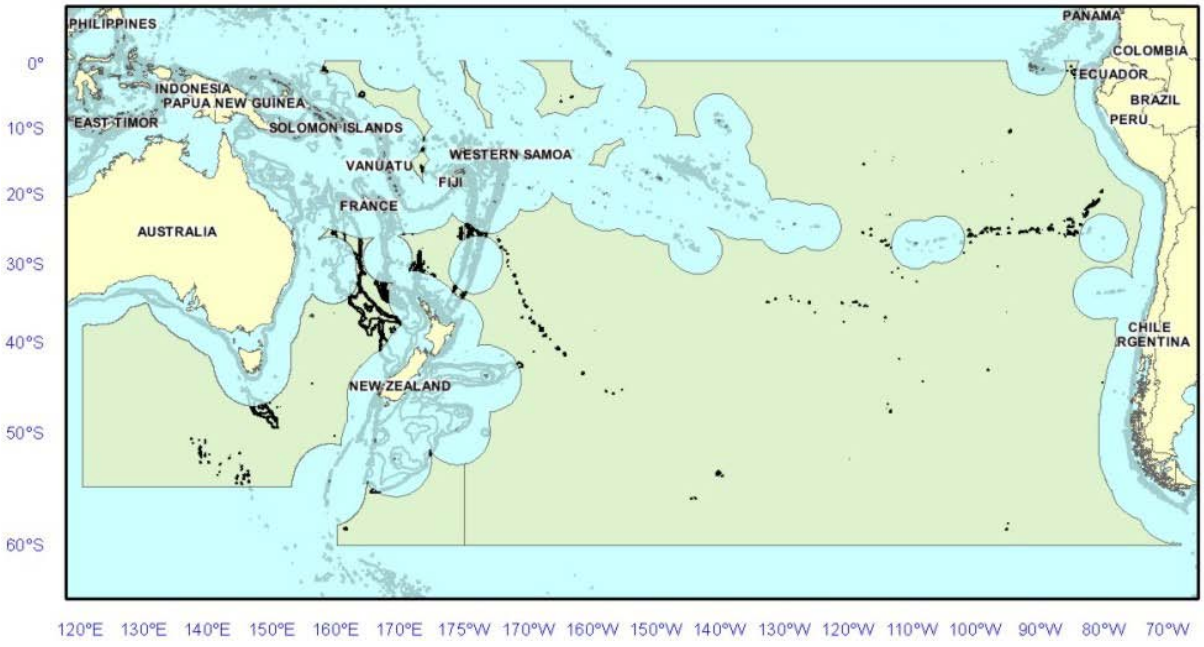

Figure 1. Map of the South Pacific Ocean showing the SPRFMO Area under negotiation, excluding state EEZs, and highlighting bathymetry contours of 200 m to 2,000 m.

4. Bottom Fishery Impact Assessment Process

The process for preparing, submitting, evaluating and commenting on these assessments was adopted at the 4th SPRFMO negotiation meeting in September 2007 (SPRFMO 2007c) and consists of the following steps:

- Participants are required to prepare bottom fishery impact assessments for all proposed bottom fishing activities in the SPRFMO Area, irrespective of the proposed scale, area or previous history of such fishing activities.

- Such impact assessments are to be prepared and submitted to the SPRFMO Secretariat prior to commencement of any bottom fishing evaluated under the assessment. Fishing may then proceed in accordance with the management and mitigation measures proposed in the assessment while the assessment is being evaluated.
- All bottom fishing impact assessments are to be posted on the SPRFMO website for public comment for a period of 30 days, and forwarded to the SWG for comment.
- The SWG is required to evaluate all assessment and provide written comments back to flag states through the SPRFMO Secretariat within 60 days of assessments being received. SWG comments on assessments are to be posted on the SPRFMO website.
- Flag states are required to respond to the written comments provided by the SWG.

5. Bottom Fishing Impact Assessment Standard

The BFIAS consists of:

- Definitions of key terms
- Detection of VMEs
- Bottom Fishery Impact Assessment Sections

5.1 Definitions

The BFIAS requires clear and specific operational definitions of risk, VMEs and significant adverse impacts (SAIs).

The FAO Guidelines (FAO 2008) currently provide the most comprehensive international definitions of these terms. Aspects of these guidelines which are relevant to SPRFMO Area fisheries have therefore been directly incorporated into this standard, in the definitions below.

5.1.1 Bottom Fishing

Bottom fishing is defined as fishing with any gear type likely to come in contact with the seafloor or benthic organisms (FAO 2008). The SPRFMO interim measures apply to all bottom fishing methods (SPRFMO 2007a).

5.1.2 Risk

The definition of risk for an assessment needs to be based on clearly stated objectives. The risk that is being determined is the risk of not achieving the stated objective.

The interim measures suggest that the high level objectives are:

1. That there are no significant adverse impacts from bottom fishing on VMEs
2. That deep sea fish stocks are managed for long-term sustainability.

These objectives need to be operationalized so that they become measurable and the risk can be assessed. Participants should clarify how this is being determined, with some suggestions given within Section 7. The impact assessment will then assess the risk of significant adverse impacts on VMEs and risk of unsustainable exploitation of deep-sea fish stocks resources. A risk-based approach recognizes that there is limited data available to directly quantify all potential impacts.

The unit of analysis for the impact assessment for VMEs is currently suggested to be 'VMEs' as a group rather than individual taxa. As more information becomes available (such as the location of different types of VMEs) it may be more appropriate to undertake the impact assessment for different types of VMEs. In terms of deep-sea fish stocks the unit of analysis should be the stock, however, similar to VMEs the data availability may constrain the unit of analysis to the species or resource assemblage level. As with VMEs, as more information becomes available it may be more appropriate to move to the stock level.

5.1.3 Low Productivity Deep Sea Resources

The FAO deep-sea management guidelines (FAO 2008, paragraph 13) recognize that marine living resources exploited by deep-sea fisheries in the high seas often have low productivity, can only sustain low exploitation rates and are slow to recover once depleted. Key biological characteristics of such low productivity species include maturation at relatively old ages; slow growth; long life expectancies; low natural mortality rates; intermittent recruitment of successful year classes; and spawning that may not occur every year (FAO 2008). Species with these characteristics within the SPRFMO Area will be considered to constitute low productivity resources, and need to be managed in accordance with the relevant guidelines and best practices for managing such resources.

5.1.4 Vulnerable Marine Ecosystems

The FAO guidelines define a number of characteristics which should be used as criteria in the definition of vulnerable marine ecosystems:

42. A marine ecosystem should be classified as vulnerable based on the characteristics that it possesses. The following list of characteristics should be used as criteria in the identification of VMEs.

    i. Uniqueness or rarity – an area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include:

        • habitats that contain endemic species;

        • habitats of rare, threatened or endangered species that occur only in discrete areas; or

        • nurseries or discrete feeding, breeding, or spawning areas.

    ii. Functional significance of the habitat – discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life-history stages (e.g. nursery grounds or rearing areas), or of rare, threatened or endangered marine species.

    iii. Fragility – an ecosystem that is highly susceptible to degradation by anthropogenic activities.

    iv. Life-history traits of component species that make recovery difficult – ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics:

        • slow growth rates;

        • late age of maturity;

        • low or unpredictable recruitment; or

        • long-lived.

    v. Structural complexity – an ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.

(FAO 2008)

The above characteristics should guide the identification and specific definition of VMEs in the SPRFMO Area. However, to provide operational definitions for use during fishing operations, it is necessary to use the above characteristics to develop lists of specific taxa (orders, families, genera or species) which are considered to contribute to VMEs in the SPRFMO Area. Annex 1 of the FAO guidelines provides a list of examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them and should be used as the basis for what constitutes a VME in the SPRFMO area:

FAO Guidelines Annex 1. Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them.

The following examples of species groups, communities, habitats and features often display characteristics consistent with possible VMEs. Merely detecting the presence of an element itself is not sufficient to identify a VME. That identification should be made on a case-by-case

basis through application of relevant provisions of these Guidelines, particularly Sections 3.2 and 5.2.

Examples of species groups, communities and habitat forming species that are documented or considered sensitive and potentially vulnerable to DSFs in the high-seas, and which many contribute to forming VMEs:

i. certain coldwater corals and hydroids, e.g. reef builders and coral forest including: stony corals (Scleractinia), alcyonaceans and gorgonians (Octocorallia), black corals (Antipatharia) and hydrocorals (Stylasteridae);

ii. some types of sponge dominated communities;

iii. 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

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

Examples of topographical, hydrophysical or geological features, including fragile geological structures, that potentially support the species groups or communities, referred to above:

i. submerged edges and slopes (e.g. corals and sponges);

ii. summits and flanks of seamounts, guyots, banks, knolls, and hills (e.g. corals, sponges, xenophyphores);

iii. canyons and trenches (e.g. burrowed clay outcrops, corals);

iv. hydrothermal vents (e.g. microbial communities and endemic invertebrates); and

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

(FAO 2008)

5.1.5 Surrogates to Identify VMEs

The FAO Guidelines note (paragraph 45) that, "*where site-specific information is lacking, other information that is relevant to inferring the likely presence of vulnerable populations, communities and habitats should be used*". This is reflected in the examples provided in Annex 1, shown above.

For much of the SPRFMO Area, data on seabed biodiversity and benthic community composition are not available. Therefore, ancillary information on physical factors (or surrogates) that influence the location of VMEs, will need to be used to predict likelihood and suitability of areas for supporting VMEs. The most important physical factors, and recommended stratification by these factors, are listed below:

Biogeographic Zone: Reflecting oceanographic conditions (water masses) in large ocean areas, such as the Southwest Pacific Ocean.

Proximity / Connectivity: Being the distance between underwater topographic features (such as seamounts), and the relationship of seamount direction to current flow. These affect the abilities of fauna to disperse and colonize adjacent seamounts. The range indicating a separate feature has been proposed as 100km - 200km and Clark (2008).

- Close (<100km separation) and Distant (> 100km separation) are recommended as appropriate strata for precautionary conservation in the central Pacific region.

Summit Depth / Seabed Depth Range: Depth is a major determinant of species composition, particularly on deep-sea seamount features with high elevation. Elevation above the abyssal plain (which typically lies at ~4000m deep in the South Pacific Ocean) is also a relative measure of seamount size. The following depth strata are recommended for the purposes of evaluating likelihood of impacts and adequacy of protection measures (modified from those recommended by Clark (2008) to divide strata at 2,000m, the current maximum trawlable depth):

- 0 - 200 m - This stratum represents the protrusion of a seabed feature into the photic zone.
- 201 - 800m - This stratum represents the depth distribution range of the scattering layer, composed of vertically migrating animals, and the impact of these on the fauna that exists on seamount summits. 800m is the upper bathyal split proposed by Zezina (1997).
- 801 - 2,000 m - This stratum covers part of the 800 - 3,500m depth band recognized as the lower bathyal biogeographic zone, as assigned by Zezina (1997) based on a global evaluation of brachiopods.
- > 2,000m - This is the stratum below current trawling technology, and currently beyond impact by deepwater trawling.

Seabed Topography: Seabed topography is an indicator of seabed geology, and therefore of substratum suitability for supporting VME species. FAO (2008) specifically recognizes the following as being features that potentially support species, groups or communities which may contribute to forming VMEs:

- Submerged edges and slopes; summits and flanks of seamounts, guyots, banks, knolls, and hills; canyons, trenches and hydrothermal vents.

(FAO 2008, Clark 2008, Penney *et al.* in press)

5.1.6 Significant Adverse Impacts

Vulnerable Marine Ecosystems

There is currently relatively little international guidance, on what would constitute a "significant adverse impact". The FAO Guidelines (FAO 2008) provide some guidance on this for VMEs:

17. Significant adverse impacts are those that compromise ecosystem integrity (i.e. ecosystem structure or function) in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types. Impacts should be evaluated individually, in combination and cumulatively.

18. When determining the scale and significance of an impact, the following six factors should be considered:

    i. the intensity or severity of the impact at the specific site being affected;

    ii. the spatial extent of the impact relative to the availability of the habitat type affected;

    iii. the sensitivity/vulnerability of the ecosystem to the impact;

    iv. the ability of an ecosystem to recover from harm, and the rate of such recovery;

    v. the extent to which ecosystem functions may be altered by the impact; and

    vi. the timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life-history stages.

19. Temporary impacts are those that are limited in duration and that allow the particular ecosystem to recover over an acceptable time frame. Such time frames should be decided on a case-by-case basis and should be in the order of 5-20 years, taking into account the specific features of the populations and ecosystems.

20. In determining whether an impact is temporary, both the duration and the frequency at which an impact is repeated should be considered. If the interval between the expected disturbance of a habitat is shorter than the recovery time, the impact should be considered more than temporary. In circumstances of limited information, States and RFMO/As should apply the precautionary approach in their determinations regarding the nature and duration of impacts.

(FAO 2008)

When evaluating the potential significance of adverse impacts of bottom fishing activities in the SPRFMO Area, the above factors should all be considered.

Each bottom fishery impact assessment will need to detail how the above factors were used to develop a definition of 'significance' for the purposes of the assessment. This should include at a minimum the criteria:

- The intensity or severity of the impact at the specific site affected (i.e. are entire colonies/habitats destroyed, or just a few branches broken), this will be gear specific (and may link be guided by the Hierarchy of Bottom Fishing Impacts (Table 2);

- The ecological consequence of a given impact (which depends on the distribution, density, and recovery potential of the organisms in question), including estimation of the likelihood of interaction;

- The spatial extent of the impact relative to the extent of the VME and whether there may be offsite impacts;

- The frequency of the impact and the cumulative fishing effort. The rate of impact (on a temporal and geographical scale) in relation to rates of recovery of taxa needs to be considered.

Many of these criteria are difficult to measure directly for deepwater fisheries and so assumptions must be made based on studies conducted elsewhere or expert input. All assumptions must be clearly documented in the impact assessments to ensure transparency.

5.1.7 Hierarchy of Bottom Fishing Impacts

The intent of UNGA Resolution 61/105 and the SPRFMO Interim Measures is to prevent significant adverse impacts on fragile benthic species in deep water. While some benthic ecosystems are more vulnerable to disturbance than others, they are also differentially vulnerable to the impacts of different bottom fishing gears.

Gear type and how the gear is to be fished is an important component of the evaluation of any fishing plan. Gear impact should be evaluated as a product of the typical seabed impact footprint per set or tow of the gear type to be used, the planned number of fishing events (to provide an estimate of the overall extent of physical impact), the likelihood of encountering vulnerable species in proposed fishing areas (including the proportion of planned deployments occurring in new areas) and the expected degree of impact by the gear type concerned, to generate an index of potential disturbance. Default rankings of expected level of impact by gear type are provided in Table 2.

Table 2. Ratings of habitat impact for each gear class on a scale of 1 (very low) to 5 (very high) (from Chuenpagdee *et al*. 2003).

Gear Class	**Benthic Habitat**	
	Physical	Biological
Gillnet –midwater	1	1
Hook and line	1	1
Longline – pelagic	1	1
Purse seine	1	1
Trawl – midwater	1	1
Longline – bottom	2	2
Gillnet – bottom	3	2
Pots and traps	3	2

Trawl – bottom[1]	5	5
Dredge	5	5

6. Detection of Vulnerable Marine Ecosystems

By using a characterisation instead of a definition, the FAO deep-sea guidelines avoid discussing region-specific details of taxonomic level, organism abundance or local biodiversity as potential criteria to use in assessments, or for triggering management actions. In order to implement the SPRFMO Interim Measures for Bottom Fisheries (SPRFMO 2007a), details of actual species or higher level taxa known or likely to contribute to VMEs in the South Pacific deep-seas, and the catching of which could indicate evidence of such VMEs, need to be established. The relevant SPRFMO interim measures state:

> ***Bottom fisheries***: In respect of bottom fisheries, Participants resolve to:
>
> 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.
>
> 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.
>
> (SPRFMO 2007a)

Implementation of these measures requires specific definitions of:

- Evidence of a VME to trigger the move-on provisions of interim measure 7; and
- Existence of areas known or likely to contain VMEs, to trigger the management requirements of interim measure 6.

[1] 'Bottom trawl' is defined for the purposes of this standard as any trawl net fished in such a way that it has a likelihood of coming into contact with the seabed at some time during the trawling operation.

It is important to distinguish between these. A protocol to determine 'Evidence of a VME' is required to enable a rapid assessment and immediate management response during actual fishing operations at sea, to limit immediate impact on areas which appear to support significant quantities of VME species. In contrast, 'Designating a VME' requires a scientific and deliberative longer-term analysis to integrate data from individual encounters and assess information on occurrence of VMEs across larger spatial scales, in order to identify, map and designate areas which are considered to constitute actual VMEs (see SPRFMO Mapping of Bottom Fishing Effort and VMEs document).

6.1 Detection of 'Evidence of VMEs'

SPRFMO bottom fishing interim measure 7 is intended to apply in cases of unexpected interactions with VMEs in areas where no other pre-determined management action has been implemented to prevent significant adverse impacts. IM 7 specifies an immediate 5 nautical mile move-on provision when 'evidence of VMEs' is encountered and is intended to be applied at sea during individual fishing operations. A number of key principles, constraints and requirements need to be considered when designing a protocol to detect evidence of a VME:

Key Principles for a Protocol to Identify 'Evidence of a VME'

- Evidence of a VME needs to be defined in a way which makes this measure implementable at sea. Such evidence must necessarily be defined in terms of benthic by-catch made during individual bottom fishing operations (e.g. trawl tows or line sets).
- Evidence should be derived from species which possess the characteristics considered to make them vulnerable to deep-sea bottom fisheries, as defined in the FAO deep-sea guidelines. Emphasis should be placed on taxonomic groups which may contribute to forming VMEs (FAO 2008, Annex 1).
- The protocol should be rapid to implement at the end of each tow or set, and should not require a high level of taxonomic identification expertise. Relatively few, higher order taxonomic groups should be used, rather than individual species or genera.
- Some measure of quantity needs to be incorporated to allow the protocol to distinguish between a sporadic capture of a single organism which may not indicate evidence of a VME and a quantity of by-catch which is considered to constitute evidence of a vulnerable ecosystem.
- Higher ranks / scores should be accorded to species considered more vulnerable to fishing impacts, or which are considered to be strong indicators of VMEs. The protocol should also incorporate some measure of biodiversity, to accord higher scores to bycatches of many species, as opposed to a single species.

Designation of Taxa Constituting Evidence of a VME

The FAO deep-sea guidelines (paragraph 42) identify characteristics of species or communities that should be considered to be vulnerable to impacts of bottom fishing. Annex 1 of the guidelines provides examples of taxonomic groups of organisms which have those characteristics, and which could contribute to forming VMEs (FAO 2008). From these guidelines, taxonomic groups selected for incorporation into a SPRFMO VME Evidence protocol should be those which are:

- Functionally significant to the community or ecosystem, either by creating structural complexity that other species may utilize as habitat, or by providing some unique function that supports the community;
- Low productivity species due to life history traits such as slow growth, high longevity, low fecundity, or unpredictable recruitment;
- Unique, rare or endemic to a small area;
- Fragile to bottom fishing gear;
- Retained to some degree, and previously observed, in bottom fishing gear;

- Quickly identifiable by scientific observers onboard without the aid of complex taxonomic identification guides or equipment.

Taxonomic groups which meet the above criteria, and which are proposed for inclusion in the SPRFMO VME Evidence protocol (Parker *et al*. in press) are listed in Table 1. Taxa such as bryozoans and feathery hydroids have been excluded from this list because they are generally not retained by bottom fishing gears.

Weight Thresholds Constituting Evidence of a VME

Bottom trawls are inefficient at sampling benthic organisms, with poor selectivity for some benthic species of concern such as fragile coldwater corals. Bottom trawl benthic bycatches are therefore likely to consist of low weights, even in areas of abundant VME taxa. However, bycatches of a single retained benthic organism may not constitute evidence of a VME. It is therefore necessary to determine appropriate bycatch weight thresholds which indicate likelihood of interaction with a actual VME, while avoiding triggering a move-on response, and unnecessary spread of fishing effort, in areas with sparse benthic organisms. Such threshold weights should be based on analysis of actual bottom fishing bycatch data for the method and region to be fished, to integrate some measure of gear selectivity for the chosen taxa.

Proposed threshold weights for SPRFMO Area bottom trawl fisheries were determined for each taxonomic group in Table 1 based on the cumulative distribution of bycatch weights observed in 19,000 bottom trawl tows in the New Zealand deep-sea trawl fishery from 1998 - 2002, an exploratory fishing period when VME encounters would be expected to have been most frequent (Parker 2008, Ministry of Fisheries 2008, Parker *et al*. in press). The median of the cumulative weight frequency distribution for by-catches of each taxonomic group is proposed as an appropriate threshold to distinguish between bycatches of isolated or spares benthic organisms, and bycatches which constitute evidence of an actual VME (see Parker *et al*. in press). The resulting bycatch threshold weights for the proposed VME evidence taxa are shown in Table 1. As additional data become available these weight thresholds will be reviewed by the Scientific Working Group.

VME Indicator / Vulnerability Rankings

In addition to threshold weights, a relative weighting score should be assigned to each taxonomic group based on understanding of the respective vulnerability of each taxon. Taxa that have life history characteristics making them vulnerable to fishing activities, or which are strongly indicative of VMEs, should be allocated a higher score. Other groups, less vulnerable themselves but which are indicators of habitats suitable for vulnerable species, could be included, but with a lower score.

Level of biodiversity is also an important measure of the vulnerability of VMEs, and of the importance of protecting such areas. In addition to evaluation of individual taxa, some measure of biodiversity should be included in the VME evidence protocol. This is achieved in Table 1 by allocating a score of 3 to taxa considered to be vulnerable and likely indicators of VMEs, while allocating a score of 1 to additional taxa which are less vulnerable, but which may indicate suitable VME habitats, and which contribute to biodiversity. The combined scoring process ensures that a single large catch of a vulnerable taxon will trigger the move-on rule, but that bycatch of several vulnerable groups, even if below the threshold weights, will also constitute evidence of a VME. As additional data become available these vulnerability rankings will be reviewed by the Scientific Working Group.

VME Evidence Protocol

The proposed taxonomic groups to be used for identifying evidence of interaction with a VME, proposed threshold weights for these taxa and proposed VME ranking scores are summarised in Table 1.

Table 1. List of taxonomic groups which should be used assessed to identify evidence of fishing on a VME in the South Pacific Ocean (Parker 2008, Ministry of Fisheries 2008, Parker *et al*. in press).

Taxonomic Group	Common Name	Bycatch Weight Threshold (kg)	VME Rank / Score
Phylum: Porifera	sponges	50	3
Phylum: Cnidaria			
Class Anthozoa:			
Order: Actiniaria	anemones	-	1
Scleractinia	stony corals	30	3
Antipatharia	black corals	1	3
Alcyonacea	soft corals	1	3
Gorgonacea	sea fans	1	3
Pennatulacea	sea pens	-	1
Class: Hydrozoa:			
Order: Anthoathecatae			
Family Stylasteridae	hydrocorals	6	3
Unidentified corals	corals	-	1
Phylum: Echinodermata			
Class: Crinoidea	sea lilies	-	1
Order: Brisingida	armless stars	-	1

(Note: Taxa associated with seep and vent systems should be included in future revisions if bottom fisheries intend to fish in the vicinity of seep and vent systems.)

The taxa, threshold weights and VME scores in Table 1 are combined into a proposed rapid assessment protocol, as detailed on the *VME Evidence Form*, shown in Appendix A. This provides a simple, rapid procedure to determine if a particular benthic bycatch is likely to be from a VME, based on a few key taxonomic groups. In incorporating the vulnerability rankings and threshold weights into a real-time protocol for use at sea, available information is synthesized on the simple scoring form, incorporating the weights of each vulnerable group, presence of habitat indicators and an index of taxonomic diversity into a single score. Under this protocol, a score of 3 constitutes evidence of a VME, and should trigger a move-on.

To aid in accurately identifying specimens from these groups, a classification guide specific to the taxa to be monitored under the *VME Evidence Protocol*, utilizing non-technical and visually apparent characteristics to rapidly distinguish the groups (Tracey *et al*. 2008), is attached in Appendix C.

6.2 Mapping of Known or Likely VMEs

Procedures for mapping known or likely VMEs are specified and described in Appendix A.

7. Bottom Fishery Impact Assessment Sections

The FAO deep-sea management guidelines (FAO 2008) provide specific recommendations on the content of impact assessments for deep-sea fisheries:

> 47. Flag States and RFMO/As should conduct assessments to establish if deep-sea fishing activities are likely to produce significant adverse impacts in a given area. Such an impact assessment should address, *inter alia*:
>
> i. type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential bycatch species, fishing effort levels and duration of fishing (harvesting plan);
>
> ii. best available scientific and technical information on the current state of fishery resources and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;
>
> iii. identification, description and mapping of VMEs known or likely to occur in the fishing area;
>
> iv. data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;
>
> v. identification, description and evaluation of the occurrence, scale and duration of likely impacts, including cumulative impacts of activities covered by the assessment on VMEs and low-productivity fishery resources in the fishing area;
>
> vi. risk assessment of likely impacts by the fishing operations to determine which impacts are likely to be significant adverse impacts, particularly impacts on VMEs and low-productivity fishery resources; and
>
> vii. the proposed mitigation and management measures to be used to prevent significant adverse impacts on VMEs and ensure long-term conservation and sustainable utilization of low-productivity fishery resources, and the measures to be used to monitor effects of the fishing operations.
>
> 48. Risk assessments referred to in paragraph 47 (vi) above should take into account, as appropriate, differing conditions prevailing in areas where DSFs are well established and in areas where DSFs have not taken place or only occur occasionally.
>
> (FAO 2008)

Following these guidelines, impact assessments for proposed bottom fishing activities in the SPRFMO Area should specifically provide information under the following sections:

7.1.1 Description of the Proposed Fishing Activities

Assessments shall contain a detailed fishing plan, providing a quantified description of the planned fishing activities, including:

- Details of the vessels to be used, providing all vessel data required in terms of the SPRFMO Data Standards for vessel data, and confirmation that they appear on the list of approved SPRFMO vessels submitted by flag states to the SPRFMO Secretariat.
- Detailed description of fishing methods (trawls, hook and lines, traps, gillnets, tangle nets) to be used, including a description and gear plan, providing the information needed to evaluate potential impacts, such as net or bottom line types, net dimensions or bottom line lengths / number of hooks, trawl-door type, size and weight, footrope dimensions and type, ground gear (bobbins, rock-hopper gear, etc), range in fishing height off bottom, net opening and any factors affecting gear selectivity.
- Seabed depth range to be fished.
- Target species, and likely or potential by-catch species.
- Intended period and duration of fishing.
- Effort indices: How many vessels, how many tows (cumulative effects), estimated tow durations or distance (ranges).
- Estimated total catch and discard quantities by target and bycatch species.

In instances where exploratory or experimental fisheries are being undertaken, assessments shall provide a quantified description of the planned fishing activities, including:

- Details of the vessels to be used, providing all vessel data required in terms of the SPRFMO Data Standards for vessel data, and confirmation that they appear on the list of approved SPRFMO vessels submitted by flag states to the SPRFMO Secretariat.
- Detailed description of fishing methods (trawls, hook and lines, traps, gillnets, tangle nets) to be used, including a description and gear plan, providing the information needed to evaluate potential impacts, such as net or bottom line types, net dimensions or bottom line lengths / number of hooks, trawl-door type, size and weight, footrope dimensions and type, ground gear (bobbins, rock-hopper gear, etc), range in fishing height off bottom, net opening and any factors affecting gear selectivity.
- Seabed depth range to be fished.
- Target species, and likely or potential by-catch species.
- Intended period and duration of fishing.
- Effort indices: How many vessels, how many tows (cumulative effects), estimated tow durations or distance (ranges).

Given the nature of exploratory and experimental fisheries, estimates of the above information can be provided. Once the exploratory or experimental fishery has concluded, detailed quantification of the above information should be submitted to the Secretariat.

7.1.2 Mapping and Description of Proposed Fishing Areas

Maps of the proposed fishing areas in relation to available information on VMEs and seabed bathymetry should be presented including:

- Maps of the intended fishing areas, in relation to the most recent SPRFMO bottom fishing footprint map. The most recent available bottom fishing footprint maps should be obtained from the Secretariat.

- Mapping of all known VMEs, or topographic features likely to support VMEs, in the proposed fishing areas, in particular, all geospatial data available from the Secretariat on distributions of known or likely VMEs, evidence of VMEs and underwater topographic features likely to support VMEs.
- Baseline data and description of the proposed fishing areas, presenting any available information, which might be useful to assessing potential impacts (past history of fishing, seabed type, depth ranges, location / presence of any known seabed topographic features and VMEs).

The SPRFMO Secretariat will make the SPRFMO geospatial maps of VMEs, bathymetry and joint trawl footprint available to facilitate mapping of proposed fishing activities in context with this baseline geo-spatial information.

To facilitate evaluation of the relationship between proposed fishing areas, the joint trawl footprint and existing VME maps, Flag States should provide their maps for proposed fishing activities to the Secretariat in a compatible GIS format, for inclusion in the SPRFMO geo-spatial database.

7.1.3 Impacts Assessment

Scoping of Issues of Concern

The initial step in a risk assessment process should be a scoping. This includes explicitly stating the management objectives, against which the risk will be assessed and the identification of all of the potential issues of concern (hazards) related to the proposed fishing activities. These will be guided by the UNGA Resolution 61/105, the SPRFMO interim measures and the FAO Guidelines.

The risk assessments should evaluate the potential impact of the 'hazards':

- Fishing activity, this will need to be evaluated for each gear type used by a participants vessels (e.g. trawling, longlining, etc.)
- Loss of bottom fishing gear, including the risk of ghost fishing and ongoing physical impact of lost gear.

For each activity (hazard) to be evaluated a brief description of the expected impacts should be provided, in terms of what may be affected and how.

Risk Assessment

The level of risk posed by each activity (hazard) should be assessed in a transparent, scientific manner. Determining the level of risk for each activity should be based on quantifiable criteria where possible. However, it is likely qualitative criteria will be needed due to data gaps, where this is the case, qualitative judgements should be underpinned by quantitative analyses where possible and sufficient documentation should be provided to enable the SWG to determine if the assigned risk levels are appropriate.

In determining the level of risk (low, medium, high) posed by an activity, the elements that should be specifically evaluated are:

1. **Intensity -** The intensity or severity of the impact at the specific site affected. This may be quantified by previous studies or an expert evaluation of the magnitude of the impact. eg *None* (no detectable impact); *Low* (some physical damage to some taxa/colonies); *Medium* (substantial damage to a small proporation of colonies/taxa, or small damage to a large number of taxa at the site, likely to modify biological and ecological processes eg reproduction) or *High* (significant damage to a significant proportion, where environmental functions and processes are significantly altered such that they temporarily or permanently cease).
2. **Duration –** how long the effects of the impact are likely to last.

3. **Spatial extent** – The spatial impact relative to the extent of the VMEs (e.g. will fishing impact 5%, 30% or 80% of the VME distribution) and whether there may be offsite impacts (e.g. will reproduction be impacted at a broader spatial scale).
4. **Cumulative impact** - The frequency of the impact will influence the risk, with activities occurring repeatedly at a site likely to have a greater risk. This will depend on the amount of fishing effort and should be considered in relation to the recovery of the VMEs/taxa.

Overall Risk. The overall risk ranking of an activity is then evaluated from the combination of the criteria used. The method for combining these criteria to assign low, medium or high risk to an activity should be detailed in the assessment report.

- Low: Where the impact will have a negligible influence on the environment and no active management or mitigation is required. This would be allocated to impacts of low intensity and duration, but could be allocated to impacts of any intensity, if they occur at a local scale and are of temporary duration.
- Medium: Where the impact could have an influence on the environment, which will require active modification of the management approach and / or mitigation. This would be allocated to short to medium-term impacts of moderate intensity, locally to regionally, with possibility of cumulative impact.
- High: Where the impact could have a significant negative impact on the environment, such that the activity(ies) causing the impact should not be permitted to proceed without active management and mitigation to reduce risks and impacts to acceptable levels. This would be allocated to impacts of high intensity that are local, but last for longer than 5-20 years, and/or impacts which extend regionally and beyond, with high likelihood of cumulative impact.

The risk assessment should be based on criteria that are independent, such that they provide separate measures of risk. Criteria should also be quantifiable, preferably with the method of quantification and ranking categories determined beforehand.

In terms of deep sea fish stocks if a robust stock assessment is available, with relevant reference points. This would constitute a high standard of risk assessment, where the outputs of the stock assessment, relative to the reference points indicates the risk to the stocks. This should be worked towards for key stocks.

Where there are data limitations a robust expert based risk assessment should be used which considers the criteria above.

Examples of different risk assessment approaches can be found:

- ICES: There have been two main approaches to assessing the sensitivity of habitat to fishing: i) ranking sensitivity of habitat units (physical and biological) to disturbance; and ii) ranking the impacts of the gear. ICES conclude that these approaches should be combined.
- NOAA EIS: Spatial and temporal analysis of the distribution of habitat type, distribution of biota, habitat use, habitat sensitivity, dynamics of fishing effort.
- MarLin: Approach consists of i) Identify "key / important" species in habitat/biotype; ii) Assess biotype sensitivity based on key species; iii) Assess recoverability of key/important species (Tyler-Walters *et al*. 2001).
- CSIRO Ecological Risk Assessment for Effects of Fishing: ERAEF is a hierarchical framework that moves from a Level 1 qualitative analysis through to a more

focussed semi-quantitative Level 2 to Level 3 which is model based and fully quantitative. This approach leads to a rapid identification of high risk activities, and evaluation of how fishing impacts on ecological systems (Hobday *et al*. 2007).

- UK Department for Environment, Food & Rural Affairs: (DEFRA) Guidelines for Environmental Risk Assessment and Management.

Interactions with VMEs

This section should specifically address the expected and potential interaction and impacts of the proposed fishing gear on VMEs: :

- What impacts are likely to result from the fishing gears to be used? All impacts should be identified, characterised and ranked. All interactions of fishing gear with the seabed will have some impact, but the nature and severity will be species / habitat dependant. Information on known or likely species and habitats in the proposed fishing area should be used to evaluate potential impacts of the fishing gears to be used.
- What will the probability, likely extent (% of habitat targeted) and magnitude of the interaction between the proposed fishing gear / targeting practices on the VMEs in the proposed fishing areas be?
- What are the characteristics of the habitats and benthic communities which may be impacted? Are the fished seabed features likely to support VMEs? Do these VMEs include fragile or biogenic habitat-forming species What proportion of the estimated distribution range of these VMEs is area will the proposed fishing activities impact? How widespread or rare are the VMEs / species? How vulnerable are the VMEs to impact by the fishing gears to be used?
- How diverse is the ecosystem in the proposed fishing areas, and will the fishing activity reduce this biodiversity? Do the proposed fishing areas contain rare species which do not occur elsewhere? What are the levels of endemism - could fishing lead to localised / global extinctions?
- What is the likely spatial scale and duration of the impacts? Will impacts be cumulative with previous impacts in the area? The overall scale of impact will be the product of spatial scale, duration and cumulative impact on VMEs and low productivity resources. Loss of substantial areas of habitat forming coral could have a prolonged impact on the environment, whereas other faunal groups may be able to recover quickly. To the extent possible, rates of recovery, regeneration and re-colonisation should be quantified or estimated.
- Are there any other threats or issues of concern expected from the proposed fishing activities, such as gear loss and ghost fishing, incidental bycatch discards, protected or endangered species mortalities, effects on ecosystem functioning?

In instances where exploratory or experimental fisheries are being undertaken the assessment should include:

- What impacts are likely to result from the fishing gears to be used? All impacts should be identified, characterised and ranked. Information on known or likely species and habitats in the proposed fishing area should be used to evaluate potential impacts of the fishing gears to be used.
- What will the probability, likely extent (% of habitat targeted) and magnitude of the interaction between the proposed fishing gear / targeting practices on the VMEs in the proposed fishing areas be?

- What are the characteristics of the habitats and benthic communities which may be impacted? Are the fished seabed features likely to support VMEs?
- How diverse is the ecosystem in the proposed fishing areas, and will the fishing activity reduce this biodiversity? Do the proposed fishing areas contain rare species which do not occur elsewhere?
- What is the likely spatial scale and duration of the impacts? The overall scale of impact will be the product of spatial scale, duration and cumulative impact on VMEs and low productivity resources. To the extent possible, rates of recovery, regeneration and re-colonisation should be quantified or estimated.
- Are there any other threats or issues of concern expected from the proposed fishing activities, such as gear loss and ghost fishing, incidental bycatch discards, protected or endangered species mortalities, effects on ecosystem functioning?

7.1.4 Information on Status of the Deepwater Stocks to be Fished

This section should provide information on the estimated state of the deepwater stocks of the intended target and main by-catch species. Such information should include:

- A list of the intended target and likely main by-catch species.
- Tables of historic catches and catch trends of these species in the intended fishing area.
- Tables, figures of analyses of historic nominal and/or standardised CPUE trends in these species.
- Results of any surveys conducted on the stocks to be fished.
- Results of the most recent stock assessments that have been conducted for the stocks to be fished, if any such stock assessments have been conducted.

In instances where exploratory or experimental fisheries are being undertaken the assessment should include:

- A list of the intended target and likely main by-catch species.
- Tables of historic catches and catch trends of these species in the intended fishing area, if available.
- Results of any surveys conducted on the stocks to be fished.
- Results of the most recent stock assessments that have been conducted for the stocks to be fished, if any such stock assessments have been conducted

7.1.5 Monitoring, Management and Mitigation Measures

For all impacts accorded an overall Moderate or High risk, effective monitoring, mitigation and management measures to detect, measure, minimise, manage or prevent significant adverse impacts need to be proposed and described.

This section should detail proposals for how the fishing activities will be planned and managed to avoid or minimise significant adverse impacts on VMEs and ensure long term sustainability of deep sea fish stocks. There should be a detailed description of specific monitoring, management and mitigation measures that are currently in place or planned to be implemented to reduce impacts to acceptable levels. Proposed management measures must be specifically designed to achieve the following results for each level of significance.

Low Significance: No additional mitigation or management measures are required. However, effective monitoring measures should be implemented to ensure that impacts are low, and to detect any change in degree of impact which would prompt the need for a re-assessment.

Medium or High Significance: Effective mitigation and management measures must be implemented, that are designed to reduce the overall significance of the impact to Low (i.e. by reducing the extent, duration or intensity of the impact concerned, such that the overall significance is reduced to low). Sufficient data and information must be provided to demonstrate how the measures will reduce the risk. Effective monitoring measures should be implemented to ensure the effectiveness of the measures and to detect any change in the degree of impact which would prompt the need for a re-assessment.

Proposed measures should specifically include the following:

- Monitoring arrangements, including the use of observers, should follow the relevant SPRFMO Data Standards and include:
    1. VMS positional information should be collected in accordance with the SPRFMO Data Standards. Provide details of VMS systems to be operated on vessels, including who these will report to, reporting frequency and reporting accuracy.
    2. Details of catch and effort data collection systems to be used, including catch and effort reporting systems to the flag states concerned, and additional systems to be implemented specifically for the proposed activity. Report how these data collection systems comply with the SPRFMO data standards. These monitoring systems should specifically address how retained and discarded by-catches are to be monitored and reported. There should also be reporting systems in place to record whether a VME has been encountered during fishing.
    3. Details of any scientific observer coverage planned for the proposed fishing activity, including levels of coverage, how deployments will be designed to achieve statistically representative coverage of the proposed fishing activities, and what information observers will be collecting. Observer data should be collected in accordance with the SPRFMO Observer Data Standard.
    4. Description of the data that will be provided to the SPRFMO Secretariat for the fishing activity including, as a minimum, data required in terms of the adopted SPRFMO data standards, but also describing other information (e.g. seabed bathymetry or mapping, VME identification and characterization) that will be provided. Details regarding the reporting of evidence of a VME to the SPRFMO Secretariat should be included.
- Proposed mitigation measures should include details on gear selection, design, modification or deployment to prevent or reduce adverse impacts on VMEs.

- Proposed management measures should include details of the process to be used to detect evidence of fishing on VMEs, to implement the SPRFMO requirement to move 5 nautical miles away from sites showing evidence of a VME and measures to be implemented to prevent significant adverse impacts on known or likely VMEs. Participants must indicate in their assessments what action will be taken in relation to avoidance of sites showing evidence of a VME during subsequent fishing operations by their vessels.

In situations where exploratory or experimental fisheries are being undertaken monitoring and mitigation measures are critical. As outlined in the FAO Guidelines:

65. Precautionary conservation and management measures, including catch and effort controls, are essential during the exploratory phase of a DSF, and should be a major component of the management of an established DSF. They should include measures to manage the impact of the fishery on low-productivity species, non-target species and sensitive habitat features. Implementation of a precautionary approach to sustainable exploitation of DSFs should include the following measures:

    i. precautionary effort limits, particularly where reliable assessments of sustainable exploitation rates of target and main by-catch species are not available;

    ii. precautionary measures, including precautionary spatial catch limits where appropriate, to prevent serial depletion of low-productivity stocks;

    iii. regular review of appropriate indices of stock status and revision downwards of the limits listed above when significant declines are detected;

    iv. measures to prevent significant adverse impacts on vulnerable marine ecosystems; and

    v. comprehensive monitoring of all fishing effort, capture of all species and interactions with VMEs.

Therefore, assessments for exploratory or experimental fisheries will include a description of the monitoring, mitigation and management measures that will be in place, as outlined above. Details regarding the reporting of evidence of a VME to the SPRFMO Secretariat should be included.

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9. Appendices

9.1 Appendix A. Mapping of Bottom Fishing Effort and VMEs

Mapping of known or likely vulnerable marine ecosystems is an important requirement to support subsequent risk assessment and development of management and mitigation measures to prevent significant adverse impacts in such areas. Scientific analyses are required to designate areas known to (or highly likely to) support VMEs, to allow these areas to be characterised and mapped. Such analyses should use all potential sources of information, in particular:

- Data on repetitive encounters of fishing vessels with vulnerable species in a particular area (e.g. Rogers *et al*. 2008).

- Predictions of areas likely to support VMEs based on information on physical data./.surrogates, used to inform habitat-suitability or niche-factor analyses (Hirzel *et al*. 2002, Clark *et al*. 2006, Davies *et al*. 2008)..

- Any data from scientific seabed biodiversity surveys which may be integrated into, or used to inform, habitat suitability analyses (Williams *et al*. 2009).

The SWG shall coordinate analyses of the data from these sources to develop habitat suitability indices, predict and map locations of seabed areas with a high likelihood of supporting VMEs in the

SPRFMO Area. The results of these analyses will contribute to the mapping of VMEs, these maps should be considered by participants in their impact assessment.

9.1 Designation of Areas as VMEs

The FAO deep-sea guidelines recognise that '*Merely detecting the presence of an element itself is not sufficient to identify a VME*'. (FAO 2008, Annex 1). Single encounters with evidence of a VME indicate the presence of a vulnerable species at some point in the area fished during the tow or set, but may not indicate the presence of a vulnerable ecosystem in the area. Further analyses are required to designate areas known to support VMEs based on repetitive encounters with vulnerable species in a particular area, prediction of areas likely to support VMEs based on information on habitat suitability for vulnerable deepwater benthic species, or seabed biodiversity surveys.

Repetitive Encounters with Vulnerable Taxa

While an encounter with evidence of a VME at a single site may not indicate presence of an actual VME, multiple or repetitive encounters with such evidence in an area provide an increasing likelihood that the area does support a benthic VME. Data on evidence of VMEs gathered during fishing operations, and reported to the SPRFMO Secretariat, should be regularly analysed to identify, map and characterise areas in which multiple or repetitive encounters with VME species are found. The following guidelines on what constitutes repetitive encounters with vulnerable taxa indicating presence of a VME are provided by Rogers *et al*. (2008):

- Two or more consecutive hauls containing > 2kgs each of live corals, or > 5kg sponges or other habitat-forming epifauna, on the same trawl track or setting area, or where consecutive trawling tracks or sets intersect.
- > 4 encounters of > 2kg of corals, or > 10 encounters of > 2kg of sponges or other habitat-forming epifauna, within an area (1km^2) within one year.
- > 4 corals per 1000 hooks in a long line fishery within one year within an area (10km^2).
- > 15% of hauls of any gear within an area (10 - 100km^2) containing corals, sponges or other habitat forming epifaunal taxa.

Prediction of Habitat Suitability and Likelihood of VMEs

Data on seabed biodiversity are lacking for most deep sea benthic areas, except for a few specifically surveyed seamount systems, and seabed biodiversity surveys are likely to remain unaffordable for all but a few areas of particular interest. In the absence of such data, biologically important physical factors (Clark 2008, Williams *et al*. 2009, Penney *et al.* in press) can be used to indicate suitability of specific areas for vulnerable benthic species, and to stratify measures such as spatial closures to protect such areas.

Physical seabed factors can be combined with physical / chemical factors such as temperature, salinity, depth, chlorophyll, oxygen, currents, productivity and water chemistry using habitat suitability models and environmental niche factor analysis (Hirzel *et al*. 2002) to predict suitability of particular areas or features as habitats for VME species. Analyses of this type have been conducted for the South Pacific region by Clark *et al*. (2006), classifying the original Kitchingman and Lai (2004) seamounts in terms of suitability as habitats for coldwater corals, and by Allain *et al*. (2008), classifying validated South Pacific seamounts in terms of depth suitability for various deepwater fish species. Taxonomic distinctness indices (Warwick and Clark 1998, Clark and Warwick 1998, 2001) can be used to evaluate comparative uniqueness, and therefore vulnerability, of communities on different features.

In addition to data on interactions with evidence of a VME, SPRFMO participants should collect and contribute data potentially useful to niche factor and habitat suitability analyses to a SPRFMO geospatial database (see Section 3 - *Provision of Geospatial Data*). These data should be used in periodic analyses coordinated by the SWG to develop habitat suitability indices, predict and map locations of seabed areas with a high likelihood of supporting VMEs in the SPRFMO Area.

Seabed Biodiversity Surveys

The most reliable data on seabed biodiversity and presence of VMEs will be provided by scientific seabed biodiversity surveys, either using seabed sampling equipment designed to quantitatively sample the fauna concerned (such as benthic sampling sleds), or using photographic or video imagery (Constable and Holt 2007, CCAMLR 2007) along planned surveys transects. Where feasible, efforts should be made to conduct such sampling in areas of particular interest or concern, such as those predicted from habitat suitability and niche factor analyses to be highly likely to support VMEs.

Particular efforts should be made to survey areas proposed for long-term and large-scale spatial closures, to ensure that such areas do contain substantial VME communities, and that they are representative (in terms of biodiversity and VME abundance) of areas to be left open to possible fishing. Such surveys could be conducted as internationally collaborative surveys between SPRFMO participants.

Where scientific surveys are not considered to be cost effective, Industry fishing vessels may be suitable platforms for conducting opportunistic seabed imaging using drop cameras or net-mounted video systems. Simultaneous collection of seabed images and benthic bycatch analyses by scientific observers would provide a particularly useful data set for improving understanding of the relationship between seabed biodiversity and benthic bycatches by various fishing gears.

Designation of VME Areas

Information and data on interactions with VME species, predictive analyses of habitat suitability and results of seabed biodiversity surveys should form the basis for mapping and designation of areas known or likely to support VMEs within the SPRFMO Area. The SWG should develop recommendations for measures to protect such areas from significant adverse impacts of bottom fishing.

9.2 Mapping of Bottom Fishing Effort

SPRFMO bottom fishing interim measure 2 requires participants to constrain fishing to within areas where fishing is '*currently occurring*':

> ***Bottom fisheries***: In respect of bottom fisheries, Participants resolve to:
>
> 2. Not expand bottom fishing activities into new regions of the Area where such fishing is not currently occurring.
>
> (SPRFMO 2007a)

At the 4th SWG meeting, areas where fishing is 'currently occurring' was defined as any area fished by at least one tow or set over the calendar years 2002 - 2006. In adopting the interim Benthic Assessment Framework in 2007 (SPRFMO 2007c), it was agreed that these areas are to be mapped as a historical bottom fishing footprint comprising all 20 minute latitude x longitude grid blocks (Lat/Lon, chart datum WGS84, unprojected) fished by at least one bottom fishing tow or set over the years 2002 - 2006.

Bottom fishing footprint maps are to be prepared using individual tow-by-tow data submitted by Participants for all historic bottom fishing operations. These data should be submitted to the Secretariat in accordance with the SPRFMO Data Standards for these fishing methods (SPRFMO 2007b), including start and end positions of individual tows or sets at a minimum resolution of 1/10th degree. Confidentiality of these data are protected under the SPRFMO standards for data exchange.

The SPRFMO Secretariat, in cooperation with the SWG, will develop and maintain electronic geospatial maps of joint bottom fishing effort for all Participants in bottom fisheries in the SPRFMO area over 2002 - 2006. Blocks will be standardized to begin on whole degrees of latitude and longitude. An example of such a map is shown in Figure 2, based on New Zealand bottom trawl tow positions.

Different bottom fishing methods have different levels of expected impact (Chuenpagdee *et al*. 2003), with mobile gears such as bottom trawling (benthic or bentho-pelagic trawling) or dredging ranked as having the highest impact, and stationary gears (such as bottom lining) having lower impact. Bottom fishing effort and footprint maps should therefore be prepared separately for each of the main bottom fishing methods: trawling, dredging, lining, stationery netting, potting and trap fishing.

Geospatial databases used to prepare bottom fishing effort maps for each of the bottom fishing methods should include the following data for each individual fishing event:

- Flag of the vessel which conducted the fishing event.
- Year of the fishing event.
- Start and end lat / lon for each individual set or tow.
- An appropriate index of effort for each event (such as: trawls - length or duration of tow; bottom longline lines - line length and number of hooks; drop lines - number of hooks).

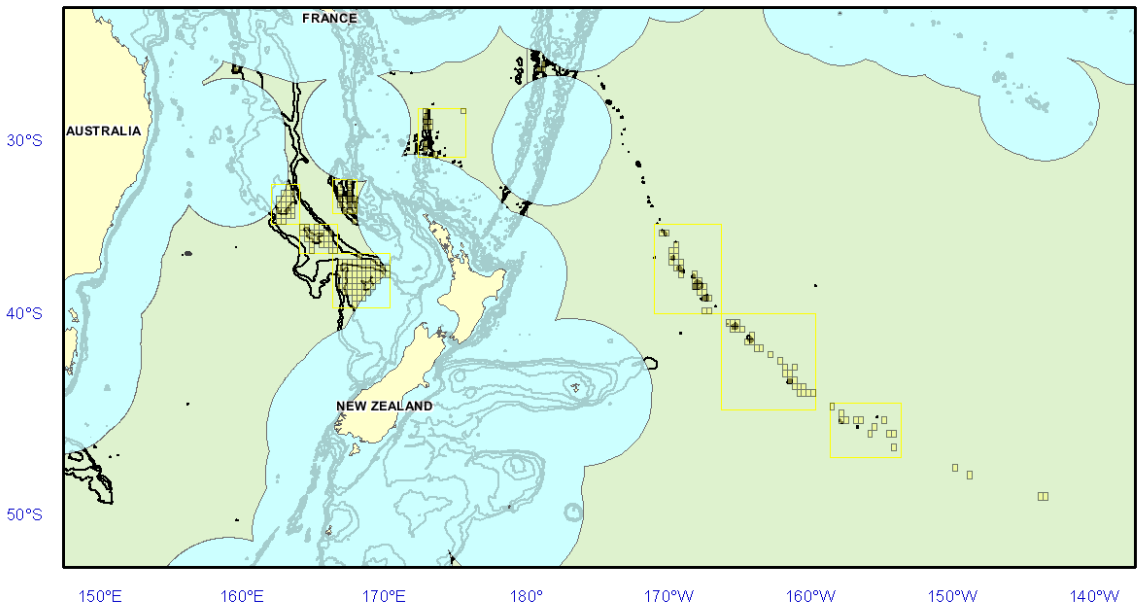


Figure 2. Example of a portion of the SPRFMO area bottom fishing footprint over the period 2002 - 2006 based on New Zealand bottom trawl data showing presence or absence of bottom trawling in 20-minute blocks (small boxes) within eight larger fishing regions (large boxes). Bathymetric contours between 200 m and 2,000 m within the SPRFMO convention area are shown.

Individual fishing position data should be submitted for all historical fishing events, including prior to 2002, and for all future bottom fishing events as part of the annual data submission process. In addition to preparing the 'currently fished areas' bottom footprint maps by method for the 2002 - 2006 reference period, this will enable maps to be prepared as and when required to evaluate fishing effort distribution and impact levels for other historical periods, or for fishing which occurs after 2006.

9.3 Mapping of Vulnerable Marine Ecosystems

Mapping of available data on the known or likely distribution of VMEs in the SPRFMO area is critical to informing the bottom fishery impact assessments participants will conduct. There a number of steps towards mapping VMEs in the SPRFMO area:

- Mapping of known or predicted underwater topographic features, particularly seamounts, which may support vulnerable benthic species and ecosystems.
- Mapping of fishing positions observed to contain 'evidence of VMEs', as defined in the rapid VME evidence assessment protocol in the BFIAS, and of scientific observer data on benthic bycatches.
- Mapping of seabed biodiversity data from research surveys, underwater visual images or scientific sampling programmes.
- Analysis of the above information to identify, designate and map areas which are known or likely to contain VMEs, and which require protection from fishing impacts.

9.4 Mapping of Underwater Topographic Features

UNGA Resolution 61/105 and the SPRFMO interim measure both identify seamounts as areas of particular concern regarding potential impact of fishing on VMEs which may occur on such features. The FAO deep-sea guidelines extend this to list a number of underwater topographic features or habitats which may contain VMEs, including summits and flanks of seamounts, submerged edges and slopes, guyots, banks, knolls, hills, canyons, trenches, hydrothermal vents and cold seeps (FAO 2008, Annex 1).

The SPRFMO SWG has requested the Secretariat to include data on such features in the SPRFMO Geospatial Database. Primary sources of such data include:

- The global database of predicted seamount features produced by Kitchingman & Lai (2004).
- The database of validated and cross-checked seamount features occurring in the SPRFMO Area produced by Allain *et al*. (2008).
- Available bathymetric grid data for the South Pacific region from the General Bathymetric Chart of the Oceans (GEBCO), and for the Tasman Sea area from GeoScience Australia.
- High resolution bathymetric data which may be collected by industry during fishing operations in the SPRFMO Area.

The bathymetric data sets should be used in geostatistical analyses coordinated by the SWG to detect and delineate seabed features with particular profile, slope, depth and elevation which characterise features which are likely to support VMEs. Such features should then be added into the SPRFMO geospatial database of underwater topographic features which may support VMEs.

9.5 Mapping of Sites with Evidence of VMEs

The SPRFMO bottom fishing interim measures require participants to monitor bottom fishing operations for 'evidence of VMEs' and report all such encounters, including details of the evidence obtained, to the SPRFMO Secretariat (bottom fishing IM 7, SPRFMO 2007a) so that such sites can be managed to prevent significant impacts of bottom fishing.

Mapping of all sites found to contain evidence of VMEs is an essential first step towards subsequent analysis of repetitive encounters with vulnerable species in a particular area, which may lead to that area then being designated as a VME (see Section 1.0 - *Designation of Areas as VMEs*). Data on encounters with evidence of VMEs should be reported to the SPRFMO Secretariat immediately after the completion of each trip on which evidence of VMEs was encountered. Data should be reported separately for each fishing event and should include:

- Date of the fishing event.
- Fishing gear type.
- Exact location of the encounter (position of start of haul of the fishing gear in Lat / Lon to the nearest 1/10th degree).
- Depth of fishing event (start of haul).
- Details of the VME evidence encountered, listing each taxonomic group recorded under the VME evidence protocol, with quantitative estimates (weight or volume) of bycatch of each taxon.

All detailed scientific observer data on benthic by-catch observed while monitoring bottom fishing operations should also be reported to the Secretariat in a similar format to the above evidence data, but with benthic species identified to the lowest taxon possible, and by-catches of each taxon quantified by weight or volume.

9.6 Mapping Areas Designated as Known or Likely VMEs

Section 1.0 details a process for analysing data on sites with repetitive encounters with evidence of VMEs, or analyses of the distribution of habitats predicted to be likely to support VMEs. Results of such analyses should be included in the SPRFMO geospatial database and mapped to provide the scientific basis for recommended management measures to protect adequate and representative areas known or likely to support VMEs in the SPRFMO Area.

One such analysis of habitat suitability is the niche-factor analysis by Clark *et al.* (2006), which evaluates the habitat suitability for coldwater corals of South Pacific seamounts in the Kitchingman & Lai (2004) seamounts database. Results of this analysis (Figure 3), provide an initial prediction of those seamounts which are considered likely to support coldwater corals in the SPRFMO Area.

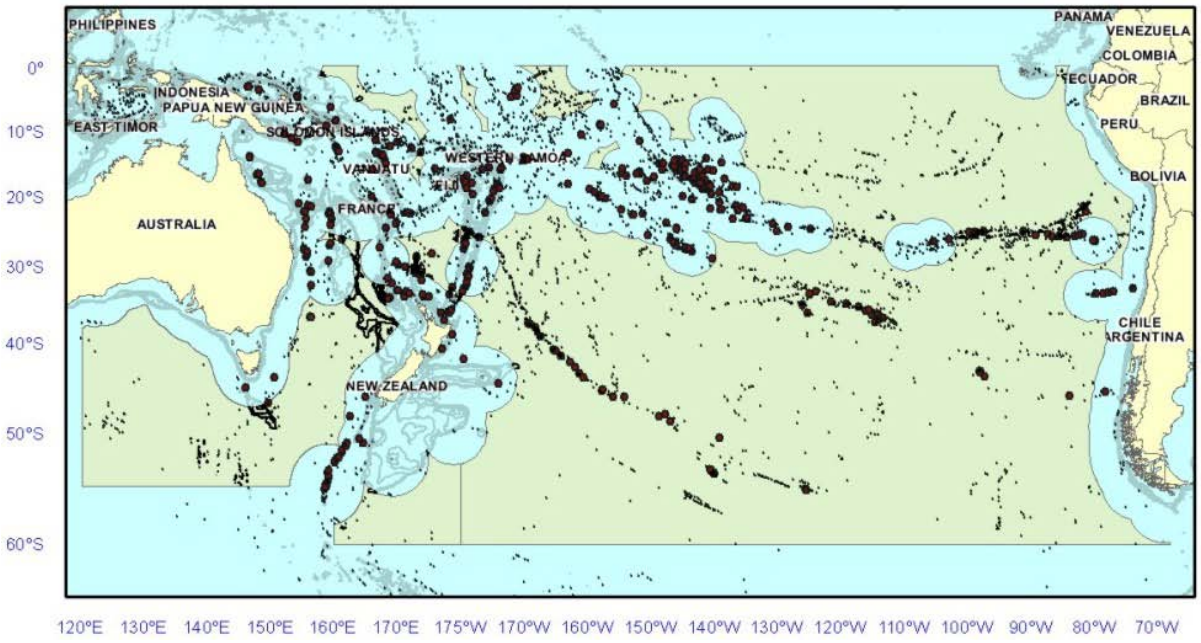


Figure 3. Map of the SPRFMO Area showing habitat suitability for stony corals of 4,000 identified seamounts based on ecological niche factor analysis (data from Clark *et al.* 2006). Small dots indicate predicted suitability less than 50%; large dots show predicted suitability of 50 - 100%.

The above geospatial information and maps will be made available to Participants for preparation of Bottom Fishery Impact Assessments. In preparing assessments, Participants should ensure that:

- Bottom fishery impact assessments specifically take account of all the above information on distribution of VMEs, evidence of VMEs and features likely to support VMEs in the intended fishing areas.
- Risk assessments evaluate the risk of interactions and significant adverse impacts on these known or likely VMEs and proposed management and mitigation measures should be designed to prevent significant adverse impacts on such areas.
- Monitoring arrangements are designed to collect relevant information which may be useful to improving the above geospatial databases and maps, including data on sites with evidence of VMEs, scientific observer data on benthic by-catch composition, visual images or sampling data which might be collected in fishing areas and high resolution bathymetric data.

9.7 Provision of Geospatial Data

Many of the supporting analyses required to prepare assessments, to design management and mitigation measures or to monitor interactions of fisheries with areas containing VMEs require geo-spatial analyses. In particular, mapping of previously fished areas, mapping of bottom fishing footprints, mapping and evaluation of interactions with underwater topographic features or sites showing evidence of VMEs and monitoring of cumulative impacts over space and time necessitate the development of geospatial databases for the SPRFMO Area, able to support the required geospatial analyses.

9.7.1 SPRFMO Geospatial Database

The SPRFMO SWG has already identified a requirement for the SPRFMO Secretariat to develop and maintain a geospatial database containing the following information:

- Boundaries of the SPRFMO Convention Area.
- Boundary areas of bordering RFMOs (including CCAMLR, WCPFC, NW Pacific RFMO, IATTC).
- FAO Statistical Areas.
- South Pacific bordering country EEZ boundaries.
- SPRFMO Area bathymetric grid data (from the General Bathymetric Chart of the Oceans (GEBCO) and GeoScience Australia), with bathymetric contours and closed bathymetry polygons derived using the grid data.
- Known or predicted distribution of seamounts and underwater topographic features (Kitchingman & Lai 2004, Allain *et al*. 2008).
- South Pacific seamounts in the niche-factor analysis by Clark *et al*. (2006), evaluating the habitat suitability for coldwater corals of seamounts in the Kitchingman & Lai (2004) database.
- Bottom fishing footprint maps for the various fishing methods, including data on year of fishing and an effort index (e.g. number of tows or sets), derived from individual fishing position data submitted by participants.

Detailed specifications for these data layers must be developed in cooperation between the SWG and Secretariat.

9.7.2 Geospatial Data Submission by Participants

To enable the Secretariat to maintain an updated geospatial database, and to allow the SWG to conduct the necessary periodic evaluation of data on sites showing evidence of a VME, all participants in SPRFMO bottom fisheries should provide the following geospatial data to the Secretariat on an annual basis, for the previous fishing year:

- Positions of all bottom fishing activities, including start and end positions for all individual trawl tows and bottom longline sets, and fishing positions for all drop line, pot or trap fishing or other method sets. These data should be submitted in accordance with the relevant SPRFMO Data Standards for these fishing methods.
- Positions of all fishing activities (tows or sets) which encountered evidence of a VME, as defined in the BFIAS, including details on the benthic by-catch constituting such evidence.
- Positions and detailed benthic species composition data for any other benthic community composition observations done in the SPRFMO Area. Such data could include detailed benthic by-catch composition recorded by scientific observers aboard fishing vessels.

Additional geospatial data which should be considered for inclusion in future submissions could include high-resolution bathymetric data collected during fishing operations, visual records (e.g. drop-camera or video images) or results of scientific biodiversity and benthic community composition surveys.

9.8 References

Allain, V. J-A. Kerandel, M. Clark (2008) Potential seamount location in the South Pacific RFMO Area: prerequisite for fisheries management and conservation in the high seas. Paper presented to the SPRFMO 5 Science Working Group Meeting, SPRFMO-V-SWG-05, 18 pp.

Clark, M.R., D. Tittensor, A.D. Rogers, P. Brewin, T. Schlacher, A. Rowden, K. Stocks and M. Consalvey 2006. Seamounts, deep-sea corals and fisheries: vulnerability of deep-sea corals to fishing on seamounts beyond areas of national jurisdiction. UNEP-WCMC, Cambridge, UK. 80 pp.

Davies, A.J., M. Wisshak, J.C. Orr, J.M. Roberts 2008. Predicting suitable habitat for the cold-water coral *Lophelia pertusa* (Scleractinia). *Deep-Sea Research*, I 55: 1048–1062.

Hirzel, A.H., J. Hausser, D. Chessel, N. Perrin 2002. Ecological-niche factor analysis: how to compute habitat-suitability maps without absence data? *Ecology*, 83: 2027 - 2036.

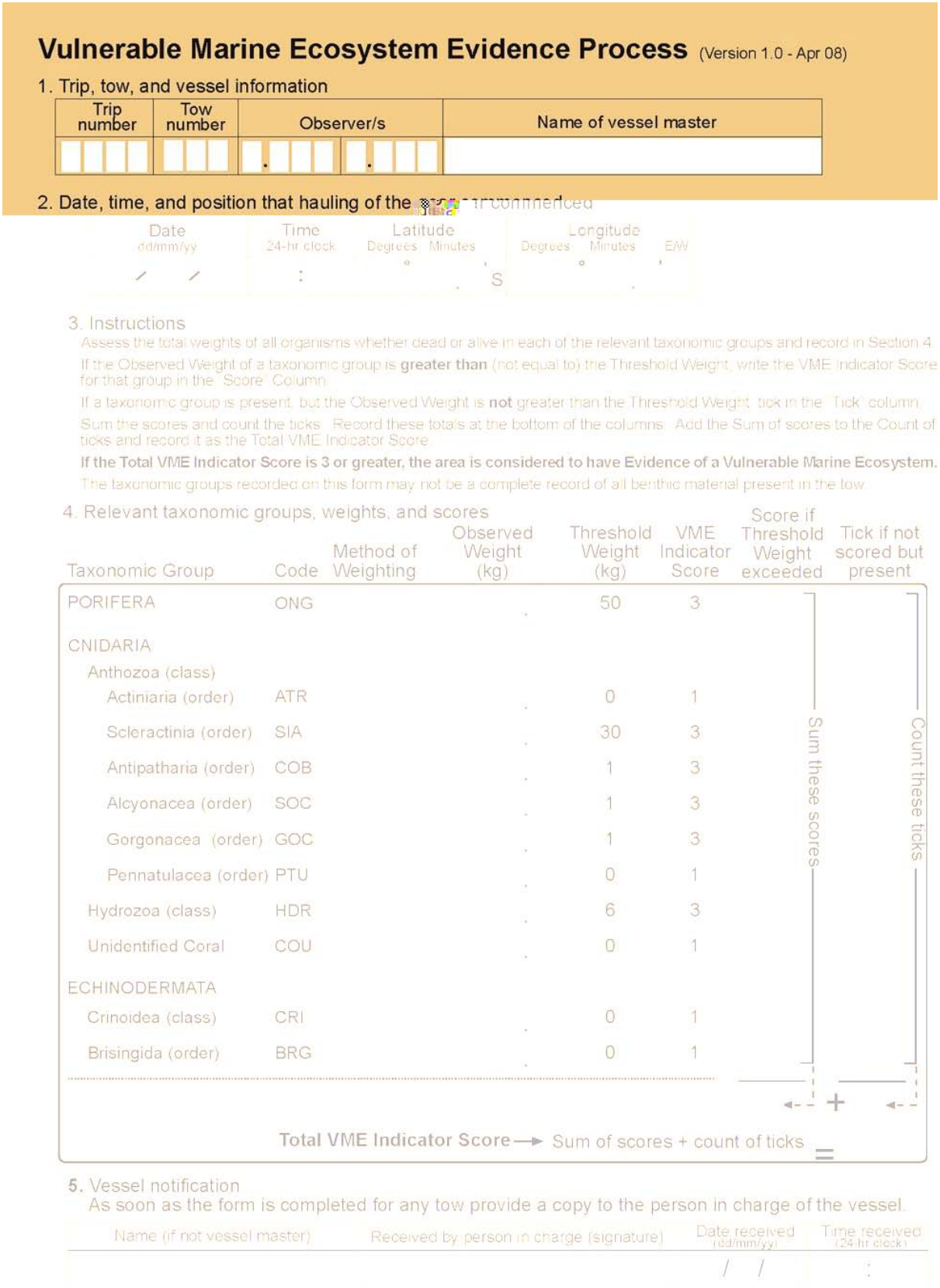
Kitchingman A., S. Lai (2004) Inferences on potential seamount locations from mid-resolution bathymetric data. *In*: Seamounts: Biodiversity and Fisheries (eds T Morato, D Pauly) UBC Fisheries Centre, 78, p. 261, Vancouver, B.C.

Penney, A.J., S.J. Parker and J. Brown (in press). Protection measures implemented by New Zealand for vulnerable marine ecosystems in the South Pacific Ocean. *Marine Ecology Progress Series*.

Rogers A.D., M.R. Clark, J.M. Hall-Spencer, K.M. Gjerde (2008) The science behind the guidelines: A scientific guide to the FAO draft international guidelines (December 2007) for the management of deep-sea fisheries in high seas and examples of how the guidelines may be practically implemented. IUCN, Switzerland, 2008.

Williams, A., N.J. Bax, R.J. Kloser, F. Althaus, B. Barker, G. Keith 2009. Australia's deep-water reserve network: implications of false homogeneity for classifying abiotic surrogates of biodiversity. *ICES Journal of Marine Science*, 66: 214–224.

9.9 Appendix B. Rapid Assessment VME Evidence Form Example



Vulnerable Marine Ecosystem Evidence Process (Version 1.0 - Apr 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 [illegible] 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.

The taxonomic groups recorded on this form may not be a complete record of all benthic material present in the tow.

4. Relevant taxonomic groups, weights, and scores

Taxonomic Group	Code	Method of Weighting	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)
		/ /	:

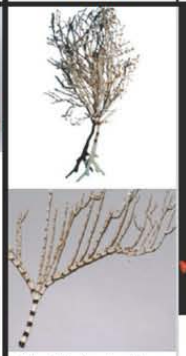
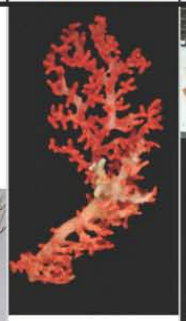
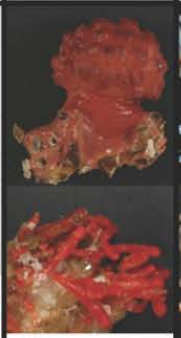
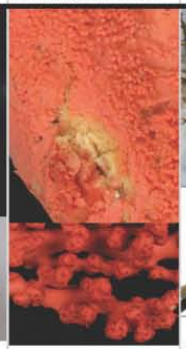
9.10 Appendix C. Rapid Assessment VME Evidence Identification Guide

DRAFT version 1.0

Note these are MFish codes

Classification guide for potentially vulnerable invertebrate taxa in the SPRFMO Area

These groups are not included: Bryozoan, Snails, Sea Stars, Clams, Urchins, Worms, Crabs

Code	SIA p71-79	COB p 57-58	SOC pg 55-56	GOC p 59-65					COR p 9; 66-68	HYF p 9
Level	Scleractinia (Order)	Antipatharia (Order)	Alcyonacea (Order)	Gorgonacea (Order)					Anthoathecate (Family)	Hydroida (Order)
Taxon	Stony corals	Black corals	Soft corals	Isididae (Bamboo)	Coralliidae (Red / Precious)	Primnoidae (Bottle brush, Sea fans)	Paragorgiidae (Bubblegum)	Chrysogorgiidae (Golden)	Stylasterids (Hydrocorals)	Hydroids
Form, Size	 **Branching:** Can form large matrices, often forms thickets **Cups:** usually small (<20cm), solitary or in small clusters	 Semi-rigid, woody, not very dense, dark brown or black skeleton, can be large (>2m). Branch tips can look like hydroids or small gorgonian	 Can be mushroom shaped. Floppy or soft, leather-like surface texture. Usually multiple large polyps, body not symmetrical, no foot or stalk	 Solid calcified trunk with brown joints (nodes), rings in x-section, branching 2D or 3D, fine tips, tree like branch tips	 Calcified skeleton, no spines. Thick, stubby stems with fine side branches	 Dark or metallic tree-like branches, flexible	 Large (up to 2m), red, thick stems, breaks when flexed	 Gold, black or green metallic lustre. Semi-rigid single, main axis with semi-soft tissue cortex. Small specimens can be feathery like hydroids or bushy like black coral	 Calcified, no rings in X-section, often pink or white. Often uniplanar, side branches lattice from obviously thicker main stems	 Entire organism small, <30cm, flexible and plant-like, often feathery, no soft tissue covering
Detail (Texture, colour, polyps)	 Calcified, very hard or brittle **Branching:** Often smooth stems **Cups:** Can be ridged Polyp calyces well formed with ridged edges, large, hard polyps	 Slimy flesh on branches. Surface with minute spines, may appear smooth. 3D, fine or bushy tips	 Similar polyps to seapens, but soft corals are not stalked	 Can scrape off surface tissue, skeleton surface smooth between nodes	 Can scrape surface tissue off. Smooth (not sandpapery) with knobbly ends. No pores on skeleton	 Usually no spines, some metallic lustre on skeleton, 3D Bushy branches, obvious polyps	 Chalky material, not hard. No spines, can scrape off surface. Bulbous ends with polyps	 Can be non-branching and whip-like. Usually no spines, metallic lustre. Fine or sparse 3D branching	 Coarse sandpaper texture, can't scrape off surface tissue. Has minute pores	 Indistinct polyps, feathery tips
Commonly mistaken for:	 Branching form can look like hard sponges but sponges are light with spicules	 Hydroid if small, or small pieces of dead Gorgonacea	 Small pieces of Corallidae. Can also resemble Demosponges, which have no polyps	 Other gorgonians if in small pieces, but won't break easily	 Soft corals, which always have soft stems	 Hydroids if small pieces, but have distinct polyps	 Small pieces of Corallidae	 Antipatharia, but tips are not slimy	 Small, hard Bryozoans or pieces of Coralliidae	 Small specimens of Gorgonacea or Antipatharia

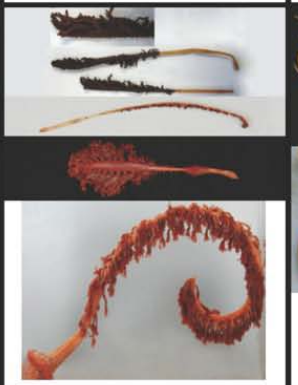
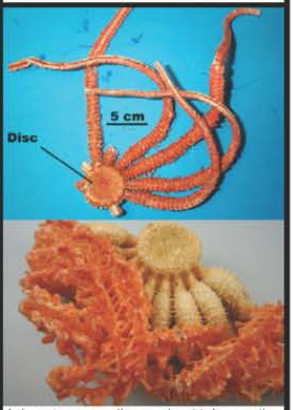
Developed by: D Tracey, S Parker, E Mackay, O Anderson, C. Ram, (2008)

DRAFT version 1.0

Note these are MFish codes

Classification guide for potentially vulnerable invertebrate taxa in the SPRFMO Area

These groups are not included: Bryozoan, Snails, Sea Stars, Clams, Urchins, Worms, Crabs

Code	ONG p 30-45		ATR p 51-54	PTU p 69-70	CRI p 230-232	BRG p 207
Level	Porifera (Phylum)		Actiniaria (Order)	Pennatulacea (Order)	Crinoidea (Class)	Brisingida (Order)
Taxon	Hexactinellida (Glass sponges)	Demospongiae (Siliceous sponges)	Anemones	Sea pens	Crinoids	Armless stars
Form, Size						
	Often hollow central chamber can be vase like. Diverse shapes; fibrous or crystalline hard forms	Many shapes, some small & hydroid-like to round hard solid masses	Rubbery bottom with single polyp with lots of tentacles. Usually in retracted hardened cylinder form when captured	Feather-shaped with fleshy polyps. Non-branching to whip-like cartilaginous stalk. Fleshy foot or anchor present, body symmetrical. Can be tall, >1 m	Stalked. Small cuplike body. Arms usually branched. Crinoids are generally fragile, often only fragments. A long stalk, some bearing whorls of hooklike cirri	At least 6 arms, usually more than 10. Arms easily separated from central disc and often all that is taken
Detail (Texture, colour, polyps)						
	Pores often visible, glass spicules visible or fibre-glass like texture in hard forms	Fleshy, slimy or rubbery. Textures stony, woody, fibrous or airy	Knobbly, slimy, with tentacles. Tentacles sometimes look like worms when detached	Fleshy polyps. Flower or feather like polyp mass	Fragile, not flexible. Brittle and segmented	Long spines on ventro-lateral margin
Commonly mistaken for:						
	Bryozoans or scleractinians that are small and of a hard matrix	Alcyonaceans or ascidians, which are not spongy and have polyps or siphons	Alcyonaceans, which usually have several polyps or the Corallmorpharia a coral called jewel anemone	Alcyonaceans or some Gorgonians due to large polyps and size	Arm fragments can look like other animals such as brisingids	Other sea stars with multiple arms (e.g., brittle stars) and crinoid arms

Developed by: D Tracey, S Parker, E Mackay, O Anderson, C Ram, (2008)