4. Evaluation of Expected Interaction with VMEs and Ecosystem Impacts

4.1 Mapping of VMEs in Proposed Fishing Areas

Requirements for RFMO/As to protect VMEs from significant adverse impacts resulting from bottom fisheries originated with United Nations General Assembly Resolution 61/105, which calls upon RFMO/As:

> *83 (a) To 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*;

This resolution did not provide a formal definition of VMEs, but referred to them as "*vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals*". In responding to this call, the SPRFMO interim measures extended this reference to recognise that VMEs "*include seamounts, hydrothermal vents, cold water corals and sponge fields*". The SPRFMO Interim Benthic Assessment Framework further expanded on this to include seamounts and other underwater topographic features which rise more than 100 m from the abyssal seafloor, habitat forming coldwater corals and sponge gardens (SPRFMO 2007b).

Subsequently, the *FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* adopted in August 2008 have provided more comprehensive guidelines on the characteristics which could be considered to define VMEs:

> ***5.2 Identifying vulnerable marine ecosystems and assessing significant adverse impacts***
>
> 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 (eg, 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 FAO deepwater guidelines further provide a list of examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them:

> ***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 may contribute to forming VMEs:
>
> i. certain coldwater corals and hydroids, eg, 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 (eg, 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 (ie, 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 (eg, corals and sponges);
>
> ii. summits and flanks of seamounts, guyots, banks, knolls, and hills (eg, corals, sponges, xenophyphores);
>
> iii. canyons and trenches (eg, burrowed clay outcrops, corals);
>
> iv. hydrothermal vents (eg, microbial communities and endemic invertebrates); and
>
> v. cold seeps (eg, mud volcanoes for microbes, hard substrates for sessile invertebrates).
>
> (FAO 2008)

The above definitions of VMEs are compatible and, within the limitations of available information, the combination of these definitions was used when evaluating the likelihood and extent of potential interaction of New Zealand high seas bottom fishing activities with potential VMEs.

4.1.1 Distribution of Seamounts in the SPRFMO Area

Initial emphasis on definitions of VMEs focussed on seamounts and the likelihood that such features will support VMEs. This emphasis on particular seabed topographic features has been retained, and expanded on, in the FAO deepwater guidelines. Given the general lack of actual data on seabed biodiversity distribution patterns, reliance on seabed topography as a primary predictor of the likely occurrence of VMEs on such features is inevitable, and likely to remain so.

An initial database of predicted seamounts in the Pacific Ocean region was provided by Kitchingman & Lai (2004), who inferred the existence and positions of over 14,000 large (> 1000 m height) seamounts from satellite altimetry-derived mid-resolution bathymetric data. A subsequent review of these data by Allain *et al*. (2008) identified a number of problems resulting in mis-identification of features such as atolls as numbers of seamounts, and generated a revised database of validated or cross-checked seamount features which specifically occur in the SPRFMO Area and adjacent EEZs. This validated seamounts database has been provided to the SPRFMO Interim Secretariat, and constitutes the primary source of currently available information on distribution of underwater features likely to support VMEs in the SPRFMO Area.

The Allain *et al*. (2008) validated seamounts database includes 1,506 underwater features with agreed positions and descriptive information. Of these, 1,450 features occur in the high seas SPRFMO Area, with marked concentrations of features occurring in the Fiji Basin, along the Kermadec, Louisville, Salas y Gomez and Nazca Ridges, the Foundation Seamounts Chain and forming the Polynesian Island Chain (Figure 18).

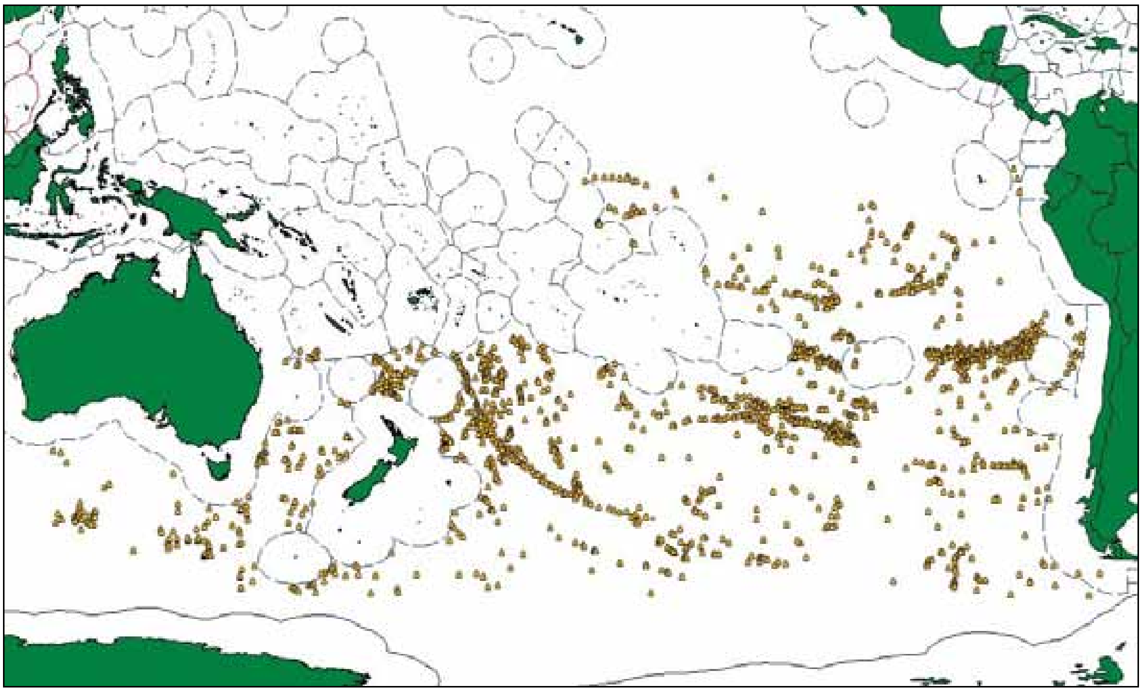

Figure 18. Distribution of validated underwater seamount features in the high seas SPRFMO Area, as reported by Allain *et al*. (2008).

These seamount features vary substantially in latitude, summit depth and elevation above the seafloor. These and other related oceanographic factors all markedly influence the suitability of these features as supporting habitats for vulnerable benthic species such as coldwater corals, or for deepwater species such as orange roughy.

Using an environmental niche factor analysis (as developed by Hirzel *et al*. 2002) incorporating factors such as temperature, salinity, depth, chlorophyll, oxygen, currents, productivity and water chemistry, Clark *et al*. (2006) classified the original Kitchingman and Lai (2004) seamounts data set in terms of suitability as habitats for coldwater corals. They concluded that there were only 88 of the 1,602 Kitchingman and Lai (2004) seamounts in the SPRFMO high seas area with a habitat suitability for coldwater corals of 50% or greater, these primarily being along the Louisville, Foundation, Salas y Gomez and Nazca Seamount Chains (Figure 19). Most seamounts predicted to be suitable for coldwater corals in fact occur within the EEZs of countries bordering the SPRFMO Area.

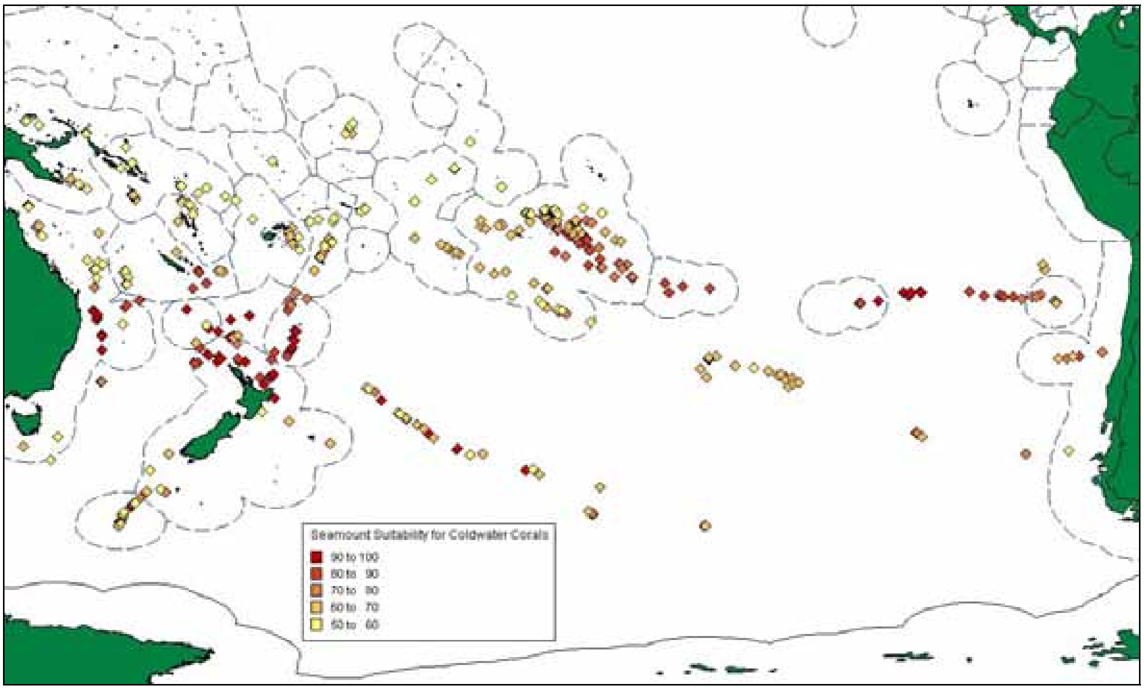

Figure 19. Distribution of the Kitchingman and Lai (2004) South Pacific seamount features predicted by Clark *et al*. (2006) to have a habitat suitability for coldwater corals of 50% or greater.

Clark *et al*. (2006) and Allain *et al*. (2008) conducted similar analyses predicting the suitability of seamount features for supporting significant abundances of the commercially important deepwater species such as orange roughy, alfonsino and oreos. Figure 20 shows the distribution of validated seamount features in the SPRFMO Area considered by Allain *et al*. (2008) to be potentially suitable habitats for orange roughy and alfonsinos, based on the preferred depth distributions of these species.

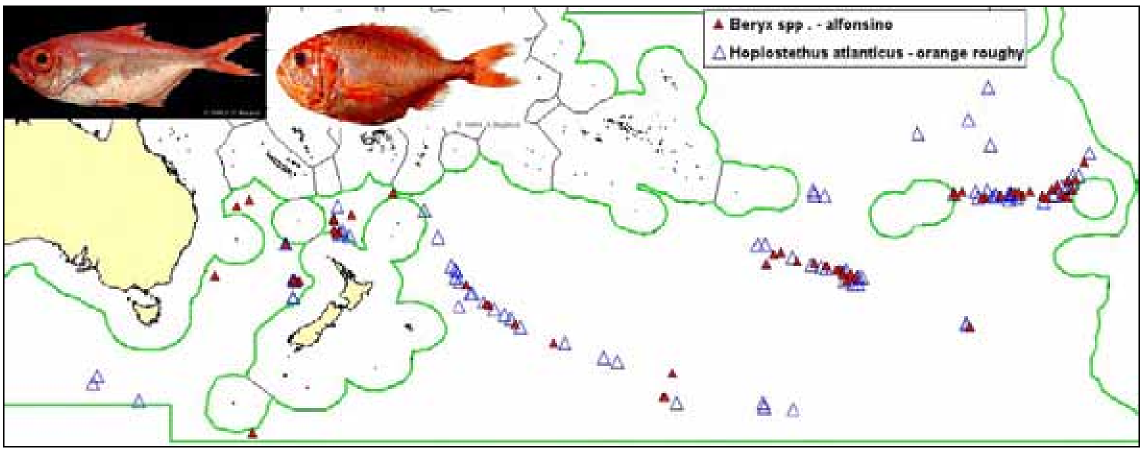

Figure 20. Distribution of seamount features considered by Allain *et al*. (2008) to be potential habitats of the orange roughy and alfonsinos based on preferred depth distributions of these species.

4.1.2 Distribution of Seamounts in Relation to the New Zealand Trawl Footprint

The distribution of validated seamounts in the SPRFMO Area from Allain *et al*. (2008) (Figure 18) was overlaid on the New Zealand bottom trawl footprint to ascertain how many of those seamounts lie within, and how many lie immediately adjacent to, the various fishing areas constituting the New Zealand trawl footprint. Table 7 summarises the number of seamounts falling within each of the fishing areas, and those up to ~250 km outside each fishing area perimeter. The respective surface areas (km^2) and proportions of the total SPRFMO Area of each fishing area are also given. Figures 21 and 22 show maps of the distribution of seamounts in relation to the trawl footprint in the Lord Howe, Challenger, West Norfolk and Louisville Ridge areas.

Table 7. Summary of the respective areas, proportions of the total New Zealand bottom trawl footprint, proportion of the total SPRFMO Area, number of seamounts within each fishing area and number of nearby seamounts.

Fishing Area	Area (km^2)	% of NZ Footprint	% of SPRFMO Area	Seamounts Within Footprint	Seamounts Within 250km of Footprint
Lord Howe North	25,082	12.1%	0.05%	0	0
Lord Howe South	25,630	11.8%	0.05%	0	0
Challenger	62,795	28.9%	0.13%	5	5
West Norfolk	19,452	8.9%	0.04%	1	1
Three Kings	11,986	7.2%	0.03%	5	64
Louisville North	26,060	12.0%	0.05%	10	53
Louisville Central	26,350	12.1%	0.05%	13	11
Louisville South	15,144	7.0%	0.03%	8	22
Kermadec / Other	4,963	2.3%	0.01%	0	12
Total Footprint	**217,463**	**100.0%**	**0.44%**	**42**	**168**

(Estimated total SPRFMO Area = 49,920,000 km^2. Total seamounts in SPRFMO Area = 1,450.)

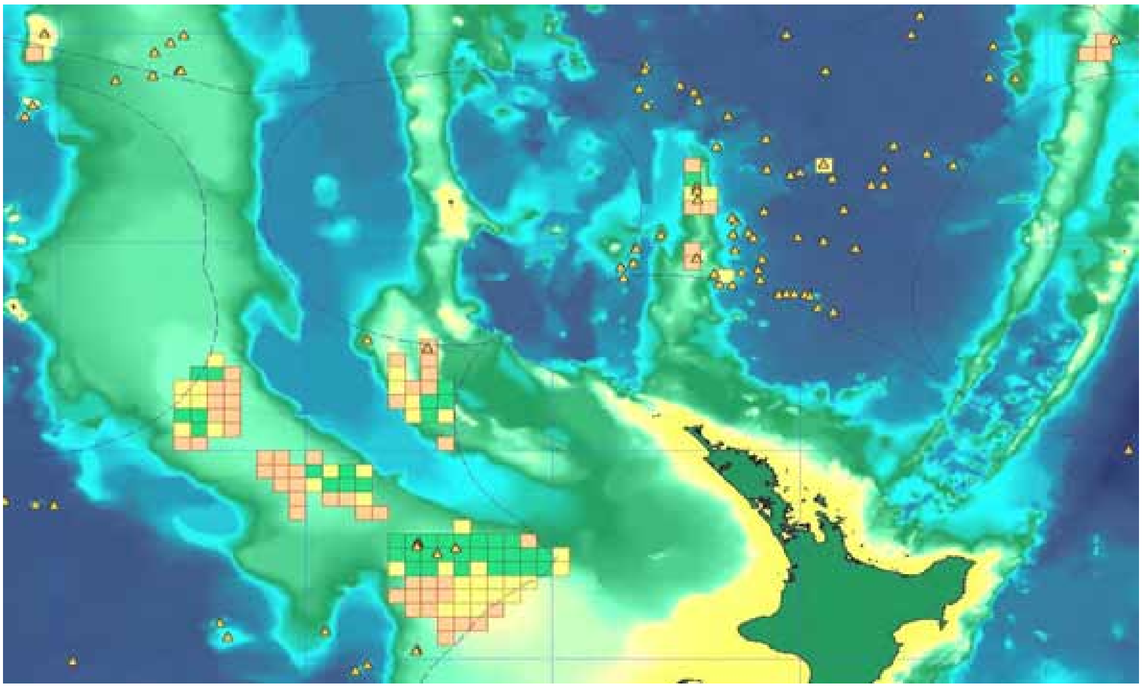

Figure 21. Distribution of Allain *et al*. (2008) seamounts within and near the New Zealand trawl footprint in the Lord Howe Rise, Challenger Plateau and West Norfolk Ridge areas.

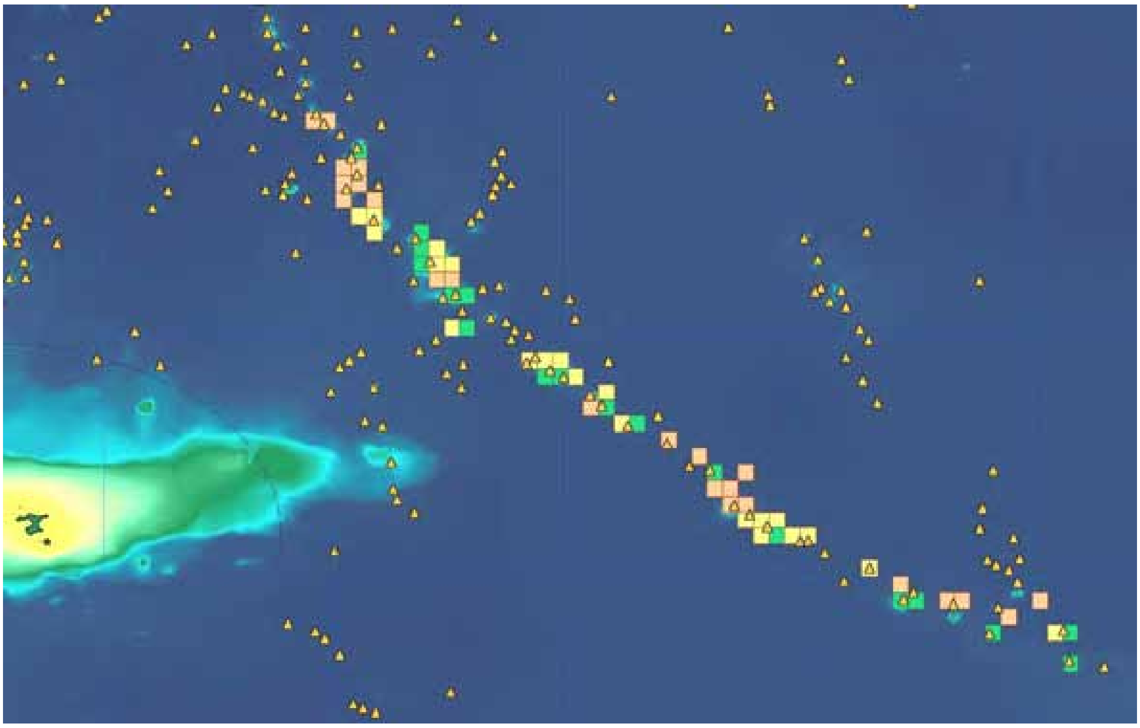

Figure 22. Distribution of Allain *et al*. (2008) seamounts within and near the New Zealand bottom trawl footprint in the Louisville Ridge area.

There are apparently no major seamounts within the low-relief Lord Howe Rise fishing areas, nor along the West Norfolk Ridge, although this latter area essentially constitutes a large and continuous ridge feature with similar edge profile to seamounts. There are also apparently no large seamounts in close proximity to these areas. The Challenger Plateau fishing area contains five seamounts, and these all lie in close proximity to each other in the area first fished on the high seas portion of the Challenger Plateau, and now heavily fished for almost two decades. Another five seamounts lie within 250 km of the Challenger area. In the Three Kings Ridge area, five seamounts lie within the footprint, but there are another 64 within 250 km, scattered throughout the Fiji Basin (Figure 21). The Louisville Ridge essentially consist of a chain of large seamounts, 31 of which lie within the fishing areas along the Ridge. Within 250 km of these lie another 86 major seamounts, outside the Louisville Ridge itself (Figure 22).

Of the total 1,450 Allain *et al*. (2008) seamounts within the SPRFMO Area, 42 (3%) lie within the New Zealand trawl footprint. Of these 42 seamounts, 18 lie within footprint blocks designated as ‘Open’ bottom trawling areas,. A further 13 lie within designated ‘Move-On’ blocks, and the remaining 11 within blocks that have been closed to fishing for New Zealand vessels. Fifty seven percent of the large seamounts that lie within the New Zealand trawl footprint are therefore being protected, either by means of a move-on provision or of a closure. Only 1% of the total SPRFMO Area Allain *et al*. (2008) seamounts therefore remain fully open to fishing by New Zealand vessels. (More detail is provided on these management measures in *Section 7. Management and Mitigation Measures*.)

4.2 Ranking of Expected Impacts by Gear Class

Not all fishing gears are expected to have the same intensity of impact on the seabed. The SPRFMO Benthic Assessment Framework (SPRFMO 2007b) specifically recognises that mobile fishing gears that contact the seabed have a high probability of impact on VMEs, whereas impacts of static gears are expected to range from Low to Medium. Chuenpagdee *et al*. (2003) provide a more detailed table of relative ratings of potential of various fishing gear types on either physical or biological benthic habitats, ranked from 1 (very low) to 5 (very high), again ranking potential impacts of mobile gears (bottom trawl or dredge) as very high, and impacts of static gears (including bottom lining) as 2 or 3 (Table 8).

Table 8. Ratings of expected habitat impact for each fishing gear class on either physical or biological habitats on a scale of 1 (very low) to 5 (very high) (after Chuenpagdee *et al.* 2003).

Gear Class	Benthic Habitat Type	
	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	5	5
Dredge	5	5

Taking this into consideration, New Zealand has focussed primarily on the development of management and mitigation measures for the bottom trawl fishery (see *Section . Management and Mitigation Measures*).

4.3 Evidence of VMEs Within the Trawl Footprint

Many of the areas typically fished by vessels targeting orange roughy, alfonsinos and oreos would be included under the topographical, hydrophysical or geological features listed in Annex 1 to the FAO Deepwater Guidelines, as being features which may potentially support the vulnerable species groups or communities listed in that Annex. Most of the targeted fishing positions within the New Zealand trawl footprint could be described as '*submerged edges and slopes, summits and flanks of seamounts, guyots, banks, knolls, and hills, canyons and trenches*' (FAO 2008). However, there is substantial topographic variability within and between the fishing areas constituting the New Zealand trawl footprint, ranging from apparently flat, relatively featureless knolls on the Lord Howe Rise, to extremely steep and high profile seamounts along the Louisville Ridge, with every conceivable topographic variation between those extremes.

However, noting the ongoing move towards shorter, more highly targeted tows, and the continuing modification of gear and implementation of operational measures to minimise seabed contact (see *Section 2. Description of Proposed Fishing Activities*), questions arise regarding what the expected frequency of trawl tows actually producing 'evidence of a VME' might be. Since 1990, scientific observers deployed aboard New Zealand bottom trawl vessels have been collecting increasing amounts of data on bycatch of benthic organisms in trawl tows that can be used to address those questions.

The '*VME Identification Protocol*' developed to determine evidence of a VME for the purposes of implementation of a move-on rule (described in *Section 7. Management and Mitigation Measures*.) was used used to evaluate the frequency with which trawl tows encountered 'evidence of a VME' in the various trawl footprint areas over 1998-2002 (a period of high benthic bycatches; see Section 7). Over that period, 1,447 bottom trawl tows by New Zealand vessels were observed in the SPRFMO Area: 25 on the Lord Howe N, 211 on the Lord Howe S, 767 on the Challenger, 189 on the West Norfolk, 224 on the Louisville N, 28 on the Louisville S and 3 on the Louisville S areas. The 'VME evidence' scores for these tows are summarised in Table 9 for each fishing area.

Table 9. Summary of the number and proportion of tows by fishing area considered to show 'evidence of a VME', or not.

Fishing Area	No VME Evidence	%	VME Evidence	%	Total
Lord Howe N	25	100%	0	0%	25
Lord Howe S	207	98%	4	2%	211
Challenger	757	99%	10	1%	767
West Norfolk	180	95%	9	5%	189
Louisville N	220	98%	4	2%	224
Louisville C	28	100%	0	0%	28
Louisville S	3	100%	0	0%	3
Totals	**1,420**	**98%**	**27**	**2%**	**1,447**

A low proportion of tows produced 'evidence of a VME' in all fishing areas. None of the observed tows in the Lord Howe N, Louisville C or Louisville S area achieving a qualifying VME score of 3 or greater. Overall, only 2% of observed trawl tows over 1998 - 2002 produced evidence of a VME using the developed protocol. If a presence/absence ranking system is used (VME score of 1 or greater), only 5.6% of tows produced retrieved any evidence of VMEs.

Resulting maps of the distribution of the high seas tows observed over 1998 - 2002, classified by VME score from 0 - 2 (no VME evidence) and >= 3 (evidence of VMEs), are shown in relation to Open, Move-On and Closed blocks in each fishing area in Figure 23 for the Lord Howe, Challenger and West Norfolk areas, and in Figure 24 for the Louisville Ridge area. In interpreting this data, it should be recalled that trawls are for VMS evidence sampling tools, as discussed in Section 7.

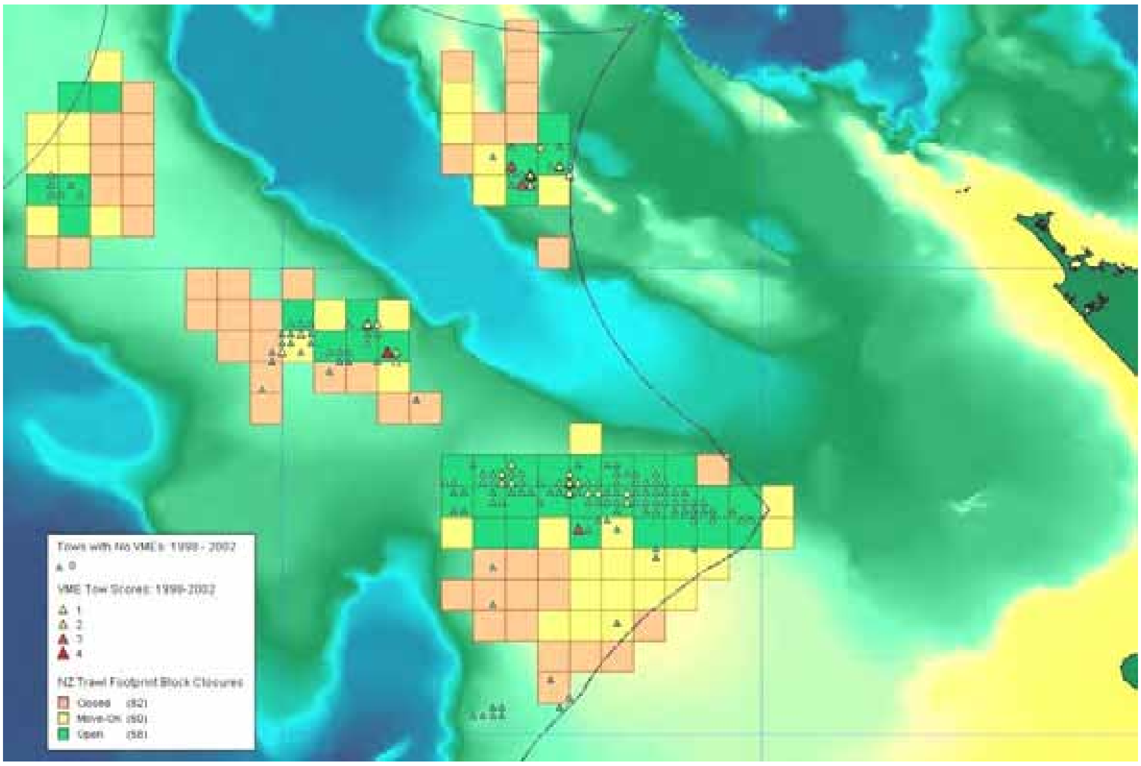

Figure 23. Distribution of VME scores for New Zealand bottom trawl tows observed in the Lord Howe, Challenger Plateau and West Norfolk areas over 1998 - 2002.

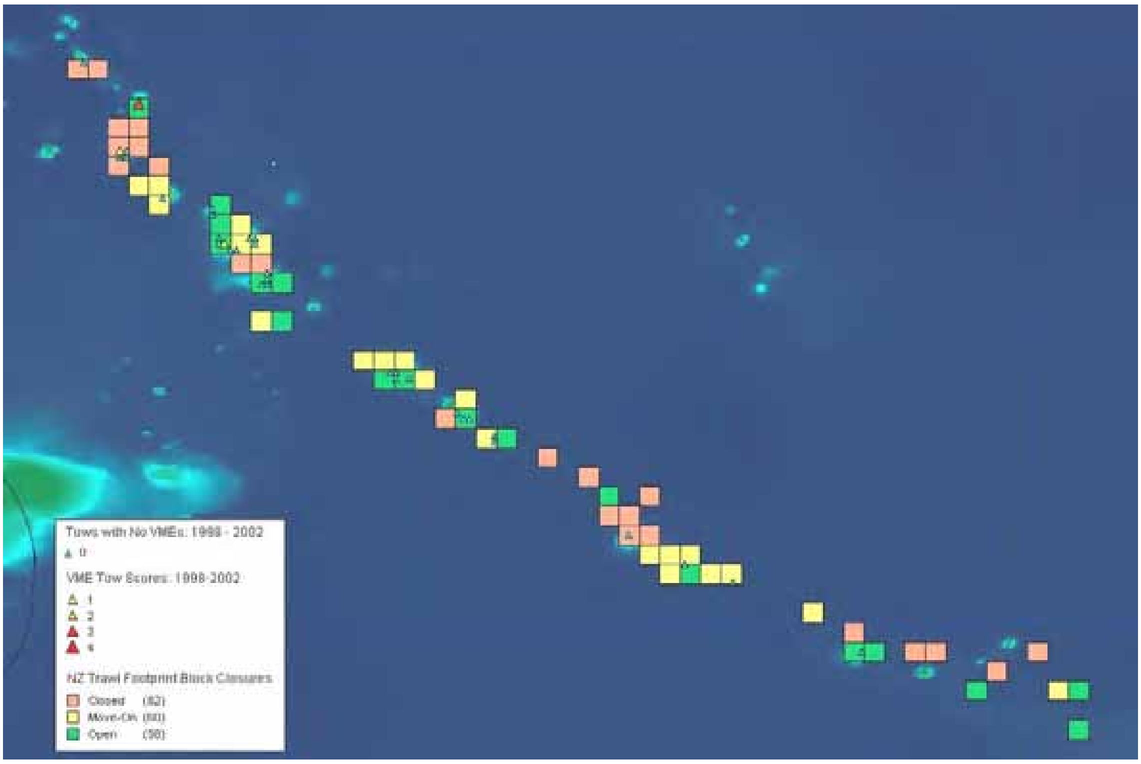

Figure 24. Distribution of VME scores for New Zealand bottom trawl tows observed in the Louisville area over 1998 - 2002.