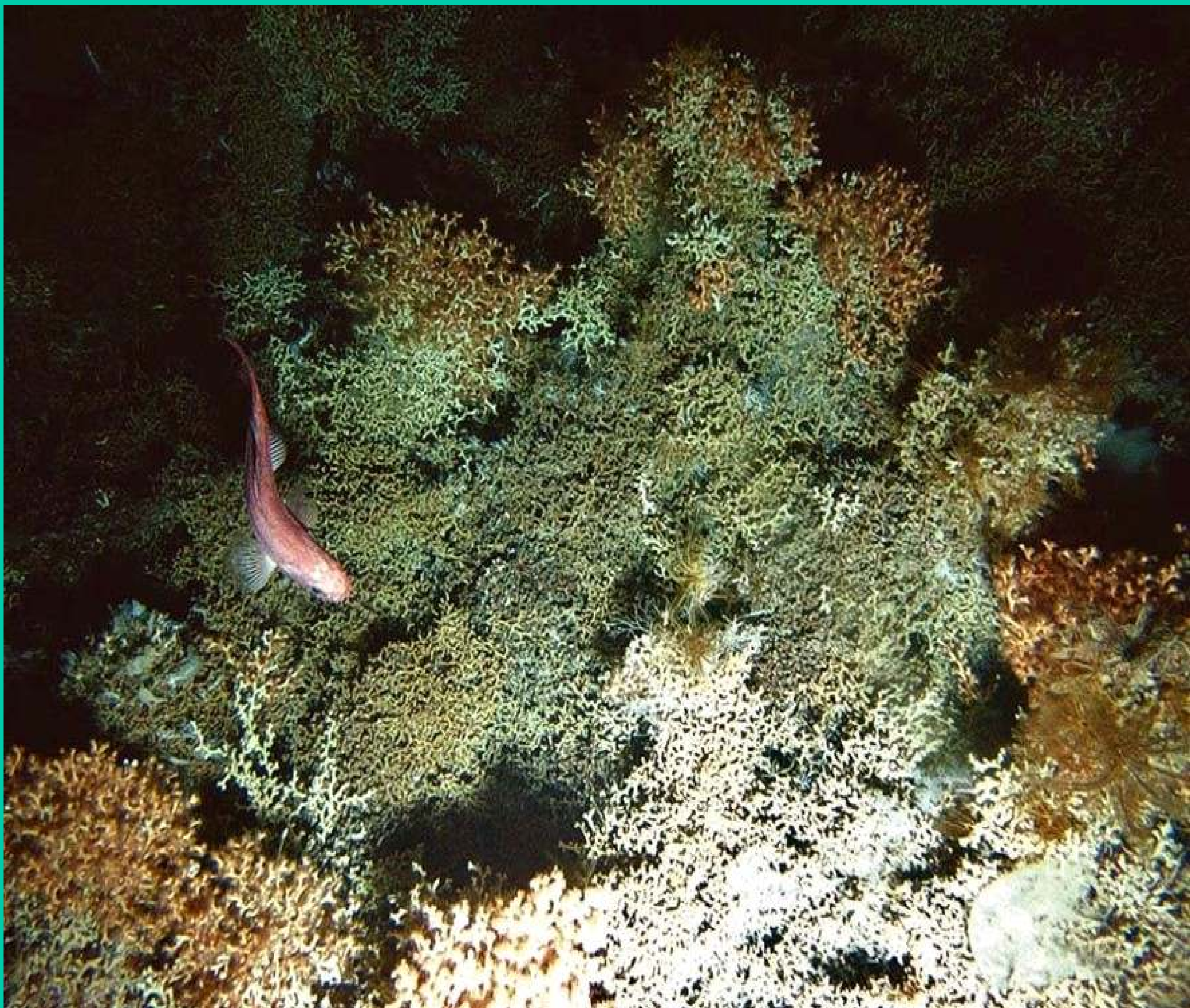
Ministry of Fisheries
Te Tautiaki i nga tini a Tangaroa

Bottom Fishery Impact Assessment

Bottom Fishing Activities by New Zealand Vessels Fishing in the High Seas in the SPRFMO Area during 2008 and 2009



CONTENTS

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(Cover photo: Orange roughy swimming over deepwater benthic community dominated by the fragile habitat forming scleractinian coral *Solenosmilia variabilis* covering steep, rocky habitat in the Graveyard Seamount complex on the Chatham Rise. Photographed in 2004 using the *RV Tangaroa* Deep Towed Imaging System. © NIWA and Ministry of Fisheries, New Zealand)

Bottom Fishery Impact Assessment

Bottom Fishing Activities by New Zealand Vessels Fishing in the High Seas in the SPRFMO Area in 2008 and 2009

1. Introduction

Participants in the negotiations to establish a South Pacific Regional Fisheries Management Organisation (SPRFMO) have adopted interim conservation and management measures in order to achieve the sustainable management of fish stocks and the protection of vulnerable marine ecosystems of the SPRFMO Area[1] (SPRFMO 2007a), pending the entry into force of the SPRFMO Convention. These include specific measures applicable to management and assessment of bottom fisheries.

The main requirements of the SPRFMO interim measures for bottom fisheries are:

- To limit bottom fishing effort or catch to average annual levels over the reference period 2002 - 2006, and to limit fishing to the specific areas fished over that period (as mapped in the joint SPRFMO bottom fishing footprint map).
- To assess whether bottom fishing activities will have significant adverse impacts on vulnerable marine ecosystems (VMEs), and to implement measures to manage fishing activities to prevent such impacts.
- To specifically implement measures to detect and document encounters with VMEs during fishing operations, and to prevent significant adverse impacts to VMEs known or likely to occur, or encountered during fishing.

New Zealand is committed to implementing these measures. To facilitate implementation, the SPRFMO interim measures have been gazetted under New Zealand law, to give them the legal status of an international arrangement. New Zealand commenced the process to implement these measures shortly after they were gazetted, and progress made with implementation of the measures is summarised in Penney *et al.* (2008).

This document constitutes the New Zealand Bottom Fishery Impact Assessment required by the interim measures, and has been prepared in accordance with the guidelines provided in the SPRFMO Benthic Assessment Framework adopted at the 4th SPRFMO meeting, held in Noumea, New Caledonia, in September 2007 (SPRFMO 2007b).

This assessment covers all New Zealand high seas bottom fishing activities within the SPRFMO Area in the interim period from 1 January 2008 to 31 December 2009. New Zealand intends to review this bottom fishery impact assessment in 2010 when it will review its implementation of the interim measures in 2010 more fully. This ties into the provision to open new regions of the SPRFMO Area in 2010 on the basis of an assessment (interim measure paragraph 3).

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[1] The area is under negotiation, but for the purposes of the interim measures and this assessment it is 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.

2. Description of Proposed Fishing Activities

This section provides the detailed description of fishing activities (the *Fishery Plan* or *Harvesting Plan*) for deepwater fishing by New Zealand vessels in the SPRFMO Area during 2008 and 2009, as required by the SPRFMO Benthic Assessment framework (SPRFMO 2007c).

2.1 Fishing Methods

The New Zealand high seas bottom fisheries are well-developed fisheries that have been in operation for about the past two decades. While fishing areas have expanded over time, and fishing methods and gear have been steadily refined and improved, the current fisheries operate in much the same way as they have for the past decade or so. Descriptions and analyses presented in this assessment have been based on data for the period from 1990 onwards, when fishery development started to increase significantly, to 2006/07, with emphasis on the years 2002 - 2006, this being the reference period in the interim measures upon which to base catch and effort management measures.

2.1.1 Bottom Trawling Methods

New Zealand flagged bottom trawling vessels fishing in the SPRFMO Area during 2008 and 2009 will be targeting orange roughy, alfonsino, cardinalfish and oreo species using specific deepwater bottom trawl nets and fishing methods developed over the past decade, and which are currently used both within and beyond the New Zealand Exclusive Economic Zone (EEZ), to specifically target these species.

- ***Deepwater Trawl Net Designs***

Modern deepwater trawling is an aimed method of trawling, usually targeting relatively dense aggregations of fish which are often located and targeted acoustically. This differs from the herding type trawl fishing of, for example, flatfish, hake or cod which are fished using long, non-aimed tows on flat, muddy seabed. To reduce damage to fishing gear on the hard ground typical of areas inhabited by species such as orange roughy, and to enable nets to be rapidly and accurately aimed at fish aggregations, deepwater trawling methods have evolved in various ways towards agile net systems that minimise groundrope length, net size and unnecessary ground contact, particularly by non-fishing gear components such as trawl doors.

Some typical deepwater trawl net designs currently used in these fisheries are shown in Figure 1. Nets are manufactured from braided nylon twines, typically ranging in thickness from 4mm for the wings, to 5mm for the end sections, doubled for areas of the net belly subject to abrasion. Codends attached to these nets are made of heavier rope meshes. Net headropes are equipped with hard floats to provide the buoyancy needed to maintain the net opening during trawling (see Plate 2), while the footrope may be equipped with a variety of ground-gear, depending on the seabed type to be trawled. The nets used are designed to provide net mouth openings (groundrope lengths) between wing-tips of 15 - 20 m under optimal towing conditions, with headline heights of 5 m - 6 m above the footrope. Nowadays, nets are also equipped with netsounders and headline sensors to monitor the net opening, to determine position of the net relative to the seabed, and to facilitate accurate targeting of nets at acoustic fish targets.

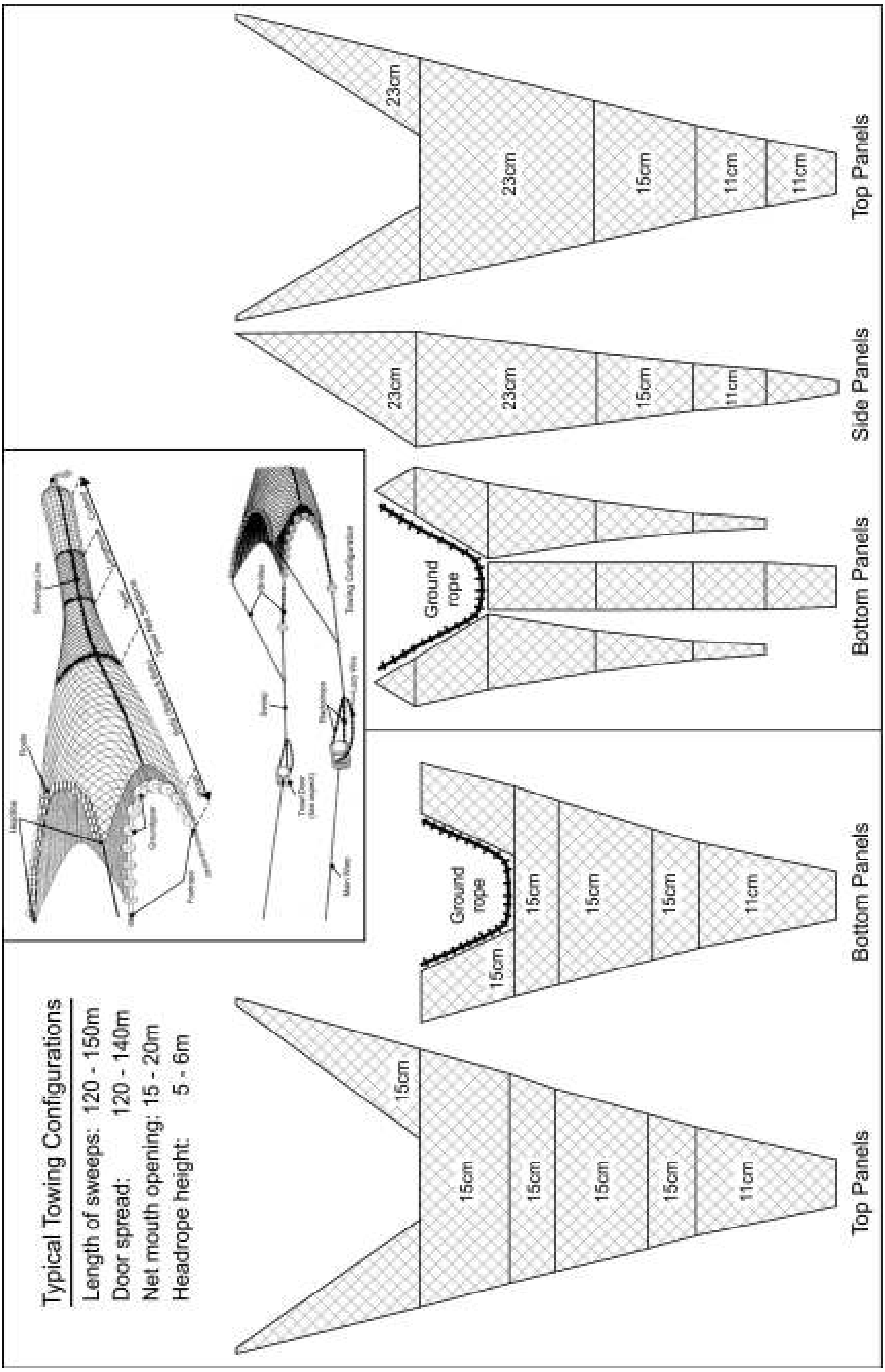

Figure 1. Stylised net construction diagrams for typical bottom trawl nets used in the New Zealand deepwater orange roughy targeted bottom trawl fishery. Two alternate simplified net designs are shown, using different mesh sizes and net wing configurations. Inset shows an illustration of the configuration of a typical bottom trawl net during trawling.

- ***Trawl Doors and Towing Configurations***

Trawl doors used in New Zealand deepwater bottom trawl fisheries were initially of the older style 'vee-door', to maximise the stability of doors during towing. Vee doors have a low aspect ratio, with their length being greater than their height (Figure 2 a), which results in greater stability. However, these doors are dependent on bottom contact (ground sheer forces) to create their net spreading force. With the move to better winch systems and increased use of electronics to accurately target fish aggregations, there has been a move to high aspect ratio doors, in which the height is 1.5 to 1.8 times length (See Figure 2 b). These doors do not require bottom contact and depend solely on hydrodynamic forces to generate spread. Efforts to reduce drag and increase control of trawl doors has also resulted in a move to smaller, more efficient doors from producers of high-technology doors, such as Nichimo, Hampidjan and Morgere.

The trawl doors currently used by New Zealand deepwater bottom trawlers typically range from ~1,200kg - 2,000kg in weight, and from ~4m^2 - 8m^2 in size, depending on the vessel engine power and net design. Modern doors (such as the Morgere WV and WX doors shown in Plate 2 b) and c) are generally designed and rigged to operate off the bottom, being set to minimise the risk of digging in should there be any contact with the seabed. Deepwater trawl nets rigged in this way are ideally 'flown' such that the net contacts the seabed only in the area of the aggregated fish shoals, with the doors themselves preferably not touching the seabed.

Lengths of sweeps and bridles (the towing and herding wires connecting the trawl doors and the net opening) have also been significantly reduced in comparison to hoki trawl nets, to provide better control over the gear and reduced seabed contact (Table 1).

Table 1. Comparative lengths of sweeps and bridles used on New Zealand hoki-targeted and orange roughy-targeted bottom trawl net systems.

Net Type	Sweep Length	Bridle Length
Hoki trawl	140 - 210m	30m
Orange roughy trawl	100 m	12m

The combination of sweeps and bridles connecting the doors to the nets on current orange roughy targeted trawls typically range in length from 120m - 140m, the combination of doors and sweep lengths being set to achieve net openings of 15m - 20m between wingtips. Under these configurations, distance achieved between trawl doors during towing (door spread) is maximally 120m - 150m under optimal towing conditions. In areas where operators wish to accurately target fish aggregations and require maximal control of the net, they may even operate with very short bridles and no sweeps.

The extent to which these gear modifications, together with other operational measures, are intended to minimise unnecessary contact with the seabed is further described in *Section 7: Management and Mitigation Measures*.

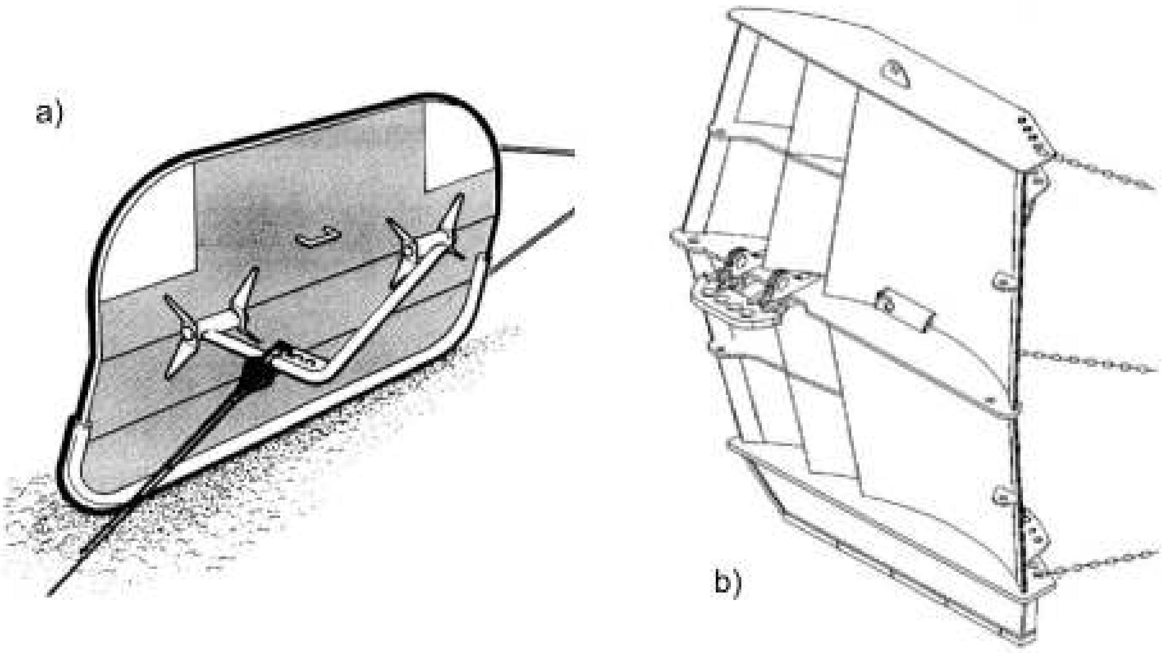

Figure 2. Illustrations of trawl doors used in New Zealand bottom trawl fisheries showing a) Older style low aspect-ratio ‘vee’ door, and b) More recent high aspect-ratio hydrodynamic door.

Plate 1. Examples of trawl doors in use on New Zealand deepwater bottom trawlers showing a) Nichimo Super-Vee doors rigged on a trawler stern, b) a Morgere WX door and c) a Morgere WV door.

Plate 2. Alternate ground-gear configurations used when deepwater bottom trawling for species such as orange roughy and oreos showing ground-ropes equipped with a) 50-60cm rubber bobbins separated by rubber spacers, and b) with more closely spaced 60-80cm ‘rockhopper’ rubber discs plus leading end steel bobbins.

- ***Ground Gear Configuration***

For bottom trawling on hard ground, net footropes are equipped with some form of ground-gear to protect the footrope, and to enable the net to manoeuvre over rough terrain or minor obstacles. Initially, deepwater trawlers used steel bobbins on the groundrope when fishing hard ground, these being standard at the time on Northern Hemisphere cod trawlers. It has been found that these are not necessary and that gear efficiency is improved and bottom contact reduced by incorporating rubber components in the ground rope. Initially, steel bobbins were replaced by smaller 40 cm - 60 cm diameter rubber bobbins (Plate 2a). More recently, there has been a shift to the use of 50cm - 80cm rubber discs separated by spacers along the footrope to create ‘rockhopper’ gear (Plate 2b). Whereas bobbins are designed to allow the footrope to roll over rough ground, the groundrope in a rockhopper system is rigged under tension, causing the net to ‘hop’ over encountered obstacles, rather than attempting to drag through or roll over them.

2.1.2 Bottom Line Fishing Methods

New Zealand vessels fishing the high seas have used a variety of bottom line fishing methods over the history of these fisheries, the most important of which have been bottom longlines, dahn lines and trot lines. The proportion of fishing effort using each of these methods over the 2002 - 2006 reference period is shown in Table 2.

Table 2. Summary of total bottom line fishing (hooks) by New Zealand vessels using various methods in the SPRFMO Area over the period 2002 - 2006.

Year	Bottom Longline Hooks	Dahn Line Hooks	Trot Line Hooks	Total Hooks
2002	0	0	0	0
2003	50,538	2,900	0	53,438
2004	229,425	36,984	2,400	268,809
2005	362,438	18,895	2,690	384,031
2006	483,194	18,610	0	501,810
Total	1,125,595	77,389	5,090	1,208,088

In recent years, the predominant line fishing method has been bottom longlines, accounting for 93% of the hooks fished over 2002 - 2006. Most of the remaining effort consisted of dahn line sets (a form of vertical drop line), with very little trot line effort (a form of suspended longline).

Typical configurations of these three types of bottom line fishing gear are illustrated in Figure 3. Bottom longline configurations on smaller vessels may use weights (~5kg), or a combination of weights and floats, to keep lines on or near the bottom, depending on target species. Larger autoline vessels may use lead-core weighted bottom lines (~50g / m) to keep the lines on the bottom. New Zealand high seas bottom longline operations, particularly when targeting bluenose and hapuku / bass, use short lines with relatively few hooks to target specific seabed features. The number of hooks used per set averaged 980 over 2002 - 2006, although with a wide range (standard deviation 1,194 hooks). Longer sets may be used when exploring new areas, or fishing flatter seabed, and a maximum of 9,000 hooks was reported over the period. New Zealand bottom longline fishermen usually use circle hooks to minimise seabird bycatches.

Dahn lines are a form of drop-line, vertically deployed between surface buoys and a seabed weight, with a bottom section rigged with hooked snoods to fish a specific depth range above the seabed (Figure 3). A vessel will usually deploy a number of Dahn lines in a specific area during a day’s fishing, and the number of hooks reported per day over 2002 - 2006 averaged 864 (s.d. 469), with a maximum reported daily effort of 1,920 hooks. These drop line systems were initially implemented to target for hapuku / bass on flanks and summits of steeper seabed features, with the length (fished depth range) of the hooked section being adjusted to target bluenose swimming higher off the seabed. Trot lines can be considered to be a combination of the bottom longline and drop line fishing methods, using a buoyed longline suspended above the seabed, equipped with short dropper lines of 20 - 25 hooked short snoods. Effort reported for trot lines during 2002 - 2006 averaged 138 hooks per set, with a maximum of 600 hooks.

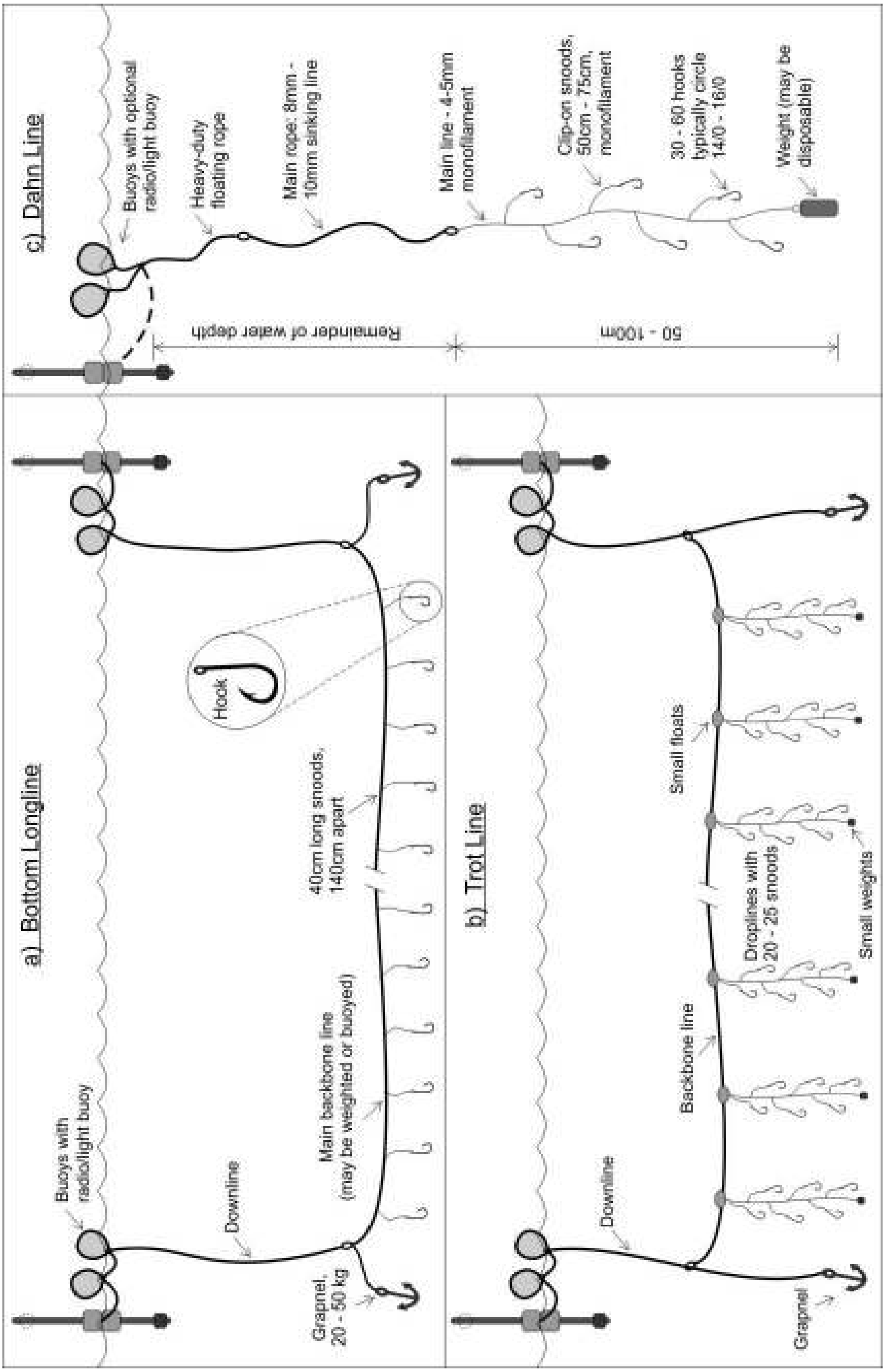

Figure 3. Diagrammatic illustration of bottom line fishing gear used by New Zealand vessels, showing example configurations for a) Bottom Longlines, b) Trot Lines and c) Dahn Lines.

2.2 Depth Ranges to be Fished

2.2.1 Bottom Trawling Fishing Depths

New Zealand vessels are required to report seabed depth on catch return forms for each fishing trip, enabling the frequency of trawl tows in different depth ranges over the period 2002-2006 to be analysed (Figure 4).

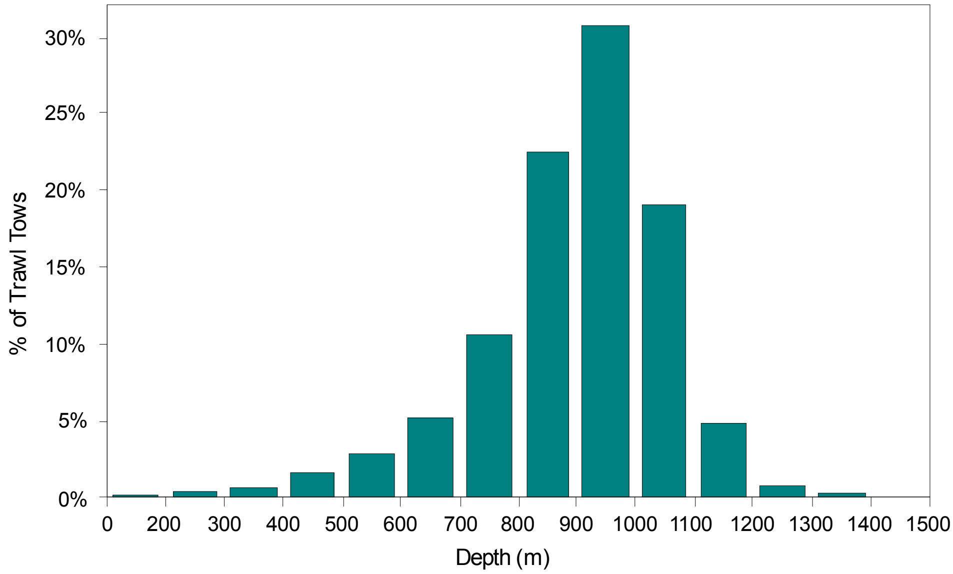

Figure 4. Fishing depth frequency distribution of high seas bottom trawl tows by New Zealand vessels fishing in the SPRFMO Area over the period 2002 - 2006. (Total tows for which depth information was available for this analysis was 13,662)

Over this period, 13,662 of the total reported 13,713 tows reported bottom depth. 11% of these tows were conducted in depths less than 700 m, 6% in depths greater than 1,100 m, with 83% of tows being conducted in the depth range 700 m - 1,100 m. Just over half the tows were conducted over the depth range 800 m - 1,000 m, with a strong mode in the 900 m - 1,000 m depth range.

The participants, fishing methods and fishing areas to be fished during 2008 and 2009 have not changed since the 2002 - 2006 reference period, and bottom trawling to be conducted during this interim period, and covered by this impact assessment, will be conducted over the same depth ranges, and in similar proportions of tows by depth range as shown in Figure 4.

2.2.2 Bottom Line Fishing Depths

Over 2002 - 2006, sets representing 962,873 of the total 1,208,088 hooks deployed reported bottom depth (Figure 5). Most bottom line fishing is conducted shallower than bottom trawling, particularly when targeting hapuku / bass, and 90% of the reported hooks were set in depths <800 m, mostly from 400 m - 600 m. However, the remaining 10% of bottom line effort was widely spread across the depth range from 1,000 m - 1,700 m. This effort generally consisted of very few, most likely exploratory, bottom longline sets at each of these deeper depth ranges.

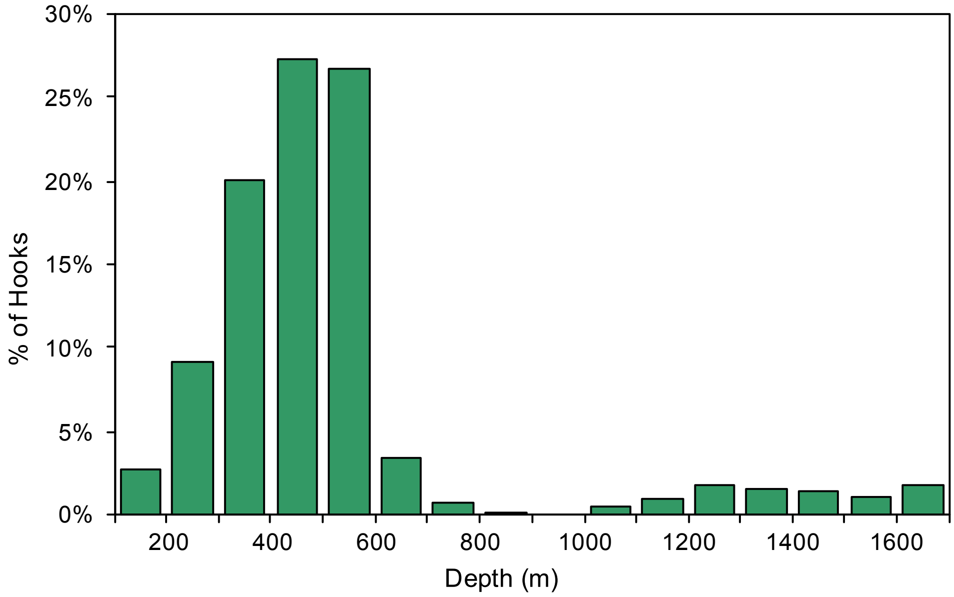

Figure 5. Fishing depth frequency distribution of high seas bottom line hooks by New Zealand vessels fishing in the SPRFMO Area over the period 2002 - 2006. (Total hooks for which depth information was available for this analysis was 962,873)

The participants, fishing methods and fishing areas to be fished during 2008 and 2009 have not changed since the 2002 - 2006 reference period, and bottom line fishing to be conducted during this period, and covered by this impact assessment, will be conducted over the same depth ranges, and in similar proportions of tows by depth range as shown in Figure 5.

2.3 Target and Likely Bycatch Species

2.3.1 Bottom Trawling Target Species

Twenty two different species were declared as bottom trawl target species over 2002 - 2006, with the top 4 species groups constituting 98% of targeted species (Table 3), and the others contributing the remaining 2%. Target species in 2008 and 2009 will remain the same.

Table 3. Top four species contribution to the total New Zealand bottom trawl catch in the SPRFMO Area over the period 2002 - 2006.

Species	% Targeting
Orange roughy	91%
Alfonsino	4%
Cardinalfish	2%
Oreos	1%
Others (<1% each)	2%

Catches of a total of 137 species or species groups were reported for 2002 - 2006. Of these, the top ten species contributed 96% of the total New Zealand high seas catch (Table 4). Reported by foreign flagged vessels landing into New Zealand, and therefore required to report the catches that contributed to those landings, have been included in Table 4 to explain the differences in reported New Zealand catch to those reported by Penney et al (2007), who included this foreign flagged catch in that paper.

Table 4. Top ten species contribution to the total New Zealand bottom trawl catch in the SPRFMO Area over the period 2002 - 2006.

Species Code	Scientific Name	Common Name	NZ Flag Catch (t)	Other Flag Catch (t)
ORH	*Hoplostethus atlanticus*	Orange roughy	9,259	2,767
BOE	*Allocyttus niger*	Black oreo	598	298
EPT	*Epigonus telescopus*	Deep sea cardinal	638	46
BYX	*Beryx splendens* and *B decadactylus*	Slender beryx, Longfinned beryx	250	181
SSO	*Pseudocyttus maculatus*	Smooth oreo	248	58
RIB	*Mora moro*	Ribaldo	276	15
RAT	*Macrouridae.Family*	Rattails	274	1
BSH	*Dalatias licha*	Seal shark	120	
BOA	*Paristiopterus labiosus*	Boarfish	85	
SOR	*Neocyttus rhomboidalis*	Spiky oreo	78	2
	Total (top 10 species)		11,827	3,368

It is expected that bottom trawl targeting over 2008-09 will closely reflect the historic targeting patterns that occurred over 2002-2006.

2.3.2 Bottom Line Fishing Target Species

The bottom line fisheries have primarily targeted bluenose and hapuku / bass over the history of these fisheries, with bluenose being targeted by 77% of effort (hooks fished), and hapuku / bass by 19% of effort, over 1990 - 2007 (Table 5). Over this period there has been a trend towards increased bluenose targeting, and decreased hapuku / bass targeting. Bluenose targeted effort increased from 58% in 1990-95 to 90% in 2007, while hapuku / bass targeting decreased from 34% to 7% in response to declining catches of hapuku and increased market demand for bluenose.

Table 5. Changes in proportion of New Zealand bottom line effort (hooks fished) targeted at the two main species groups, bluenose and hapuku / bass, in the SPRFMO Area over the period 1990 - 2007.

Period	Bluenose	Hapuku / Bass	Others
1990-1995	58%	34%	8%
1996 - 2001	70%	16%	14%
2002-2006	80%	16%	4%
2007	90%	7%	3%
Overall	77%	19%	4%

A number of other species are caught in addition to these primary targets, with a total of 59 species or species groups reported on bottom line catch return forms for 2002 - 2006. Of these, the top ten species contributed 97% of the total bottom line catch from all high seas areas over the period (Table 6).

Table 6. Top ten species contribution to the total New Zealand bottom longline, trot line and dahn line catch in the SPRFMO Area over the period 2002 - 2006.

Species Code	Scientific Name	Common Name	Catch (t)
BNS	*Hyperoglyphe antarctica*	Bluenose	495
HPB	*Polyprion oxygeneios / P. americanus*	Hapuku / Bass	158
KTA	*Nemadactylus* spp.	King tarakihi	24
SPD	*Squalus acanthias*	Spiny dogfish	20
SKI	*Rexea spp.*	Gemfish	6
KIN	*Seriola lalandi*	Kingfish	5
PTO	*Dissostichus eleginoides, D. mawsoni*	Toothfish	4
SPE	*Helicolenus* spp.	Sea perch	3
SCH	*Galeorhinus galeus*	School shark	3
RSN	*Centroberyx affinis*	Red snapper	2
Total (top 10 species)			720

It is expected that bottom line targeting over 2008-09 will closely reflect the historic targeting patterns that occurred over 2002-2006.

2.4 Intended Period and Duration of Fishing

Vessels involved in New Zealand bottom fisheries on the high seas are also involved in domestic fisheries within the New Zealand EEZ, fishing the high seas once quotas for the year have been fished, or when lulls in domestic fishery seasons permit time for fishing the high seas. Both the trawl and line fisheries on the high seas therefore show strong seasonal patterns.

2.4.1 Bottom Trawling Fishing Season

The New Zealand high seas bottom trawl fishery is a southern hemisphere winter fishery, primarily occurring over the months April to August. Over 2002 - 2006, there was some evidence of differences in the peak fishing times for orange roughy between the different fishing areas, with the Challenger and West Norfolk areas peaking in June, the West Norfolk area in July and the Louisville Ridge area in August (Figure 6).

2.4.2 Bottom Line Fishing Season

In contrast to the bottom trawl fishery, the New Zealand flagged bottom line fishery is a southern hemisphere summer fishery, occurring primarily over the months October to January with a strong peak in catches in December, and with effort extending out to April (Figure 7).

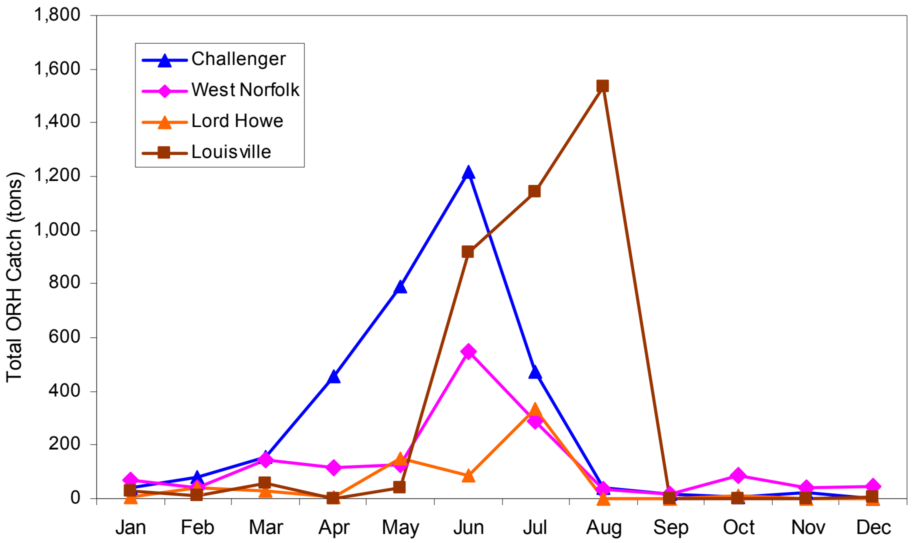

Figure 6. Total New Zealand bottom trawl catch of orange roughy per month in the various fishing areas in the SPRFMO Area over the period 2002 - 2006.

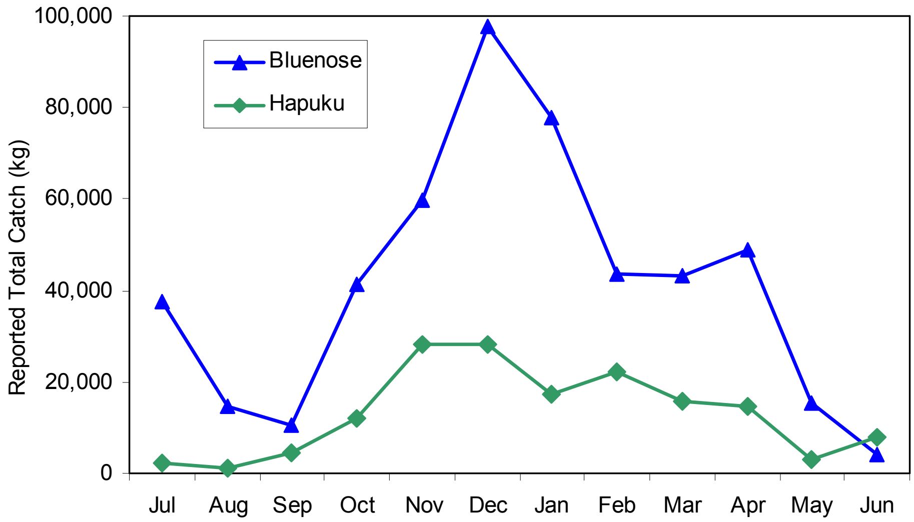

Figure 7. Total New Zealand bottom line catch of bluenose and hapuku / bass per month in the SPRFMO Area over the period 2002 - 2006.

2.5 Effort Indices

2.5.1 Bottom Trawl Fishing Effort

There has been a steady declining trend in the number of New Zealand vessels participating in high seas bottom trawl fisheries (see *Section 5. Status of the Deepwater* Stocks to be Fished), from a peak of 55 vessels in 1996 to 9 vessels in 2007. Over the period 2002 - 2006, the number of vessels declined from 23 to 12, with an average of 18 per year.

The SPRFMO interim measures require Participants to limit their effort or catch to the annual average over the period 2002 - 2006. Given the decline in effort and the management measures now in place, (see *Section 7. Management and Mitigation Measures*), the number of New Zealand bottom trawl vessels is not expected exceed the 2002 - 2006 average of 18 vessels. Between May, when the 2008 New Zealand high seas permits incorporating the SPRFMO interim measure provisions were issued, to end November 2008, only four of the vessels issued with high seas permits (listed in Appendix A) had conducted bottom trawl fishing operations in the SPRFMO Area.

The number of bottom trawl tows has also declined over the reference period from 2,944 tows in 2002 to 1,135 tows in 2006 (see *Section 5. Status of Deepwater Stocks*). In terms of evaluating seabed impact of these tows, most orange roughy targeted bottom trawls are of short duration and distance. Over 2002 - 2006, tow duration averaged 2.19 hours (s.d. 2.63 hours), and an average 5.84 nm (s.d. 6.98 nm) in length. However, almost one third of these tows were shorter than 15 minutes, and 60% were shorter than 30 minutes. Over half the tows extended for less than 2 nm (3.7 km) (Figure 8). These short tows are typical of the highly targeted fishing on dense fish aggregations, or specific seabed features known to support fish. The wide range in tow durations / distances results from fewer long tows, usually on flatter ground adjacent to high profile features.

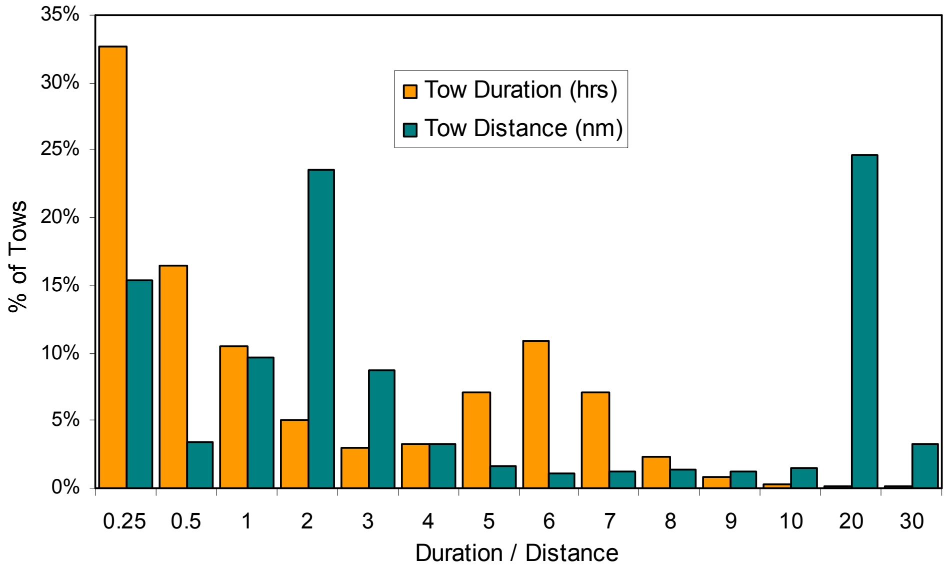

Figure 8. Frequency distribution of tow duration and tow distance by New Zealand high seas bottom trawlers fishing in the SPRFMO Area over the period 2002 - 2006.

As a result of the continuing trend towards highly targeted trawling in the high seas orange roughy fishery, tow durations and lengths continue to decrease. Of the four vessels which have conducted fishing on the high seas in 2008, observer data are so far available for four trips by three of these vessels. Two hundred and thirty five bows were observed on these four trips, with an average duration of 14 minutes per tow, and a maximum reported duration of 3.3 hours. Lengths of these tows averaged 1.3 km (s.d. 1.7 km), with a maximum reported length of 14.9 km.

2.5.2 Bottom Line Fishing Effort

In contrast to the bottom trawl fishery, effort in the New Zealand high seas bottom line fisheries increased over the period 2002 - 2006, from zero effort in 2002, 3 vessels (53.438 hooks) in 2003, to 10 vessels (501,810 hooks) in 2006, averaging 6 vessels over the period. This effort increase reflects a resurgence in interest and targeting for bluenose, following recent increased market demand for the species. New Zealand operators historically operated 10 bottom line vessels on the high seas from 1995 to 1998 (see *Section 5. Status of Deepwater Stocks*).

Plate 3. Typical compact bottom trawling vessels used by New Zealand operators to target deepwater species such as orange roughy in the SPRFMO Area.

2.6 Information on Vessels to be Used

Between May and December 2008, 30 vessels were issued with New Zealand high seas fishing permits (Appendix A). These include bottom trawl, midwater trawl, purse-seine and bottom line vessels, many of which intend to primarily fish within the EEZ, but which take out high seas permits to allow for high seas fishing, if required, for highly migratory, pelagic and demersal species. Of these vessels, only four had conducted any bottom trawl fishing in the SPRFMO Area by December 2008. The vessels which have conducted high seas bottom trawling during 2008 range in length from 32.7 m to 43.7 m, in gross tonnage from 317 t to 671 t, and are equipped with engines ranging in power from 690 to 1,620 kilowatts (see Appendix A). Photographs of typical New Zealand bottom trawlers used to target species such as orange roughy are shown in Plate 3.

3. Mapping and Description of Proposed Fishing Areas

3.1 Definition of Fishing Areas

Past New Zealand high seas bottom trawling effort has been focussed on five distinct and separate fishing grounds (Figure 9), with bottom line fishing also being conducted in two further areas (the Hjort Trench and Southwest Pacific Basin) over 2002-2006. From experience with studies conducted within the New Zealand EEZ, these separate fishing grounds are likely to support separate stocks of species such as orange roughy. Catch summaries were therefore stratified by these fishing areas. The latitude / longitude boundaries for these fishing grounds originally defined by Clark (2006) for New Zealand high seas orange roughy catch analyses were modified for SPRFMO implementation purposes to reflect the specific footprint areas over 2002-2006, at the 20 minute lat/lon block resolution specified in the SPRFMO Interim Benthic Assessment Framework (SPRFMO 2007b):

South Tasman Rise (although no fishing was conducted here in 2002 - 2006)
46° 00.0' S - 50° 00.0' S and 145° 00.0' E - 150° 00.0' E

Lord Howe Rise
North: 32° 40.0' S - 34° 40.0' S and 162° 20.0' E - 163° 20.0' E
South: 35° 20.0' S - 36° 20.0 S and 165° 00.0' E - 166° 20.0' E

West Norfolk Ridge
32° 20.0' S - 34° 20.0' S and 166° 40.0' E - 168° 00.0' E
(excluding tows within the New Zealand EEZ)

Northwest Challenger Plateau
36° 40.0' S - 39° 00.0' S and 166° 40.0' E - 170° 20.0 E
(excluding tows within the New Zealand EEZ)

Three Kings Ridge
28° 00.0' S - 31° 00.0 S and 172° 20.0' E - 175° 40.0' E

Louisville Ridge
North: 36° 00.0' S - 40° 00.0' S and 169° 40.0' W - 167° 00.0'W
Central: 40° 20.0' S - 44° 20.0' S and 166° 00.0' W - 159° 40.0' W
South: 44° 40.0' S - 48° 00.0' S and 158° 40.0' W - 149° 40.0' W

Hjort Trench
58° 20.0' S - 60° 00.0' S and 158° 40.0' E - 161° 40.0 E

Southwest Pacific Basin
56° 00.0' S - 56° 20.0' S and 143° 40.0' W - 143° 00.0 W

A map showing the boundaries and coordinates of these fishing areas is available on the New Zealand National Biodiversity Information System (NABIS - http://www.nabis.govt.nz), and is shown in Figure 9.

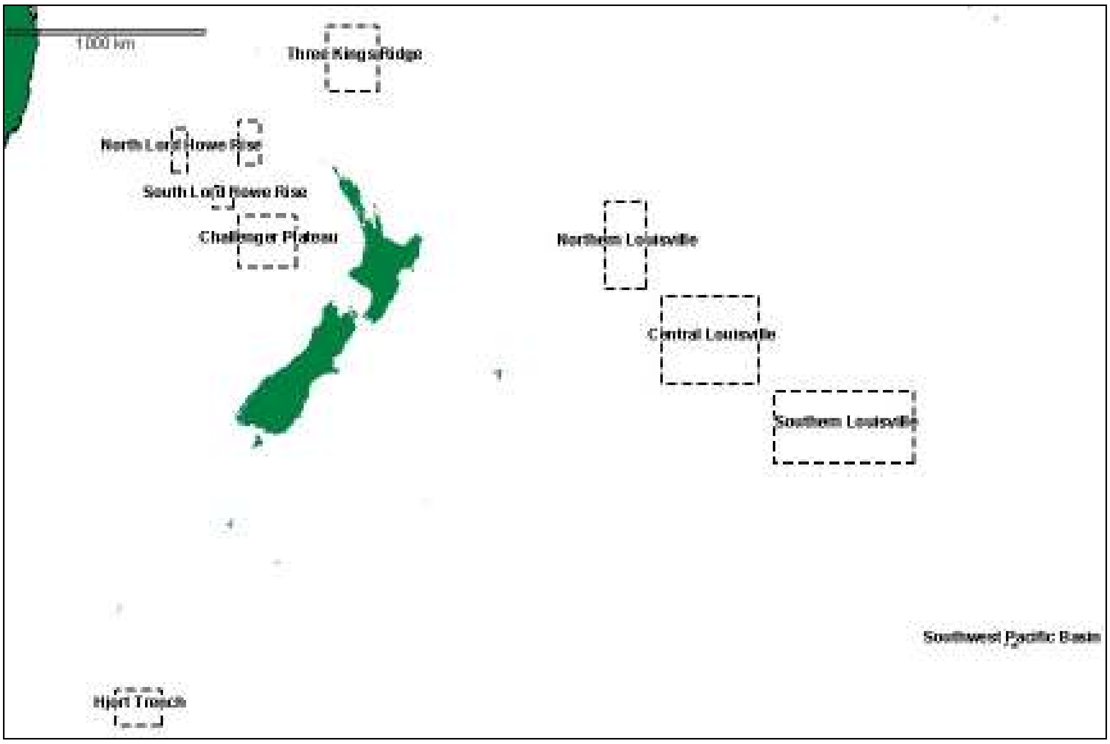

Figure 9. Location of the major bottom fishing areas outside New Zealand and Australian EEZs (map available on NABIS: http://www.nabis.govt.nz)

3.2 Data Preparation & Summary

New Zealand trawl fishing operations are required to complete daily tow-by-tow High Seas Trawl Catch Effort Return (HSTCER) forms. Catch returns are also received from foreign flagged vessels that land fish into New Zealand. Returns from both New Zealand and foreign vessels were used in the mapping of bottom footprint maps, to comply with the intention that this footprint should be a joint footprint of all participants (SPRFMO 2007b). The data sets used for all other analyses however were extracts of high seas bottom fishing data (bottom- and midwater trawl, bottom longline, trot line and dahn line) from New Zealand flagged vessels only.

These data were comprehensively groomed under contract by NIWA using the same grooming rules used for previous analyses of bottom trawl data, and corrected for apparent errors in factors such as tow start or end position (particularly east-west errors), tow durations and distances relative to tow positions, and catches relative to tow durations. Complete details of this grooming process have been retained and are available to those interested in how this was done. The groomed data were imported into SPlus® and MS Excel® for subsequent summary of catches by species, year, area and flag.

3.3 Mapping of 'Currently Fished Areas'

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

> "*This joint footprint map is to be expressed as grid blocks of 20 minute resolution, with a 'fished' block being defined as any grid block partially crossed by at least one trawl track. The period 2002 - 2006 is to be used as the reference period for developing this joint trawl footprint map."* (SPRFMO 2007b)

While the SPRFMO interim Secretariat has been charged with the responsibility of obtaining the necessary tow-by-tow data, and preparing the joint SPRFMO bottom fishing footprint map on behalf of Participants, no interim Secretariat had been established by the implementation date of the interim measures of 30 September 2007. New Zealand therefore generated initial bottom fishing footprint maps from all data available, including New Zealand and foreign flag catch, as a first contribution to the joint SPRFMO bottom fishing footprint map.

Results have already been presented in a New Zealand paper on implementation of the SPRFMO interim measures (Penney *et al*. 2008). All tow start and end positions were imported into MapInfo® GIS mapping software, which was used to plot all trawl tows as straight lines between the reported start and end positions. These were then covered with a grid of blocks at 20 minute resolution (in WGS84 geo-coordinate system) and any block touched by at least one tow was retained, to constitute the bottom trawl footprint map, consisting of 200 x 20 minute blocks.

In a final data grooming step, the original catch / effort return for any individual tow which was particularly influential in causing an extra block to be added to the footprint (as a result of being isolated from other tows, or particularly long, extending across many blocks) was checked against the original catch return form, to correct data capture errors. All tows included in the final footprint have therefore been through a rigorous error checking and validation process. The resulting 2002 - 2006 bottom trawl footprint map is shown in Figure 10 for the Lord Howe, Challenger, West Norfolk and Three Kings Ridge fishing areas (134 blocks), and in Figure 11 for the Northern, Central and Southern Louisville fishing areas (66 blocks).

A footprint map was similarly developed for New Zealand bottom longlining, trot-lining and dahn-lining[2]. Catch returns for these methods typically only report start position of each set, particularly for trot lines and dahn lines. Footprint maps for bottom lining were therefore compiled from any 20 minute grid block within which at least one bottom line set start position fell over the period 2002 - 2006. The resulting 2002 - 2006 bottom line footprint map consists of 40 blocks and is shown in Figure 12 for the Challenger, West Norfolk and Three Kings Ridge fishing areas (35 blocks), in Figure 13 for the Hjort Trench fishing area (3 blocks) and in Figure 14 for the Southwest Pacific Basin area (2 blocks).

[2] No foreign flagged bottom line vessels landed catch into New Zealand during 2002 – 2006.

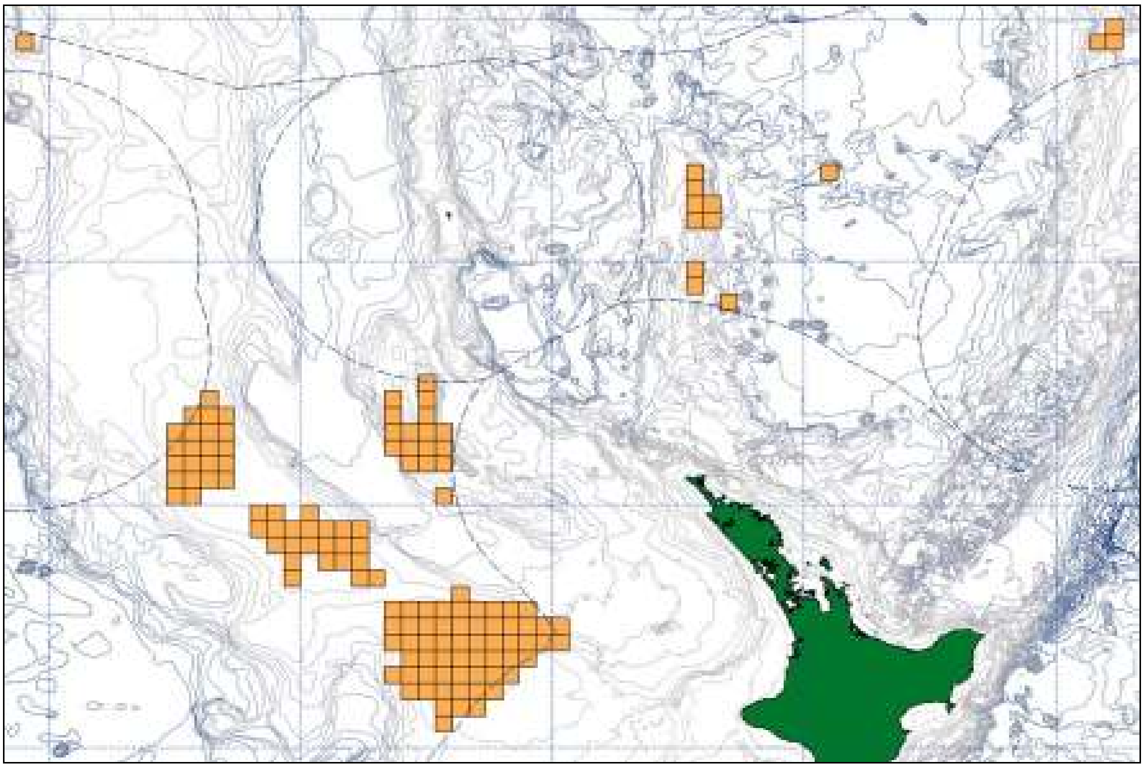

Figure 10. New Zealand bottom trawl footprint map for the Lord Howe N, Lord Howe S, Challenger Plateau, West Norfolk and Three Kings Ridge fishing areas, showing the 134 blocks fished over the 2002 - 2006 reference period.

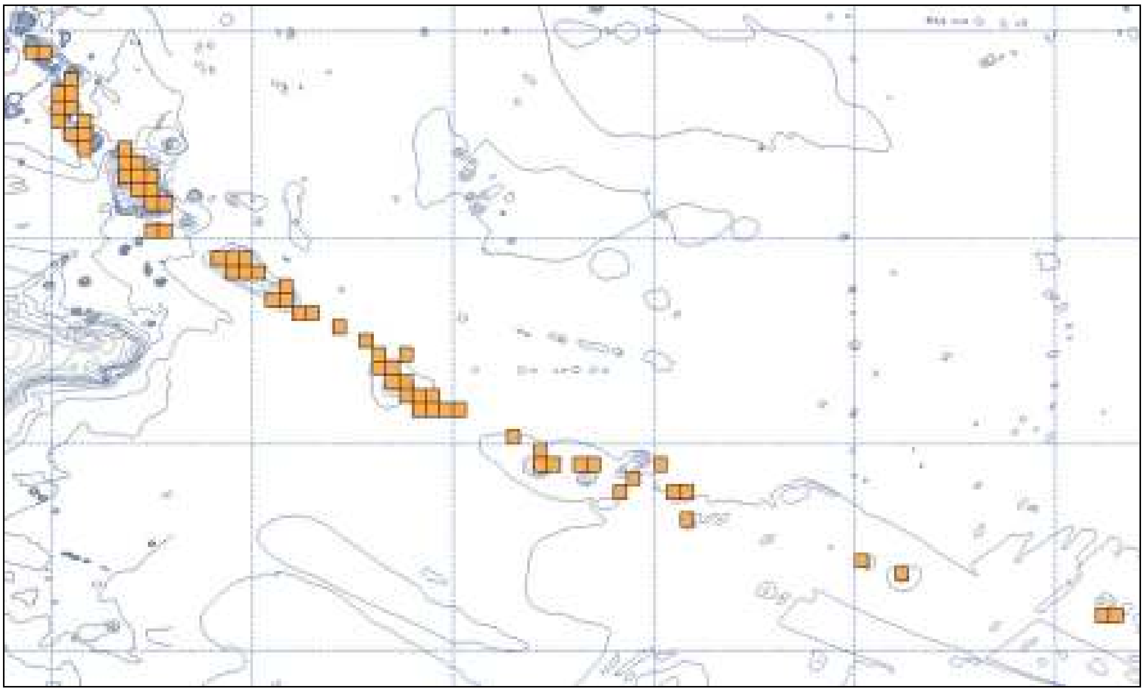

Figure 11. New Zealand bottom trawl footprint map for the North, Central and South Louisville Ridge fishing areas, showing the 66 blocks fished over the 2002 - 2006 reference period.

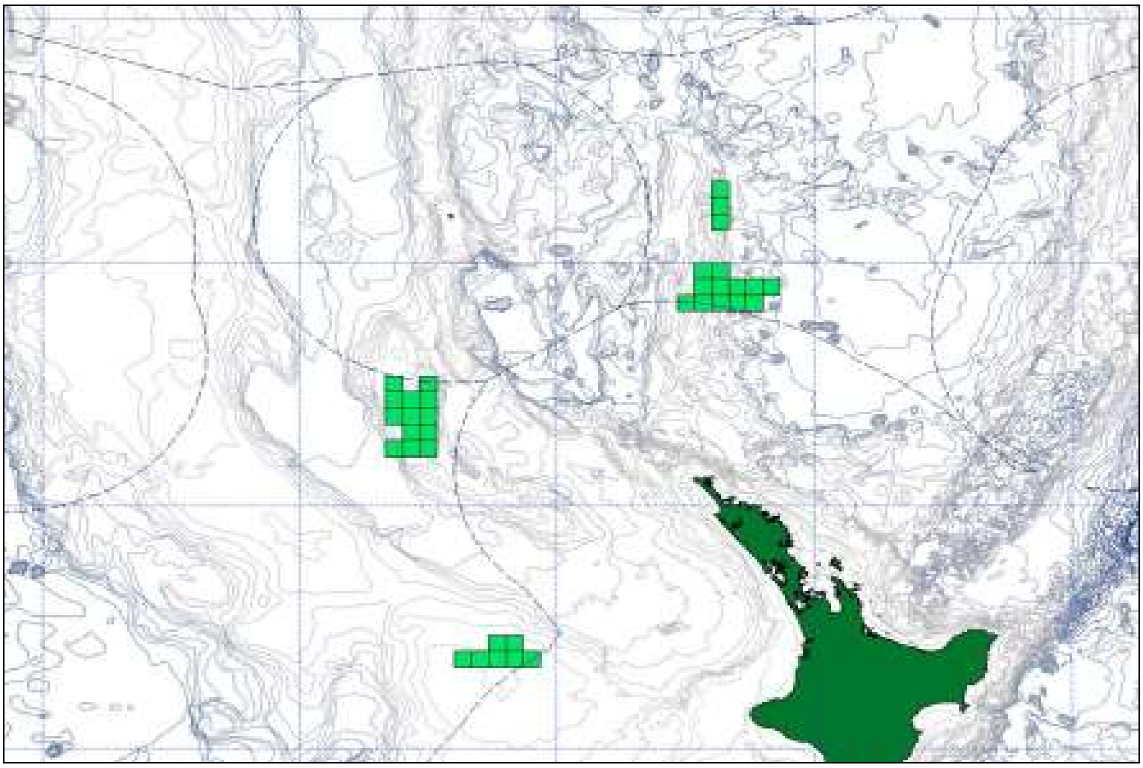

Figure 12. New Zealand bottom line footprint map for the Challenger Plateau, West Norfolk and Three Kings Ridge fishing areas, showing the 35 blocks fished over the 2002 - 2006 reference period.

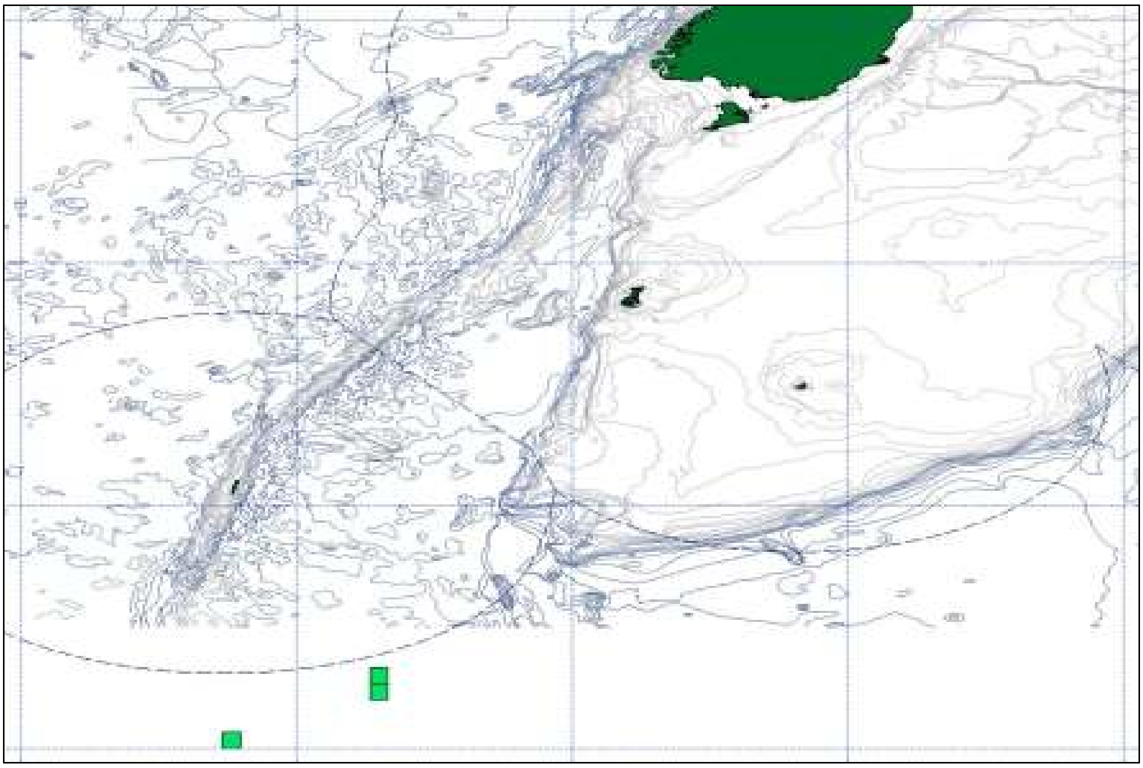

Figure 13. New Zealand bottom line footprint map for the Hjort Trench fishing area, showing the three blocks fished over the 2002 - 2006 reference period.

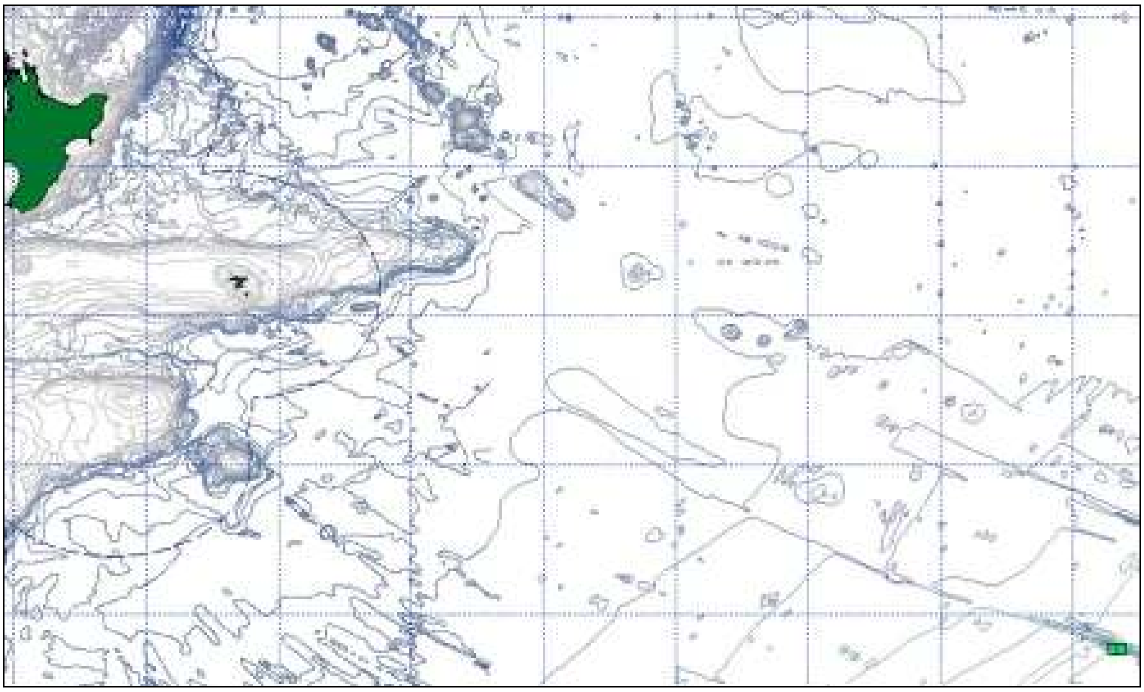

Figure 14. New Zealand bottom line footprint map for the Southwest Pacific Basin fishing area, showing the two blocks fished over the 2002 - 2006 reference period.

- ***Combined Bottom Fishing Footprint***

The bottom trawl and bottom line footprint maps in Figures 10 - 14 were combined to generate an all methods, all areas bottom fishing footprint map over the reference period 2002 - 2006. This combined bottom fishing footprint of 218 x 20-minute blocks is shown in Figure 15.

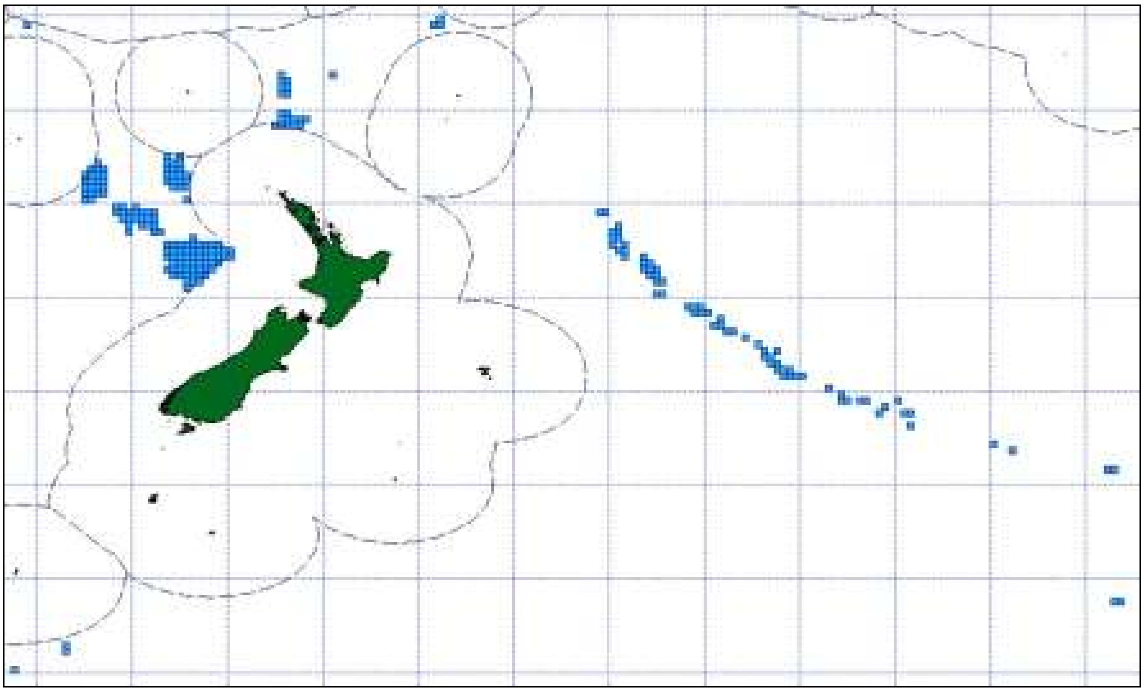

Figure 15. New Zealand all methods, all areas, combined bottom fishing footprint map, showing the total 218 blocks fished by any method over the 2002 - 2006 reference period.

3.4 Effort Stratification of the Bottom Trawl Footprint

At the 4th SPRFMO Meeting held in Noumea in September 2007, at which the Interim Benthic Assessment Framework was adopted, the Scientific Working Group noted the value of having an effort index (such as total number of trawls) for each block in footprint maps prepared by participants, to provide an index of relative past impact in each block (SPRFMO 2007d). An analysis tabled by New Zealand at that meeting (Penney *et al*. 2007) demonstrated that increasing block size used in footprint maps results in exponentially increasing exaggeration of the mapped footprint in comparison with actual seabed impact area of individual trawl tracks. Compared to trawl tracks buffered by a 200m wide impact zone around the actual tracks, compilation of footprint maps at 20 minute block resolution can result in an exaggeration of fished area by 2 - 7 times, depending on intensity of fishing.

One of the principles that New Zealand followed in developing management and mitigation measures for high seas bottom trawling operations over interim period (see *Section 7. Management and Mitigation Measures*) was to limit fishing during the interim period, as far as practicable, to the actual area previously fished within the 20 minute block footprint, and particularly those most impacted by past fishing. This requires an index of effort for each fished block.

To determine an effort index for each of the 200 bottom trawl footprint blocks shown in Figures 10 and 11, tows which crossed adjacent block boundaries were split by the footprint block boundaries into tow segments within each block. These tow segments were then summed to provide an effort index (the number of impacting tows) for each block. An analysis of these effort indices per block indicated that three broad classes of trawled blocks can conceptually be recognised within the trawl footprint (Penney *et al*. 2008):

- Almost one-third of the blocks (62) which have been very lightly-trawled, with only 1 or 2 trawls over the 5 year period, or an average of zero trawls / year over 2002 – 2006.
- At the other end of the scale, there are numerous blocks which have clearly been targeted, and heavily trawled, over the period. In these blocks:
  - Most of the trawling effort has been focussed.
  - Most of the orange roughy catch has been made.
  - It is known that most trawling is conducted on seamount features.
  - Historical seabed impacts will have been most concentrated.
- In-between these extremes, there are a number of moderately trawled blocks in which:
  - Effort and catch have been rather low compared to the heavily trawled blocks.
  - There is less likelihood that fishing was conducted on seamounts.
  - Seabed impacts have been low.

The moderately to heavily trawled blocks were divided to allocate equal numbers of blocks to these effort categories, to create a three-tier effort classification system, with 62 lightly trawled blocks, and 69 each ‘moderately’ and ‘heavily’ trawled blocks. This resulted in categories with 3 - 9 tows (‘moderately’ fished) and >9 tows (‘heavily’ fished) per block. The bottom trawl footprint maps (Figures 10 and 11) were then colour-coded to generate Figures 16 and 17, which show the trawl footprint in the areas to the west and east of New Zealand, shaded by fishing effort tier.

Stratification of the New Zealand trawl footprint into these three effort tiers allowed for the implementation of different management approaches within each tier, tailored to the level of past impact, the likelihood of encounters with VMEs and the importance of different areas to the fishery. These management approaches are explained in more detail in *Section 7. Management and Mitigation Measures*.

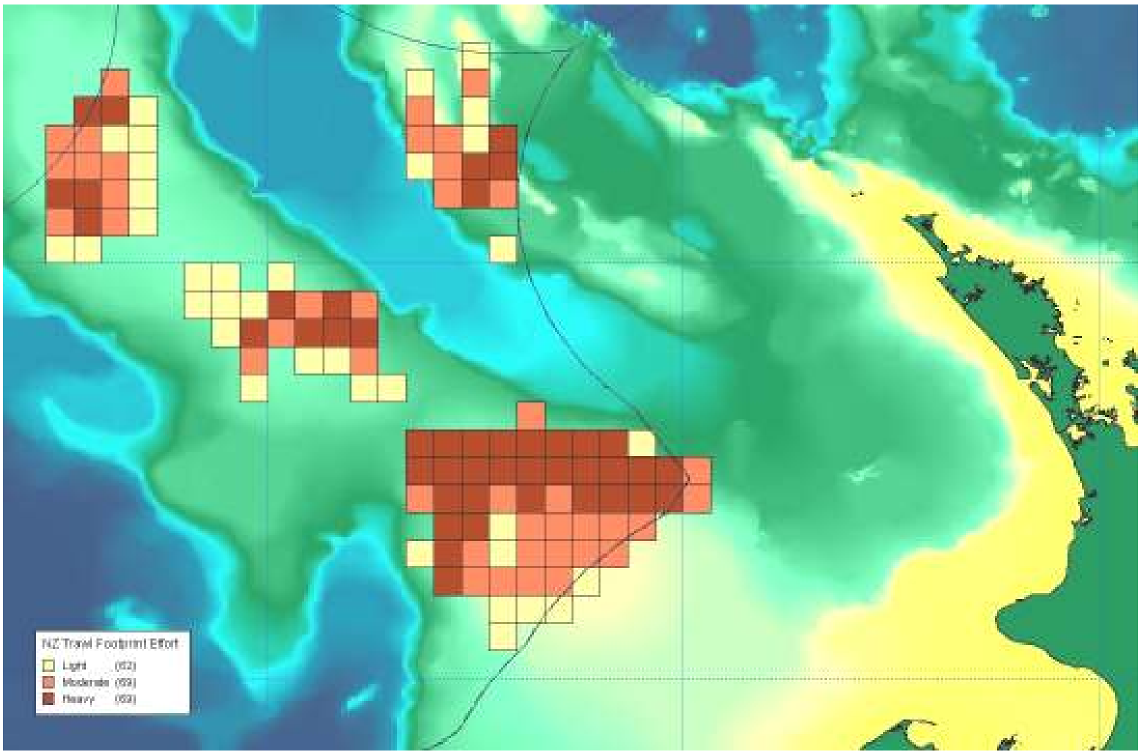

Figure 16. Stratification of the New Zealand bottom trawl footprint in the Lord Howe, Challenger Plateau and West Norfolk areas into lightly (< 3 tows), moderately (3 - 9 tows) and heavily (> 9 tows) trawled areas (map available on NABIS: http://www.nabis.govt.nz).

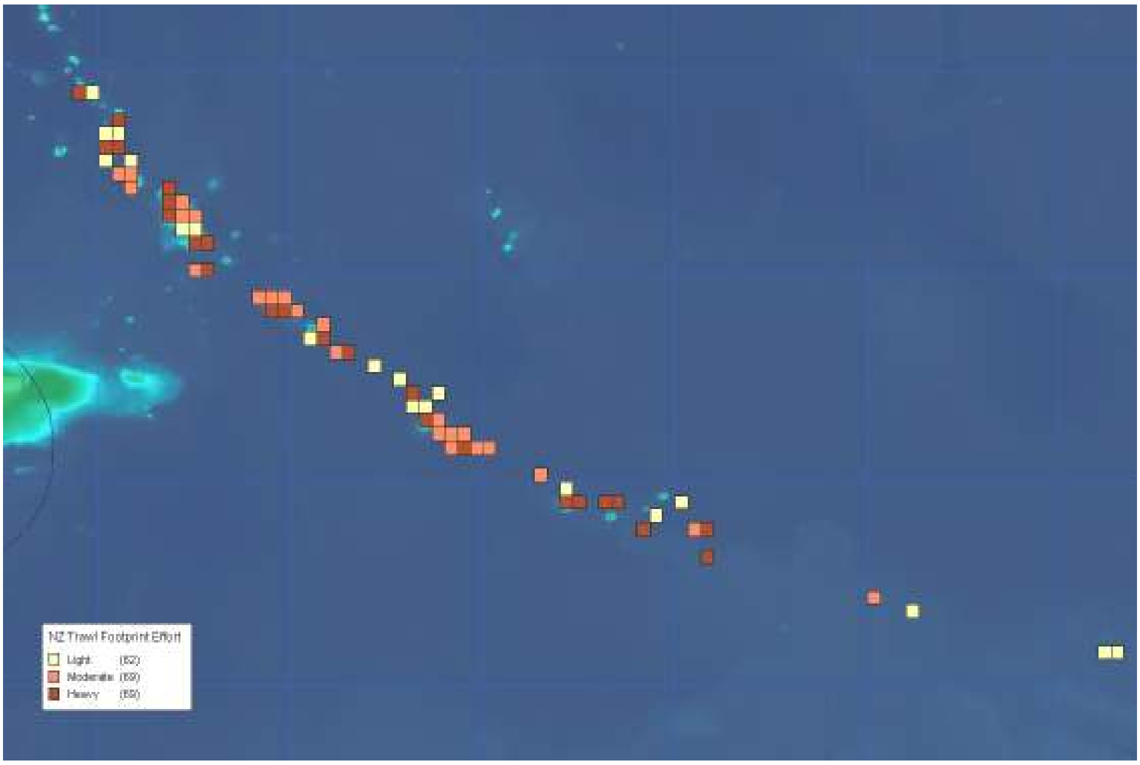

Figure 17. Stratification of the New Zealand bottom trawl footprint in the Louisville Ridge area into lightly (< 3 tows), moderately (3 - 9 tows) and heavily (> 9 tows) trawled areas (map available on NABIS: http://www.nabis.govt.nz).

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).

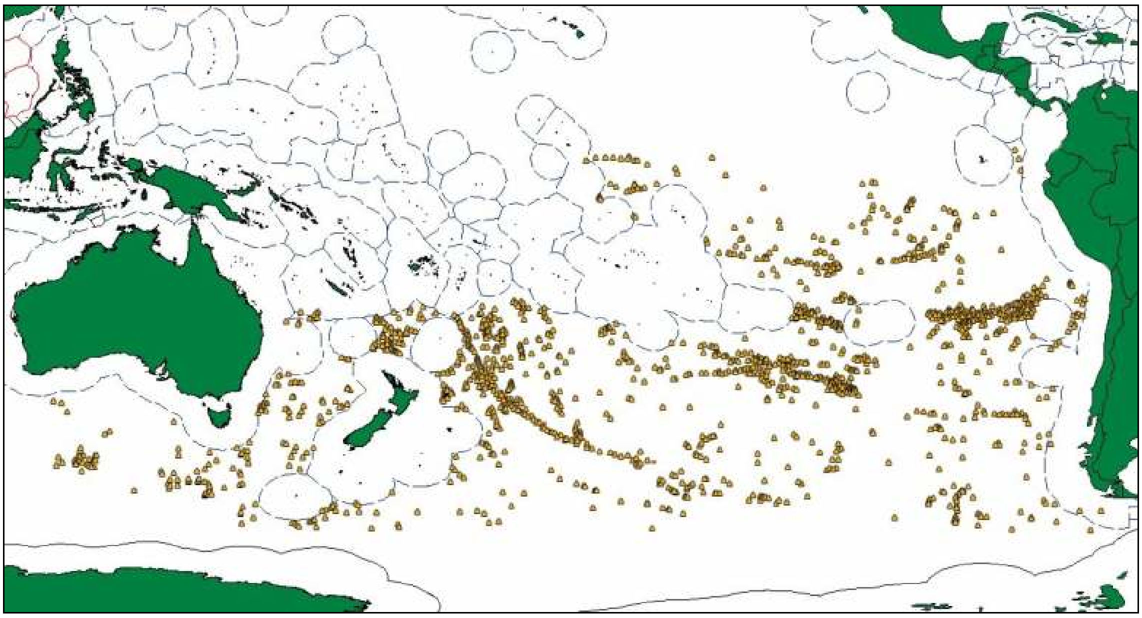

Figure 18. Distribution of validated underwater seamount features in the high seas SPRFMO Area, as reported by Allain *et al*. (2008).

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.

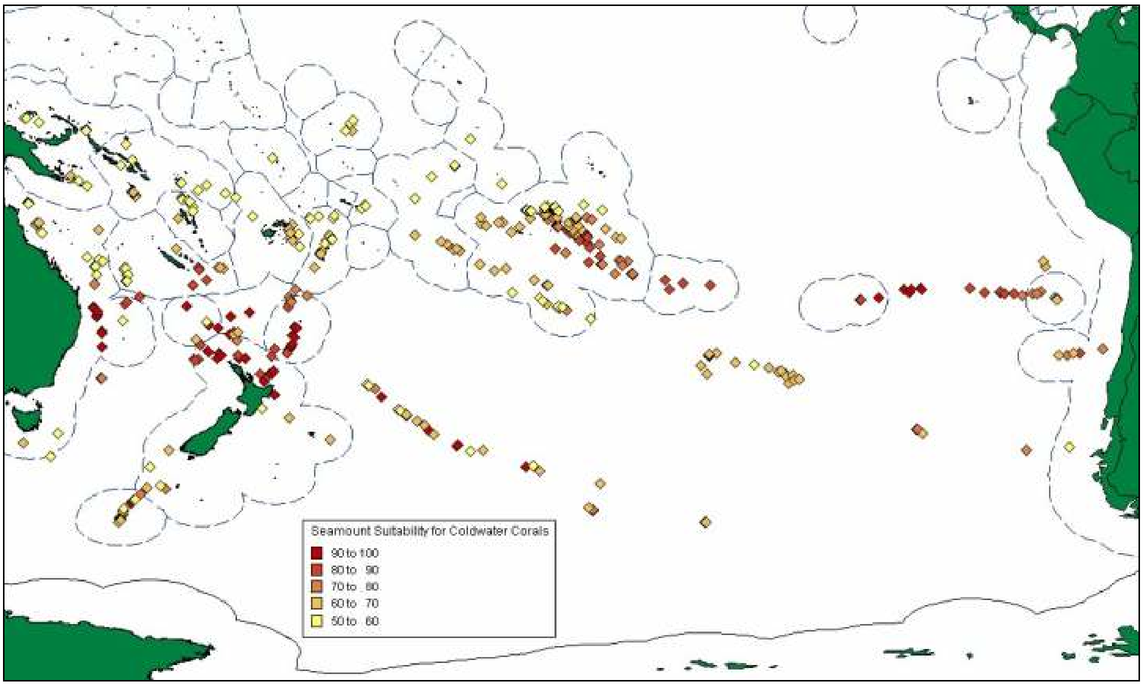

Figure 19. Distribution of the Kitchingman and Lai (2004) South Pacific seamount features predicted by Clark *et al*. (2006) to have a habitat suitability for coldwater corals of 50% or greater.

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.

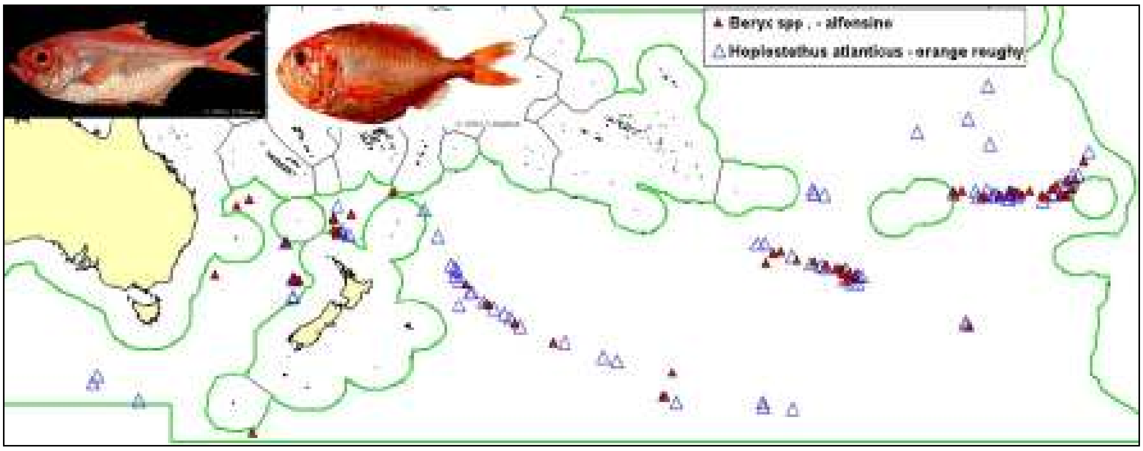

Figure 20. Distribution of seamount features considered by Allain *et al*. (2008) to be potential habitats of the orange roughy and alfonsinos based on preferred depth distributions of these species.

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.)

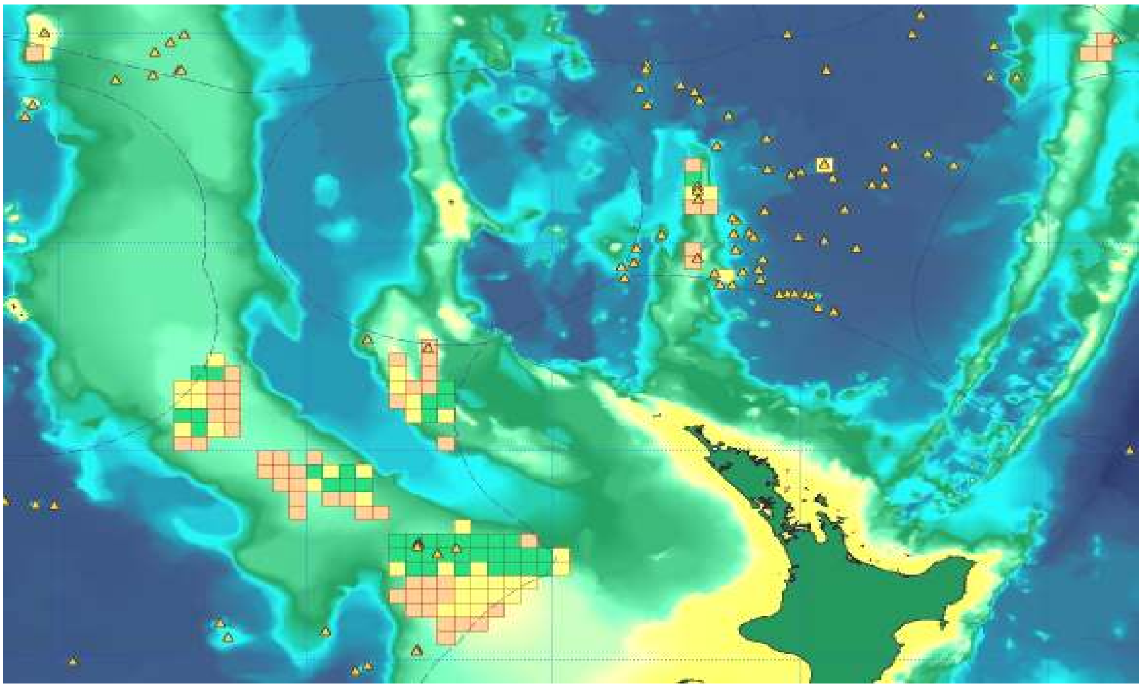

Figure 21. Distribution of Allain *et al*. (2008) seamounts within and near the New Zealand trawl footprint in the Lord Howe Rise, Challenger Plateau and West Norfolk Ridge areas.

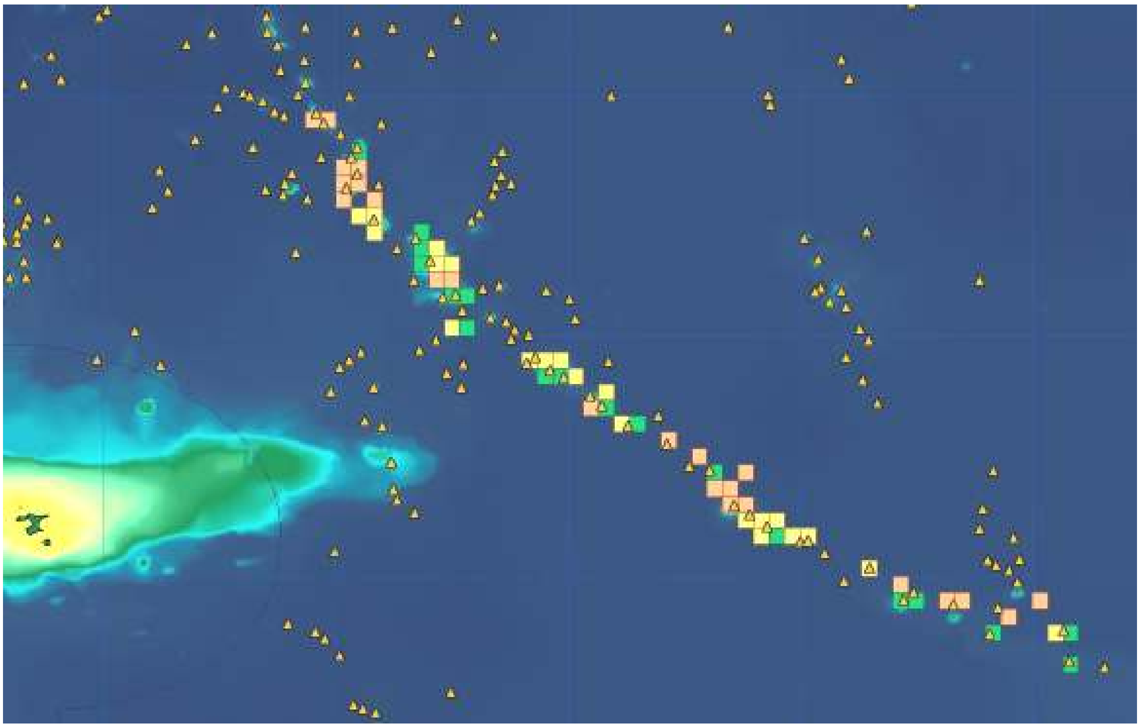

Figure 22. Distribution of Allain *et al*. (2008) seamounts within and near the New Zealand bottom trawl footprint in the Louisville Ridge area.

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.

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 some 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.

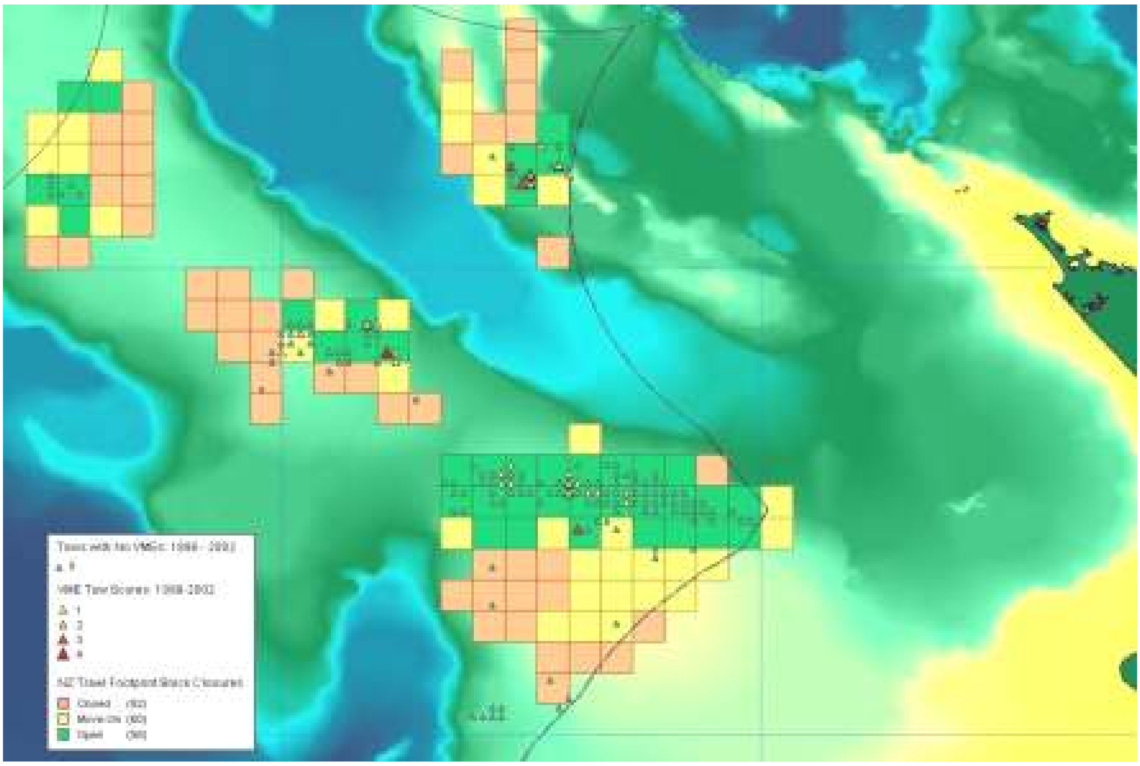

Figure 23. Distribution of VME scores for New Zealand bottom trawl tows observed in the Lord Howe, Challenger Plateau and West Norfolk areas over 1998 - 2002.

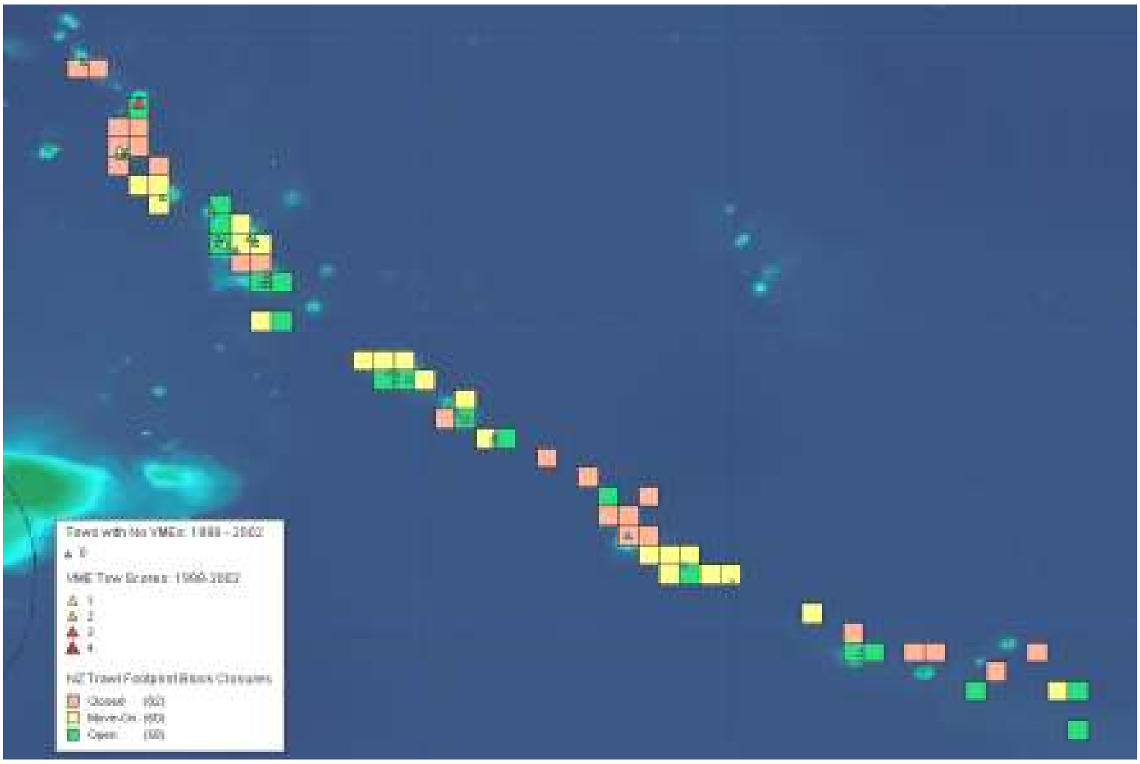

Figure 24. Distribution of VME scores for New Zealand bottom trawl tows observed in the Louisville area over 1998 - 2002.

5. Status of the Deepwater Stocks to be Fished

5.1 Historic Catch and Effort Trends

An initial description of New Zealand high seas bottom fisheries in the SPRFMO Area was provided by Penney *et al*. (2007). The information below is primarily extracted from that document, with catch and effort data updated to reflect New Zealand flagged vessels only, with catch from foreign flagged vessels landing into New Zealand removed.

5.1.1 Catch and Effort Summaries

- ***Bottom Trawl Fishery***

Table 10 shows the total reported trawling effort (number of vessels and number of tows), and catch of the top ten species, and for all species, in all fishing areas over 2002-2006. A total of 40 different New Zealand flagged vessels participated in the fishery over 2002-2006, making 11,145 tows and reporting 12,352t of all species (retained) catch. The average annual effort (vessels and tows) and average annual catches of the top ten species in all areas, are also shown for each year, with an average of 18 vessels conducting an average 2,229 tows per year over the period. Table 11 shows the total trawl effort (number of tows) and catches of the top ten species over the 2002 - 2006 period, split by the fishing areas shown in Figure 9.

Over the reference period, the number of New Zealand flagged vessels participating in this fishery per year declined from 23 in 2002 to 12 in 2006. Together, the top ten species contributed 96% of the reported total catch by New Zealand flagged vessels. Orange roughy contributed 75% of the reported catch by these vessels, and was the declared target species on most trips. The average annual Orange Roughy catch over 2002-2006 was 9,259,377 kg. Other significant contributors to catches, and occasionally listed as target species, were deep sea cardinal fish, oreos (black, smooth and spiky oreo) and alfonsinos (slender and longfinned beryx). Longer-term orange roughy catch trends over 1990 - 2007 are summarised separately by fishing area and year in Table 12, and plotted in Figure 25.

Table 10. Summary of the total annual catch (kg) per year of the top ten species by New Zealand flagged high seas trawling operations in the SPRFMO Area from 2002-2006. (See Table 4 for species codes)

Year	No. Vessels	No. Tows	ORH	BOE	EPT	BYX	SSO	RIB	RAT	BSH	BOA	SOR	All Species
2002	23	2,944	2,578,152	120,845	159,107	16,960	50,088	42,624	61,497	36,863		17,329	3,179,785
2003	19	2,928	1,972,503	62,390	226,286	94,256	25,391	91,775	84,349	55,702	84,754	29,142	2,937,207
2004	17	1,952	1,696,753	89,708	42,396	85,036	91,135	45,917	34,399	7,998		13,592	2,188,152
2005	17	2,186	1,597,109	267,756	188,516	25,557	75,414	62,905	67,297	4,817	30	13,624	2,395,380
2006	12	1,135	1,414,860	57,187	21,245	27,785	5,922	33,238	26,956	15,099		4,477	1,651,776
Average	18	2,229	1,851,875	119,577	127,510	49,919	49,590	55,292	54,900	24,096	16,957	15,633	2,470,460
Total	40	11,145	9,259,377	597,886	637,550	249,594	247,950	276,459	274,498	120,479	84,784	78,164	12,352,300

Table 11. Summary of the total annual catch (kg) by fishing area (Figure 1) of the top ten species by New Zealand flagged high seas trawling operations in the SPRFMO Area from 2002-2006. (See Table 4 for species codes)

Fishing Area	No. Tows	ORH	BOE	EPT	BYX	SSO	RIB	RAT	BSH	BOA	SOR	All Species
Challenger	6,242	3,298,557	6,169	395,025	54,824	880	250,602	272,153	114,178	30	48,754	4,741,510
West Norfolk	1,075	1,560,184	110	30,186	3,726	10	4,165	378	32		241	1,609,341
Lord Howe	1,145	664,612	1,516	212,169	188,256	1,268	18,221	1,161	1,474	30	13,945	1,168,666
Louisville	2,570	3,735,294	589,941	170	2,193	245,792	3,421	651	4,015		15,224	4,639,629
Other	113	730	150		595		50	155	780	84,724		193,154
Total	11,145	9,259,377	597,886	637,550	249,594	247,950	276,459	274,498	120,479	84,784	78,164	12,352,300
% Contribution		75%	5%	5%	2%	2%	2%	2%	1%	1%	1%	100%

Table 12. Reported total catch (tonnes) of orange roughy by New Zealand flagged high seas trawling operations in the SPRFMO Area from 2002-2006, by fishing area, and average annual catch over the period. (The shaded area shows the SPRFMO interim measures reference period.)

Year	No. Vessels	South Tasman	Challenger	West Norfolk	Lord Howe	Louisville Ridge	Other Areas	Total
1990	13		35		126	377	20	559
1991	14		1		52	17	70	141
1992	21		230		484	13	32	758
1993	27		666		1,179	624	97	2,566
1994	41		950		584	625	36	2,195
1995	53		635		19	10,465	77	11,195
1996	55		477		21	7,402	101	8,002
1997	45	405	378		30	3,025	25	3,862
1998	42	463	278		17	1,569	2	2,329
1999	37	1,641	756		21	2,409	121	4,948
2000	29	30	193		17	1,315	19	1,574
2001	14		730	176	108	1,486		2,499
2002	23		1,460	432	96	568	22	2,578
2003	19		868	25	218	859	3	1,973
2004	17		347	106	132	1,106	5	1,697
2005	17		425	327	190	623	33	1,597
2006	12		202	670	29	493	22	1,415
2007	9		36	515	34	280		866
Total		2,539	8,667	2,251	3,356	33,256	685	50,753

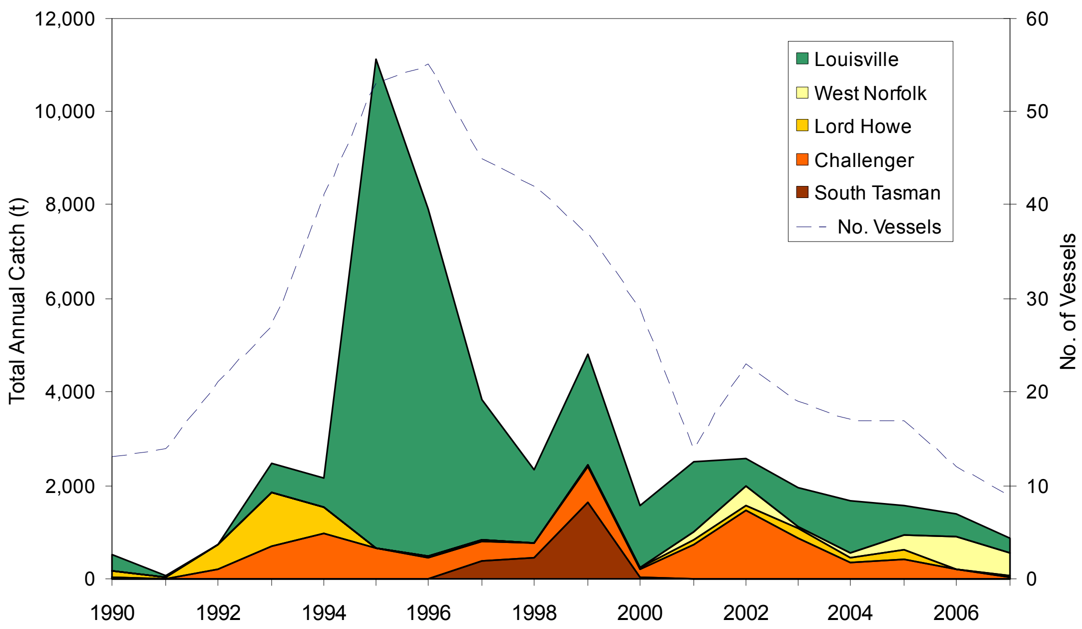

Figure 25. Summary showing trends in total reported annual effort (no. of vessels) and total catch (tonnes) of orange roughy by New Zealand flagged high seas trawling operations in the four main high seas fishing areas over the period 1990 - 2006 (see Table 12 for data).

The most important fishing area for orange roughy over the history of these fisheries has been the Louisville Ridge, producing 66% of the total New Zealand flagged catch since 1990 (Table 12). The next most important area has been the NW Challenger Plateau, contributing 17% of the catch, with the high seas portion of the South Tasman Rise producing 5% of the total catch in a brief fishery over 1997 - 2000.

There have, however, been different catch trends over time in these different fishing areas. The first area to be targeted was, in fact, the Lord Howe Rise, where catches peaked at 1,179 t in 1993, rapidly declined to low levels, and then picked up somewhat over the reference period as a result of increased effort on the southern Rise. At the same time, reasonably good catches were made on the Challenger Plateau, reaching 950 t in 1994, declining to low levels by 2000, and then increasing rapidly to a peak of 1,460 t in 2002. Catches on the Challenger Plateau have since decreased to low levels.

After the decline in the Lord Howe Rise fishery, effort shifted to the Louisville Ridge, where catches increased rapidly to a peak of 10,456 t in 1995. The number of participating vessels also more than doubled over this period (Table 12, Figure 25). Catches on the Louisville Ridge then declined rapidly to <1,000 t by 2002. A brief fishery on the South Tasman Rise reached a peak catch by New Zealand flagged vessels of 1,641 t in 1999, and then collapsed. Most recently, fishing effort has focussed on the West Norfolk Ridge. Fishing only started in that area in 2001, and the area now produces most of the annual orange roughy catch by New Zealand flagged vessels, reaching a recent peak of 670 t in 2006.

- ***Bottom Line Fisheries***

In contrast to the bottom trawl fishery, fishing effort by New Zealand flagged bottom line (bottom longline, trot line and dahn line) fisheries increased steadily over the SPRFMO reference period of 2002 - 2006 (Table 13), from zero in 2002 to 10 vessels fishing 501,810 hooks, in 2006. A total of 17 different vessels bottom-lined in the SPRFMO Area over the period, fishing a total of 1.2 million hooks. Effort averaged 6 vessels and 303,298 hooks per year over the period.

Table 13. Reported total annual high seas bottom line fishing effort (no. of vessels and no. of hooks for the bottom longline - BLL, dahn line - DL, trot-line - TL and handline - HL fisheries) by New Zealand flagged vessels over the reference period of 2002 - 2006.

Year	No. Vessels	BLL Hooks	DL Hooks	TL Hooks	HL Hooks	Total Hooks
2002	0					
2003	3	50,538	2,900			53,438
2004	7	229,425	36,984	2,400		268,809
2005	11	362,438	18,895	2,690	8	384,031
2006	10	483,194	18,610		6	501,810
Average	6	281,399	19,347	2,545	7	303,298
Total	17	1,125,595	77,389	5,090	14	1,208,088

The total catch of the 59 species that contributed to bottom line catches was 741.4 t. Of this, 97% of the catch (719.7 t) consisted of the top ten species (Table 14). The primary target species was bluenose, which contributed 67% of the catch, with hapuku / bass being the only other significant target species, contributing 21% of the catch.

Table 14. Reported total annual New Zealand flagged high seas bottom line catch of the top ten species / groups in the SPRFMO Area over the reference period of 2002 - 2006 (see Table 6 for species codes).

Year	BNS	HPB	SPD	KTA	SKI	KIN	PTO	SPE	SCH	RSN	Total
2002											
2003	6,028	7,240	1,200	1,356			745	459	164	10	17,202
2004	116,303	24,224	379	6,166	1,892	880	3,215	197	1,003	230	154,489
2005	101,607	30,978	12,857	10,277	1,876	2,937		603	1,039	614	162,788
2006	271,270	95,231	5,750	5,782	2,321	1,514		1,671	568	1,065	385,172
Total	495,208	157,673	20,186	23,581	6,089	5,331	3,960	2,930	2,774	1,919	719,651
%	66.8%	21.3%	2.7%	3.2%	0.8%	0.7%	0.5%	0.4%	0.4%	0.3%	97%

While bluenose contributed 67% of the bottom line catch over 2002 - 2006, this species was actually reported as the intended target on 80% of the returns for that period, with hapuku / bass being the reported target on 16% of returns. There has been a steady trend in the ratio of targeting between these two species over time, with hapuku / bass targeting decreasing from 34% over 1990-95 to 7% in 2007, while bluenose targeting has increased from 58% over 1990-1995 to 90% in 2007.

There have also been strong fluctuations in fishing effort and catch over the bottom line fishing time series from 1990 - 2007. Effort and catch increased rapidly after 1990, with 6 vessels reporting a catch of bluenose and hapuku / bass of over 300t by 1993 (Table 15 and Figure 26). Despite the number of vessels remaining high to 1998, catches declined to half their 1993 levels, and interest, effort and catch declined rapidly to zero by 2002. Increased market demand and prices for bluenose then prompted a resurgence in this fishery, with effort, bluenose targeting and catch rapidly increasing to their highest levels in 2006.

Table 15. Reported total annual New Zealand flagged high seas bottom effort (No. of vessels and no. of hooks) and catches (tonnes) of the primary target species, bluenose and hapuku / bass, in the SPRFMO Area over the period 1990 - 2007. (Shaded cells show the SPRFMO reference period.)

Year	No. of Vessels	No. of Hooks	Bluenose Catch	Hapuku/Bass Catch
1990	2	27,250	65	530
1991	5	36,400	3,850	3,090
1992	3	21,525	41,035	15,634
1993	6	308,130	214,762	97,579
1994	3	37,649	126,570	59,715
1995	10	94,621	166,787	57,055
1996	7	112,244	90,457	22,807
1997	8	91,292	168,021	26,693
1998	10	214,382	115,211	15,168
1999	4	355,889	52,277	8,250
2000	3	8,580	17,400	9,310
2001	1	36,170	46,235	1,935
2002	0			
2003	3	53,438	6,028	7,240
2004	7	268,809	116,303	24,224
2005	11	384,031	101,607	30,978
2006	10	501,810	271,270	95,231
2007	7	423,420	144,409	31,651

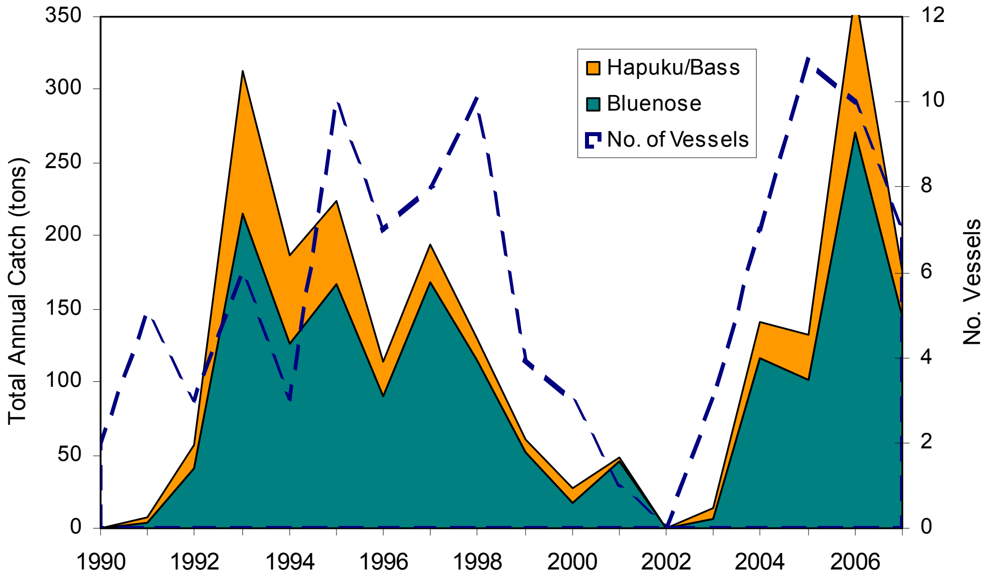

Figure 26. Trends in annual New Zealand flagged bottom line effort (no. of vessels) and catches of bluenose and hapuku / bass in the SPRFMO Area over the period 1990 - 2007.

5.2 Stock Assessments or Fishery Surveys

No formal stock assessments or fisheries independent scientific assessment surveys have been conducted of the deepwater stocks to be fished by New Zealand vessels in the SPRFMO Area. However, New Zealand has annually contracted a review of all available information on catch and effort trends in high seas fisheries for orange roughy, the main target species in the high seas bottom trawl fishery. The most recent review by Clark (2008) presents information on trends in fishing effort, geographic distribution and magnitude of catch and unstandardised CPUE for the Lord Howe Rise, NW Challenger Plateau, West Norfolk Ridge, South Tasman Rise and Louisville Ridge orange roughy fisheries up to the end of the 2005-06 fishing year (Figures 27 - 30).

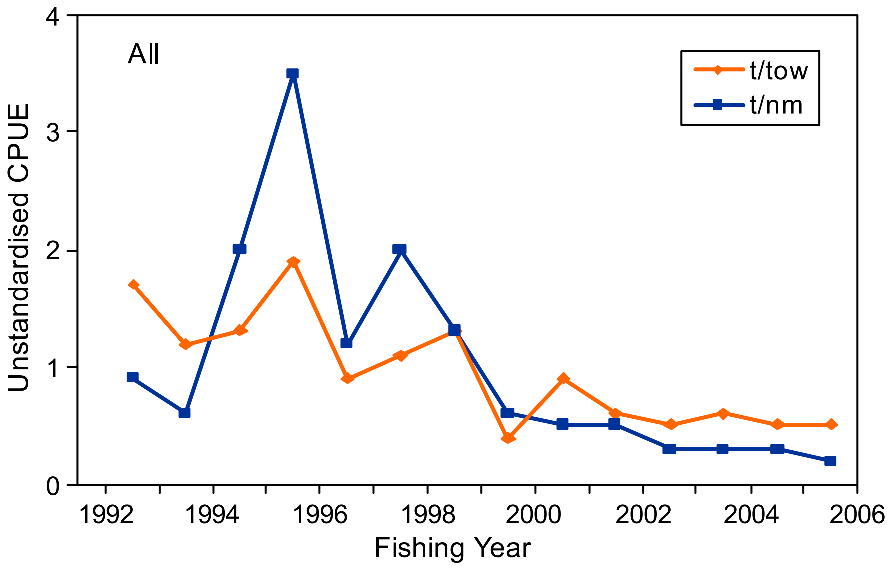

Figure 27. Unstandardised CPUE indices (tonnes per tow or nautical mile) from the Northwest Challenger orange roughy fishery from 1992-93 to 2005-06, for all vessels in all seasons (from Clark 2008).

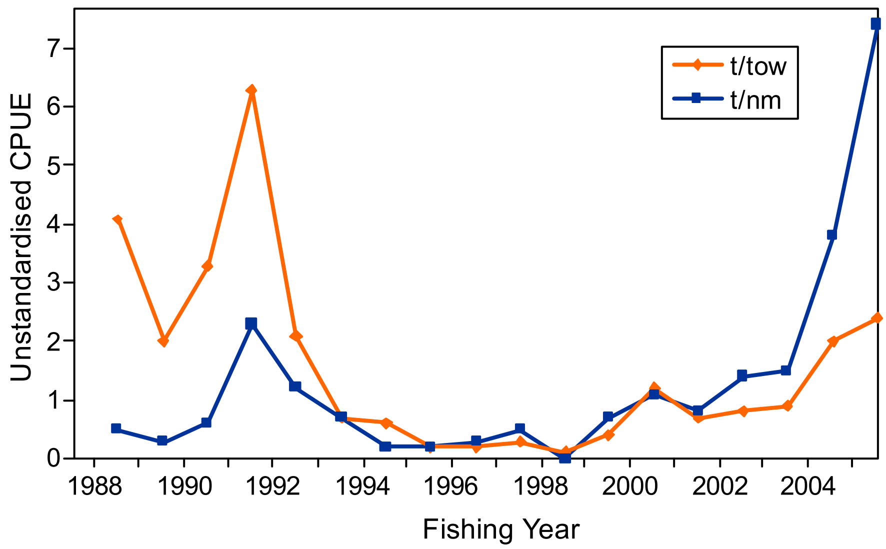

Figure 28. Unstandardised CPUE indices (tonnes per tow or nautical mile) from the Lord Howe Rise orange roughy fishery from 1988-89 to 2005-06 (from Clark 2008).

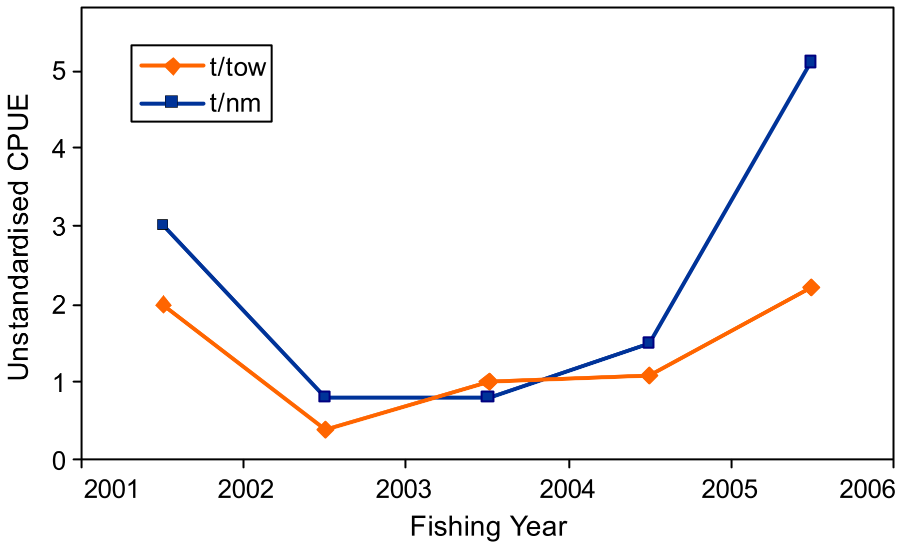

Figure 29. Unstandardised CPUE indices (tonnes per tow or nautical mile) for the Northwest Challenger orange roughy fishery from 2001-02 to 2005-06 (from Clark 2008).

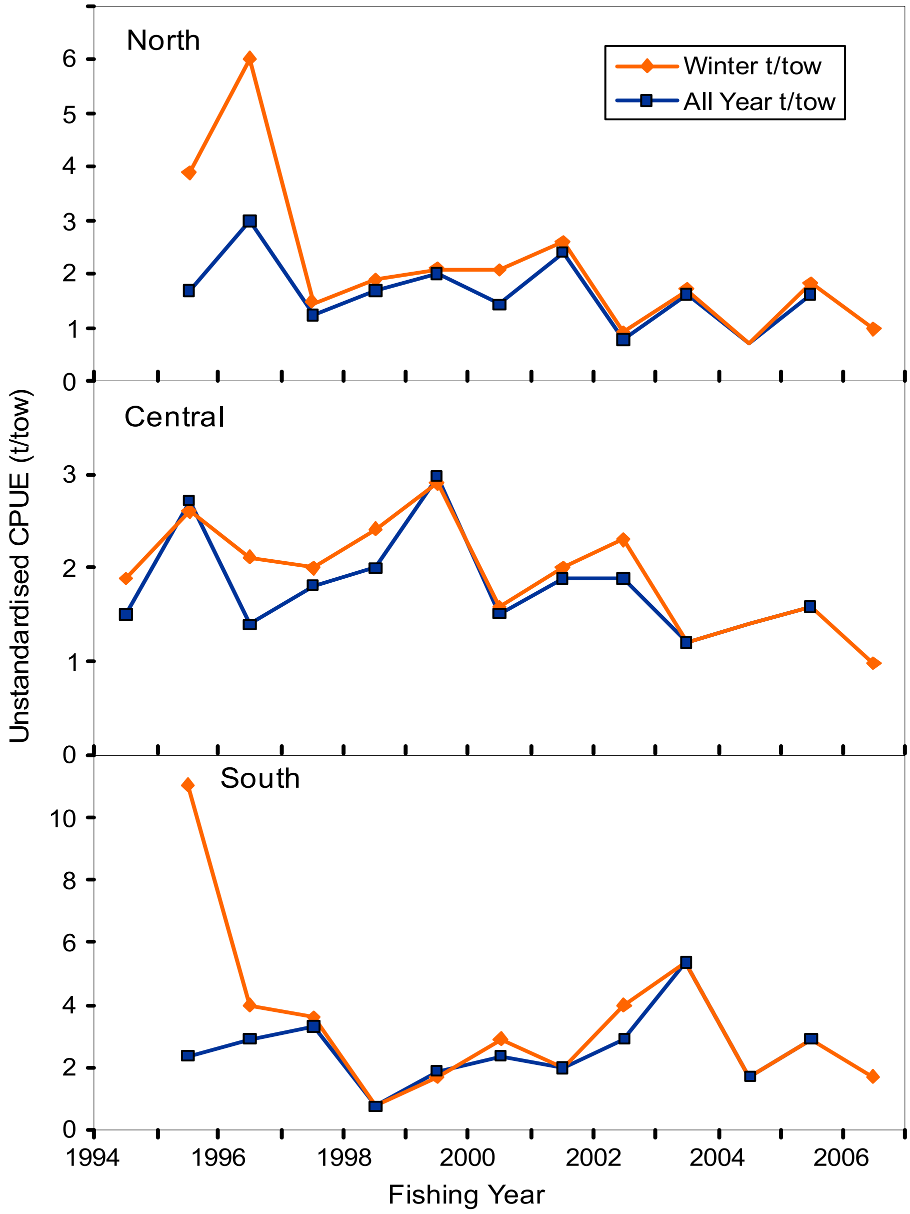

Figure 30. Unstandardised CPUE indices (tonnes per tow or nautical mile) for the Northern, Central and Southern Louisville Ridge roughy fisheries from 1994-95 to 2006-07 (from Clark 2008).

Clark (2008) provides the following overview of trends in these fisheries:

> "*The total catch by New Zealand vessels had remained relatively consistent up to 2004-05 at between 2000 and 2500 t, but decreased in 2005-06 to about 1700 t. The Northwest Challenger Plateau catch has declined substantially in the last few years, as did the Louisville Ridge in 2005–06 from levels of 1300-1500 t down to 670 t. Catches from the Norfolk Ridge increased substantially in 2004-05 over the preceding two years, and again in 2005-06 to over 700 t. Catch rates on the Lord Howe Rise have shown an increasing trend in the last 3 years. Tow duration has increased consistently in the Northwest Challenger fishery, and, although catch rates overall have remained relatively constant, those in the winter hill fishery have decreased to very low levels. Catch rates on the Louisville Ridge have been variable in recent years, and trends have differed between individual seamounts, with some showing increases, others*

strong declines, in catch and catch rates. Catch rates of orange roughy on the West Norfolk Ridge were higher in 2004–05 and in 2005–06 than in 2002–03 and 2003–04."

New Zealand has contracted additional research to evaluate the potential use of effort, catch and standardised CPUE trends, niche-factor analysis and carrying capacity of seamount features to estimate sustainable orange roughy catch rates in the various high seas fishing areas. This work will be conducted over January - September 2009 and results will be used to revise New Zealand's catch limits for orange roughy in the SPRFMO Area (see *Section 7: Management and Mitigation Measures*).

6. Information Gathering and Reporting

This section provides information on all of the fisheries monitoring and data collection systems implemented by New Zealand for bottom fishing vessels in the SPRFMO Area, the extent to which these comply with the SPRFMO Data Standards (SPRFMO, 2007c), and the process and progress with submitting data to the SPRFMO Secretariat.

6.1 Commercial Catch and Effort Returns

All holders of New Zealand high seas fishing permits are required to submit comprehensive catch and effort information on all fishing operations. The main commercial catch return forms required from high seas fisheries are the *Commercial High Seas Trawl Catch Effort Return* (HSTCER) for all trawl operations, and the *Commercial High Seas Lining Catch Effort Return* (HLCER) for all line fishing operations.

Examples of commercial catch and effort data return forms are shown in Appendix B, showing the data collected on each form. These data collection systems comply with the SPRFMO data collection standards for these fisheries in most respects, differing only in the following:

- ***Commercial High Seas Trawl Catch Effort Return (HSTCER)***

  - Retained catch of all species: These catch returns are currently designed to report catch of the top five species, and not of all species. However, catch of all species is recorded by scientific observers.
  - Estimation of discards by species: Commercial returns do not report discards. However, discards are recorded by scientific observers.
  - Captures of marine mammals, seabirds or reptiles: These are not recorded on commercial returns. However, information on all protected species captures is recorded by scientific observers.

With the implementation of 100% observer coverage on the New Zealand high seas bottom trawl fishery, all of the bottom trawl data required by the SPRFMO data standards are therefore collected.

- ***Commercial High Seas Lining Catch Effort Return (HLCER)***

Commercial catch returns for bottom line fishing are similar to bottom trawl returns, and also only record information on catch of the top five species, and do not record discards or captures of marine mammals, seabirds and reptiles. New Zealand is working to implement at least 10% scientific observer coverage on high seas bottom line fisheries to provide indices of this information.

6.2 Scientific Observer Coverage and Data Collection

In accordance with the interim measures, all bottom trawling vessels have been required to carry at least one scientific observer on all bottom trawl fishing trips in the SPRFMO Area since December 2007, and may be required to carry two observers if the vessel is capable of fishing 24 hours / day. For high seas bottom line fisheries, New Zealand has established an initial target of 10% observer coverage of bottom line fishing operations.

New Zealand observers complete a wide range of data collection forms, depending on the nature of the fishing operation, and data collection priorities each trip. Examples are provided in Appendix B of two of the main forms relevant to scientific observation of high seas bottom trawling operations, the *Observer Trawl catch Effort Logbook* and the *Observer Benthic Materials Form*,. Observers are also required to complete a *Vulnerable Marine Ecosystem Evidence Process* form (shown in Appendix C) for bottom trawl tows in any fishing areas in which a move-on rule is being applied. In addition, they collect data on length frequency, maturity stages, ageing materials and captures of protected species, in accordance with priorities for each trip.

6.3 Implementation of Vessel Monitoring Systems

Minimum standards for vessel monitoring system (VMS) data collection and reporting by participants in fisheries in the SPRFMO Area are set out in Annex G of the report of the 4th SPRFMO Meeting. New Zealand legislation requires all New Zealand fishing vessels operating in the SPRFMO Area to be fitted with tamper-proof Automatic Location Communicators (ALC) that continuously transmit information to the New Zealand Ministry of Fisheries VMS. This transmitted information is routinely monitored and can be used to assist with verifying catch effort activity reported by the commercial operators. The minimum standards set by the Ministry of Fisheries fully meet the specifications for the frequency, accuracy and content of VMS position reports outlined in the VMS Standard.

6.4 Provision of Data to the SPRFMO Secretariat

New Zealand has provided bottom trawl catch and effort data for all high seas fishing operations in the SPRFMO Area over the calendar years 2002 - 2006, and jack mackerel catch and effort data from 1990 onwards, to the SPRFMO Secretariat in 5° x 5° resolution 'public domain' format (as described in the SPRFMO Data Standards). New Zealand has also extracted, groomed and error-corrected bottom trawl and bottom line catch and effort data for all high seas fishing operations from 1990 - 2007, and undertaken to provide these to the Secretariat once it has developed the database and security systems required to store and manage these data securely.

Details of data submissions made to the SPRFMO Secretariat are as follows:

2007 Submission – (Jan 2008)

- Data on fishing activities (all methods) from 1 January 2002 to 31 December 2006, aggregated to the "public domain" level - calendar year and 5 degree by 5 degree areas. Notes have been included to explain data aggregation or grooming methods.
- The report, '*New Zealand's CPUE data preparation documentation to SPRFMO*', documents the data preparation process from the raw catch and effort logbook data to the final data supplied to the SPRFMO Interim Secretariat. This details the extent to

which each of the data types required by the SPRFMO data Standard are being collected and any steps being taken to fill any gaps.

- Register of NZ vessels fishing in SPRFMO Area for the period May 2007 – April 2008.
- Trawl footprint submission, footprint maps and block coordinates.

2008 Submission – (Mar 2008)

- Preliminary summary of estimated catches of blue mackerel, jack mackerel and mackerels in the New Zealand EEZ by calendar year 2002 – 2007.

2008 Submission – (Jun 2008)

- The report, 'New Zealand Jack Mackerel Conservation and Management Measures'.

2008 Submission – (Oct 2008)

- Data on fishing activities for the calendar year 2007 (all methods), aggregated to the "public domain" level - calendar year and 5 degree by 5 degree areas.
- The report, '*New Zealand's CPUE data preparation documentation to SPRFMO*', updates the previous report of the same name and documents the data preparation process from the raw catch and effort logbook data to the final data supplied to the SPRFMO Interim Secretariat.
- Data on New Zealand flagged vessels authorized to fish in the SPRFMO Area for non-highly migratory species for the period 1 May 2008 – 30 April 2009.
- Chilean jack mackerel conservation and management measures information and catch data proportions (estimates) in mixed jack mackerel catches as prepared for the calendar years 1985 to 2006 in 5 degree by 5 degree areas. Estimated catch totals for each year, fishing method (purse seine & trawl), and latitude / longitude block were raised so the total estimated catch equals the total Chilean jack mackerel landings for the summary period.

Future Submissions

- Revise 2002 -2006 to report data from NZ flag vessels only.
- Provide all 1990 – 2002 data at public domain resolution.

7. Management and Mitigation Measures

With respect to addressing the obligations under UNGA Resolution 61-105 to prevent significant adverse impacts to VMEs, the SPRFMO interim measures state:

> 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.

This section describes the analyses conducted, the VME interaction monitoring protocols developed and the management and mitigation measures implemented by New Zealand to implement the requirements of the above measures for New Zealand bottom trawlers operating in the SPRFMO Area. New Zealand is implementing the interim measures through a series of sequential implementation steps. A number of the requirements of the interim measures are already satisfied through existing management systems for New Zealand fisheries (such as VMS requirements), while other measures have required further implementation of existing systems (such as increased observer coverage). Other requirements (such as spatial restrictions and the ‘move-on’ rule) are initially being implemented through conditions imposed on New Zealand high seas fishing permits, required by all vessels wishing to fish the high seas under New Zealand flag. It is anticipated that permit conditions will be followed by regulations, once these have been developed, to strengthen the legal framework, and to improve implementation of the interim measures.

The bottom trawl fishery has been the primary focus of initial implementation steps because of the higher impact that this gear has on the seabed compared with other forms of bottom fishing (SPRFMO 2007b), and the fact that bottom trawling is the dominant fishing method by New Zealand vessels in this fishery. A summarised overview of new Zealand’s approach to implementing each of the individual interim measures for bottom fisheries is provide in Penney *et al*. (2008).

7.1 Precautionary Closures and the 'Move-On' Rule

7.1.1 Three-Tier Effort Classification of the New Zealand Trawl Footprint

The stratification of the New Zealand bottom trawl footprint into three tiers of past fishing impact over the period 2002 - 2006 is described in *Section 3. Mapping and Description of Proposed Fishing Areas*. The New Zealand high seas bottom trawl footprint consists of 200 20' x 20' (WGS84) blocks, as defined in the Interim Benthic Assessment Framework agreed by Participants at the fourth SPRFMO meeting. The footprint blocks have been classified into three levels, being 'lightly' trawled blocks, with < 3 trawls over the 2002 - 2006 period, 'moderately' trawled, with 3 - 50 trawls over the period, and 'heavily' trawled blocks, with > 50 trawls over the period. The resulting numbers of blocks in each effort tier are shown in Table 16 maps of the trawl footprint blocks are shown in Figures 23 and 24.

Table 16. The number of 20' x 20' minute blocks in each effort tier in the various fishing areas constituting the New Zealand bottom trawl footprint in the SPRFMO Area.

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

Stratification of the footprint into these effort tiers was done to facilitate the implementation of different management approaches in areas of substantially different degree of targeting by bottom trawling, different levels of past effort, and therefore different levels of past impact. Principles for Developing Management Approaches

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

New Zealand considers this approach to be consistent with the interim measures and with UNGA Resolution 61/105. It is also consistent with the approach taken by the European Community for its vessels operating on the high seas where there is no RFMO or interim measures in place (EC Regulation 734/2008).

Management and mitigation measures to give effect to the SPRFMO bottom fishery interim measures 6 and 7 were developed in consultation with industrial representatives and NGO stakeholders. Numerous consultation meetings were held with key stakeholders, and a summarised record of those consultations is provided in Appendix D. Clearly competing principles to guide development of management approaches evolved during these consultations, primarily:

- To protect adequate areas (in terms of what is known about their likely depth, seabed habitat and geographic distribution ranges) of benthic habitat and associated vulnerable ecosystems, characteristic of the various fishing areas.
- To provide access to adequate and suitable target areas to provide for a viable and sustainable deepwater trawl fishery.

The suite of management measures adopted, and described below, attempts to balance these competing requirements, while fulfilling the interim measures.

7.1.2 Three Tier Management of the New Zealand Trawl Footprint

Bottom trawling is not permitted within the footprint of other bottom fishing methods (eg, bottom longlining) in order to limit the impacts of bottom trawling to existing areas. Within the bottom trawl footprint a three-tier approach to implementing paragraphs 6 and 7 has been developed taking into account the above interpretation. This approach also takes into account the precautionary approach.

- ***Tier 1: Lightly Trawled Blocks***

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

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

- ***Tier 2: Moderately Trawled Blocks***

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

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

Data generated by trawls encountering evidence of a VME will be reviewed annually together with other observer data on benthic bycatch, and additional closures of moderately trawled

20 x 20 minute blocks will be considered if consistent and significant evidence of VMEs is found within such blocks.

- ***Tier 3: Heavily Trawled Blocks***

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

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

- ***Additional Block Closures***

While the heavily trawled blocks are, in principle, 'open' fishing areas in terms of interim measure paragraph 6, to afford protection to seamount features in heavily or moderately trawled areas, an additional 10% of total footprint blocks has been closed to protect representative areas in the moderately and heavily trawled areas. The 20 additional block closures were selected based on depth and topography (see Section 7.3), using detailed bathymetry of the areas. Adequate and representative area closures have been recognized as probably the most suitable long-term VME protection measure by the SPRFMO Science Working Group meeting (SPRFMO, 2007d) and the FAO (FAO, 2008). Recent IUCN recommendations on protection of seamounts and deep sea VMEs recommend a minimum closure of 30% - 40% of such areas (Rogers *et al*. 2008).

These closures, implemented from the outset, are also consistent with the precautionary approach required by the interim measures. In order to ensure that the closures are representative of fishing areas, they are distributed across the various fishing areas in proportion to the number of blocks in those areas (Table 17).

Table 17. Summary of the number of 20' x 20' minute block closed in the lightly fished tier, plus additional closures in the moderately (9 blocks) and heavily trawled (11 blocks) tiers, in each fishing area.

Fishing Area	Lightly Trawled Closed Blocks	Additional Closures (Mod & Heavy areas)
Lord Howe North	9	2
Lord Howe South	12	2
Challenger Plateau	9	6
West Norfolk	6	2
Three Kings Ridge	7	1
Louisville North	7	3
Louisville Central	6	2
Louisville South	6	2
Total	62	20

The mitigation measures to prevent significant adverse impacts from bottom trawling in the footprint (as required under SPRFMO interim measure paragraph 6) are therefore the combination of closure of all lightly trawled blocks; the application of the move on rule in all moderately trawled blocks with the potential progressive closure of moderately trawled blocks found to contain significant evidence of VMEs; and additional precautionary closures of representative blocks in the moderately and heavily trawled areas. A diagrammatic representation of this three-tier effort classification and management approach is shown in Figure 31, which summarises the number of blocks, describes effort and past impact characteristics per effort tier.

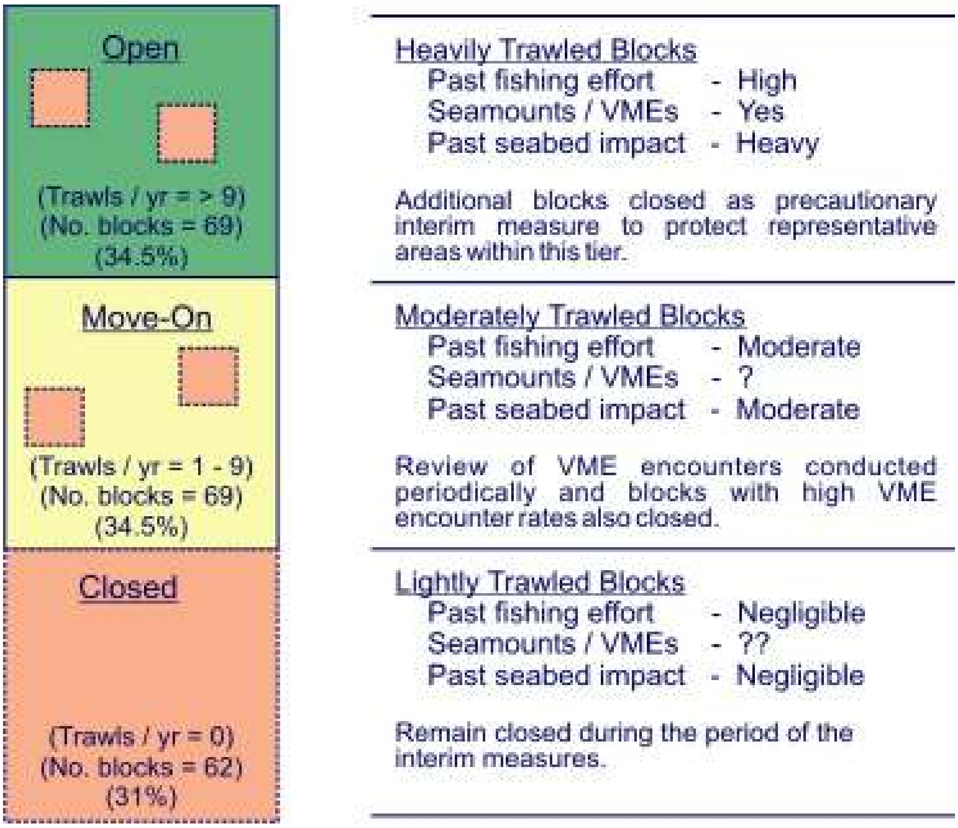

Figure 31. The three-tier past-effort classification system adopted by New Zealand as a basis for management of bottom trawling in the New Zealand trawl footprint.

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

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

7.2 Seabed Topography of Open, Move-On and Closed Footprint Blocks

In addition to benthic bycatch data collected by observers, a range of other information is useful in predicting likelihood of the presence of VMEs, and selecting representative areas for protection by means of spatial closures. In the absence of actual benthic biodiversity data, the most important additional information relates to physical characteristics of seabed topography and overlying oceanography:

Physical Characteristics Indicative of Vulnerable Marine Ecosystems

Bio-Geographic Zone

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

Separation / Connectivity

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

Summit Depth

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

Substratum Type

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

Seabed Topography

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

Oxygen Concentration & Nutrient Levels

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

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

The most important remaining characteristics to consider in any broader analysis to detect and map distribution of VMEs are therefore summit depth, substratum type (hardness) and seabed topography, all of which can be reasonably evaluated using high resolution bathymetric data. In recognition of the importance of seabed topography as indicative of likely presence of VMEs, and the general paucity of biodiversity data, Annex 1 to the *FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* (FAO 2008) list a number of seabed topographic or geological features which would be likely to support VMEs (see *Section 4: Evaluation of Expected Interaction with VMEs*).

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

7.2.1 Selection of Additional Block Closures

In the absence of detailed biodiversity data for the individual blocks within each of the fishing areas, the above characteristics, and particularly depth and topography, were used as the main guiding principles when selecting the 20 additional blocks to be closed in the moderately and heavily fished tiers in each fishing area (see Table 20 for proportional distribution of these additional closures between the fishing areas.) The New Zealand fishing industry has gathered substantial quantities of high-resolution bathymetric data for all of the fishing areas within the New Zealand trawl footprint, using the underway mapping systems described in *Section 2. Description of Proposed Fishing Activities*.

As these data are commercially confidential, and available public domain bathymetric data are of limited resolution to critically evaluate comparability of seabed topography between various blocks, selection of additional closures was done in consultation with key industry representatives with access to their high resolution bathymetric data. Past catch and effort data were also reviewed to identify key target blocks.

7.2.2 Topographic Analysis of Open, Move-On and Closed Blocks

Three dimensional analysis was conducted of the topography and cross-sectional profiles of all of the blocks in each fishing area. Analyses and three-dimensional mapping was done using the Vertical Mapper® component of MapInfo Professional®. Best available public domain bathymetric data were used to generate the digital terrain mesh models and three-dimensional surfaces. For the Tasman Sea area between Australia and New Zealand, the 1nm resolution gridded bathymetric data set produced by Australian GeoScience was used. This covered the Lord Howe Rise, Challenger Plateau and West Norfolk Ridge fishing areas, providing fairly high resolution topographic maps of these. For the Three Kings Ridge and Louisville Ridge areas, use was made of public domain General Bathymetric Chart of the Oceans (GEBCO) bathymetric data, available from http://www.gebco.net/.

For each fishing area, a three dimensional seabed topographic surface was generated, coloured by depth, and draped with the New Zealand trawl footprint blocks, themselves colour coded by Open, Move-On and Closed status. The Vertical Mapper® profile tool was then used to generate cross-sectional profiles from edge-to-edge across the fishing areas, through the centre points of each line of blocks. The profile length / depth data from these profiles was exported to Microsoft Excel® to generate standardised charts of all profiles for each fishing area. These were finally exported to CorelDraw® to compile the three dimensional surface plots, transect line positions and block profiles into overview plots for each fishing area (Figures 35 to 42).

7.2.3 Evaluation of the Representivity of Block Closures

Figures 32 to 39 were used to evaluate the extent to which closed (and move-on) blocks in each fishing area are representative of blocks left open to fishing, at least in terms of depth range and large-scale topography.

- ***NW Challenger Plateau***

Much of the current fishing on the Challenger takes place along the northern and western upper flanks of the Plateau. The six additional block closures along the SW flank are representative of these fished areas in both depth and topography, and include a hilly shallow area and a canyon feature. There are no seamounts in the closed areas comparable to the seamount features initially fished on the NW end of the Plateau, but the closed areas, as well as the central move-on blocks, contain particularly shallow hilly features. The central hill features have only been moderately trawled, but have been fished by bottom longliners targeting species such as bluenose and hapuku known to inhabit high profile rocky areas likely to support VMEs.

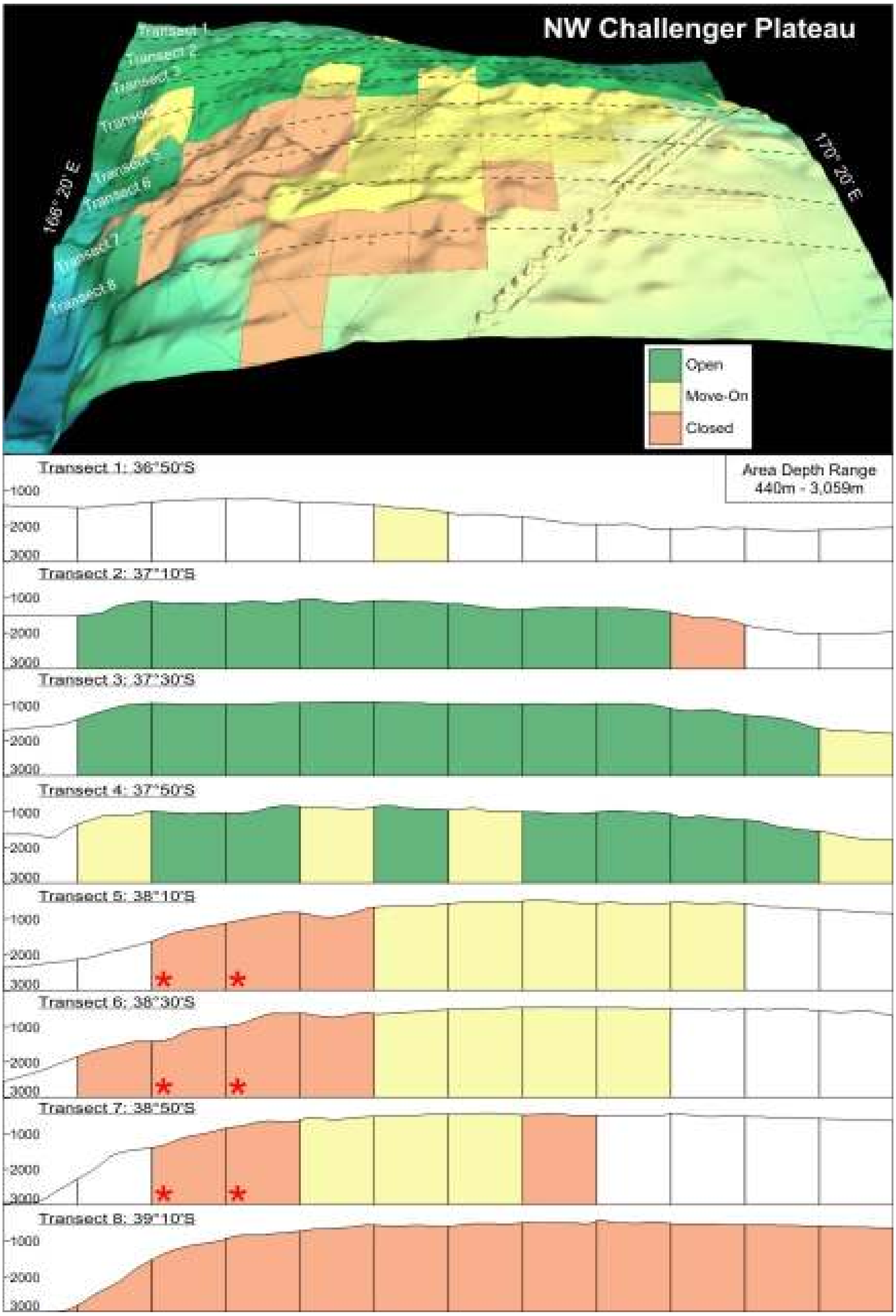

Figure 32 Three-dimensional seabed topography in the Challenger Plateau fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

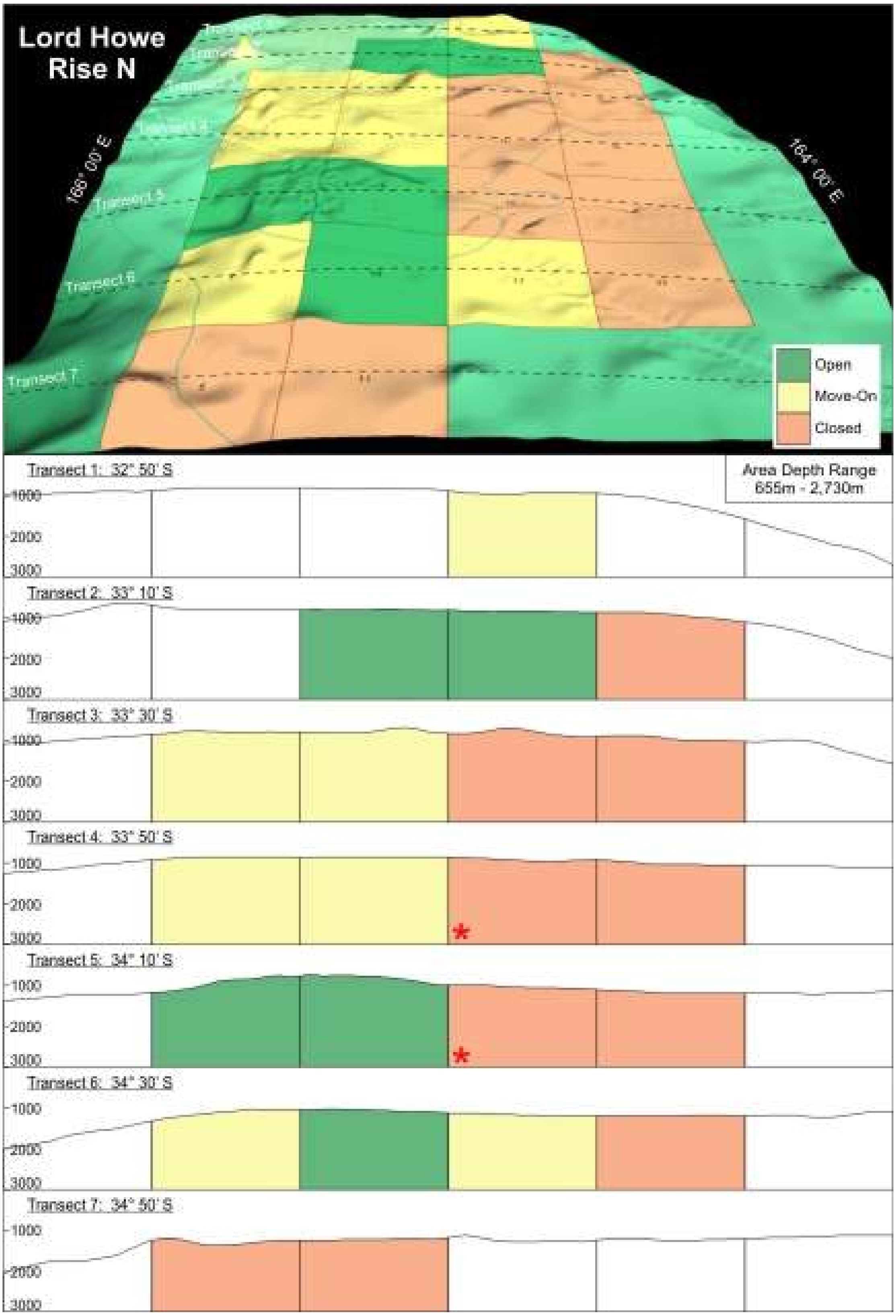

Figure 33. Three-dimensional seabed topography in the Lord Howe Rise North fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

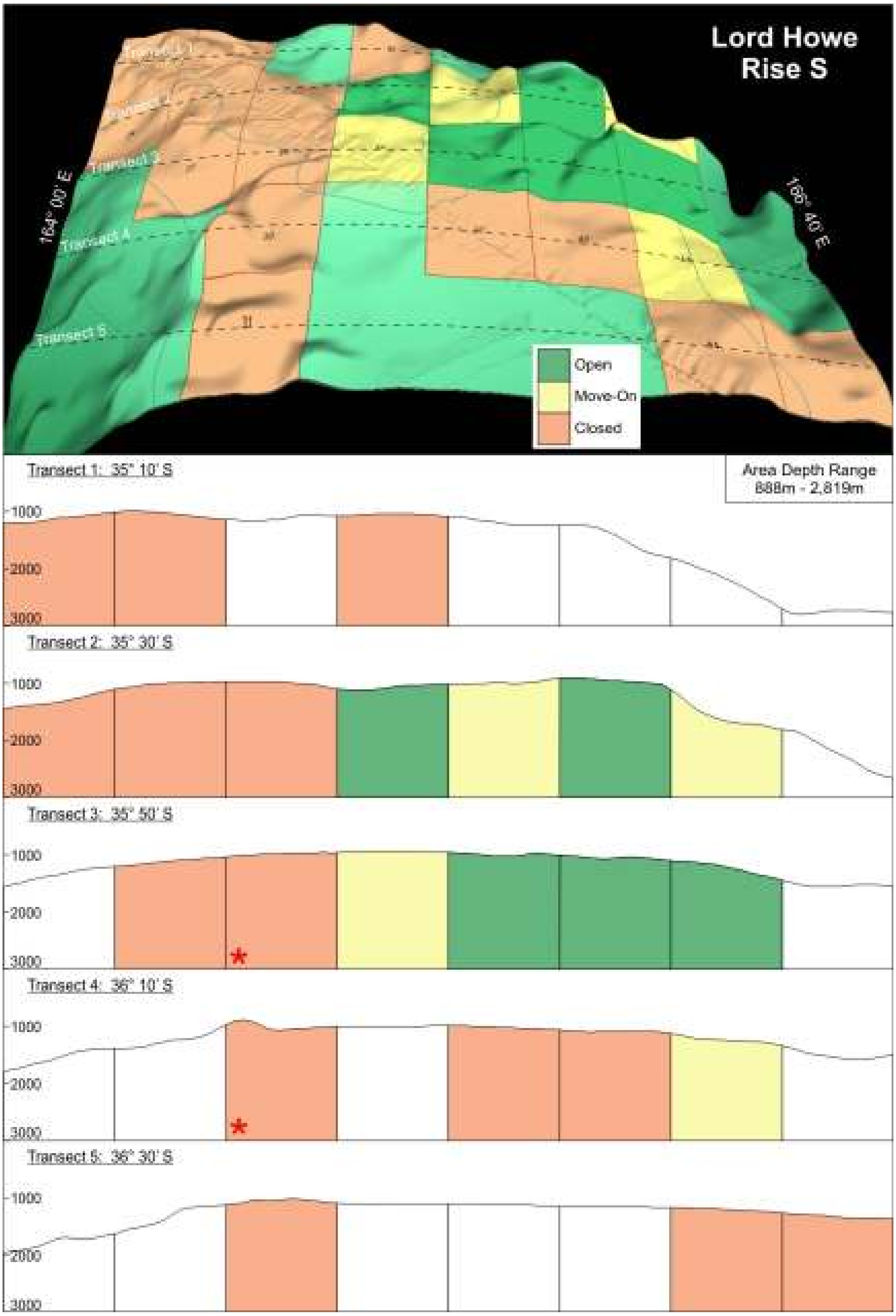

Figure 34. Three-dimensional seabed topography in the Lord Howe Rise South fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

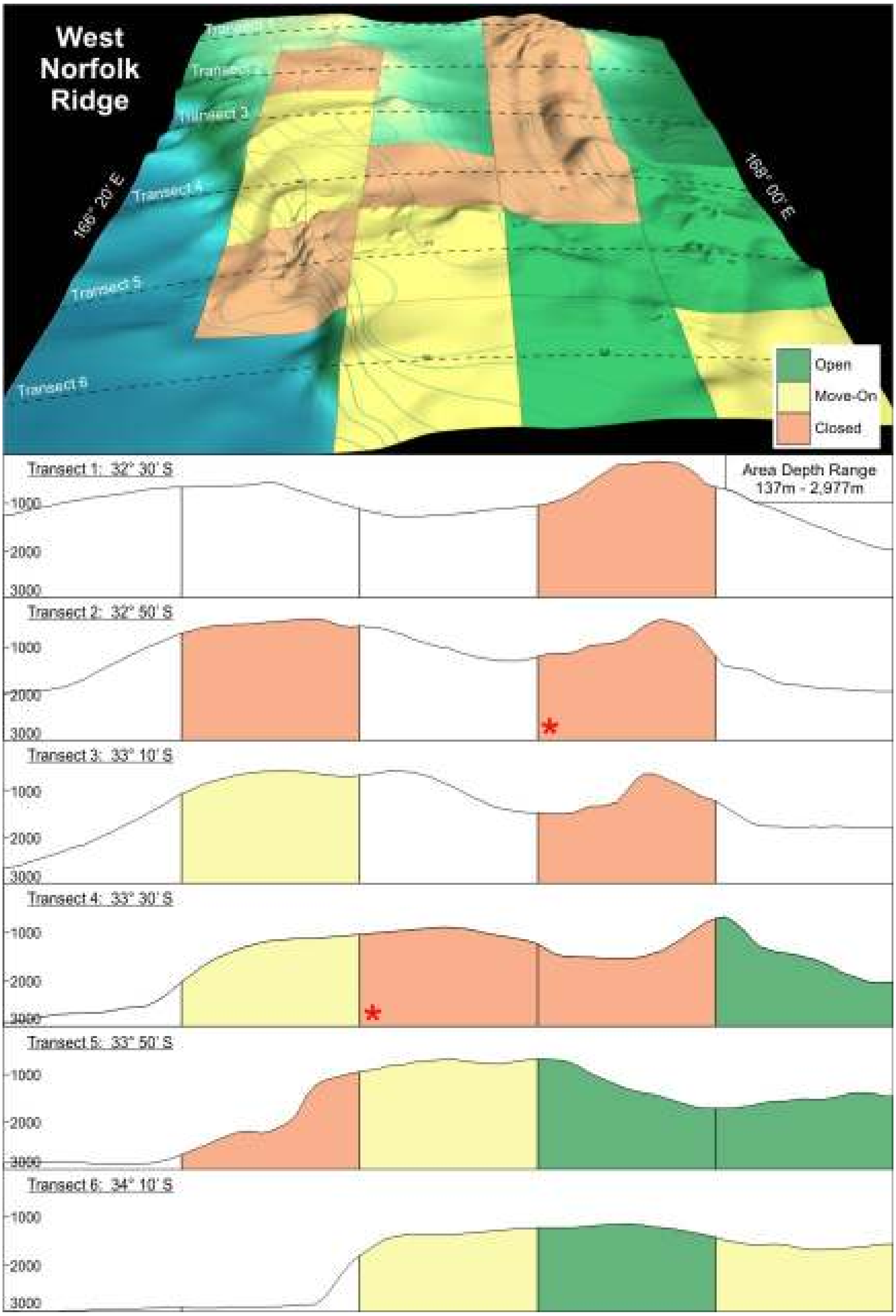

Figure 35. Three-dimensional seabed topography in the West Norfolk Ridge fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

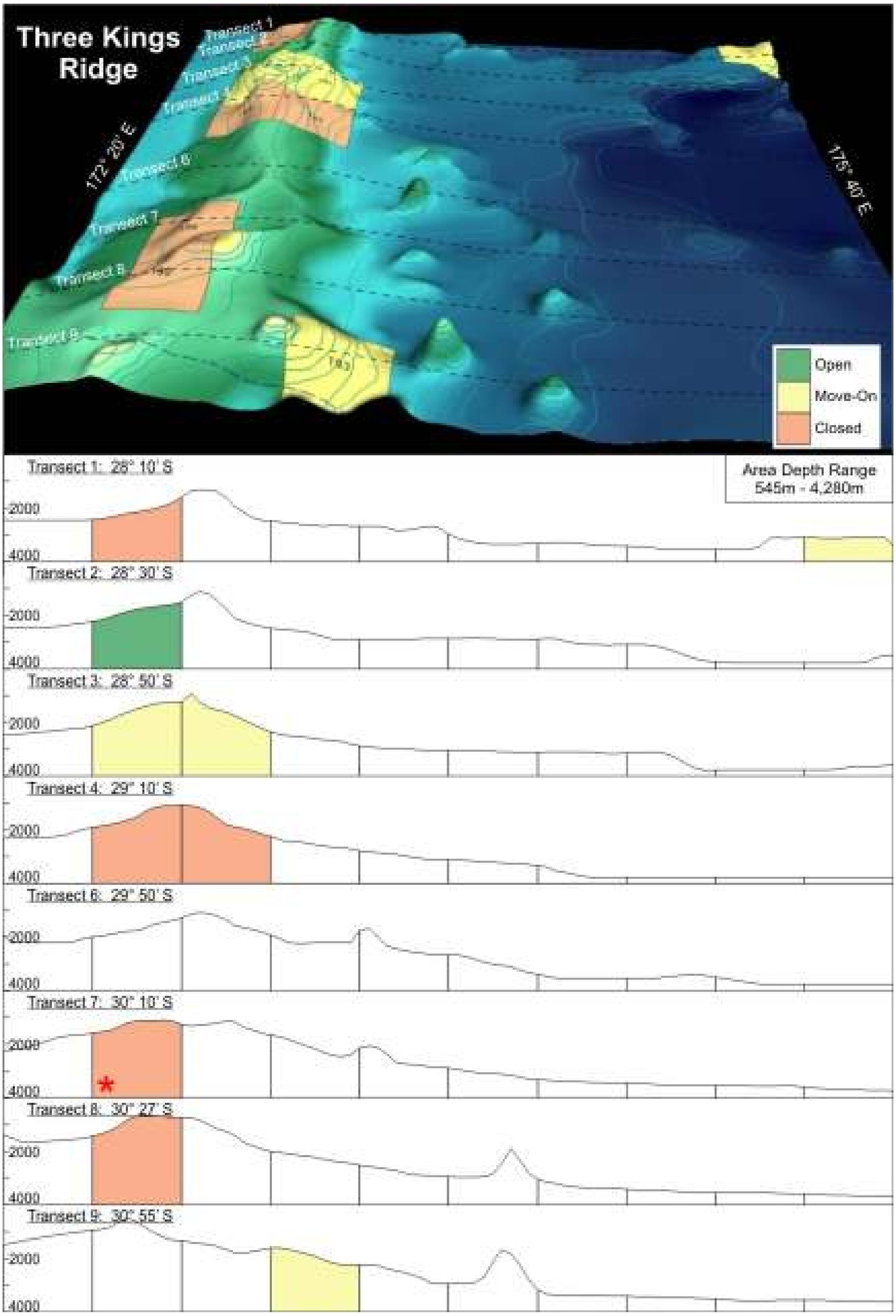

Figure 36. Three-dimensional seabed topography in the Three Kings Ridge fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

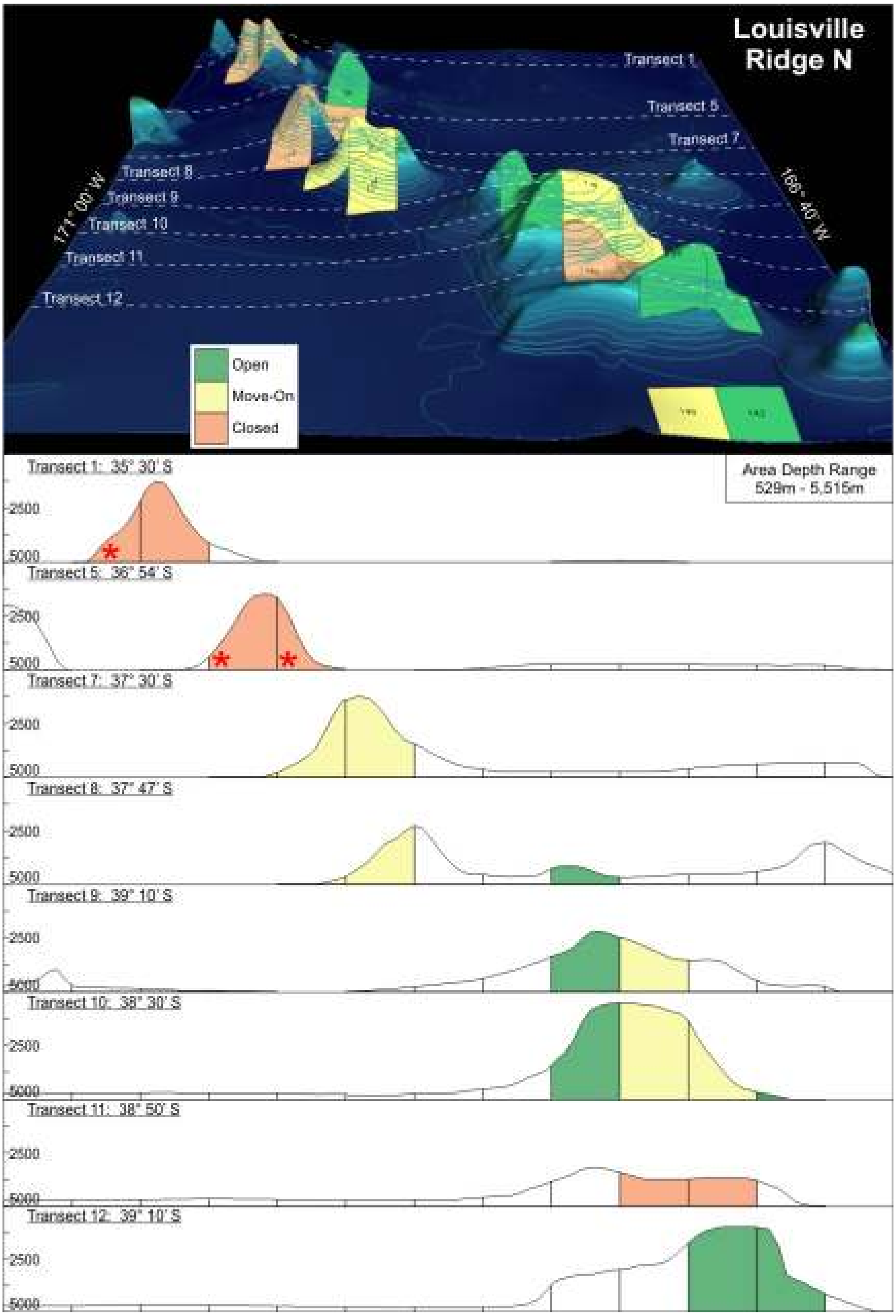

Figure 37. Three-dimensional seabed topography in the Louisville Ridge North fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

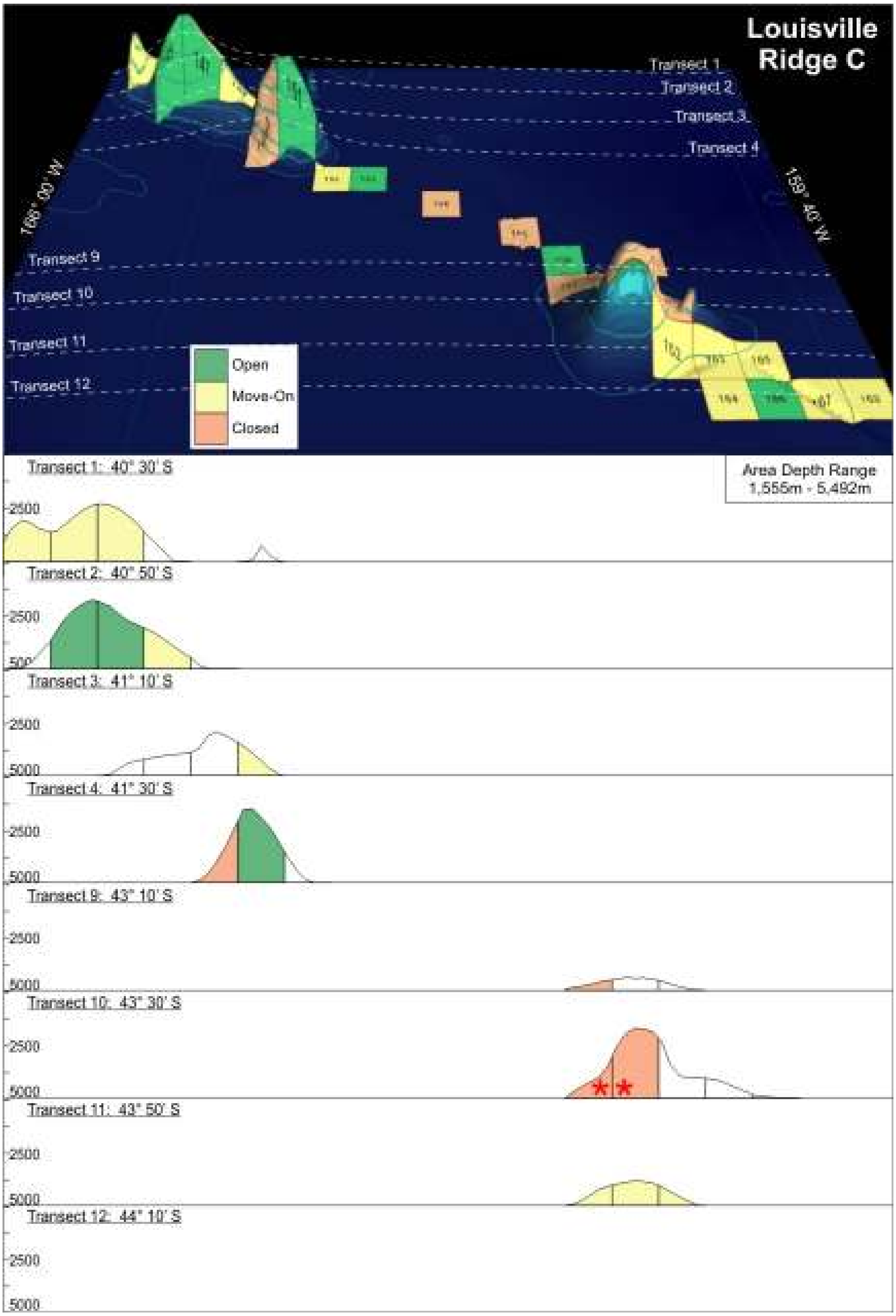

Figure 38. Three-dimensional seabed topography in the Louisville Ridge Central fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks.

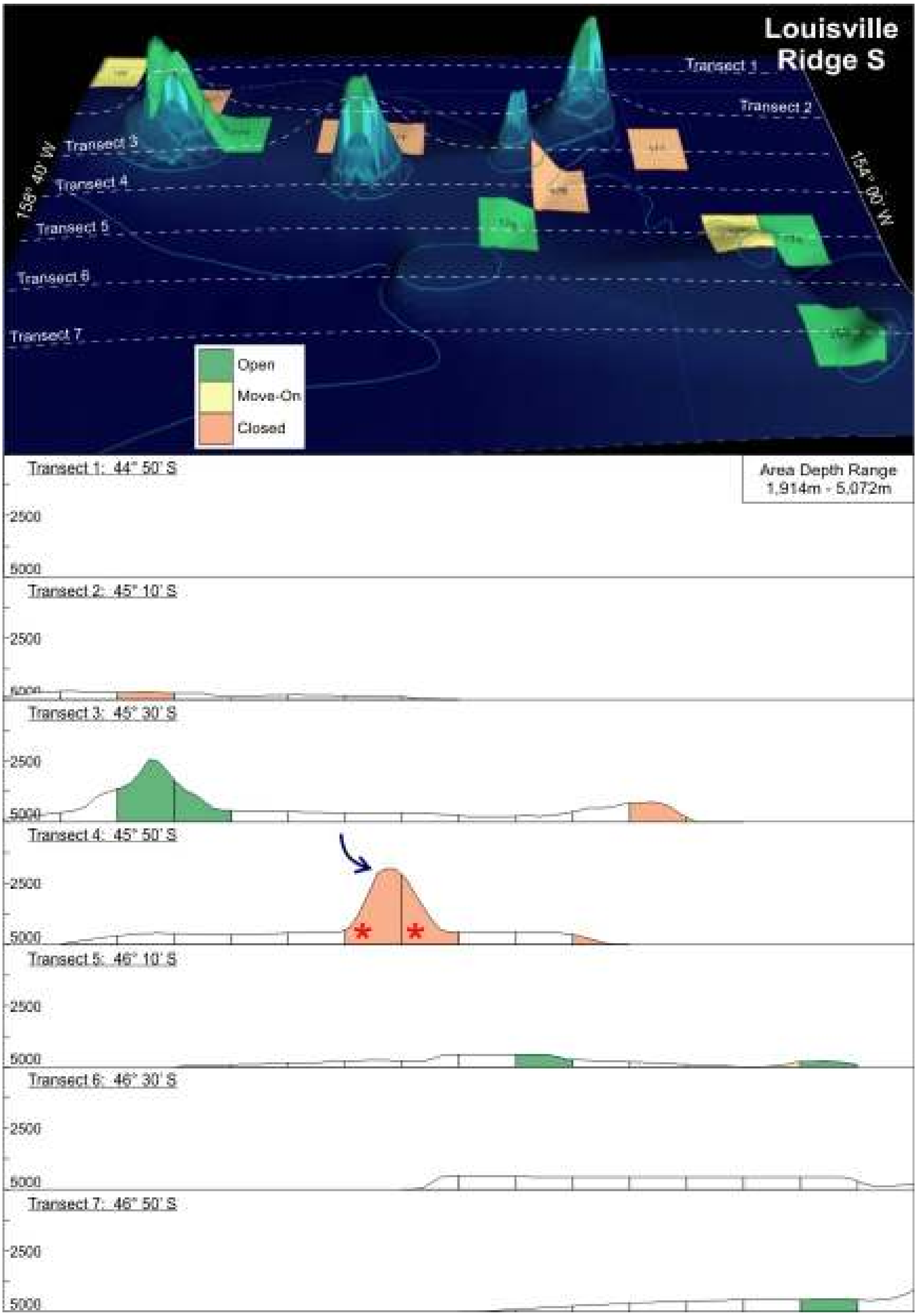

Figure 39. Three-dimensional seabed topography in the Louisville Ridge South fishing area showing the distribution of Open, Move-On and Closed blocks. Transects through the indicated block centre latitudes show the comparative profiles of Open, Move-On and Closed blocks, and of areas outside the footprint. Asterisks show additional closures of moderately and heavily trawled blocks. Arrow shows apparent positional error of a seamount feature.

- ***Lord Howe Rise North***

There are no areas of elevated, broken ground in the Lord Howe North move-on or closed blocks fully comparable to the shallower area in the centre of the open area. This is essentially the only feature fished in this area. However, there is a series of lesser hills running down the eastern edge of the area and, with the two additional block closures, these were all closed. The central move-on blocks contain similar hill features. The combination of these established a moderate profile closed / move-on area across the central region, and extending down the eastern flank of the area.

- ***Lord Howe Rise South***

The Lord Howe South area is also relatively flat, with scattered areas of low profile hard, broken ground protruding through surrounding muds across the area, and a number of lesser hill features. The fishery has focussed on the hill features in the somewhat deeper areas on the eastern flank. These are represented in the move-on blocks adjacent to the fished area. With the two additional block closures, the closed areas contain some of the highest profile and shallowest hill features in the area, extending down the western flank, and in the deeper southern area.

- ***West Norfolk Ridge***

The West Norfolk Ridge is a complex, rugged and high profile area of hills, steep flanks and canyons, dominated by two dominant ridge features running roughly north-south. The shallowest and highest profile of these in the northeast of the area is a primary area for bottom longline vessels targeting bluenose and hapuku on steep rock features along this entire ridge. This area has remained relatively untrawled in the past, and one additional block closure has resulted in the entire eastern ridge being closed to trawling. Trawling has focussed on features on the southeast and central parts of the area. The former are more than adequately represented by the eastern ridge closure, and the latter are represented in the move-on blocks covering the shallowest part of the central area, plus the other additional block closure, which protects a central canyon between the ridges. To the west, the southwest block closure protects a particularly steep flank area. Together with the move-on blocks, the entire high profile western flank is also protected.

- ***Three Kings Ridge***

The Three Kings Ridge footprint area lies along the eastern edge of the Fiji Basin, and is surrounded by a large number of relatively isolated, steep, high profile and unfishable seamounts (see also Figure 21). Most of the areas of likely high biodiversity on this area lie outside the footprint, and have remained unfished. Along the ridge area within the footprint, only one block remains open to fishing. The combination of closed, move-on and outside-footprint blocks surrounding this protect most of the shallowest, high profile areas in the northern part of this area. The one additional block closure, plus one move-on block, have resulted in complete protection of the southern part of this area, particularly the shallowest feature.

- ***Louisville Ridge North***

The entire Louisville Ridge consists of high, steep volcanic seamounts rising directly from the surrounding abyssal plain, and relatively isolated from one another. Many of these seamounts have proven to be unfishable, and often only a limited part of those that are fished is fishable. In the Northern Louisville area, open fishing areas are limited to the larger features in the southern part which provide larger trawlable areas. The fishery is concentrated on the large southern group of features, and specifically to one side of these features, the other slopes being move-on areas. With the three additional closures, two large seamount features in the northern part of this area are protected. The large central feature lies within a move-on block. There are also a number of adjacent seamounts outside the footprint which also represent the depth and topography of the open areas.

- ***Louisville Ridge Central***

Two of the large seamounts in the northern central Louisville area are open to fishing, while a third lies partially outside the footprint, and partially within a move-on block. With the two additional closures, the remaining major seamount in the southern central area is protected, while the surrounding shallower area lies within move-on blocks.

- ***Louisville Ridge South***

Bathymetric position data appears to be rather inaccurate in the southern area of the Louisville Ridge, with a number of seamount features apparently lying outside reported fishing areas. Visually correcting for this (shown by the arrow in Figure 39), one large seamount lies within an open block to the west, and one large central seamount lies within an area protected through the additional closure of two blocks. A third large seamount further east appears to lie outside the footprint.

7.2.4 Limited Availability of Trawlable Area on Seamounts

Industry frequently emphasized the fact that only limited areas of many, particularly steeper, seamounts are suitable for trawling, either because the ground is too steep to accurately target fish aggregations, too rough to trawl without losing substantial quantities of gear, or because fish do not aggregate on much of the feature.

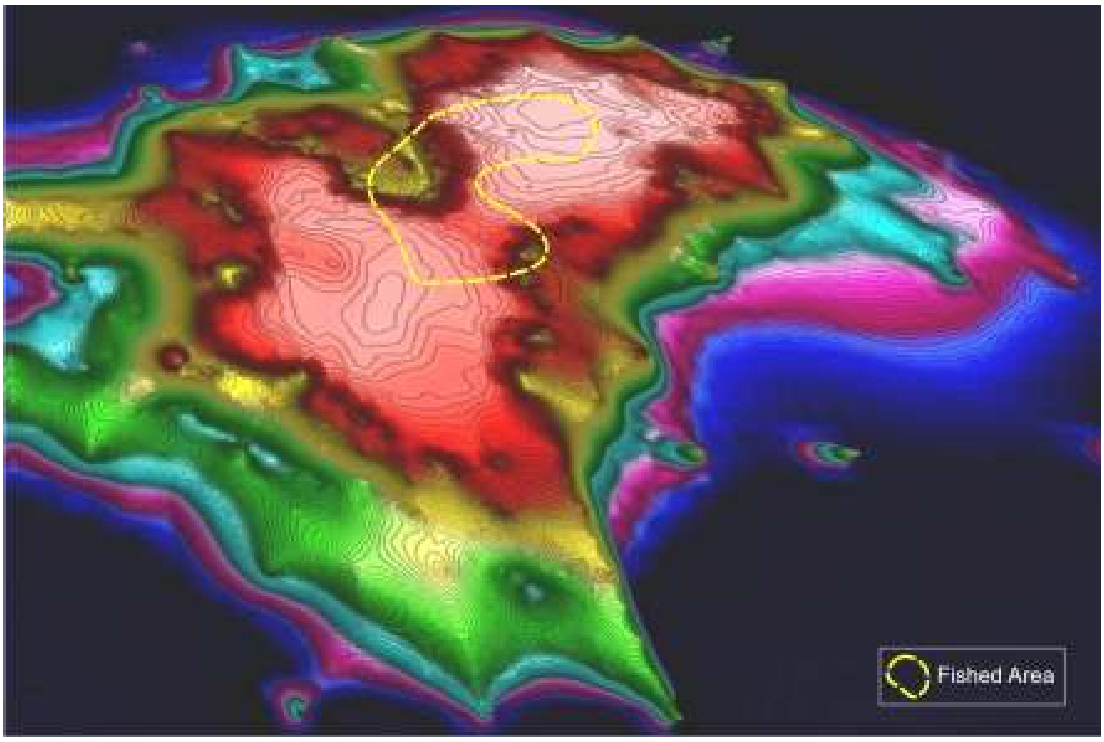

Figure 40. High-resolution bathymetry three-dimensional plot of one of the seamounts on the Louisville Ridge, showing the limited area of this seamount found to be suitable for bottom trawling.

Figure 40 shows an example of a three dimensional plot of a typical seamount, produced from the high resolution bathymetric data collected by industry underway mapping systems during fishing operations. The fished area outline shows the perimeter of the area covered by recent trawl tracks. On this particular feature, a very limited portion of the central area supports fish aggregations, and has been found to be suitable for trawling.

7.3 Detection of 'Evidence of VMEs'

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

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

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

The UNGA, SPRFMO and FAO definitions of VMEs, and the FAO list of examples of potentially vulnerable ecosystems, listed in *Section 4. Evaluation of Expected Interactions with VMEs*, were used as a starting point for selecting species to use as evidence of fishing on a VME, when encountered as bycatch in a bottom trawl net. The rationale used to determine whether taxa were to be included in the list defining 'evidence of a VME' follows:

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

The specific rationale for each taxonomic group considered, including its inclusion and threshold weight, is provided in more detail in Penney *et al*. (2008).

7.3.2 Threshold Weight Determination

Having determined which taxonomic groups should be considered to constitute evidence of a VME, available data on past trawl bycatches of these species recorded by scientific observers on New Zealand bottom trawl vessels fishing within the New Zealand EEZ, and on the high seas, were analysed to determine cumulative catch weight curves for each taxonomic group. The data used for this analysis were scientific observer data primarily from the 1998 - 2002 period, for fishing deeper than 200m for which any catch of corals or sponges was reported by observers. This was chosen as a period after observers started routinely collecting data on benthic bycatches, and before bycatches decreased to recent lower levels (Figure 41), to try and represent fishing on lightly impacted areas.

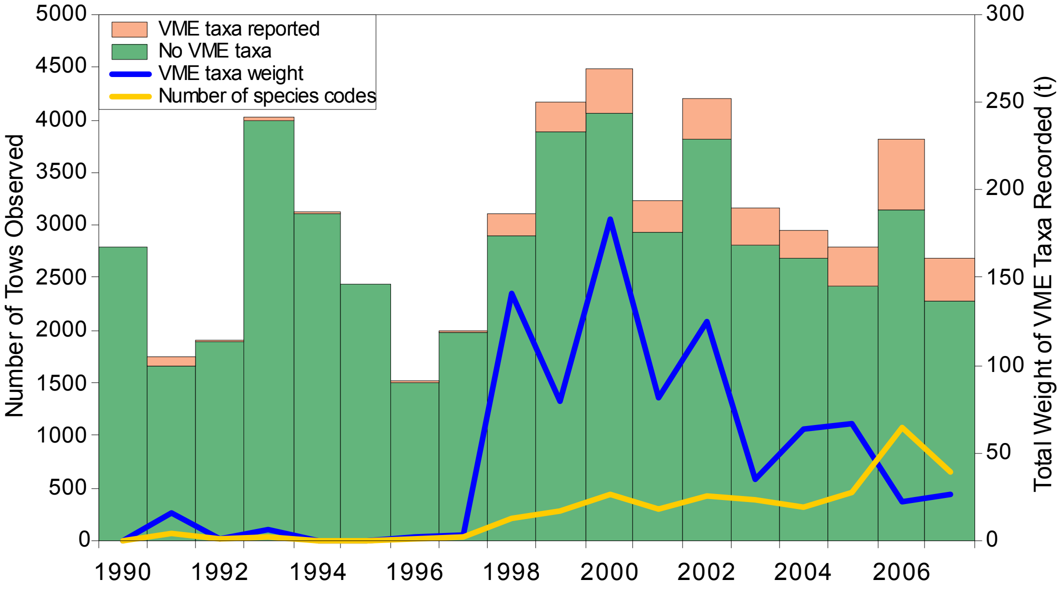

Figure 41. Total number of observed New Zealand bottom trawl tows with and without VME taxa present in the catch, total VME taxa weights and the number of benthic taxa species codes recorded by observers each year.

This selection resulted in 1,603 observer data records being analysed, which constituted about 5% of the total number of tows recorded in those areas over that time period. The remaining tows reported no corals or sponges. This period was chosen as coral and sponge catches were higher than in recent years, although many species codes were not yet in use, and many corals were listed as ‘unidentified’. For this analysis, the COU (unidentified coral) code was interpreted to indicate stony corals (SIA), this being the most likely component of any significant ‘unidentified coral’ bycatch. The 1998 - 2002 observer data included tows targeting mainly hoki (49%), orange roughy (32%) and oreos (13%). Most tows came from the New Zealand South East Chatham Rise area (23%), then Sub-Antarctic (21%), High Seas (19%), and Southeast Coast (18%). Data from all these tows were analysed together, as the 305 tows from the high seas were not considered sufficient to support a separate analysis of high seas bycatches.

Catch weights of the individual vulnerable taxonomic groups were ranked in order of increasing catch weight per tow, and plotted as cumulative catch weights against percentage of tows catching increasing cumulative weights (Figure 42). The distribution of cumulative catch weights is highly skewed, with most tows catching small quantities, and quickly decreasing numbers of tows with larger catches. The objective of this analysis was to identify weight thresholds which could be considered to be ‘evidence of a VME’, by exceeding a chosen threshold weight for each taxon.

Any VME score based on exceeding some threshold weight for each vulnerable taxonomic group will obviously be sensitive to the weight percentile chosen as a threshold. Essentially, the percentile chosen equates to the percentage of tows that would not be above the threshold for that taxon code. Most of the observed tows had a reported catch of only one VME indicator taxon, so typically only a single code generates the VME score. The threshold weights from the analyses shown in Figure 33 for various cumulative percentage of tows are summarised in Table 18 below.

Table 18. Threshold percentile weights (in kg) for each taxonomic code. Data are from observed bottom trawl tows, >200 m depth from 1998-2002 except Gorgonacea (GOC) and Alcyonacea (SOC), which had so few observations that 1998-2007 observations were used. (Example: 75% of bycatch observations of ANT were below 100 kg.)

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

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

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

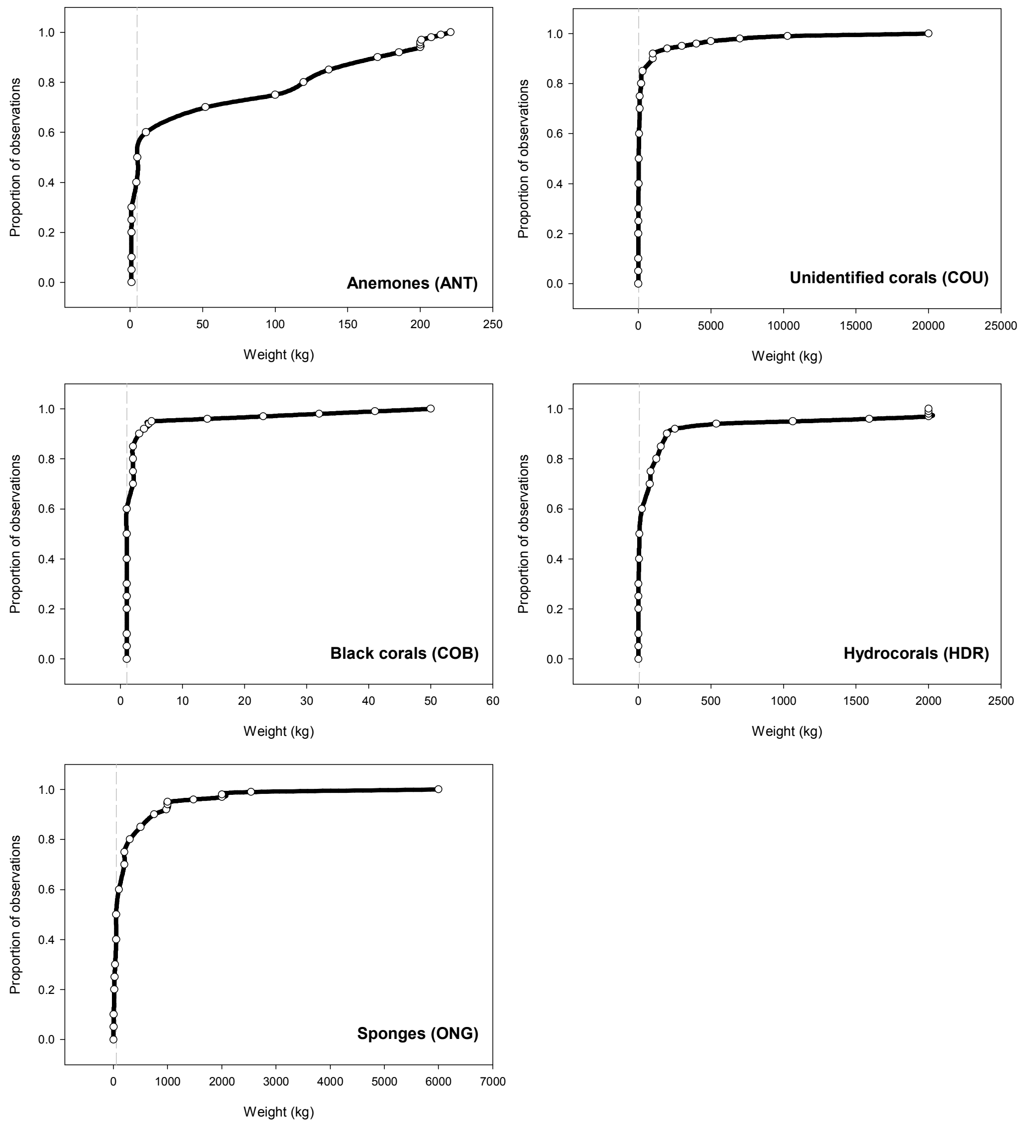

Figure 42. Cumulative catch distributions of VME indicator species codes used to determine threshold weights. Dashed lines indicate the 50th, 75th, and 90th percentile values. Inset shows same data truncated at 500kg for more detail.

In the absence of any specified definition, or management objective, for 'evidence of a VME', and in recognition of the generally poor performance of trawl nets in sampling corals, the following approach was taken. Weight thresholds need to be high enough to exclude insignificant encounters which might not actually provide evidence of VMEs (ie, above presence-absence). However, the thresholds would nonetheless need to be low, and probably below the median of the dataset, to include tows that, in all likelihood, had fished areas containing VMEs. From Table 18 it can be seen that the weight thresholds for taxa such as black corals, soft corals and sea fans are particularly low, being only 1 kg at the 50% cumulative weight level based on the data analysed. While recognising that different sectors have widely differing views on what would constitute the most appropriate weight threshold to use, it was decided to use the median of the weight distributions.

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

7.3.3 Rationale for the Proposed VME ID Form

The VME Evidence Process Form developed using the above rationale and analyses is shown in Appendix C. The VME form contains a checklist of vulnerable categories, organized to quickly categorize bycatch specimens with regard to the possibility that the bycatch provides evidence of a VME. The approach is to use a simple, fast procedure to determine if a particular catch was likely to be from a VME so that the vessel skipper can utilize the information in choosing the next fishing location. A detailed species identification procedure cannot be completed in this timeframe, nor is it necessary, as evidence of a VME is based on the presence of broad taxonomic groupings.

A specific VME Species ID Guide (also shown in Appendix C) was prepared to assist observers with rapid identification of the species on the VME ID form to broad taxonomic level. Additional detailed species identification is done afterwards as part of the normal benthic materials sampling process conducted by scientific observers aboard New Zealand bottom trawling vessels. Determination of actual *existence* of a VME, or of significant adverse impacts on a VME, requires a subsequent, more thorough scientific analysis of all benthic bycatch data collected by observers over the areas fished, together with other data which might indicate presence areas likely to support VMEs.

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

These scores are based on a 3-level importance score to the presence of that taxon, based on its apparent sensitivity to impact (Low=1, Medium=2, High=3). The importance levels chosen for each taxonomic group are based on the FAO Deepwater Guidelines (FAO 2008, Annex 1) on vulnerability of those taxa to disturbance, and information on their life history characteristics from the FAO Expert Consultation (FAO 2007). Summing all the individual taxon VME scores provides a score for taxa that exceed their weight thresholds. Currently, all taxa are allocated a sensitivity of 1 or 3, and no taxa score 2. However, splitting groups such as sponges and stony corals would create categories where a medium score is warranted. Future data collection is needed to inform such refinements.

7.3.4 Incorporating Species Diversity

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

7.3.5 Performance of the VME Protocol Using Existing Observer Data

Analysis of the 1,603 observer data records from 1998 - 2002 with the present scoring system leads to 49% of tows catching corals or sponges to be categorized as ‘*Evidence of a*

VME' (Table 19). As only about 5% of all observed tows deeper than 200 m caught corals or sponges at all, this would translate to about 2.5% of total observed tows deeper than 200 m during the period. Very few tows score 2 and most qualifying tows score only 3, indicating the tows are not qualifying based on diversity, but based on exceeding the threshold weight for a single category.

Table 19. The VME indicator score distribution of observed tows 1998-2002 >200m showing the number of tows at each VME score using the 50th percentile threshold weights. Bold numbers indicate the number of tows qualifying as evidence for a VME.

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

Because the dataset includes tows targeting species such as hoki within the EEZ, threshold weights were compared using only orange roughy target tows, which decreases the sample size to only 530 observations. In general, orange roughy target tows tended to catch less anthozoa, hydrozoa and sponges, and about the same black coral and unidentified coral.

Using the more recent 2002 - 2007 data as the basis for performance analysis results in lower coral and sponge catches but more codes, which tend to emphasize diversity. However, the percent qualifying using the weight thresholds determined above, expectedly decreases from 49% to 27% as a result of lower weights caught in recent years. The decrease in catch weights during the later period is more influential than having more taxon codes and the diversity aspect of the scoring does not result in many more tows exceeding the threshold (Figure 43). Re-doing the weight threshold analysis using the 2002 - 2007 data would consequently result in lower weight thresholds for anthozoa, hydrozoa and sponges, and about half the 2002 - 2007 tows would again qualify as evidence of VMEs. The proportion of 1998 - 2002 tows qualifying as evidence of VMEs using such lower thresholds would increase to substantially more than half.

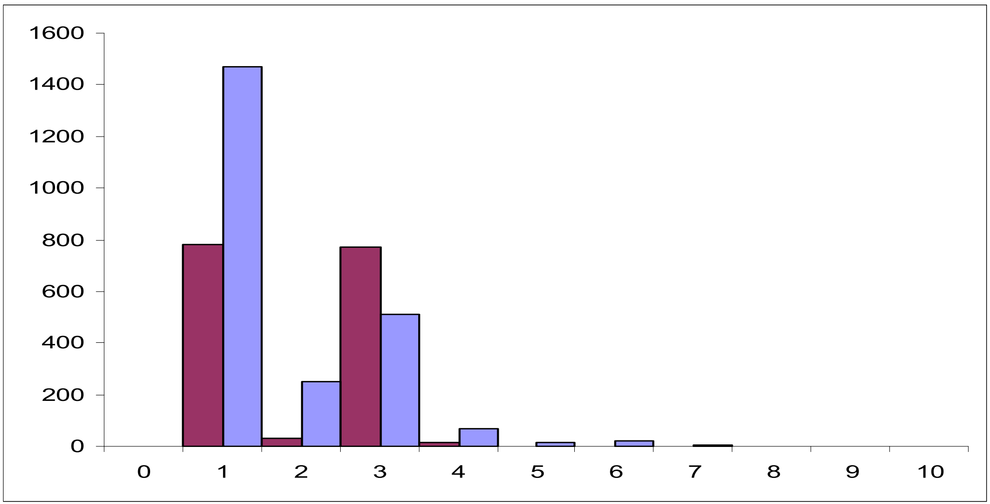

Figure 43. Comparison of total VME score distributions using 1998 - 2002 (magenta bars) versus 2002 - 2007 (blue bars) data.

Examples of application of the proposed VME ID protocol are provided in Table 20, showing hypothetical invertebrate catches and their resulting VME scores (where a score of >= 3 indicates evidence of a VME). Bold items are over the threshold, others count as 1 point, contributing to the biodiversity score.

Table 20. Examples showing the use of the New Zealand 'VME ID Protocol' to determine VME scores for different hypothetical benthic bycatches in bottom trawl tows.

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

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

7.3.6 Comparison with Known Seamounts with Various Invertebrate Densities

Few datasets exist to investigate the relationship between what benthic invertebrates are actually on the bottom and what comes up in a trawl. The Graveyard Complex of seamounts within the New Zealand EEZ have a mix of fished and un-fished seamounts, have some towed camera frame imagery, some tows with an epi-benthic sled and some experimental trawl fishing. However, when combined, only one tow from research cruise AEX9901 in overlapping areas with sled tows and camera tows caught coral, and this was on Graveyard, a highly fished area. The other 8 tows did not return corals, highlighting the poor ability of these trawls to retain benthic materials, assuming the same areas were fished. Although research cruise TAN0604 also has camera and sled tows, the research cruise AMA0501 fished 1 tow on Graveyard, and 2 on Zombie, so any comparison would be minimal.

7.3.7 Potential Bias in Identification of Evidence of VMEs

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

Design May Overestimate Evidence of a VME

- Observer data from 1998-2002 mainly categorized corals as COU. Available observer data from early / exploratory phases of the fishery, when coral catches are typically higher, did not identify individual identified coral orders. The form and current practice will generate more taxonomic categories than occur in past data, generating more diversity points and resulting in somewhat higher scores.

Design May Underestimate Evidence of a VME

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

7.3.8 Analytical Process to Identify Actual Existence of VMEs

While the VME Evidence protocol and form described above is designed to provide initial *evidence* of the possible existence of a VME, single encounters do not demonstrate actual *existence* of a significant VME in the area, nor of significant adverse impact on a VME. The intention is therefore to periodically review all evidence gathered using the VME ID form, all additional data collected by observers doing detailed benthic bycatch analyses for all high seas tows (including outside the moderately trawled 'move-on' blocks), as well as any other relevant information which might be useful in determining the likelihood of presence of VMEs.

IUCN have proposed, for example, how repeated encounters showing evidence of a VME over time or space could be periodically analysed to identify areas with a high likelihood of actual existence of VMEs (Rogers *et al*. 2008):

IUCN Criteria for Existence of Vulnerable marine Ecosystems

Corals

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

Sponges or other Habitat-Forming Epifauna

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

> 15% of hauls of any gear within an area (10 - 100 km^2) containing sponges or other habitat forming epifaunal taxa.

7.4 Operational Measures to Minimise Benthic Effects

Over the past two decades, the New Zealand deepwater trawling industry has increasingly implemented gear modifications and operational measures to reduce damaging interactions with the seabed. Most of these modifications and procedures have been motivated by a desire to reduce costs associated with damage to fishing gear, to increase efficiency of trawling operations, to maximise catch rates and to reduce the time and fuel costs of fishing operations. Many of the modifications relate to electronic systems to facilitate accurate aiming of the gear at dense aggregations of fish, modernising of trawl doors and lightening of the gear to facilitate manoeuvrability, and rigging and towing gear to minimise the risk of non-fishing components (doors and warps) touching the seabed.

Generally, modern deepwater trawling is aimed at acoustically located aggregations of fish or known productive fishing positions or towlines. It is not a “tow and hope” operation. While some bottom contact is required for species such as orange roughy and oreos, other species such as alfonsinos and bluenose can be caught in midwater trawls without any seabed contact. It should be noted that in many alfonsino fisheries the gear may come very close to the bottom, but the gear is typically lighter and sacrificial links on the groundrope are designed to break if the gear touches the bottom, to minimise damage to the net, but resulting in loss of the catch for that tow.

Most of the tow time for deepwater trawls is spent shooting and hauling, with actual bottom contact and fishing time being very short, and ideally only in the vicinity of the dense aggregation being targeted. The bottom times of orange roughy targeted tows are typically very short, perhaps 3 - 10minutes, compared to 2 - 5 hours for traditional flat-bottom trawling. All contact of the trawl gear with rough ground often fished in these fisheries carries the risk of gear damage and associated expense for repair of trawl systems typically worth $75,000 - $100,000. This encourages continual investment in systems that catch fish efficiently with minimal bottom contact. A major driver of efficiency in these fisheries is the need for accuracy and precision of placement of the gear and there has been continuous investment in acoustic, navigational and gear systems to reduce trawling time and to minimise the number of empty tows.

- ***Electronic Navigational Aids***

Since the development of trawling in waters deeper than 700m there has been a substantial move to greatly improved navigational systems to position the vessel correctly, now including GPS with accuracy to 1.5m. New Zealand vessels often carry more than one system to ensure continuous service, integrated into navigational plotters and echosounder systems to provide fishing masters with full three-dimensional displays of the area being fished, and the position of the vessel in relation to seabed features and fish aggregations.

The recent move to sophisticated 3D plotting software such as the Piscatus® or MaxSea® underway mapping systems allows vessels to rapidly generate high resolution three dimensional maps of an area without the need for experimental tows. The level of detail available from such plots allows very precise and consistent placement of the gear. These systems also accurately record the vessel trawl tracks and footprint, potentially providing information useful for evaluation of habitat impact.

- ***Electronic Fishing Aids***

With the advent of deepwater fishing came the need for echosounders capable of giving clear definition of both target fish and the seabed. This has lead to installation of echosounders with greater power (10kw) and lower frequency (28khz) capable of delivering detailed and accurate images at these depths. More recently, acoustic systems have moved to PC-based technology which allows for rapid and enhanced signal processing, as well as ceramic transducers for better signal transmission and pickup. Many vessels now also use some form of scanning sonar, used to scan areas other than below the vessel to eg, locate fish aggregations in three dimensional space, provide lateral images of the seabed or track fishing gear in relation to fish aggregations and seabed features.

- ***Fishing Gear Monitoring Equipment***

Deepwater trawlers have placed acoustic link monitors on the trawl nets to feed information back to the vessel on the vertical position of the trawl net in relation to the seabed. The time, extent and pressure of contact of the gear with the seabed can therefore be accurately monitored and controlled. These systems can also provide information in regard to water temperature and volumes of fish entering the trawl. Net positioning systems such as the Simrad ITI® allow accurate placement of the net on the intended target trawl zone, minimising the impact of currents which could push the net off the tow line. Acoustic link systems are used to prevent any seabird tow cable strikes which might result from using cable linked systems.

- ***Winches***

The ability to rapidly and accurately control the gear in response to information provided by the electronic systems described above is completely dependant on the power and control of the vessels winches. New Zealand deepwater trawlers have all moved to using hydraulically or electrically controlled self tensioning systems that have sufficient power to rapidly respond to the instructions related to altering the net position or behaviour.

- ***Fishing Gear***

Since the commencement of deepwater trawling in New Zealand there have been major changes to the trawl gear. The reasons for these changes resulted from the desire to minimise bottom contact by doors and sweeps, to minimise the risk of trawls sticking fast on the seabed, and subsequently being damaged. The shift from use of old-style vee doors to modern, high aspect ratio hydrodynamic doors is described in *Section 2. Description of Proposed Fishing Activities*. This shift to doors designed to be towed within the water column have resulted in a greatly reduced risk of doors contacting the seabed.

Modifications to trawl net design to facilitate highly accurate targeting of aggregations of species such as orange roughy are also described in Section 2. Most significantly, the move towards shorter sweeps and bridles and smaller net openings not only improves the manoeuvrability of nets, but also reduces the width of groundrope impact. Ideally, efficient targeting of fish aggregations should also reduce the duration and extent of ground contact by the net. The shift away from steel bobbins to rubber bobbins, and then to rubber disc rockhopper gear (see Section 2) has also been designed to reduce the risk of gear coming fast on the seabed, instead hopping over obstacles encountered.

- ***Skipper Experience***

The current New Zealand deepwater fishing skippers have built up substantial personal experience, both working in various crew positions on deepwater vessels, and subsequently learning how to most efficiently fish seabed areas and features. This experience is critically important to fishing efficiency and minimising seabed impacts, and is typically under-estimated.

- ***Costs of Gear Improvements***

The costs of these various improvements and modifications represent a substantial investment for operators, and are summarised in Table 21.

Table 21. Typical costs per vessel of deepwater fishing technology for aimed bottom trawling.

Item	Cost
Scientific Sounder	$100,000
Sonar	$150,000
Video Plotting Systems	$30,000
GPS Systems	$10,000
Trawl Monitoring System: Furuno Simrad	$60,000 $100,000
Trawl Gear (entire system)	$75,000

A summary of the gear modifications and operational measure improvements implemented over the past two decades is shown in Table 22.

Table 22. Overview of gear improvements and fishing operational measures implemented on New Zealand bottom trawlers over the past two decades to improve fishing efficiency and reduce seabed contact in deepwater aimed trawling.

<table>
<tr><th>Past</th><th colspan="2">Recent</th><th>Present</th></tr>
<tr><td>Radar</td><td colspan="2">SatNav</td><td>GPS</td></tr>
<tr><td>Chart</td><td colspan="2">Video Plotter</td><td>3D Colour Plotter</td></tr>
<tr><td>Wet Paper Sounder</td><td colspan="2">Colour Sounder</td><td>Scientific Sounder</td></tr>
<tr><td colspan="2">No Sonar</td><td colspan="2">Sonar</td></tr>
<tr><td colspan="2">Manual Winch</td><td colspan="2">PC based winch system</td></tr>
<tr><td>No net monitor</td><td colspan="2">Headline Monitor</td><td>Full gear monitoring system</td></tr>
<tr><td colspan="2">Low aspect ration bottom doors</td><td colspan="2">High aspect semi pelagic doors</td></tr>
<tr><td colspan="2">Long groundrope</td><td colspan="2">Very short groundrope</td></tr>
<tr><td colspan="2">Long sweeps / bridles</td><td colspan="2">Short sweeps / bridles</td></tr>
<tr><td>Steel bobbins</td><td colspan="2">Rubber bobbins</td><td>Rockhopper discs</td></tr>
</table>

Information on the extent to which these gear modifications and operational measures appear to have been successful in reducing seabed interactions and impacts is provided in section 7.5.

7.5 Review of 2008 Implementation of SPRFMO Management Measures

Since issuing of the revised New Zealand high seas fishing permits (incorporating the management measures described in this assessment) on 1 May 2008 and end October 2008, three New Zealand bottom trawl vessels have conducted four fishing trips in the SPRFMO Area (see Appendix A for a list of authorised vessels). This section provides a review on implementation and effectiveness of the New Zealand management approaches in the various management tiers in the bottom trawl footprint.

These vessels all carried scientific observers. Data provided by these observers can be used to evaluate the intensity of fishing and the extent of impact of these operations on the fished areas. In particular, the observers collected detailed data on composition of all benthic bycatches on all tows using the new *Benthic Materials Form*, and these data can be used to evaluate the extent of interaction with VMEs by each tow, the effectiveness of New Zealand management approaches in mitigating adverse impacts in VMEs, and the effectiveness of industry operational measures in minimising seabed impacts.

7.5.1 Description of 2008 Bottom Trawling Operations

On the four fishing trips conducted up to the date of this assessment, the three vessels conducted a total of 235 tows in the Lord Howe, Challenger and West Norfolk fishing areas. These tows had an average duration of 14 minutes per tow, and a maximum reported duration of 3.3 hours. Lengths of these tows averaged 1.3 km (s.d. 1.7 km), with a maximum reported length of 14.9 km. All tows were conducted in Open blocks and vessels made no attempt to fish in any of the Move-On blocks. However, skippers reported finding and fishing new, previously unfished features in the open areas. Analysis of trawl tracks showed that this was the case, and much of the successful fishing effort was targeted at these new areas.

The total number of tows and total tow length per fishing area are summarised in Table 23 Tow lengths were converted to (exaggerated) estimates of swept area by assuming that no tows over-lapped, and that the impacted swept width of each tow was 200m. (Actual swept widths were, in all likelihood, less than half of this.) The resultant maximum estimates of total swept area and percentage of the Open portion of the respective fishing area footprints that this represents are also shown in Table 23 The 235 tows maximally impacted 0.14% of the Open areas fished, or 0.05% of the total of the footprint areas concerned. Given the long duration of any resultant impacts on slow growing benthic organisms, impacts would be cumulative, and need to be added to estimates of past swept area. However, the management approach taken was successful in confining fishing effort to at least the footprint blocks most heavily fished.

Table 23. Summary of the total number of tows, tow length, estimated swept area and percentage of the footprint area swept (assuming a 200 m swept width, and no tow overlap) in each fishing area fished to date of this assessment during 2008.

Fishing Area	Total Area (km^2)	Open Area (km^2)	No. of Tows	Tow Length (km)	Swept Area (km^2)	% of Area Swept
Lord Howe N	25,082.2	5,705.6	1	0.7	0.1	0.003%
Lord Howe S	25,630.3	5,578.2	97	102.4	20.5	0.367%
Challenger	62,795.2	27,252.4	27	60.3	12.1	0.044%
West Norfolk	19,452.1	4,564.6	110	143.5	28.7	0.629%
Total	**132,959.9**	**43,100.8**	**235**	**306.9**	**61.4**	**0.142%**

Given the industry reports that new, previously unfished, features were being fished, it might be expected that trawls would have encountered and retrieved significant benthic bycatch evidence of interactions with VMEs in these previously unfished areas. However, 158 of the 235 tows (67%%) retrieved no benthic bycatch at all, and 224 tows (95.3%) would have been accorded a VME score of <3 (not evidence of a VME) under the New Zealand VME ID Protocol, had these been Move-On areas (Table 24. Only 11 tows would have been given a VME score of 3 or greater, indicating 'evidence of a VME'. This is despite the fact that these retrospective analyses were based on detailed benthic materials data which observers had more time to collect and classify than under the rapid VME ID Protocol, probably resulting in higher scores for biodiversity than would otherwise have been achieved.

Table 24 Summary of the number of tows achieving retrospectively calculated VME scores in the areas fished to date in 2008, showing the number that would and would not have been considered to show evidence of a VME.

Fishing	VME Score							Total
Area	0	1	2	3	4	5	7	Tows
Lord Howe N	1							1
Lord Howe S	62	21	9	4			1	97
Challenger	23	2	2					27
West Norfolk	72	22	10	4	1	1		110
Total	**158**	**45**	**21**	**8**	**1**	**1**	**1**	**235**
		Not VMEs	**224**		**VMEs**		**11**	**4.68%**

Actual weights of benthic organisms retrieved in these tows were also very low, with a total weight of 114.1 kgs of corals (0.49 kg/tow), 11.2 kgs of sponges (0.05 kg/tow) and 10.4 kgs of echinoderms (0.04 kg/tow) being caught, further indicating that duration of net contact with the bottom was low.

7.5.2 Conclusions Regarding 2008 Implementation of Management and Mitigation Measures

- Reluctance by the industry to fish in the move-on blocks, preferably targeting new features and dense fish aggregations in open areas, effectively means that bottom trawling has been limited to the open heavily trawled blocks, which constitute 29% of the New Zealand bottom trawl footprint.
- Even in the open area blocks fished, the actual impacted area amounted to maximally 0.14% of those areas (assuming a swept width of 200m per tow), which amounts to only 0.05% of the total area of the New Zealand trawl footprint.
- Industry implemented operational measures during these fishing operations appear to have been successful at reducing contact with the seabed, as benthic bycatch weights, even when fishing in new areas, were substantially lower than in historical data. The short tows and high catch rates achieved by these fishing operations attest to the accurate and successful targeting of orange roughy aggregations. Low benthic bycatches and absence of any benthic materials in the nets on two thirds of the tows, despite fishing in new areas, indicates that nets made reduced bottom contact in comparison with data for historical fishing operations.

8. Environmental Impact Assessment

The evaluation and ranking system in the tables below has been designed to assess the elements of risk considered most important in determining vulnerability and the significance of bottom fishing related impacts, based on the FAO Deepwater Guidelines (FAO 2008), and to include specific definitions for the various rating criteria. To the extent possible, allocation to ranks was based on quantifiable criteria. It must be noted that the allocated ranks in the tables below refer to the resultant impact itself (eg, area of seabed affected, and duration of the impact), and not of the cause thereof (level or extent of fishing effort). Elements of risk specifically evaluated are:

- **Description of Impact** - Provides a brief description of the expected impacts, answering the question, “What will be affected and how?”
- **Extent** - Indicates whether the impact will be: *Site Specific* (limited to within one kilometre of the fished site); *Local* (limited to within one fished 20’ block, or 50km of the fished site); *Regional* (limited to the fishing area ~200-500 km radius); or *Oceanic* (extending across a significant proportion of an ocean basin, or of the SPRFMO Area).
- **Duration** - Gives the expected duration of the effects of the impact, being: *Short* (months, <1 year); Medium (years, 5-20); or *Long* (> 20 years, decades to centuries).
- **Intensity** - Provides an expert evaluation of whether the magnitude of the impact is destructive or innocuous and whether or not it exceeds set standards, and is described as: *None* (no impact); *Low* (where environmental processes are slightly affected); *Medium* (where environmental processes continue to function but in a noticeably modified manner); or *High* (where environmental functions and processes are altered such that they temporarily or permanently cease and/or exceed established standards / requirements).
- **Cumulative Impact** - An assessment of whether the impact is cumulative over time or space or not, and is expressed as being: *Unlikely* (the event is either a low-impact rare event, or recovery is rapid, such that effects will not accumulate over time or area); *Possible* (depending on extent, severity, natural disturbance levels and recovery rates); or *Definite* (at the intensities occurring, effects will endure such that, over time or space, impacts from a number of separate operations will accumulate).
- **Overall Significance** - The overall significance of each impact is then evaluated from the combination of duration, extent, intensity and cumulative effects. Overall Significance is determined as follows:
  - **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..

- **Monitoring, Management and Mitigation Measures** - Description of specific monitoring, management and mitigation measures that are currently in place or can be considered when taking action to reduce impacts to acceptable levels.

8.1 Identification of Potential Adverse Impacts

Each of the main potential impacts and issues of concern related to bottom trawl and line fisheries in the SPRMO Area are listed in the tables below, evaluated and ranked in terms of the risk elements described above.

8.1.1 Adverse Impacts on Benthic VMEs

Impact of Bottom Trawling on VMEs

D*escription of Impact:* Damage to fragile and vulnerable, habitat-forming, biogenic benthic communities is the primary concern related to deep sea bottom trawl fisheries, and the main reason for current increased international concern regarding these fisheries.

- Bottom trawls conducted on hard ground areas supporting biogenic, habitat forming species will inevitably result in damage to such communities. Damage to such communities will be substantial in areas where fishing gear is towed in hard contact with the seabed. Very long recovery times for such communities mean that such impacts will be cumulative and enduring.

Extent: Site Specific	Duration: **Long**	*Intensity:* Low / Medium
Cumulative Impact: **Definite**	Overall Significance: **High**	

Extent – Site Specific. Bottom trawls will only damage benthic communities on the specific seabed areas actually contacted by the fishing gear, including any contact by trawl doors, sweeps, bridles, ground-gear and the net itself. For the average tow length of 10.8 km reported in 2002-2006 data, and a door spread of 200m, maximum area impacted would be ~2 km^2 per tow. Impacts of the footrope alone, or of shorter tows observed in 2007, would be about one tenth of this.

Duration – The species forming these VMEs have extremely slow growth and recovery rates, generally of the order of centuries to millennia. While some colonising species have been found to show recruitment within decades, the duration of substantial impacts to coral-dominated deepwater communities will certainly be Long.

Intensity – This will depend on spatial scale of the area fished in relation to the distributional ranges of the VME species concerned, and the intensity of trawling in fished areas. In lightly fished areas, impact intensity will be Low. In more heavily fished areas, impacts on specific, individual heavily trawled seamount features have probably been heavy, but such features are limited in extent. In comparison with the spatial extent of the ecosystems and habitats affected, overall impact may be Medium. Within the New Zealand trawl footprint, there are probably no areas which have been so heavily fished, at large spatial scale, that ecosystem processes are substantially altered across the spatial scale of the ecosystems concerned.

Cumulative Nature – Definite, given the very slow recovery times of these ecosystems.

Management & Mitigation – Active management and mitigation measure are required by the interim measures to protect areas of deepwater VMEs from impacts of trawling. Management measures implemented by New Zealand to prevent significant adverse impacts of bottom trawling include:

- Closure of all areas outside the trawl footprint, in terms of the SPRFMO interim measures.
- Stratification of the trawl footprint into lightly, moderately and heavily trawled areas.
- Closure of all lightly fished (essentially unfished and non-impacted) blocks to trawling.

- Closure of an additional 10% of footprint blocks, distributed across moderately and heavily trawled areas, to protect representative blocks in these areas. Seabed bathymetric data were used to select closures that are representative of open areas in terms of depth and large-scale topography.
- Implementation of a VME Evidence protocol, and associated move on rule, in all moderately fished blocks.

The trawling industry is continually improving gear designs, rigging and other operational measures to minimise unnecessary contact of the gear with the seabed, with increasing success. Ongoing improvement in these measures is likely to result from the strong economic incentives to increase gear efficiency and minimize gear damage, while still permitting good catch rates.

In the longer term, effective protection of deepwater VMEs is likely to require implementation of a series of large-scale spatial closures to protect adequate and representative areas of specific vulnerable ecosystems.

Monitoring – New Zealand commercial catch and effort return systems provide for the collection of information necessary to monitor and analyse intensity and spatial extent of seabed impact by these fisheries.

The 100% observer coverage of high seas bottom trawl fisheries, coupled with implementation of the new detailed Benthic Materials Form, and the rapid VME ID Protocol and Guide, is providing information to monitor and evaluate composition of benthic-bycatches retrieved in trawl tows. High levels of observer coverage are necessary to ensure that such data collection continues at adequate levels.

However, trawl nets remain poor tools to sample benthic materials, and much of the benthic material damaged, and perhaps even initially caught, by trawl nets is lost through the meshes, particularly the fragile and vulnerable cold water corals. Dedicated before/after or control/impact scientific surveys are probably the only way to reliably and quantitatively evaluate benthic impacts of deepwater trawling operations.

Impact of Bottom Line Fishing on VMEs

Description of Impact: Bottom line fishing operations make some catches of benthic organisms, including vulnerable hard corals, gorgonians and sponges.

- Bottom line operations can either catch benthic organisms directly on the fishing hooks, or may cause damage to benthic communities if lines are transversely pulled across the seabed by currents, or during hauling.

Extent: Site Specific	Duration: **Medium**	Intensity: **Low**
Cumulative Impact: **Possible**	Overall Significance: **Low / Medium**	

Extent – Seabed impacts will be limited to areas directly damaged by the fishing gear, including areas across which it may move during hauling. For the average of ~1000 hooks per bottom longline set over 2002 - 2006, with a hook spacing of 3m (for bluenose and hapuku targeted longlines) and assuming an impact of 1m either side of the line, even if the line was dragged its full length again, or double this width, during hauling, impacted area would be ~0.012 km^2, two orders of magnitude less than maximum impacts of an average trawl tow.

Duration – Given the low growth rates of the benthic organisms which may be impacted, a duration of Medium must be assumed. However, at the current low fishing effort levels and spatial scales in the SPRFMO Area, duration of impacts, at an ecosystem level, may well be Low. For the limited areas expected to be damaged by bottom lining, recolonisation from adjacent areas would be expected to be more rapid than for a larger impact area.

Intensity – Impact intensity is Low at current fishing effort levels and spatial scales.

Cumulative Nature – Possible, particularly in areas fished often enough that line damage may result in reduction in biodiversity.

Management & Mitigation – At current low levels and spatial scale of fishing effort, active management or mitigation measures are probably not necessary. However, fishing effort intensity and spatial scale, as well as benthic bycatch rates and composition, need to be monitored to ascertain whether effort or impacts rise to levels requiring active management. Should this occur, similar measures, including possible precautionary closures or move-on provisions, as implemented for bottom trawling, may be necessary.

Monitoring – New Zealand commercial catch and effort returns include start and end position for bottom longline operations, but end positions are not always provided. Start position only is probably adequate for dahn line fishing. However, both start and end positions are required for bottom longline and trot line fishing, to allow the spatial scale of fishing effort to be monitored and analysed.

Current low levels of observer coverage on high seas bottom line fishing vessels would need to be increased to provide adequate information on benthic bycatches, using the new Benthic Materials form, to monitor and evaluate composition of benthic bycatches by bottom lines.

8.1.2 Over-Exploitation of Low Productivity Deepwater Species

Over-Exploitation of Deepwater Trawled Species

Description of Impact: Species such as orange roughy, the primary target in the high seas bottom trawl fisheries, have low productivity as a result of slow growth rates and extreme longevity (low natural mortality). Annual sustainable yields of such species are typically extremely low. These species tend to form dense aggregations at particular times and areas, which are easily targeted.

- High catch rates on dense aggregations of deepwater species with very low productivity typically result in over-fishing which can lead to rapid depletion of accumulated stocks.
- Failure to detect such declines, and to implement low catch limits at long-term sustainable levels, have resulted in the over-exploitation and depletion of many of the world's stocks of species such as orange roughy.

Extent: Local / Regional	Duration: **Long**	*Intensity:* Medium / High
Cumulative Impact: **Definite**	Overall Significance: **High**	

Extent – Local / Regional, depending on the distribution ranges of the stocks or populations being fished. There is conflicting information for species such as orange roughy, indicating that such species may form separate stocks at very small scales, such as on individual seamounts, or alternatively may form local aggregations on such features, but be gradually supplemented from a diffuse distribution of fish from a larger surrounding area. It is likely that such species at least form separate stocks in areas of the spatial scale of the various fishing areas constituting the footprint.

Duration – Considering the very long life span and slow growth of these species, duration of the effects of any fishing mortality above replacement yields will be Long (decades to centuries).

Intensity – This will depend on the level of fishing mortality in relation to the sustainable yield levels for each stock. While this may be Medium for some moderately exploited areas, an intensity of High is assumed on the basis of experience of rapid depletions on some fishing areas .

Cumulative Nature – Definite, given the very low productivity of such species, over-fishing effects of fishing mortality levels that typically exceed long-term optimal exploitation levels of the order of $F = F_{msy}$ or $F = M$.

Management & Mitigation – The *FAO Deep-Sea Guidelines* (FAO 2008) specifically call for precautionary effort and spatial catch limits to prevent serial depletion of low productivity species, as well as processes to revise such limits downwards when significant declines are detected. They further note that '*for low-productivity species, fishing mortality should not exceed the estimated or inferred natural mortality*'. Current best estimate of natural mortality (*M*) for orange roughy is ~0.45 (Ministry of Fisheries 2008), indicating that exploitation rates should be less than 5%.

New Zealand intends to implement a catch limit for orange roughy set at the average annual catch level over the SPRFMO reference period 2002 - 2006, as required by paragraph one of the bottom fishing interim measures. Further work is being done to establish a basis for determining likely long-term sustainable catch levels of orange roughy in each area, based on information on species biology, standardised CPUE trends, niche-factor analysis and estimates of likely carrying capacity of seamount-type features. Such long-term sustainable limits are likely to be lower than average over 2002 – 2006 catches. However, effective implementation of limits at such levels will require international cooperation, coupled with effective monitoring and compliance, to ensure that catch limits apply to, and are respected by, all participants in SPRFMO bottom trawl fisheries.

Monitoring – New Zealand commercial catch return systems are already designed to collect the necessary high-resolution catch and effort data for such species.

Scientific observers on high seas bottom trawlers are also already required to monitor catch and effort for all target species, and to supplement this with length-frequency and biological sampling (gonad staging and otoliths). High levels of observer coverage are necessary to ensure that adequate data are collected to monitor inter-annual trends in these fisheries, to allow for the implementation of a process to revise catch limits downwards when significant declines are detected, as recommended by the FAO.

Over-Exploitation of Bottom Lined Species

Description of Impact: Bottom line fisheries primarily target hapuku / bass and bluenose, both of which are slow growing species:

- Hapuku are large, slow-growing and apparently fairly resident species that have been found to undergo moderately rapid localised depletions when targeted at moderate fishing effort levels.
- Bluenose have recently been found to be slow growing, although with somewhat higher productivity than species like orange roughy (Ministry of Fisheries 2008). Bluenose appear to be wider ranging than hapuku, but do form feeding or spawning aggregations on high profile seabed features as adults, which are targeted. There are indications that such aggregations may show CPUE hyper-stability, followed by sudden declines if heavily fished. All bluenose stocks within the New Zealand EEZ were recently assessed to have been over-exploited as a result.

Extent: **Regional**	Duration: **Medium**	Intensity: **Low**
Cumulative Impact: **Likely**	Overall Significance: **Low - Medium**	

Extent – Regional, as bottom line targeted species, particularly bluenose, appear to be wider ranging than species such as orange roughy. However, stocks are still likely to be largely confined to areas of the spatial scale of the fishing areas constituting the footprint, particularly for hapuku.

Duration – At current fishing effort and mortality levels, duration of impacts are likely to be Medium, despite the slow growth of these species. However, if exploitation rates increase to the level where fishing mortality exceeds sustainable levels and over-fishing occurs, duration of impacts may be Long.

Intensity – Low, at present, given the very low level of bottom line fishing effort in the SPRFMO Area. However, there are indications of increasing market demand, and resultant increasing fishing effort, for species such as bluenose

Cumulative Nature – Likely, considering the slow growth rates of these species, but this will depend on exploitation rates. Stock depletion will occur if fishing mortality exceeds long term sustainable levels.

Management & Mitigation – Current low effort and catch levels on the high seas probably do not require any active management or mitigation measures. Nonetheless, the FAO Deepwater Guidelines recommend the implementation of precautionary effort or catch limits for all low productivity deepwater species, set at levels likely to ensure long term sustainability. Current best estimate of natural mortality (*M*) for bluenose is ~0.8 (Ministry of Fisheries 2008), indicating that exploitation rates should not exceed 8%.

Should high seas bottom line fishing effort levels continue to increase to the level where fishing mortality exceeds this natural mortality, precautionary effort or catch limits would need to be established for the primary target species, such as bluenose and hapuku, in the main targeted fishing areas.

Monitoring – Existing commercial catch return systems are already specifically designed to collect the necessary high-resolution catch and effort data for such species. Scientific observers on high seas bottom liners are also already required to monitor catch and effort for all target species, and to supplement this with length-frequency and biological sampling (gonad staging and otoliths). Observer coverage levels would need to be increased to ensure that adequate data are collected to monitor inter-annual trends in these fisheries, to allow for the implementation of a process to revise catch limits downwards when significant declines are detected, as recommended by the FAO.

8.1.3 Incidental Mortality of Deepwater Elasmobranchs

Incidental Trawl Mortality of Elasmobranchs

D*escription of Impact:* All trawl fisheries make catches of elasmobranch species (sharks, skates and rays), many of which are unmarketable, and usually discarded. All elasmobranch species have low fecundity and many have slow growth rates, particularly deepwater elasmobranchs. Populations of these species therefore typically have very low productivity.

- As many elasmobranchs caught incidentally in trawls are discarded, they are usually not reflected on catch returns. Estimates of elasmobranch bycatches are therefore usually poor, making evaluation of impacts difficult.

Extent: Local / Regional	*Duration:* Medium / Long	*Intensity:* Low / Medium
Cumulative Impact: **Possible**	Overall Significance: **Medium**	

Extent – Depending on the residency, migratory behaviour and distribution ranges of the species caught, the species may be locally or regionally distributed. It is likely that elasmobranchs caught at the depths of these fisheries at least form separate regional populations in each of the fishing areas, separated by abyssal plains between such areas.

Duration – Given the slow growth rates and low productivity of these species, any significant fishing-related reduction in the populations would certainly take many years, and possibly decades, to rebuild.

Intensity – Low / Medium. Although bycatches of such species are relatively low, in the absence of better information on elasmobranch population sizes and actual catches, and resultant fishing mortality rates in relation to population sizes, a precautionary intensity of Medium should be allowed for. Improved information on population distribution ranges and bycatch rates may confirm the intensity to be Low, if adequate areas supporting populations of these species remain largely unfished.

Cumulative Nature – Possible, given the slow growth rates, low productivity and potentially long recovery times of such populations. Fishing mortality rates which exceed long term sustainable levels will result in depletion of the populations.

Management & Mitigation – Given the poor knowledge of total catches, distributional ranges, productivity and stock status of most deepwater elasmobranchs, it is difficult to propose sensible and effective mitigation measures, other than closure of fisheries. In the long term, such species could best be protected in specific areas as a consequence of large-scale and representative closures of certain deepwater habitats to protect VMEs, with consequential protection of elasmobranchs inhabiting these areas.

Monitoring – Commercial fishers typically do not report minor catches of these species on catch returns, particularly if these are discarded. It is unlikely that catch return systems could efficiently be modified to ensure reporting of all such catches.

Observers on high seas bottom trawlers are already required to document all catches of all species, and this is the best source of data on elasmobranch catches. High levels of observer coverage should be maintained on high seas bottom trawlers, and observers should specifically document discards of such species, to enable subsequent raised estimate of elasmobranch discards using commercial catch return data.

8.1.4 Loss of Fishing Gear

Loss of Bottom Trawl Fishing Gear

Description of Impact: Bottom trawling operations targeting species such as orange roughy on rough ground have a definite risk of losing fishing gear as a result of coming fast on the seabed.

- As nets are the primary fishing component of the gear contacting the seabed, greatest risk is damage to nets, and loss of net components, ranging from the codend to entire nets.
- In circumstances where trawl doors hook up on the seabed, gear losses may include sweeps, doors, and perhaps even trawl warps themselves.

Extent: Site Specific	*Duration:* Low / Medium	Intensity: **Low**
Cumulative Impact: **Unlikely**	Overall Significance: **Low**	

Extent – Site Specific, as lost trawl gear will remain on the seabed where it was lost, unless retrieved.

Duration – Low / Medium. Duration of impact on fish stocks will be Low, as lost trawl gear is not considered to ghost fish. Impact on biodiversity may be Medium as, at the depths of these high seas fishing operations, growth and recovery of biogenic benthic communities is slow and it is likely to take years to decades for lost gear to become covered with benthic growth, and integral with the seabed communities. However, such 'recovery' is likely to occur.

Intensity – Low, given the effort that operators put into minimising gear loss, and attempting to retrieve significant gear losses (nets, warps or doors). The combination of these efforts, plus increasing knowledge of seabed characteristics in currently fished areas, has resulted in decrease in gear losses. Certain experienced skippers have never lost gear, and most will spend time attempting to retrieve any substantial gear losses.

Cumulative Nature – Unlikely, given the combination of relatively low gear losses and the low likelihood of ghost fishing or subsequent impact on the seabed.

Management & Mitigation – Industry are continually improving gear design, rigging and operational measures to minimise gear losses. Given the substantial financial cost of any gear loss, and the strong incentives to minimise this, responsibility for mitigation of gear loss within currently fished areas should be left to industry.

The situation in exploratory fisheries is likely to be different. With little knowledge of seabed characteristics in new areas, the risk of gear loss increases. However, this risk is being increasingly reduced by improved seabed mapping and sonar technology, allowing new areas to be fished with reduced risk of gear loss.

Monitoring – Scientific observers on high seas bottom trawling vessels are not currently required to formally document type and quantity of gear loss, although some do record such events in daily logs. Observers should be required to document all significant (to be defined) gear losses in a way that permits GIS plotting of such positions, and analysis of gear losses.

Options should also be investigated for industry to similarly record gear losses. Industry reports that most skippers already record such positions as areas to be avoided during future fishing operations. This would be particularly important for any exploratory fisheries in new fishing areas.

Loss of Bottom Line Fishing Gear

Description of Impact: Bottom line fishing operations targeting species such as bluenose and hapuku / bass intentionally target areas of steep, high profile, rocky seabed, usually also under conditions of current across these features. There is an inevitable risk of gear loss in such areas:

- Greatest risk is loss of weights and anchors, and gear may be rigged with weak links to such gear to prevent loss of fishing components and catch, should anchors stick fast. This would be particularly relevant to dahn line and trot line gear, where the fishing components are suspended above the seabed. Lost anchors pose little ongoing threat to the seabed.
- For bottom longline gear, particularly using bottom main lines with integrated weighted cores, there is a significant risk of sections of bottom line plus snoods being lost. This may be of concern, should such gear continue to ghost fish for any appreciable length of time.

Extent: Site Specific	Duration: **Medium**	Intensity: **Low**
Cumulative Impact: **Unlikely / Possible**	Overall Significance: **Low**	

Extent – Usually Site Specific, as weighted lost gear will remain at the site at which it was lost. There is some risk of loss of floating components which may then drift away from the fished area. These pose no threat to the seabed, but may be of concern if they ghost fish for any appreciable length of time.

Duration –Medium: at the depths of these high seas fishing operations, growth and recovery of biogenic benthic communities is slow, and it is likely to take years to decades for lost gear to become covered with benthic growth, and integral with the seabed communities. However, such ‘recovery’ is likely to occur.

Intensity – Low, if there is little or no risk of ghost fishing by lost gear, but medium if gear may continue to fish for any length of time. Risk of ghost fishing may be low if the gear ceases to become effective once baits have been removed, or decayed away.

Cumulative Nature – Unlikely / Possible, but only if gear continues to ghost fish for any appreciable length of time, exceeding months. More information is required on the likelihood of ghost fishing by various bottom line fishing gears.

Management & Mitigation – Economic costs of gear loss in the bottom line fisheries are lower than in trawl fisheries and, while some incentive clearly remains, there is less economic incentive for industry to minimise gear loss. Industry should be consulted on the extent of gear loss and options for improving gear design and deployment to minimise gear loss (for example, by incorporating sacrificial components), and particularly for minimising the risk of ghost fishing by lost gear.

Monitoring – Scientific observers on high seas bottom lining vessels are not currently required to formally document type and quantity of gear loss, although some do record such events in daily logs. Observers should be required to document all significant (to be defined) gear losses in a way that permits GIS plotting of such positions, and analysis of gear losses.
Options should also be investigated for industry to similarly record gear losses. Industry reports that most skippers already record such positions as areas to be avoided during future fishing operations. This would be particularly important for any exploratory fisheries in new fishing areas.

8.1.5 Seabird Injuries and Mortalities

Trawl Induced Mortality of Seabirds		
Description of Impact: High seas bottom trawling operations targeting species, such as orange roughy may have the following impacts on seabirds: • Mortality via net or trawl warps captures. • Injury and/or mortality of seabirds as a result of warp-strikes during trawl tows.		
Extent: **Oceanic**	Duration: **Medium**	Intensity: **Low**
Cumulative Impact: **Unlikely**	Overall Significance: **Low**	
Extent – Oceanic due to the migratory nature of many seabirds. For example, Chatham albatross are known to cross the Southern Pacific to feed along the coast of Peru and Chile and return to breed on a small rock island south of the Chatham Islands. *Duration* – Given a low intensity of impact (below), the duration of the impact is likely to be Medium, between age at first maturity (up to ten years for albatross species) and the lifespan (up to fifty years or more for some species). *Intensity* – Low. Trawling for orange roughy fishing within the New Zealand EEZ has been observed to have low bycatch rates of seabirds. The rate of seabirds captures since 2000-01 has been between 0.04 and 0.39 birds per hundred tows except in 2004-05 when 14 Cape petrels were observed caught thereby increasing the bycatch rate to 1.21 birds per hundred tows (Baird & Smith 2007, 2008).If the seabirds are captured during their breeding phase, the capture will result in the death of their chick and in rare cases their mate as well. If the mate survives the wait on the nest for the captured bird, they may not breed in the following season, as many seabirds mate with the same partner for long periods, although there are cases of ‘divorce’. *Cumulative Nature* – Unlikely, given the low mortality rates in these fisheries. As some threatened seabirds species, including Northern royal albatross (considered Endangered by IUCN), Salvin’s albatross (Vulnerable), and Wandering albatross (Vulnerable), are caught by deepwater trawling there may be a cumulative impact at the population or species level, if taken together with the cumulative impacts of all bycatch from fisheries that catch individuals from that population/species.		
Management & Mitigation – While the overall significance is rated as Low, improved estimates of bycatch rates on the high seas and knowledge of the current industry practices and mitigation measures are necessary. This may consequently warrant consideration of mandatory management measures such as those required for vessels fishing inside the New Zealand EEZ eg, use of paired tori lines, bafflers or warp scarers and/or the reduction or elimination of offal discharge during certain fishing operations, for instance shoot, trawl and haul. It should also be noted that the species caught by bottom longline vessels within the New Zealand 2002-2006 footprint in SPRFMO may vary from that caught within the New Zealand EEZ due to the change in location and distance from shore. *Monitoring* – The 100% observer coverage of high seas bottom trawl fisheries, enables the observation of all hauls for seabird captures, as well as warp strike observations. Observers will also record the implementation seabird avoidance measures. With permission from the Department of Conservation where required, observers should return carcasses of any bird mortalities for necropsy and confirmation of species identification. Observers will also record the implementation of seabird avoidance.		

Line Fishing Induced Mortality of Seabirds
Description of Impact: High-seas bottom line fishing, primarily using bottom longlines, targeting species such as bluenose and hapuku / bass in the fishing areas within the new Zealand 2002 - 2006 bottom fishing footprint may have the following impacts on seabirds: • Capture, injury and/or mortality of seabirds taking baits during setting and hauling of longlines.

Extent: **Oceanic**	Duration: **Medium**	*Intensity:* Medium / High
Cumulative Impact: **Possible**	Overall Significance: **Medium / High**	

Extent – Oceanic due to the migratory nature of many seabirds. For example, Chatham albatross are known to cross the Southern Pacific to feed along the coast of Peru and Chile and return to breed on a small rock island, 'The Pyramid', south of the Chatham Islands.

Duration – Even at a medium to high intensity of impact (below), the duration of the impact is likely to be medium, between the age at first maturity (up to ten years for albatross species) and the lifespan (up to fifty years or more for some species).

Intensity – Medium to High. Dependent on the fishing gear configuration and setting techniques used, bottom longlining for bluenose and hapuku / bass can pose medium to high risk in terms of the intensity of seabird mortalities. Within the New Zealand EEZ, an incident was observed in 2007 when 10 Chatham albatross and 22 Salvin's albatross were caught by a bottom longline vessel while targeting bluenose and ling on the Chatham Rise.

If the seabirds are captured during their breeding phase, the capture will result in the death of their chick and in rare cases their mate as well. If the mate survives the wait on the nest for the captured bird, they may not breed in the following season, as many seabirds mate with the same partner for long periods, although there are cases of 'divorce'.

Cumulative Nature - Possible. As some threatened seabirds species, including Chatham albatross (considered Critically Endangered by IUCN), black petrel (Vulnerable), Salvin's albatross (Vulnerable) and Wandering albatross (Vulnerable), are caught by bottom longlining within the New Zealand EEZ targeting ling, bluenose and häpuku (Rowe 2008), there may be a cumulative impact at the population or species level. However, impact at the population or species level would include the cumulative impacts of all bycatch from fisheries that catch individuals from that population/species.

Note that the species caught by bottom longline vessels within the New Zealand 2002-2006 footprint in SPRFMO may vary from that caught within the New Zealand EEZ due to the change in location and distance from shore.

Management & Mitigation – Given the status of some seabird species and the overall significance rating of Medium/High, improved estimates of bycatch rates on the high seas and knowledge of current industry fishing practices and mitigation measures are necessary. This may consequently warrant consideration of mandatory management measures such as those required for vessels fishing inside the New Zealand EEZ eg, use of streamer lines, restrictions on setting times, and/or offal discharge requirements.

Monitoring – When in place, the 10% observer coverage on bottom longliners will enable the observation of a proportion of hooks retrieved for seabird captures. This will allow for an extrapolation of total seabird bycatch (although this extrapolation is likely to be reasonably uncertain) for the fishery and consideration of the impact of this bycatch on the population/species affected.

With permission from the Department of Conservation, observers should return carcasses of any bird mortalities for necropsy and confirmation of species identification. Observers will also record the implementation of seabird avoidance.

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10. Appendices

Appendix A. Details of New Zealand vessels issued with high seas permits during 2008/09.

Appendix B. Examples of commercial catch and effort returns and observer data collection forms used to monitor New Zealand high seas fisheries.

Appendix C. VME identification Form and associated VME Species Identification Guide implemented on New Zealand high seas bottom trawlers.

Appendix D. Record of stakeholder consultations conducted in preparation of this assessment.

10.1 Appendix A. Details of New Zealand vessels issued with high seas permits during 2008/09.

(Bolded vessels are those that conducted bottom trawling operations in the SPRFMO Area to date of this assessment.)

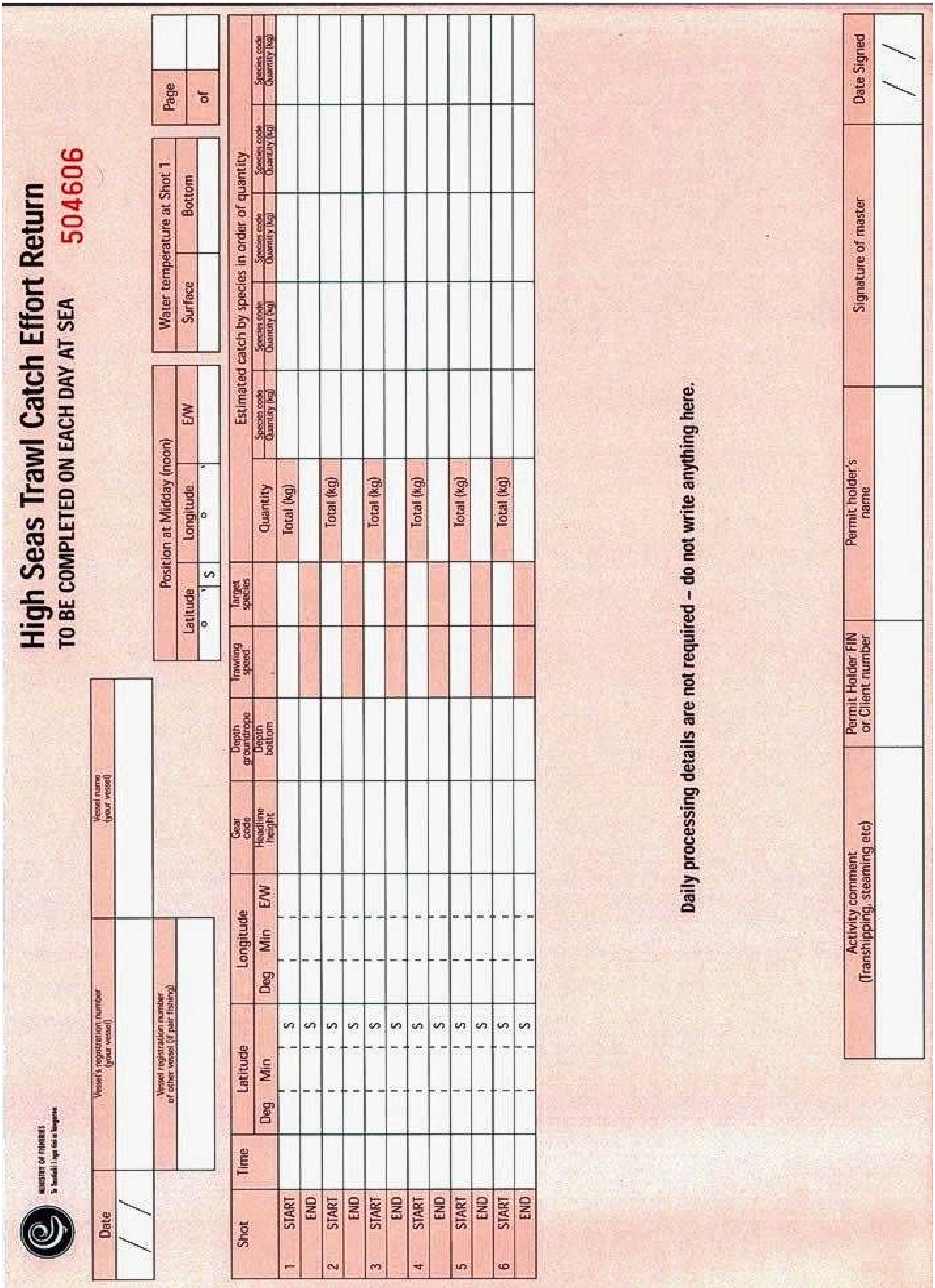
Vessel Name	Callsign	Lloyds IMO	Fishing Methods	Freezer / Iceboat	Year Built	Overall Length (m)	Moulded Depth (m)	Beam (m)	Gross Tonnes	Engine Kilowatts	Holds (m^3)
Amaltal Mariner	**ZMAM**	**9132466**	**Pair bottom trawl; Bottom trawl; Pair midwater trawl; Midwater trawls**	**Iceboat**	**1996**	**37.0**		**9.6**	**498**	**1,470**	**380**
Ocean Pioneer	**ZM2582**	**9100750**	**Pair bottom trawls; Non-specified bottom trawls; Non-specified midwater trawls; Mechanised handlines and pole-lines; Non-specified long lines; Trolling lines**	**Iceboat**	**1994**	**32.7**		**8.5**	**317**	**690**	**210**
Seamount Explorer	**ZMOI**		**Bottom trawl; Midwater trawl**	**Iceboat**	**1987**	**43.7**		**11**	**671**	**1,620**	**200**
Tasman Viking	**ZMDM**	**8706480**	**Bottom trawl; Midwater trawl; Set longlines**	**Iceboat**	**1989**	**36.6**		**8.2**	**372**	**1,006**	**240**
Altair III	ZM2750		Pots, non-specified traps; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Iceboat	1992	18.3	9.0	4.8	98	235	60
Amaltal Explorer	ZMTZ	8610805	Pair bottom trawl; Bottom trawl; Pair midwater trawl; Midwater trawls	Freezer	1986	65.7		12.0	136	1,350	26,401
Antonio Z	ZM2169		Purse seine nets; Mechanised handlines and pole lines; Set longlines; Trolling lines; Pots	Iceboat	1991	25.4	3.4	6.4	117	107	100
Captain M J Souza	ZMAS	7823396	Purse seine nets	Freezer	1979	68.1	5.6	12.8	1,468	3,600	4,179
Chatham Explorer	ZMCE	8870736	Pots	Freezer	1980	34.4		6.2	119	620	90
Daniel Solander	ZMCH	7354773	Mechanised handlines and pole lines; Set longlines; Trolling lines	Freezer	1973	53.6	3.8	8.5	345	970	447
Galatea II	ZMZK	7816197	Bottom trawl; Midwater trawl; Set longlines	Iceboat	1979	26.0	3.5	7.2	157	383	130

Jennifer	ZM7970		Non-specified bottom trawls; Boat dredges; Pots, non-specified traps; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Iceboat	1972	19.1	3.0	5.4	71	186	35
Medea	ZMA4402		Pots and non-specified traps; Mechanised handlines and pole lines; Set longlines; Trolling lines	Iceboat	1987	18.0		5.0	40	254	20
Ocean Breeze	ZMOB	6717801	Purse seine nets	Freezer	1967	61.0	8.8	12.0	1,355	3,070	1,142
Ocean Ranger	ZMOR	8615851	Bottom trawl; Midwater trawl	Freezer	1987	42.7		9.0	335	1,080	150
Otakou	ZMOK	8803721	Pair bottom trawls; Non-specified bottom trawls; Pair midwater trawls; Non-specified midwater trawls	Iceboat	1989	42.0		11.0	799	1,875	130
Petersen	ZMRG	7810193	Bottom trawl; Midwater trawl	Freezer	1979	44.0		9.0	650	1,104	300
Rehua	ZMRE	9147784	Pair bottom trawls; Non-specified bottom trawls; Pair midwater trawls; Non-specified midwater trawls	Freezer	1997	66.0		14.0	2,483	3,530	1,000
San Nanumea	ZMSN	8102866	Purse-seine and Danish-seine nets; Pair bottom trawls; Pair midwater trawls; Mechanised handlines and pole lines; Set longlines; Trolling lines; Dredges, pots and traps	Freezer	1982	76.8	8.3	12.5	1,678	2,684	1,592
San Nikunau	ZMNK	8131441	Purse-seine and Danish-seine nets; Pair bottom trawls; Pair midwater trawls; Mechanised handlines and pole lines; Set longlines; Trolling lines; Dredges, pots and traps	Freezer	1991	79.7	5.9	12.9	1,957	2,982	1,724
San Rakaia	ZMA3228	9149926	Purse-seine and Danish-seine nets; Pair bottom trawls; Pair midwater trawls; Mechanised handlines and pole lines; Set longlines; Trolling lines; Dredges; pots and traps	Iceboat	1997	32.0		10.0	498	1,051	330
San Waitaki	ZMA3176	8901468	Purse-seine and Danish-seine nets; Pair bottom trawls; Pair midwater trawls; Mechanised handlines and pole lines; Set longlines; Trolling lines; Dredges, pots and traps	Freezer	1991	64.1	8.9	13.0	1,899	3,342	1,118

Santa Maria	ZM2781		Set gillnets (anchored); Pots; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Iceboat	1983	16.0	4.3	5.5	72	250	32
Sapphire	ZM6339		Boat dredges; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Iceboat	1972	14.8	2.4	4.4	40	127	16
Sea Maru	ZMA2591		Long lines	Iceboat	1976	27.0	2.3	5.5	98	447	56
Stella B	ZM2766		Danish Seines; set gillnets (anchored); pots; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Iceboat	1984	19.1	2.7	6.1	120	297	40
Stromboli	ZM7048	8881890	Bottom trawls; Mechanised handlines and pole lines; Set longlines; Trolling lines; Pots	Iceboat	1990	25.3	3.1	7.2	185	248	160
Taimania	ZMTI	8803733	Pair bottom trawls; Non-specified bottom trawls; Pair midwater trawls; Non-specified midwater trawls	Iceboat	1989	42.0		11.0	799	1,875	130
Tangaroa	ZMFR	9011571	Pair bottom trawls; Non-specified bottom trawls; Boat dredges; Non-specified lift nets; Set gillnets (anchored); Encircling gill nets; Non-specifed traps; Mechanised handlines and pole lines; Set longlines; Non-specified longlines; Trolling lines; Nonspecified hooks and lines; Miscellaneous gear	Research vessel	1991	70.0		13.8	2,282	4,023	400
Thomas Harrison	ZMTH	8611324	Pair bottom trawls; Non-specified bottom trawls; Pair midwater trawls; Non-specified midwater trawls	Freezer	1989	42.5		12.0	1,048	1,776	300

10.2 Appendix B. Examples of commercial catch and effort returns and observer data collection forms used to monitor New Zealand high seas fisheries.

- ***Commercial High Seas Trawl Catch Effort Return (HSTCER)***



High Seas Trawl Catch Effort Return

TO BE COMPLETED ON EACH DAY AT SEA 504606

Date	Vessel's registration number (your vessel)	Vessel name (your vessel)
/ /		

Vessel registration number of other vessel (if pair fishing)

Position at Midday (noon)		
Latitude	Longitude	E/W
° ' S	° '	

Water temperature at Shot 1	
Surface	Bottom

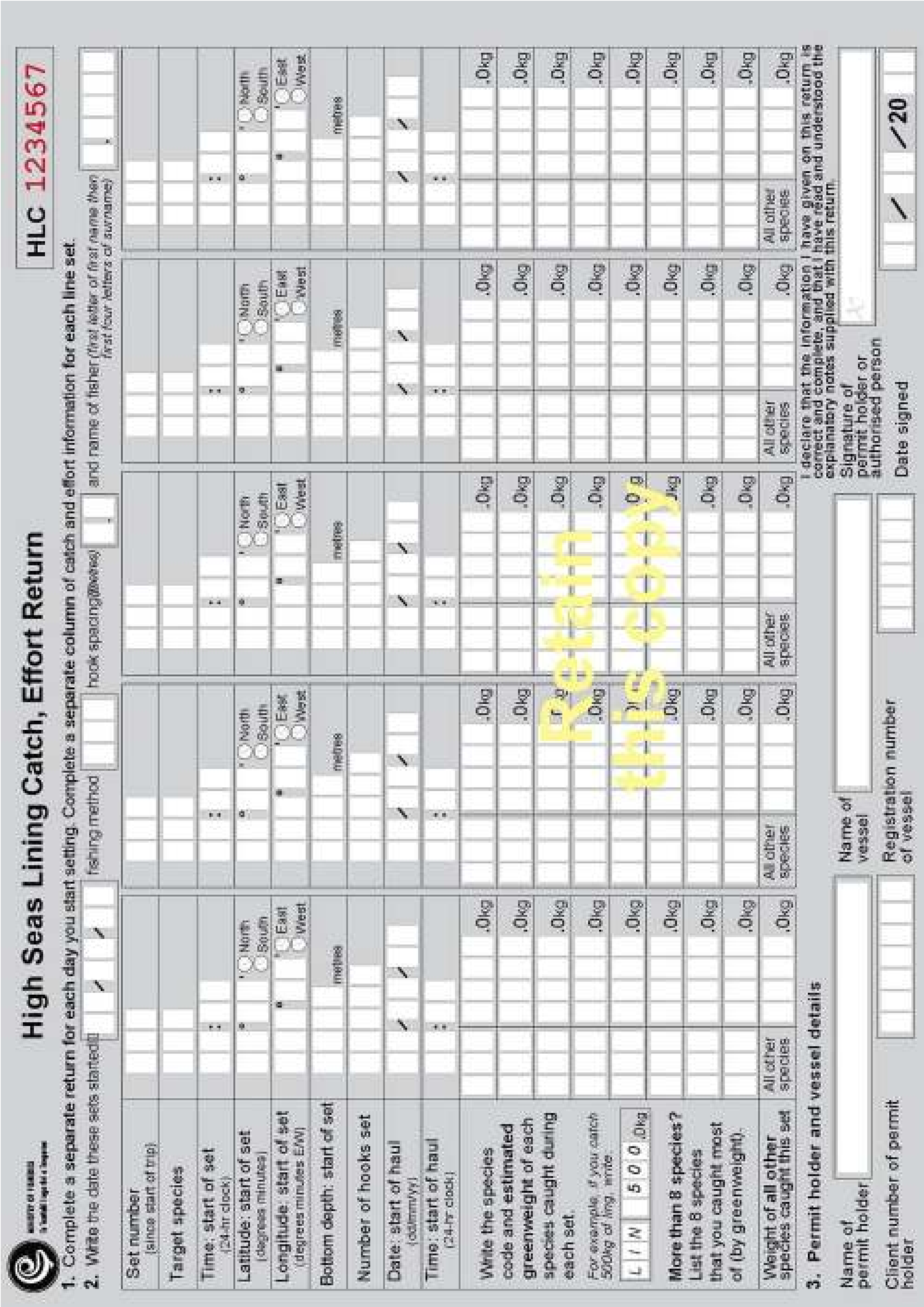
Page of

Shot		Time	Latitude Deg	Latitude Min		Longitude Deg	Longitude Min	Longitude E/W	Gear code / Headline height	Depth groundrope / Depth bottom	Trawling speed	Target species	Quantity	Estimated catch by species in order of quantity					
														Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)
1	START				S								Total (kg)						
	END				S														
2	START				S								Total (kg)						
	END				S														
3	START				S								Total (kg)						
	END				S														
4	START				S								Total (kg)						
	END				S														
5	START				S								Total (kg)						
	END				S														
6	START				S								Total (kg)						
	END				S														

Daily processing details are not required – do not write anything here.

Activity comment (Transhipping, steaming etc)	Permit Holder FIN or Client number	Permit holder's name	Signature of master	Date Signed
				/ /

- ***Commercial High Seas Lining Catch Effort Return (HLCER)***



HLC 1234567

High Seas Lining Catch, Effort Return

1. Complete a separate return for each day you start setting. Complete a separate column of catch and effort information for each line set.
2. Write the date these sets started / / fishing method hook spacing (metres) and name of fisher (first letter of first name then first four letters of surname)

Set number (since start of trip)

Target species

Time: start of set (24-hr clock)

Latitude: start of set (degrees minutes) North South

Longitude: start of set (degrees minutes E/W) East West

Bottom depth: start of set metres

Number of hooks set

Date: start of haul (dd/mm/yy)

Time: start of haul (24-hr clock)

Write the species code and estimated greenweight of each species caught during each set. .0kg

For example, if you catch 500kg of ling, write L I N 5 0 0 .0kg

More than 8 species? List the 8 species that you caught most of (by greenweight).

Weight of all other species caught this set — All other species .0kg

3. Permit holder and vessel details

Name of permit holder

Client number of permit holder

Name of vessel

Registration number of vessel

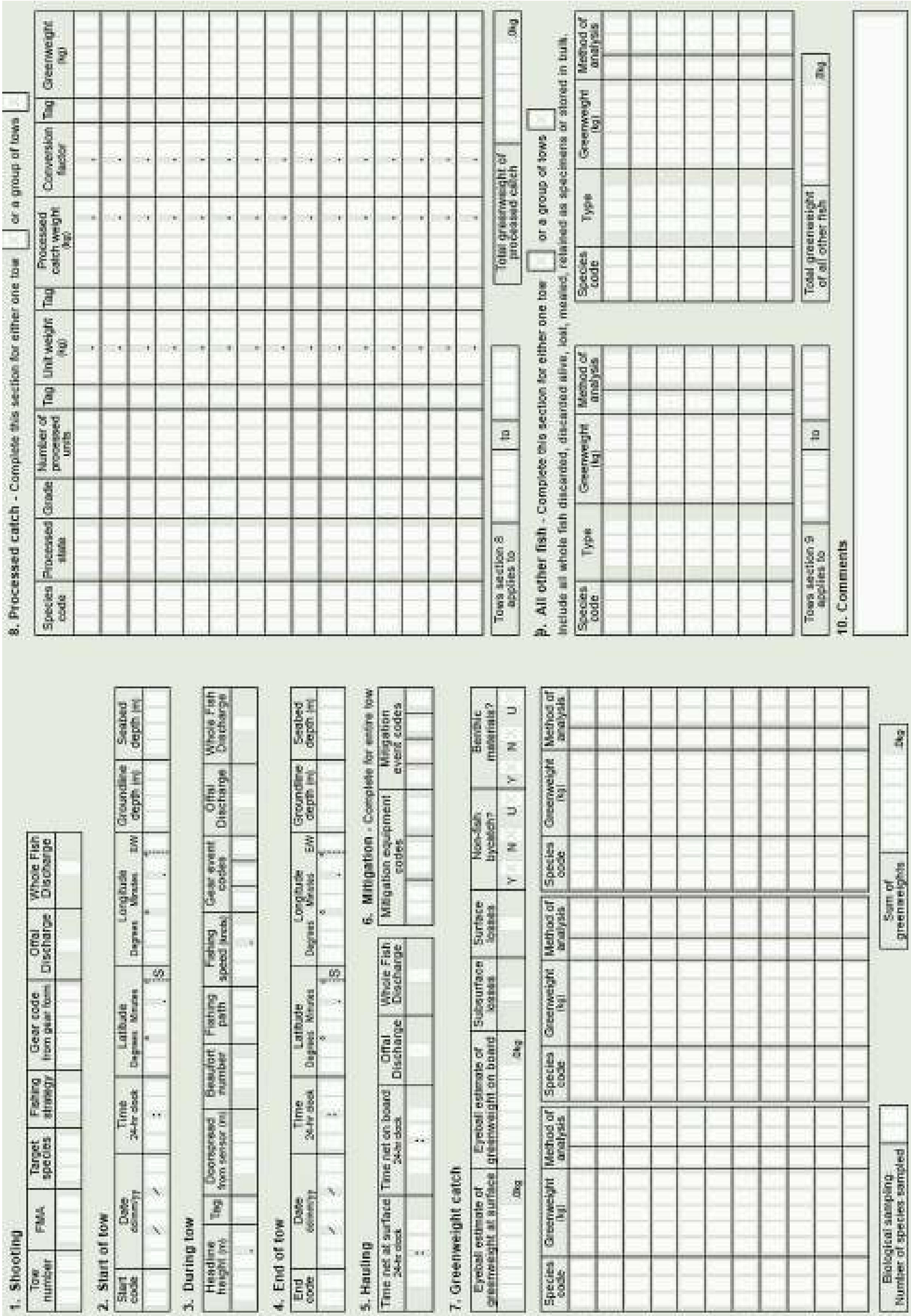
I declare that the information I have given on this return is correct and complete, and that I have read and understood the explanatory notes supplied with this return.

Signature of permit holder or authorised person

Date signed / /20

Retain this copy

- ***Observer Trawl catch Effort Logbook***



1. Shooting

Tow number	FMA	Target species	Fishing strategy	Gear code from gear form	Offal Discharge	Whole Fish Discharge

2. Start of tow

Start code	Date dd/mm/yy	Time 24-hr clock	Latitude Degrees Minutes	Longitude Degrees Minutes E/W	Groundline depth (m)	Seabed depth (m)
	/ /	:	° . ' S	° . '		

3. During tow

Headline height (m)	Tag	Doorspread from sensor (m)	Beaufort number	Fishing path	Fishing speed (knots)	Gear event codes	Offal Discharge	Whole Fish Discharge
.					.			

4. End of tow

End code	Date dd/mm/yy	Time 24-hr clock	Latitude Degrees Minutes	Longitude Degrees Minutes E/W	Groundline depth (m)	Seabed depth (m)
	/ /	:	° . ' S	° . '		

5. Hauling

Time net at surface 24-hr clock	Time net on board 24-hr clock	Offal Discharge	Whole Fish Discharge
:	:		

6. Mitigation - Complete for entire tow

Mitigation equipment codes	Mitigation event codes

7. Greenweight catch

Eyeball estimate of greenweight at surface	Eyeball estimate of greenweight on board	Subsurface losses	Surface losses	Non-fish bycatch?	Benthic materials?
.0kg	.0kg			Y N U	Y N U

Species code	Greenweight (kg)	Method of analysis	Species code	Greenweight (kg)	Method of analysis	Species code	Greenweight (kg)	Method of analysis

Biological sampling Number of species sampled [ ] Sum of greenweights [.0kg]

8. Processed catch - Complete this section for either one tow [ ] or a group of tows [ ]

Species code	Processed state	Grade	Number of processed units	Tag	Unit weight (kg)	Tag	Processed catch weight (kg)	Conversion factor	Tag	Greenweight (kg)
					.		.	.		

Tows section 8 applies to [ ] to [ ] Total greenweight of processed catch [.0kg]

9. All other fish - Complete this section for either one tow [ ] or a group of tows [ ]

Include all whole fish discarded, discarded alive, lost, mealed, retained as specimens or stored in bulk.

Species code	Type	Greenweight (kg)	Method of analysis	Species code	Type	Greenweight (kg)	Method of analysis

Tows section 9 applies to [ ] to [ ] Total greenweight of all other fish [.0kg]

10. Comments

- ***Observer Benthic Materials Form***

Observer Benthic Materials Form (Version 1 - October 2007)

1. Benthic Material includes all **Non-targeted** marine invertebrates, marine plants and/or structures that are connected with the seafloor. You should complete a **separate row** for each individual identifiable item.

2. Write the trip number [ ] and Observer code/s (*first letter of first name then first three letters of surname*) [ ] and [ ]

Sample number	Tow/Set number	MFish code	End Type	Weight (kg)	Method of analysis	Life status	Links	Quantity (code)	Number (optional)	Comments
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						
B				.						

3. This form is page number [ ] for this trip. Is this form the last page for this trip? → Yes [ ] No [ ]

10.3 Appendix C. VME Identification Form and associated VME Species Identification Guide implemented on New Zealand high seas bottom trawlers

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 gear commenced

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

3. Instructions

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

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

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

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

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

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		

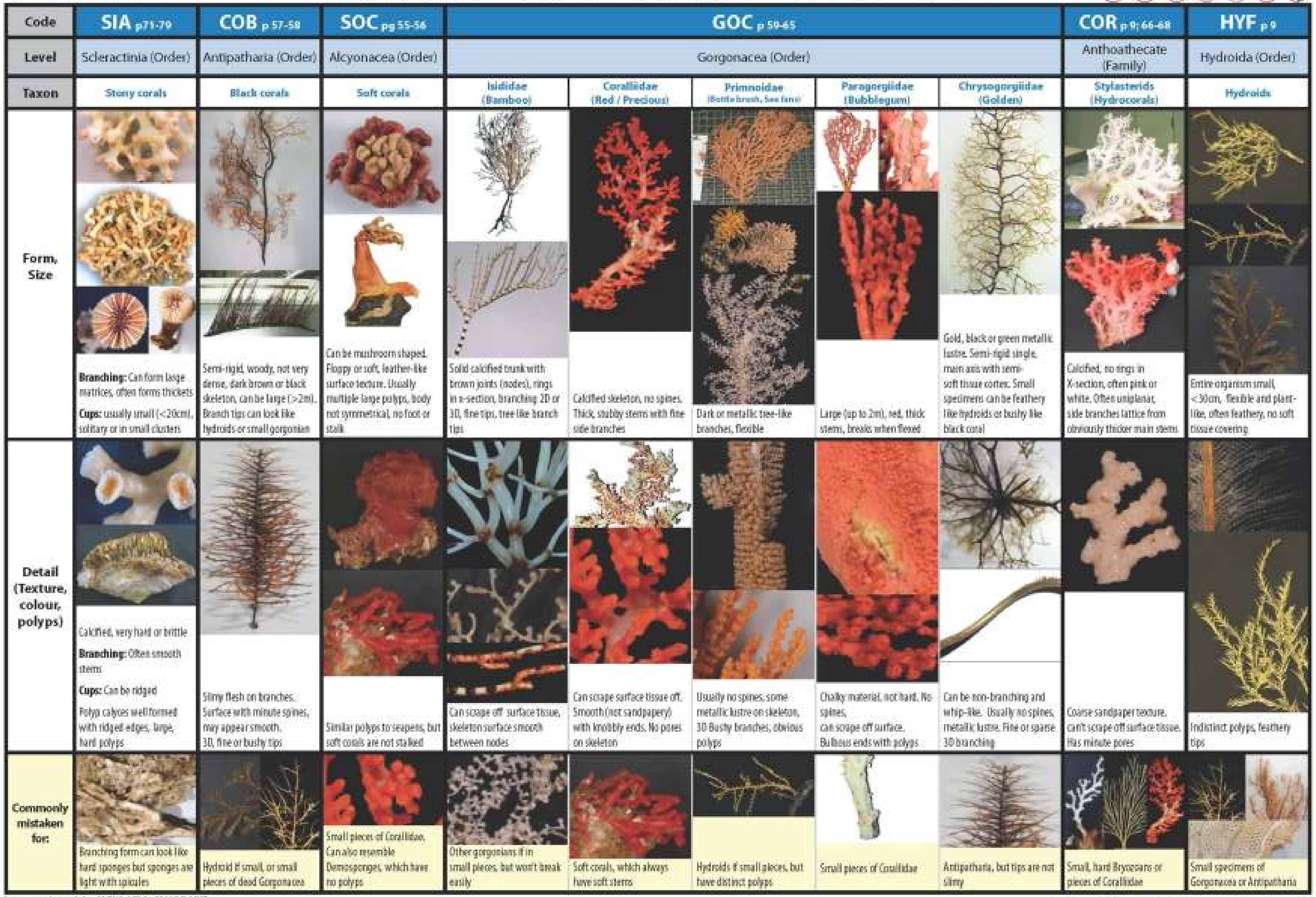
Sum these scores + Count these ticks

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)
		/ /	:



Classification guide for potentially vulnerable invertebrate taxa in the SPRFMO Area

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 Coralliidae. 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 Coralliidae	Antipatharia, but tips are not slimy	Small, hard Bryozoans or pieces of Coralliidae	Small specimens of Gorgonacea or Antipatharia

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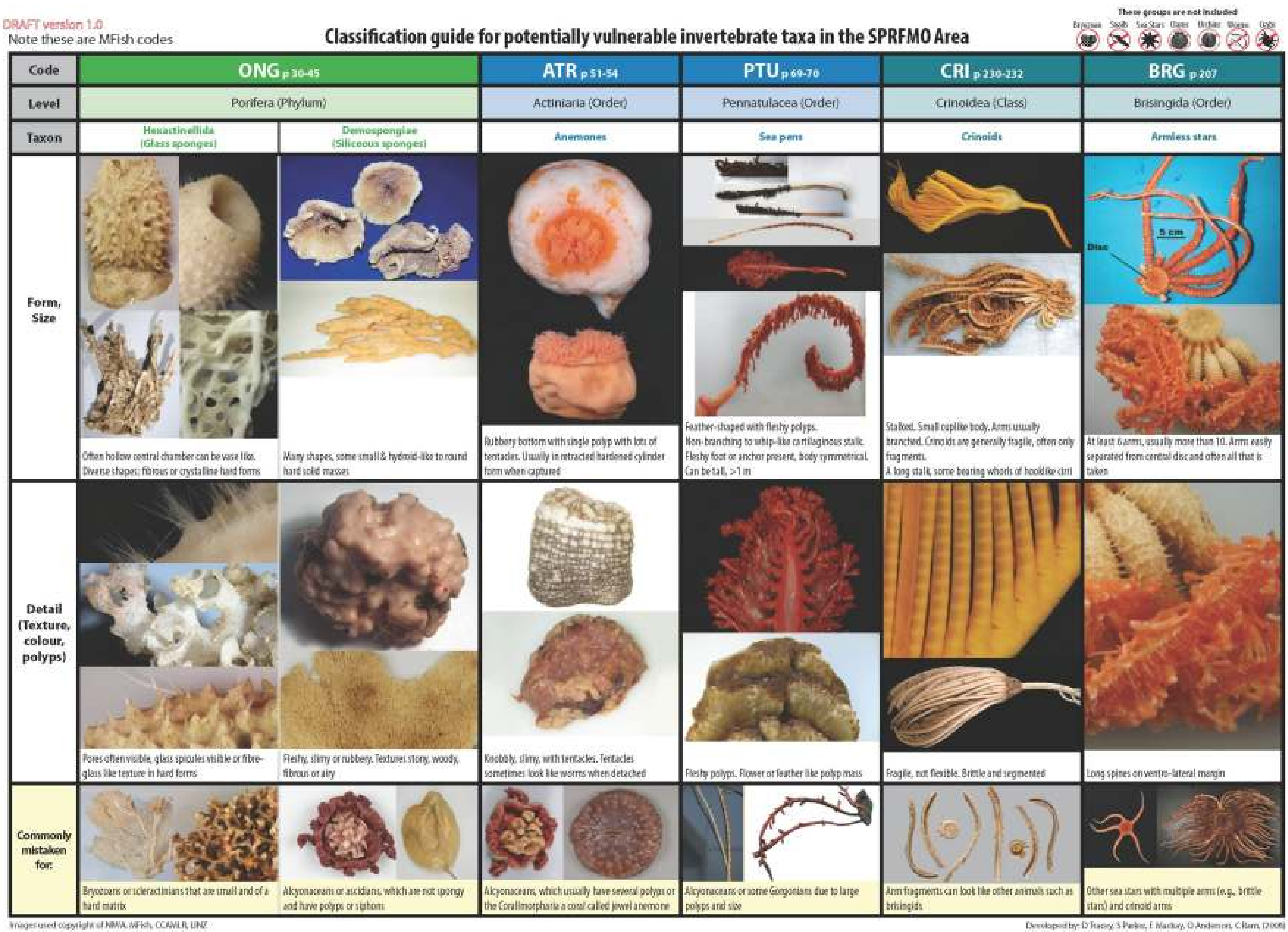
Developed by: D Tracey, S Parker, E Mackay, O Anderson, C Ramm (2008)


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
Code
Level
Taxon
ONG p 30-45
Porifera (Phylum)
Hexactinellida (Glass sponges)
Demospongiae (Siliceous sponges)
ATR p 51-54
Actiniaria (Order)
Anemones
PTU p 69-70
Pennatulacea (Order)
Sea pens
CRI p 230-232
Crinoidea (Class)
Crinoids
BRG p 207
Brisingida (Order)
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
Disc
5 cm
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 Corallimorpharia 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
Images used copyright of NIWA, MFish, CCAMLR, LINZ
Developed by: D Tracey, S Parker, E Mackay, O Anderson, C Ram, (2008)

10.4 Appendix D. Record of stakeholder consultations held in preparation of this assessment

Date	Type of Consultation	Purpose	Participants	Issues Raised
07/07/2007	Letter	Notification of NZ's obligation to implement the SPRFMO Interim Measures and the initiation of a consultation process	Letter from Minister to industry: All HSFP Holders + Seafic	• Details of interim measures • Changes to high seas bottom trawling forthcoming • Officials to consult stakeholders
20/07/2007	Letter	Begin consultation on interim measures implementation	Letter from MFish to industry: All HSFP Holders + Seafic	• Details of consultation process
30/07/2007	Meeting, MFish, Wellington	Start of consultation process: • Introduction of interim measures • Update on NZ science work • Compilation of catch and effort data • Mapping of VMEs • Development of benthic assessment standard • Discussion of options for managing bottom trawling from 30 Sep 07 – 1 April 08	Industry: Seafic, Sealord, Endurance Fishing, Richardson Fishing, Pursuit Fishing, Crusader Fishing	• Questioned whether other States will be operating within their national footprint or a joint footprint • Basis of 2002-06 reference period • Government measures are needed as voluntary control is very unlikely to work • Use of MFish observers questioned • The scale/resolution upon which the footprint is calculated should be done with other States
31/07/2007	Meeting, MFish, Wellington	Start of consultation process: • Introduction of interim measures • Update on NZ science work • Compilation of catch and effort data • Mapping of VMEs • Development of benthic assessment standard • Discussion of options for managing bottom trawling from 30 Sep 07 – 1 April 08	NGOs: ECO, DSCC, Greenpeace NZ	• Voluntary measures wont be effective therefore legally binding measures are needed • Many of the operators are economically marginal therefore their contribution to NZ is not significant • Control of nationals is needed as well as NZ flagged vessels because of reflagging risk
20/08/2007	Meeting, MFish, Wellington	Consult on implementation approach: • Update on science work • Update on process for proposed changes • Proposed approach to managing bottom trawling from 30 Sep 07 – 1 April 08	Industry: Sealord, Talley's, Seafic, Sanders Enterprises Ltd & Richardson Fishing	• Concerns over assessment requirements/expectations and what happens in the event an assessment is judged to be inadequate • Observers will be policemen in administering the move on rule • Objections to the use of MFish cost recovered observers • Spatial controls advocated for VME protection • VME (evidence) definition is unclear • NZ is requiring individual operators to do assessments while other States are doing a single government assessment • Post 2010 implementation questioned • Some vessels have no physical space to carry 2 observers • If fishing is prohibited it wont be possible to map VMEs and develop

Date	Type of Consultation	Purpose	Participants	Issues Raised
				sensible spatial management • Fishing in the mid 1990s is not reflected in the footprint
27/08/2007	Meeting, MFish, Wellington	Consult on implementation approach: • Update on science work • Update on process for proposed regulations • Proposed approach to managing bottom trawling from 30 Sep 07 – 1 April 08	NGOs: Greenpeace NZ, DSCC, BirldLife International, WWF NZ.	• Pointed to FAO Deepwater Guidelines under development • Cameras might be useful in monitoring bycatch but cannot replace observers for move on rule purposes • Wary of contracted observers because of poor training and potential conflicts of interest • Bentho-pelagic trawling should be treated the same as bottom trawling • Questioned what NZ would do to deter and address reflagging • Calls for quality controls of industry assessments
31/08/2007	Letter	Respond further to consultation meetings	Letter from Sealord to MFish	• Questioned stakeholder consultation process • Concerned the interim measures could have little to no effect on achieving sustainable utilisation • 2002-2006 footprint window is arbitrary and has not been determined in consultation with NZ operators; • Impact of window on IP • Would like past fishing acknowledged and further fishing permitted in such areas
31/08/2007	Meeting, MFish, Wellington	Proposed approach to managing bottom trawling from 30 Sep 07 – 1 April 08: • Impact assessment & fishing plan • Definition of areas/boundaries of current fishing • Move on rule • Observers • VMS	Seafic, Sealord	• Interim measures cover all forms of bottom fishing: footprint should reflect this • Tiered approach should be taken with impact assessment requirements reflecting the level of fishing effort • Moving 1nm, fishing depth, or 1nm at a time suggested as apposed to 5nm • Unlevel playing field with other States key concern
06/11/2007	Letter	Response to MFish consultation letter	Letter from Seafic to MFish	• Draft conditions fail to define the region(s) within which fishing is permitted • Interim measure concentrate effort in areas that may otherwise fall under the VME definition • It is likely that previously fished areas have already been modified therefore VME evidence to trigger a move-on should be set high ie, 500kg • Some vessels are too small to take two observers • Not practicable for observers to carry out any significant sampling and analysis work because of processing space • Recommend one observer per vessel, define fishable areas in permit, permit fishing in areas previously fished
09/11/2007	Meeting, MFish Nelson	Consult on proposed high seas fishing permit conditions • Fishing plans, authorisation & benthic assessment Benthic Assessment Framework (VMEs	Industry: Sealord, Seafic, Richardson Fishing, Talley's, Endurance Fishing, Fisheries Audit Services, Oceanlaw	• Lack of level playing because of stricter NZ interpretation and implementation of the interim measures • Legality of proposed permit conditions, specifically the prohibition to bottom trawl subject to an authorisation. • Merit of individual assessments as opposed to a single national

Date	Type of Consultation	Purpose	Participants	Issues Raised
		& significant adverse impact) • Trawl footprint • VME map • Move on rule (observer role & evidence of a VME) • Observers		assessment undertaken by MFish. • Advocated an open/closed area approach • Concern about unknown assessment requirements, with a call for clear guidelines/tick box as to what is required of an industry assessment • Unclear basis for the move on rule – 'evidence of a VME' needs defining quantitatively • Two observers unworkable on the basis of vessel space limitations and costs.
15/11/2007	Letter	Respond further to consultation meetings	Letter from Sealord to MFish	• One observer per vessel is sufficient rather than two • Should be able to contract independent observers rather than cost recovered MFish observers due to expense • Concerns that observer identification of VME evidence makes them a compliance officer • Concerned about security of NZ operators' data; • Concern about differing interpretation of interim measures and creation of non-level playing field that disadvantages NZ operators • Uncertainty about what a VME is, what determines significant adverse impact and what will trigger the move-on rule • Suggest that the move-on rule does not apply to areas that have already been fished or that an area management regime be established to remove the need for the move-on rule or a substantial risk assessment in the area • Concerned that the assessment framework is unworkable, would like to know the basis for catch and effort constraints and whether catch will be accorded an individual or global TACC • Concerned with losing value of intellectual property in South pacific
15/11/2007	Letter	Respond further to consultation meetings	Letter from Oceanlaw to MFish, on behalf of Anton's Group and Talley's	• Proposed high seas permit conditions are unlawful; • The definition of VME and associated move-on rule is vague and unworkable • Did not support the adoption of environmental impact assessments • 100% observer coverage requirement not stated in interim measures • Placement of 2 observers is unrealistic and unworkable for some vessels • Interim measures only require the prevention of significant adverse impact, but do not specify scale • Unfair to leave the VME qualitative assessment to a vessels master • Opposed to individual fishing operator having to complete an environmental impact assessment: should be done at a collaborative level facilitated by Government; • Proposed measures go beyond the scope of the interim measures.
07/12/2007	Meeting, MFish, Wellington	MFish response and process to consultations	Sealord, Talley's, Richardson & Pursuit Fishing	• Tiered approach doable, with clear lines on maps • Fishing effort is an indicator of fish abundance, not VMEs

Date	Type of Consultation	Purpose	Participants	Issues Raised
		• A tiered approach: open areas, closed areas and the move on rule Ongoing and future processes • NZ Regulations • Benthic assessments • 2010: expansion of effort & opening of regions		• Free riders and the ability to fish in new areas are of concern • Industry can test cameras to monitor VME evidence
19/12/2007	Meeting, MFish, Wellington	Consult on proposed conservation and management measures	NGOs: DSCC	• Bottom fishing should be stopped in the absence of an assessment • Bottom trawling definition too narrow • Heavily trawled areas do not have adequate conservation measures • Closures not based on representative areas • Need closures of heavily trawled seamounts to gauge recovery rates • Move on rule should apply to all open areas • Definition of VME evidence questioned
22/01/2008	Letter	Respond further to consultation meetings	DSCC to MFish	• 10% closure of heavily fished area inadequate to prevent significant adverse impact on VMEs • Assessment required in all open areas prior to fishing, and no process to follow for such assessments • No measures to protect the sustainability of fishstocks
18/02/2008	Meeting, MFish, Wellington	Consult on proposed conservation and management measures	Industry: Sealord, Seafic, Anton's Seafood, Talley's, Oceanlaw.	• Principles for area closures • International precedent setting nature of measures • Assurance that area closures will be reviewed post-2010 • Legal foundation of measures • 2002-06 20'x20' minute footprint not indicative of actual historical-spatial trawl footprint
22/02/2008	Meeting, Oceanlaw Offices Nelson	Consult on proposed conservation and management measures	Industry: Sealord, Talley's, Anton's Seafood, Endurance Fishing & Richardson Fishing.	• Move-on + closures = effective 80% closure of footprint • Objection to VME evidence thresholds • precedent setting nature of measures • Concern about protection of commercial sensitivity of fishing data submitted to SPRFMO
25/02/2008	Letter	Respond further to consultation meetings	MFish to Oceanlaw on behalf of Anton's, Sealord's, Talley's, and Richardson Fishing to 18/02/2008 consultation	• Measures undermine the viability of the fishery • VME evidence indicator thresholds are unrealistic and results in closure of the moderately trawled blocks – shuts 80% of footprint in total; • Suggest changing block descriptions to least, intermediately, and most trawled; • The unprecedented restriction will be driven into other fisheries, nationally and internationally • Concern over confidentiality of information
26/02/2008	Meeting, MFish, Wellington	Consult on proposed conservation and management measures	Industry: Sealord, Talley's, Anton's Seafood, Endurance Fishing & Richardson Fishing.	• Issue of precedence setting • Questioned whether measures apply to mid water trawl gear that contact bottom or bottom trawl gear only • Unhappy with extent of closures, including closure of lightly trawled

Date	Type of Consultation	Purpose	Participants	Issues Raised
				blocks • Hauling of gear outside footprint should be permitted • Scientists should join fishing trips to gain first hand experience
10/04/2008	Teleconference, MFish Wellington & Sealord	Discussion of final conservation and management measures in the form of high seas fishing permit conditions	Industry: Sealord, Talley's, Anton's Seafood, Oceanlaw, Endurance Fishing, Richardson Fishing, & Independent Fishing NGOs: ECO, Forest & Bird & DSCC	• Fishing does not indicate presence of VMEs therefore closure of heavily trawled areas is not justified • Impact assessment should be completed before fishing • An impact assessment can not be done without fishing • When will features outside the footprint become part of the assessment of significant adverse impact? • Scale of assessment? • Closures + move-on = 70% area constraint • What observer data has been used to judge evidence of VME threshold weights? • Concern about future of fishery and lack of knowledge of areas that are not fishing grounds • 70% area constraint does not equal 70% of effort constraint • Unequal playing field for NZ flagged vessels compared to other States • Trawl net is not a good sampling tool therefore need presence/absence move on rule • Some seamounts are flat and do not have corals therefore move on rule is not necessary • Measures could impact on employment – 2 vessels, 40 jobs • Concern at lack of scientific data especially from beyond NZ EEZ • Disproportionate effect on NZ vessels, while others trawl in the region • Expense of MFish cost recovered observer • On what basis/assessment are area closures being decided? • When is a vessel considered to be fishing? • Measures should include other bottom fishing methods • If an observer onboard cannot observe because of illness, what happens? • Measures fall short of requirements of SPRFMO interim measures.
14/04/2008	Letter	Respond further to consultation meetings	Letter from DSCC to MFish	• Measures do not require an environmental impact assessment • Absence of process for conducting such assessments • Move-on rule should be applied to all open fishing areas • No measures to protect the sustainability of fishstocks • VME evidence threshold for stony coral and sponges too high