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Bottom Fishing Impact Assessment – Cook Islands

Relates to agenda item: 6.2 Working paper ☒ Info paper ☐

Delegation of Cook Islands

Abstract

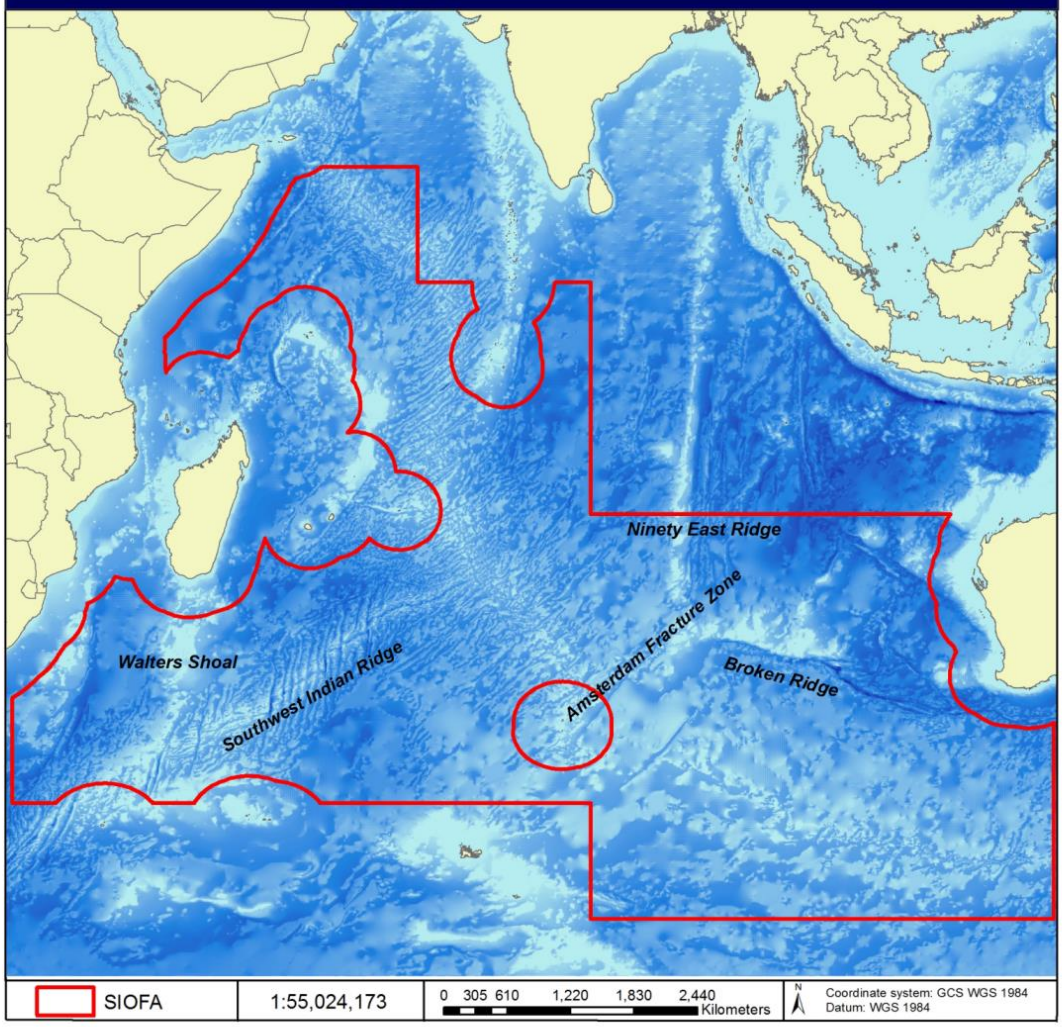
This paper presents the Bottom Fishing Impact Assessment of Cook Islands.

Recommendations

SC is invited to consider this BFIA.

Ministry *of* Marine Resources
GOVERNMENT OF THE COOK ISLANDS

Cook Islands
SIOFA Bottom Fishery Impact Assesment



Document prepared by the Ministry of Marine Resources

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1. Introduction

1.1 Cook Islands international commitments

Following the adoption of UNGA Resolutions 61/105 in 2006, 64/72 in 20092 and 66/68 in 2013 on deep-sea fisheries, the management of bottom fisheries and the protection of deep-sea ecosystems on the high seas has been a priority for the international community. Prior to the adoption of the resolution, the Cook Islands assisted the fishing industry organisation SIODFA and the IUCN in introducing the Indian Ocean Benthic Protected Areas to the signatories of SIOFA in June 2006. The Cook Islands adopted these protective measures immediately as a condition of licence, effectively closing a number of known vulnerable marine ecosystems to bottom impacts from Cook Islands vessels. The Cook Islands considers that these flag state measures exceed the requirements of the UNGA resolutions.

Subsequently UNGA Resolution 61/105 called on high seas fishing nations and RFMOs to take urgent action to protect vulnerable marine ecosystems (VMEs) from destructive fishing practices. In particular, Resolution 61/105 called on States to:

- Conduct impact assessments to determine whether bottom fishing activities would have significant adverse impacts on VMEs, and ensure effective management to prevent such impacts, or prohibit the activity;
- Close areas of the high seas to bottom fishing where VMEs are known or likely to occur unless fishing in these areas can be managed to prevent significant adverse impacts to such ecosystems; and
- Establish and implement protocols requiring vessels to cease fishing in areas where an encounter with VMEs occurs; and to report the encounter so that appropriate measures can be adopted in respect of the site.

Measures to implement UNGA Resolutions have been put in place by a number of States and through RFMOs, including those active in high seas bottom fisheries in the Southern Ocean, North East Atlantic, North West Atlantic and South East Atlantic Oceans.

Resolution 61/105 was further encouraged in UNGA Resolution 64/72, paragraph 113 which encourages States and RFMOs to implement measures in accordance with FAO International Guidelines for the Management of deep-sea fisheries in the high seas (“the FAO Guidelines”, FAO 2008).

UNGA Resolution 64/72, paragraph 119(a) also stated that fishing should not be permitted until impact assessments have been carried out and made publicly available.

1.2 Assessment Process for Cook Islands fishing vessel impact

SIOFA CMM 2016/01 Conservation and Management Measure for the Interim Management of Bottom Fishing in the SIOFA Agreement Area noted the expectations within the UNGA Resolutions. CMM 2016/01 also directed the Scientific Committee (SC) to develop a SIOFA Bottom Fishing Impact Assessment Standard (BFIAS). This standard was adopted at SIOFA SC2 (Annex I), and this standard has been followed in drafting the Cook Islands BFIA.

In particular, the CMM 2016/01 identifies that BFIAs shall be prepared, to the extent possible, in accordance with FAO Guidelines. It follows that the BFIAS, therefore, should be consistent with FAO Guidelines, as the implementation regime for UNGA Resolutions.

The purpose of the BFIAS is to provide a minimum standard for assessing the potential impacts of bottom fishing activities on VMEs and deep sea fish stocks. The potential impacts include consideration of past fishing activity and the cumulative effects of fishing. The Cook Islands BFIA takes into account all past bottom fishing activity by vessels flying its flag, including where the vessel owner has had prior activity with the same vessel under another flag state. In this manner the Cook Islands has provided the SIOFA Secretariat with a time series of historical data from the inception of the deepwater fishery in 1996.

In presenting this BFIA, the Cook Islands notes its compliance to the requirements of both the SIOFA resolution to freeze the footprint of existing bottom impact fisheries. The requirements include closing known VME structures to bottom impact fisheries. However, to close these known VMEs to impact requires SIOFA to adopt the precautionary approach and ensure Fishery Closures are implemented.

We note that the FAO Guidelines (paragraph 13) recognized that marine living resources exploited by deep sea fisheries in the high seas often have low productivity, only sustain low exploitation rates and are slow to recover once depleted. Key biological characteristics of these low productivity species include maturation at relatively old ages; slow growth; long life expectancies; low natural mortality rates; intermittent recruitment of successful year classes; and spawning that may not occur every year (FAO 2008). However more recent work by the FAO (in press), and the recent MSC certification of three orange roughy fisheries in New Zealand shows that when best practices are followed, they provide for sustainable management of such resources.

Bottom trawling impacts on the benthic habitat in the ocean, and the principles of ecosystem-based management are a cornerstone of Cook Islands approach to marine resources management and protection, as further described in this BFIA. Previous to the development of SIOFA, the industry-based organisation SIODFA, supported by Cook Islands, worked with vessels of different flag states on a variety of strategies to mitigate their fishery impact, such as spatial closures, protection of known VMEs, and data collection programs, and subsequently introduced these strategies to Signatories to the Agreement in June 2006.

2 Description of the Proposed Fishing Activities

The Cook Islands has had as many as five vessels operating in the SIOFA Area since 2001, permitted under High Seas fishing authorisations issued by the Ministry of Marine Resources (MMR). This assessment takes account of previous flag arrangements for the two currently active vessels to account for prior impact and also takes into account data for several New Zealand flagged vessels previously under the management of one of the current operators. The inclusion of their fine scale data from all these sources helps to establish the total known fished footprint.

Most recently, in line with UNGA and SIOFA Resolutions for all flag states to freeze their bottom fishery footprint, the Cook Islands has licensed only two trawl vessels to operate in the SIOFA fishery and further does not licence bottom longliners or gill net vessels in the SIOFA area. The two trawl vessels target deep-water finfish species, primarily alfonsino *(Beryx splendens)* and orange roughy *(Hoplosthethus atlanticus)* using both bottom and mid water trawl fishing methods.

2.1 Details of the vessels to be used

Cook Islands has two vessels operating year round in the SIOFA area, and full vessel details have been provided to the SIOFA Secretariat. The two trawlers in the fishery are the *FV Will Watch* (Plate 1) and *the FV Nikko Maru No 1* (Plate 2). Full details to SIOFA standard are included as Table 1.

Vessel Name	Vessel registration number	International radio call sign	UVI (Unique Vessel Identifier)/ IMO Number	Previous names	Port of registry	
Nikko Maru No. 1	CI-1412	E5U2323	870732	N/A	Avatiu	
Will Watch	CI- 01/1	E5WW	7225831	***Cheung Shing***	Avatiu	
Previous flag (if any)	Previous flag (country code)	Type of vessel (ISSCFV code)	Type of fishing method (ISSCFG code)	Length (m)	Length Type	Gross tonnage (GT)*
Nambia	NM	TTP	TM	65	LOA	736
Panama	PA	TTP	TM	74.4	LOA	1016
Gross register tonnage (GRT)*	Power of main engine(s) (Kw)	Fish Hold capacity (m3)	Owner	Address of owner(s)	Name of operators	
1418	2134	600	ORAFCO Limited	No 3, South Arm Rd, Victoria Basin, Cape Town waterfront, South Africa 8000	ORAFCO Limited	
1587	2850 bhp	525	United Fame Investments	1st floor BCI House, Rarotonga, Cook Islands	Sealord Group Ltd	
Address of operators	3 recent photographs supplied? (y/n)	Freezer type	Freezing capacity (t/day)	number of freezing units (if applicable)		
No 3, South Arm Rd, Victoria Basin, Cape Town waterfront, South Africa 8000	Y	Air Coils	unknown	7		
149 Vickerman Street Nelson , NZ	Y	Air Coils	50	1		
Vessel communication types and identification	VMS system					
Inmarsat mobile- 451837311	Blue Finger AZUR TRAC- SC (TT30220)					
Inmarsat mobile- 451299190	Sailor H16622D					

Table 1 Vessel Details

Plate 1 FV Will Watch

Plate 2 FV Nikko Maru No. 1

2.2 Description of fishing methods

The two Cook Islands vessels operate with target bottom and midwater trawling. It is critical to fully understand target fishing with different gear types in the context of benthic impacts.

Modern deepwater trawling in SIOFA is an aimed method of trawling, targeting aggregations of acoustically identified fish. This method is completely different to the herding type trawl fishing of species such as North Atlantic cod and haddock, or Southern hemisphere hoki and hake species which are all typically fished using long, un-aimed tows on a relatively flat sandy or muddy seabed, with the trawl doors hard on the bottom throughout the tow.

In much of the target bottom trawling in SIOFA, the net is simply allowed to roll down a slope, with the skipper attempting to keep the net on the bottom. The objective is to maintain bottom contact, but this does not always occur, and the net then flies off the bottom. The trawl path is generally a straight line, and often the trawl shot ends when the trawl stops on an obstruction ('fast', 'sticker'). On some bottom trawl grounds, trawl data may suggest longer tows can be carried out, but often during these tows the trawl has to climb over, or be flown over a known piece of rugged and unfishable habitat. Without knowledge of this 'sticker' the trawl would become 'fast'. This fishing process is shown in Figure 1 and Figure 2 *(Courtesy of Michael Shane O'Connor,* FV Will Watch*)*.

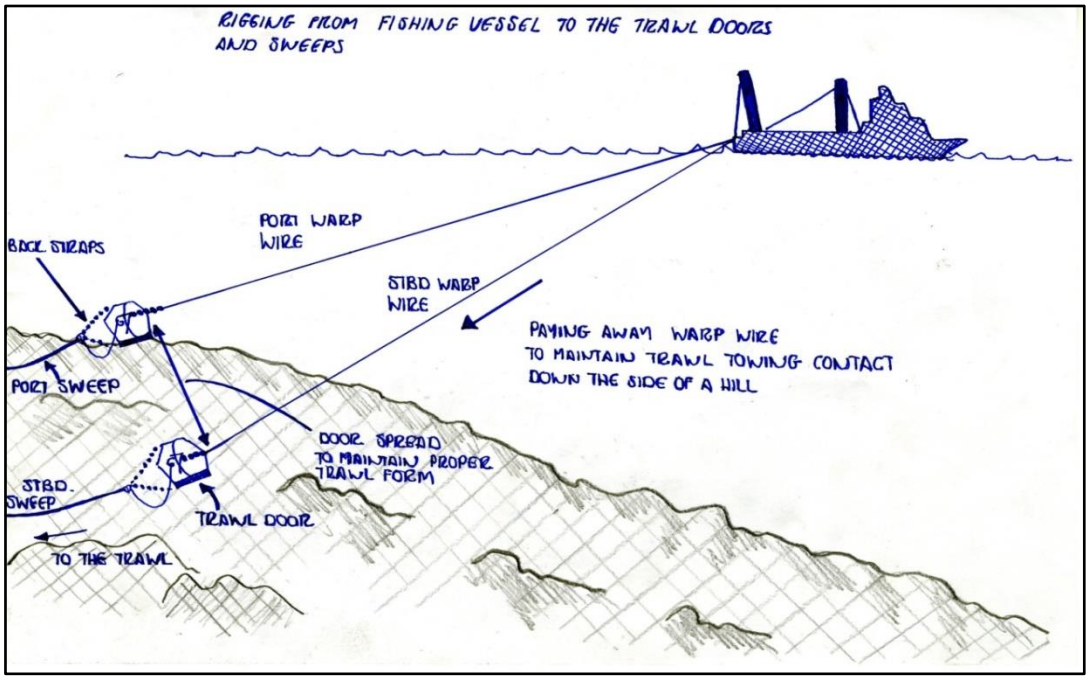


Figure 1 SIOFA Bottom Trawling

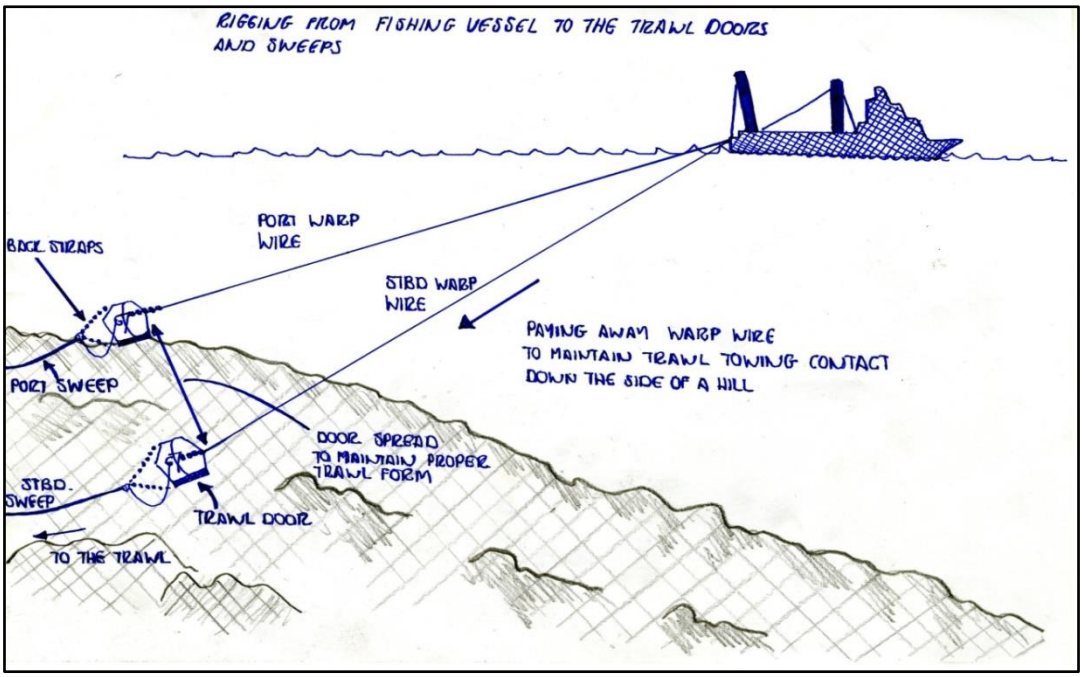


Figure 2 SIOFA Bottom Trawl in operation

To reduce damage to fishing gear on the rocky habitat typical of areas (Plate 3) inhabited by orange roughy, and to enable the nets to be rapidly and accurately aimed at the fish aggregations, in SIOFA the deepwater trawling methods have evolved towards agile net systems that minimise groundrope length, overall net size and reduce unnecessary ground contact, particularly by non-fishing gear components such as the trawl doors. On most bottom trawl shots undertaken by Cook Island vessels, the trawl doors rarely touch the bottom. If a trawl door dropped into the 4 metre hole identified in Plate 3 it would be trapped and the vessel anchored to the bottom by a 3000 meter 28 mm cable (the trawl warp).

Plate 3 View looking down from headline to rocky bottom being trawled over

The Cook Islands notes that neither of the vessels currently in the fishery has permanently lost a trawl door since year 2000. On one occasion, the *FV Will Watch* lost one trawl door, but because of the precise Simrad ITI position fixing system, the vessel was able to deploy a grapple to pick the door up. However there are trawl doors left on the bottom by operators from other states during year 2000, notably on an area called Porky's. The Cook Islands has position information on those doors.

A door in midwater can hit the side of a cliff wall by mistake, or a small steep rock on one side of the tow, and drop down to the bottom. If this happens, the trawl generally stops and is carefully retrieved immediately, otherwise the doors may cross, leading to many hours on deck untangling a twisted trawl and sweep wires.

A typical SIOFA feature, the knoll shown in Figure 3 is on the island of Mauritius, and is typical of many of the geological structures found below sea level in SIOFA on the Southwest Indian Ridge. Potential fishable paths are shown in red. If a trawl is attempted on the un-trawlable ground, the trawl door off the bottom would likely hit the steep pinnacle to the side.

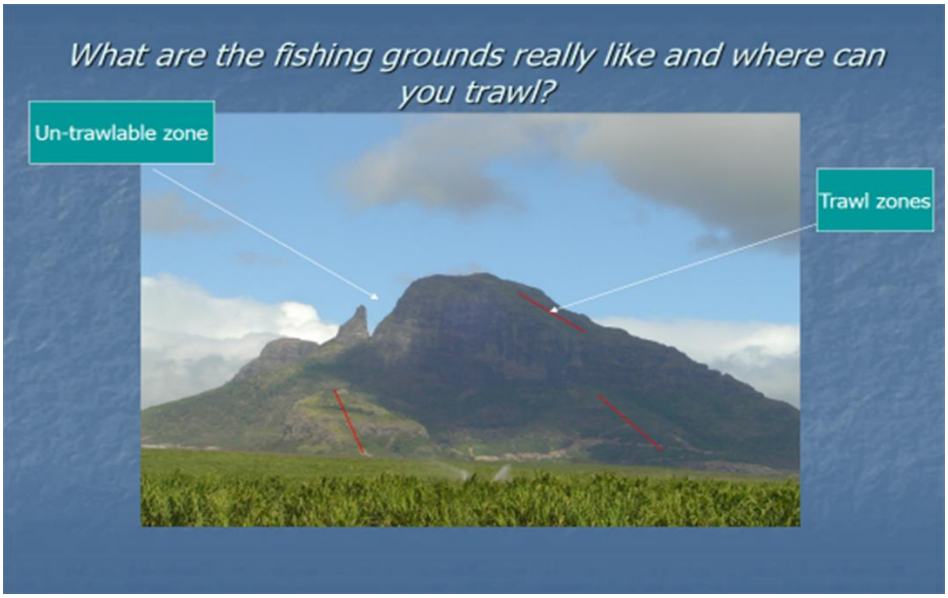


Figure 3 A SIOFA Seamount that has not sunk below sea level

Most of the trawl shots in the SIOFA area cover relatively short distance. One way to look at this is to compare the length of average trawls with the size of the runway at Rarotonga International Airport in the Cook Islands (Plate 4, Figure 4).

Plate 4 Runway, Rarotonga Airport Cook Islands

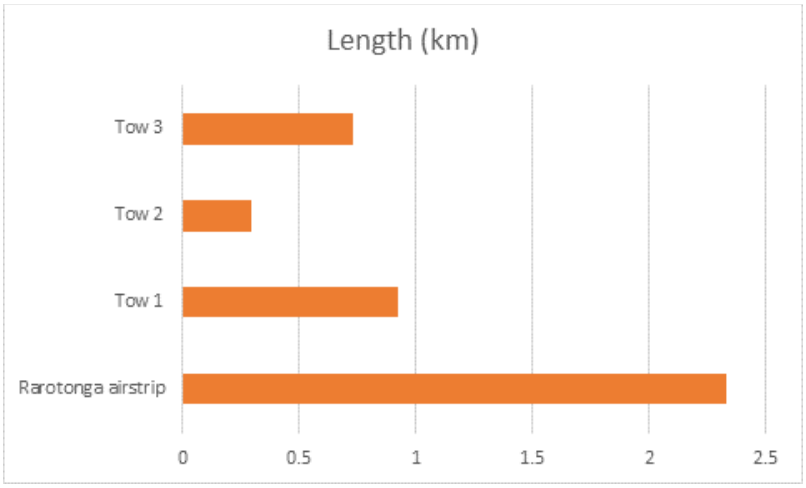


Figure 4 Length of Bottom Trawl Shots Compared with Rarotonga Airport runway

Most of the demersal trawling from 1997-2017 in SIOFA has been carried out with either a standard "Alfredo 3A2" (Figure 5) net or the 9 inch Arrow trawl (Figure 6), which both have groundrope spread of up to 25 m between the wing ends. These are typically the trawls used by New Zealand skippers that were on many vessels in the fleet during 2000-2001. The nets are manufactured from braided 5 mm polyethelene twines, doubled for areas of the net that are subject to abrasion or tearing from rocky habitat. The codends attached to the nets are 130 mm diamond codend meshes made from 8 mm nylon.

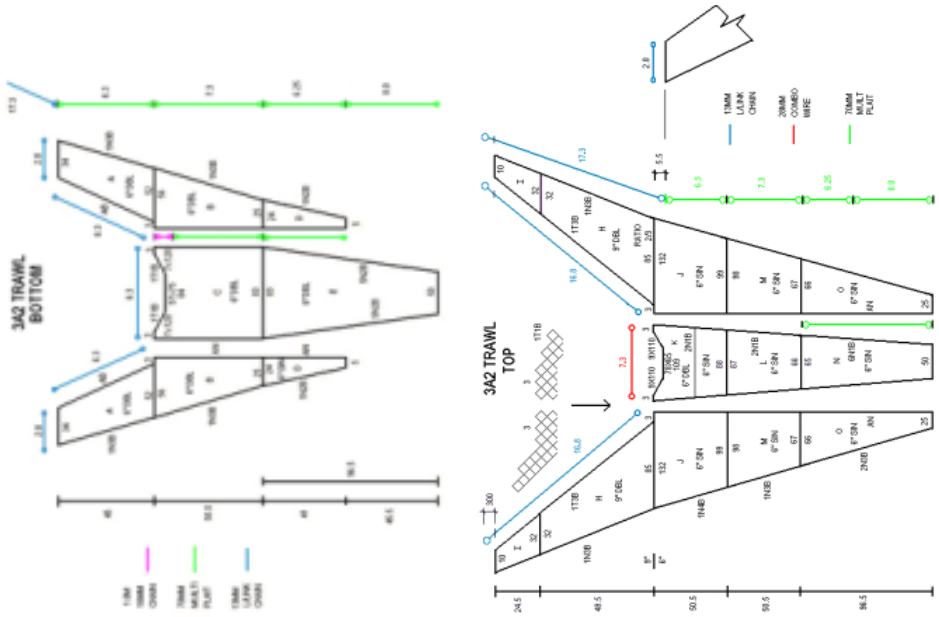


Figure 5 Alfredo Bottom Trawl

Figure 6 Arrow Bottom Trawl

The net headropes are equipped with hard floats to provide buoyancy to keep the net open during trawling. Rather than the heavy steel bobbins on the groundrope used in other bottom trawl fisheries, rubber rockhoppers are used (Plate 5), with series of 6 small steel bobbins per side for weight, and rockhoppers on the wing end. At times on very steep slopes, the centre section of the

groundrope is swapped out with a 6.2 metre length of 48 cm rubber bobbins (Plate 6) to provide additional weight to sink the trawl. Without this weight the trawl would never touch the bottom.

The sweeps and bridles are significantly different from those used in most global bottom trawl fisheries. The bottom bridle is 31 metres, which is chain with small rubbers, and also is considered part of the groundrope as the lower wing has been removed. The top bridle is only 13-15 m. The sweeps used are 135 m. Under these configurations the distance between the doors is 120-150 m (as measured by the SImrad ITI system).

Plate 5 Rockhopper groundrope in operation

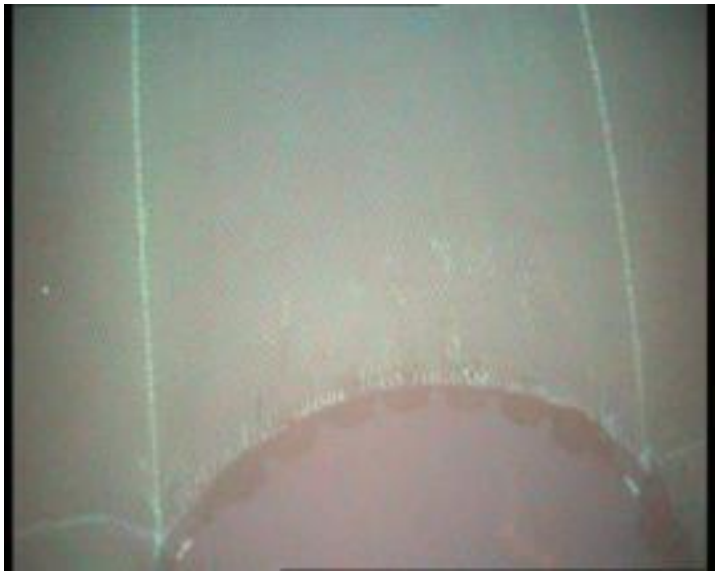


Plate 6 Rubber bobbins in centre of groundrope

The *FV Nikko Maru No 1* uses a standard Champion Bottom trawl developed by Motueka Nets, which is similar to those used by Australian vessels that have operated in the SIOFA area.

With a 'midwater' trawl the net typically has large meshes (i.e. 22 metre diamond meshes in the wings of the net), and is a pelagic net specifically designed for off-bottom fishing. Four trawls are generally used, the 111 (Figure 7), 153, Dragon and Mother trawl, all designed by Motueka Nets from Nelson New Zealand, and commonly used in New Zealand pelagic fisheries.

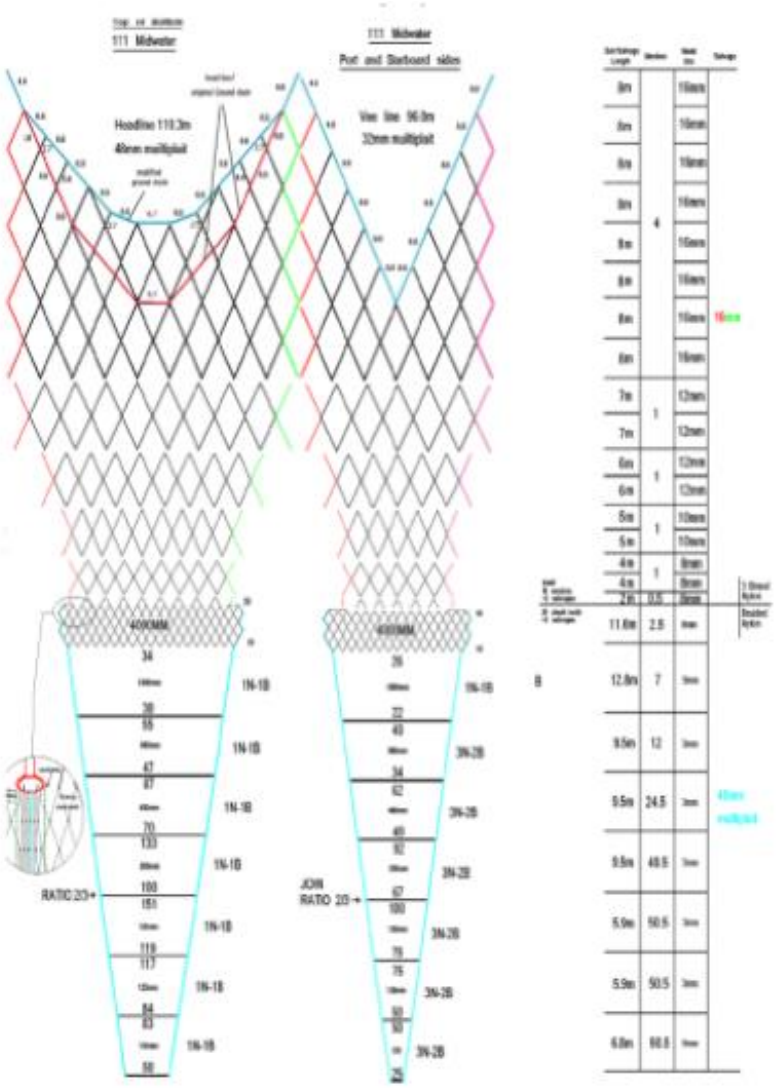


Figure 7 Midwater Trawl 111

Midwater Trawling is a highly specialised form of fishing, and prior to making any set the skipper will survey the fishing grounds and the nature of fish aggregations to determine (i) the amount of fish in the school and how close to the seabed it is and ii) whether the bathymetry and nature of the fishing ground allow the gear to be safely set without risk of loss or damage. The high price of a midwater trawl and their fragility makes captains risk averse and conservative in fishing operations.

An added measure of protection comes from the use of a sacrificial footrope or breakaway chains in case the net touches any rocky bottom habitat. This weak link is inserted into the centre of the

footrope so that if an obstruction is encountered on any part of the groundrope, sweeps or bridles, the footrope will part at the weakest link (Plate 7) When this occurs, the catching power of the trawl is effectively reduced to zero, and the net will need to be repaired after hauling. This is why fishers take extreme care when fishing close to the bottom. The bridles for the midwater trawls are typically around 200m.

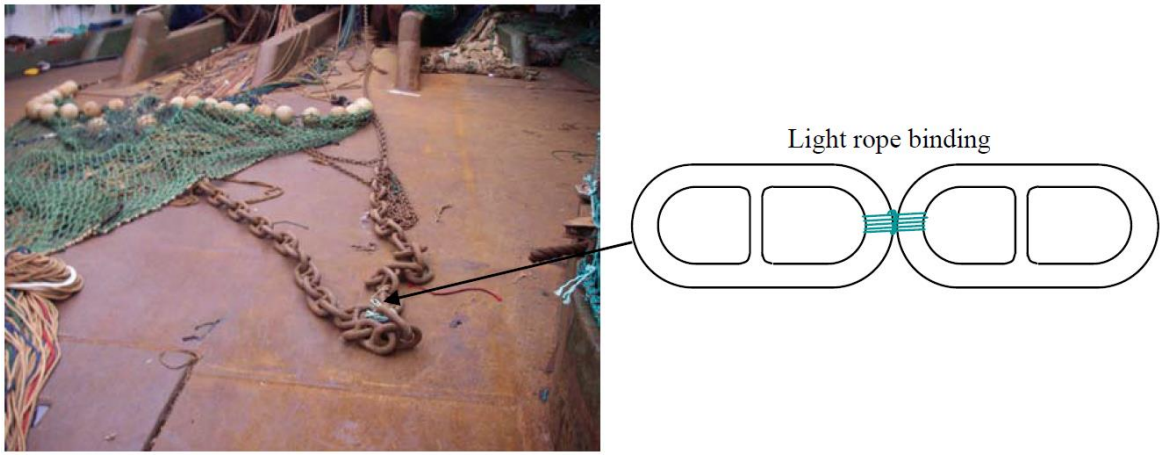


Plate 7 Weak Link on Midwater Trawl footrope

The trawl doors used by both Cook Islands vessels are high aspect ratio doors which rely on hydrodynamic forces to generate spread. They do not require bottom contact and the ground sheer forces to generate net spread, as low aspect ratio doors do. Low aspect ratio doors with length greater than height are used in most traditional bottom trawling operations, as reported to the UNGA for their 2006 session on fisheries. The result is a widespread misunderstanding of deepwater trawl fisheries and their potential habitat impact. This BFIA seeks to correct this misunderstanding.

The same trawl doors are used for bottom and midwater trawling. For *FV Will Watch* the doors are Nichimo style, 7 m^2 in size and 2.1 tonnes in weight (Figure 8). These were developed in New Zealand for combined midwater and bottom trawling, and are in use since 1997. For the *FV Nikko Maru No. 1* they are Thyboron type 7 @7.5 m^2 in size and 2.5 tonnes in weight, made in Denmark.

Figure 8 Trawl Doors

2.3 Seabed depth range to be fished

Both Cook Islands vessels have been in the fishery since 1997 and have consistently recorded start and finish depths for bottom trawls. For one vessel, in total 11,374 verified start and end depths were available for analysis, and this has enabled the frequency of bottom trawl shots in different depth ranges to be analysed. The data are separated by start and end depths, to provide the full depth range fished. There was negligible fishing effort shallower than 400 metres, but in 400-500 metre depths there are small target fisheries for species other than orange roughy.

Less than 10% of the trawls started shallower than 700 metres, and 20% in 800-900 metres. There was an even spread of start depths from 800-1200 metres. Almost 30% of the trawls were hauled back at depths around 1100 metres, with 12% of the trawls reaching 1300 metres. In terms of impact assessment, most fishing occurs between 800 and 1200 metres. This depth footprint is expected to remain the same in future years, in terms of depth range and similar proportion of tows.

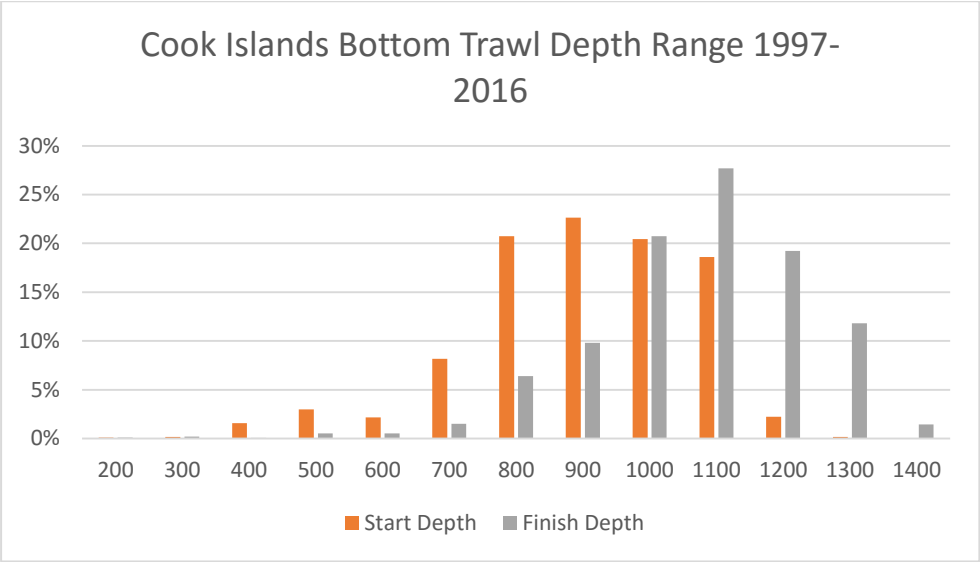


Figure 9 Fishing depth frequency distribution of SIOFA bottom trawls by one vessel 1997-2016

2.4 Target species, and likely or potential by-catch species

The main target species for Cook Island vessels are Orange Roughy (*Hoplostethus atlanticus*) and Alfonsino (*Beryx splendens*). Bycatch species are primarily Oreo Dories, *Allocyttus niger, Pseudocyttus maculatus, Neocyttus rhomboidalis.*

Other minor target species include the following:

- Rubyfishes (*Emmelichthys nitidus* and *Plagiogeneion rubiginosum*)
- Butterfishes (generally *Centrolophus niger* and *Hyperoglyphe antarctica*)
- Armourhead/Boarfish (*Pseudopentaceros richardsoni*)
- Cardinalfish (Epigonus telescopus)

During target orange roughy fishing in 2009 (Sanders, 2011), incidental species caught included *Alepocephalus australis* (Small scaled brown slickhead), *Mora moro* (Common mora), *Coryphaenoides dossenus* (Humpback whiptail), *Ruvettus pretiosus (oilfish), Mesobius antipodium or Mesobius berryi (Bathypelagic rattail), Antimora rostrata* (Blue antimora), and *Caelorinchus sp. Aff. Labiatus*. The catch by proportion is shown in Figure 10.

The main species of shark caught in this fishery, representing 77% (by number) of the all sharks typically caught are the Lanternshark (*Etmopterus baxteri*), with 11% being Roughskin dogfish (*Centroscymnus owstoni*) and 6% an unknown *Centroselachus* (possibly *Centroselachus crepidater*). In some areas *Hydrolagus* (possibly *Hydrolagus trolli* [Pointy nose blue chimaera]) are caught, but these are rarely caught on Walter's Shoal. Other sharks caught include *Apristurus, Deania, Centrophorus, Dalatias licha* (Kitefin shark), *Parmaturus macmillani* (McMillan's cat shark), *Proscymnodon plunketi* (Plunket shark) and *Zameus squamulosus* (Velvet dogfish). Overall, the shark bycatch is a very low proportion of total catch (Figure 11).

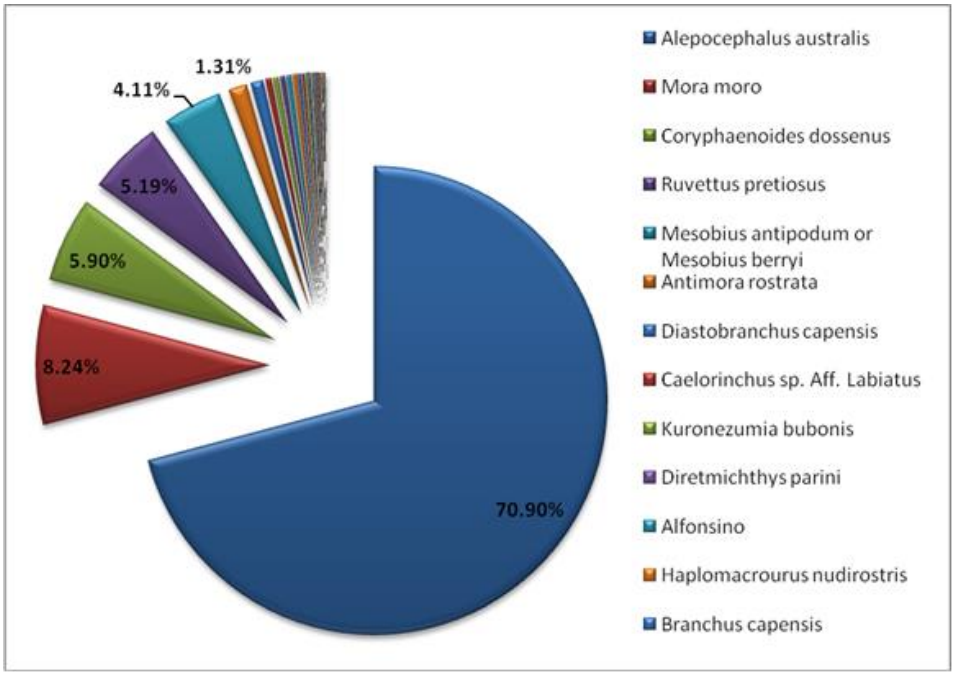


Figure 10 Bony Fishes Discard by weight proportion Indian Ocean 2009

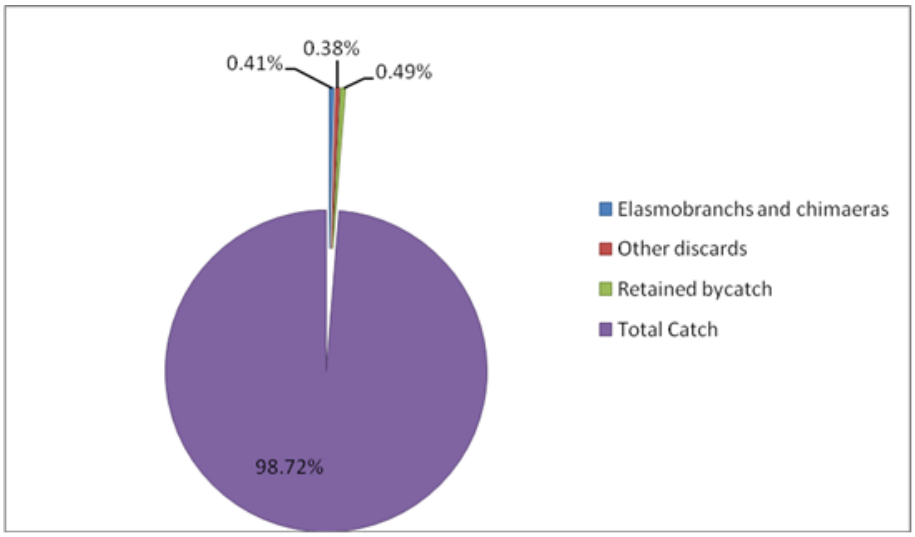


Figure 11 Total amount of elasmobranch and chimaeras discards, "other" discards, and retained bycatch in one target Orange Roughy voyage, June-July 2009

2.5 Intended period and duration of fishing

From 2003 to 2010 the Cook Islands was the major Contracting Party operating in SIOFA, with up to 5 vessels operating (Table 2). In compliance with the UNGA and SIOFA resolutions to freeze the footprint of bottom impact fisheries, the Cook Islands currently has limited its trawl effort in the past 6 years to only two vessels that operate year round in the fishery (Table 2).

In total 540-670 vessel days at sea are expected, with 450-560 active fishing days. Most bottom trawling will occur in the southern hemisphere winter from June to October, but midwater trawling occurs throughout the year.

Year	Total trawls	Midwater	Bottom	Days Fished	Days at sea
2011	1899	1088	728	558	664
2012	1781	1357	424	490	602
2013	1601	1118	483	524	636
2014	1971	1406	565	523	645
2015	2729	2050	679	501	604
2016	1999	1909	590	455	544
2017	2230	1779	451	495	627

Table 2 Fishing effort by Cook Island vessels from 2011-2017.

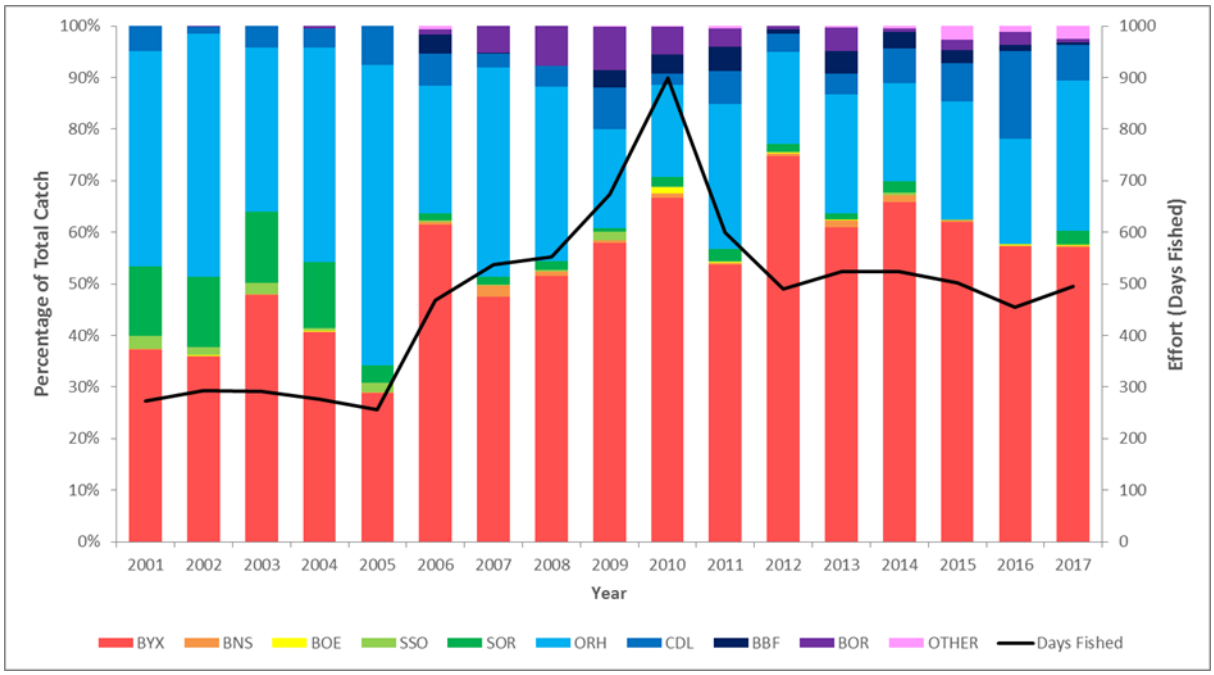
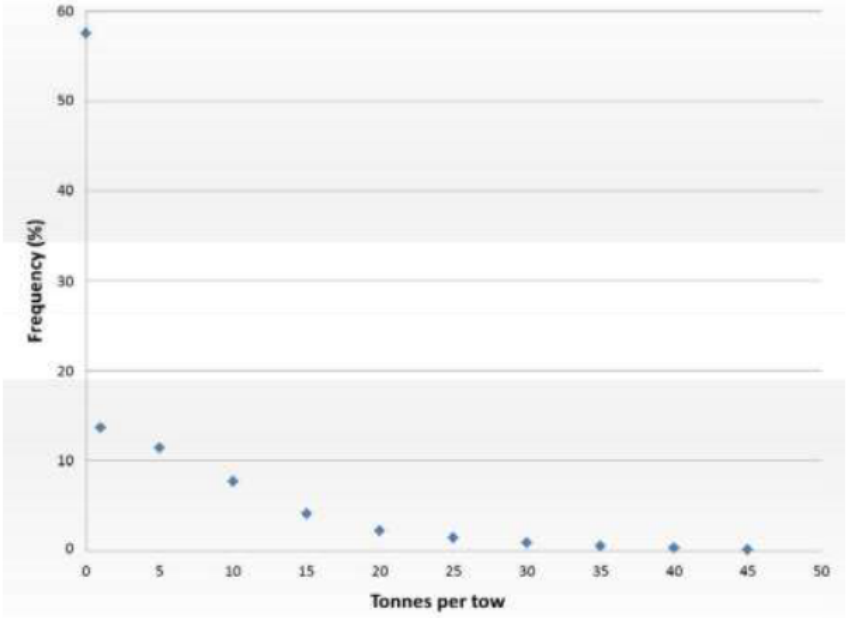


Figure 12 Cook Islands Catch and Effort 1997-2017

The Cook Islands midwater trawl fishery for alfonsino is a target trawl fishery, where the captain observes a school of alfonsino, and targets a trawl at this identified mark. The total number of trawls each year can be highly variable, primarily because of the large number of 'zero' tows that occur in these target fisheries. This was described in the Global Alfonsino review (FAO 2016), figure 51, reproduced here as Figure 13.

FIGURE 51
Frequency of alfonsino catch rates, one vessel, Southern Indian Ocean, 1997–2011



Source: modified from Patchell (2012)
Note: n = 7 186

Figure 13 Alfonsino Target Fishery Frequency of Successful trawls

In March 2015, one vessel commenced recording of any bottom contact by midwater trawls, and from October 2015 began recording actual bottom contact time. There were 1530 midwater trawls from March 2015 to December 2016. Of these, 333 touched the bottom (22%). In total hours, the bottom contact time was 16.71 hours, but 6.5 hours of this came from 30 trawls on a single flat topped seamount that is covered with sand, gravel and hard flat rock. This seamount was mapped in 1997 with sidescan sonar, which showed the soft sediment on the top.

Of the 333 trawls that had some bottom contact, 121 (36.3%) of these had bottom contact for 1 minute or less.

3 Mapping and Description of Proposed Fishing Areas

Mapping of the fishing areas was undertaken using two different criteria. For the bottom fisheries impact, the definition of fishing is taken from SIOFA CMM 2017/021 Annex A, where fishing is defined as when the net reaches the bottom and is retrieved from the bottom. However, this is a different definition to "Fishing" than is covered by the SIOFA Agreement.

In Article A of the Agreement, the definition of 'Fishing" means (inter alia):

(i) the actual or attempted searching for, catching, taking or harvesting of fisheries resources;
(ii) engaging in any activity which can reasonably be expected to result in the locating, catching, taking or harvesting of fishery resources for any purpose including scientific research

In this defintion the act of fishing includes placing the codend of the trawl net into the water, and hauling the codend back on to the deck of the vessel. It also includes using the vessel echosounder when preparing a trawl shot. In establishing the Cook Islands Fishing Footprint, the calculated position of the vessel when preparing to set the net is taken as the start position and when the net is fully on board, as the finish position, for establishing the footprint boxes.

A conflict exists with different definitions in RFMOs, for example in SPRFMO, where the closure of some 'non' footprint boxes by New Zealand also effectively closed open footprint boxes, because the net must be placed into the water in a closed box, to reach the bottom in an "open" box.

3.1 The Cook Islands Bottom Fishing Footprint

The 20x20 minute Fishing Footprint boxes for Cook Island vessels from 1997-2015 is shown in Figure 14. This footprint was computed as follows. The top left corner of each box started at a fixed degree of latitude and longitude, then plus 20 or 40 minutes. This set the same area coverage as used in the Australian BFIA, and in SPRFMO by New Zealand and Australia. So an example box would be 40° S 40'E, runing south to 40 ° 20' S and across to 40 ° 20' E. A box was put then around the trawl lines for both vessels, and an allowance of about 5 miles made for Article A, with the Compliance start and end of fishing. Then the sum boxes of each vessel were combined to produce a CKI footprint. These boxes were then crossed checked by skippers on their bridge navigation systems, to ensure there were no conflicts.

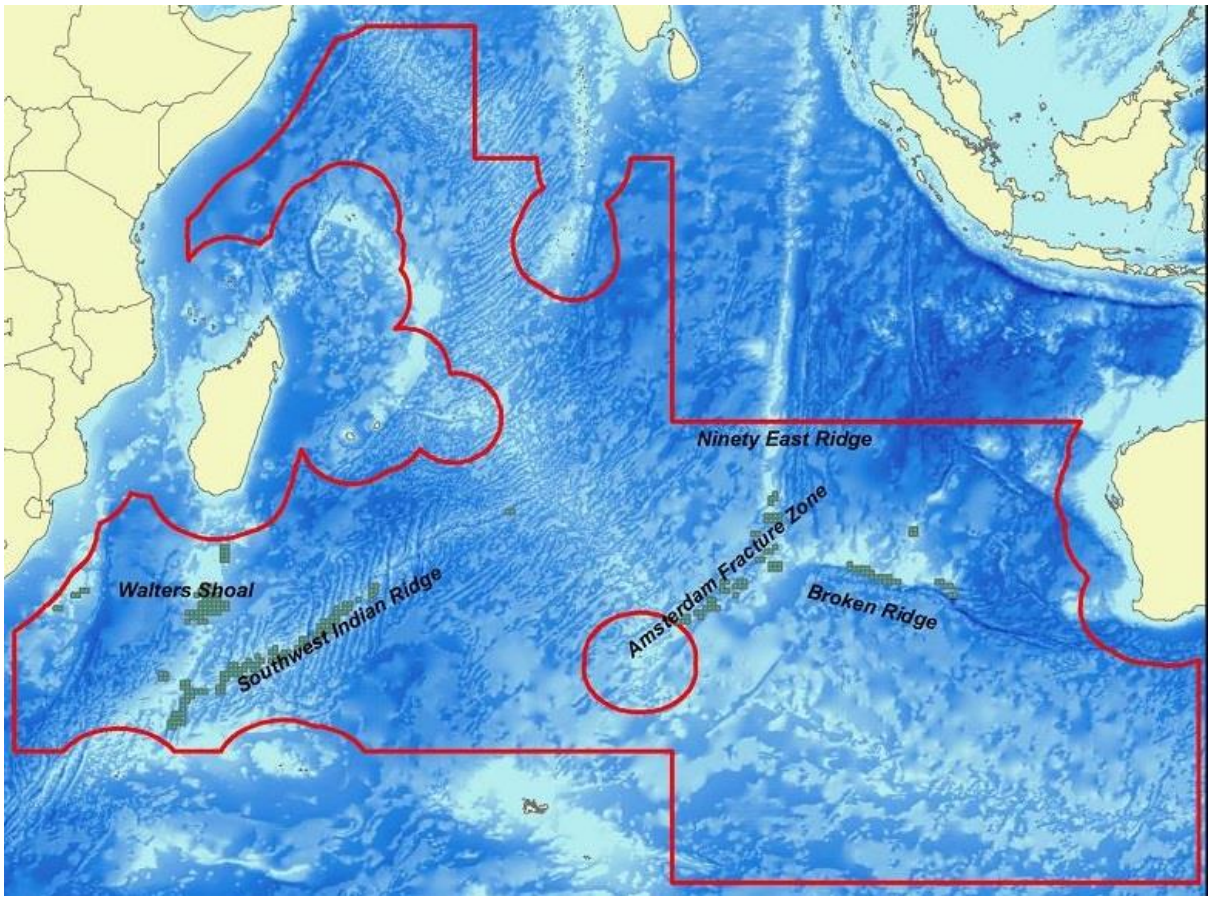


Figure 14 Cook Islands Bottom Fishing Footprint 1996-2016

3.2 Known VMEs, or areas where there is evidence of VMEs in the SIOFA area

The Cook Islands, and the managers, skippers and crews of Cook Islands vessels, were heavily involved in the establishment of the Benthic Protected Areas (BPA) in the Southern Indian Ocean. Originally, these areas were established not only for the maintenance and protection of biodiversity in the region, but also to protect what we considered, from experience, to be known VMEs. In recent years, when either fishers or agencies such as the IUCN have indicated the presence of significant coldwater coral systems, and have concluded these be rated as VMEs, these have been registered as BPAs.

The Cook Islands formally lists the following areas as Known VMEs in SIOFA (Table 3):

Rusky	31° 20'	94° 55'	3 1 ° 30'	95° 00'
Fools · Flat	31° 30'	94° 40'	3 1 ° 40'	95° 00'
Atlantis Bank	32° 00'	57° 00'	32° 50'	58° 00'
Walters Shoal	33 ° 00'	43° 10'	33° 20'	44° 10'
Coral	41 ° 00'	42° 00'	41° 40'	44° 00'
Banana	30° 20'	45° 40'	30° 30'	46° 00'
Middle of What (MoW)	37° 54'	50° 23'	37° 56.5. 5'	50° 27

Table 3 Known VMEs in SIOFA

There is well documented evidence on the presence of VMEs in these areas. For example, industry analysis of the Rusky Knoll on Broken Ridge (Figure 15) has observed and documented catches of complete Black Coral trees during bottom fishing activities. These types of coral trees are found deeper than 600 metres deep in the SIOFA area, and although listed on CITES, are target fisheries around the world for precious coral jewellery, notably in the USA and European Union. This site is one of the few sites in the SIOFA area where black coral has been detected in quantity. The Cook Islands position is that the area should be protected.

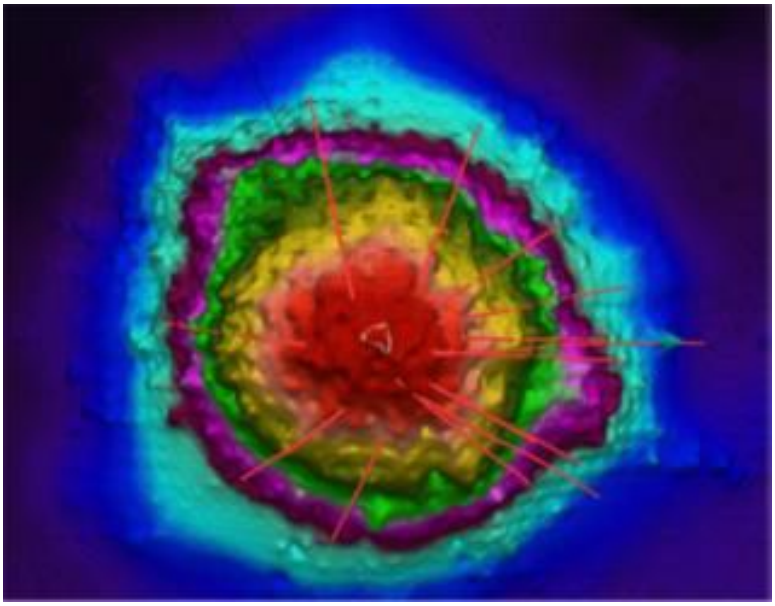


Figure 15 Rusky Knoll with towlines marked in red

Another known VME, detected by the Habitat Mapping program described later in this BFIA, was Fools Flat. An acoustic survey in 2005 over this region with a high performance Simrad ES60 sounder showed clearly that the "fish school" observed with an early Furuno Color Sounder was actually a coldwater coral reef (Figure 16). The new echosounder shows how a fisher can detect coldwater coral habitat by the signal return from the bottom, showing as yellow in the image as missed bottom detects (Figure 17). The area potentially has the largest coldwater coral reefs on the planet.

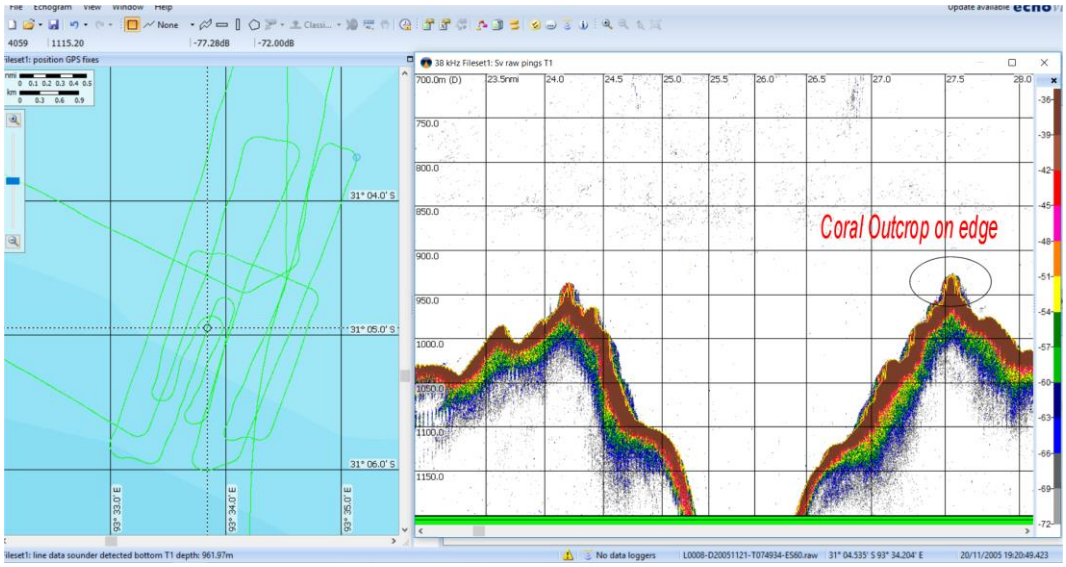


Figure 16 Fool's Flat Coral Habitat

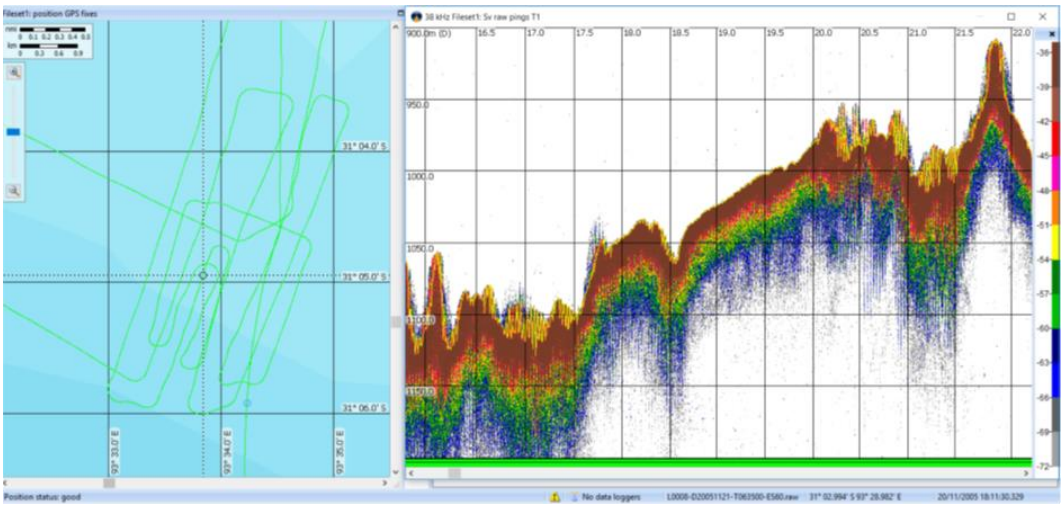


Figure 17 SImrad ES60 Identification of Cold Water Coral reefs

There are currently no more known regions of VMEs in the SIOFA region that are likely to be impacted by bottom fishing activities. However, we note the large number of VME encounters from bottom longline activities in the CCAMLR region, which has led to large scale closures in some areas. It is clear from Cook Island observations of bottom longlining and gillnetting in SIOFA, that longlines can be deployed on fishing grounds that trawlers cannot operate on. There is thus a risk to VMEs in SIOFA that cannot be dealt with under this BFIA, which is concerned with bottom trawling only.

4 Impact Assessment

4.1 Scoping of Issues

These assessments are based on application of the scientific method, and the precautionary approach. In this BFIA is documented the bottom fishing activity of Cook Islands flagged vessels in the SIOFA area from 1997 to 2016 to assess whether these activities have had any Significant Adverse Impact (SAI) on Vulnerable Marine Ecosystems (VMEs), and whether these activities provide for long terms sustainability of the deepwater fish stocks in SIOFA.

The Cook Islands concludes that there has been an evident failure of the earlier predictive modelling in the SIOFA area. Predictive modelling is not considered further in this BFIA, and the Cook Islands does not support continuation of this type of assessment. This current risk assessment uses actual data, rather than imputed data, to establish if there is any continuing risk of SAI. SPRFMO experiences with VME management may be informative for SIOFA to note, and this has been discussed and noted in previous SIOFA Scientific Committee reports.

It is important when scoping issues of concern, to avoid taking undue account of ill-informed or non-science based claims. In particular, the BFIA should be evidence-based; failure to consider evidence can seriously affect risk assessments. An example of this is the New Zealand 2009 BFIA for SPRFMO which implies coral provides an important habitat for orange roughy by a header illustration of a lone orange roughy swimming above coral. Research surveys, including the Louisville Ridge biodiversity study (MPI 2014) show this is assumption is false; a 'false' positive as defined under the Ecological Risk Assessment of the Effects of Fishing Framework (ERAEF) (Hobday et al, 2011). A term now being used for such images is "*Fake Biology*". From all the underwater camera footage recorded in deepwater surveys over the past decade, The Cook Islands knows of no image being posted of a large aggregation of orange roughy with extensive coral habitat underneath them.

In the SIOFA area, when the S-AOS acoustical optical system has been used on orange roughy aggregations at Sleeping Beauty and Boulder, no indications of coral or any VME indicators were evident on the videos. These are available on request and were previously shown at SIOFA SC.

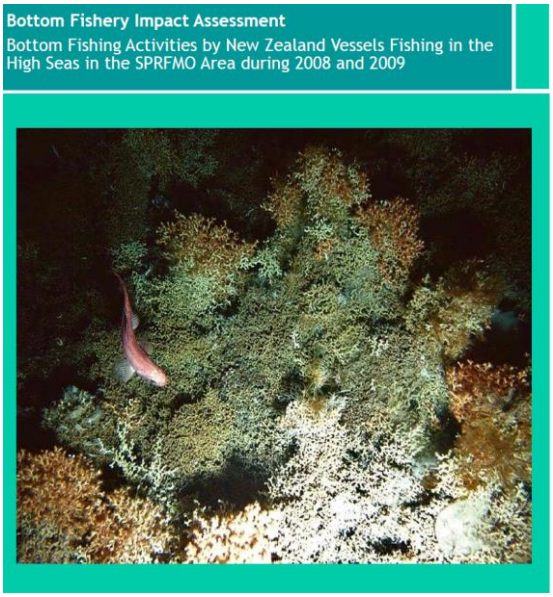


Plate 8 SPACWG2015-20 NZ Bottom Fishery Impact Assessment Cover Photo (a 'false positive')

The requirements for an RFMO to protect VMEs from significant adverse impacts resulting from bottom fisheries originated with United Nations General Assembly Resolution 61/105, which calls upon RFMOs: 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 refers to “vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals”

Subsequently, the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas adopted in August 2008 provided more comprehensive guidelines on the characteristics which could be considered to be evidence of VMEs. The FAO (2010) also attempted to correct the language of the UNGA resolution, which could be interpreted in different ways. FAO (2010) made it clear that bottom trawling is not a destructive fishing technique. The Guidelines also noted that Seamounts are not VMEs, though seamounts may have VMEs present. This is important scoping guidance for this BFIA.

4.2 Fished Area

4.2.1 Spatial Extent Processing

The fine scale bottom trawl data for the *FV Will Watch* was used to develop a bottom fished footprint for the SIOFA area using data from 1997 to 2016. The fine-scale position data are recorded electronically on the Seaplotpro ™ navigation system used on Cook Island vessels. This system logs gear down and gear up to degrees, minutes and decimal seconds.

For example:

GrDn S 36 48.83 E 052 4.869 GrUp S 36 48.83 E 052 4.868

The system is also able to log the actual net position calculated by the Simrad ITI system, where it picks up the IIGLL string. (:$IIGLL,3425.571,S,04409.811,E,065023,A). This reporting standard is not required by the SIOFA Data Standards.

In total 5,139 fine scale bottom trawl shots with both start and end position were available for spatial analysis from a total of 11,051 bottom trawl shots, and these covered all of the historical fishing grounds in SIOFA. For the remainder of the trawl shots, only degree/decimal minutes are currently available. Use of these non-fine scale trawl shots would have biased the fished footprint as they are only accurate to within 1 nautical mile. For midwater trawling a further 5,673 trawls were available with both start and finish position, out of 11,945 trawls.

Software program modifications are in development to increase the proportion of fine-scale bottom trawl records, but this increase in numbers is not expected to change the fished footprint, because most of the fishery is based on target trawls repeated on precise trawl paths that have been previously fished. The data from almost all of these were captured in the current analysis.

The navigational systems on board most deepwater trawlers consistently log bottom depth data. These data were combined with sidescan sonar data (described later), to build a bathymetric database of 135 million depth points in the SIOFA area by 2015. Virtually every feature shallower than 2000 metres (Ridge, Seamount, Bank, Knoll) in the SIOFA area is known, and bathymetric data available for this footprint analysis. In 2006, most of this database was already available and used to produce an area assessment of the amount of fishable habitat in different depth zones for different region boxes and strata in SIOFA (Table 4). All area calculations were made using Lambert Equal Area Azimuthal with central meridian and reference latitude roughly the mid-point of each box. The analysis was done by Seabed Mapping New Zealand Limited, and these estimates have been used in the following footprint analysis.

Bathymetric feature		0-100m	101-300m	301-700m	701-1000m	1001-15000m	over 1500m	Total (ie, feature area)
Ninety East Ridge		0.00	0.00	70.10	351.00	14,113.40	896,414.80	910,949.30
Broken Ridge		0.00	0.00	156.40	1,565.80	21,590.90	355,986.30	379,299.40
South West Indian Ridge		0.00	68.40	525.40	1,024.60	8,509.70	2,060,290.50	2,070,418.60
Walter's Shoal		83.50	104.80	652.00	16,562.90	26,239.40	255,054.30	298,696.90
Merged SWIR/WS		83.50	173.20	1,177.40	17,562.80	34,357.70	2,195,719.60	2,249,074.20
Total Feature Area		83.50	173.20	1,403.90	19,479.60	70,062.00	3,448,120.70	3,539,322.90

Table 4 SIOFA Bottom Fishing Area Analysis

To generate estimates of actual seabed swept area from the tow-by-tow data, all tows were buffered assuming a 25 metre swept area of the groundrope. As described earlier, the trawl doors and sweeps do not touch the bottom in normal trawling operations in the SIOFA region, thus this was considered the appropriate swept width. However, analyses with a 160 metre swept width between trawl doors were also done, which is the maximum door spread normally achieved by these vessels, as measured by door sensors. This buffering was carried out by implementing an ArcGIS spatial buffer of 12.5 m either side of each tow.[1] The resulting 25 m wide polygon trawl tracks were dissolved (ArcGIS / Dissolve) by fishing area for the whole period, to produce complex merged polygons of swept area as shown in Figure 18.

The result of dissolving is a full fine-scale analysis of actual true footprint impact. Fine scale data accurate to within 10 metres of the actual position, have been used.

Figure 18 shows a fishing fooprint on a ridge of the Southwest Indian Ridge in fine scale, where the trawls are from west to east down the side of a steep ridge. Most of the trawls are on one line. On many of the other trawl lines, the net became fast on the bottom. The total fished area on this entire ridge is 7.54 km^2, which is 2.2% of the fishable area on this ridge which is over 20 miles long (Figure 18). Four of the trawls shown are actually midwater trawls wrongly classified and not detected in this analysis. This is one of the more important orange roughy fisheries on the Southwest Indian Ridge.

A knoll in the Walter's Shoal area that has been extensively fished over many years is shown in Figure 20. For this knoll the total fished area is 3.94 km^2. Only one side of this knoll can be fished, as is shown by the trawl tracks. The other side is too steep to fish.

[1] The Cook Islands acknowledges Eagle Technologies, New Zealand for the provision of ArcGIS and technical support to MMR for this spatial analysis work.

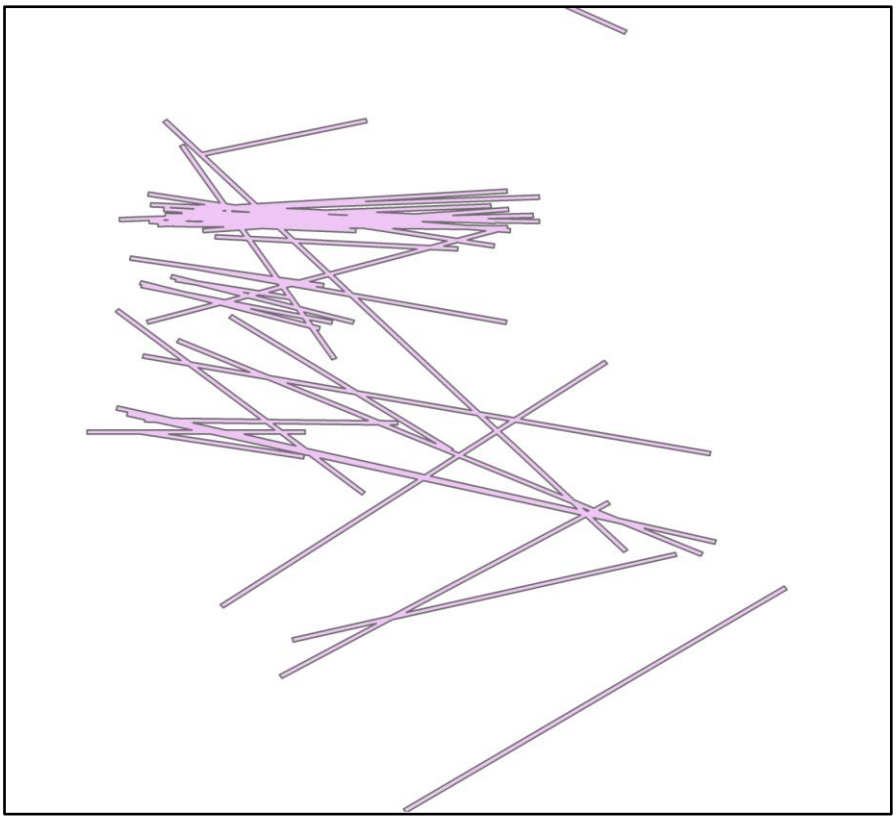


Figure 18 Dissolved trawl tracks on the Southwest Indian Ridge

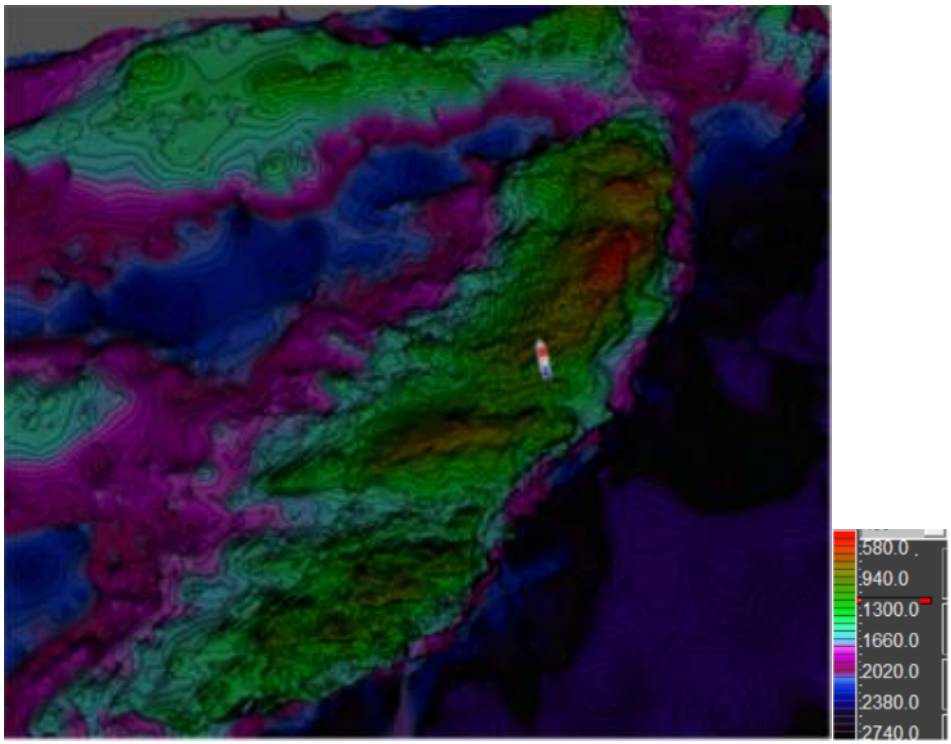


Figure 19 Bathymetry of a Ridge on the Southwest Indian Ridge

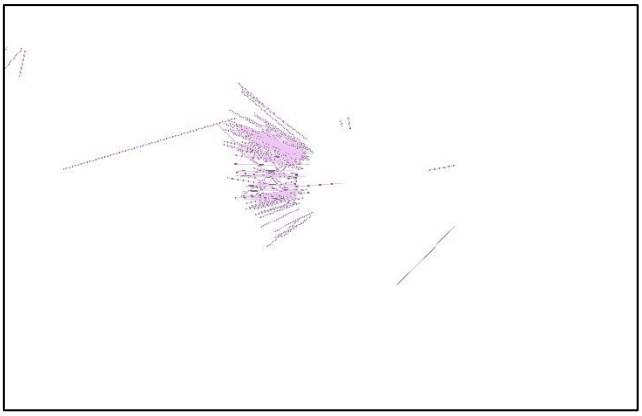


Figure 20 Fished Area Footprint for one Walters Shoal knoll.

The results of the analysis are shown in Table 5. Ninety East Ridge and Broken Ridge are not included in the analysis, as the bottom fished area in this region is insignificant (<.001%). Using the swept area of the groundrope for the Southwest Indian Ridge, the fished habitat is 0.74% of the total. If the distance between the doors is used, it increases to 3.31%. For the Walter's Shoal region, the bottom trawl impact is only 0.16%, increasing to 2.61% .

If the whole region of SIOFA is considered, only 0.16% of the potential fishable habitat from 0 metres to 1500 metres has ever been potentially impacted by bottom trawling. If we assumed that all midwater trawling touched the bottom for the entire tow, this increases to 0.28%.

This habitat includes rocky and elevated features, and sandy bottom habitat where an early exploratory fishery caught orange roughy, and also where a Russian research fleet surveyed in the 1970's.

Region	Fished Area (km2)					
	25 M BT	%	160 M Door	%	25 M All Trawl	%
South West Indian Ridge	74.63	0.74%	317	3.13%		
Walter's Shoal	68.37	0.16%	264	2.61%		
Total Feature Area	143	0.16%	581	0.64%	256	0.28%

Table 5 Fished Habitat Area SIOFA by Cook Island vessels 1997-2016

4.3 Interactions with VMEs

To best understand the risk to the resources, it is critical to assess the chances of orange roughy being found aggregated on a VME- "is it high, moderate or low?" likelihood. This evaluation needs real data, excluding 'false' positives, and using absence data.

The impact of bottom trawling on sensitive habitat is well accepted. If an orange roughy bottom trawl hits a single stand of emergent coral, such as a black coral tree, or stony corals, that coral will end up in the net and be recorded. All such interactions have been recorded since 2006 by Cook Islands vessels in the SIOFA area. If the bottom trawl impacts on dead coral, it is likely to result in a significant bycatch (=tonnes), and damage to, or loss of the net.

The largest orange roughy spawning stock in the world is on the North East Chatham Rise of New Zealand, and the orange roughy spawn primarily over soft sediment on a relatively flat bottom (Figure 21), across most of their range, but with limited spawning on one knoll. This stock was estimated to be 3x larger than the next two largest stocks, the Eastern Tasmanian stock and the East Coast North Island stock in New Zealand. The fourth largest stock was the Challenger Plateau stock in New Zealand where the fish have typically spawned on the flat, sandy, featureless bottom (e.g Northeast Flats) where no VME habitat is known.

The Northwest Chatham stock is different in that the fish spawn on two knolls, and biomass switches between these from year to year. One knoll is a volcano with a deep crater in the centre, and no historical evidence of VME encounters. Video footage over recent years confirm this, The other knoll has had major biodiversity studies that led to the knoll being closed to fishing to measure recovery rates of VMEs. The problem with the analysis is that it only considered the 'fished' habitat, and excluded the 'unfished' habitat which had extensive pristine coral habitat present. The fished habitat had no coral rubble observable in video recordings, and fishermen have said they never caught coral on this knoll.

Stock	**Stock Size B_o**	**Habitat type**	**Likelihood of VME**
North East Chatham	320,000	Flat bottom, mud	Extremely low
East Coast North Is.	95,000	Rocky, mud,	Extremely low
East Tasmania	C 90,000	Seamount	Low to moderate
Challenger Plateau	88,000	Flat sandy with some knolls	Extremely low
Northwest Chatham	66,000	Knolls 300-400 m high	Highly debatable
Louisville Ridge	C 20,000	Seamounts	Extremely low
Tasman Sea		Flat rocky habitat	Unknown-only presence recorded, not absence

Figure 21 Orange Roughy Spawning Habitat Northeast Chatham Rise New Zealand

The 'quantitative' assessments of likely VME distribution that have been widely described in the literature typically have used only presence data and extrapolated from these. In the SPRFMO assessments prior to 2015 there was a lack of absence data included from extensive biodiversity studies, with the resulting conclusion that VMEs were everywhere:

*"Several samples contained fewer than five species; these were judged to be failed samples, unrepresentative of the fauna present, and were excluded from analysis (Table 3.3.1.2). We note that these sites may have been characterized by sparse fauna" (*CSIRO 2006).

Other biodiversity studies in the Tasman Sea using the same survey technology (Anderson *et al* 2011) concluded that the latter conclusion may have been valid:

"Therefore, while many seamounts may support dense coverage of cold water corals with high associated biodiversity (Koslow et al, 2001; Clark et al., 2006, others support much sparser assemblages (e.g Sisters and Mongrel Seamounts, CSIRO unpublished data: Thresher pers.comm: Gifford Guyot- this study). Consequently it is clear that not all seamounts are equally capable of supporting high density assemblages even when rocky substrata are present.

The rocky substrata of peaks had sparse coverage of sessile organisms, characterised by mixed cold-water corals (e.g., Metallogorgia sp., Callogorgia sp., black corals (Order: Antipatharia, sponges (Class: Demospongiae and Hexactinellida (glass sponges)) and dead coral rubble….. but supported no dense habitat-forming biota." (Anderson *et al* 2011)

The conclusions of this paper carry no weight in the debate about risk to VMEs with bottom trawling in SPRFMO, despite being well described in the Australian BFIA for SPRFMO (SWG-10 DW01a).

In 2014, a biodiversity survey, again using the same research vessel and technology was carried out on Louisville Ridge. This survey searched the areas extensively fished by bottom trawl over many years and found ZERO impact from bottom trawling on VMEs on the seamounts. The conclusions from the draft report (MPI 2014) give important guidance for SIOFA and this BFIA:

"The greater depth at which the stony corals occurred was unexpected. The median depth of Solenosmilia and Goniocorella on the New Zealand slope and small seamounts is 900– 1000 m., whereas on the Louisville seamounts it was 1200–1300 m.

Similarly, the amount of dead, but intact, coral matrix was surprising, although this has also been observed in other parts of the New Zealand EEZ, the Macquarie Ridge, and off Tasmania. Follow up work is planned to age the coral, and hence enable us to evaluate whether a large "die off" could coincide with a major oceanographic event, be related to the seamounts slowly getting deeper with age, or be an effect of high sedimentation rates on the guyot-shape seamounts.

Our previous experience with seamount, knoll and hill features in the New Zealand region had implied that the summit and upper flank areas are often the best sites for finding high density coral "reefs". However, with the large guyot structure of the Louisville seamounts, the summit areas were plateau-like, and predominantly soft sandy sediment.

Stony corals were therefore patchy in their distribution, and were often localised in areas of steep and rough topography, such as ridges or small knob-like hills on the seamounts. Knowledge of the detailed bathymetry, and also the backscatter from the multibeam (enabling soft-hard to be discriminated) were key aspects in coral distribution. The relatively small spatial scale of biological

distribution compared to the relatively large-scale environmental parameter knowledge is a challenge. "(MPI 2014)

Conclusion 1: It is not possible to extrapolate from VMEs on knolls within the New Zealand EEZ to the high seas
Conclusion 2: Large amounts of dead coral appear common
Conclusion 3: VMEs are patchy in distribution and of relatively small scale
Conclusion 4: Sidescan sonar backscatter and knowledge of detailed bathymetry are key aspects in coral distribution

The SIOFA area is now one of the more heavily sampled regions of the ocean. By 2007 there had been extensive surveys, contrary to the view of Rogers et al (2007). Substantial information was presented by Shotton (2006), and some of the conclusions of this report were confirmed by Rogers et al (2012), who sampled seamounts identified by SIODFA as known to contain VME structures. The best information on potential VMEs has come from communication with Captains and crew who have spent 15 years at sea in the SIOFA area, spending up to 6 months at sea each year, fishing over the region. The important data set from these observations is the 'null' report or absence.

4.4. Habitat Mapping in SIOFA

The seafood company Sealord Group undertook a habitat mapping program for the Southern Indian Ocean in 1996. Sealord is the owner of the Cook Islands company United Fame Investments (UFI) which operates the *FV Will Watch*. The survey program was carried out by the University of Hawaii Mapping Research Group (HMRG), and included marine scientists and geologists. The first survey was carried out prior to any exploratory fishing being undertaken. The first 3 years of fishing activity were all undertaken in the surveyed area in the eastern Indian Ocean.

In 1999 the *FV Will Watch* began exploratory fishing operations in the western Indian Ocean, and undertook another full habitat mapping program in this area in year 2000. The results of all this work were presented to SIOFA SC1 (SC-01-INFO-17). These results are commercially sensitive and confidential to the work of the Scientific Committee. However, one chart (from a total of 91) is shown in Figure 23. As noted, the high backscatter from the sonar is shown in black, and sediment or sand is in lighter colour. As was noted in Section 4.3, the advantage of this technology is that it assists in definition of VME habitat. This has enabled the full definition of and rocky habitat in the SIOFA region, and areas of reef-forming corals when they form around gravel or sedimented habitat.

We note that this habitat mapping research is substantially more extensive than the limited area covered in the SPRFMO region, which led to the Zonation analysis undertaken by New Zealand. They used data from a limited survey on Louisville Ridge (which did not detect any fishery impact on VMEs) to extrapolate over the entire western South Pacific.

The *FV Will Watch* has this sidescan sonar imagery and bathymetry available to view on the bridge navigational computers, and thus while fishing is able to avoid potential VME's. For example, Figure 23 shows the coral reefs in Fool's Flat, surrounded by sedimented habitat. Investigative trawl shots were carried out on this sediment without risk of impact on VME's. This is one of the suite of tools used to avoid significant adverse impact on VME's. Figure 24 shows one chart from the year 2000 survey which shows the change in terminology to Habitat Mapping.

The data from these habitat mapping surveys were reviewed by a science team during development of the Benthic Protected Areas in the SIOFA area, as described in FAO 1020. A number of both

known and likely VME areas were closed to fishing for Cook Island vessels in June 2006, and this compliance approach was adopted by Australia.

The habitat mapping work has shown that defining 'Seamounts' in any analysis of impacts in the SIOFA area is of limited use because a large part of the current and historical fishery is not on seamounts, but on Ridges and Banks. Most of the previous impact assessments in SIOFA and SPRFMO **incorrectly** conclude that fishing effort distribution is not independent of VME distribution and that target species are often concentrated at the same finer scale locations as VMEs, including on seamount peaks and the heads of submarine canyons (e.g Rogers et al 2008). This is not true in the SIOFA region, and as described in Section 4.3, fishing effort is completely independent of VME distribution. There is no evidence that orange roughy aggregate to spawn on VMEs.

The Australian BFIA (SC-01-INFO-25) indicated the feature "Austral Alps" was a seamount of potential VME habitat. This feature is actually 400 km^2 in planar area (Figure 22), and none of the fishery is on a peak (top). It is a complex geological structure that drops to 6000 metres on the western side. The only fishing activity takes place on the southern side of a single ridge, with less than 1% of the entire habitat, at less than 1600 metres, ever impacted by bottom trawl. In addition, the trawls also do not land on the top of the ridge, but deeper than this to avoid the small black oreo dory which aggregate on the top. This is target trawling.

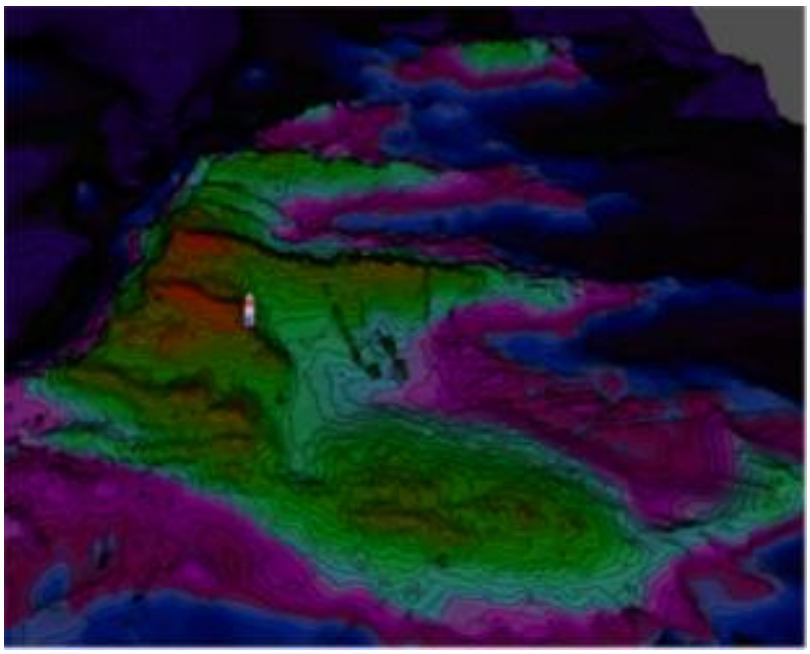


Figure 22 "Austral Alps' or 'David's on the Southwest Indian Ridge

On Walter's Shoal, shown in Figure 24, there are no classical Seamounts that the IUCN refer to as centres of biodiversity (Rogers and Taylor 2012). Most of the areas here are connected by water less than 2000 metres, and there are few areas here that could be called special centres of unique biodiversity. The ecosystem in this fishing area is not very diverse, and there is a very low chance of the fishing activity reducing this biodiversity. This fishing area is highly unlikely to contain rare species that do not occur elsewhere, except in the shallow areas around the actual Walter's Shoal, which is closed to fishing for Cook Island vessels. The similar spread of deepwater species across this region- orange roughy, alfonsino, cardinalfish, boarfish, suggest the levels of endemism are low and fishing is highly unlikely to lead to any localised or global extinctions.

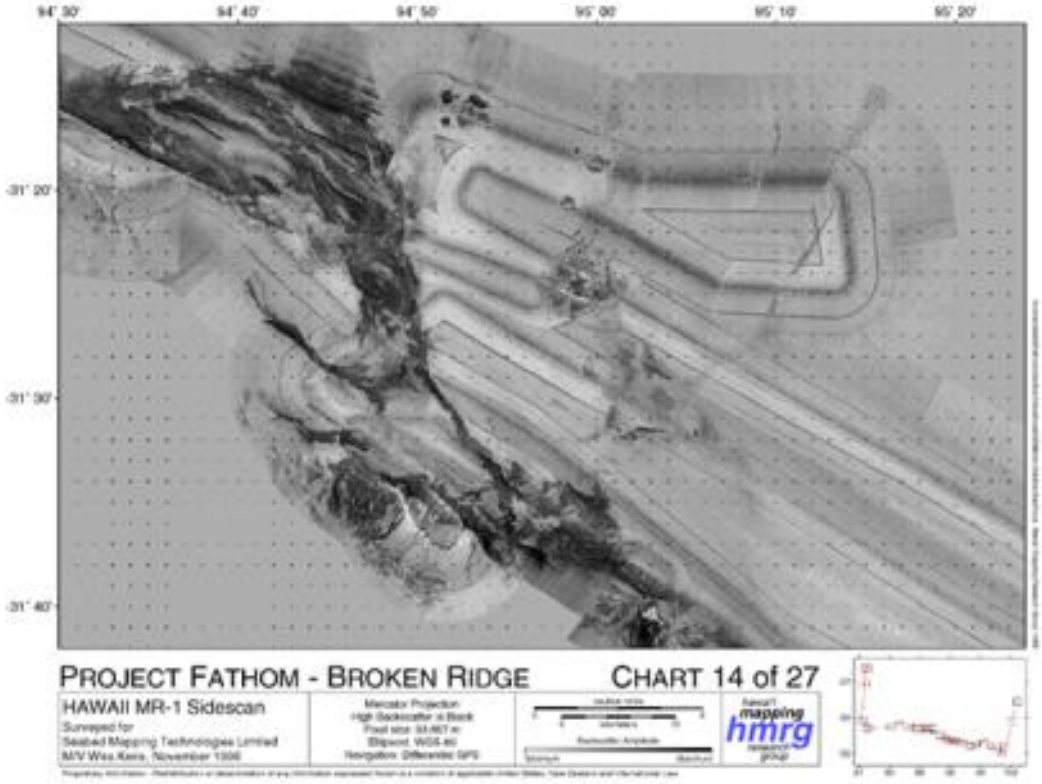


Figure 23 Broken Ridge Sidescan Sonar Image including Fool's Flat and Rusky

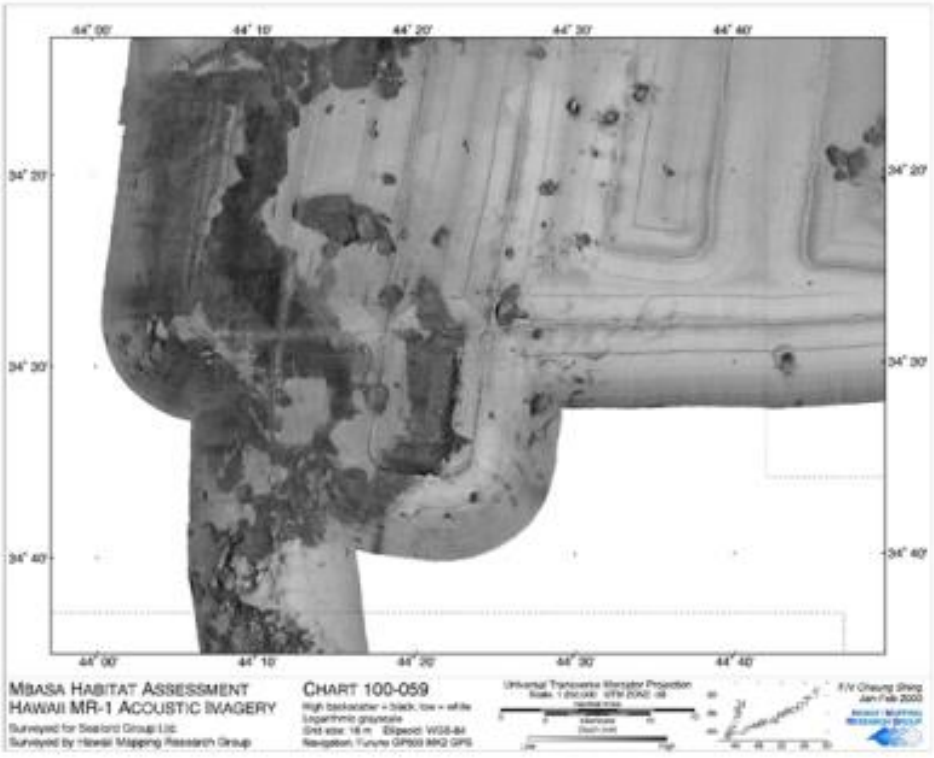


Figure 24 Year 2000 Habitat Assessment of Southern Walter's Shoal

However, the sidescan sonar imagery cannot identify VME structures that may occur on hard rock substrate. Other tools have been used by Cook Islands vessels to identify these. The Seacorder Net Camera system is a robust unit that has been regularly deployed on a bottom trawl headline or groundrope, to observe fishing operations, and use of this is required when the Cook Islands VME encounter protocol is triggered.

4.5 Spatial Scale of Fishing Activity in the SIOFA Area

It is not possible to calculate the bottom area impact of midwater trawls by the Cook Islands vessels, as noted earlier. This is because only a relatively small (21.7%) proportion of the tows actually touch the bottom, and of these 36.3% had bottom contact for I minute or less. The actual contact point cannot generally be recorded, as the skipper are usually very intent on keeping the gear clear of the bottom as the fish are positioned in the mouth of the net. If the net does touch the bottom, the groundrope parts as the breakaway link does its job, and the net will need to be repaired. Hence it is an accident when the bottom is touched, but is a possibility. The method has been rated as low impact in SPRFMO.

From the geospatial analysis of the bottom trawl footprint, it is possible to calculate the proportion of habitat actually fished (Table 6). For the Southwest Indian Ridge, using the 25 m groundrope contact results in 0.74% of this habitat actually trawled. Even when an assumption is made of the impact being for the full extent of the doors and sweeps (160 metres), the fished area only increases to 3.13 %. For Walter's Shoal region, the 25 metre bottom contact is on only 0.16% of the habitat.

The region of 90 East and Broken Ridge are not included as a separate region, because the total number of bottom trawls in this region is less than 100. This region is primarily a midwater trawl fishery, and if it is assumed that both midwater and bottom trawls had equal impact, the overall area fished only increases from 0.16% to 0.28%.

A large proportion of the habitat, in depths of 400-1500 m is simply unfishable by bottom trawl. If the potential VME habitat was considered to be 100% of the fishable depths down to 1500 metres, which is what early predictive models suggested, then the current analysis shown in Table 6 indicates that 99% of the VME habitat is not at risk from the fishery. As shown in this table the fished area by 25 M Bottom Trawl is 74.63 km^2 on the Southwest Indian Ridge, or 0.74%.

Region		Fished Area (km2)							
	Area	25 M BT	% Fished	% Unfished	160 M Door	% Fished	All Trawls	% Fished	% Unfished
South West Indian Ridge	10,128	74.63	0.74%	99.26%	317	3.13%			
Walter's Shoal	43,643	68.37	0.16%	99.84%	264	2.61%			
Total Feature Area	91,202	143	0.16%	99.84%	581	0.64%	256	0.28%	99.72%

Table 6 SIOFA Fished Habitat by Cook Islands vessels

4.6 Bottom Contact Times

From the detailed fine scale data, 4,480 bottom trawl tows were available with accurate touch down and lift off bottom data to produce an analysis of true contact time (Figure 25). Most trawls (>50%) only had from 5 to 15 minutes of bottom contact time.

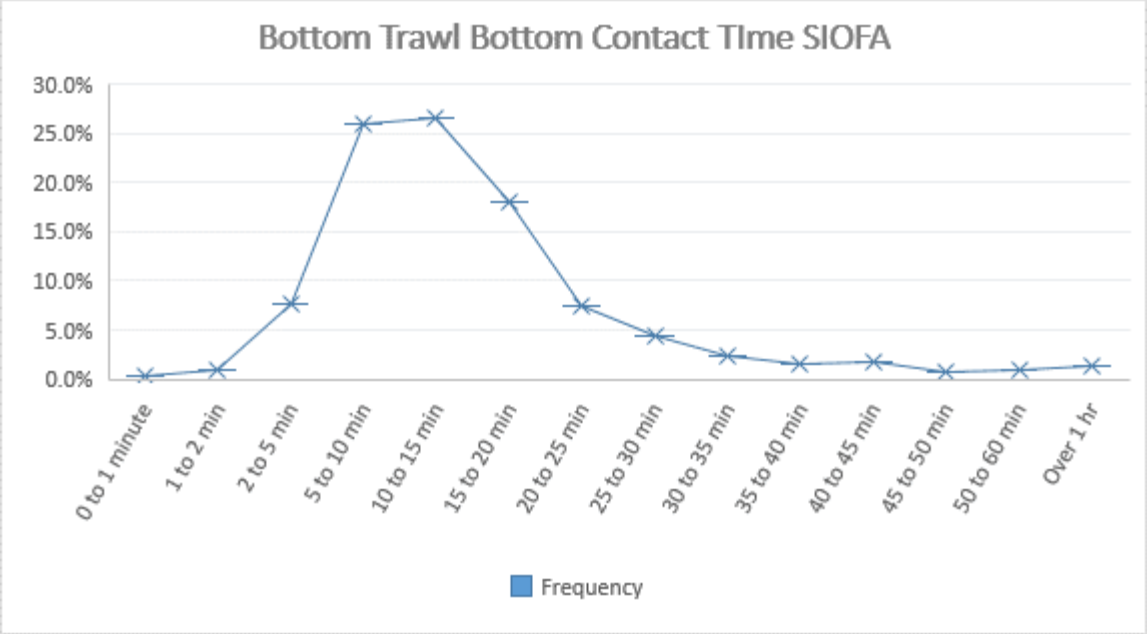


Figure 25 Bottom Trawl Contact Time FV Will Watch 1997-2017

5 Information on Status of the Deep-sea Stocks to be Fished

5.1.1 Orange Roughy Research Programs and Stock Status

The Cook Islands has presented a number of reports to the Scientific Committee, detailing the extensive science programs that have been carried out since 2004. The principal paper given to the first meeting of the Scientific Committee (SC01-15) was the summary of extensive acoustic surveys carried out by Sealord Group over many years. This report outlined the large number of identified spawning stocks in the SIOFA region, more stocks than exist in New Zealand and Australia combined. This showed the magnitude of work that would be required for stock assessment of Orange Roughy in this region.

The initial results from this Orange Roughy stock assessment work suggested that the current harvest levels by Cook Islands vessels were sustainable in the long term, as the catch level was below that likely to come from any Harvest Control Rule for SIOFA when developed. Other scientific papers presented to the Scientific Committee included detailed biological information by stock.

In 2017, three New Zealand Orange Roughy Stocks were certified by the Marine Stewardship Council, and the assessments for these stocks were underpinned by robust acoustic data and age composition. These assessments went through an extensive external science review process, before final acceptance. Prior to this, no orange roughy stock assessments had been accepted in New Zealand. This set a benchmark for SIOFA to match, and a process by which reliable stock assessments could be undertaken. In addition, the FAO Expert Review of Orange Roughy has provided guidance. A number of steps have been put in place in SIOFA to bring together the first deepwater stock assessment.

The first Scientific Committee discussed potential review processes and the need to agree standards on which to accept stock assessments. The Committee noted that part of the quality control and peer review included a review of the data that are available and may be included in the assessment.

The Scientific Committee has a key role in the peer review, but it was noted that at times specific expertise may be required, such as in the discussion of the acoustic data.

To advance the timetable for the review, a preliminary review workshop was held under the FAO-ABNJ program in February 2017 and the report from this meeting was presented to SC2 (SC-02-08 (01) Indian Ocean Orange Roughy acoustic survey ABNJ review (Cook Islands). This workshop was financially supported by CSIRO, FAO, and Sealord Group, and acoustic data made fully available to participants.

This review process began with an agreed terms of reference developed by SC2.

1. Describe the use and interpretation of acoustic data within a deep-water orange roughy stock assessment framework. This would consider various levels of uncertainty (e.g. species identification, survey design, target strength, absorption, calibration and data quality). This would also propose guidance to evaluate the quality of the data and the corresponding estimations.
2. Recommend methods for acoustic data collection from fishing vessels without on-board dedicated technicians to meet the stock assessment objectives above; including issues such as data collection, quality control, survey design and ancillary species identification, target strength and biological parameters.
3. Provide an evaluation of the existing industry data, focused on one or two fishing grounds, against the adopted framework and how these data may be used within single stock assessments, as for orange roughy. This will include consideration of uncertainty in species identification, absorption, dead zone, data quality, calibration and survey strategy. This will be dependent on access to the industry data collected to date negotiated with the assistance of the SIOFA Secretariat.

The second workshop was held in Puerto Montt, Chile, from 22-26 January 2018. Again this workshop was partly funded by SIOFA, but also significantly supported by CSIRO, and by Sealord Group. This review of the assumptions and approaches used, and the uncertainty, was in our view more intensive than ever carried out in an RFMO before. It was certainly more rigorous than any SPRFMO reviews of stock assessment data.

Key outputs from the review include the first ever Target Strength (TS) measurements for SIOFA orange roughy were obtained from fish identified. In situ TS measurements were made using the Sealord net-mounted AOS (S-AOS), deployed from the FV Will Watch. The AOS was attached to the headline of a standard commercial orange roughy demersal trawl (see Ryan et al., 2009 and Kloser et al., 2013 for a detailed description of the AOS). The trawl was towed at a speed of 2-4 knots (1.2-1.7 ms^{-1}) through aggregations that were considered to be orange roughy. The net was towed across the top of Boulder bank at a depth of about 1100 m with the AOS at 2-12 m above the seabed (this applies to the areas where TS measurements were made). Target strength measurements were based on 6 minutes of optically verified acoustic data collected between 01:45-01:51 GMT (Figure 26). These results will be submitted as part of the CSIRO Acoustic Review to the Scientific Committee in 2018, but some of the results are presented here, to show recent progress.

The Cook Islands notes there are no in situ TS measurements for Orange Roughy in any other RFMO.

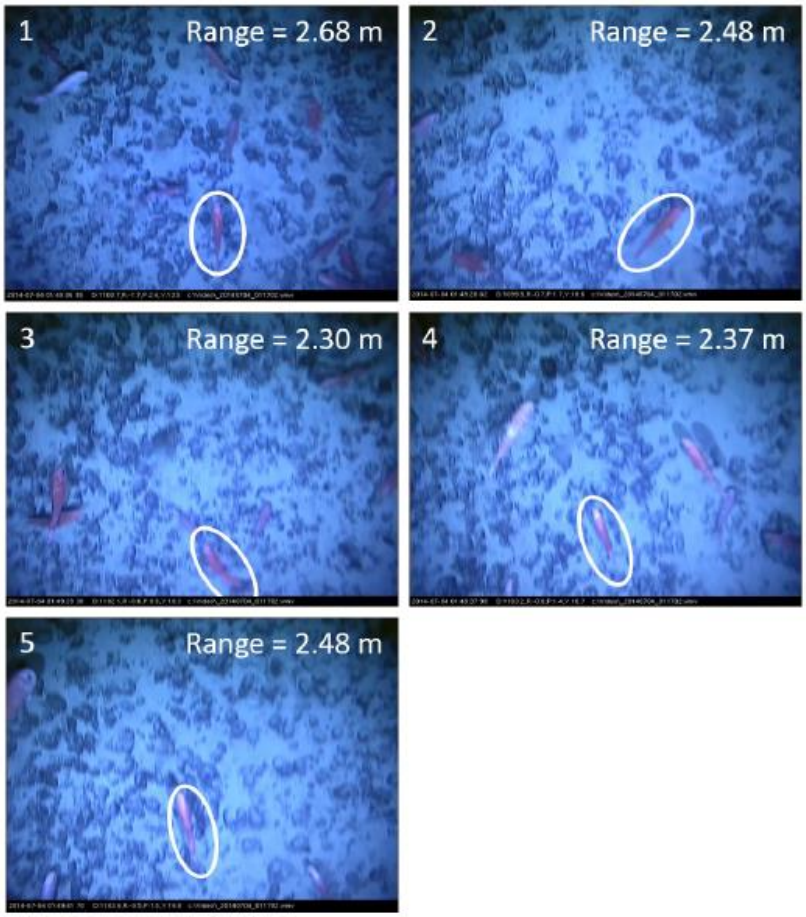


Figure 26 Boulder Bank Orange Roughy detected in S-AOS in 2014

5.1.2 SIOFA Orange Roughy Stocks with Acoustic Biomass Estimates

To date there have been 111 orange roughy acoustic surveys in the SIOFA area with data of suitable quality for assessment (Table 7). There were no acceptable surveys in 2016 on FV Will Watch, even though extensive research was undertaken, because a new Simrad transducer had a quadrant fail during July 2016, only later discovered. Potentially some data could be analysed from 2016 if necessary, by using other data to calibrate the sounder.

Only 2 of these surveys (2005 and 2009 SB) have been extensively reviewed. However, the results from the review suggest that many of these other estimates could be used in stock assessments, following modification to some of the area assumptions. More importantly, for some of the standard transect surveys that were undertaken and reported in this table under the geostatistical approach, the biomass indices are much lower than that reported under the traditional Jolly and Hampton (1990) ESDU approach.

This was established during the review process, with the estimate of biomass from the 2009 Geostatistical analysis for SB at 10, 618 tonnes compared with 17,050 tonnes for the traditional approach used in New Zealand and Australia. The advantage with the geospatial approach is that it makes use of surveys that are not carried out to the normal regular grid survey approach.

Year	Species	Aggregation	Survey ID	Type	Status	Year	Species	Aggregation	Survey ID	Type	Status
2004	ORH	Boulder	1	Hull Mounted	Assessed	2009	ORH	Sleeping Beauty	1	Hull Mounted	Assessed
2004	ORH	Boulder	2	Hull Mounted	Assessed	2009	ORH	Sleeping Beauty	13	Hull Mounted	Assessed
2004	ORH	Boulder	3	Hull Mounted	Assessed	2009	ORH	Sleeping Beauty	14	Hull Mounted	Assessed
2004	ORH	Boulder	6	Hull Mounted	Assessed	2009	ORH	Sleeping Beauty	1201	Hull Mounted	Assessed
2004	ORH	Harvey's	1	Hull Mounted	Assessed	2009	ORH	Sleepy Hollows	1202	Hull Mounted	Assessed
2004	ORH	Sleeping Beauty	3	Hull Mounted	Assessed	2009	ORH	Sleepy Hollows	8	Hull Mounted	Assessed
2004	ORH	Eric's	1	Hull Mounted	Assessed	2009	ORH	Wrongford's	14	Hull Mounted	Assessed
2004	ORH	Harlot	1	Hull Mounted	Assessed	2009	ORH	Wrongford's	5	Hull Mounted	Assessed
2004	ORH	M.M	1	Hull Mounted	Assessed	2009	ORH	Wrongford's	60	Hull Mounted	Assessed
2004	ORH	M.M	2	Hull Mounted	Assessed	2009	ORH	Abby Road	68	Hull Mounted	Assessed
2004	ORH	M.M	3	Hull Mounted	Assessed	2010	ORH	Boulder	23.1	Hull Mounted	Assessed
2004	ORH	M.M	4	Hull Mounted	Assessed	2010	ORH	Boulder	7.1	Hull Mounted	Assessed
2004	ORH	M.M	5	Hull Mounted	Assessed	2010	ORH	BD	30.1	Hull Mounted	Assessed
2004	ORH	Scud	4	Hull Mounted	Assessed	2010	ORH	EP	23.1	Hull Mounted	Assessed
2005	ORH	Angelo's	12	Hull Mounted	Assessed	2010	ORH	Grover	14.1	Hull Mounted	Assessed
2005	ORH	Angelo's	14	Hull Mounted	Assessed	2010	ORH	Novel	12.1	Hull Mounted	Assessed
2005	ORH	Angelo's	June-18	Hull Mounted	Assessed	2010	ORH	Sleeping Beauty	July afternoon-7	Hull Mounted	Assessed
2005	ORH	Angelo's	19	Hull Mounted	Assessed	2010	ORH	Sleeping Beauty	July morning-7	Hull Mounted	Assessed
2005	ORH	Angelo's	21	Hull Mounted	Assessed	2010	ORH	Sleepy Hollows	30.1	Hull Mounted	Assessed
2005	ORH	Boulder	14	Hull Mounted	Assessed	2010	ORH	Wrongford's	27.11	Hull Mounted	Assessed
2005	ORH	Boulder	15	Hull Mounted	Assessed	2010	ORH	Wrongford's	27.12	Hull Mounted	Assessed
2005	ORH	Da Vinci	14.1	Hull Mounted	Assessed	2010	ORH	Wrongford's	28.1	Hull Mounted	Assessed
2005	ORH	Da Vinci	14.2	Hull Mounted	Assessed	2010	ORH	Wrongford's	28.11	Hull Mounted	Assessed
2005	ORH	Harvey's	11	Hull Mounted	Assessed	2011	ORH	Sleepy Hollows	July-15	Hull Mounted	Assessed
2005	ORH	Sleeping Beauty	11	Hull Mounted	Assessed	2011	ORH	Zedric	August-13	Hull Mounted	Assessed
2005	ORH	Sleeping Beauty	12.1	Hull Mounted	Assessed	2011	ORH	Sleeping Beauty	1 july	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	12.2	Hull Mounted	Assessed	2012	ORH	Boulder	8 july	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	12.3	Hull Mounted	Assessed	2012	ORH	Novel	1 june	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	14.1	Hull Mounted	Assessed	2012	ORH	Danilo	I june	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	14.2	Hull Mounted	Assessed	2013	ORH	Sleeping Beauty	1 june	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	19	Hull Mounted	Assessed	2013	ORH	Sleeping Beauty	1 july	Hull Mounted	Not Assessed
2005	ORH	Sleeping Beauty	21	Hull Mounted	Assessed	2013	ORH	Boulder	1 june	Hull Mounted	Not Assessed
2005	ORH	Sleepy Hollows	10	Hull Mounted	Assessed	2013	ORH	Boulder	1 july	Hull Mounted	Not Assessed
2005	ORH	David's	20050908	Hull Mounted	Assessed	2014	ORH	Sleeping Beauty	1 july	AOS-ID	Partial Assessment
2005	ORH	Zedric	20050908	Hull Mounted	Assessed	2014	ORH	Sleeping Beauty	1 july	AOS-ID	Partial Assessment
2007	ORH	Boulder	39270	Hull Mounted	Assessed	2014	ORH	Boulder	1 july	AOS-ID	Partial Assessment
2008	ORH	David's	0	Hull Mounted	Assessed	2014	ORH	David's	1 sep	AOS-ID	Not Assessed
2008	ORH	M.M	0	Hull Mounted	Assessed	2014	ORH	Saddle	1 mar	AOS-ID	Not Assessed
2008	ORH	Saddle	0	Hull Mounted	Assessed	2014	ORH	Saddle	I mar	AOS-ID	Not Assessed
2008	ORH	Sleeping Beauty	0	Hull Mounted	Assessed	2014	ORH	Big Ted's	1 apr	AOS-ID	Not Assessed
2008	ORH	Sugarol	0		Assessed	2014	ORH	Eric's	1 sep	AOS-ID	Not Assessed
2008	ORH	Wrongford's	0	Hull Mounted	Assessed	2015	ORH	Boulder	July-4	Hull Mounted	Assessed
2008	ORH	Dreamtime	0	Hull Mounted	Assessed	2015	ORH	Boulder	June-28	Hull Mounted	Assessed
2008	ORH	Scud	0	Hull Mounted	Assessed	2015	ORH	OK Coral	July-2	Hull Mounted	Assessed
2008	ORH	Bill and Ben	0	Hull Mounted	Assessed	2015	ORH	Porky's	June-29	Hull Mounted	Assessed
2008	ORH	Boulder	0	Hull Mounted	Assessed	2015	ORH	Sleeping Beauty	June-29	Hull Mounted	Assessed
2009	ORH	Boulder	14	Hull Mounted	Assessed	2015	ORH	Wrongford's	June-21	Hull Mounted	Assessed
2009	ORH	Da Vinci	21	Hull Mounted	Assessed	2017	ORH	Wrongford's	Jun-24	Hull Mounted	Not Assessed
2009	ORH	Grover	19	Hull Mounted	Assessed	2017	ORH	Novel	Jun-25	Hull Mounted	Not Assessed
2009	ORH	Robb's	24	Hull Mounted	Assessed	2017	ORH	Sleeping Beauty	Jul-1	Hull Mounted	Not Assessed
2009	ORH	Zedric	17	Hull Mounted	Assessed	2017	ORH	Sleeping Beauty	Jul-5	Hull Mounted	Not Assessed
2009	ORH	Zedric	16	Hull Mounted	Assessed	2017	ORH	Boulder	Jun-22	Hull Mounted	Not Assessed
2009	ORH	Angelo's	17	Hull Mounted	Assessed	2017	ORH	Boulder	Jun-23	Hull Mounted	Not Assessed
2009	ORH	Sleeping Beauty	12	Hull Mounted	Assessed	2017	ORH	Boulder	Jun-28	Hull Mounted	Not Assessed
						2017	ORH	Sleepy Hollows	Jul-1	Hull Mounted	Not Assessed

Table 7 Orange Roughy Acoustic Surveys by FV WIll Watch in SIOFA

5.1.3 Age Composition and Biological Data for Orange Roughy

The other critical components to an orange roughy stock assessment include age composition and biological parameters. To advance this the vessel crews on FV Will Watch in 2017 made a special effort to collect samples of 100 otoliths per trawl shot from Sleeping Beauty, and smaller samples of 40 otoliths per trawl, across SB and other aggregations. This was a major increase in sampling rate, established by NIWA, New Zealand, for the age composition sample size used in the New Zealand stock assessments. The historical samples of 10 fish per trawl, which had been part of the data collection program since 2006, were inadequate for this stock assessment.

The ageing work was direct contracted by Sealord Group with NIWA, to follow the same protocols as proposed by SC02. The preliminary age composition (Figure 27) shows that the modal age of fish in the population is 30-40 year old orange roughy, but some are as old as 140 years. The difference between these fish, and those in New Zealand and Australia, is that these orange roughy are 2 kg in weight at 25 years old, compared with 1 kg. This means the SB orange roughy put on weight and length much faster than fish in either Australia or New Zealand.

This means that in a spawning aggregation measured acoustically, there is only half the number of fish in a SB aggregation of 20,000 tonnes, than would be in the St Helen's spawning aggregation in Australia.

A large number of additional biological measurements were taken in 2017 to ensure the necessary data were available for stock assessment. In Figure 28 the size composition data are presented for 10, 312 fish, and the length weight relationship by sex in Figure 29.

These data are critical to the stock assessment that is planned for the SIOFA SAWG in February 2018, and this assessment will produce Orange Roughy biological parameters and estimated natural mortality for the SB stock. It is anticipated that M for SIOFA orange roughy will be in the same range (0.03-0.06) as natural mortalities found in New Zealand and Australia.

Data for other spawning stocks in SIOFA are available for many areas to the same data quality standards as the SB data set.

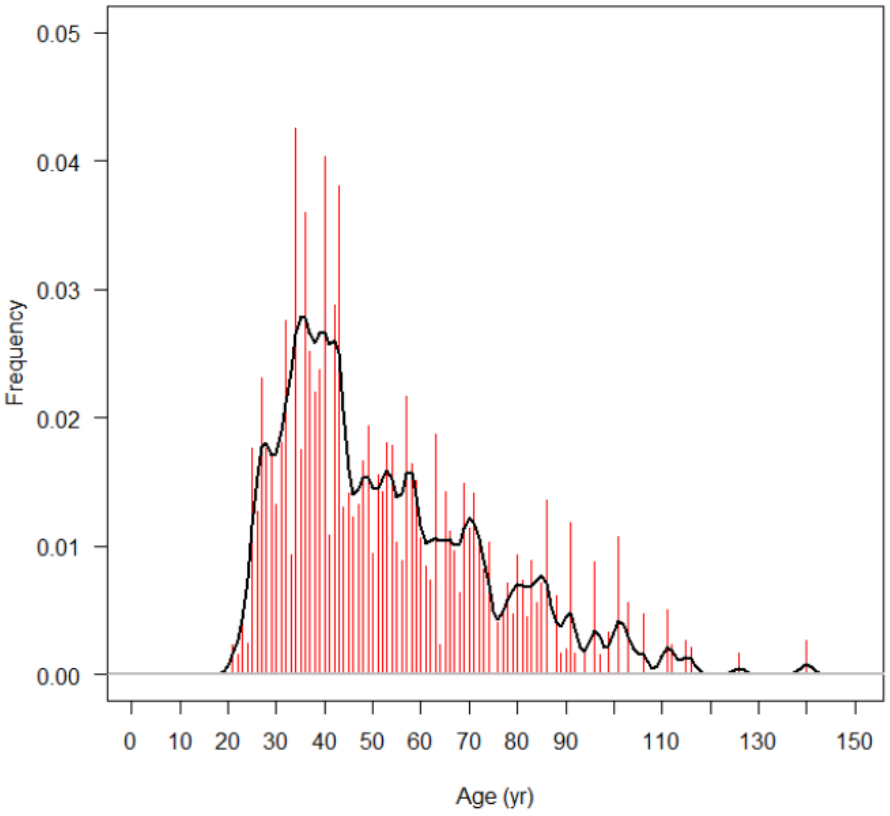


Figure 1: 2017 Sleeping Beauty estimated age frequency (red bars) with a smoothed density through the age estimates (black curve).

Figure 27 Age Composition Sleeping Beauty 2017

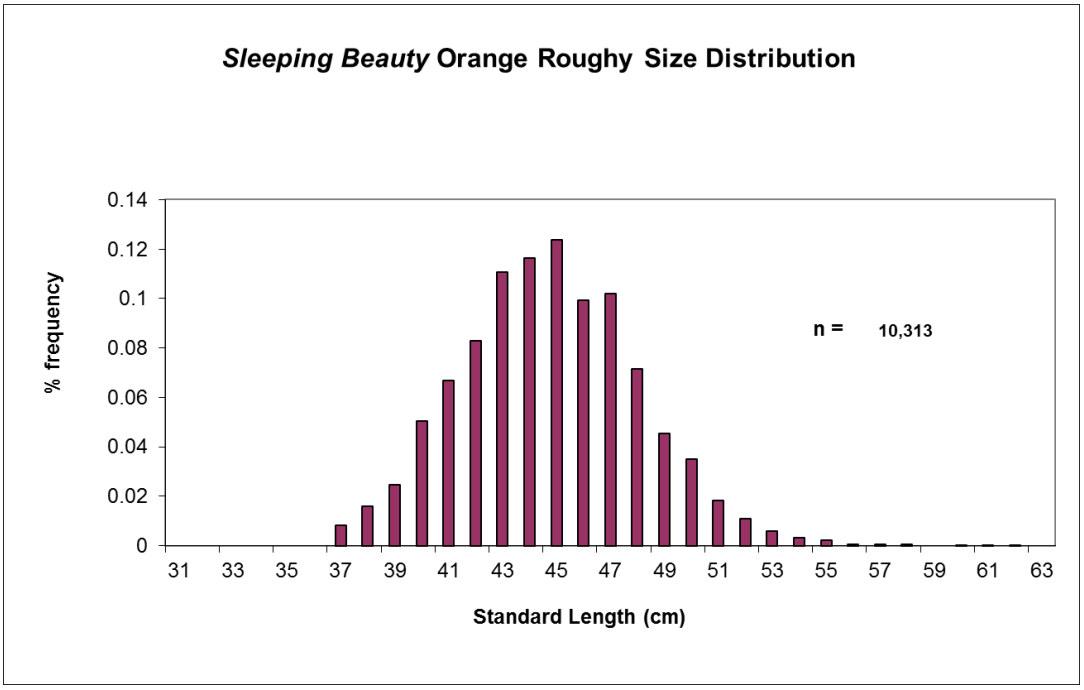


Figure 28 SB Size Composition 2006-17

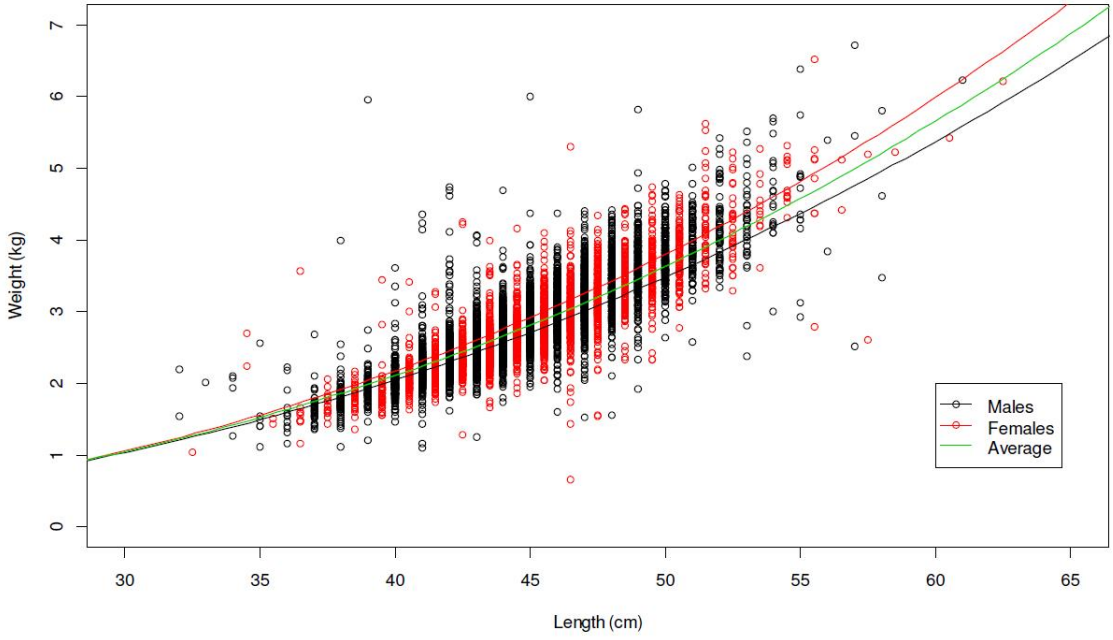


Figure 29 Length Weight Relationship by sex, Sleeping Beauty

5.1 4 Stock Assessment and Harvest Control Rules for SIOFA Orange Roughy Stocks

A stock assessment for Walter's Shoal orange roughy is in progress and will be reviewed by the SAWG meeting in March 2018. As part of this stock assessment, the data outlined above will be used to establish the biological parameters and develop a Harvest Control Rule (HCR) for orange roughy in the SIOFA area. This will be the first HCR ever developed in an RFMO for orange roughy.

5.2 Alfonsino Research Programs and Stock Status

Cook Islands vessels have a long history of data collection on Alfonsino stocks in the SIOFA area. Some of the results of this work were published in the FAO Global Review of Alfonsino provided to the SC by Japan as SC-02-INFO-01 Global Review of Alfonsino (*Beryx spp*.). In particular, this report highlighted the major problems around the world with stock assessment of alfonsino, and the failure to adequately track stock status with catch per unit indices. The major problem with these is the 'zero' tows, which are trawls targeted at an aggregation of alfonsino, which miss the fish. It is well understood in the commercial fishery that the alfonsino become more reactive and avoidance increases with fishing activity.

Concern are highlighted the Cook Islands 2016 National Report about the stock status of Western Indian Ocean alfonsino stocks, with a decline in mean catch rate over the period 2013-2016. A request was made to the Scientific Committee to establish a Working Group to develop management and harvest strategies for this fishery, to commence in 2017. The updated trend to the end of 2017 is shown in Figure 30. Catch per unit effort does not provide a good measure of current stock status in terms of depletion. With this index shown, the stock may have reduced from 90%Bo to 50%Bo, and it is not possible to establish this from the data. The Cook Islands notes there was substantially more effort in the fishery during 2010-2011 than in recent years.

In the summer of 2017-2018 the effort in the Eastern SIOFA area trebled, and this is another potential indicator of stock issues to address in the Western.

The Cook Islands supports the maintenance of a freeze on footprint and expansion of effort in the Alfonsino fishery. This freeze across all CPs should be maintained until the SAWG has undertaken stock assessments on alfonsino.

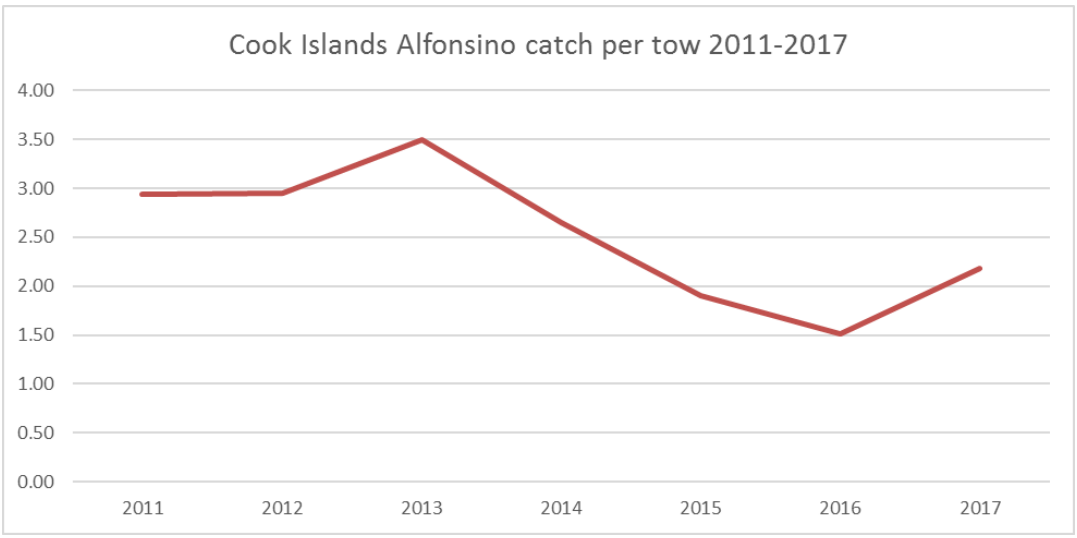


Figure 30 Cook Islands Alfonsino Tonnes per Trawl 2011-2017

Biomass estimates from acoustic surveys on alfonsino were included in (SC01-15), and these have been reproduced in Table 8. Figure 31 and Figure 32 show two acoustic surveys by *FV Nikko Maru No. 1* in the western SIOFA area in 2013 that are suitable for biomass estimation. A full list of the star surveys carried out in the SIOFA area is being compiled, and there are more than 30 surveyed aggregations. Most of these have not been worked up, as emphasis has been given to the Orange Roughy work, where the Target Strength (TS) issues were better understood.

Table 8: Surveyed area (A, km^2), estimated biomass index (B.I., ton) and coefficient of variation (CV) for Alfonsino in the Indian Ocean by feature, reporting zone and year (2007 & 2008). Precision of estimates exceed convention about significant digits to assure numeric consistency among related quantities.

Zone code	Feature code	2007			2008			Mean	
		A	B.I.	CV	A	B.I.	CV	B.I.	C.V.
3654	EURO				2.4	386	0.34	386	0.34
2787	ENNO	13.2	1666	0.81				1,666	0.81
	ENSO	3.9	78	0.62				78	0.62
	CRNE				1.1	349	0.64	349	0.64
	TB2E				1.9	1701	0.52	1,701	0.52
	TB2W				3.3	1032	0.99	1,032	0.99
	Sub-total	17.1	1744	0.77	6.3	3082	0.44	4,826	0.40
3357	FREO				4.1	1269	0.33	1,269	0.33
Total		17.1	1744	0.77	12.8	4737	0.30	6,095	0.32

Table 8 Alfonsino Biomass Estimates from Acoustic Surveys

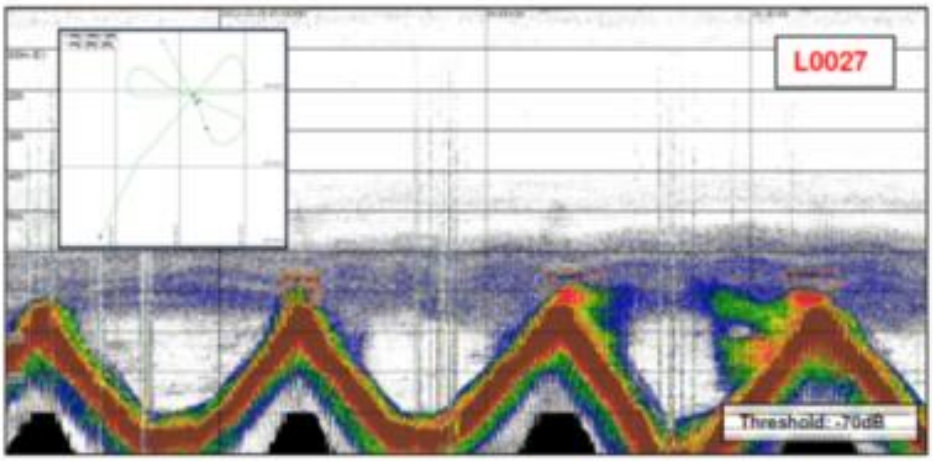


Figure 31 Alfonsino Acoustic Survey SWIR FV Nikko Maru No. 1

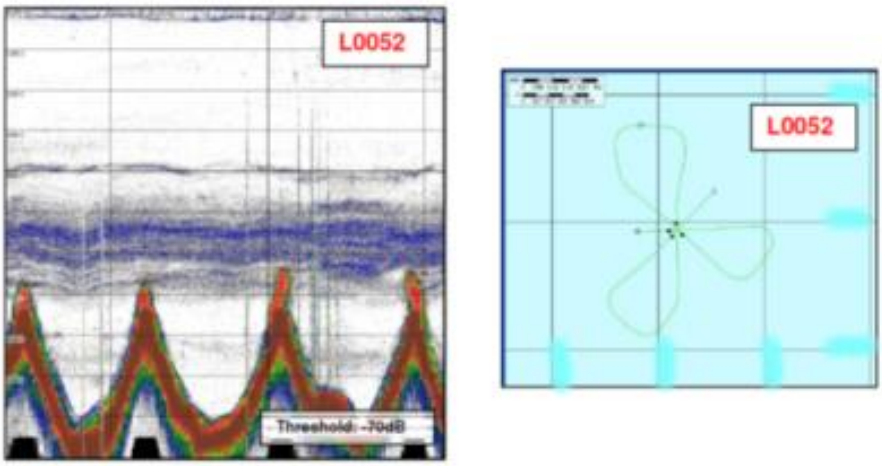


Figure 32 January 2013 Alfonsino Acoustic Survey Walter's Shoal by MV Nikko Maru No. 1

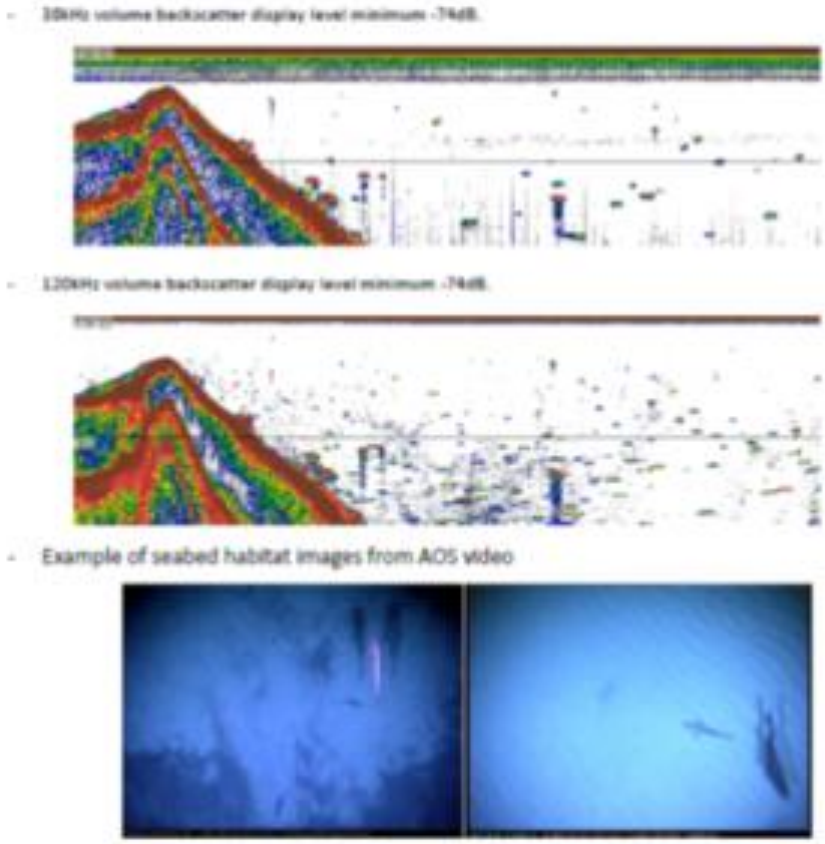


Figure 33 Alfonsino targets in AOS survey for Target Strength (TS) Measurements

5.3 Deepwater Sharks

Paragraph 6a of CMM 2016/01 instructs the SIOFA Scientific Committee to provide advice and recommendations to the Meeting of the Parties on the status of stocks of principal deep-sea fishery resources targeted, and, to the extent possible, taken as bycatch and caught incidentally in these deep-sea fisheries, including straddling fishery resources by 2019.

The SIOFA Scientific Committee proposed that ecological risk assessment (ERA) is a practical approach for addressing the potential and current effects of fishing on target stocks and also those caught incidentally in SIOFA's deep-sea fisheries. The SC recommended that a working group be established under the SIOFA Scientific Committee to progress work related to ecological risk assessments required to address this action.

The ERAWG was established in late 2017, and initially the working group has focused on an ERA for deepwater sharks in the SIOFA Agreement Area. Initial work has included the development of species list and collation of the species' productivity attributes. Deepwater sharks are defined as those with core distributions below 200m depth. The species list was developed using the FAO Guides to Deep-sea Cartilaginous Fishes of the Indian Ocean, Ebert et al. 2013 and various other sources in the published literature. The Cook Islands, Southern Indian Ocean Deepsea Fishers' Association, provided sharks bycatch data and a number of photographs of deepwater chondrichthyans, which were used to refine the species list. There were initially over 200 species included in the species list, but this was iteratively reduced to a final list of 101 species. These species comprised sharks (76%), batoids (15%) and chimaeras (9%).

The ERAWG reviewed preliminary risk scores from the PSA and SAFE assessments, which were based on the existing model assumptions. The ERAWG discussed that there a still a number of assumptions on which general SC agreement is needed before the models can be updated and systematic review of risk scores can take place. Once this is completed, it will be possible to look at risk, and consider management actions if required. A critical component in the analysis will be the actual fished footprint by Cook Islands vessels, as presented in this BFIA.

Shark bycatch recording has been routine on Cook Islands vessels since 2007 when the sampling program was introduced. These data were provided to the ERAWG, along with catch location. The ERAWG discussed whether the bycatch data provided were used to verify pup numbers and whether the collection of these data was valuable. It was noted that information on pup numbers was derived from published literature, but the ERAWG strongly emphasised that the collection of these data is extremely useful for understanding species biology and that this data collection should continue. The reporting format used by Cook Islands vessels is described under the next section.

The total quantity of sharks taken by both midwater and bottom trawl from 2011 to 2017 are shown in Table 9. This includes live releases such as Sleeper Sharks, which have been released and recaptured. As a proportion of total greeenweight catch of all species, the annual landings are less than 1%. The sharks taken as bycatch in this fishery, are also a target fishery by bottom and tuna longliners and gill netters, with the annual deepwater longline catch approximately 50 times as much as the Cook Islands bycatch.

Year	Tonnes	% of total catch
2011	14.8	0.2%
2012	17.5	0.3%
2013	23.3	0.4%
2014	33.8	0.6%
2015	27.0	0.4%
2016	34.7	0.7%
2017	29.8	0.4%

Table 9 Shark Annual Discards 2011-17

5.4 Bycatch Species

The major bycatch species taken by Cook Island vessels are black, smooth and spiky oreo dory. In general the vessels try and avoid these species as there is a limited commercial market available. The bycatch is known to be sustainable, because there are very large aggregations of these species on the Southwest Indian Ridge (Figure 34), and spiky dory appear to be more abundant than orange roughy. At some time in the future, the acoustic data could be used to produce abundance estimates, but the fishing mortality on these species is extremely low. The annual retained catches of the minor target species and bycatch species are shown in Table 10.

	BNS	BOE	SSO	SOR	CDL	BBF	BOR
1997	0	0	0	0	0	0	16
1998	0	0	0	0	0	0	0
1999	5	0	101	187	41	0	4
2000	33	0	76	282	157	0	120
2001	1	4	98	514	185	0	1
2002	4	6	50	466	49	0	4
2003	5	0	41	269	79	0	1
2004	7	3	11	290	81	0	13
2005	4	2	76	133	305	0	1
2006	25	5	17	69	324	190	56
2007	132	2	11	88	167	5	309
2008	57	3	30	122	290	0	557
2009	50	1	170	67	844	347	866
2010	65	97	23	157	191	321	454
2011	15	7	10	140	372	281	217
2012	33	5	5	83	191	47	31
2013	92	3	1	75	266	280	286
2014	73	6	27	118	383	180	45
2015	23	2	2	0	464	161	123
2016	10	4	10	0	855	60	127
2017	23	6	8	184	467	30	54

Table 10 Minor target species and retained bycatch 1997-2017

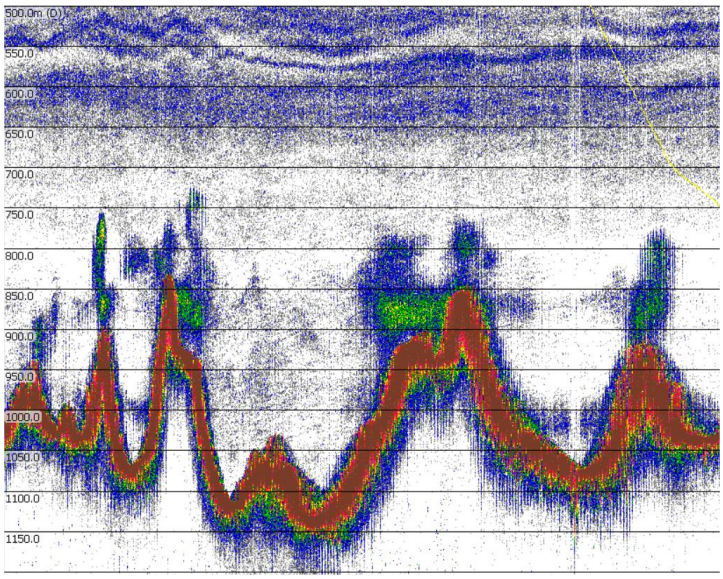


Figure 34 Oreo Dory Aggregations Southwest Indian Ridge

6.0 Risk Assessment

This report is a bottom fisheries impact assessment on the operations of Cook Islands vessels in SIOFA. The BFIAS also specifies that elements of risk, management and mitigation be considered. Some elements of the ecological risk in this assessment are quantitative, as result of the extensive data availability for the Cook Islands. However other elements are qualitative. We are unable to take account of the cumulative impacts of other threatening activities in the SIOFA region, such as bottom longlining impacts, deep sea mining and ocean acidification as the Cook Islands is not involved in any such activity nor contribute to any cause of these effects in the Indian Ocean.

6.1 VME Risk Assessment

Intensity - The crux of this criterion is 'what is the specific site being affected'? The sea floor that is affected is where there is contact with the bottom trawl. As indicated in sections 2.2, 4.2 and 4.5 of this BFIA, tows are usually undertaken on highly-defined lanes. In general, where fishing occurs, the impact will be intense, chronic and have severe impacts. However, of relevance is the intensity or severity of the impact of the bottom trawl *on the ecosystem, community, habitat or population* **as a whole.** These concepts are frequently confounded, even though they are different and raise different considerations. The FAO Guidelines refer to 'ecosystem integrity', i.e. the state of being whole and undivided, which again raises immediate difficulties in interpretation. The intensity can be set at severe at the local scale, but this is not appropriate for the BFIA, which should consider the wider VME impact, and is indeed noted in paragraph 18 of the Guidelines that notes that when determining the scale and significance of an impact, among the factors to be considered is "*the spatial extent of the impact relative to the availability of the habitat type affected*".

Duration – The duration of the impact, depending on the species, may be **long,** if a VME is actually impacted. This is well documented in a range of studies that are not reported in this BFIA. However, it recent research shows that it is not uncommon to find VMEs that have been destroyed naturally.

Spatial extent – The spatial impact relative to the distribution of any VMEs has been described quantitatively in this assessment as being **extremely small**. For the seamounts and ridges of the Southwest Indian Ridge, 99.29% of the fishable habitat is untouched, and much is untouchable. And for the slopes, banks and knolls of Walter's, large areas are impossible to fish with a bottom trawl.

Cumulative impact - The risk from cumulative impact is **low**, as most trawls are carried out on repeat trawl lines. If the trawl removes the benthos, the duration will be long for that site, but it is not possible to remove what is not there. Hence the impact remains constant, not cumulative.

All known VMEs are closed to fishing by Cook Island trawler vessels, which reduces risk even further.

6.2 Fisheries Risk Assessment

A robust stock assessment for deep sea stocks is currently being developed for Orange Roughy, with relevant reference points, and this is expected to constitute a high standard of risk assessment. The outputs of this stock assessment, relative to the reference points, will indicate the risk to the stocks.

Although this assessment is initially covering one proposed management area (WSR), it is underway for other stocks. The Cook Islands began acoustic biomass surveys in 2004 to ensure that harvest levels were sustainable and concluded that the stock status relative to unfished state in the major Cook Islands fishing areas was high. Some stocks had been significantly fished down during the period 1999-2001, but these have been lightly fished or not fished since then. After 15 years of low

catches, signs of stock recovery have been monitored with acoustic surveys. However it is not possible to monitor many of these stocks in the Northern Ridge area, because the spawning aggregation time is the same as in the Southern Walters Shoal and Walter's Seamount areas.

The status of Alfonsino stocks in the SIOFA region is uncertain. Substantial data sources are available, notably acoustic surveys, but to date there has been insufficient research support available to process these data.

The stock status of bycatch species is uncertain, but risk assessments are under way for deepwater sharks. The fished habitat analysis is critical to establishing a quantitative measure, and as 99% of the habitat of deepwater sharks is not fished, we conclude that there is a very low risk to these stocks from Cook Islands fishing activities.

6.3 Overall Risk.

The overall risk classification of our fishing activity can be evaluated from the combination of the criteria used. The risk is the product of the *consequences* of an undesirable ecological event happening and the *chance* that it might happen.

The most important criteria in this evaluation is the Spatial Extent, which substantially reduces the overall risk. All impacts are at a local scale, when or if they occur. All known VMEs are closed to fishing by the Cook Islands. Despite the duration of any impact being long and intense, 99% of the habitat remains unaffected; and monitoring, management, and mitigation measures are in place.

Thus, the overall risk of the Cook Islands fishing activity having a Significant Adverse Impact on VMEs and bio-diversity in the SIOFA region is concluded to be **LOW**.

7 Monitoring, Management and Mitigation Measures

The Cook Islands has a comprehensive monitoring system in place for SIOFA. This includes all vessels covered by a vessel monitoring system and certified Cook Islands Fisheries Observers onboard for 100% of voyages. The Observers are cross-endorsed from the existing Pacific Islands Regional Fisheries Observer (PIRFO) certification programme, and are fully trained and certified Observers withcross-credit in trawl method and practice, achieved by additional training in New Zealand under Cook Islands supervision.. This approach has proven to be very successful, and a further cross-endorsement training programme is planned for Rarotonga in April 2018.

The Cook Islands fully supports the self-sampling research programs that have been in operation on Cook Islands vessels since 2004, prior to the formation of this RFMO. The substantial databases collected by this programme form the basis for both stock assessments of deepwater species in SIOFA, and incidental bycatch data, being the foundation for the ecological risk assessments undertaken by the Scientific Committee ERAWG. The detailed coral reporting by vessels since 2006 substantiates the low impact of this fishery (SIODFA 2007) Additionally, with every trawl shot carried out the vessels record incidental shark bycatch, along withany potential VME indicator species, is recorded.

There are a large number of isolated seafloor features in the Indian Ocean. Strong and variable currents affect target fishing. The Ministry of Marine Resources (MMR) VME encounter protocol requires that the presence of more than 60 kg of live coral and/or 400 kg of live sponge indicates a VME encounter that must be reported to Director Offshore at MMR within 24 hours. If any

subsequent trawl within 1nM of the encounter trawl contains more than 30 kg of live coral/and or 200 kg of live sponge the vessel must not fish within 5nM of that area until the Ministry of Marine Resources has completed an investigation. However, if the vessel deploys an underwater camera system on the trawl net, and the Cook Islands Observer verifies that no substantial VME structures (such as a Cold water reef community) are present, fishing can continue, pending outcome of the investigation.

Because of the complex ridge and rocky benthic habitat and variable ocean currents in the Indian Ocean, the species targeted in SIOFA are often only accessible to fishing for short periods. The protocol is therefore designed to avoid a fishery being closed unnecessarily because of a trawl net being pushed significantly away from a known trawl lane by currents and causing an accidental encounter. Some regions of relatively flat deepwater habitat also have large numbers of 100kg – 5000 kg boulders that may be rolled into a bottom trawl which have, in the past, sometimes been declared as VMEs by Fisheries Observers. This classification is problematic in that granite or basalt rocks are not likely to be rare, endemic nor significant habitats.

The Cook Islands notes that other RFMOs are rapidly progressing to spatial management as a standardised conservation and management measure to minimise bottom fishing impacts, in preference to move-on rules. This follows the original UN Resolution which recommends RFMOs move towards spatial management, and have move-on rules as a backup when this is not possible. This development recognises holistic management values achieved via spatial management that are not possible within a move-on rule framework.

As SPRFMO noted in their Scientific Committee report in 2017, “move-on rules provide a rapid response to evidence of vulnerable marine ecosystems in bottom fisheries and they can be used to develop protective measures for VMEs in the early stages of a fishery when information is scarce. However, once objectively-designed spatial management measures have been implemented to prevent significant adverse impacts on VMEs, move-on rules provide little additional benefit for VMEs and they have significant costs in terms of monitoring requirements and operational uncertainty for fishers.”

One paper presented to SPRFMO (SC5-DW08), considered that the potential information gathering benefits of move-on rules can be better met using structured and mandatory collection and review of benthic bycatch in bottom fisheries. Move-on rules are best viewed as an interim data collection and protection measure until evidence-based and comprehensive measures are in place.

The Cook Islands fully supports the use of Benthic Protected Areas (BPA) conservation closures to meet the requirements of Resolution 61/105. Many areas in SIOFA are already identified and closed to Cook Islands vessels due to the potential for significant adverse impact on known VMEs by bottom impact activity, and these were identified earlier in this BFIA.

Cook Islands vessels intending to transit any BPA are directed to:
a. Give at least 24 hours advance notice to MMR prior to entering or exiting any BPA;
b. Ensure their vessel monitoring system polls once every hour while in theBPA; and
c. Require that fishing gear is properly stowed before entering, and in transit through, a BPA and not able to be deployed.

7.1 VMS Monitoring

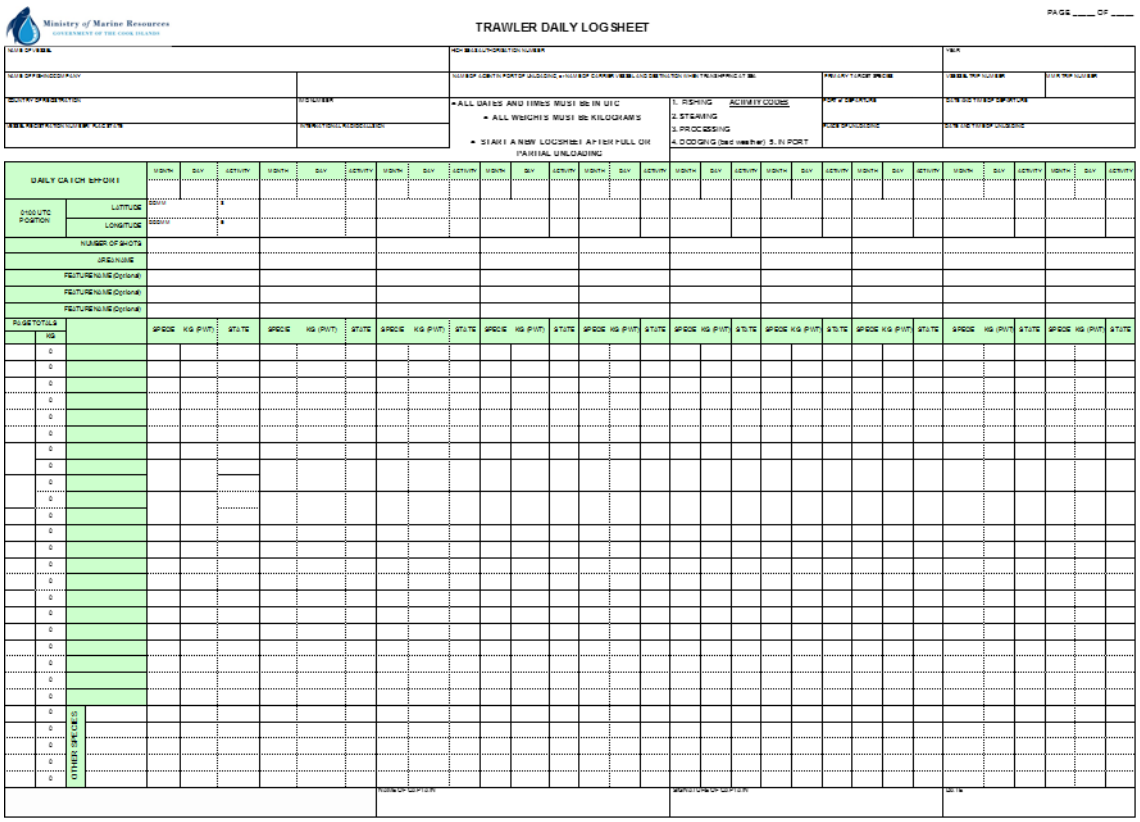
Cook Islands vessels are required by law to carry and operate VMS systems which poll once an hour via Inmarsat-C to the service provider (Marinecom). The vessels are monitored on a large screen at the National Oceans Monitoring Centre, housed at MMR in Rarotonga, using advanced track

webmapping provided via internet from Marinecom of Auckland, New Zealand. *FV Nikko Maru No. 1* uses a Blue Finger AZUR TRAC- SC (TT30220) and *FV Willwatch* operates a Sailor H16622D. The systems are accurate to a few meters in normal operating conditions and meet the SIOFA Data Standards.

7.2 Catch and Effort Reporting

The Cook Islands has introduced a new standardised catch and effort spreadsheet for 2018 to replace the historical recording forms used by the vessels; combining this with the previous Cook Islands daily report. The vessels have been recording fine scale catch and effort data for many years, but in different systems. The daily logsheet contains some fishing information, but primarily the daily production record (Table 11). A separate tow by tow record is also required, detailing estimated catch weight by species, and position accuracy to degrees,minutes andseconds. These logbooks fully comply with SIOFA Data Standards.

Historical data is currently being transferred and transcribed to this new format, and will be maintained by the Data Manager at MMR. Duplicate copies will be maintained on each vessel.


Ministry of Marine Resources
GOVERNMENT OF THE COOK ISLANDS

TRAWLER DAILY LOGSHEET

PAGE ____ OF ____

• ALL DATES AND TIMES MUST be IN UTC
• ALL WEIGHTS MUST be KILOGRAMS
• START A NEW LOGSHEET AFTER FULL OR PARTIAL UNLOADING

1. FISHING ACTIVITY CODES
2. STEAMING
3. PROCESSING
4. DODGING (bad weather) 5. IN PORT

DAILY CATCH EFFORT

0100 UTC POSITION — LATITUDE, LONGITUDE

NUMBER OF SHOTS

AREA NUME

FEATURE NAME (Optional)

FEATURE NAME (Optional)

FEATURE NAME (Optional)

FLEET TOTALS — KG

SPECIE | KG (FWT) | STATE

OTHER SPECIES

Table 11 Cook Islands Daily Trawler Logbook

7.3 Shark Reporting

For every trawl shot a report is produced on shark bycatch (Table 12), and the forms returned to MMR, and to SIODFA. These forms exceed the SIOFA Data Standards with the detail of data collected. Vessel crews have been heavily involved in development of the FAO Shark Guide for the Indian Ocean, trialling the guides, photographing unusual or unidentified species and providing this information directly to FAO. Factory managers have taken part in identification workshops held in

Mauritius. They also had training from the Pacific Shark Research Centre, with Paul Clerkin taking two voyages on the *FV Will Watch*, as shown on Discovery Channel's "Alien Sharks" program. From this collaboration, vessel crews are well trained in searching for "wanted" sharks.

SIODFA Shark Bycatch Record

Southern Indian Ocean

Deepwater Fisher's Association Shark Bycatch Record

Vessel: Willwatch

Trip 71

Date	Tow No.	Time Net		Depth (m)		Features	Trawl	Species	No. Sharks	Length	Weight	Sex	Pups	Comments
		Tow Start	Tow End	Start	Finish	Code				(cm)	(kg)	(m/f)	(y/n)	
03 Mar. 2017	1	440	545	875	836	Platt's Plateau	153	ETM	1	61	1.2	M		
03 Mar. 2017	2	947	1052	830	878	Platt's Plateau	153	NIL						
05 Mar. 2017	3	436	542	743	730	Platt's Plateau	153	NIL						
05 Mar. 2017	4	1912	1949	750	740	Avis	153	SCK	1	105	5	M		

Table 12 Shark Bycatch Record Form

7.4 VME Reporting

Every trawl shot is recorded in a Corals Bycatch spreadsheet and links the tow number to the individual tow record (Table 13). There are currently 52 indicator species in the list with codes that link to a SIODFA guide, and the list includes various coral types, sponges, and volcanic rock. This record meets and exceeds the SIOFA Data Standard.

SIODFA

Southern Indian Ocean

Deepwater Fisher's Association Corals Bycatch Record

Date	Tow No.	Time Net		Depth (m)		Features	Trawl
		On bottom	Off bottom	Start	Finish	Code	
20 July 2015	1	2031	2037		1020	Timbucktoo	M/W
20 July 2015	2	2348	2355	1190	1310	I.T.M	BT
21 July 2015	3	805	821	1180	1300	Pott's	BT
21 July 2015	4	1110	1130	1180	1310	Pott's	BT
21 July 2015	5	1609	1616	750	880	Rainbow	M/W
21 July 2015	6	1810	1818	750	895	Rainbow	M/W
22 July 2015	7	1032	1049	900	1110	Saddle	BT
23 July 2015	8	1017	1025	1049	1200	MM	BT
23 July 2015	9	1257	1300	1140	1180	MM	BT
23 July 2015	10	1609	1613	740	740	Kettles	M/W
23 July 2015	11	1903	1907	840	960	Kettles	M/W
24 July 2015	12	429	446	950	1050	Scud	BT
25 July 2015	13	1007	1022	780	1110	Robb's	BT
25 July 2015	14	1245	1254	1090	1190	Zedrick's	BT
25 July 2015	15	1446	1451	880	970	Robb's	BT

Table 13 VME recording form

7.5 Vessel Activity Reporting

Vessel activity reporting provides information on other fishing vessels in the area, and potential IUU operations. These reports were requested by SIODFA originally, and now they form part of the reporting requirements for MMR.

7.6 Seabird Interaction Reporting

A vessel seabird reporting form for any incidental bycatch of seabirds is completed for every voyage. These reports are additional to SIOFA Data Standards. The data collected under this program would enable any increased impact of fishing to be detected.

7.7 Marine Mammal Reporting

The Cook Islands has requested both Observers and masters to take note of all marine mammals observed during transits and fishing operations, and provide this in a standard return. These reports are additional to SIOFA Data Standards.

7.8 Seabird Interaction Mitigation Measures

A full Vessel Seabird Management Plan (VSMP) has been in operation on vessels since 2012, following a United Nations FAO Observer undertaking a voyage in the SIOFA area and noting some seabirds feeding on discharged offal. An example of this Management Plan is included as a separate paper to the BFIA. These measures were adopted to ensure there is now zero risk to seabirds from the fishing operation, and follows the approach successfully adopted for factory fishing vessels in New Zealand. Since then we have had no records of seabird interactions being noted by Observers on board Cook Islands vessels, and conclude that Cook Islands fishing operations in the Indian Ocean have a zero risk to seabirds.

"Seabirds were present in varying numbers throughout the trip. Initially, when there was less wind and less catch, 10-15 birds were often cruising in the wind currents behind the vessel. Near the end of the trip larger numbers of birds were seen cruising in the wind currents, landing on the water and also eating the offal. The birds seemed completely uninterested in the whole fish, both when the trawl net was floating on the surface (sometimes up to 1 hour when the fish was being washed back) or on deck. Four to five seabird species were seen. Though the offal floated towards the back of the boat the seabirds were never observed closer than about 3 m or so from the warps and were usually more concentrated toward the port side near the offal shoot or behind the vessel as the offal floated on the surface. No bird strikes were observed by the reporting officer" Sanders (2011).

References

Anderson et al (2011) Deep-sea bio-physical variables as surrogates for biological assemblages, an example from the Lord Howe Rise. Deep-Sea Research II 58 (2011) 979–991.

SIRO (2006) Biodiversity survey of Seamounts and Slopes of the Norfolk Ridge and Lord Howe Rise. Final report to the Department of the Environment and Heritage (National Oceans Office) June 2006.

Ebert, D.A. (2013) 'Deep–sea Cartilaginous Fishes of the Indian Ocean. Volume 1. Sharks.' (FAO species catalogue for fishery purposes. No. 8, Vol. 1. Rome, FAO.) pp 256.

Ebert, D.A. (2014) 'Deep–sea Cartilaginous Fishes of the Indian Ocean. Volume 2. Batoids and Chimaeras.' (FAO Species Catalogue for Fishery Purposes. No. 8, Vol. 2. Rome, FAO.) pp 138.

FAO (2010) Report of the FAO/UNEP Expert Meeting on Impacts of Destructive Fishing Practices, Unsustainable Fishing, and Illegal, Unreported and Unregulated (IUU) Fishing on Marine Biodiversity and Habitats. Rome, 23–25 September 2009. FAO Fisheries and Aquaculture Report No. 932 FIRF/R932 (En)

FAO (2013) Report on the FAO Regional workshop on the development of species identification guides for deep-sea cartilaginous fishes of the Indian Ocean, Flic en Flac, Mauritius,16-18 January 2013 FAO Fisheries and Aquaculture Report No. 1050, Rome.

FAO (2016) Global review of alfonsino (Beryx spp.), their fisheries, biology and management, by Ross Shotton. FAO Fisheries and Aquaculture Circular No. 1084. Rome, Italy.

Hobday, A.J., et al. (2011). Ecological Risk Assessment for the Effects of Fishing. Fisheries Research 108, 372-384.

Jolly, G.M., Hampton, I., (1990). A stratified random transect design for acoustic surveys of fish stocks. Can. J. Fish. Aquat. Sci. 47, 1282±1291

MPI (2014) VOYAGE REPORT OF A SURVEY OF DEEP-SEA HABITATS OF THE LOUISVILLE SEAMOUNT CHAIN (TAN1402). Project report VMES133.

Rogers A.D., Baco A., Griffiths H.J., Hall-Spencer J.M. (2007) Corals on seamounts. In: Pitcher A, Clark M, Morato T (Eds.) Seamounts: Ecology, Fisheries and Conservation. Blackwell. Pp: 141-169.

Rogers A.D. & M.L. Taylor. 2012. Benthic biodiversity of seamounts in the southwest Indian Ocean Cruise report – R/V James Cook 066 Southwest Indian Ocean Seamounts expedition – November 7th – December 21st, 2011. 235pp.
http://www-odp.tamu.edu/publications/prelim/176_PREL/176OBJT.HTML

Sanders (2011) A report on aimed trawling in the Indian Ocean - F/V Will Watch, 2009" FAO working paper, 2011.

SIODFA 2007. Analysis of Coral Bycatch by SIODFA Vessels in the Southern Indian Ocean, 2006- 2007. Southern Indian Ocean Deepsea Fishers‟ Association Tech. Rep. 07/01. 14 pp.

SIOFA 2018. SWG-10 DW-01a Australian BFIA Final Report