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Review of benthic sampling and bycatch data, including VME taxa, in SPRFMO bottom fisheries

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1. Introduction

This paper provides a summary of the benthic bycatch, including of species thought to be components of vulnerable marine ecosystems, VMEs, of New Zealand bottom fisheries in the SPRFMO Area. There have been few dedicated scientific surveys of benthic invertebrates in the SPRFMO Area, but observers have been increasingly used to record benthic invertebrate bycatch on commercial fishing vessels, providing data inputs for habitat suitability modelling (Vierod et al. 2014, Anderson et al. 2016 a and b) and underpinning the development of VME encounter protocols to prevent significant adverse impacts on VMEs (Parker et al. 2009, Penney et al. 2009, Ardron et al. 2014, Cryer et al. 2018). New Zealand government observers have conducted such work, recording all benthic invertebrate bycatch from the deep-water bottom trawl fisheries in the SPRFMO Area since at least 2008 when the SPRFMO interim management measures were replaced with more focussed conservation and management measures. On New Zealand-flagged vessels, 100% observer coverage is required for trawling and a minimum of 10% is required for bottom line methods. In order to support a wider understanding of the nature and variability of the bycatch of benthic invertebrates, including VME indicator taxa, this paper summarises and explores trends in the benthic bycatch by New Zealand-flagged vessels conducting bottom trawl and bottom longline fishing within the SPRFMO Area between 2008 and 2018.

2. Methods

2.1 Data used in Analysis

Data relating to: benthic invertebrate taxa caught; the distributions of catch weights; and the number of benthic invertebrate taxa caught per fishing event were extracted from the MPI Centralized Observer Database (COD) (accessed 15 June 2018) and provided by Fisheries New Zealand. Data were restricted to 8,890 New Zealand bottom trawl tows (including mid-water trawls) and 254 bottom longline sets in the western part of the SPRFMO Area over the period 2008–2018 (noting that the 2018 data is not for a full fishing year) and included tow-by-tow or set-by-set observer data for all observed fishing events. General fishing areas are shown in Figure 1.

Bottom trawl (incl. midwater trawl) data, for which 100% observer coverage is required, included tows targeting BNS - bluenose (*Hyperoglyphe antarctica*); BOA - sowfish (*Paristiopterus labiosus*); BOE - black oreo (*Allocyttus niger*); BYS - alfonsino (*Beryx splendens*); BYX - alfonsino and long-finned beryx (*Beryx decadacylus*); CDL - cardinal fish (*Epigonus telescopus*); EPT - deepsea cardinalfish (*Epigonus telescopus*); HAP - hapuku (*Polyprion oxygeneios*); HPB - hapuku & bass (*Polyprion oxygeneios* and *P. americanus*); ORH - orange roughy (*Hoplostethus atlanticus*); RIB - ribaldo (*Mora moro*); SBO - southern boarfish (*Pseudopentaceros richardsoni*); SOR - spiky oreo (*Neocyttus rhomboidalis*); SQU - arrow squid (*Nototodarus sloanii* and *N. gouldi*); TAR - tarakihi (*Nemadactylus spp.*); and WAR - common warehou (*Seriola lalandi*).

Bottom longline sets, for which 10% observer coverage is required, included sets targeting ATO - Antarctic toothfish (*Dissostichus mawsoni*); BAS - bass (*Polyprion americanus*); BNS - bluenose

(*Hyperoglyphe antarctica*) HAP - hapuku (*Polyprion oxygeneios*); HPB - hapuku and bluenose; KTA - king terakihi (*Nemadactylus spp.*); LIN - ling (*Genypterus blacodes*); and SWO - swordfish (*Xiphias gladius*). For bottom longline, the number of hooks per set ranged between 60 and 5,123 (median = 500 and mean = 821 hooks per set); however, as we are interested in the gross impact on benthic invertebrate taxa, data were not standardized by number of hooks per set.

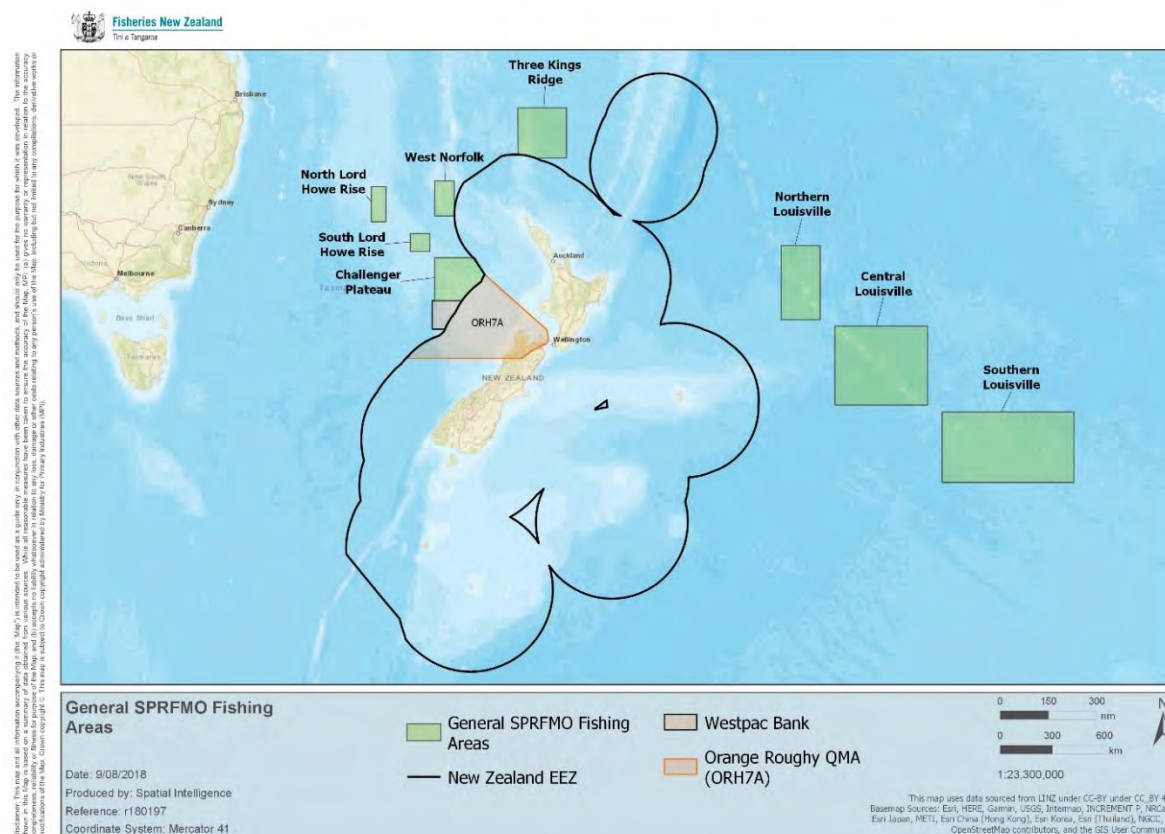


Figure 1: The general areas bottom fished by New Zealand trawlers in the SPRFMO Area since 2002. New Zealand observers use area codes as follows: LOUR, Louisville Seamount Chain; CET, Challenger Plateau; HOWE, Lord Howe Rise; WANB, Three Kings Ridge and Wanganella Bank; SOET, southern ocean (line methods only).

The data consisted of one record per benthic invertebrate taxon encountered for each fishing event, and included trip number, fisheries management area, tow or set number, fishing method, benthic species code, common name, bycatch weight, method of weight analysis and information on whether the benthic material was encrusting anything or something else was encrusting it. Although observers are instructed to only record sessile benthic invertebrate, non-sessile taxa were present in the dataset (e.g., squid, octopus, crabs and shrimp, salps). Assuming most observers did not record the presence of non-sessile invertebrates (as per the instructions), only sessile invertebrates were included in the analysis.

We checked some potential source of bias in the data extract. Of the total 6,835 benthic bycatch records in the New Zealand database, 109 had no or zero specified weight. Inspection revealed that

these were either samples less than 0.1 kg in weight that could not be accurately weighed at sea, due to rounding error, or the observer simply recorded the presence of a taxon. Because it was found that zero weights were indicative of the presence of benthic taxa as bycatch, all zero weights were retained in the analysis. No other data checking or error correction was conducted.

2.2 VME indicator taxa used in the analysis

VME indicator taxa used in the analysis were those defined for the southwest Pacific by Parker et al (2009, Table 1). Individual benthic species within the bycatch dataset were assigned to higher groups using taxonomic designations from the World Register of Marine Species (www.marinespecies.org, accessed 12 July 2018). Individual benthic species that met VME indicator criteria were aggregated into higher taxonomic groups and allocated FAO VME taxa codes (Table 1 and Appendix A), resulting in 5,762 individual aggregated VME taxa records across 2,962 bottom trawl tows, and 49 individual aggregated records across 33 longline sets. Based on advice from the Observer Programme, COU (unidentified coral) was interpreted to indicate stony coral (Scleractinia) and ANT (anemone) was interpreted to indicate a mix of VME indicator taxa (Actinaria, Zoanthidea) and non-VME indicator taxa (Ceriantharia, Corallimorpharia) and was therefore not included as a VME indicator taxon.

Of the 5,762 bycatch records from bottom trawl and bottom line fishing events involving the indicator taxa in Table 1, 23 included weights over 100 kg. For each of these records, the observer comments, bycatch forms and any available photographs were reviewed to verify that samples did include VME indicator taxa and weren't composite samples that also included non-VME indicator components, and that reported weights seemed reasonable. None of the records greater than 100 kg was recorded as encrusting something, and only four were recorded as being encrusted by something else. For all but three records (Porifera 1091 kg; Scleractinia 200 kg and 120 kg), all weights over 100 kg were estimated by eye. Because there was no compelling evidence in the forms or images that reported weights were incorrect, all records > 100 kg were retained in the analysis.

Table 1 Rationale for taxonomic groups as indicators of VMEs (modified from Parker et al. 2009) and the allocation of Fisheries New Zealand benthic bycatch codes to VME taxonomic groups.

FAO Code	Taxon	Rationale for inclusion as VME indicator taxa	No. spp. codes	Fisheries New Zealand codes
PFR	Porifera (Phylum) <i>Sponges</i>	Include both classes (Demospongiae and Hexactinellida). These are found in the deep sea, can form complex structures and are vulnerable to disturbance by fishing gears. Longevity and resilience of cold-water sponges is unknown.	19	APU, CFU, CLS, DSO, ERE, FAR, GLS, GVE, HYA, ONG, PAZ, PHB, PHW, PLN, RHA, SLT, THN, TLD, TTL
GGW	Gorgonacea (Order) <i>Sea fans</i>	Gorgonacea (Sea fans) have been revised and subsumed into the Alcyonacea (soft corals) but are left separated here as important VME taxa that may be complex, large, fragile, and form complex biogenic structure.	1	GOC
AXT	Stylasteridae (Family) <i>Hydrocorals</i>	Covers a wide range of taxa from small (cm scale) to massive <i>Macropora</i> reef, but if big enough to be caught by fishing gear, they are indicative of VME.	4	COR, CRE, ERR, LPT
CSS	Scleractinia (Order) <i>Stony corals</i>	Includes six complex branching, thicket or mound forming genera matching VME criteria: <i>Solenosmillia</i> ; <i>Goniocorella</i> ; <i>Oculina</i> ; <i>Enallopsammia</i> ; <i>Madrepora</i> , and <i>Lophelia</i> .	8	COU, DDI, ERO, GDU, MOC, OVI, SIA, SVA
AQZ	Antipatharia (Order) <i>Black corals</i>	All taxa are structure forming, fragile and associated with habitats that tend to be more diverse (heterogeneous seabed with accelerated current flow).	11	ATP, BTP, COB, DDP, DEN, LEI, LIL, LSE, PTP, SLP, TDP
ATX	Actiniaria (Order) <i>Anemones</i>	Anemones are not listed by FAO (2007) but can be large and are indicators of hard substrate and habitats that support corals, so are included as an indicator of vulnerable species.	5	ACS, ATR, BOC, HMT, LIP
AJZ	Alcyonacea (Order) <i>Soft corals</i>	Deep-sea species may be erect, large and branching, providing structural habitats and associated with other VME taxa.	14	ARO, BOO, CHR, CLL, CTP, IRI, ISI, LLE, MTL, PAB, PLE, PMN, PRI, THO
NTW	Pennatulacea (Order) <i>Sea pens</i>	They are typical of softer substrates but do provide complex structure, have been associated with fish species and are vulnerable to trawl gear because they can be tall and often live in trawlable habitat.	7	ALF, DGR, FQU, GYS, PNN, PTU, SPN
CWD	Crinoidea (Class) <i>Sea lillies</i>	All taxa are fragile and associated with habitats that tend to be more diverse (heterogeneous seabed with accelerated current flow)	3	CMT, CRI, CRN
BHZ	Brsingida (Order) <i>'Armless' stars</i>	All taxa are fragile and associated with habitats that tend to be more diverse (Heterogeneous seabed with accelerated current flow)	1	BRG

2.3 Bycatch analysis

For each bottom fishing method (trawl or line), summary statistics were calculated describing the percent of tows or sets that included benthic invertebrate bycatch, the number of benthic invertebrate taxa reported per tow or set, the weight of benthic invertebrate bycatch per tow or set, and the top ten benthic invertebrate bycatch taxa across all tows or sets by weight. For trawl data, temporal patterns in bycatch weight were calculated for the six invertebrate taxa that dominated bycatch. There were insufficient data to do this for the line methods. All summary statistics were calculated separately for each fishing area for each fishing type, and for VME indicator taxa.

A complete list of all benthic invertebrate taxa recorded by New Zealand observers in the bottom trawl and bottom long fisheries within the SPRFMO Area between 2008 and 2018 is in Appendix 1.

3. Bottom trawl bycatch

3.1 Bycatch of benthic invertebrate taxa in bottom trawls

For the four Fisheries Management Areas (FMAs) within which benthic invertebrate bycatch was recorded (CET (Challenger Plateau), HOWE (Lord Howe Rise), LOUR (Louisville Seamount Chain) and WANB (Wanganella Bank and Three Kings Ridge), bycatch was recorded in 23.8% to 53.9% of bottom trawls (Table 2). Observers recorded 95 unique benthic invertebrate taxa, with a combined weight of 34,256 kg (Table 2).

In any individual trawl that caught benthic invertebrate bycatch, 0.1 to 5,001 kgs was taken (mean = 11.4 kg; SD = 128.01; Table 2). Bushy hard corals and stony corals dominated by weight, but many other invertebrates were also recorded (Table 3 and Figure 2). Different invertebrate taxa dominated in different areas (Table 3); on the Louisville Seamount Chain, 98% of benthic invertebrate bycatch was of bushy hard corals and stony corals, whereas bycatch in the Tasman Sea was more evenly spread across a broader range of taxa.

Within each FMA, bycatch weights were highly variable between years for the six benthic invertebrate taxa that dominated bycatch (Figures 3 to 6). On the Challenger Plateau, the annual bycatch of smooth deepsea anemones increased from 2015, whereas the bycatch of stony coral decreased between 2009 and 2013. Elsewhere in the Tasman Sea, the bycatch of branching bamboo corals and sponges decreased between 2009 and 2011 (Figures 4 & 6).

Table 2 Incidence of benthic invertebrate bycatch in the bottom trawl fisheries, with data disaggregated by FMA.

FMA	Tows with bycatch	Total Tows	Percent of tows with bycatch	Number of benthic invertebrate taxa per positive tow					Weight (kg) of benthic invertebrate taxa per positive tow				
				Min	Max	Mean	SD	Unique	Min	Max	Mean	SD	Total
CET	1,288	3,243	39.7%	1	10	2.35	1.55	81	0.1	200.0	5.54	10.94	7,144.0
HOWE	700	2,943	23.8%	1	8	1.70	1.12	59	0.1	260.8	3.76	15.07	2,628.9
LOUR	663	2,046	32.4%	1	6	1.29	0.66	47	0.1	5,001.0	28.79	263.88	19,091
SOET	0	1	0.0%	-	-	-	-	-	-	-	-	-	-
WANB	354	657	53.9%	1	11	2.22	1.61	50	0.1	1,132.8	15.23	84.61	5,390.9
All FMAs	2,882	8,890	33.8%	1	11	1.95	1.38	95	0.1	5,001.0	11.40	128.01	34,255.8

Table 3 Top ten benthic invertebrate bycatch taxa by weight (kg). Data is from the bottom trawl fisheries and disaggregated by Area. Number of tows refers to the number of times each taxa was recorded as benthic bycatch. Within a single tow, multiple taxa may have been recorded, therefore number of tows does not sum to 8,890.

Area	Species Code	Common name	Taxon	Observed weight (kg)	% bycatch weight in Area	No. tows	Percent tows in Area
CET	ACS	Smooth deepsea anemones	Actinostolidae	3,200.7	44.8%	580	19.2%
	EPZ	Zoanthid anemone	<i>Epizoanthus sp.</i>	667.2	9.3%	468	15.5%
	SIA	Stony corals	Scleratinia	581.9	8.1%	147	4.9%
	ANT	Anemones	Actiniaria, Ceriantharia, Corallimorpharia, Zoanthidea	554.6	7.8%	87	2.9%
	HMT	Warty deepsea anemones	Hormathiidae	370.6	5.2%	221	7.3%
	ATR	Sea anemones	Actiniaria	180.3	2.5%	77	2.5%
	ERO	Deep water branching coral	<i>Enallopsammia rostrata</i>	172.3	2.4%	37	1.2%
	PHB	Grey fibrous massive sponge	<i>Phorbis spp.</i>	170.6	2.4%	52	1.7%
	STP	Solitary bowl coral	<i>Stephanocyathus platypus</i>	170.3	2.4%	242	8.0%
	ONG	Sponges	Porifera	162.1	2.3%	172	5.7%
HOWE	ERO	Deep water branching coral	<i>Enallopsammia rostrata</i>	489.6	18.6%	109	9.2%
	BOO	Branching bamboo coral	<i>Keratoisis spp.</i>	415.1	15.8%	47	4.0%
	ONG	Sponges	Porifera	361.9	13.8%	76	6.4%
	SIA	Stony corals	Scleratinia	355.7	13.5%	49	4.1%
	COB	Black corals	Antipatharia	201.6	7.7%	236	19.9%
	GLS	Glass sponges	Hexactinellida	191.9	7.3%	36	3.0%
	GOC	Gorgonian coral	Gorgonacea	101.6	3.9%	115	9.7%
	ISI	Bamboo corals	Isididae	88.5	3.4%	24	2.0%
	LLE	Bamboo coral	<i>Lepidisis spp.</i>	47.1	1.8%	27	2.3%
	ATR	Sea anemones	Actiniaria	44.0	1.7%	27	2.3%
LOUR	GDU	Bushy hard coral	<i>Goniocorella dumosa</i>	10,149.0	53.2%	216	25.2%
	SIA	Stony corals	Scleratinia	8,529.3	44.7%	312	36.4%
	GOC	Gorgonian coral	Gorgonacea	63.2	0.3%	35	4.1%
	ONG	Sponges	Porifera	57.2	0.3%	23	2.7%
	GRE	Curling stone sponge	<i>Geodia regina</i>	42.0	0.2%	11	1.3%
	SVA	Deepwater branching coral	<i>Solenosmilia variabilis</i>	36.7	0.2%	18	2.1%
	COB	Black corals	Antipatharia	35.9	0.2%	48	5.6%
	TTL	Bristle ball sponge	<i>Tetilla australe</i>	31.1	0.2%	5	0.6%
	GLS	Glass sponges	Hexactinellida	27.4	0.1%	11	1.3%
	COU	Coral (Unidentified)	Alcyonacea, Gorgonacea, Scleractinia, Antipatharia	18.9	0.1%	16	1.9%
WANB	ONG	Sponges	Porifera	1,557.0	28.9%	87	11.1%
	GDU	Bushy hard coral	<i>Goniocorella dumosa</i>	1,324.8	24.6%	122	15.5%
	SIA	Stony corals	Scleratinia	799.6	14.8%	116	14.8%
	GLS	Glass sponges	Hexactinellida	624.6	11.6%	99	12.6%
	PAB	Bubblegum coral	<i>Paragorgia arborea</i>	381.2	7.1%	39	5.0%
	CFU	Smooth white cup sponge	<i>Corallistes fulvodesmus</i>	195.8	3.6%	7	0.9%
	HYA	Floppy tubular sponge	<i>Hyalascus spp.</i>	110.2	2.0%	15	1.9%
	ERO	Deepwater branching coral	<i>Enallopsammia rostrata</i>	105.1	1.9%	18	2.3%
	APU	Pimpled ear sponge	<i>Aciculites pulchra</i>	67.1	1.2%	4	0.5%
	BOO	Branching bamboo coral	<i>Keratoisis spp.</i>	35.4	0.7%	16	2.0%
ALL FMAs	GDU	Bushy hard coral	<i>Goniocorella dumosa</i>	11,560.9	33.7%	399	6.8%
	SIA	Stony corals	Scleratinia	10,266.5	30.0%	624	10.7%
	ACS	Smooth deepsea anemones	Actinostolidae	3224.4	9.4%	617	10.5%
	ONG	Sponges	Porifera	2138.2	6.25%	358	6.1%
	GLS	Glass sponges	Hexactinellida	988.2	2.9%	284	4.8%
	ERO	Deepwater branching coral	<i>Enallopsammia rostrata</i>	767.4	2.2%	165	2.8%
	EPZ	Zoanthid anemone	<i>Epizoanthus sp.</i>	679.4	2.0%	513	8.8%
	ANT	Anemones	Actiniaria, Ceriantharia, Corallimorpharia, Zoanthidea	559.9	1.6%	95	1.6%
	BOO	Branching bamboo coral	<i>Keratoisis spp.</i>	455.6	1.3%	79	1.3%
	PAB	Bubblegum coral	<i>Paragorgia arborea</i>	382.9	1.1%	46	0.8%

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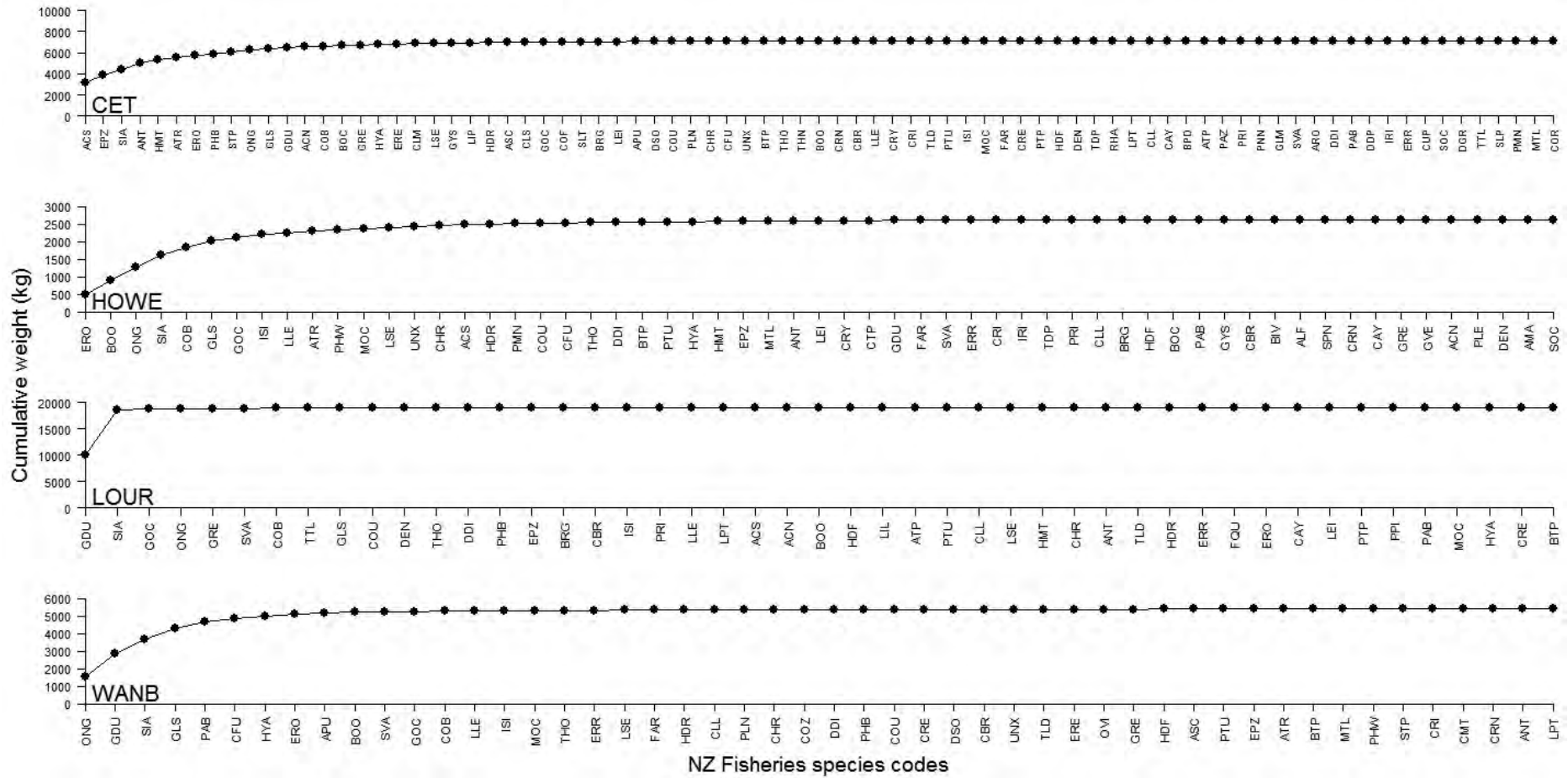


Figure 2 Cumulative benthic invertebrate bycatch (kg) from the bottom trawl fisheries, disaggregated by Area. Full taxonomic designation of species codes is presented in Appendix 1. Note: y-axis scales differ between panels.

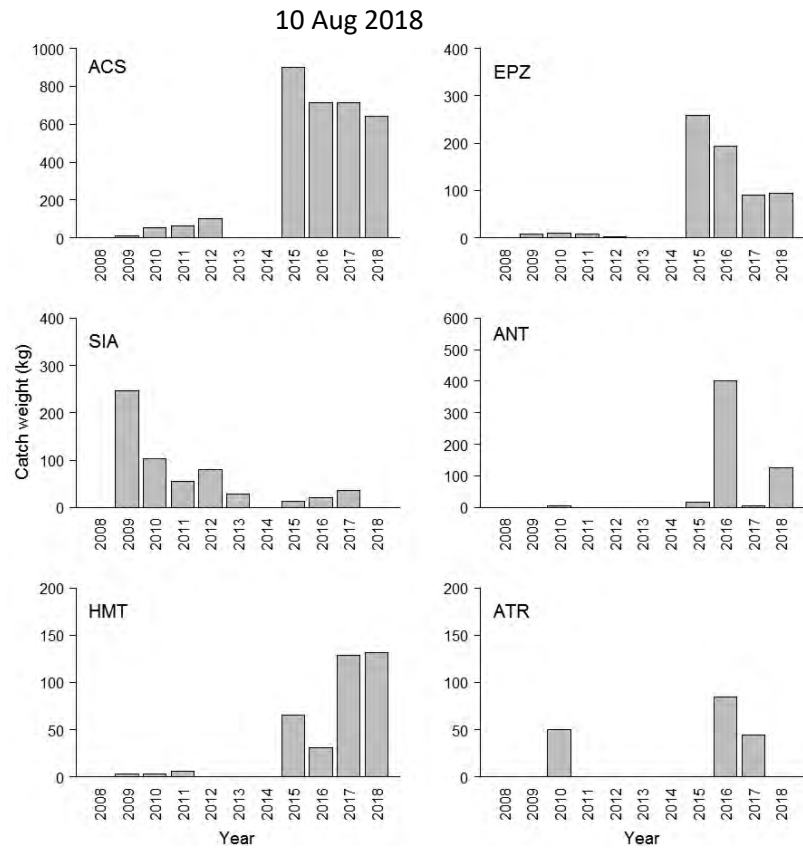


Figure 3 Per annum catch-weight (kg) from bottom trawl tows for the six-bycatch species with the largest cumulative bycatch weight over the 2008-2018 period within the CET Fisheries Management Area. Note: y-axis scales differ between panels. The taxa presented are Actinostolidae (ACS), Epizoanthus sp. (EPZ), Scleratinia (SIA), Actiniaria, Ceriantharia, Corallimorpharia, Zoanthidea (ANT), Hormathiidae (HMT), Actiniaria (ATR).

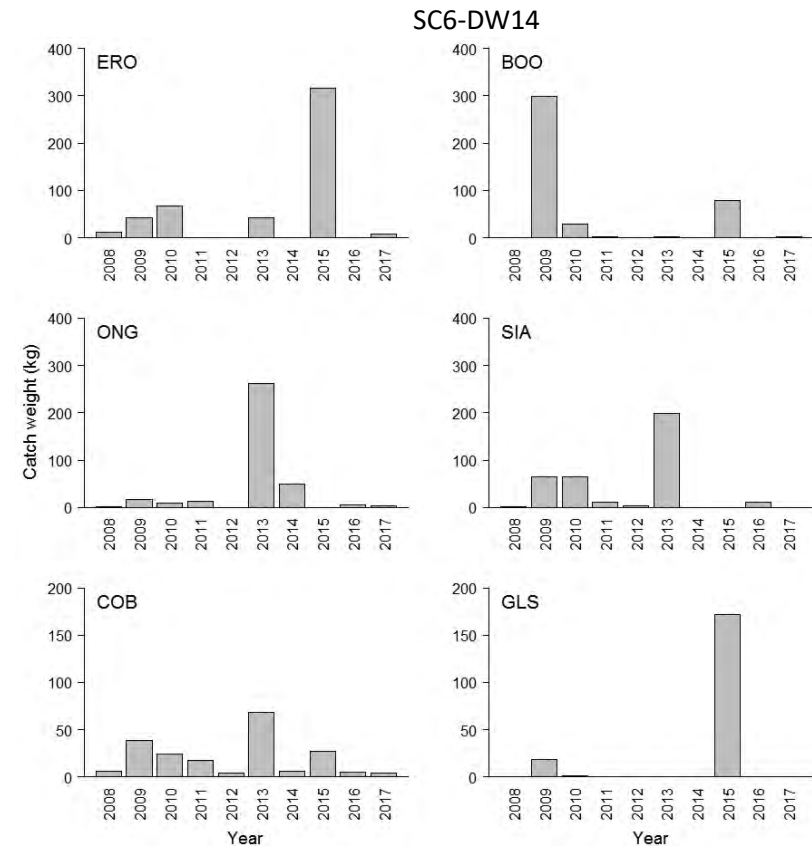


Figure 4 Per annum catch-weight (kg) from bottom trawl tows for the six-bycatch species with the largest cumulative bycatch weight over the 2008-2018 period within the HOWE Fisheries Management Area. Note: y-axis scales differ between panels. The taxa presented are Enallopsammia rostrata (ERO), Keratoisis spp. (BOO), Porifera (ONG), Scleratinia (SIA), Antipatharia (COB), Hexactinellida (GLS).

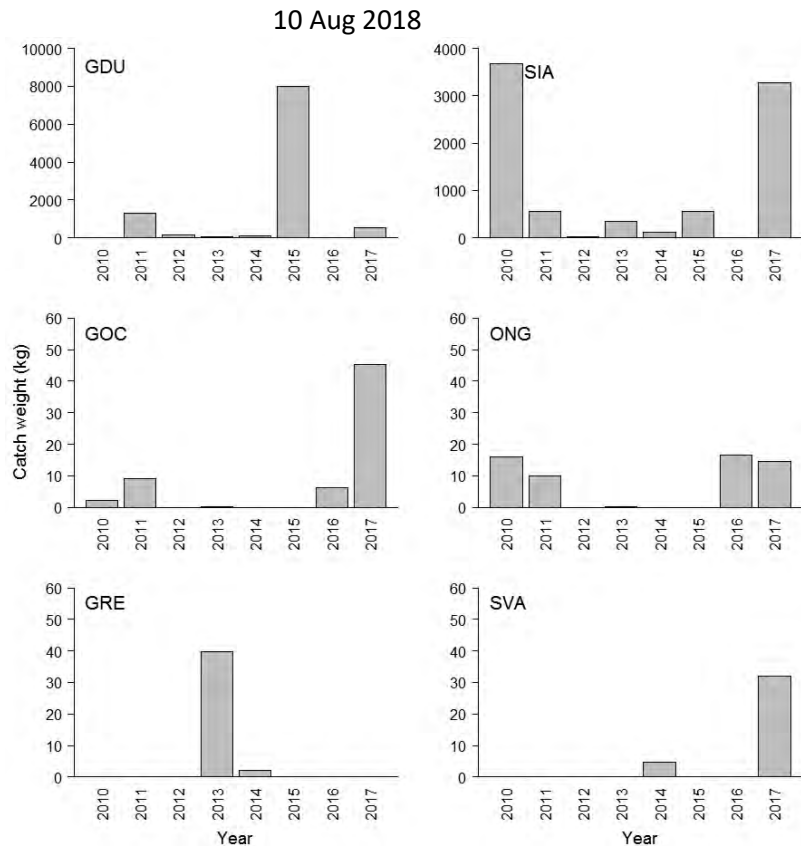


Figure 5 Per annum catch-weight (kg) from bottom trawl tows for the six-bycatch species with the largest cumulative bycatch weight over the 2008-2018 period within the LOUR Fisheries Management Area. Note: y-axis scales differ between panels. The taxa presented are *Goniocorella dumosa* (GDU), *Scleratinia* (SIA), *Gongonacea* (GOC), *Porifera* (ONG), *Geodia regina* (GRE), *Solenosmilva variabilis* (SVA).

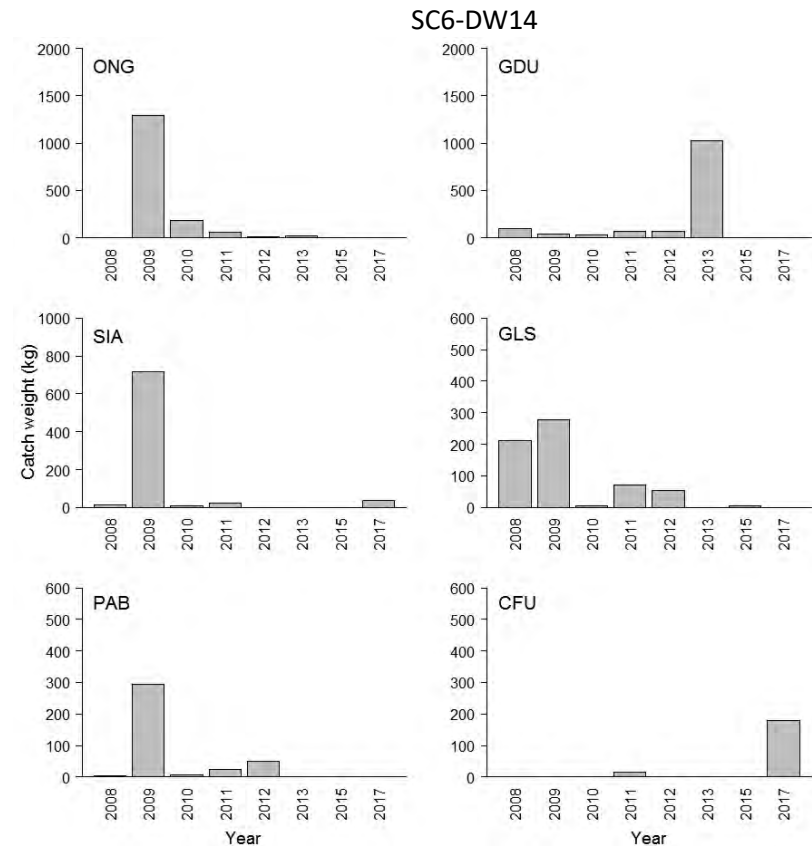


Figure 6 Per annum catch-weight (kg) from bottom trawl tows for the six-bycatch species with the largest cumulative bycatch weight over the 2008-2018 period within the WANB Fisheries Management Area. Note: y-axis scales differ between panels. The taxa presented are *Porifera* (ONG), *Goniocorella dumosa* (GDU), *Scleratinia* (SIA), *Hexactinellida* (GLS), *Paragorgia arborea* (PAB), *Corallistes fulvodesmus* (CFU).

3.2 Bycatch of VME indicator taxa in bottom trawls

Of the 34.3 tonnes of benthic invertebrate bycatch recorded from bottom trawls between 2008 and 2018, 32.8 tonnes (or 95.7%) was VME indicator taxa (after Parker et al. 2009). For the four fishing areas within which VME bycatch was recorded (CET, HOWE, LOUR and WANB), VME indicator taxa were observed in 23.2% to 53.4% of bottom trawls (Table), with a combined weight of 32,777 kg (Table 4).

In any individual trawl that caught VME indicator taxa, 0.1 to 5,001 kg was taken (mean = 3.69 kg; SD = 74.58; Table 4). Scleractinia, Porifera and Actinaria dominated VME indicator bycatch (Table 5 and Figure 7). Scleractinia made up a large proportion of VME indicator bycatch weight in all FMAs, with Porifera also dominant in the WANB FMA, Porifera and Alyonacea dominant in the HOWE FMA and Actinaria dominant in the CET FMA (Table 5). Within the LOUR FMA, 98% of the weight of VME indicator bycatch was comprised of Scleractinia.

Bycatch weights of VME indicator taxa had high variability between years. Within the CET FMA, the total bycatch weight of Stylasteridae and Porifera increased between 2014 and 2016, while the bycatch weight of Scleractinia steadily decreased between 2010 and 2017 (Figure 8).

Table 4 Incidence of VME indicator bycatch in the bottom trawl fisheries, with data disaggregated by FMA.

Area	Tows with VME bycatch	Total Tows	Percent	Number of benthic invertebrate taxa per positive tow					Weight of benthic invertebrate taxa per positive tow				
				Min	Max	Mean	SD	Unique	Min	Max	Mean	SD	Total
CET	1,184	3,243	36.5%	1	6	0.62	0.98	10	0.1	200	1.77	6.42	5,755.34
HOWE	682	2,943	23.2%	1	6	0.36	0.77	10	0.1	260.4	0.87	7.48	2,565.6
LOUR	650	2,046	31.8%	1	4	0.38	0.61	9	0.1	5,001	9.32	150.74	19,078.5
SOET	0	1	0.0%	-	-	-	-	-	-	-	-	-	-
WANB	351	657	53.4%	1	7	0.99	1.20	9	0.1	1132.3	8.18	62.51	5,377.28
All Areas	2,867	8,890	32.2%	1	7	0.51	0.88	10	0.1	5,001	3.69	74.58	32,776.76

Table 5 Top ten benthic bycatch VME indicator taxa by weight. Data is from the bottom trawl fisheries and disaggregated by Area. Number of tows refers to the number of times each VME indicator taxa was recorded as benthic bycatch. Within a single tow, multiple taxa may have been recorded.

Area	Species Code	VME taxon	Observed weight (kg)	% VME bycatch weight within Area	No. tows	Percent tows in Area
CET	ATX	Actiniaria	3,834.2	66.6%	698	21.5%
	CSS	Scleractinia	1,033.0	17.9%	495	15.3%
	PFR	Porifera	680.1	11.8%	459	14.2%
	AQZ	Antipatharia	125.5	2.1%	200	6.2%
	NTW	Pennatulacea	29.6	0.5%	55	1.7%
	AJZ	Alcyonacea	19.1	0.3%	57	1.8%
	GGW	Gorgonacea	14.0	0.2%	40	1.2%
	BHZ	Brsingida	12.1	0.2%	10	0.3%
	CWD	Crinoidea	5.0	0.1%	4	0.1%
	AXT	Stylasteridae	2.7	<0.1%	5	0.2%
HOWE	CSS	Scleractinia	905.6	35.3%	191	6.5%
	AJZ	Alcyonacea	613.4	23.9%	187	6.4%
	PFR	Porifera	613.0	23.9%	133	4.5%
	AQZ	Antipatharia	246.4	9.6%	307	10.4%
	GGW	Gorgonacea	101.6	4.0%	115	3.9%
	ATX	Actiniaria	71.6	2.8%	69	2.3%
	NTW	Pennatulacea	7.9	0.3%	15	0.5%
	CWD	Crinoidea	2.7	0.1%	21	0.7%
	AXT	Stylasteridae	2.0	0.1%	2	0.1%
	BHZ	Brsingida	1.4	0.1%	6	0.2%
LOUR	CSS	Scleractinia	18,750.7	98.3%	551	26.9%
	PFR	Porifera	170.0	0.9%	54	2.6%
	GGW	Gorgonacea	63.2	0.3%	35	1.7%
	AQZ	Antipatharia	55.2	0.3%	63	3.1%
	AJZ	Alcyonacea	25.9	0.1%	37	1.8%
	BHZ	Brsingida	5.6	<0.0%	12	0.6%
	AXT	Stylasteridae	3.3	<0.0%	8	0.4%
	ATX	Actiniaria	3.0	<0.0%	5	0.2%
	NTW	Pennatulacea	1.6	<0.0%	5	0.2%
	CWD	Crinoidea	0.0	0.0%	0	0.0%
WANB	PFR	Porifera	2,576.0	47.9%	183	27.9%
	CSS	Scleractinia	2,278.1	42.4%	270	41.1%
	AJZ	Alcyonacea	459.5	8.5%	91	13.9%
	AQZ	Antipatharia	27.1	0.5%	50	7.6%
	GGW	Gorgonacea	24.4	0.5%	43	6.5%
	AXT	Stylasteridae	10.7	0.2%	6	0.9%
	NTW	Pennatulacea	0.5	<0.1%	2	0.3%
	CWD	Crinoidea	0.5	<0.1%	5	0.8%
	ATX	Actiniaria	0.5	<0.1%	2	0.3%
	BHZ	Brsingida	0.0	0.0%	0	0.0%
ALL Areas	CSS	Scleractinia	22,967.3	70.1%	1,507	17.0%
	PFR	Porifera	4,039.5	12.3%	829	9.3%
	ATX	Actiniaria	3,909.3	11.9%	774	8.7%
	AJZ	Alcyonacea	1,117.5	3.4%	372	4.2%
	AQZ	Antipatharia	454.3	1.4%	620	7.0%
	GGW	Gorgonacea	203.2	0.6%	233	2.6%
	NTW	Pennatulacea	39.6	0.1%	77	0.9%
	BHZ	Brsingida	19.1	0.1%	28	0.3%
	AXT	Stylasteridae	18.7	0.1%	21	0.2%
	CWD	Crinoidea	8.2	<0.1%	30	0.3%

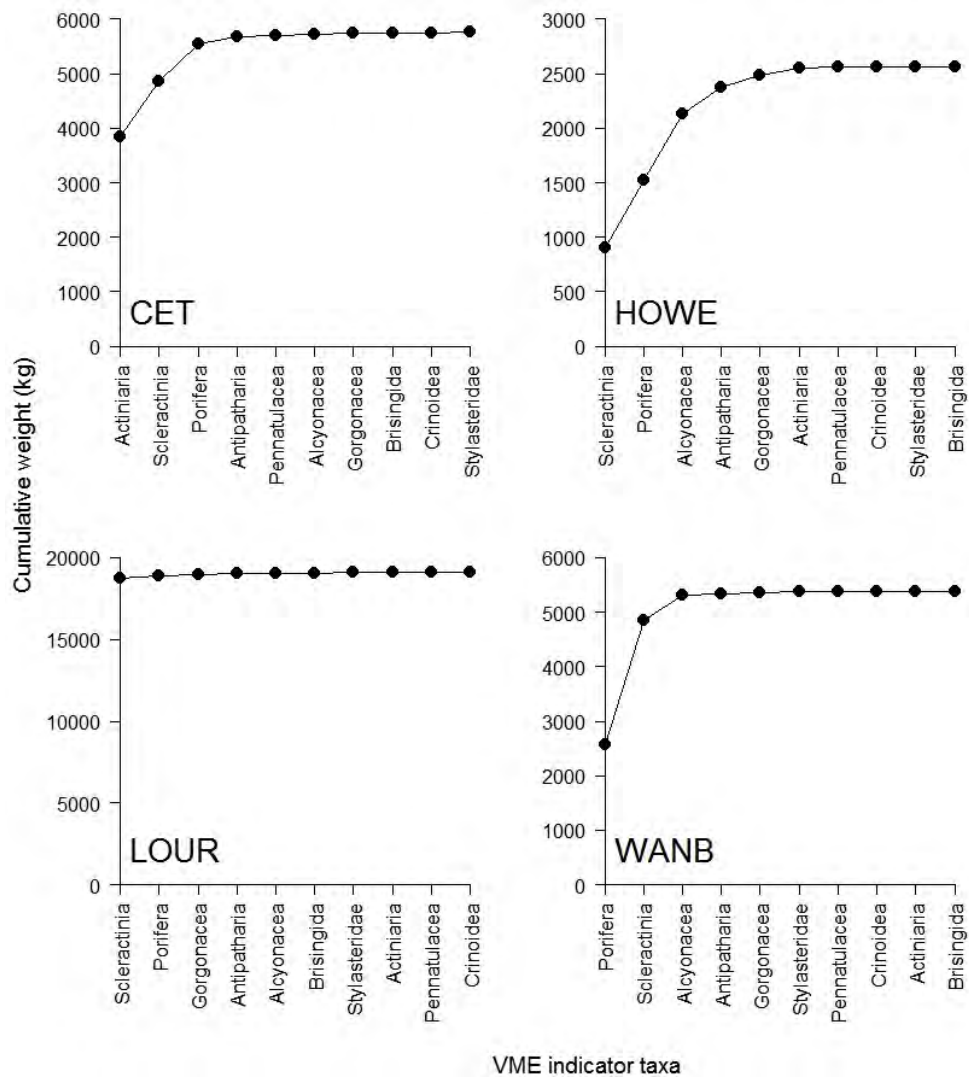


Figure 7 Cumulative bycatch weight (kg) for VME indicator taxa from the bottom trawl fisheries, disaggregated by Area. Note: y-axis scales differ between panel.

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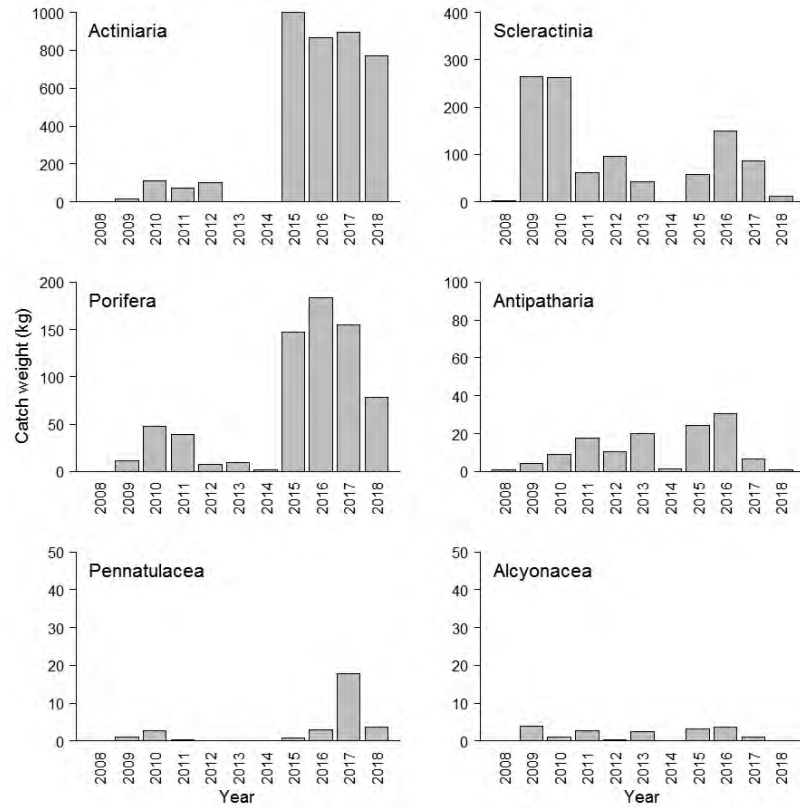


Figure 8 Per annum catch-weight for the six VME indicator taxa with the largest cumulative bycatch weight over the 2008-2018 period within the CET Fisheries Management Area. Note: y-axis scales differ between panels. The VME indicator taxa presented are Stylasteridae (ATX), Scleractinia (CSS), Porifera (PFR), Antipatharia (AQZ), Pennatulacea (NTW), Alcyonacea (AJZ).

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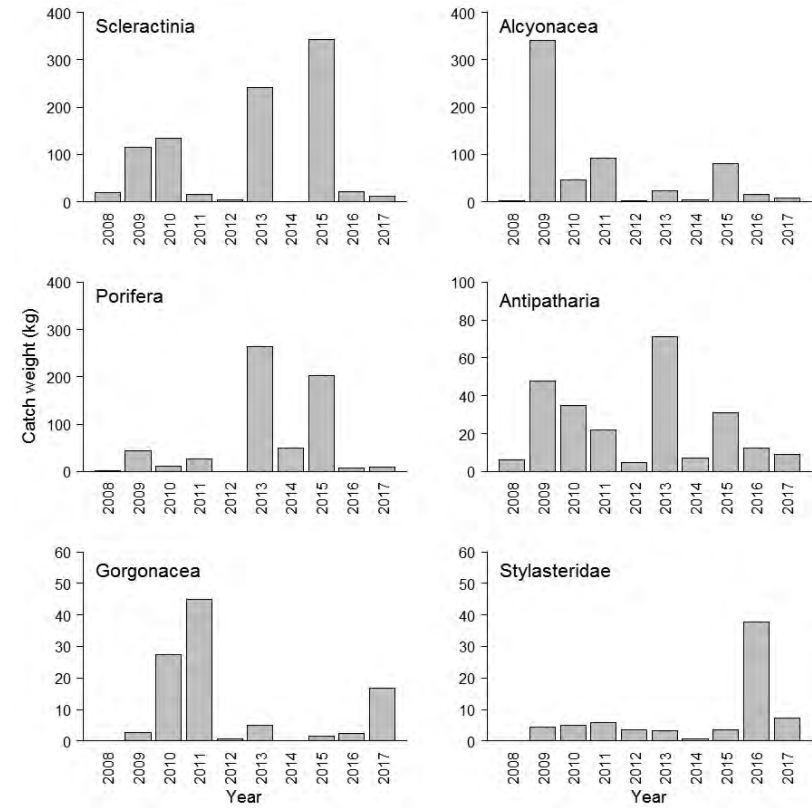


Figure 9 Per annum catch-weight for the six VME indicator taxa with the largest cumulative bycatch weight over the 2008-2018 period within the HOWE Fisheries Management Area. Note: y-axis scales differ between panels. The VME indicator taxa presented are Scleractinia (CSS), Alcyonacea (AJZ), Porifera (PFR), Antipatharia (AQZ), Gorgonacea (GGW), Actiniaria (ATX).

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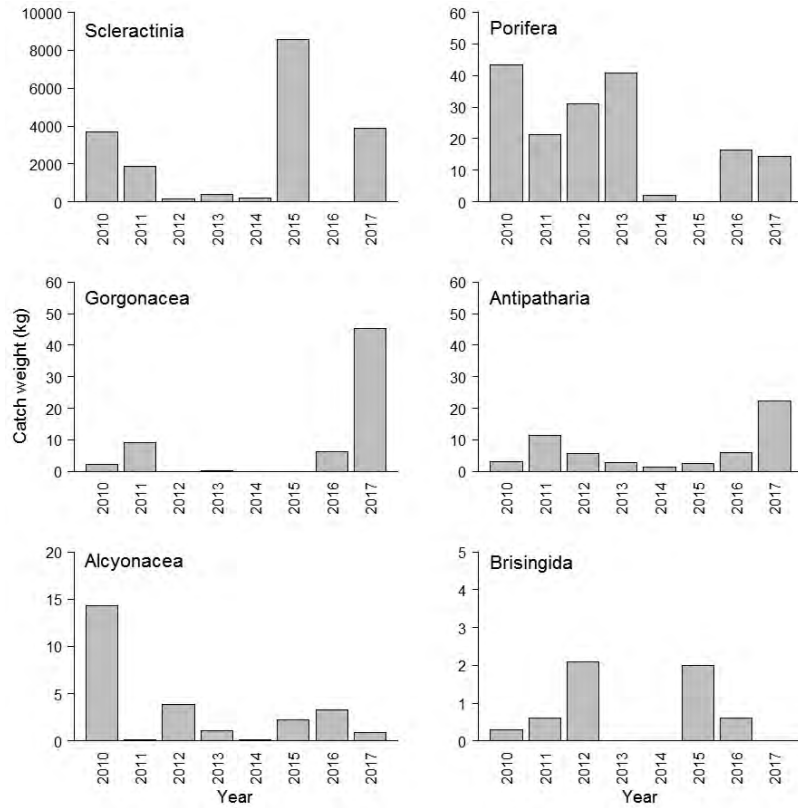


Figure 10 Per annum catch-weight for the six VME indicator taxa with the largest cumulative bycatch weight over the 2008-2018 period within the LOUR Fisheries Management Area. Note: y-axis scales differ between panels. The VME indicator taxa presented are Scleractinia (CSS), Porifera (PFR), Gorgonacea (GGW), Antipatharia (AQZ), Alcyonacea (AJZ), Brisingida (BHZ).

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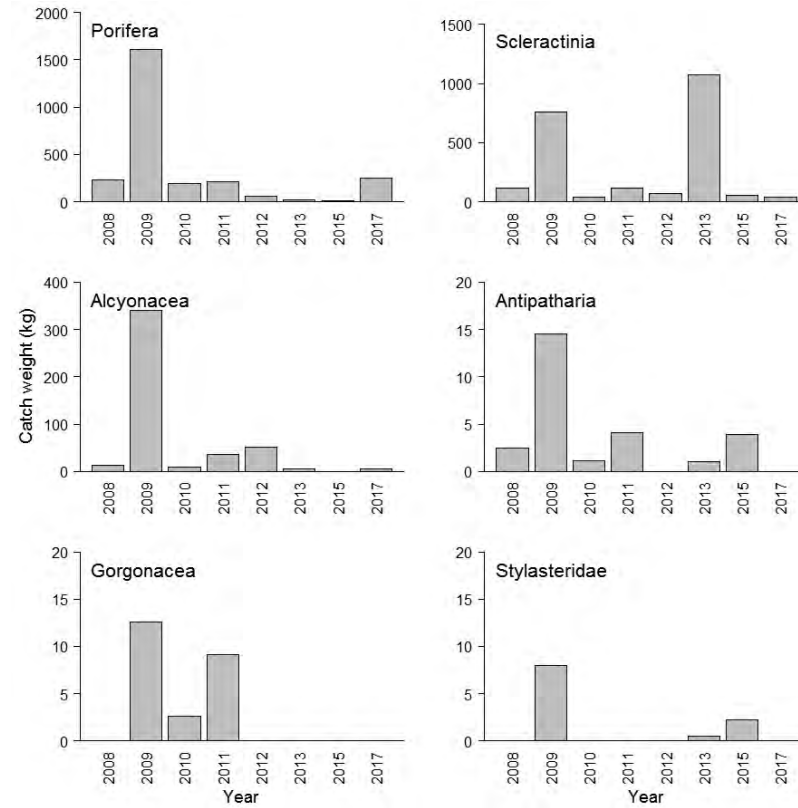


Figure 11 Per annum catch-weight for the six VME indicator taxa with the largest cumulative bycatch weight over the 2008-2018 period within the WANB Fisheries Management Area. Note: y-axis scales differ between panels. The VME indicator taxa presented are Porifera (PFR), Scleractinia (CSS), Alcyonacea (AJZ), Antipatharia (AQZ), Gorgonacea (GGW), Stylasteridae (AXT).

4. Bottom line bycatch

4.1 Bycatch of benthic invertebrate taxa in bottom longline sets

For the three FMAs within which observers recorded benthic invertebrate bycatch from bottom line sets (CET, SOET and WANB), benthic invertebrate bycatch was recorded in 6.0% to 57.9% of all sets (Table 6). Across all observed bottom line sets, 18 unique benthic invertebrate taxa were recorded by observers, with a combined weight of 32.8 kg (Table 6).

In any individual longline set that caught benthic invertebrate bycatch, 0.1 to 4 kg was taken (mean = 1.37 kg; SD = 0.49; Table 6). Unidentified corals and sponges dominated by weight, but many other invertebrates were observed (Table 7 and Figure 12). There was little consistency between fishing areas in the composition of invertebrate bycatch, and only gorgonian coral was recorded as benthic invertebrate bycatch in all three fishing areas (Table 7).

Table 6 Incidence of benthic invertebrate bycatch in the bottom longline fisheries, with data disaggregated by Area.

Area	Sets with bycatch	Total Sets	Percent of sets with bycatch	Number of benthic invertebrate taxa per positive set					Weight (kg) of benthic invertebrate taxa per positive set				
				Min	Max	Mean	SD	Unique	Min	Max	Mean	SD	Total
CET	7	117	6.0%	1	2	1.28	0.48	6	0.1	0.2	0.16	0.05	1.1
SOET	11	19	57.9%	1	2	1.27	0.47	8	0.2	2.4	1.22	0.64	13.4
TKET	0	42	0.0%	-	-	-	-	-	-	-	-	-	-
WANB	17	76	22.4%	1	2	1.47	0.51	12	0.1	4	1.08	1.04	18.3
ALL Areas	35	254	13.4%	1	2	1.37	0.49	18	0.1	4	0.94	0.89	32.8

Table 7 Benthic bycatch taxa by weight (kg). Data is from the bottom longline fisheries and disaggregated by Area. Number of tows refers to the number of times each taxa was recorded as benthic bycatch. Within a single tow, multiple taxa may have been recorded.

Area	Species Code	Common name	Taxon	Observed weight (kg)	% bycatch weight in Area	No. tows	Percent tows in Area
CET	BOO	Branching bamboo coral	<i>Keratoisis spp.</i>	0.4	36.4	3	2.6%
	CRY	Starry white hydrocoral	<i>Cryptelia spp.</i>	0.2	18.2	2	1.7%
	CRE	White hydrocoral	<i>Calyptopora reticulata</i>	0.2	18.2	1	0.9%
	SIA	Stony corals	Scleratinia	0.1	9.1	1	0.9%
	HDF	Feathery hydroids	Leptomeduseae, Anthoathecatae	0.1	9.1	1	0.9%
	GOC	Gorgonian coral	Gongonacea	0.1	9.1	1	0.9%
SOET	ONG	Sponges	Porifera	4.0	29.9%	4	21.1%
	HDR	Hydroids	Hydrozoa	2.8	20.9%	3	15.8%
	CRE	White hydrocoral	<i>Calyptopora reticulata</i>	2.3	17.2%	1	5.3%
	GOC	Gorgonian coral	Gongonacea	2.0	14.9%	2	10.5%
	CRI	Sea lilies	Crinoidea	1.0	7.5%	1	5.3%
	ATR	Sea anemones	Actiniaria	1.0	7.5%	1	5.3%
	COU	Coral (Unidentified)	Alcyonacea, Gorgonacea, Scleractinia, Antipatharia	0.2	1.5%	1	5.3%
	GLS	Glass sponges	Hexactinellida	0.1	0.7%	1	5.3%
WANB	COU	Coral (Unidentified)	Alcyonacea, Gorgonacea, Scleractinia, Antipatharia	7.9	43.2%	5	6.6%
	COB	Black corals	Antipatharia	2.3	12.6%	4	5.3%
	ECB	Erect cyclostome bryozoans	Cyclostomatida	2.0	10.9%	2	2.6%
	PAB	Bubblegum coral	<i>Paragorgia arborea</i>	1.0	5.5%	1	1.3%
	ONG	Sponges	Porifera	1.0	5.5%	3	3.9%
	MOC	Madrepora coral	<i>Madrepora oculata</i>	1.0	5.5%	1	1.3%
	CRN	Sea lilies	Isocrinida, Millericrinida, Cyrtocrinida	1.0	5.5%	1	1.3%
	ASC	Sea squirt	Ascidiacea	1.0	5.5%	1	1.3%
	GOC	Gorgonian coral	Gongonacea	0.6	3.3%	4	5.3%
	CRI	Sea lilies	Crinoidea	0.3	1.6%	1	1.3%
	SIA	Stony corals	Scleratinia	0.1	0.5%	1	1.3%
	HDR	Hydroids	Hydrozoa	0.1	0.5%	1	1.3%
ALL	COU	Coral (Unidentified)	Alcyonacea, Gorgonacea, Scleractinia, Antipatharia	8.1	24.7	6	2.4%
	ONG	Sponges	Porifera	5.0	15.2	7	2.8%
	HDR	Hydroids	Hydrozoa	2.9	8.8	4	1.6%
	GOC	Gorgonian coral	Gongonacea	2.7	8.2	7	2.8%
	CRE	White hydrocoral	<i>Calyptopora reticulata</i>	2.5	7.6	2	0.8%
	COB	Black corals	Antipatharia	2.3	7.0	4	1.6%
	ECB	Erect cyclostome bryozoans	Cyclostomatida	2.0	6.1	2	0.8%
	CRI	Sea lilies	Crinoidea	1.3	4.0	2	0.8%
	PAB	Bubblegum coral	<i>Paragorgia arborea</i>	1.0	3.0	1	0.4%
	MOC	Madrepora coral	<i>Madrepora oculata</i>	1.0	3.0	1	0.4%
	CRN	Sea lilies	Isocrinida, Millericrinida, Cyrtocrinida	1.0	3.0	1	0.4%
	ATR	Sea anemones	Actiniaria	1.0	3.0	1	0.4%
	ASC	Sea squirt	Ascidiacea	1.0	3.0	1	0.4%
	BOO	Branching bamboo coral	<i>Keratoisis spp.</i>	0.4	1.2	3	1.2%
	SIA	Stony corals	Scleratinia	0.2	0.6	2	0.8%
	CRY	Starry white hydrocoral	<i>Cryptelia spp.</i>	0.2	0.6	2	0.8%
	HDF	Feathery hydroids	Leptomeduseae, Anthoathecatae	0.1	0.3	1	0.4%
	GLS	Glass sponges	Hexactinellida	0.1	0.3	1	0.4%

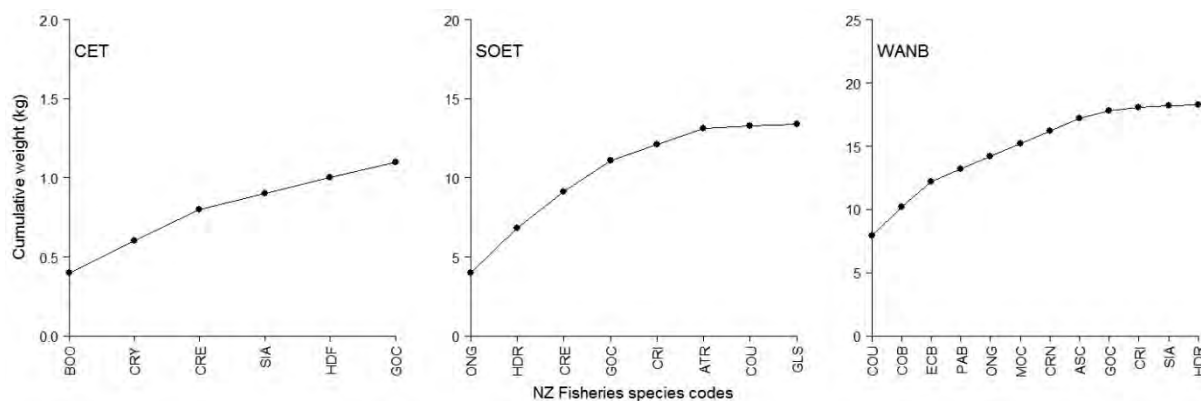


Figure 12 Cumulative benthic invertebrate bycatch (kg) from the bottom longline fisheries, disaggregated by Area. Taxa are ordered from those with the largest recorded bycatch weight on the left to those with the smallest recorded bycatch weight on the right. Full taxonomic designation of species codes is presented in Table 7 and Appendix 1. Note: y-axis scales differ between panel.

4.2 VME indicator taxa-specific results for bottom longline

Of the 32.8 kg of benthic invertebrate bycatch recorded from bottom longline sets between 2008 and 2018, 26.6 kg (or 81%) was VME indicator taxa (after Parker et al. 2009). For the three fishing areas within which observers recorded VME indicator bycatch from bottom longline sets (CET, SOET and WANB), benthic invertebrate bycatch was recorded in 4.3% to 52.6% of all sets (Table 8). Across all observed bottom longline sets, Scleractinia, Porifera and Gorgonacea dominated by weight (Table 9 and Figure 13). Of the ten VME indicator taxa, two (Pennatulacea and Brisingida) were not recorded as benthic bycatch in bottom longline sets. Within any individual fishing area, between four and six different VME indicator taxa were recorded as benthic bycatch. In any individual longline set that caught benthic invertebrate bycatch, 0.1 to 3 kg was taken (mean = 0.10 kg; SD = 0.39; Table 8).

Table 8 Incidence of VME indicator bycatch in the bottom longline fisheries, with data disaggregated by FMA.

FMA	Sets with VME bycatch	Total Sets	Percent of sets with bycatch	Number of VME indicator taxa per positive set					Weight (kg) of VME indicator taxa per positive set				
				Min	Max	Mean	SD	Unique	Min	Max	Mean	SD	Total
CET	5	117	4.3%	1	2	0.05	0.26	4	0.1	0.2	0.01	0.03	0.8
SOET	10	19	52.6%	1	2	0.58	0.69	6	0.1	2.4	0.56	0.74	10.6
TKET	0	42	0.0%	-	-	-	-	-	-	-	-	-	-
WANB	16	76	21.1%	1	2	0.28	0.58	6	0.1	3	0.2	0.55	15.2
ALL FMAs	31	254	12.2%	1	2	0.15	0.44	8	0.1	3	0.10	0.39	26.6

Table 9 Top ten benthic bycatch VME indicator taxa by weight. Data is from the bottom longline fisheries and disaggregated by Area. Number of tows refers to the number of times each VME indicator taxa was recorded as benthic bycatch. Within a single tow, multiple taxa may have been recorded.

Area	FAO Code	VME taxon	Observed weight (kg)	% Area bycatch weight	No. tows	Percent tows in Area with bycatch
CET	AJZ	Alcyonacea	0.4	50.0%	3	2.6%
	AXT	<i>Stylasteridae</i>	0.2	25.0%	1	0.9%
	GGW	<i>Gorgonacea</i>	0.1	12.5%	1	0.9%
	CSS	Scleractinia	0.1	12.5%	1	0.9%
	PFR	Porifera	-	-	-	-
	NTW	Pennatulacea	-	-	-	-
	CWD	Crinoidea	-	-	-	-
	BHZ	Brsingida	-	-	-	-
	ATX	Actiniaria	-	-	-	-
	AQZ	Antipatharia	-	-	-	-
SOET	PFR	Porifera	4.1	38.7%	5	26.3%
	ATX	<i>Stylasteridae</i>	2.3	21.7%	1	5.3%
	GGW	<i>Gorgonacea</i>	2.0	18.9%	2	10.5%
	CWD	<i>Crinoidea</i>	1.0	9.4%	1	5.3%
	ATX	<i>Actiniaria</i>	1.0	9.4%	1	5.3%
	CSS	Scleractinia	0.2	1.9%	1	5.3%
	NTW	<i>Pennatulacea</i>	-	-	-	-
	BHZ	<i>Brsingida</i>	-	-	-	-
	AQZ	Antipatharia	-	-	-	-
	AJZ	Alcyonacea	-	-	-	-
WANB	CSS	Scleractinia	9.0	59.2%	7	9.2%
	AQZ	Antipatharia	2.3	15.1%	4	5.3%
	CWD	<i>Crinoidea</i>	1.3	8.6%	2	2.6%
	PFR	Porifera	1.0	6.6%	3	3.9%
	AJZ	<i>Alcyonacea</i>	1.0	6.6%	1	1.3%
	GGW	<i>Gorgonacea</i>	0.6	3.9%	4	5.3%
	NTW	Pennatulacea	-	-	-	-
	BHZ	Brsingida	-	-	-	-
	AXT	<i>Stylasteridae</i>	-	-	-	-
	ATX	Actiniaria	-	-	-	-
ALL	CSS	<i>Scleractinia</i>	9.3	35.0%	9	3.5%
	PFR	Porifera	5.1	19.2%	8	3.1%
	GGW	<i>Gorgonacea</i>	2.7	10.2%	7	2.8%
	AXT	<i>Stylasteridae</i>	2.5	9.4%	2	0.8%
	CWD	Crinoidea	2.3	8.6%	3	1.2%
	AQZ	Antipatharia	2.3	8.6%	4	1.6%
	AJZ	Alcyonacea	1.4	5.3%	4	1.6%
	ATX	Actiniaria	1.0	3.8%	1	0.4%
	NTW	Pennatulacea	-	-	-	-
	BHZ	Brsingida	-	-	-	-

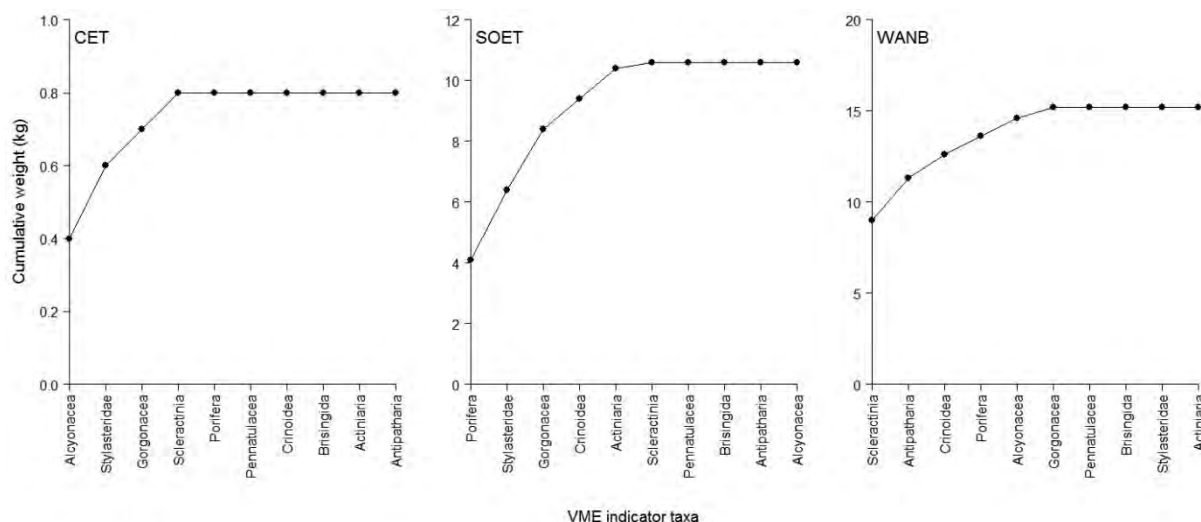


Figure 13 Cumulative VME indicator bycatch (kg) from the bottom longline fisheries, disaggregated by Area. VME indicator taxa are Actiniaria (ATX), Scleractinia (CSS), Porifera (PFR), Antipatharia (AQZ), Pennatulacea (NTW), Alcyonacea (ALZ), Gorgonacea (GGW), Brisingsida (BHZ), Crinoidea (CWD), Stylasteridae (AXT). Taxa are ordered from those with the largest recorded bycatch weight on the left to those with the smallest recorded bycatch weight on the right. Note: y-axis scales differ between panels.

5. Discussion

Benthic invertebrate bycatch recorded here likely represents an incomplete picture of the benthic community impacted by bottom fishing due to a combination of fishing gear selectivity and variation in the catchability of different benthic invertebrate taxa (Ardron et al. 2014). For example, trawl gear used in the orange roughy fishery has large bobbins set along the ground rope which may crush some invertebrates in their path, with smaller species being passed over by the trawl. Conversely, larger upright species (e.g. black corals), spiny species that snag in the trawl mesh (e.g., stylasterids, brisingids), and large soft species that become pinched in the trawl mesh (e.g., holothurians) are more likely to be retained (Probert et al 1997).

Due to difference in the selectivity of different fishing gear, as well as to differences in fishing locations, there were marked differences in the quantity and composition of benthic invertebrate bycatch between bottom longline and trawl fisheries. There were also differences in the quantity and composition of benthic invertebrate bycatch between fishing areas. This may be due to a combination of differences in species composition between biogeographic regions and a distinction between fishing occurring on relatively flat seafloor in some areas versus feature-based fishing, especially on the Louisville Seamount Chain, that have harder substrates that allow the development of benthic assemblages dominated by large sessile species such as scleractinian corals. For example, bottom trawl bycatch from the Louisville was dominated by bushy hard corals and stony corals, whereas bycatch in the Tasman Sea where fishing is less-focussed on features was more evenly spread across a wider range of benthic invertebrate taxa.

Data on the by-catch of benthic invertebrates is used to determine if move-on rules have been triggered, and the effectiveness of spatial management measures included in the [draft for a new](#)

[conservation and management](#) measure (CMM) for bottom fisheries within the western SPRFMO Area. Fishing gears are, however, not designed to capture or retain non-target species and more work is required to determine the catchability of benthic invertebrate taxa before bycatch data can be used in sophisticated ways. Catchability is dependent on the specific configuration of the gear, the physical characteristics of the species determining if it is initially retained (versus displaced, injured or killed), the probability that the specimen is landed by the vessel and recorded, and the interaction between all three. If catchability is low or highly variable, then little inference about the presence of benthic invertebrate taxa can be made when by-catch is zero, and conclusions are restricted to observations of presence-only when by-catch occurs. However, if catchability is moderate or high, and sampling density is sufficiently high, then both presence and (potentially) absence can be inferred. Analysis of by-catch rates for several benthic invertebrate taxa from longline sets or bottom trawl tows made with different gear configurations in the same fishing area at similar times may be useful to assess the relative catchabilities of taxa using different gear types and to identify discrepancies in reporting patterns. Ideally, this should be confirmed with independent sampling to link actual densities on the seafloor with amounts of by-catch observed using different fishing methods.

6. Recommendations

We recommend that the Scientific Committee:

- **Notes** the variability in benthic invertebrate bycatch and catchability of different fishing methods and fished areas.
- **Agree** that further work should be done to assess catchability in both trawl and bottom line fisheries to enable more sophisticated use of bycatch data in habitat suitability models and the development of thresholds for move-on rules where these might be required.

7. References

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Appendix A: Benthic taxonomic codes used by scientific observers

Table A1 Assignment of benthic invertebrate taxa to higher order VME groups, where NZ Code is the benthic taxonomic code used by scientific observers to report benthic bycatch in the SPRFMO Convention Area, and the FAO Code is the corresponding FAO 3-alpha code.

NZ Code	Common Name	Phylum	Class	Order	Family	Genus	Species	VME Group	FAO Code
ACN	Bushy bamboo coral	Cnidaria	Anthozoa	Alcyonacea	Isidiidae	<i>Acanella</i>		-	-
ACS	Smooth deepsea anemones	Cnidaria	Anthozoa	Actiniaria	Actinostolidae			Stylasteridae	ATX
ALF	Long-leaf sea pen	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	<i>Acanthoptilum</i>	<i>longifolium</i>	Pennatulacea	NTW
AMA	Giant file shell	Mollusca	Bivalvia	Limida	Limidae	<i>Acesta</i>	<i>maui</i>	-	-
ANT	Anemones	Cnidaria	Anthozoa	Actiniaria, Ceriantharia, Corallimorpharia, Zoanthidea				-	-
APU	Pimpled ear sponge	Porifera	Demospongiae	Tetractinellida	Scleritodermidae	<i>Aciculites</i>	<i>pulchra</i>	Porifera	PFR
ARO	Gigantic coral	Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	<i>Anthomastus</i>	<i>robustum</i>	Alcyonacea	AJZ
ASC	Sea squirt	Chordata	Ascidiacea					Ascidiacea	-
ASR	Sea stars	Echinodermata	Asteroidea					-	-
ATP	Antipathes spp.	Cnidaria	Anthozoa	Antipatharia	Antipathidae	<i>Antipathes</i>		Antipatharia	AQZ
ATR	Sea anemones	Cnidaria	Anthozoa	Actiniaria				Stylasteridae	ATX
BIV	Bivalves (unidentified)	Mollusca	Bivalvia					-	-
BOC	Deepsea anemones	Cnidaria	Anthozoa	Actiniaria	Actiniidae	<i>Bolocera</i>		Stylasteridae	ATX
BOO	Branching bamboo coral	Cnidaria	Anthozoa	Alcyonacea	Isidiidae	<i>Keratoisis</i>		Alcyonacea	AJZ
BPD	Lamp shells	Brachiopoda						Brachiopoda	-
BRG	Armless stars	Echinodermata	Asteroidea	Brsingida	Brsingidae, Hymenodiscidae, Novodiniidae, Freyellidae			Brsingida	BHZ
BTP	Bathypathes spp.	Cnidaria	Anthozoa	Antipatharia	Schizopathidae	<i>Bathypathes</i>		Antipatharia	AQZ
CAY	Carnation cup coral	Cnidaria	Anthozoa	Scleractinia	Caryophylliidae	<i>Caryophyllia</i>		Scleractinia	CSS

NZ Code	Common Name	Phylum	Class	Order	Family	Genus	Species	VME Group	FAO Code
CBR	Stony branching corals	Cnidaria	Anthozoa	Scleractinia	Dendrophylliidae, Oculinidae, Caryophylliidae			Scleractinia	CSS
CFU	Smooth white cup sponge	Porifera	Demospongiae	Tetractinellida	Corallistidae	<i>Corallistes</i>	<i>fulvodesmus</i>	Porifera	PFR
CHR	Golden corals	Cnidaria	Anthozoa	Alcyonacea	Chrysogorgiidae	<i>Chrysogorgia</i>		Alcyonacea	AJZ
CLL	Precious corals	Cnidaria	Anthozoa	Alcyonacea	Coralliidae	<i>Corallium</i>		Alcyonacea	AJZ
CLM	Coral-like anenomes	Cnidaria	Anthozoa	Corallimorpharia	Corallimorphidae			-	-
CLS	Calcareous sponges	Porifera	Calcerea					Porifera	PFR
CMT	Feather star	Echinodermata	Crinoidea	Comatulida				Crinoidea	CWD
COB	Black corals	Cnidaria	Anthozoa	Antipatharia				Antipatharia	AQZ
COF	Flabellum cup corals	Cnidaria	Anthozoa	Scleractinia	Flabellidae	<i>Flabellum</i>		Scleractinia	CSS
COR	Hydrocorals	Cnidaria	Hydrozoa	Anthoathecata	Stylasteridae			Stylasteridae	AXT
COU	Coral (Unidentified)	Cnidaria	Anthozoa	Scleractinia	Stylasteridae			Scleractinia	CSS
COZ	Bryozoan	Bryozoa						Bryozoan	-
CRE	White hydrocoral	Cnidaria	Hydrozoa	Anthoathecata	Stylasteridae	<i>Calyptopora</i>	<i>reticulata</i>	Stylasteridae	AXT
CRI	Sea lilies	Echinodermata	Crinoidea					Crinoidea	CWD
CRN	Sea lilies	Echinodermata	Crinoidea	Isocrinida, Millericrinida, Cyrtocrinida				Crinoidea	CWD
CRY	Starry white hydrocoral	Cnidaria	Hydrozoa	Anthoathecata	Stylasteridae	<i>Cryptelia</i>		-	-
CTP	Calyptrophora spp.	Cnidaria	Anthozoa	Alcyonacea	Primnoidae	<i>Calyptrophora</i>		Alcyonacea	AJZ
CUP	Stony cup corals	Cnidaria	Anthozoa	Scleractinia	Flabellidae, Fungiacyathidae, Caryophylliidae			Scleractinia	CSS
DDI	Crested cup coral	Cnidaria	Anthozoa	Scleractinia	Caryophylliidae	<i>Desmophyllum</i>	<i>dianthus</i>	Scleractinia	CSS
DDP	Black coral	Cnidaria	Anthozoa	Antipatharia	Schizopathidae	<i>Dendropathes</i>		Antipatharia	AQZ
DEN	Dendrobathypathes spp.	Cnidaria	Anthozoa	Antipatharia	Schizopathidae	<i>Dendrobathypathes</i>		Antipatharia	AQZ
DFO	Delectopecten fosterianus	Mollusca	Bivalvia	Pectinidae	Pectinidae	<i>Delectopecten</i>	<i>fosterianus</i>	-	-
DGR	Two-lined sea pen	Cnidaria	Anthozoa	Pennatulacea	Protoptilidae	<i>Distichoptilum</i>	<i>gracile</i>	Pennatulacea	NTW
DSO	Demosponges	Porifera	Demospongiae					Porifera	PFR
ECB	Erect cyclostome bryozoans	Bryozoa	Stenolaemata	Cyclostomatida				-	-
EPZ	Zoanthid anemone	Cnidaria	Anthozoa	Zoantharia	Epizoanthidae	<i>Epizoanthus</i>		Zoantharia	-

NZ Code	Common Name	Phylum	Class	Order	Family	Genus	Species	VME Group	FAO Code
ERE	Basket-weave horn sponge	Porifera	Hexactinellida	Lyssacinosida	Euplectellidae	<i>Euplectella</i>	<i>regalis</i>	Porifera	PFR
ERO	Deepwater branching coral	Cnidaria	Anthozoa	Scleractinia	Dendrophylliidae	<i>Enallopsammia</i>	<i>rostrata</i>	Scleractinia	CSS
ERR	Red hydrocorals	Cnidaria	Hydrozoa	Anthoathecata	Stylasteridae	<i>Errina</i>		Stylasteridae	AXT
FAR	Lacey honeycomb sponges	Porifera	Hexactinellida	Sceptrulophora	Farreidae	<i>Farrea</i>		Porifera	PFR
FQU	Rope-like sea pen	Cnidaria	Anthozoa	Pennatulacea	Funiculinidae	<i>Funiculina</i>	<i>quadrangularis</i>	Pennatulacea	NTW
GDU	Bushy hard coral	Cnidaria	Anthozoa	Scleractinia	Caryophylliidae	<i>Goniocorella</i>	<i>dumosa</i>	Scleractinia	CSS
GLM	Green-lipped mussel	Mollusca	Bivalvia	Mytilida	Mytilidae	<i>Perna</i>	<i>canaliculus</i>	-	-
GLS	Glass sponges	Porifera	Hexactinellida					Porifera	PFR
GOC	Gorgonian coral	Cnidaria	Anthozoa	Gongonacea				Gorgonacea	GGW
GRE	Curling stone sponge	Porifera	Demospongiae	Tetractinellida	Geodiidae	<i>Geodia</i>	<i>regina</i>	-	-
GVE	Ostrich egg sponge	Porifera	Demospongiae	Tetractinellida	Geodiidae	<i>Geodia</i>	<i>vestigifera</i>	Porifera	PFR
GYS	Siboga sea pen	Cnidaria	Anthozoa	Pennatulacea	Pennatulidae	<i>Gyrophyllum</i>	<i>sibogae</i>	Pennatulacea	NTW
HDF	Feathery hydroids	Cnidaria	Hydrozoa	Leptomeduseae, Anthoathecatae				-	-
HDR	Hydroids	Cnidaria	Hydrozoa					-	-
HMT	Warty deepsea anemones	Cnidaria	Anthozoa	Actiniaria	Hormathiidae			Stylasteridae	ATX
HYA	Floppy tubular sponge	Porifera	Hexactinellida	Lyssacinosida	Rossellidae	<i>Hyalascus</i>		Porifera	PFR
IRI	Iridescent coral	Cnidaria	Anthozoa	Alcyonacea	Chrysogorgiidae	<i>Iridogorgia</i>		Alcyonacea	AJZ
ISI	Bamboo corals	Cnidaria	Anthozoa	Alcyonacea	Isididae			Alcyonacea	AJZ
LEI	Leiopathes spp.	Cnidaria	Anthozoa	Antipatharia	Leiopathidae	<i>Leiopathes</i>		Antipatharia	AQZ
LIL	Lillipathes spp.	Cnidaria	Anthozoa	Antipatharia	Schizopathidae	<i>Lillipathes</i>		Antipatharia	AQZ
LIP	Deepsea anemones	Cnidaria	Anthozoa	Actiniaria	Liponematidae	<i>Liponema</i>		Stylasteridae	ATX
LLE	Bamboo coral	Cnidaria	Anthozoa	Alcyonacea	Isididae	<i>Lepidisis</i>		Alcyonacea	AJZ
LPT	Spiny white hydrocorals	Cnidaria	Hydrozoa	Anthoathecata	Stylasteridae	<i>Lipidotheca</i>		Stylasteridae	AXT
LSE	Black coral	Cnidaria	Anthozoa	Antipatharia	Leiopathidae	<i>Leiopathes</i>	<i>secunda</i>	Antipatharia	AQZ
MOC	Madrepora coral	Cnidaria	Anthozoa	Scleractinia	Oculinidae	<i>Madrepora</i>	<i>oculata</i>	Scleractinia	CSS
MTL	Metallic coral	Cnidaria	Anthozoa	Alcyonacea	Chrysogorgiidae	<i>Metallogorgia</i>		Alcyonacea	AJZ
ONG	Sponges	Porifera						Porifera	PFR
OVI	Oculina virgosa	Cnidaria	Anthozoa	Scleractinia	Oculinidae	<i>Oculina</i>	<i>virgosa</i>	Scleractinia	CSS
PAB	Bubblegum coral	Cnidaria	Anthozoa	Alcyonacea	Paragorgiidae	<i>Paragorgia</i>	<i>arborea</i>	Alcyonacea	AJZ
PAZ	Rocky dumpling sponge	Porifera	Demospongiae	Tetractinellida	Geodiidae	<i>Pachymatisma</i>		Porifera	PFR

