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SC11 – DW10
Development of a process to review all recent and historical benthic VME bycatch data

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Development of a process to review all recent and historical benthic VME bycatch data

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1. Purpose

The purpose of this paper is to provide a progress update on the SC multiannual workplan task to develop "*a process to review all recent and historical benthic bycatch data to determine the ongoing effectiveness of the spatial management measures*". The paper provides an update to the work that was presented in 2022 (SC10-DW03). It also presents an approach for undertaking fine-scale spatio-temporal analysis of benthic bycatch in areas where there has historically been a high frequency of interactions with VME indicator taxa.

2. Background

The Conservation and Management Measure for the Management of Bottom Fishing in the SPRFMO Convention Area (CMM03-2023) implements a spatial management regime and complementary encounter protocols designed to, inter alia, prevent Significant Adverse Impacts (SAI) on Vulnerable Marine Ecosystems (VMEs). These spatial management measures were established under CMM 03-2019 to protect large proportions of the predicted distribution of VME indicator taxa while permitting access for fisheries. A key component of the spatial management regime is Bottom Trawl Management Areas (BTMAs), which designate areas within Fisheries Management Areas (FMAs) within which bottom trawling can occur. From 2024, the SPRFMO Commission is required to apply a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa (paragraph 19 of CMM03-2023), which will result in an alteration of the boundaries of some BTMAs established in paragraph 14 and Annex 4 of CMM03-2023. Proposed boundary changes to achieve a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa are outlined in SC11-DW05 (Table 1).

Table 1 | For each Fishery Management Area, the area (in km²) available to fishing under the current BTMAs (as specified in CMM03-2023) and modified boundaries presented in SC11-DW05, and the estimated reduction of area open to fishing (as a percentage).

Fishery Management Area (FMA)	Area open to fishing (km²)		Reduction in area open to fishing (%)
	CMM03-2023	SC11-DW05	
West Norfolk	3,909	1,834	53
North Lord Howe	4,852	4,851	0
Central Lord Howe	8,238	7,392	10
Northwest Challenger	26,210	6,234	76
Westpac Bank	680	680	0
North Louisville	4,399	4,397	0
Central Louisville	4,219	750	82
South Louisville	9,814	5,962	39
South Tasman Rise	1,423	1,423	0

CMM03-2023 requires the SPRFMO Scientific Committee (SC) to "*review all available data and provide advice on the ongoing effectiveness of the management measures in this CMM to ensure the measure meets its objective and the objectives of the Convention and implements the relevant United Nations General Assembly Resolutions*". Historical records of benthic bycatch data, which provide information on where VME indicator taxa potentially occur (or could have occurred in the past), are a potentially

useful tool to help evaluate the effectiveness of management measures. Acknowledging this, a sub-task was added to the SC multiannual workplan titled "*Development of a process to review all recent and historical benthic bycatch data to determine the ongoing effectiveness of the spatial management measures*" as part of the wider "*VME Encounters and benthic bycatch*" task.

In response, New Zealand undertook a review of benthic bycatch data in 2022 to determine broad-scale spatial patterns of historic bycatch relative to the location of BTMAs, which was subsequently presented to the SC as SC10-DW03. To help identify spatial patterns of VME indicator taxa bycatch within and adjacent to BTMAs (as defined in Annex 4 of CMM03-2022), SC10-DW03 presented a series of cell-based metrics to visualise spatial patterns of benthic bycatch within each FMA (**Table**), with the purpose of identifying key areas of interest for closer examination of fine-scale spatio-temporal patterns in historic bycatch for to determine the potential presence of VMEs. The results of that mapping exercised identified a series of BTMAs where there has historically been a high frequency of interactions with VME indicator taxa (e.g., the Central Lorde Howe – East; Northwest Challenger; and Central Louisville 15 Management Areas) or exceptionally large bycatch events (e.g., of Scleractinia in the West Norfolk; North Louisville Ridge 23; Central Louisville Ridge 13, 14 and 15). Conversely, the mapping also identified BTMAs where bycatch of VME indicator taxa has been relatively infrequent (e.g., North Lord Howe – North; North Lord Howe – South; Westpac Bank; North Louisville Ridge 17 and 18; South Louisville Ridge 3, 5, 7, 8, 9 and 11). Following review of SC10-DW03, the SC:

a. noted that progress has been made in mapping the spatial distribution of historical bycatch of VME indicator taxa between 2008 and 2022.

b. noted that data included within the mapping is limited to that from New Zealand vessels operating within the evaluated area between 2008 and 2022, and is not representative of bycatch of VME indicator taxa in areas not fished by the New Zealand trawl fleet.

c. noted that the maps can overestimate the spatial distribution of bycatch and represent the maximum potential catch that could have come from a particular cell.

d. agreed that the mapping approach is useful for identifying the general areas within FMAs where fine-scale spatio-temporal investigations of historical bycatch should be undertaken, but that the per-cell statistics should be treated with caution as they present information at a smaller scale than is available in some of the data.

The SC also *recommended that for areas within FMAs with a high number of encounter events, or with high bycatch, that fine-scale spatio-temporal investigations of historical bycatch are undertaken*.

The mapping approach provided in SC10-DW03 is useful for identifying BTMAs where fine-scale spatio-temporal investigations of historical bycatch should be undertaken. However, because paragraph 19 of CMM03-2023 requires refinements of the BTMAs to ensure a minimum of 70% protection of suitable habitat for each modelled VME indicator taxon, the analysis presented in SC10-DW03 will be outdated when the new BTMAs are established. Here, we provide an update on the results reported in SC10-DW03 with reference to the BTMA boundaries proposed in SC11-DW05 to meet a minimum level of 70% protection of suitable habitat for modelled VME indicator taxa. We also propose an approach for fine-scale spatio-temporal analysis of areas within BTMAs where there has historically been a high frequency of interactions with VME indicator taxa.

Table 2 | Key cell-based metrics used to identify spatial patterns of VME indicator taxa bycatch.

Metric	Description
Trawl effort	Per-cell number of tows, based on a straight-line path between the reported start and end point of each tow
Number of times encounter thresholds triggered	For each VME indicator taxon, the per-cell number of times encounter thresholds in CMM03-2022 would have been exceeded had the encounter protocol been in place at the time of the fishing event. The encounter threshold is assumed to have been triggered in each cell intersected by a tow where the VME indicator taxon catch would have exceeded the encounter protocol threshold.
Cumulative potential bycatch of tows exceeding encounter thresholds	For each VME indicator taxon, the per cell cumulative potential bycatch of trawls that would have triggered encounter thresholds had they been in place. The full catch of each VME indicator taxon taken on a tow is assigned to each cell intersected by the tow.
Average potential bycatch per tow	For each VME indicator taxon, the per-cell average potential bycatch weight (kg) (i.e., taxon-specific cumulative potential bycatch, as defined above, divided by the number of tows intersecting the cell).
Maximum bycatch weight of tows exceeding encounter thresholds	For each VME indicator taxon, the per-cell maximum potential bycatch weight over all tows intersecting the cell that would have triggered encounter thresholds had they been in place.
Number of times biodiversity thresholds triggered	Per-cell number of times biodiversity thresholds in CMM03-2022 would have been exceeded had the encounter protocol been in place at the time of the fishing event. The biodiversity threshold is assumed to have been triggered for each cell intersected by a tow where the VME indicator taxa catch would have triggered the biodiversity threshold.

3. Methods

3.1 Data

The present analysis makes use of the historical and recent bycatch dataset from New Zealand bottom trawl tows that was compiled and processed as part of SC10-DW03. A full description of that data, data quality control and processing is provided in SC10-DW03. Briefly, the dataset contains data from the Fisheries New Zealand Centralised Observer Database (*cod*) (accessed 29th March 2022) for bottom trawl tows (including mid-water trawls) in the Evaluated Area in the western side of the SPRFMO Convention Area (Figure 1) over the 2008-2022 period. Data were collected by scientific observers (the New Zealand bottom trawl fleet has 100% observer coverage in the SPRFMO Convention Area) and included 10,440 unique fishing events targeting black oreo (*Allocyttus niger*), alfonsinos (*Beryx splendens and B. decadacylus*), cardinal fish (*Epigonus telescopus*), orange roughy (*Hoplostethus atlanticus*) and spiky oreo (*Neocyttus rhomboidalis*).
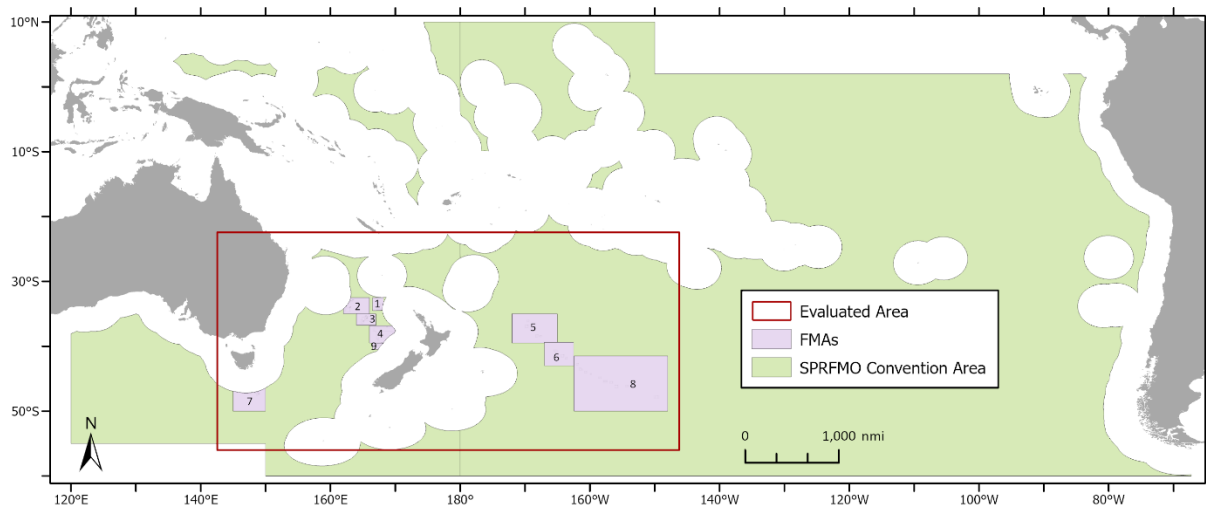
Figure 1 | SPRFMO Convention Area (light green area) including the extent of the Evaluated Area (red boundaries) with numbered Fishery Management Areas (FMAs) defined under SPRFMO CMM03-2023 (purple polygons). FMAs numbered as 1) West Norfolk, 2) North Lord Howe Rise, 3) Central Lord Howe Rise, 4) Northwest Challenger, 5) North Louisville Ridge, 6) Central Louisville Ridge, 7) South Tasman Rise, 8) South Louisville Ridge, and 9) Westpac Bank. A detailed figure for each FMA (and their respective BTMAs) can be found in Annex 1.

For tows containing VME indicator taxa bycatch (~33% of all tows), individual VME indicator species were aggregated into higher-order VME indicator taxa as defined in Annex 5 of SPRFMO CMM03-2022 using taxonomic designations from the World Register of Marine Species (Horton et al. 2018), resulting in a final dataset consisting of 3,520 unique tows with VME indicator bycatch and 6,707 VME indicator taxa records (see Appendix 1 of SC9-DW10 for the allocation of New Zealand fisheries codes to VME indicator taxa).

The data was aggregated into 3 nm^2 gridded cells using the statistical software *R* (R Core Team 2019). To help identify spatial patterns of VME indicator taxa bycatch within and adjacent BTMAs presented in SC11-DW05, a series of cell-based metrics to visualise spatial patterns of benthic bycatch were developed (Table).

3.2   Impact of modifying BTMA boundaries

Analysis presented in SC10-DW03 to identify BTMAs where fine-scale spatio-temporal investigations of historical bycatch should be undertaken were updated to reflect modifications in BTMAs boundaries proposed in SC11-DW05 to meet a minimum level of 70% protection of suitable habitat for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for detailed FMAs and BTMAs boundaries). Per-cell metrics (described in Table) presented in Tables 4-6 of SC10-DW03 were re-calculated using the modified BTMA boundaries. This allows an evaluation of the effectiveness of changes to the BTMA boundaries in avoiding opening areas to fishing where there has historically been a high frequency of interactions with, or large bycatch of, VME Indicator taxa (which may be indicative of the potential presence of VMEs).

Maps from SC10-DW03 were updated to display cells within each BTMA where there has historically been a high frequency of interactions with, or large bycatch of, VME Indicator taxa. To comply with

New Zealand regulations around commercially sensitive data release, the figures only show the cells where fishing activity was carried out by more than two unique vessels.

3.3   Application of fine-scale spatio-temporal analysis

To conduct fine-scale spatio-temporal investigations of historical bycatch, the metrics in Tables 3-6 can be filtered to identify those BTMAs where there has historically been a high frequency of interactions with VME Indicator taxa or exceptionally large bycatch events. The preferred filtering approach (i.e., sensitivity of the filter) is as much a management decision as it is a science decision. Having filtered BTMAs, the same filters can be applied on a per cell basis within BTMAs to identify cells of interest. Once cells of interest have been identified, cell-based metrics can be derived (Table 3) and stacked annual potential cumulative bycatch (kg bycatch per year) of VME indicator taxa from bottom trawl tows that intersect the cells (and labelled as *local* if the tows only intersected the cell of interest, and *shared* if it intersected multiple cells) can be plotted, with an overlay of annual cumulative fishing effort (number of tows per year) and VME encounters (see **Figure 2** for a hypothetical example).

Visual interpretation of the resulting plots allows detection of cells where patterns of VME indicator taxa bycatch may be of interest to management. For example, in a cell where VME indicator taxa bycatch continues following a bycatch event that would have triggered a VME encounter protocol, there may be evidence of a potential VME in the cell (see a theoretical example in **Figure 2**). Alternatively, where fishing effort remains constant and VME indicator taxa bycatch rates remain low following a large bycatch event, there may be little evidence that a VME remains present within the cell. Alternatively, in cells where there are no subsequent fishing events following a large bycatch event little inference can be drawn about the ongoing presence of potential VMEs.

To demonstrate the application of this approach, we apply it to BTMAs presented in SC11-DW05 and filter historic VME indicator taxa bycatch to identify BTMAs where historic bycatch of individual VME indicator taxa has been reported as > 100 kg from a single bottom trawl tow (i.e., West Norfolk - Wanganella, Central Lord Howe – East, Northwest Challenger, North Louisville 23, and Central Louisville 13 BTMAs). We then apply the same filter on a cell-by-cell basis to identify cells of interest, and for those cells, generate and interpret stacked annual potential cumulative bycatch plots. We acknowledge that the use of > 100 kg as a filter is arbitrary and there are alternative approaches to filtering focal BTMAs (e.g., BTMAs where historic bycatch would have triggered the encounter protocol had it been in place, or BTMAs where Maximum Average Potential Bycatch is above a pre-defined taxon-specific threshold).
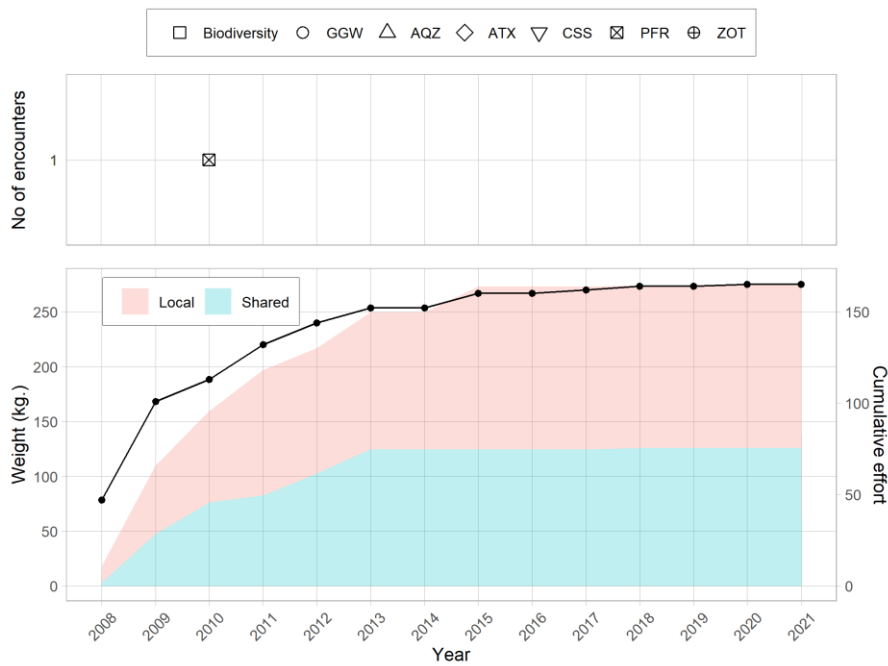
Figure 2 | Example of individual cell analysis. Upper figure shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered had the encounter protocol in CMM03-2022 been in place at the time of the fishing event. Lower figure shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *Local* (salmon) and *Shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

Table 3 | Key cell-based metrics used to evaluate identified cells of interest over time.

Metric	Description
Cumulative trawl effort	Per-cell cumulative number of tows, aggregated by year
Cumulative bycatch (*local*)	Per-cell cumulative VME indicator taxa bycatch, aggregated by year, from tows that intersect a single cell.
Cumulative bycatch (*shared*)	Per-cell potential cumulative VME indicator taxa bycatch, aggregated by year, from tows that intersect multiple cells.
Number of times encounter thresholds triggered	For each VME indicator taxon, the per-cell number of times encounter thresholds in CMM03-2022 would have been exceeded had the encounter protocol been in place at the time of the fishing event. The encounter threshold is assumed to have been triggered on each cell intersected by a tow where the VME indicator taxon catch would have exceeded the encounter protocol threshold.

4. Results

4.1   Impact of modifying BTMA boundaries

Modifications to BTMA boundaries decreased maximum average potential bycatch (Table 4, 5), and the number of times encounter protocols, had they been in place at the time, would have been triggered by weight (Table 6) or biodiversity thresholds (Table 7) in areas open to fishing, relative to the BTMA boundaries designated under CMM03-2023. BTMAs where boundary modifications result in the closure of areas to fishing where there has historically been a high frequency of interactions with, or large bycatch of, VME Indicator taxa include West Norfolk, Central Lord Howe - West, and Northwest Challenger (Tables 4-7). Additionally, to achieve a minimum of 70% protection in the

Central and South Louisville FMAs, several BTMAs are proposed to be closed in their entirety, including some where individual historic bottom trawl tows have recorded more than 1,000 kg of stony coral bycatch (e.g., in the Central Louisville FMA, BTMAs 14 and 15).

Table 4 | Maximum Average Potential Bycatch (kg) (as defined in Table 3) for cells fished by New Zealand trawl bottom trawl vessels between 2008 and 2022 for each Bottom Trawling Management Area (BTMA). Closed is the area outside BTMAs within an FMA that is closed to trawling. Values are provided using both 1) BTMA boundaries specific in CMM03-2023, and 2) BTMA boundaries as proposed in SC11-DW05 to achieve a minimum level of 70% protection for modelled VME indicator taxa. The table includes results for Porifera, Scleractinia, Antipatharia, Alcyonacea, Gorgonian Alcyonacea, Pennatulacea and Actiniaria. Green cells indicate where modifications to BTMA boundaries in SC11-DW05 result in less maximum average potential bycatch being exposed to fishing, relative to BTMAs designated in CMM03-2023. Shading of BTMA cell names indicate BTMAs that are either closed (orange shading) or have their boundaries modified (yellow shading) in SC11-DW05 to achieve the 70% protection target in para 19 of CMM03-2023.

FMA (Clark et al 2016)	BTMA	No. of tows		No. tows with VME indicator taxa bycatch		VME Indicator taxa														
						Porifera		Scleractinia		Antipatharia		Alcyonacea		Gorgonian Alcyonacea		Pennatulacea		Actiniaria	
		CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05
West Norfolk	Wanganella	676	446	368	221	12.500	12.500	12.211	12.211	0.250	0.109	0.000	0.000	15.109	6.250	0.003	0.003	0.021	0.001
West Norfolk	Closed	4	234	3	150	1091.199	1091.199	5.000	8.211	5.500	5.500	0.000	0.000	24.100	24.10	0.000	0.000	0.100	0.100
Nth Lord Howe	N. Lord Howe - East	244	244	3	3	0.088	0.088	0.000	0.000	< 0.001	< 0.001	0.000	0.000	< 0.001	< 0.001	0.000	0.000	0.000	0.000
Nth Lord Howe	N. Lord Howe - South	1072	1072	116	116	0.409	0.409	0.038	0.038	0.550	0.550	0.000	0.000	0.755	0.755	0.050	0.050	0.699	0.699
Nth Lord Howe	N. Lord Howe - West	334	334	33	33	0.037	0.037	0.002	0.002	0.25	0.25	< 0.001	< 0.001	0.349	0.349	0.022	0.022	0.800	0.800
Nth Lord Howe	Closed	360	360	98	98	0.428	0.428	0.382	0.382	0.699	0.699	0.000	0.000	7.500	7.500	0.001	0.001	0.699	0.699
Central Lord Howe	C. Lord Howe - East	207	207	130	130	5.200	5.200	8.250	8.25	9.699	9.699	0.000	0.000	61.974	61.974	0.021	0.021	3.000	3.000
Central Lord Howe	C. Lord Howe - West	1347	627	401	176	1.250	0.078	0.500	0.142	0.400	0.400	0.000	0.000	3.099	3.099	0.009	0.001	2.228	2.228
Central Lord Howe	C. Lord Howe - South	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Central Lord Howe	Closed	6	726	4	229	0.000	1.250	7.000	7.000	2.099	2.099	0.000	0.000	1.000	1.000	0.000	0.009	0.000	1.100
NW Challenger	Northwest Challenger	3333	2676	1440	1020	11.000	2.306	1.596	1.596	0.608	0.608	0.011	0.003	0.190	0.190	1.000	0.376	65.000	31.000
NW Challenger	Closed	39	696	8	428	10.000	11.000	1.000	1.299	0.000	0.250	0.000	0.011	0.006	0.075	1.000	1.000	10.000	65.000
Westpac Bank	Westpac Bank	470	470	80	80	< 0.001	< 0.001	0.023	0.023	0.170	0.170	0.000	0.000	0.030	0.030	0.001	0.001	0.050	0.050
Westpac Bank	Closed	8	8	3	3	0.200	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.100	0.000	0.000	5.000	5.000
Nth Louisville	17	73	73	20	20	0.955	0.955	0.105	0.105	0.011	0.011	0.000	0.000	0.077	0.077	0.000	0.000	0.000	0.000
Nth Louisville	18	56	56	25	25	0.000	0.000	1.299	1.299	4.800	4.800	0.000	0.000	43.099	43.099	0.000	0.000	0.000	0.000
Nth Louisville	22	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nth Louisville	23	3	3	3	3	0.000	0.000	5,000.000	5000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nth Louisville	Closed	39	39	4	4	0.100	0.100	2.400	2.400	3.000	3.000	0.000	0.000	13.199	13.199	0.000	0.000	0.000	0.000
Central Louisville	13	61	61	24	24	0.000	0.000	102.250	102.25	0.000	0.000	0.000	0.000	0.109	0.109	0.000	0.000	0.000	0.000
Central Louisville	14	315	-	144	-	0.035	-	333.366	-	0.020	-	0.000	-	0.050	-	0.000	-	0.000	-
Central Louisville	15	899	-	441	-	1.729	-	16.498	-	0.071	-	0.000	-	0.222	-	0.000	-	0.080	-
Central Louisville	Closed	14	1228	4	589	0.000	1.729	0.218	333.366	0.009	0.071	0.000	0.000	0.000	0.222	0.000	0.000	0.000	0.08
South Louisville	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Louisville	3	95	95	6	6	0.000	0.000	2.900	2.900	0.000	0.000	0.000	0.000	0.150	0.150	0.001	0.001	0.000	0.000
South Louisville	4	117	117	12	12	0.000	0.000	0.007	0.007	0.089	0.089	0.000	0.000	0.020	0.02	0.200	0.200	0.001	0.001
South Louisville	5	16	-	5	-	0.000	-	0.600	-	0.000	-	0.000	-	0.000	-	0.033	-	0.000	-
South Louisville	6	448	-	79	-	0.000	-	0.081	-	0.384	-	< 0.001	-	0.040	-	< 0.001	-	0.003	-
South Louisville	7	12	12	3	3	0.000	0.000	0.000	0.000	0.008	0.008	0.000	0.000	0.016	0.016	0.000	0.000	0.000	0.000
South Louisville	8	2	2	1	1	0.000	0.000	0.400	0.400	0.000	0.000	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.000
South Louisville	9	88	-	8	-	0.000	-	0.042	-	0.004	-	0.000	-	0.000	-	0.000	-	0.000	-
South Louisville	10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Louisville	11	12	-	1	-	0.000	-	0.125	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
South Louisville	Closed	11	563	6	98	0.000	1.099	0.125	1000	0.000	0.296	0.000	< 0.001	0.000	0.038	0.000	0.200	0.000	0.003

Table 5 | Maximum Average Potential Bycatch (kg) (as defined in Table 3) for cells fished by New Zealand bottom trawl vessels between 2008 and 2022 for each Bottom Trawling Management Area (BTMA). Closed is the area outside BTMAs within an FMA that is closed to trawling. Values are provided using both 1) BTMA boundaries specific in CMM03-2023, and 2) BTMA boundaries as proposed in SC11-DW05 to achieve a minimum level of 70% protection for modelled VME indicator taxa. The table includes results for Zoantharia, Hydrozoa, Stylasteridae, Bryozoa, Brisingida, and Crinoidea. Green cells indicate where modifications to BTMA boundaries in SC11-DW05 result in less maximum average potential bycatch being exposed to fishing, relative to BTMAs designated in CMM03-2023. Shading of BTMA cell names indicate BTMAs that are either closed (orange shading) or have their boundaries modified (yellow shading) in SC11-DW05 to achieve the 70% protection target in para 19 of CMM03-2023.

| FMA (Clark et al 2016) | BTMA | No. of tows | | No. tows with VME indicator taxa bycatch | | VME Indicator taxa | | | | | | | | | | | |
| | | | | | | Zoantharia | | Hydrozoa | | Stylasteridae | | Bryozoa | | Brisingida | | Crinoidea | |
		CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05	CMM03-2023	SC11-DW05
West Norfolk	Wanganella	676	446	368	221	0.004	0.001	0.033	< 0.001	0.050	0.002	0.024	0.024	0.000	0.000	0.009	0.009
West Norfolk	Closed	4	234	3	150	0.000	0.004	0.500	0.500	8.000	8.000	0.000	0.000	0.000	0.000	0.100	0.100
Nth Lord Howe	N. Lord Howe - East	244	244	3	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nth Lord Howe	N. Lord Howe - South	1072	1072	116	33	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.016
Nth Lord Howe	N. Lord Howe - West	334	334	33	116	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001
Nth Lord Howe	Closed	360	360	98	98	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.100	0.100
Central Lord Howe	C. Lord Howe - East	207	207	130	130	0.200	0.200	0.000	0.000	0.250	0.250	0.000	0.000	0.250	0.250	0.007	0.007
Central Lord Howe	C. Lord Howe - West	1347	627	401	176	1	1	0.019	0.019	0.007	0.005	0.000	0.000	< 0.001	< 0.001	0.000	0.000
Central Lord Howe	C. Lord Howe - South	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Central Lord Howe	Closed	6	726	4	229	0.200	0.200	0.000	0.000	0.000	0.007	0.000	0.000	0.000	< 0.001	0.000	0.000
NW Challenger	Northwest Challenger	3333	2676	1440	1020	4.72	4.482	0.012	0.012	0.022	0.022	< 0.001	< 0.001	3.000	0.068	1.000	0.222
NW Challenger	Closed	39	696	8	428	1	4.720	0.016	0.016	0.000	0.017	0.000	0.000	0.000	3.000	0.222	1.000
Westpac Bank	Westpac Bank	470	470	80	80	0.023	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Westpac Bank	Closed	8	8	3	3	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nth Louisville	17	73	73	20	20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nth Louisville	18	56	56	25	25	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nth Louisville	22	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nth Louisville	23	3	3	3	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000	0.000
Nth Louisville	Closed	39	39	4	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Central Louisville	13	61	61	24	24	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Central Louisville	14	315	-	144	-	0.010	-	0.002	-	0.015	-	0.000	-	0.000	-	0.000	-
Central Louisville	15	899	-	441	-	0.044	-	0.013	-	0.010	-	0.000	-	0.071	-	0.000	-
Central Louisville	Closed	14	1228	4	589	0.000	0.044	0.000	0.013	0.000	0.015	0.000	0.000	0.000	0.071	0.000	0.000
South Louisville	1	0	0	-	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
South Louisville	3	95	95	6	6	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
South Louisville	4	117	117	12	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.020	0.000	0.000
South Louisville	5	16	-	5	-	0.000	-	0.000	-	0.000	-	0.000	-	0.001	-	0.000	-
South Louisville	6	448	-	79	-	0.000	-	0.000	-	0.000	-	0.000	-	0.001	-	0.000	-
South Louisville	7	12	12	3	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
South Louisville	8	2	2	1	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
South Louisville	9	88	-	8	-	0.000	-	0.000	-	0.000	-	0.000	-	0.050	-	0.000	-
South Louisville	10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Louisville	11	12	-	1	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
South Louisville	Closed	11	563	6	98	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.000	0.000

Table 6 | Per management area summary statistics for encounter events that would have exceeded threshold weights had the encounter protocol in CMM03-2023 been in place at the time of the fishing event. Closed is the area outside BTMAs within an FMA that is closed to trawling. Summary statistics include the number of tows that would have exceeded VME indicator taxon-specific threshold weights (N), and the range of bycatch weights of tows that would have exceeded threshold weights (R). Also shown are the total number of encounters per management area (Total N). Values are provided using both 1) BTMA boundaries specific in CMM03-2023, and 2) BTMA boundaries as proposed in SC11-DW05 to achieve a minimum level of 70% protection for modelled VME indicator taxa. Green cells indicate where modifications to BTMA boundaries in SC11-DW05 result in fewer historic encounters (had the encounter protocol been in place) being in areas open to fishing, relative to BTMAs designated in CMM03-2023. Shading of BTMA cell names indicate BTMAs that are either closed (orange shading) or have their boundaries modified (yellow shading) in SC11-DW05 to achieve the 70% protection target in para 19 of CMM03-2023.

FMA (Clark et al 2016)	BTMA	Porifera				Scleractinia				Antipatharia				Gorgonian Alcyonacea				Actiniaria				Zoantharia				Total N	
		CMM03-2023		SC11-DW05		CMM03-2023		SC11-DW05		CMM03-2023		SC11-DW05		CMM03-2023		SC11-DW05		CMM03-2023		SC11-DW05		CMM03-2023		SC11-DW05		CMM03-2023	SC11-DW05
		N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)	N	R (kg)		
West Norfolk	Wanganella	13	25 - 200	3	26-50	3	100-1,000	1	1,000	0	-	0	-	7	15.1-125.1	2	22.6-25	0	-	0	-	0	-	0	-	16*	6
West Norfolk	Closed	1	1,091.2	11	25-1091.2	0	-	2	100-300	1	5.5	1	5.5	1	24.1	6	15.11-125.1	0	-	0	-	0	-	0	-	1	16*
Nth Lord Howe	N. Lord Howe - East	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Nth Lord Howe	N. Lord Howe - South	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Nth Lord Howe	N. Lord Howe - West	0	-	0	-	0	-	0	-	1	5.8	1	5.8	0	-	0	-	0	-	0	-	0	-	0	-	1	1
Nth Lord Howe	Closed	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Central Lord Howe	C. Lord Howe - East	4	25 -50	4	25-50	3	60-220.2	3	60-220.2	7	5-10.4	7	5-10.4	12	15-200	12	15-200	0	-	0	-	0	-	0	-	20*	20*
Central Lord Howe	C. Lord Howe - West	0	-	0	-	0	-	0	-	0	-	0	-	1	15	1	15	0	-	0	-	0	-	0	-	1*	1*
Central Lord Howe	C. Lord Howe - South	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-
Central Lord Howe	Closed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
NW Challenger	Northwest Challenger	0	-	0	-	2	90-200	0	-	1	6.8	1	6.8	1	80	1	80	11	35-80	6	35-80	11	10-114	8	10-114	26	18
NW Challenger	Closed	0	-	0	-	0	-	2	90-200	0	-	0	-	0	-	0	-	0	-	5	35-40.1	0	-	3	10-15	0	8
Westpac Bank	Westpac Bank	0	-	0	-	0	-	0	-	1	6	1	6	0	-	0	-	0	-	0	-	0	-	0	-	1	1
Westpac Bank	Closed	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Nth Louisville	17	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Nth Louisville	18	0	-	0	-	0	-	0	-	0	-	0	-	1	43.1	1	43.1	0	-	0	-	0	-	0	-	1	1
Nth Louisville	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nth Louisville	23	-	-	0	-	2	3,000-5,000	2	3,000-5,000	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	2	2
Nth Louisville	Closed	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
Central Louisville	13	0	-	0	-	1	400	1	400	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	1	1
Central Louisville	14	0	-	-	-	8	66.3-1,000	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	8	-
Central Louisville	15	0	-	-	-	13	60-3,000	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	13	-
Central Louisville	Closed	0	-	0	-	0	-	21	60-3,000	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	21
South Louisville	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Louisville	3	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
South Louisville	4	0	-	0	-	0	-	0	-	1	8.9	1	8.9	0	-	0	-	0	-	0	-	0	-	0	-	1	1
South Louisville	5	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
South Louisville	6	0	-	-	-	0	-	-	-	1	7.6	-	-	0	-	-	-	0	-	-	-	0	-	-	-	1	-
South Louisville	7	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	0
South Louisville	8	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
South Louisville	9	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
South Louisville	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0
South Louisville	11	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
South Louisville	Closed	0	-	0	-	1	1,000	1	1,000	0	-	1	7.6	0	-	0	-	0	-	0	-	0	-	0	-	1	2

* Note the sum of the number of times VME indicator taxon-specific threshold weights were exceeded doesn't equal Total N because bycatch from bottom trawl tows sometimes contained more than 1 VME indicator taxa that would have exceeded their taxon-specific threshold weights had the encounter protocol been in place.

Table 7 | Number of times biodiversity thresholds would have been triggered in each BTMA had the encounter protocol in CMM03-2022 been in place at the time of the fishing event. Closed areas are those areas outside BTMAs within an FMA that are closed to trawling. Values are provided using both 1) BTMA boundaries specific in CMM03-2023, and 2) BTMA boundaries as proposed in SC11-DW05 to achieve a minimum level of 70% protection for modelled VME indicator taxa. Green cells indicate where modifications to BTMA boundaries in SC11-DW05 result in fewer historic encounters (had the encounter protocol been in place) in areas open to fishing, relative to BTMAs designated in CMM03-2023. Shading of BTMA cell names indicate BTMAs that are either closed (orange shading) or have their boundaries modified (yellow shading) in SC11-DW05 to achieve the 70% protection target in para 19 of CMM03-2023.

FMA (Clark et al 2016)	BTMA	No. times biodiversity thresholds triggered	
		CMM03-2023	SC11-DW05
West Norfolk	Wanganella	0	0
West Norfolk	Closed	1	1
Nth Lord Howe	N. Lord Howe - East	0	0
Nth Lord Howe	N. Lord Howe - South	0	0
Nth Lord Howe	N. Lord Howe - West	0	0
Nth Lord Howe	Closed	0	0
Central Lord Howe	C. Lord Howe - East	11	11
Central Lord Howe	C. Lord Howe - West	1	1
Central Lord Howe	C. Lord Howe - South	0	0
Central Lord Howe	Closed	0	0
NW Challenger	Northwest Challenger	20	15
NW Challenger	Closed	0	5
Westpac Bank	Westpac Bank	0	0
Westpac Bank	Closed	0	0
Nth Louisville	17	0	0
Nth Louisville	18	0	0
Nth Louisville	22	0	0
Nth Louisville	23	0	0
Nth Louisville	Closed	0	0
Central Louisville	13	0	0
Central Louisville	14	0	-
Central Louisville	15	0	-
Central Louisville	Closed	0	0
South Louisville	1	0	0
South Louisville	3	0	0
South Louisville	4	0	0
South Louisville	5	0	-
South Louisville	6	0	-
South Louisville	7	0	0
South Louisville	8	0	0
South Louisville	9	0	-
South Louisville	10	0	0
South Louisville	11	0	-
South Louisville	Closed	0	0

West Norfolk FMA

The **West Norfolk FMA** includes a single BTMA (**Wanganella**), which has its boundaries modified in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (see Figure A1 for the West Norfolk FMA). Within the modified Wanganella BTMA boundaries, 221 of 446 tows (50%) included bycatch of VME indicator taxa (from eleven VME indicator taxa – Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Hydrozoa, Stylasteriade, Bryozoa and Crinoidea) (Table 4, Table 5, Table 6). Six tows would have triggered taxon-specific threshold weights (Table 4, Table 5), had the encounter protocol been in place. Three of those tows would have exceeded the taxon-specific threshold weight for Porifera, with per tow bycatch of Porifera for these tows ranging between 26 and 50 kg (Table 6). Two tows would have exceeded the taxon-specific weight threshold for Gorgonian Alcyonacea, with per tow bycatch ranging between 22.6 and 25 kg of Gorgonian Alcyonacea (Table 6). A single tow would have exceeded the taxon-specific threshold weight for Scleractinia (cell 185619), with a bycatch weight of 1,000 kg (therefore, the Wanganella BTMA is included in the demonstration of the application of fine-scale spatio-temporal analysis). None of the 221 tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol had it been in place (Table 7).

North Lord Howe Rise FMA

The **North Lord Howe Rise FMA** includes three BTMAs (**N. Lord Howe - East, South** and **West**) which currently achieve a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the North Lord Howe Rise FMA). Ten VME indicator taxa were reported as benthic bycatch across bottom trawl tows by New Zealand vessels within the North Lord Howe Rise FMA (Porifera, Scleractinia, Antipatharia, Alcyonacea, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Bryozoa and Crinoidea) (Table , Table 5).

Within the **N. Lord Howe – East** BTMA, 3 of 244 tows (~1%) included bycatch of VME indicator taxa (from three VME indicator taxa – Porifera, Antipatharia, and Gorgonian Alcyonacea) (Table , Table). No historic tows would have triggered taxon-specific threshold weights or the biodiversity component of the encounter protocol, had it been in place (Table 6, Table 7).

Within the **N. Lord Howe – South** BTMA, 116 of 1072 tows (11%) included bycatch of VME indicator taxa (from eight VME indicator taxa – Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia and Crinoidea) (Table , Table , Table 6). No historic tows would have triggered taxon-specific threshold weights or the biodiversity component of the encounter protocol, had it been in place (Table 6, Table 7).

Within the **N. Lord Howe – West** BTMA, 33 of 334 tows (10%) included bycatch of VME indicator taxa (from ten VME indicator taxa – Porifera, Scleractinia, Antipatharia, Alcyonacea, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Bryozoa and Crinoidea) (Table , Table , Table 6). A single historic tow would have triggered a taxon-specific threshold weight for Antipatharia, had the encounter protocol been in place, with per tow bycatch of 5.8 kg (Table 6). No other taxon-specific thresholds were exceeded, and no tows would have triggered the biodiversity component of the encounter protocol, had it been in place (Table , Table 7).

Central Lord Howe Rise FMA

The **Central Lord Howe Rise FMA** includes three BTMAs (**Central Lord Howe - East, South** and **West**), with the boundaries of the Central Lord Howe West and Central Lord Howe East boundaries having been modified in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the Central Lord Howe FMA). Eleven VME indicator taxa were reported as benthic bycatch across bottom trawl tows by New Zealand vessels within the Central Lord Howe Rise FMA (Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Hydrozoa, Stylasteridae, Brisingida and Crinoidea) (Table , Table 5).

Within the modified boundaries of the **C. Lord Howe – East** BTMA, 130 of 207 tows (63%) included bycatch of VME indicator taxa (from ten VME indicator taxa – Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Stylasteridae, Brisingida and Crinoidea) (Table , Table , Table 6). Twelve tows would have exceeded the taxon-specific threshold weight for Gorgonian Alcyonacea, had the encounter protocol been in place, with per tow bycatch of Gorgonian Alcyonacea for these tows ranging between 15 and 200 kg (Table 6). Seven tows would have exceeded the taxon-specific threshold weight for Antipatharia, with per tow bycatch of Antipatharia for these tows ranging between 5 and 10.4 kg (Table 6). Three tows would have exceeded the taxon-specific threshold weight for Scleractinia, with per tow bycatch of Scleractinia for these tows ranging between 60 and 220.2 kg (Table 6) (therefore, the C. Lord Howe – East BTMA is included in the demonstration of the application of fine-scale spatio-temporal analysis). Four tows would have exceeded the taxon-specific threshold weight for Porifera, with per tow bycatch of Porifera for these tows ranging between 25 and 50 kg (Table 6). Eleven of the 130 tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

No tows were recorded within the boundaries of the **C. Lord Howe – South** BTMA**.**

Within the modified boundaries for the **C. Lord Howe – West** BTMA, 176 of 627 tows (28%) included bycatch of VME indicator taxa (from ten VME indicator taxa – Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Hydrozoa, Stylasteridae, and Brisingida) (Table , Table , Table 6). A single tow would have triggered the taxon-specific threshold weight for Gorgonian Alcyonacea, had the encounter protocol been in place, with 15 kg of Gorgonian Alcyonacea (Table 6). No other taxon-specific thresholds were exceeded. A single tow containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

Northwest Challenger

The **Northwest Challenger FMA** includes a single BTMA (**Northwest Challenger**) whose boundaries are modified in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the Northwest Challenger FMA). Within the modified boundaries, 1020 of 2676 tows (38%) included bycatch of VME indicator taxa (from all thirteen VME indicator taxa – Porifera, Scleractinia, Antipatharia, Alcyonacea, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, Zoantharia, Hydrozoa, Stylasteridae, Bryozoa, Brisingida, and Crinoidea (Table , Table , Table 6). Eighteen tows would have triggered taxon-specific threshold weights (Table 6). Eight tows would have exceeded the taxon-specific threshold weight for Zoantharia had the encounter protocol been in place, with per tow bycatch of Zoantharia for these tows ranging between

10 and 114 kg (Table 6) (therefore, the Northwest Challenger BTMA is included in the demonstration of the application of fine-scale spatio-temporal analysis). Six tows would have exceeded the taxon-specific weight threshold for Actiniaria, with per tow bycatch of Actiniaria ranging between 38 and 80 kg (Table 6). A single tow would have exceeded the taxon-specific threshold weight for both Gorgonian Alcyonacea and Antipatharia, had the encounter protocol been in place, with a bycatch weight of 80 and 6.8kg for Gorgonian Alcyonacea and Antipatharia, respectively. Fifteen of the 1020 tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol had it been in place (Table 7).

Westpac Bank FMA

The **Westpac Bank FMA** includes a single BTMA (**Westpac Bank**) that currently achieves a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the Westpac Bank FMA). Within the Westpac Bank BTMA, 80 of 470 tows (17%) included bycatch of VME indicator taxa (from seven VME indicator taxa – Porifera, Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria and Zoantharia (Table , Table , Table 6). A single tow would have triggered the taxon-specific threshold weight for Antipatharia, had the encounter protocol been in place, with 6 kg of Antipatharia bycatch (Table 6). No other taxon-specific thresholds were exceeded. No tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

North Louisville Ridge FMA

The **North Louisville Ridge FMA** includes four BTMAs (**17**, **18**, **22** and **23**) that currently achieve a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the North Louisville Ridge FMA). Six VME indicator taxa were reported as benthic bycatch across bottom trawl tows by New Zealand vessels within the North Louisville Ridge FMA (Porifera, Scleractinia, Antipatharia and Gorgonian Alcyonacea, Hydrozoa and Brisingida) (Table , Table 5).

Within BTMA **17**, 20 of 73 tows (27%) included bycatch of VME indicator taxa (from four VME indicator taxa - Porifera, Scleractinia, Antipatharia and Gorgonian Alcyonacea) (Table , Table , Table 6). None of the tows would have triggered either the taxon-specific threshold weights or the biodiversity components of the encounter protocol, had it been in place (Table , Table 7).

Within BTMA **18**, 25 of 56 tows (45%) included bycatch of VME indicator taxa (from four VME indicator taxa – Scleractinia, Antipatharia, Gorgonian Alcyonacea and Hydrozoa) (Table , Table , Table 6). A single tow would have triggered the taxon-specific threshold weight for Gorgonian Alcyonacea, had the encounter protocol been in place, with 43.1 kg of Gorgonian Alcyonacea (Table 6). No other taxon-specific thresholds were exceeded, and no tows would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

No tows were recorded within the 70% protection scenario open area of BTMA **22**.

Within BTMA **23**, 3 of 3 tows (100%) included bycatch of VME indicator taxa (from two VME indicator taxa – Scleractinia and Brisingida) (Table , Table , Table 6). Two tows would have triggered taxon-specific threshold weights (Table 4, Table 5). Both tows would have exceeded the taxon-specific threshold weight for Scleractinia had the encounter protocol been in place, with per tow bycatch for these tows ranging between 3,000 and 5,000 kg of Scleractinia bycatch (Table 6); therefore, BTMA 23

is included in the demonstration of the application of fine-scale spatio-temporal analysis. No other taxon-specific thresholds were exceeded, and no tows would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

Central Louisville Ridge FMA

The **Central Louisville Ridge FMA** currently includes three BTMAs, two of which are proposed to be closed in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (see Annex 1 – Fishery Management Areas (FMAs) for the Central Louisville Ridge FMA). Within the remaining BTMA, 24 of 61 tows (39%) included bycatch of VME indicator taxa (from three VME indicator taxa – Scleractinia, Gorgonian Alcyonacea, and Zoantharia (Table , Table , Table 6). A single tow would have triggered the taxon-specific threshold weight for Scleractinia, had the encounter protocol been in place, with 400 kg of Scleractinia bycatch (Table 6) (therefore BTMA 23 is included in the demonstration of the application of fine-scale spatio-temporal analysis). No other taxon-specific thresholds were exceeded. No tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol, had it been in place (Table 7).

South Louisville Ridge FMA

The **South Louisville Ridge FMA** currently includes ten BTMAs, four of which are proposed to be closed in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa, leaving BTMAs (**1**, **3**, **4**, **7**, **8** and **10**) (see Annex 1 – Fishery Management Areas (FMAs) for the South Louisville Ridge FMA). Within BTMA **4**, 12 of 117 tows (10%) included bycatch of VME indicator taxa (from six VME indicator taxa – Scleractinia, Antipatharia, Gorgonian Alcyonacea, Pennatulacea, Actiniaria, and Brisingida (Table , Table , Table 6). A single tow would have triggered the taxon-specific threshold weight for Antipatharia, had the encounter protocol been in place, with bycatch of 8.9 kg (Table 6). No other taxon-specific thresholds were exceeded. None of the 12 tows containing bycatch of VME indicator taxa would have triggered the biodiversity component of the encounter protocol, had it been in place in BTMA 4 (Table 7).

No bottom trawl tows in BTMAs 1, 3, 7, 8 or 10 would have triggered taxon-specific VME weight thresholds or biodiversity thresholds, had the encounter protocol in CMM03-2023 been in place at the time. All cells within BTMAs 1, 3, 7, 8 and 10 recorded ≤ 3kg potential cumulative bycatch of VME indicator species.

4.2   Application of fine-scale spatio-temporal analysis

Four BTMAs had historic bottom trawl tows where VME indicator bycatch exceeded 100 kg (West Norfolk - Wanganella, Central Lord Howe – East, Northwest Challenger, North Louisville 23, and Central Louisville 13). For each of these BTMAs, we evaluated temporal patterns in cells where bottom trawl tows had > 100 kg of VME indicator taxa bycatch.

Table 8 | Cells of interest in the West Norfolk - Wanganella, Central Lord Howe – East, Northwest Challenger, North Louisville - 23 and Central Louisville - 13 BTMAs, as presented in SC11-DW05. Presented is the per-cell number of tows, with the proportion of tows intersecting a single cell (*local* tows) and multiiple cells (*shared* tows), the proportion of tows with VME indicator taxa bycatch and the total potential cumulative VME indicator taxa bycatch weight.

FMA	BTMA	Cell	No. of tows	Proportion of *local* tows (%)	Proportion of *shared* tows (%)	Proportion of tows with VME indicator taxa bycatch (%)	Potential Cumulative VME indicator taxa bycatch weight (kg)
West Norfolk	Wanganella	185619	89	79	21	57	1,202.82
Central Lord Howe	East	217904	91	44	56	78	1,105.80
Central Lord Howe	East	223292	4	75	25	75	259.40
NW Challenger	NW Challenger	250233	46	0	100	72	552.00
NW Challenger	NW Challenger	250234	208	13	87	33	366.42
NW Challenger	NW Challenger	250235	487	25	75	22	491.82
NW Challenger	NW Challenger	251312	35	29	71	57	198.30
NW Challenger	NW Challenger	251313	29	7	93	55	170.20
North Louisville	23	226892	1	100	0	100	3,001.00
North Louisville	23	227968	1	0	100	100	5,001.00
North Louisville	23	227969	1	0	100	100	5,001.00
Central Louisville	13	348681	4	25	75	50	409.00
Central Louisville	13	348682	31	81	19	39	440.10

West Norfolk – Wanganella

One cell of interest was identified within the modified boundaries of the Wanganella BTMA as having historic tows with >100 kg bycatch of a VME indicator taxon (Figure 3). Within cell 185619, 89 tows have been recorded since 2008 (Table 8), with most tows not being recorded as intersecting adjacent cells. A single tow in 2009 would have exceeded the weight threshold for Gorgonian Alcyonacea, and a single tow in 2013 would have exceeded the weight threshold for Scleractinia, had the encounter protocol in CMM03-2023 been in place at the time (Figure 3). In the 2013 fishing year, potential cumulative bycatch of VME indicator taxa within cell 185619 was approximately 1,000 kg. Despite low levels of fishing within cell 185619 since 2013 (approximately 10 tows), there has been no reported bycatch of VME indicator taxa since (Figure 3). Therefore, it's difficult to infer the ongoing presence of a potential VME due to a lack of subsequent fishing effort.
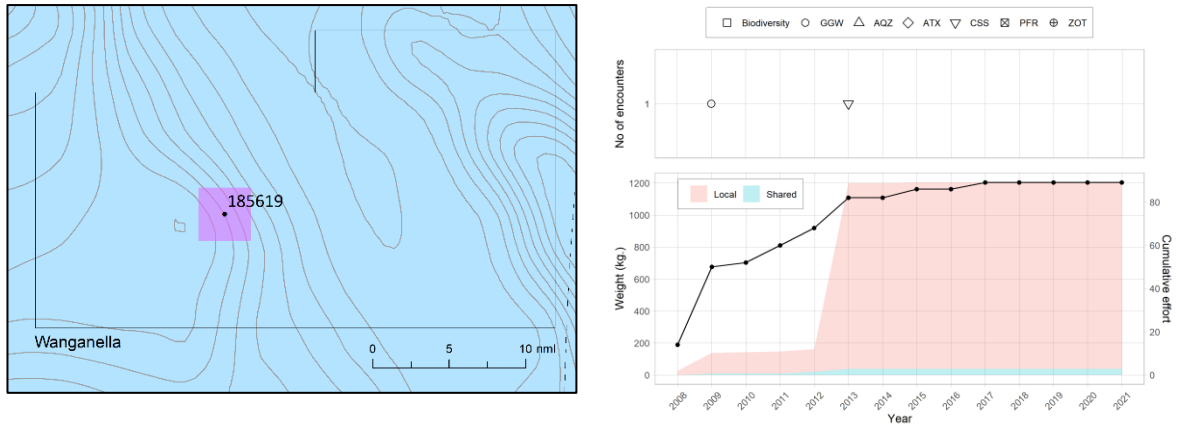
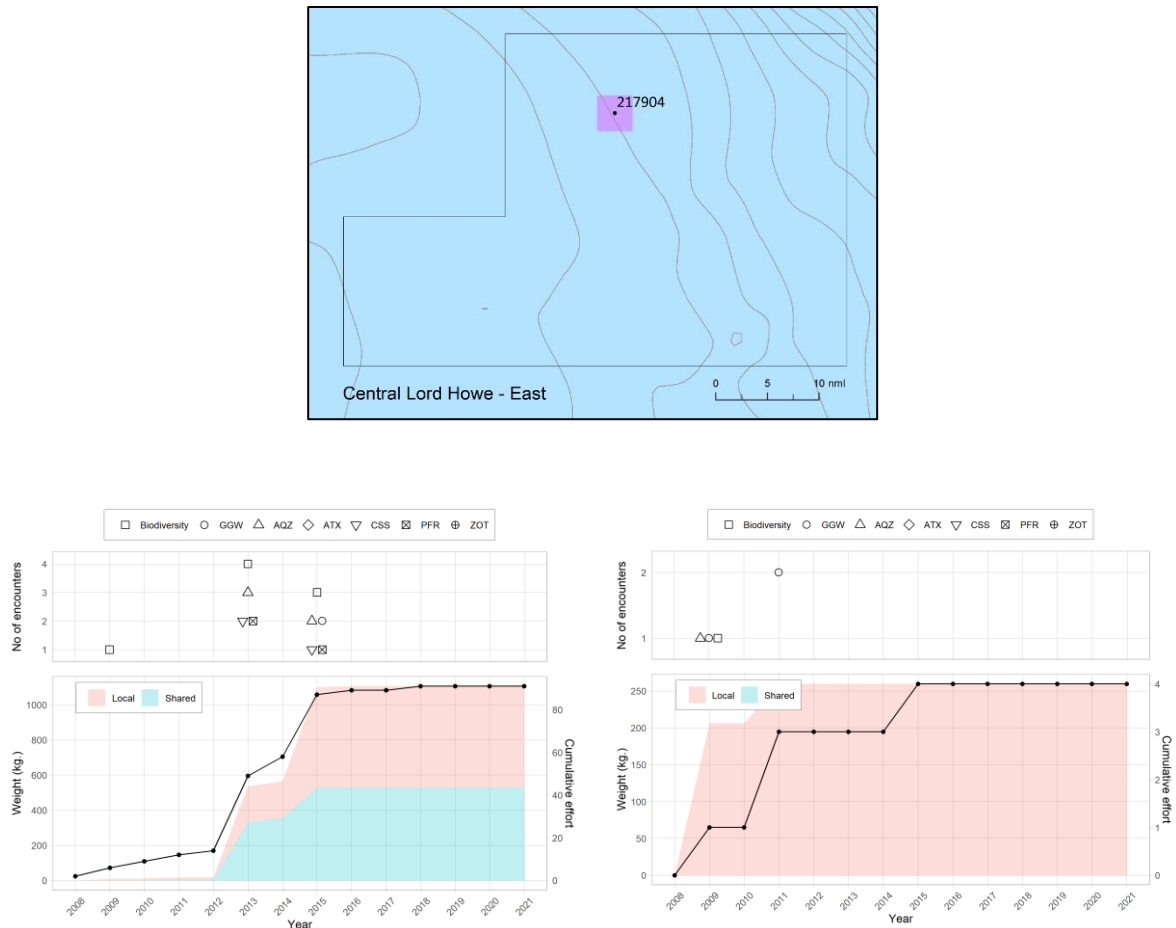**Figure 3** | Cell of interest in the modified Wanganella BTMA boundaries presented in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (Left). Potential cumulative historic bycatch for cell 185619 (right). Upper portion of panel shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered had the encounter protocol in CMM03-2022 been in place at the time of the fishing event. Lower portion shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *local* (salmon) and *shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

Central Lord Howe – East

Two cells of interest were identified within the modified boundaries of the Central Lord Howe – East BTMA as having historic tows with >100 kg bycatch of a VME indicator taxa (Figure 4). Within cell 217904, 91 tows have been recorded since 2008 (Table 8). Tows in 2009, 2013 and 2015 would have exceeded biodiversity thresholds, and tows in 2013 and 2015 would have exceeded weight thresholds for various VME indicator taxa, had the encounter protocol in CMM03-2023 been in place at the time (Figure 4). Between 2012 and 2015, approximately 800 kg of VME indicator bycatch has been report by observers from cell 217904 (Figure 4). There has been very little fishing effort in cell 217904 since 2015, and none since 2018.

Within cell 223292, four tows have been recorded since 2008 (Table 8). One tow was conducted in 2009, which would have triggered the biodiversity threshold and weight thresholds for Gorgonian Alcyonacea and Antipatharia. Two tows were conducted in 2011, and one of those two tows would have triggered the weight threshold for Gorgonian Alcyonacea, had the encounter protocol in CMM03-2023 been in place at the time. Approximately 250 kg of VME indicator taxa were reported as bycatch across the 2009 and 2011 fishing years (Figure 4). The fourth tow was conducted in 2015,

with no VME indicator taxa recorded as bycatch (Figure 4). Since 2015, there has been no fishing in cell 223292.

Figure 4 | Cells of interest in the modified Central Lord Howe - East BTMA boundaries presented in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (Top – cell 223292 omitted due to confidentiality clause, in line with FNZ regulations for the release of commercially sensitive data). Potential cumulative historic bycatch for cells 217904 (bottom left) and 223292 (bottom right). Upper portion of panel shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered had the encounter protocol in CMM03-2022 been in place at the time of the fishing event (jigging overlapping points may cause a slight horizontal displacement). Lower portion shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *local* (salmon) and *shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

Northwest Challenger

Five cells of interest were identified within the modified boundaries of the Central Lord Howe – East BTMA as having historic tows with >100 kg bycatch of a VME indicator taxa (Figure 5).

Within cell 251312, 32 tows have been reported since 2008, with approximately 198 kg of VME indicator bycatch reported between 2009 and 2016. If the encounter protocol had been in effect at the time, three bottom trawl tows within cell 251312 would have exceeded the weight threshold for

Zoantharia in 2015, and one tow would have exceeded the biodiversity threshold in 2016. There has been very little fishing effort in cell 251312 since 2016, and none since 2018. All bottom trawls tows within cell 251312 also crossed other cells; therefore, it is difficult to determine from the stacked potential cumulative bycatch plots alone if this bycatch originated from cell 251312 or neighbouring cells.

Within cell 250234, 208 tows have been reported since 2008, with approximately 366 kg of VME indicator bycatch reported between 2009 and 2020. Both the weight threshold for Zoantharia and the biodiversity threshold would have been exceeded in 2015, had the encounter protocol been in place at the time. There has been very little fishing effort in cell 250234 since 2018, and none since 2020. Most bottom trawls tows within cell 250234 also crossed other cells; therefore, it is difficult to determine from the stacked potential cumulative bycatch plots alone if this bycatch originated from cell 250234 or neighbouring cells.

Within cell 250233, 4 tows have been reported since 2008, with approximately 552 kg of VME indicator bycatch reported between 2009 and 2020. If the encounter protocol had been in effect at the time, two bottom trawl tows within cell 251312 would have exceeded the weight threshold for Zoantharia in 2015, one tow would have exceeded the biodiversity threshold in 2016, and in 2018 two bottom trawl tows would have exceeded the weight threshold for Actiniaria and three tows would have exceeded the weight threshold for Zoantharia. There has been very little fishing effort in cell 250233 since 2018, and none since 2020. All of the bottom trawl tows within cell 250233 also crossed other cells; therefore, it is difficult to determine from the stacked cumulative bycatch plots alone if this bycatch originated from cell 250233 or neighbouring cells.

Within cell 251313, 29 tows have been reported since 2008, with approximately 170 kg of VME indicator bycatch reported between 2014 and 2021. If the encounter protocol had been in effect at the time, one bottom trawl tow within cell 251313 would have exceeded the weight threshold for Zoantharia in 2015, and one tow would have exceeded the biodiversity threshold in 2016. No bycatch was recorded prior to 2015. There has been very little fishing effort in cell 251313 since 2017, and none since 2018. Most bottom trawls tows within cell 251313 also crossed other cells; therefore, it is difficult to determine from the stacked cumulative bycatch plots alone if this bycatch originated from cell 251313 or neighbouring cells.

Within cell 250235, 487 tows have been reported since 2008, with approximately 492 kg of VME indicator bycatch reported between 2008 and 2020. If the encounter protocol had been in effect at the time, one bottom trawl tow within cell 250235 would have exceeded the weight threshold for Scleractinia in 2009, and the weight threshold for Zoantharia and the biodiversity threshold would have been triggered in 2015. Despite increased fishing effort in cell 250235 between 2015 and 2018, no further weight or biodiversity thresholds would have been triggered. Most bottom trawls tows within cell 250235 prior to 2014 didn't cross into adjacent cells, so it is likely the bycatch of Scleractinia in 2009 originated from that cell. After 2014, most tows are reported as crossing into adjacent cells; therefore, it is difficult to determine from the stacked cumulative bycatch plots alone if the bycatch from 2014 onwards originated from cell 250235 or neighbouring cells.
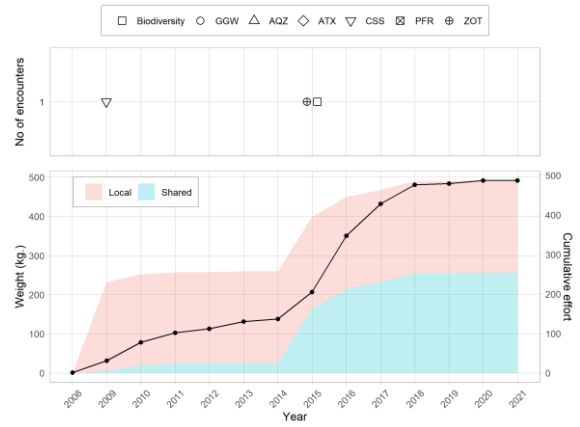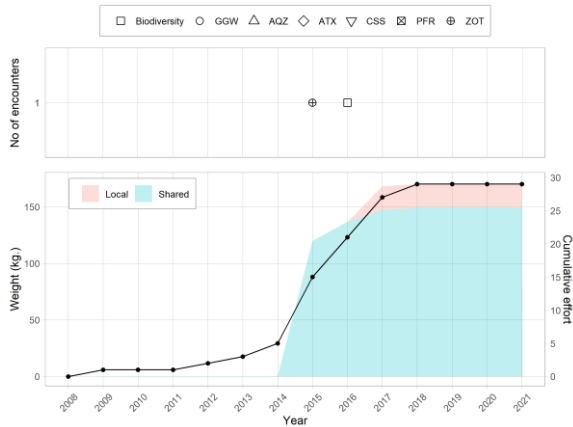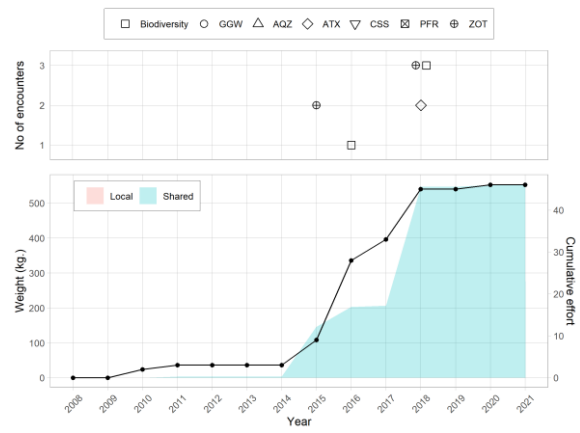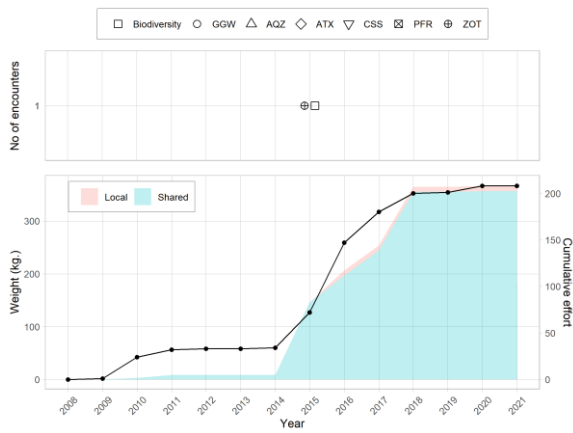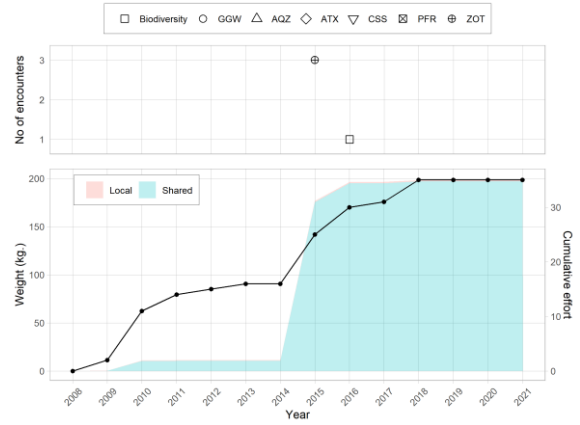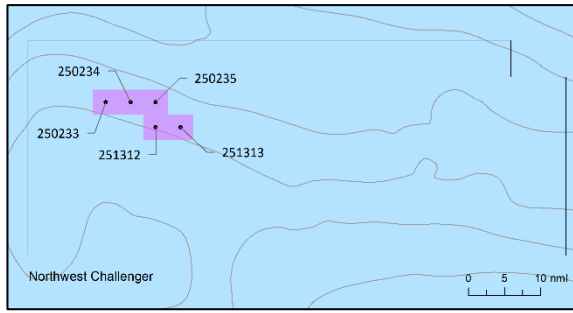
Figure 5 | Cells of interest in the modified Northwest Challenger BTMA boundaries presented in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (top left). Potential cumulative historic bycatch for cells 251312 (top right); 250234 (middle left); 250233 (middle right); 251313 (bottom left); and 250235 (bottom right). Upper portion of panel shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered had the encounter protocol in CMM03-2022 been in place at the time of the fishing event (jigging overlapping points may cause a slight horizontal displacement). Lower portion shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *local* (salmon) and *shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

North Louisville - 23

Three cells of interest were identified within the modified boundaries of the North Louisville 23 BTMA as having historic tows with >100 kg bycatch of a VME indicator taxa (figure of cells of interest in Central Lord Howe – East BTMA omitted due to confidentiality clause, in line with FNZ regulations for the release of commercially sensitive data). Within cell 226892, a single bottom trawl tow occurred between 2008 and 2021. That tow recorded approximately 3,000 kg of stony coral bycatch and would have triggered the encounter protocol had it been in place at the time (Figure 6). No bottom trawl fishing events have occurred within cell 226892 since.

A single fishing event intersected cells 227968 and 227969 in 2015, with that bottom trawl tow recording approximately 5,000 kg of stony coral bycatch (Figure 6). That bottom trawl tow would have triggered the encounter protocol had it been in place at the time. No fishing events have occurred in cells 227968 and 227969 since.
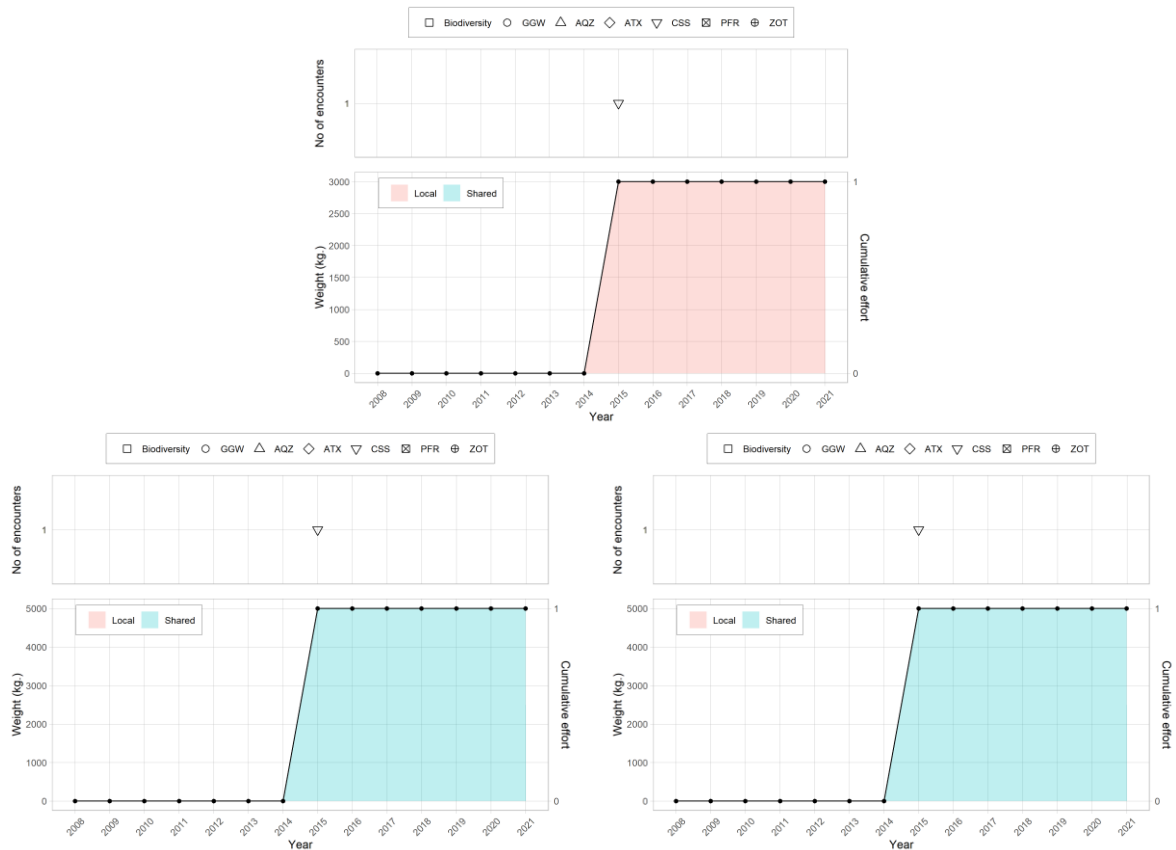
Figure 6 | Potential cumulative historic bycatch for cells 226892 (top); 227968 (bottom left); and 227969 (bottom right). Upper portion of panel shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered had the encounter protocol in CMM03-2022 been in place at the time of the fishing event. Lower portion shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *local* (salmon) and *shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

Central Louisville - 13

Two cells of interest were identified within the modified boundaries of the Central Lord Howe – East BTMA as having historic tows with >100 kg bycatch of a VME indicator taxa (Figure 7 – cell 348681 omitted due to confidentiality clause, in line with FNZ regulations for the release of commercially sensitive data). A single bottom trawl tow recording approximately 400 kg of stony coral bycatch intersected cells 348681 and 348682 in 2015. That bottom trawl tow would have triggered the encounter protocol had it been in place at the time. Cell 348681 had one bottom trawl fishing event in 2014 and three bottom trawl events in 2015 (Figure 7). Within cell 348682, two bottom trawl fishing events occurred prior to 2015, with 38 kg of VME indicator bycatch reported from 12 tows in 2014 (Figure 7). No fishing events have occurred in cells 227968 and 227969 since 2015 (Figure 7).
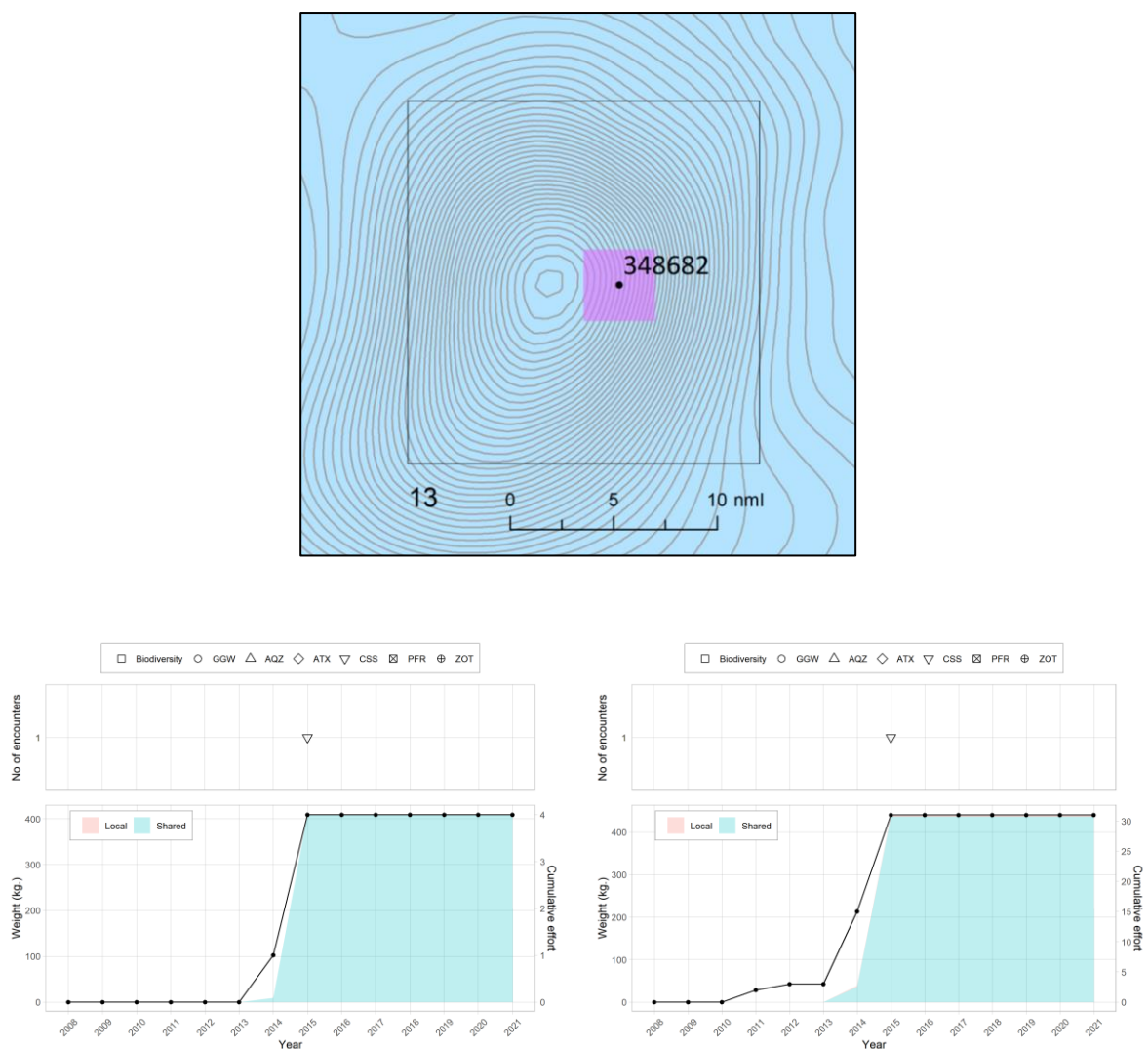
Figure 7 | Cells of interest in the modified Central Louisville 13 BTMA boundaries presented in SC11-DW05 to achieve a minimum of 70% protection for modelled VME indicator taxa (Top). Potential cumulative historic bycatch for cells 348681; (bottom left) and 348682 (bottom right). Upper portion of panel shows per-year number of times taxon-specific VME weight thresholds or biodiversity thresholds would have been triggered

had the encounter protocol in CMM03-2022 been in place at the time of the fishing event. Lower portion shows stacked potential cumulative bycatch weights for VME indicator taxa (left hand y-axis), for *local* (salmon) and *shared* (light blue) bycatch events (as defined in Table 3) and cumulative fishing effort (number of tows, right hand y-axis).

5. Discussion

Here we update bycatch metrics presented in SC10-DW03 with respect to modified BTMA boundaries presented in SC11-DW05 to achieve a minimum level of 70% protection for modelled VME indicator taxa. The updated analysis allows for an evaluation of the effectiveness of changes to the BTMA boundaries in avoiding opening areas to fishing where there has historically been a high frequency of interactions with VME Indicator taxa or exceptionally large bycatch events (which may be indicative of the potential presence of VMEs), particularly in FMAs where the decrease in area open to fishing is significant.

Modifications to the BTMA boundaries presented in SC11-DW05 result in the closure of areas to fishing where there has historically been a high frequency of interactions with, or large bycatch of, VME indicator taxa, including in the West Norfolk - Wanganella, Central Lord Howe - West, and Northwest Challenger BTMAs. Additionally, SC11-DW05 proposes closing several BTMAs to achieve a minimum of 70% protection, including the Central Louisville BTMAs 14 and 15 (both of which have had historic bottom trawl fishing events reporting bycatch of > 1,000 kg of stony coral), and the Southern Louisville BTMA 6, all of which would have had encounter protocols triggered by historic fishing events, had they been in place at the time.

Assessments of the broad-scale spatial distribution of historic bycatch of VME indicator taxa can be used to guide finer-scale spatio-temporal assessments of VME indicator bycatch to determine the ongoing effectiveness of the spatial management measures. This first requires identification of BTMAs of interest (typically those where there has historically been a high frequency of interactions with VME indicator taxa or exceptionally large bycatch events) by filtering BTMA bycatch metrics. In our example application we used a filter of > 100 kg of VME indicator bycatch from a single bottom trawl tow to identify focal BTMAs. Similarly, within focal BTMAs, we used the same filter to identify cells of interest. Importantly, these filter values were arbitrarily set to demonstrate the approach. The selection of which metrics to filter and the values at which filters are set should be informed by management objectives. There are several potential approaches to filtering cells, including using filters to identify BTMAs or cells within BTMAs where historic bycatch would have triggered the encounter protocol had it been in place, or using filters to identify BTMAs or cells where Maximum Average Potential Bycatch is above a pre-defined taxon-specific threshold.

Having identified cells of interest, we used stacked annual potential cumulative bycatch to assess patterns of historic bycatch of VME indicator taxa relative to fishing effort to try and identify cells where VMEs may potentially occur. Visual inspection of the plots can be used to identify cells where VME indicator taxa bycatch remains high following a large bycatch event, suggesting there may be evidence of a potential VME in the cell. Alternatively, where fishing effort remains constant and VME indicator taxa bycatch rates remain low following a large bycatch event, there may be little evidence that a VME remains present within the cell. Alternatively, in cells where there are no subsequent

fishing events following an encounter little inference can be drawn about the ongoing presence of potential VMEs.

The interrogation of stacked annual potential cumulative bycatch plots presented here identified cells where historic large bycatch events have occurred with no subsequent fishing following the bycatch event (e.g., in the North Louisville 23 BTMA cell 226892 with a bottom trawl tow with 3,000 kg of stony coral bycatch, and cells 227968 and 227969 with a tow with 5,000 kg of stony coral bycatch; and in the Central Louisville 13 BTMA cells 348681 and 348681 with 400 kg of stony coral bycatch). We were also able to identify cells where the encounter protocol would have been triggered repetitively, had the encounter protocol been in place at the time (e.g., within the Central Lord Howe – East BTMA cells 217904 and 223292). However, our ability to infer the ongoing presence (or lack thereof) of potential VMEs in the cells examined was hindered by a general decline in fishing effort in recent years, likely due to the impact that tighter spatial restrictions on bottom trawl activities and the lowering of Total Allowable Catch has had on the economic viability of the fishery.

In interpreting these patterns, it is important to understand the distribution of fishing effort within cells, which are 3nm^2. For example, where fishing effort is distributed elsewhere in the cells following a large bycatch event, it may not be possible to infer the ongoing presence of a potential VME within the location of the bycatch event. Consequently, when interpreting the plots, it is important to do so with respect to fine-scale plots of the spatio-temporal distribution of tows within the cell (which is not able to be made publicly available for New Zealand data due to confidentiality clauses). Although we did not do this for the demonstration analyses resented here, we recommend that it is done for future investigations.

Potential overestimation of bycatch can arise in the analyses presented here via double counting of bycatch from tows that cross multiple cells. The nature of fishing differs between FMAs, with fishing in some FMAs including a large proportion of tows that cross multiple cells (i.e., Northwest Challenger), which increase the potential for overestimation of per-cell potential cumulative bycatch. To address this, we have distinguished bycatch from *local* tows (tows that cross a single cell) and *shared* tows (tows that cross multiple cells) to facilitate the detection of cells within BTMAs where the interpretation of bycatch patterns is more certain. Similarly, there may be single tows that may have exceeded more than one VME indicator taxon-specific threshold, had the encounter protocol been in place at the time of the event.

The spatial and temporal patterns of historic bycatch identified here, particularly for those BTMAs with cells exhibiting a high amount of local bycatch (and therefore increased certainty, in terms of spatial location), could be used to inform ongoing refinement of spatial management, should Commission want to further reduce the potential for significant adverse impacts (SAIs) on VMEs in these areas.

6.   Recommendations

It is recommended that the Scientific Committee:

- **Notes**:
    - That metrics describing the spatial distribution of historic bycatch of VME indicator taxa have been updated with reference to the modified BTMAs proposed by Australia

and New Zealand in SC11-DW05 to protect a minimum of 70% of suitable habitat for modelled VME indicator taxa.

- That the updated BTMA boundaries presented in SC11-DW05 close some areas where there has historically been fishing events with high levels of VME indicator bycatch, particularly within some of the West Norfolk, Central Lord Howe, Northwest Challenger, Central Louisville and South Louisville BTMAs.
- That per-cell analyses have been developed to evaluate temporal patterns of fishing effort and associated bycatch of VME indicator taxa.
- That there is a need to agree how to filter bycatch metrics to identify BTMAs and cells within BTMAs to which per-cell analyses should be applied, and that this should be guided by management objectives.

- **Recommends**:
  - That work is undertaken by the SC and Commission to agree filters to identify BTMAs and cells to identify cells of interest.
  - Within these cells, the per-cell analysis described in this paper is applied to identify cells where additional management consideration may be required.

7.   Acknowledgements

8.   References

Geange, S.W., Rowden, A.A., Nicol, S., Bock, T. and Cryer, M. (2020). A data-informed approach for identifying move-on encounter thresholds for vulnerable marine ecosystem indicator taxa. Frontiers in Marine Science, 7, p.155. LINK

Horton, T., Kroh, A., Ahyong, S., Bailly, N., Boyko, C. B., Brandão, S. N., ... & Zhao, Z. (2018). World register of marine species (WoRMS). WoRMS Editorial Board. LINK

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. LINK

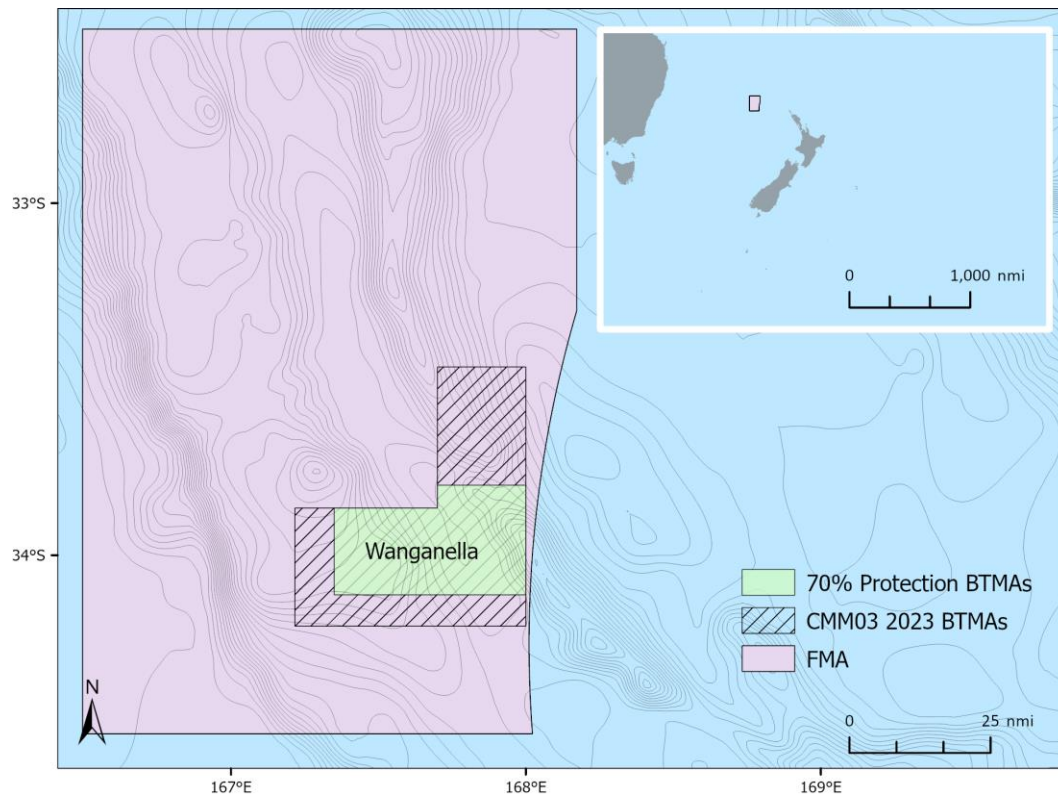# Annex 1 – Fishery Management Areas (FMAs)

Figure A1 | West Norfolk FMA (pink box) and the Wanganella BTMA open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).
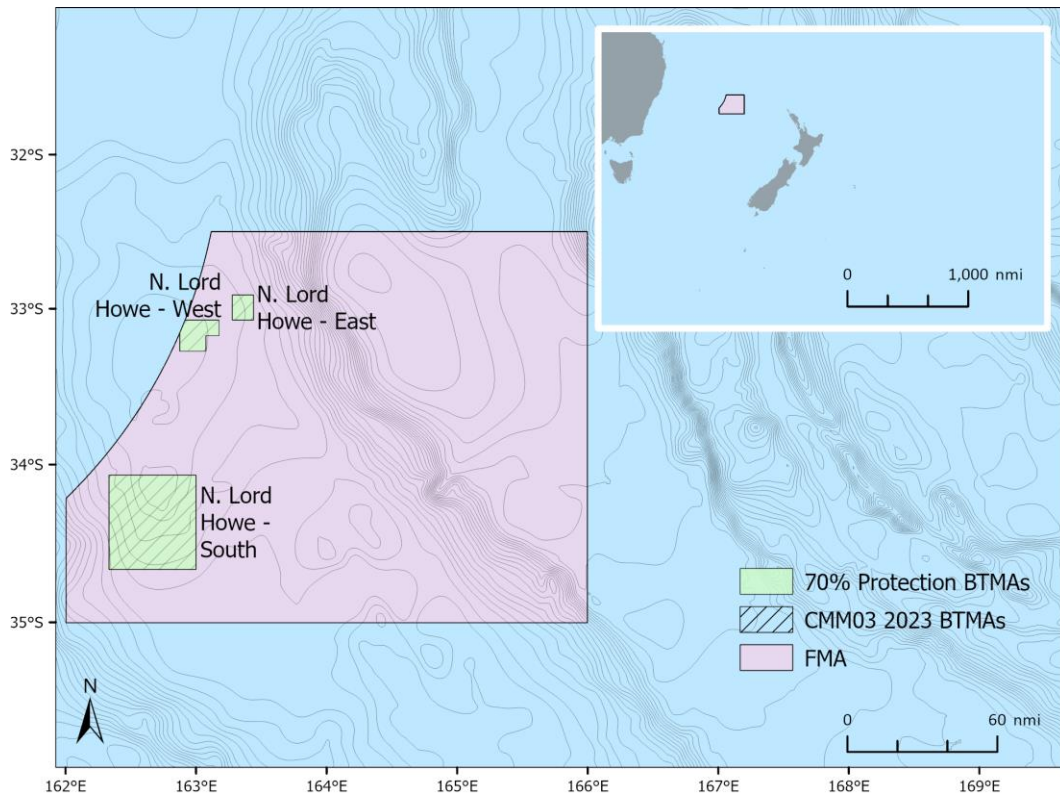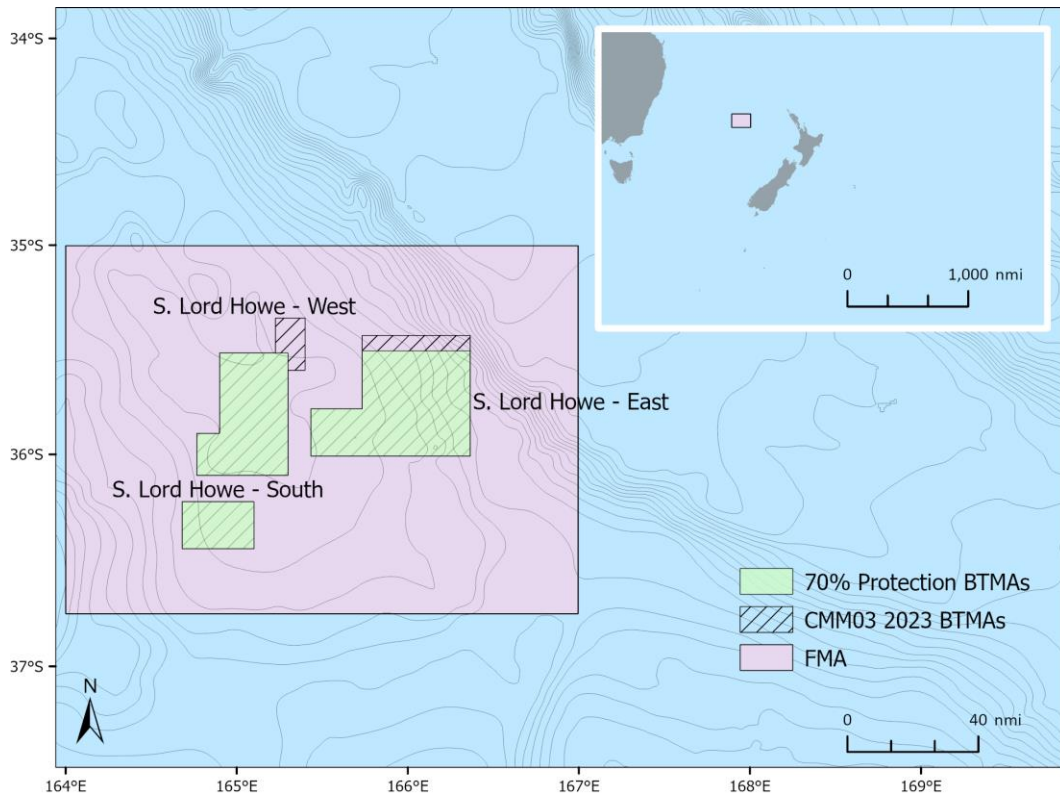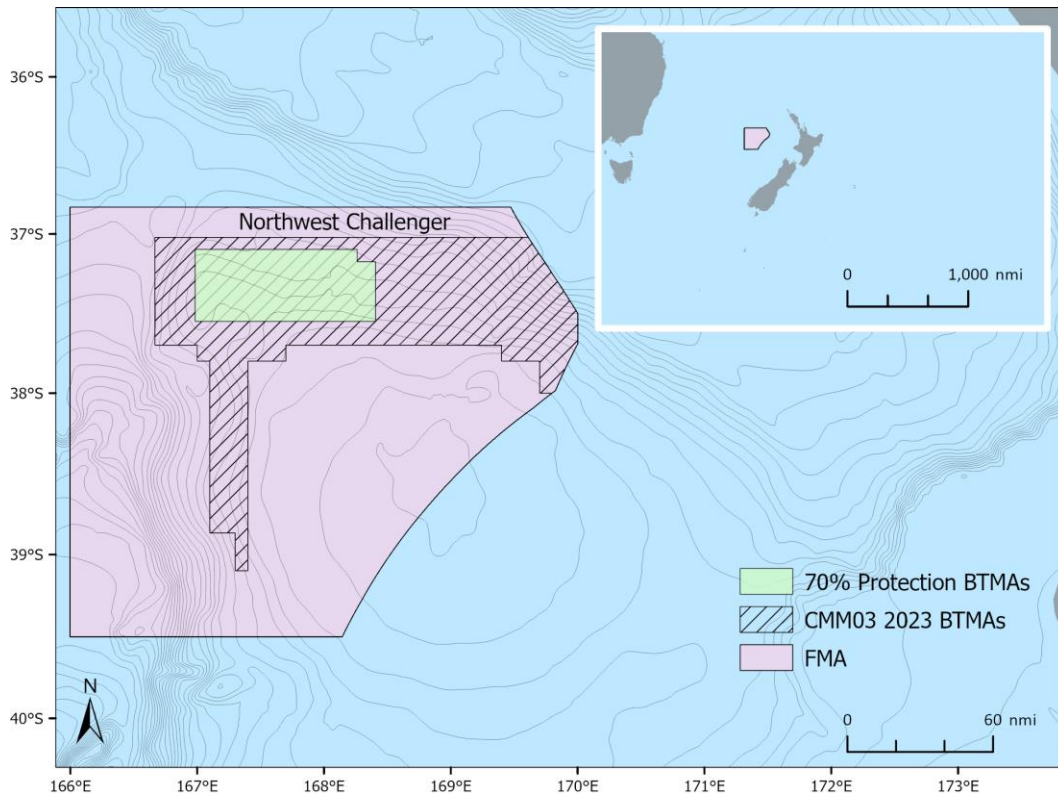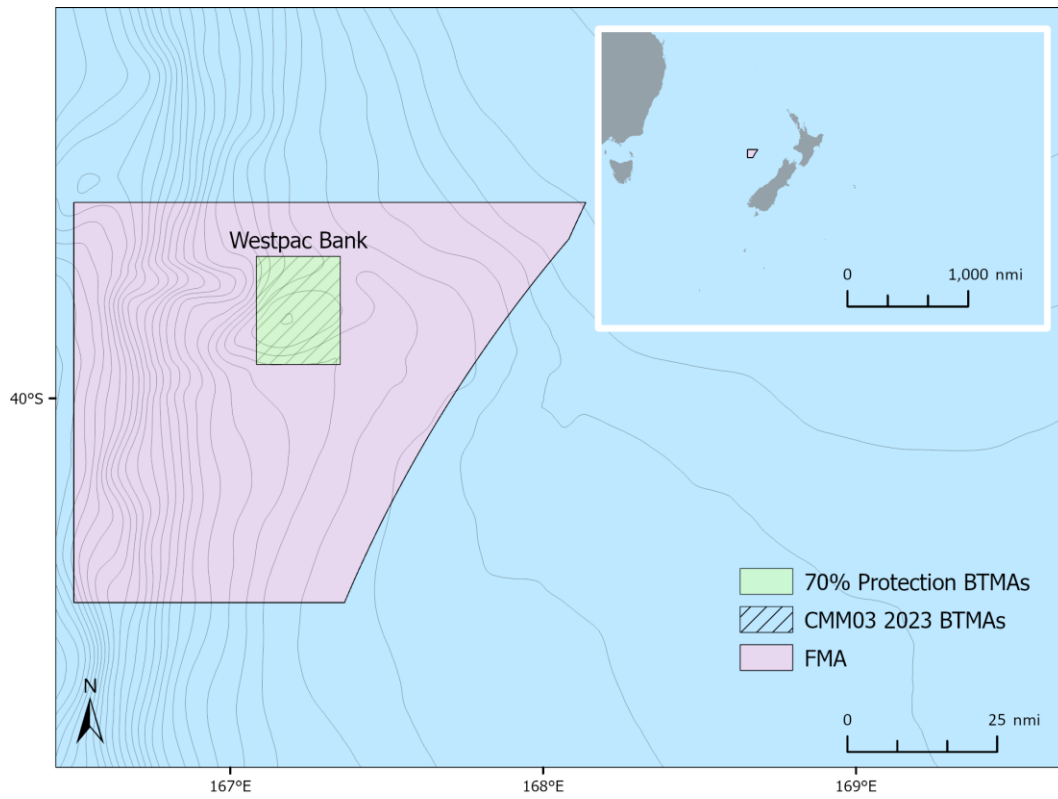
Figure A2 | North Lord Howe Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).

Figure A3 | Central Lord Howe Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).
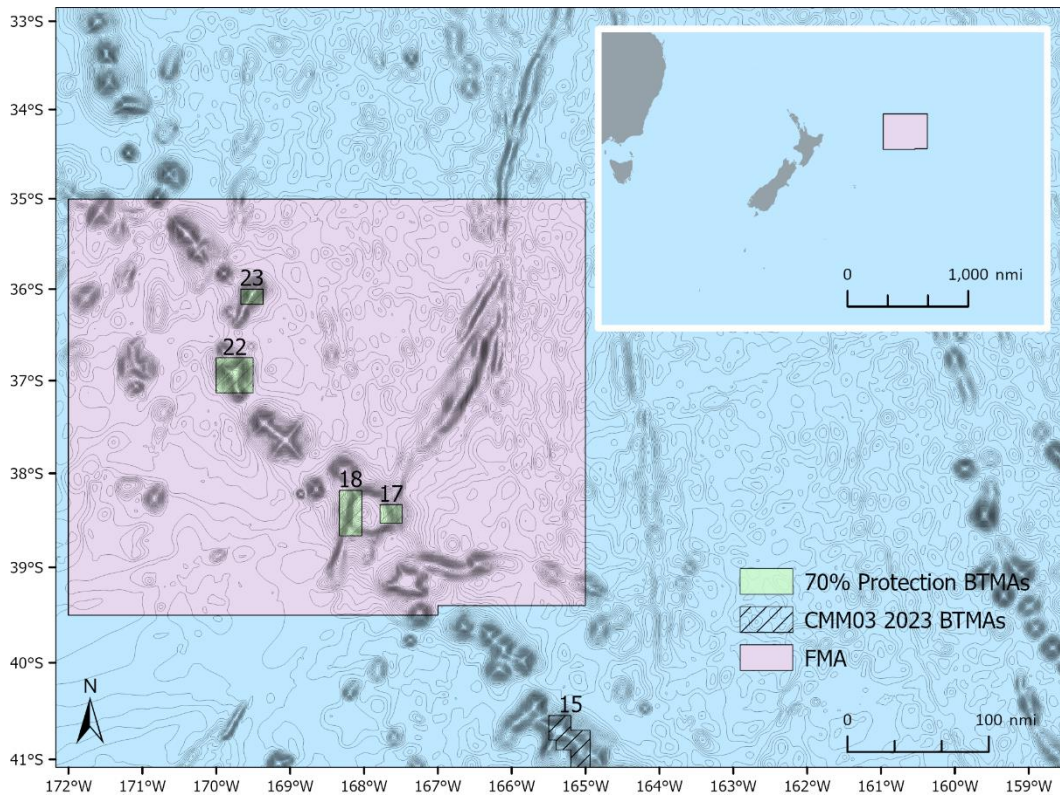
Figure A4 | Northwest Challenger FMA (pink box) and the BTMA open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).

Figure A5 | Westpac Bank FMA (pink box) and the BTMA open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).
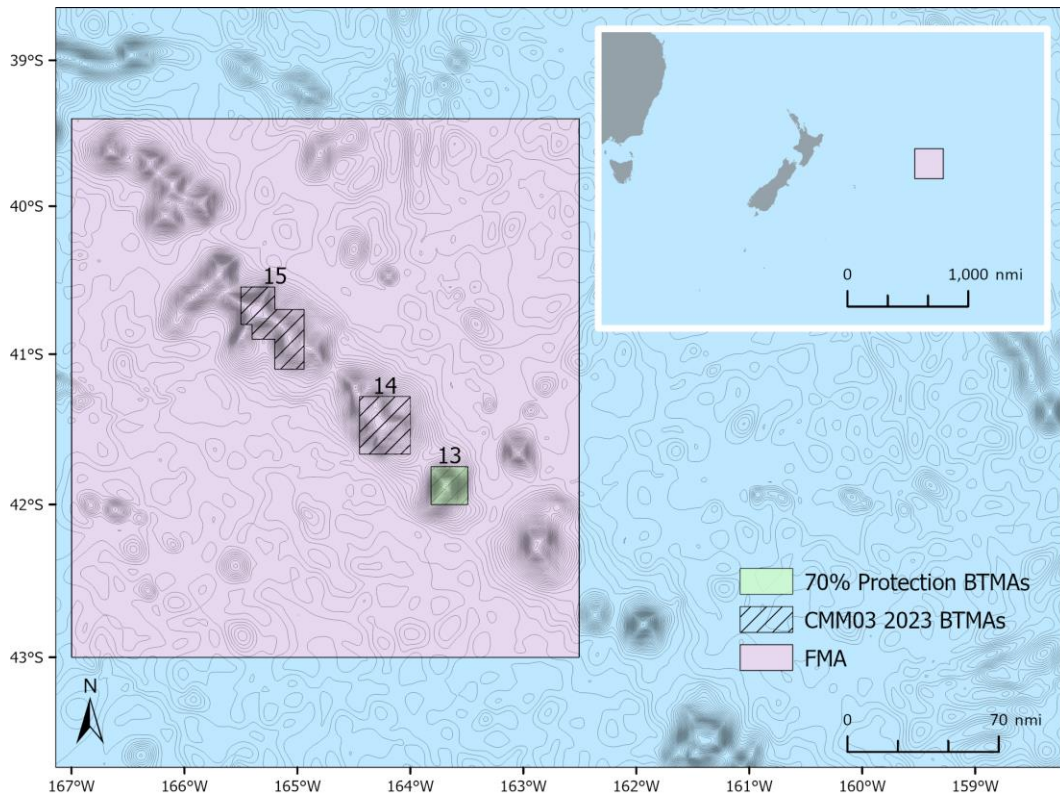
Figure A6 | North Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).
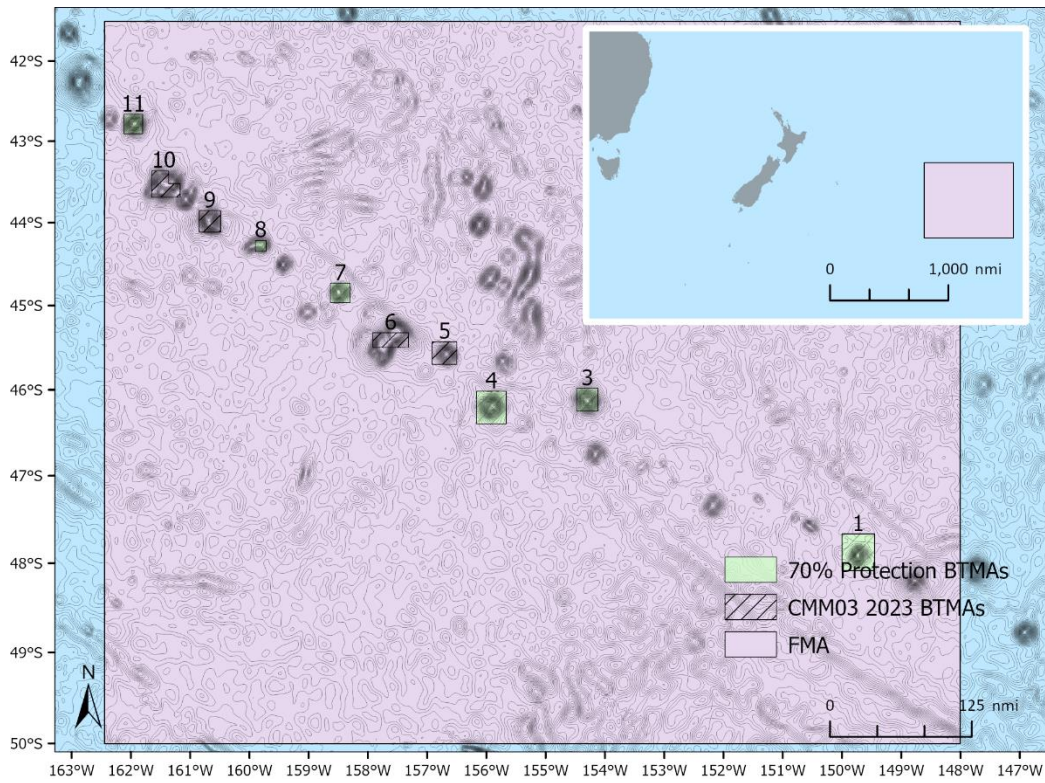
Figure A7 | Central Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).

Figure A8 | South Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).
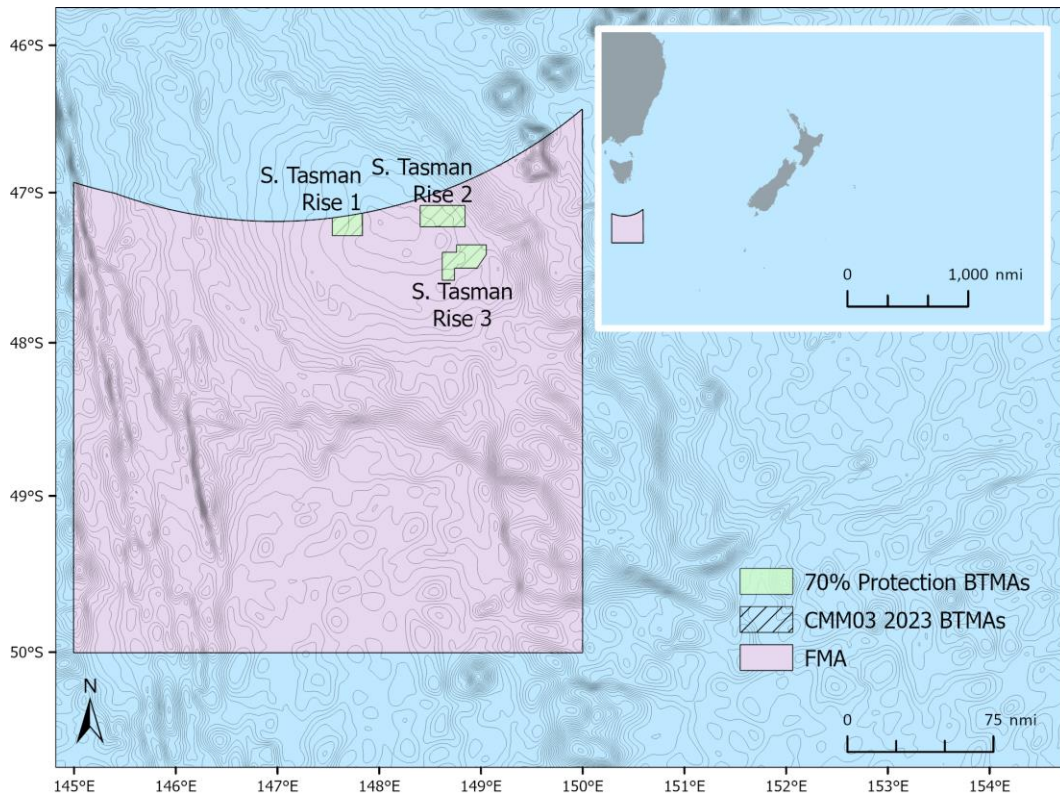
Figure A9 | South Tasman Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and the BTMA proposed in COMM10-Inf03 to achieve a minimum of 70% protection for modelled VME indicator taxa (light green box).