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SC11 – DW05
Modification of Bottom Trawl Management Area Boundaries to Achieve a 70% Protection Target for VME Indicator Taxa

New Zealand

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Modification of Bottom Trawl Management Area Boundaries to Achieve a 70% Protection Target for VME Indicator Taxa

Australia / New Zealand

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1. Purpose

The purpose of this paper is to present modifications to the boundaries of the Bottom Trawl Management Areas established under para 14 and Annex 4 of CMM03-2023 to allow the Commission to apply a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa, as required under para 19 of CMM03-2023.

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 designed to, inter alia, prevent Significant Adverse Impacts (SAI) on Vulnerable Marine Ecosystems (VMEs). The spatial management regime was initially agreed at the 7th Commission Meeting (CMM03-2019) based on recommendations from the SPRFMO Scientific Committee (SC) that the process described in SC6-DW11 to design the Bottom Trawl Management Area (BTMA) boundaries was appropriate.

An evaluation of the level of protection of VME indicator taxa provided by the BTMA boundaries initially implemented in CMM03-2019 was presented in the Cumulative Bottom Fishery Impact Assessment for Australia and New Zealand 2020 (BFIA, SC8-DW07_Rev1). Following review of the BFIA, the SC agreed that "*the proportion of suitable VME indicator taxa habitat [for which habitat suitability models exist] protected is uncertain but qualitatively favourable at most scales assessed. However, there are a number of areas at smaller scales (Fishery Management Areas) where the level of suitable habitat protected for some VME taxa is less favourable including Northwest Challenger, Central Louisville and Southern Louisville*" (para 73 of SC8 Report).

The SC also agreed that "*although the appropriate scale to assess and manage impacts on VMEs has not been defined in SPRFMO, the smaller scale of the Fishery Management Areas is likely to be a more biologically appropriate scale at which to assess and manage these impacts than larger scales*" (para 73 of SC8 Report).

At the 9th SPRFMO Commission Meeting, members noted ongoing discussions relating to the appropriate level of protection to prevent SAIs on VMEs in the SPRFMO Convention Area. Following discussions, Members agreed to specific tasking of the SC to ensure the information required to support the review of CMM03 in 2022 was provided, including: "*The SC to include in its workplan for 2021+ the development of spatial management scenarios for Bottom Trawling. This work will inform the Commission's determination of the level of protection required to prevent SAI on VMEs in the SPRFMO Convention Area. Scenarios should encompass protection levels of 70%, 80%, 90%, 95% for the modelled VME indicator taxa using temporally static and temporally dynamic assessment methods. The SC should also explicitly account for uncertainties in current model predictions, the relative availability of VME indicator taxa in an area, and recommendations from other RFMOs or guidance documents when formulating its recommendations to the Commission. Evaluations should be undertaken at spatial scales comparable to the Fisheries Management Areas described in SC8-DW07_rev1.*" (COMM9-Doc 06_Rev3)

Following the 9th meeting of the SPRFMO Commission, Australia and New Zealand co-developed a methodology to develop the scenarios and to estimate protection levels provided by BTMAs within

each Fisheries Management Area (FMA) for modelled VME indicator taxa with > 1% of their distribution within the FMA. The methodology was presented to the 9th meeting of the SPRFMO SC in SC9-DW06_rev1. Following discussion of SC9-DW06_rev1, the SC:

- **Noted** the metrics used to assess the protection levels for VME indicator taxa, ROC 0-linear and Power Mean, are representative of the metrics spectrum presented in the BFIA.
- **Noted** that protection level assessment was completed for all protection levels using both temporally static and a temporally dynamic methods, as requested by the Commission.
- **Agreed** that the approach taken to develop spatial management protection scenarios and report on their performance is appropriate and work will continue intersessionally to refine scenarios to meet all protection targets for presentation to Commission.
- **Recommended** that the Commission consider the results of the spatial protection scenarios including to inform its determination of the level of protection required to prevent SAIs on VMEs in the SPRFMO Convention Area.
- **Noted** that ecologically relevant spatial scales for assessing protection levels to prevent SAIs on VME indicator taxa still remain to be agreed, but that the existing information at the [Fisheries Management Area] FMA is likely to be a more biologically appropriate compared with larger scales.

Following the 9th SPRFMO SC meeting, Australia and New Zealand continued to refine the BTMA boundaries presented in SC9- DW06_rev1 to ensure scenarios achieved the desired minimum levels of protection in each FMA for each modelled VME indicator taxa that had > 1% of its distribution within the FMA (this percentage was selected as a cut-off based on an assumption that FMAs with < 1% of the overall distribution of a taxon are unlikely to represent a representative part of the population (SC9- DW06_rev1)).

The modified BTMA boundaries were presented to the 10th meeting of the SPRFMO Commission in 2022 (COMM10-Inf03). Following discussion of COMM10-Inf03 and the review of other components of the Scientific Committee's deepwater work programme, the SPRFMO Commission established a bottom fishing Intersessional Working Group (IWG) charged with the responsibility to review SPRFMO's bottom fishing measure. The IWG was tasked to address specific questions within the following five topics: the appropriate scale of management to assess and prevent significant adverse impacts (SAIs) on Vulnerable Marine Ecosystems (VMEs), spatial management (i.e., protection) scenarios, the move-on rule (i.e., weight thresholds and move-on distance), the encounter review process and the 2020 VME encounter.

The IWG reported back to the 11th meeting of the SPRFMO Commission in 2023 (COMM11-Doc07). The Review considered scientific, legal and management factors and documented all scientific advice provided to the Commission on the five topics. It also clearly documented the history of the CMM and areas for future work.

Regarding the appropriate level of protection, the IWG reviewed the two key, complementary elements in CMM03 which seek to prevent SAIs on VMEs: the BTMA boundaries, which are the first line of defence, and the encounter protocol, which is intended to address any residual risk in preventing SAIs on VMEs. The IWG found a clear relationship between the two in terms of managing the risk of SAIs on VMEs – the IWG determined that each tool is important and plays a role in managing

the current risk of SAIs on VMEs. The IWG also determined that preventing SAIs on VMEs is essential from the perspective of achieving SPRFMO's legal obligations, but it also noted that these two elements influence business costs and uncertainty depending on how conservative the BTMA boundaries are, and the extent of the residual risk absorbed by the move-on rule. The IWG ultimately concluded that the BTMA boundaries should continue to be the first line of defence, but the encounter protocol should continue to play a role within the current system, particularly given the current uncertainties.

Significantly, the IWG considered the SC's earlier advice to implement additional precautionary measures for areas and taxa at a higher risk from bottom trawl fisheries. The IWG noted that the SC had identified that there were several FMAs where the level of suitable modelled habitat protected for some VME indicator taxa was less favourable, including the Northwest Challenger, the Central Louisville, and the Southern Louisville. The IWG considered that this advice should be addressed through modifications to the BTMA boundaries to increase the level of protection for VMEs.

The IWG noted that current BTMAs can be modified to achieve the specific objectives of VME management if agreed by the Commission, and recommended several basic principles that should be considered when modifying BTMA boundaries within a broader suite of management measures to prevent SAIs on VMEs:

a) BTMA boundaries should, as much as possible, be straight-line boxes.
b) Regardless of the minimum level of protection decided by the Commission, it is important to recognise that there remains a risk that SAIs on VMEs may still occur. Therefore, the move-on rule should remain a key part of the management regime in the interim.
c) In order to prevent SAIs on VMEs, if the SC identifies that the level of protection of modelled VME indicator taxa is, or is likely to be, below the agreed minimum level of protection, protection should be increased.
d) The agreed upon minimum level of protection provided by the BTMA boundaries should be consistent across all FMAs.
e) The BTMA boundaries should be routinely reviewed.

Ultimately, the IWG recommended that the Commission sets a minimum level of protection for each modelled VME indicator taxon, noting the Commission has the discretion to decide what the minimum level should be, provided it meets its obligations. The IWG also referenced SC9-DW06_rev1 and COMM10-Inf03, which describes the methodology used to modify BTMA boundaries to achieve different protection targets, the assumptions and caveats associated with this work, and COMM10-Inf03 which presents modified BTMA boundaries that achieve protection levels of 70%, 80%, 90%, and 95% for all modelled VME indicator taxa. The IWG report, did also note however, that subsequent to COMM10-Inf03 habitat suitability models for previously unmodelled taxa had been developed SC10-DW05 and accepted by the SC (SC10-Report para 121), and the modified BTMA boundaries presented in COMM10-Inf03 hadn't been evaluated against those newly modelled VME indicator taxa.

On presenting the IWG report to the 11th SPRFMO Commission meeting, the IWG Chair clarified that the IWG concluded it was essential to prevent SAIs on VMEs, and that the Commission's legal obligations had been comprehensively analysed. To this end, the IWG had noted the Commission's obligation under Article 192 of UNCLOS to protect and preserve the marine environment, as well as the requirements of the SPRFMO Convention. The IWG had concluded that the Commission had a

range of options available to it that could satisfy its legal obligations. The IWG had also considered the United Nations General Assembly Sustainable Fisheries Resolutions as they relate to bottom fishing. The IWG concluded that its advice and recommendations, which were reflected in COMM11-Prop08_rev4 and included a provision for a minimum level of 70% protection of suitable habitat for each modelled VME indicator taxa, were consistent with both its legal obligations and the General Assembly Resolutions.

Many Members considered that COMM11-Prop08_rev4 represented a significant step forward in preventing significant adverse impacts on VMEs. Some Members considered 80% would be the most appropriate minimum level of protection, expressing concerns with scientific uncertainties. Other Members considered 70% would be suitably precautionary, recognising that the modelling level of protection for many taxa would be much higher than 70% in practice. One Member expressed strong concern about using un-tested modelling as a justification for such significant reductions to fishing grounds. While most Members were satisfied that the proposal was consistent with the General Assembly Resolutions, the 1995 UN Fish Stocks Agreement, FAO guidelines, UNCLOS and the SPRFMO Convention, one Member considered that the proposal was not consistent with the commitment to prevent SAIs on VMEs.

Following discussion of the IWG report (COMM11-Doc07) and COMM11-Prop08_rev4, the Commission accepted the IWG's recommendations and adopted the COMM11-Prop08_rev4, establishing 70% minimum level of protection, with CMM03-2023 requiring that:

19. *From 2024, the Commission shall apply a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa. The Commission, taking into account the advice and recommendations of the Scientific Committee, shall review the boundaries of the Management Areas established in paragraph 14 and Annex 4 of this CMM and make any modifications necessary to achieve this level of protection at its 12th annual meeting in 2024.*

With an associated footnote:

> *Recognising that the minimum level of protection is an interim approach recommended in COMM11-Doc07, and notwithstanding paragraph 19, the Commission may, in 2024 or any year thereafter, adopt a different level of protection to prevent significant adverse impacts on VMEs. The Commission will receive further advice on thresholds for SAIs, multi-spatial scale risk assessments to assess encounters, and how to reduce uncertainties in these risk assessments based on the fulfilment of the work set out in the Scientific Committee's multi-annual work plan including to assess the feasibility of developing catchability estimates for VME indicator taxa.*

On adopting a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa at the 11th meeting of the SPRFMO Commission, it was acknowledged that there are alternative scenarios to those presented in COMM10-Inf03 that may yield slightly different configurations of areas open to bottom fishing and effects on industry. Following the 11th SPRFMO Commission meeting, Australia and New Zealand evaluated the 70% management scenario presented in COMM10-Inf03 and agreed that the spatial configuration of management areas would meet the requirements of para 19 of CMM03-2023 while providing for a sustainable fishery, and that they would propose those management areas for adoption at the 12th meeting of the SPRFMO Commission in 2024.

Here, we present modifications to the BTMA boundaries established under para 14 and Annex 4 of CMM03-2023 to allow the Commission to apply a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa, as required under para 19 of CMM03-2023. The performance of

the modified BTMA boundaries in achieving a minimum level of 70% protection is evaluated against all VME indicator taxa for which models currently exist, including those presented in SC10-DW05.

3. Summary of Methods

New Zealand and Australia have developed habitat suitability models (HSI) for VME indicator taxa through a series of projects over recent years. The spatial models have been progressively refined, and both detailed methods to develop the models and the history of refinements are described in the Section 4.4.2.1 of the BFIA (SC11-DW01). HSI models are currently available for all VME indicator taxa identified in Annex 5 of CMM03-2023 (Table 1).

Table 1 | VME indicator taxa from Annex 5 of CMM03-2023, with qualifying taxa, associated weight and biodiversity thresholds, and references to current habitat suitability models.

FAO code	VME indicator taxon	Common Name	Qualifying taxa	Weight Threshold	Biodiversity Threshold	Habitat suitability models
PFR	Porifera (Phylum)	Sponges	All taxa of the classes Demospongiae and Hexactinellidae	25	5	Separate models for Demospongiae and Hexactinellida (Stephenson et al. 2021)
CSS	Scleractinia (Order)	Stony corals	All taxa within the following genera: Solenosmilia; Goniocorella; Oculina; Enallopsammia; Madrepora; Lophelia	60	5	Separate models for Enallopsammia rostrata, Madrepora oculata, Solenosmilia variabilis, Goniocorella dumosa (Stephenson et al. 2021)
AQZ	Antipatharia (Order)	Black corals	All taxa	5	1	Modelled as a single group (Stephenson et al. 2021)
ALZ	Alcyonacea (Order)	True soft corals	All taxa excluding Gorgonian Alcyonacea	-	1	Modelled as a single group (Unpublished layer)
GGW	Gorgonian Alcyonacea (Informal group)	Sea fans octocorals	All taxa within the following suborders: Holaxonia; Calcaxonia; Scleraxonia	15	1	Modelled as a single group (Stephenson et al. 2021)
NTW	Pennatulacea (Order)	Sea pens	All taxa		1	Modelled as a single group (Stephenson et al. 2021)
ATX	Actiniaria (Order)	Anemones	All taxa	35	5	Modelled as a single group (Stephenson et al. 2022)
ZOT	Zoantharia (Order)	Hexacorals	All taxa	10	1	Modelled as a single group (Stephenson et al. 2022)
HQZ	Hydrozoa (Class)	Hydrozoans	All taxa within the orders Anthoathecata and Leptothecata, excluding Stylasteridae	-	1	Modelled as a single group (Stephenson et al. 2022)
AXT	Stylasteridae (Family)	Hydrocorals	All taxa	-	1	Modelled as a single group (Stephenson et al. 2021)
BHZ	Bryozoa (Phyllum)	Bryozoans	All taxa within the orders Cheilostomatida and Ctenostomatida	-	1	Modelled as a single group (Stephenson et al. 2022)
BHZ	Brisingida (Order)	Armless stars	All taxa	-	1	Modelled as a single group (Stephenson et al. 2022)
CWD	Crinoidea (Class)	Sea lillies and feather stars	All taxa	-	1	Modelled as a single group (Stephenson et al. 2022)

Two metrics were derived from the HSI model values to represent the presence and abundance of VME taxa, respectively: the ROC 0-linear ("ROC") and the Power Mean ("Power") metrics. The ROC metric uses taxa-dependent thresholds to exclude areas with low likelihood of the presence of

suitable habitat (below the threshold) and assumes that the higher the HSI values the higher the likelihood of VME indicator taxa presence (or abundance). The Power metric assumes that the mean power curve (mean in the range of low and high estimates for power relationships) represents the relationship between HSI values and the abundance of a VME indicator taxon. Section 4.6.7 in the BFIA (SC11-DW01) provides more information on these metrics. The SC has previously agreed that the approach of using ROC 0-linear and Power Mean metrics to develop spatial management protection and report on their performance is appropriate (SC9-Report para 78).

The ROC 0-linear and Power Mean metrics (where available) were used to evaluate the performance of modified BTMA boundaries using both trawl-impacted and unimpacted baselines. Using an unimpacted baseline provides information on VME indicator taxa protection levels for a pristine or pre-trawling state, whereas impacted baselines provide information on protection of the VME indicator taxa that presumably remain following the impacts of historical trawling. Conceptually, the unimpacted baseline should provide a more conservative estimate of the performance of BTMA boundary modifications if BTMA boundaries are centred on areas of high historical fishing effort because it predicts higher HSI values in areas that have historically been trawled, relative to impacted baselines which assume the loss of VME indicator taxa due to the impacts of historical fishing activities. Section 4.5 of the BFIA (SC11-DW01) provides a description of the development of impacted baselines.

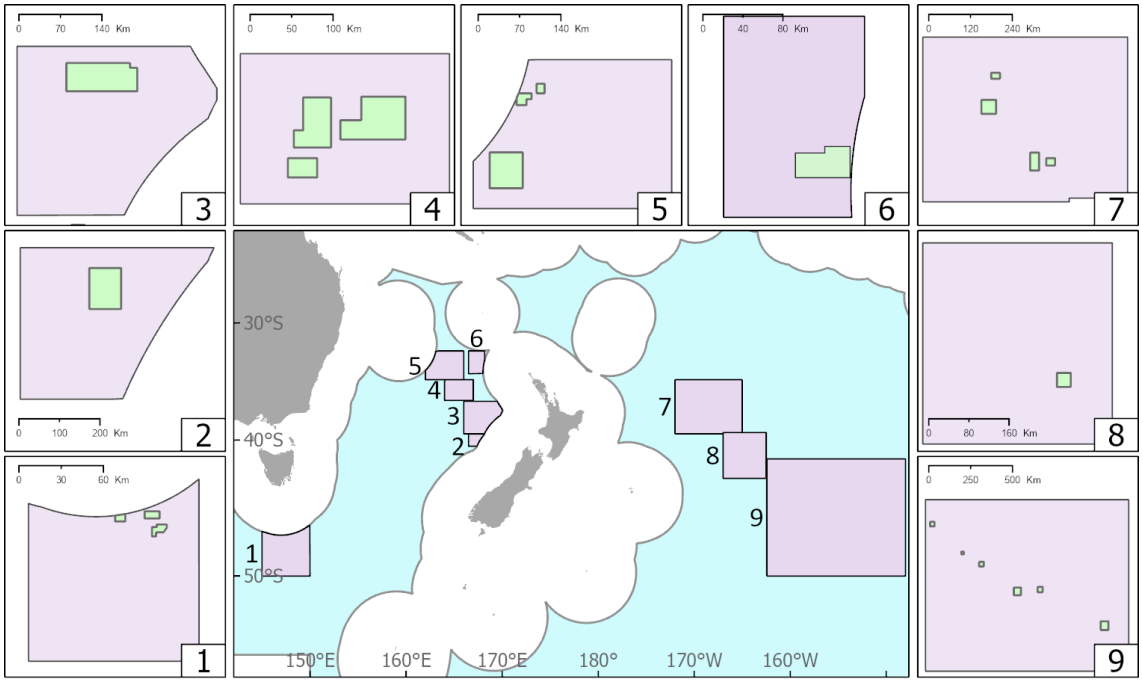

Figure 1 | Map of Fishing Management Areas (FMAs) (light purple) and boundaries of modified Bottom Fishing Management Areas (BTMAs) boundaries (light green). FMAs are: 1) South Tasman Rise, 2) Westpac Bank, 3) North-West Challenger, 4) South Lord Howe Rise, 5) North Lord Howe Rise, 6) West Norfolk, 7) North Louisville, 8) Central Louisville and 9) South Louisville. Maps of individual FMAs are provided in Annex 1.

As in previous assessments (e.g., SC9- DW06_rev1 and COMM10-Inf03), the performance of modified BTMAs was calculated for each FMA as the proportion of a VME indicator taxon within the FMA that occurs in areas closed to trawling (i.e., outside BTMAs - see Figure 1 and Annex 1). This was done for each VME indicator taxa with > 1% of its distribution (within the high seas portion of the evaluated area) within the FMA. Proportions protected within each FMA were calculated using intersect analyses in ArcGIS[1]. This method, in effect, describes the level of protection that is provided by the area closed to trawling.

Interpretation of the assessment results was done in reference to paragraphs 19 and 39 of CMM03-2023, which state that:

19. *From 2024, the Commission shall apply a minimum of 70% protection of suitable habitat for each modelled VME indicator taxa. The Commission, taking into account the advice and recommendations of the Scientific Committee, shall review the boundaries of the Management Areas established in paragraph 14 and Annex 4 of this CMM and make any modifications necessary to achieve this level of protection at its 12th annual CMM 03-2023 Bottom Fishing 5 meeting in 2024.*

39. *From 2023, the Scientific Committee shall adopt the Fishery Management Area as the appropriate scale of management for assessing the performance of the VME spatial management scenarios that underpin this CMM.*

Therefore, a reference point for evaluating the performance of modifications to the BTMA boundaries is attaining a minimum of 70% protection of suitable habitat for each modelled VME indicator taxon in each FMA.

Where available, the performance of modified BTMA boundaries within each FMA using impacted and unimpacted baselines was evaluated against the lower of ROC 0-linear and Power-mean metrics, with the lower estimates representing the most conservative performance estimate. For the seven VME indicator taxa for which Power-mean metrics are not currently available (Actiniaria, Alcyonacea, Zoantharia, Hydrozoa, Bryozoa, Brisingida and Crinoidea), performance is reported against the ROC 0-linear metric only.

Estimating impact on the bottom trawl fishery

To assess potential impacts on the bottom trawl fishery when evaluating the performance of modifications to the BTMA boundaries, a spatial layer incorporating historical trawl catch and effort was developed by the New Zealand fishing industry to describe fisheries value (Cordue 2017). This layer used spatial catch records from over 54,000 fishing events to estimate the value of fisheries within 1km^2 cells. As in previous assessments (e.g., SC9- DW06_rev1 and COMM10-Inf03), the impact of modified BTMA boundaries on industry was calculated as the proportion of the fishery

[1] The use of ArcGIS to intersect BTMA polygons with HSI raster layers differs from previous analysis (presented in SC9- DW06_rev1 and COMM10-Inf03), which first converted BTMA polygons to 1 nm gridded raster layers and then used Zonation to calculate overlap with HSI layers. Differences in the treatment of BTMA layers between the two approaches may result in small differences in the protection values reported here and those reported in SC9- DW06_rev1 and COMM10-Inf03.

value layer within an FMA that occurs in areas closed to bottom trawling. Because the fishery layer represents the reported start and end positions of tows, which are based on the position of the vessel when the net reaches/leaves fishing depth, it does not provide information on run-in (time and distance) required for the net to leave the vessel and reach fishable depth or be returned to the surface. Consequently, the evaluation presented here may underestimate the impact on the fishing industry.

4. Results

To achieve a minimum of 70% protection for all modelled VME indicator taxa with more than 1% of their distribution within a FMA, modifications to the BTMA boundaries were required, as follows:

- In the **West Norfolk FMA,** there is one area open to bottom trawling. The BTMA boundaries do not currently meet the 70% protection target for all modelled VME indicator taxa with > 1% of their distribution within the FMA, and the area of the BTMA had to be reduced by 53% to achieve the 70% protection target (Table 3, Figure A1.1)**.**
- In the **North Lord Howe FMA**, there are currently three BTMAs open to bottom trawling, with the 70% protection target achieved for all VME indicator taxa with > 1% of their distribution within the FMA. Consequently, no modifications to the BTMA boundaries within the North Lord Howe FMA were required (Figure A1.2)**.**
- In the **Central Lord Howe FMA**, there are currently three BTMAs open to bottom trawling. The BTMA boundaries do not currently meet the 70% protection target for all modelled VME indicator taxa with > 1% of their distribution within the FMA, and the boundaries for the Central Lord Howe West and Central Lord Howe East BTMAs were decreased in size, reducing the overall area open to bottom trawling by 10% to achieve the 70% protection target (Table 3, Figure A1.3).
- In the **Northwest Challenger FMA**, there is currently one BTMA open to bottom trawling. The BTMA boundaries do not currently meet the 70% protection target for all modelled VME indicator taxa with > 1% of their distribution within the FMA, and the area of the BTMA had to be reduced by 76% to achieve the 70% protection target (Figure A1.4).
- In the **Westpac Bank FMA**, there is currently one BTMA open to bottom trawling, with the 70% protection target achieved for all VME indicator taxa with > 1% of their distribution within the FMA. Consequently, no modifications to the BTMA boundaries within the Westpac Bank FMA were required (Figure A1.5)**.**
- In the **South Tasman Rise FMA**, there are currently three BTMAs open to bottom trawling, with the 70% protection target achieved for all VME indicator taxa with > 1% of their distribution within the FMA. Consequently, no modifications to the BTMA boundaries within the South Tasman Rise FMA were required (Figure A1.6)**.**
- In the **North Louisville FMA**, there are currently four BTMAs open to bottom trawling, with the 70% protection target achieved for all VME indicator taxa with > 1% of their distribution within the FMA. Consequently, no modifications to the BTMA boundaries within the North Louisville FMA were required (Figure A1.7)**.**
- In the **Central Louisville FMA**, there are currently three BTMAs (features) open to bottom trawling. The BTMA boundaries do not achieve the 70% protection target for all modelled

VME indicator taxa with > 1% of their distribution with the FMA. Due to the nature of the Louisville Ridge, the overlap of fishing with modelled depths and distribution of VME indicator taxa is high. Consequently, all but one BTMA had to be closed to achieve the 70% protection target, resulting in an 82% reduction in the area open to bottom trawling (Table 3, Figure A1.8).

- In the **South Louisville FMA**, there are currently ten BTMAs (features) open to bottom trawling. The spatial management does not meet the 70% protection target for all modelled VME indicator taxa with > 1% of their distribution within the FMA**.** Due to the nature of the Louisville Ridge, the overlap of fishing with modelled depths and distribution of VME indicator taxa is high. Consequently, four of the BTMAs had to be closed to achieve the 70% protection target, resulting in a 39% reduction in the area open to bottom trawling (Table 3, Figure A1.9).

These modifications to the BTMAs allowed a minimum level of 70% protection to be achieved in all FMAs for all modelled VME indicator taxa with > 1% of their distribution within an FMA, as assessed against the lower of ROC 0-linear and Power-mean estimates of performance (Table 2). Importantly, achieving a minimum of 70% protection for all VME indicator taxa with > 1% of their distribution within an FMA resulted in many taxa achieving protection levels exceeding 90% protection (e.g., Demospongiae in the West Norfolk, North Lord Howe Rise, and Northwest Challenger FMAs, the stony coral *Goniocorella dumosa* in the North Lord Howe, Northwest Challenger, South Tasman Rise, and Central Louisville FMA – Table 2).

BTMA boundaries did not need to be modified in four of the nine FMAs (North Lord Howe, Westpac Bank, South Tasman Rise, and North Louisville) to achieve the 70% protection target for all modelled VME indicator taxa with > 1% of their distribution in an FMA. Consequently, access to historical fishing value and the overall area open to bottom fishing within those FMA is unchanged relative to the spatial management measures currently included in CMM03-2023.

For the other five FMAs, estimated loss of historical fishing value ranges between 15.2 and 86.8% (Table 3). Across all FMAs, there is an approximate 47% reduction in the total are open to fishing (33,531 km2 open under the modified boundaries versus 63,745 km2 open under the boundaries specified in CMM03-2023).

Table 2 | Estimates of the percentage of each modelled VME indicator taxon in areas outside modified bottom trawl management areas for each Fishery Management Area. Values are percent (%) Habitat Suitability Index that is closed to bottom trawl fishing within each Fishery Management Area, derived from the lower of the ROC 0-linear and Power-mean estimates from the unimpacted baseline for taxa with > 1% of their Habitat Suitability Index within the Fishery Management Area (as presented in Annex 2). ROC 0-linear and Power-mean estimates are not currently available for all taxa, and * indicates taxa where ROC 0-linear values are reported. Cell shading refers to taxa with more (green) than 70% of their distribution in closed areas.

	Fisheries Management Area (FMA)								
VME Indicator Taxon	**West Norfolk**	**North Lord Howe**	**Central Lord Howe**	**Northwest Challenger**	**Westpac Bank**	**South Tasman Rise**	**North Louisville**	**Central Louisville**	**South Louisville**
Sponges (Porifera Demospongiae)	99.57	97.65	99.85	99.52					
Sponges (Porifera Hexactinellida)	94.80	97.86	97.37	87.55			80.23		
Stony corals (*Enallopsammia rostrata*)	72.81	87.44	75.07	74.71	86.07	70.10			
Stony corals (*Goniocorella dumosa*)	79.91	90.43	75.24	92.40	90.77	96.88	70.41	90.30	79.11
Stony corals (*Madrepora oculata*)	93.81		74.89	83.23	85.92	96.26			
Stony corals (*Solenosmilia variabilis*)	87.52		71.87		75.50	95.46	74.24	92.75	80.57
Black corals (Antipatharia)	90.35	83.59	73.66	71.06	78.05	86.74	76.66	83.15	72.05
True soft corals (Alcyonacea)*	95.37	99.96	99.78	100.00		99.99			
Gorgonians (*Gorgonian Alcyonacea*)	89.45	82.81	71.13	91.74	72.89	96.77	79.65	91.77	
Sea pens (Pennatulacea)	94.05	92.80	95.87	96.85		100.00			
Anemones (Actiniaria)*	99.41	84.10	77.23	80.70	99.30	100.00			
Hexacorals (Zoantharia)*	94.10	91.56	85.79	86.59	92.70	97.85			
Hydroids (Hydrozoa)*	94.91	97.43	91.51	99.51		98.92	78.58		
Hydrocorals (Stylasteridae)	98.80					93.94	75.88	100.00	
Bryozoans (Bryozoa)*	94.72	95.99	92.76	99.78		99.03	79.22		76.96
'Armless' Stars (Brisingida)*	91.23	94.14	89.08	97.34	93.78	98.48			
Sea lillies and feather stars (Crinoidea)*	94.30	94.32	92.19	99.89		98.61	79.28		
Max	99.57	99.96	99.85	100.00	99.30	100.00	80.23	100.00	80.57
Min	72.81	82.81	71.13	71.06	72.89	70.10	70.41	83.15	72.05

Table 3 | Summary of the predicted fishery impacts**.** For each Fishery Management Area, the modelled historical fishing value lost, reduction in area open to fishing, and the number of bottom trawl management areas open to bottom trawling.

	Fisheries Management Area (FMA)								
VME Indicator Taxon	**West Norfolk**	**North Lord Howe**	**Central Lord Howe**	**Northwest Challenger**	**Westpac Bank**	**South Tasman Rise**	**North Louisville**	**Central Louisville**	**South Louisville**
Current loss of historical fishing value (%)	2.6	19.8	6.2	1.1	1.3	1.7	41.7	1.6	1.8
Additional loss of historical fishing value (%)	18.53	0	15.15	31.12	0	0	0	86.84	59.54
Current km^2 available to fishing	3,909	4,852	8,238	26,210	680	1,423	4,399	4,219	9,814
% reduction in overall km^2 available to fishing	53	0	10	76	0	0	0	82	39
Current no. BTMAs open	1	3	3	1	1	3	4	3	10
No. BTMAs closed by modifications	0	0	0	0	0	0	0	2	4

5. Recommendations

It is recommended that the Scientific Committee:

- **Notes** that the performance of the modifications to the boundaries of the Bottom Trawl Management Areas (BTMAs) has been assessed against all currently accepted VME indicator taxa habitat suitability models.
- **Notes** that the modifications to the boundaries of the BTMAs to meet a 70% protection target, as presented here, substantively reduces access to areas of historic fishing value in five of nine Fishery Management Areas.
- **Agrees** that the report on the performance of modifications to the BTMA boundaries is appropriate, with respect to requirements under paragraphs 19 and 39 of CMM03-2023.
- **Recommends** that the Commission applies a minimum of 70% protection of suitable habitat for each modelled VME indicator taxon, as required under para 19 of CMM03-2023, by adopting the modifications to the BTMA boundaries as presented in SC11-DW05.
- **Recommends** that GIS shape files of the modified BTMA boundaries are submitted to the SPRFMO secretariat if adopted by the Commission.

6. References

Cordue P.L., 2017. Revised fishing value layers. Presentation at the Second SPRFMO Stakeholder workshop, 15 August 2017.

Stephenson, F., Bennion, M., Geange, S., Rowden, A., Anderson, O., Bowden, D., Biggerstaff, A. (2022) Further development of VME indicator taxa distribution models. *Paper DW-05 for the 10th Meeting of the SPRFMO Scientific Committee , 26-30 September 2022*: 52.

Stephenson, F., Rowden, A.A., Anderson, O.F., Pitcher, C.R., Pinkerton, M.H., Petersen, G., Bowden, D.A. (2021) Presence-only habitat suitability models for vulnerable marine ecosystem indicator taxa in the South Pacific have reached their predictive limit. *ICES Journal of Marine Science*, 78(8): 2830-2843. 10.1093/icesjms/fsab162

Annex 1 – Modifications to BTMA Boundaries

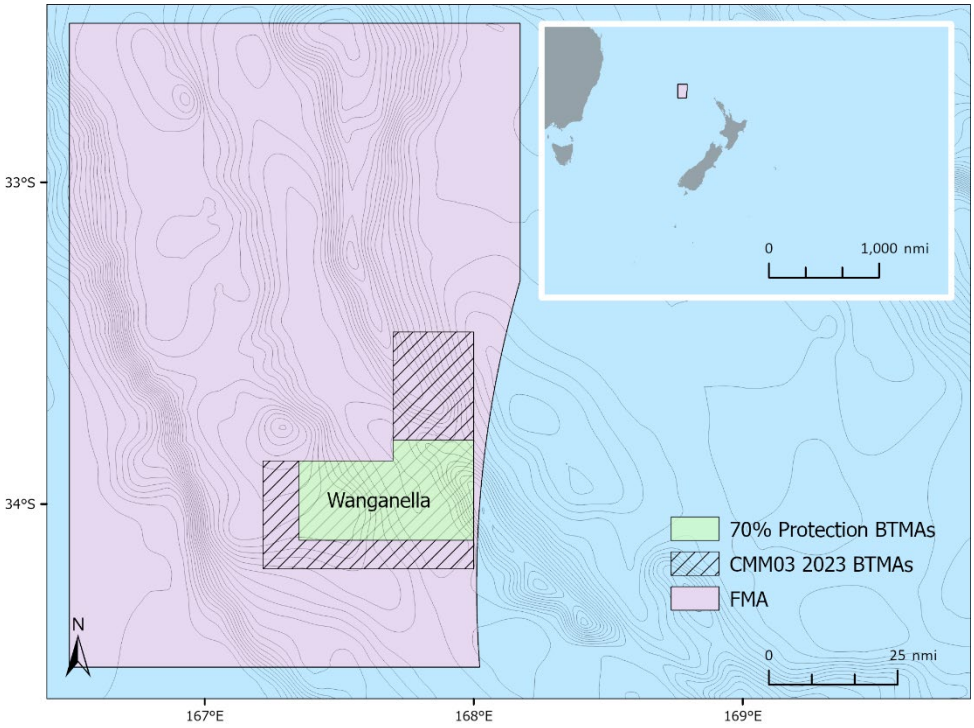

Figure A1 | West Norfolk FMA (pink box) and the Wanganella BTMA open to fishing under CMM03-2023 (box with diagonal lines) and modified BTMA to meet the 70% protection target (light green box).

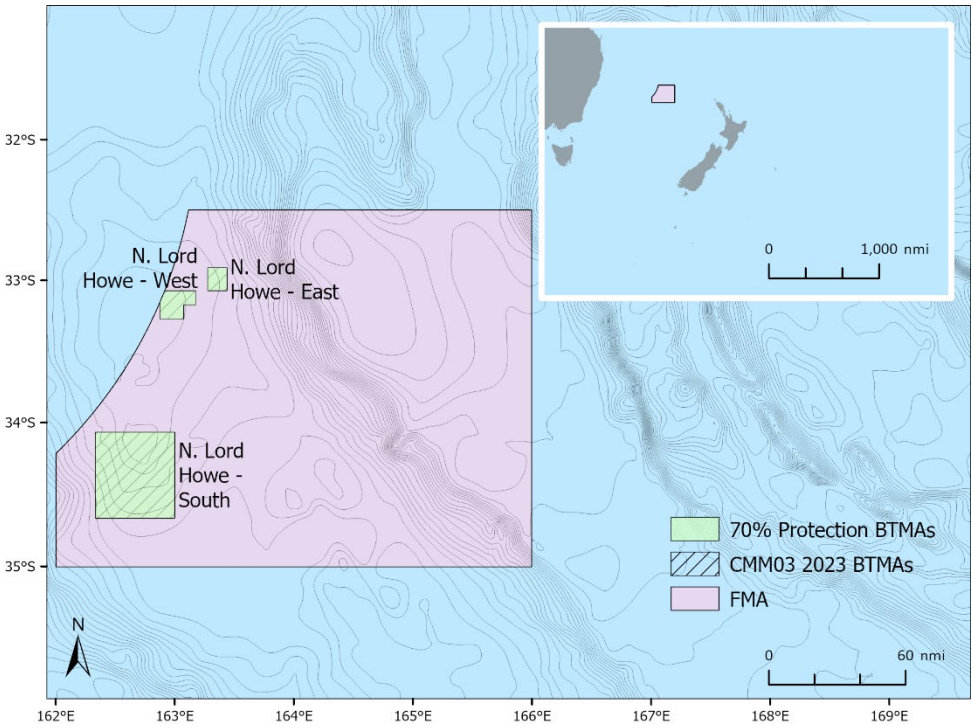

Figure A1.2 | North Lord Howe Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) which meet the 70% protection target (light green box).

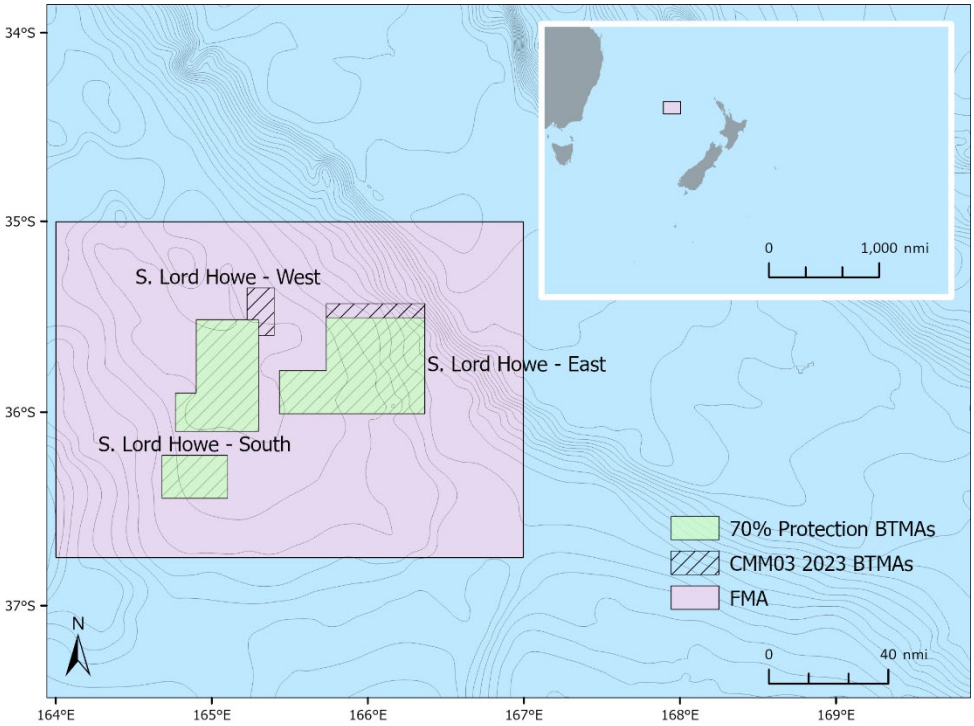

Figure A1.3 | Central Lord Howe Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and modified BTMAs to meet the 70% protection target (light green box).

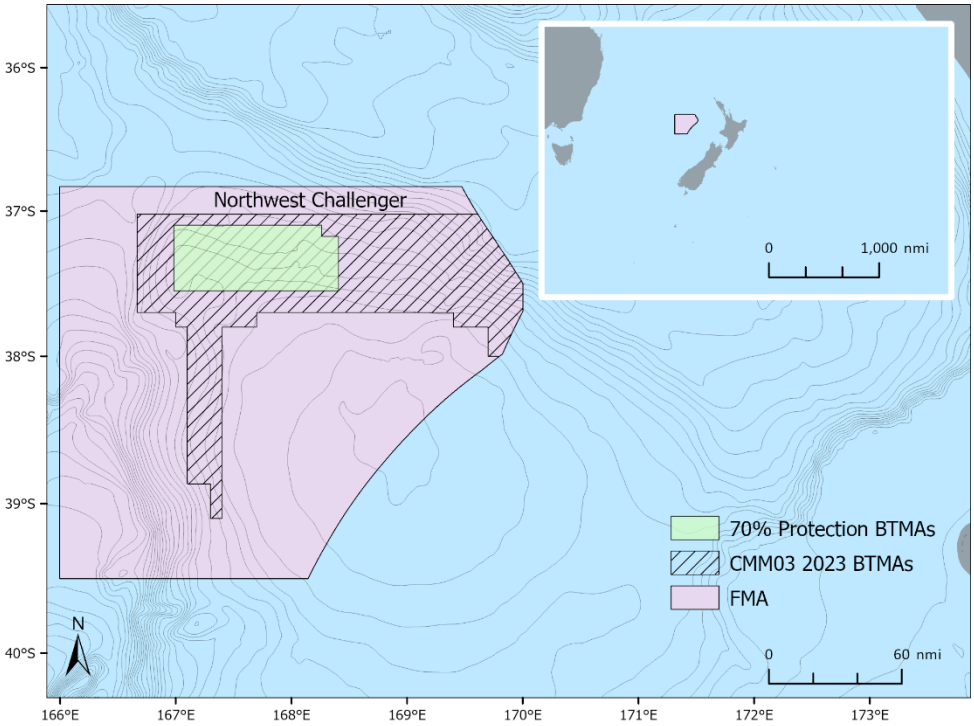

Figure A1.4 | Northwest Challenger FMA (pink box) and the BTMA open to fishing under CMM03-2023 (box with diagonal lines) and the modified BTMA to meet the 70% protection target (light green box).

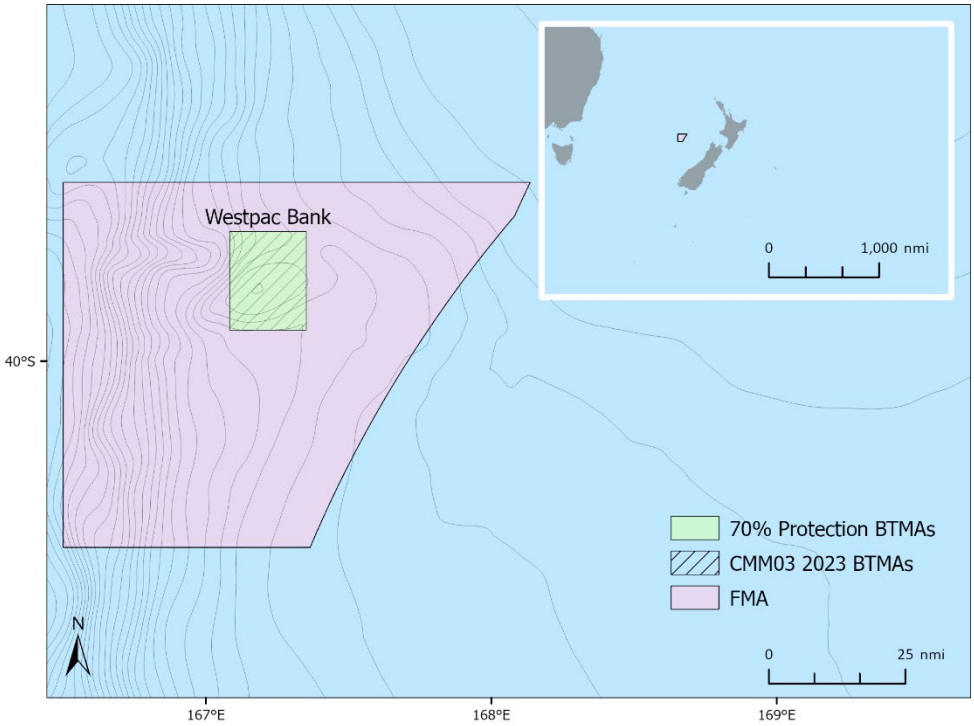

Figure A1.5 | Westpac Bank FMA (pink box) and the BTMA open to fishing under CMM03-2023 (box with diagonal lines), which meets the 70% protection target (light green box).

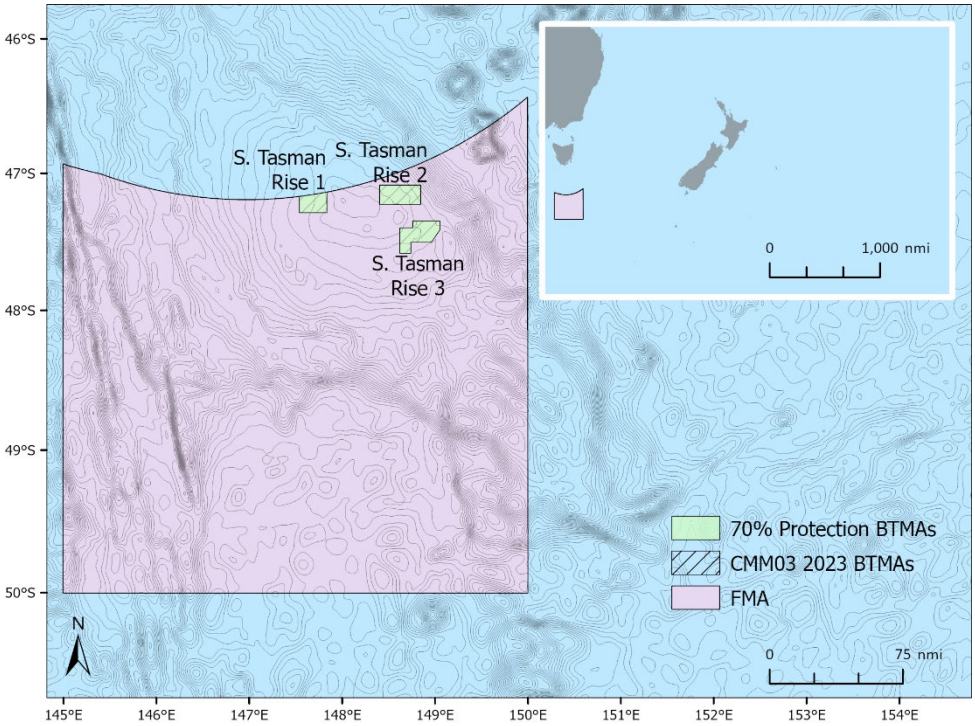

Figure A1.6 | South Tasman Rise FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines), meet the 70% protection target (light green box).

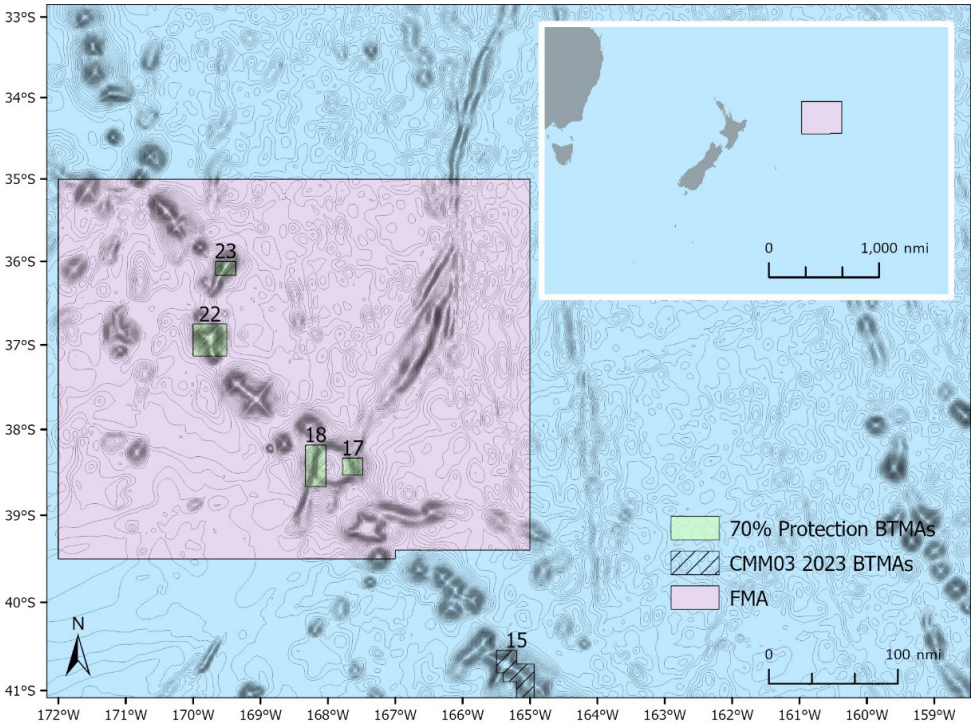

Figure A1.7 | North Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines), which meet the 70% protection target (light green box).

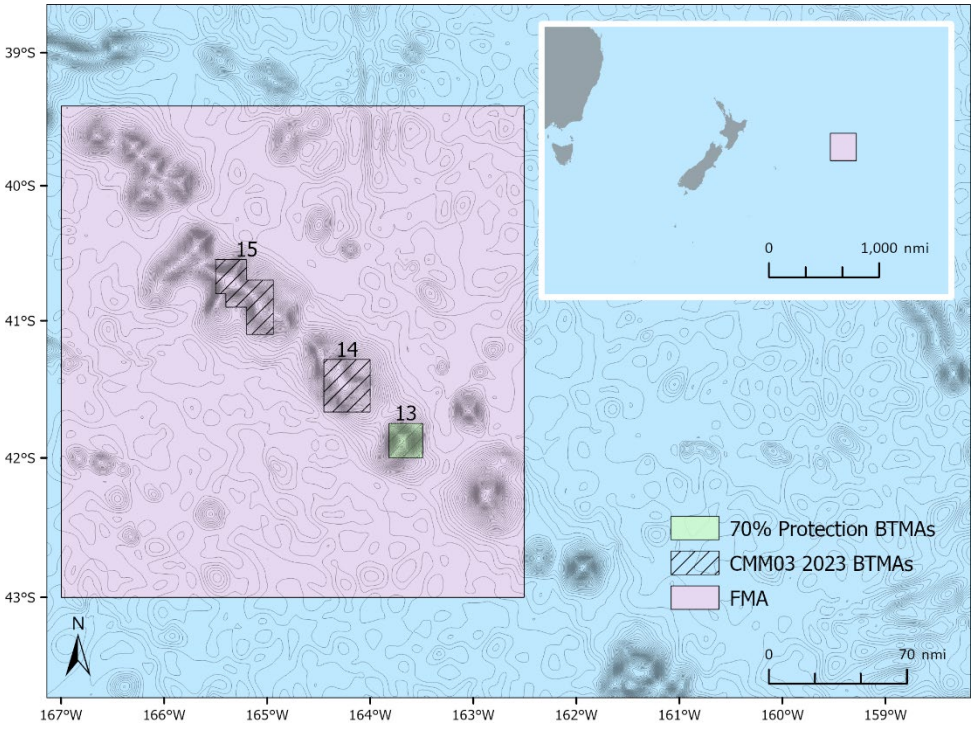

Figure A1.8 | Central Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and BTMA which meets the 70% protection target (light green box).

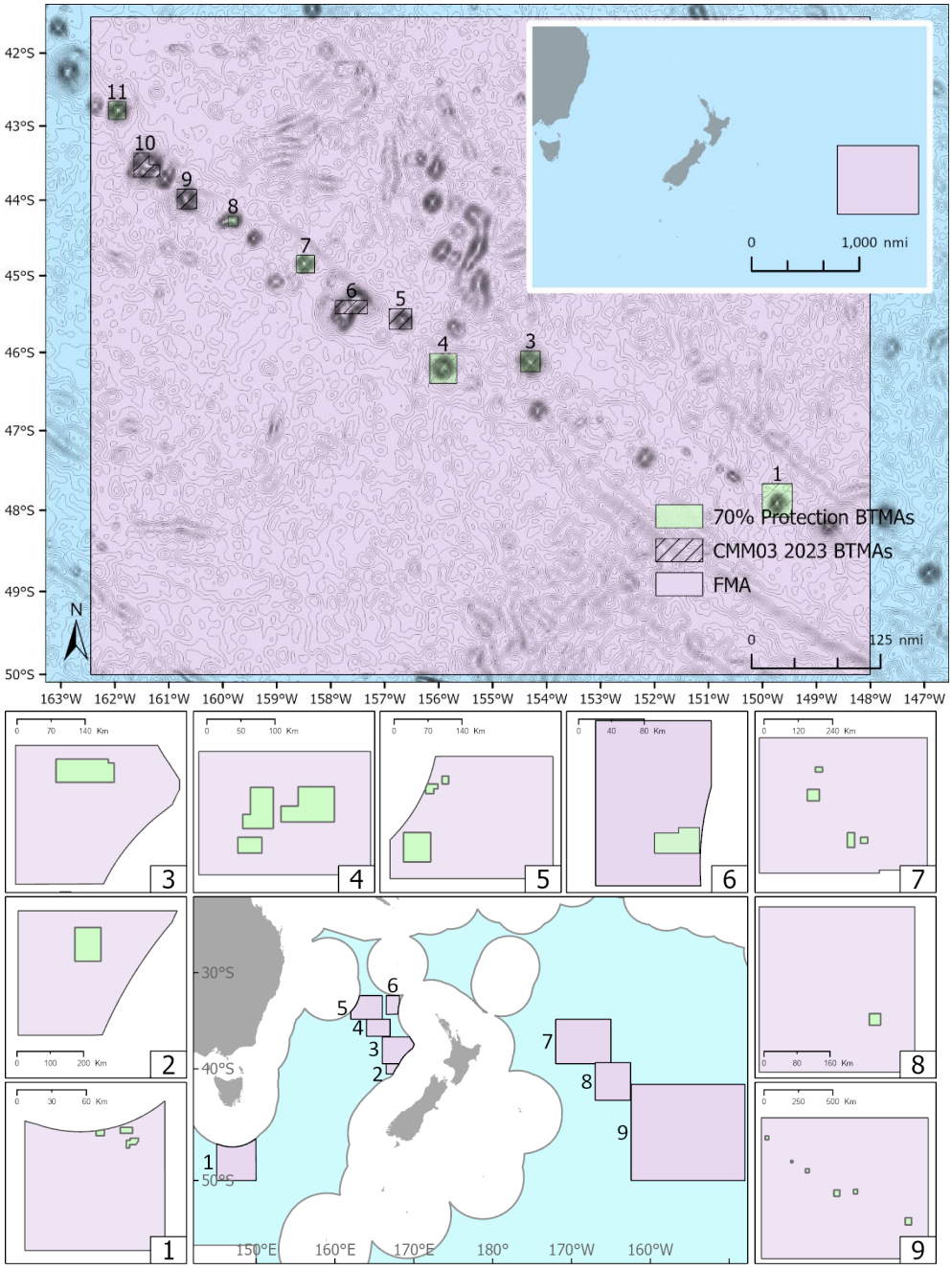

Figure A1.9 | South Louisville Ridge FMA (pink box) and the BTMAs open to fishing under CMM03-2023 (box with diagonal lines) and BTMAs which meet the 70% protection target (light green box).

Annex 2 - Details of post-accounting results to estimate the proportion of each VME indicator taxon outside the bottom trawl management areas.

This appendix includes the detailed post-accounting results at and the scale of the nine orange roughy fishery management areas (FMAs).

Post accounting results are calculated using ROC 0-linear and Power-mean estimates of the proportion of each VME taxon in areas closed to bottom trawling using impacted and unimpacted baselines. Results are presented for closed areas within each Fishery Management Area proposed for adoption by Commission in 2024 to meet the required minimum level of 70% protection.

Table A2.1 | ROC 0-linear estimates of the proportion of each VME indicator taxon in areas closed to bottom trawling for modified BTMA boundaries to achieve the 70% protection target. Values are percent (%) Habitat Suitability Index that is closed to bottom trawl fishing within each FMA using ROC 0-linear from the unimpacted baseline for taxa with > 1% of their Habitat Suitability Index within the FMA. Cell shading refers to taxa with more (green) than 70% of their distribution in closed areas or less (yellow) than 1% of their Habitat Suitability Index within the FMA. Taxa with < 1% of their HSI within the FMA excluded from Max and Min calculation.

	West Norfolk		North Lord Howe		Central Lord Howe		Northwest Challenger		Westpac Bank		South Tasman Rise		North Louisville		Central Louisville		South Louisville	
VME Indicator Taxon	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**
Sponges (Porifera Demospongiae)	9.90%	99.57	10.03%	97.65	1.18%	99.85	10.84%	99.52	0.87%	100.00	0.37%	100.00	0.99%	77.51	0.05%	100.00	0.00%	100.00
Sponges (Porifera Hexactinellida)	2.53%	94.80	4.07%	97.86	3.44%	97.37	6.33%	89.26	0.57%	99.81	0.10%	99.83	1.61%	80.23	0.52%	99.57	0.20%	89.23
Stony corals (*Enallopsammia rostrata*)	3.10%	80.14	12.11%	87.44	34.68%	76.21	17.46%	74.71	4.39%	86.58	12.84%	77.99	0.00%	0.00	0.00%	100.00	0.00%	NA
Stony corals (*Goniocorella dumosa*)	1.31%	79.91	0.13%	56.47	1.62%	75.24	56.79%	95.88	0.35%	83.61	0.06%	100.00	1.65%	70.41	6.02%	90.30	12.62%	82.33
Stony corals (*Madrepora oculata*)	5.19%	93.81	0.70%	98.87	7.51%	78.30	14.74%	83.23	3.06%	85.92	12.01%	97.79	0.61%	60.28	0.27%	100.00	0.35%	98.89
Stony corals (*Solenosmilia variabilis*)	2.37%	87.52	0.80%	100.00	1.19%	71.87	0.97%	99.89	2.40%	75.50	21.61%	95.46	8.96%	74.24	7.81%	92.75	5.70%	80.57
Black corals (Antipatharia)	7.83%	92.10	18.92%	84.20	22.32%	76.58	15.01%	71.06	2.99%	82.30	1.18%	86.74	4.52%	81.75	1.96%	83.15	3.28%	72.05
True soft corals (Alcyonacea)	7.40%	95.37	6.23%	99.96	1.67%	99.78	7.41%	100.00	0.56%	96.03	19.62%	99.99	0.06%	93.51	0.00%	100	0.68%	31.03
Gorgonians (Gorgonian Alcyonacea)	4.67%	94.10	10.32%	88.31	6.68%	75.17	4.84%	91.74	1.86%	87.10	16.92%	97.46	2.47%	79.65	1.08%	91.77	0.97%	85.19
Sea pens (Pennatulacea)	1.40%	94.05	5.19%	92.80	2.88%	95.87	6.96%	96.85	0.82%	99.13	5.79%	100.00	0.36%	80.31	0.03%	100.00	0.01%	76.75
Anemones (Actiniaria)	2.18%	99.41	7.09%	84.10	8.65%	77.23	28.66%	80.70	2.07%	99.30	2.94%	100.00	0.00%	NA	0.00%	NA	0.00%	NA
Hexacorals (Zoantharia)	3.60%	94.10	7.91%	91.56	7.06%	85.79	8.09%	86.59	1.55%	92.70	7.77%	97.85	0.32%	96.15	0.05%	95.58	0.13%	76.98
Hydroids (Hydrozoa)	3.08%	94.91	3.21%	97.43	3.10%	91.51	6.15%	99.51	0.91%	94.70	7.74%	98.92	1.34%	78.58	0.77%	94.70	0.84%	76.03
Hydrocorals (Stylasteridae)	14.17%	98.80	0.01%	32.34	0.01%	0.00	0.62%	99.57	0.01%	85.94	17.16%	94.69	5.71%	75.88	1.99%	100.00	0.41%	99.71
Bryozoans (Bryozoa)	2.89%	94.72	3.90%	95.99	2.37%	92.76	4.30%	99.78	0.74%	95.18	7.29%	99.03	1.56%	79.22	0.92%	93.48	1.05%	76.96
'Armless' Stars (Brisingida)	2.18%	91.23	5.52%	94.14	3.51%	89.08	5.69%	97.34	1.32%	93.78	9.93%	98.48	0.63%	83.93	0.58%	91.52	0.86%	73.58
Sea lillies and feather stars (Crinoidea)	3.39%	94.30	4.73%	94.32	3.11%	92.19	4.79%	99.89	0.93%	92.66	7.55%	98.61	1.55%	79.28	0.92%	93.77	0.99%	76.70
Max		99.57		99.31		99.85		99.89		99.3		100		81.75		100		82.33
Min		79.91		84.1		71.87		71.06		75.5		77.99		70.41		83.15		72.05

Table A2.2 | ROC 0-linear estimates of the proportion of each VME indicator taxon in areas closed to bottom trawling for modified BTMA boundaries to achieve the 70% protection target. Values are percent (%) Habitat Suitability Index that is closed to bottom trawl fishing within each FMA using ROC 0-linear from the impacted baseline for taxa with > 1% of their Habitat Suitability Index within the FMA. Cell shading refers to taxa with more (green) than 70% of their distribution in closed areas or less (yellow) than 1% of their Habitat Suitability Index within the FMA. Taxa with < 1% of their HSI within the FMA excluded from Max and Min calculation. NOTE: ROC 0-linear estimates are not available (NA) for six taxa.

	West Norfolk		North Lord Howe		Central Lord Howe		Northwest Challenger		Westpac Bank		South Tasman Rise		North Louisville		Central Louisville		South Louisville	
VME Indicator Taxon	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**
Sponges (Porifera Demospongiae)	9.90%	99.57	10.03%	97.66	1.18%	99.95	10.80%	99.58	0.87%	100.00	0.37%	100.00	0.96%	77.60	0.05%	100.00	0.00%	100.00
Sponges (Porifera Hexactinellida)	2.54%	94.81	4.08%	97.89	3.45%	97.41	6.09%	90.25	0.57%	99.81	0.10%	99.83	1.61%	80.36	0.51%	99.57	0.20%	89.22
Stony corals (*Enallopsammia rostrata*)	3.14%	80.59	12.51%	87.53	35.10%	77.61	15.74%	78.16	4.47%	87.58	13.09%	78.90	0.00%	0.00	0.00%	100.00	0.00%	NA
Stony corals (*Goniocorella dumosa*)	1.29%	80.91	0.13%	58.91	1.61%	77.03	57.05%	96.74	0.35%	84.60	0.06%	100.00	1.65%	71.28	5.43%	90.22	12.55%	82.48
Stony corals (*Madrepora oculata*)	5.25%	93.95	0.71%	98.90	7.48%	79.81	13.61%	86.09	3.09%	86.21	12.20%	97.80	0.62%	60.45	0.27%	100.00	0.36%	98.89
Stony corals (*Solenosmilia variabilis*)	2.39%	87.73	0.81%	100.00	1.18%	73.67	0.98%	99.92	2.39%	76.61	21.80%	95.90	8.68%	75.04	7.30%	92.63	5.61%	80.68
Black corals (Antipatharia)	7.95%	92.22	19.20%	84.40	22.48%	77.36	14.08%	72.89	3.01%	83.08	1.18%	88.25	4.52%	82.24	1.90%	82.91	3.29%	72.01
True soft corals (Alcyonacea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gorgonians (Gorgonian Alcyonacea)	4.68%	94.20	10.33%	88.45	6.62%	75.97	4.75%	92.89	1.85%	87.57	16.95%	97.56	2.45%	79.75	1.07%	91.94	0.96%	85.18
Sea pens (Pennatulacea)	1.40%	94.05	5.19%	92.84	2.88%	95.87	6.91%	97.02	0.82%	99.13	5.79%	100.00	0.36%	80.37	0.03%	100.00	0.01%	76.75
Anemones (Actiniaria)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexacorals (Zoantharia)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydroids (Hydrozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrocorals (Stylasteridae)	14.20%	98.81	0.01%	37.93	0.00%	0.00	0.62%	99.77	0.01%	89.13	17.16%	94.92	5.61%	76.19	1.91%	100.00	0.40%	99.71
Bryozoans (Bryozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
'Armless' Stars (Brisingida)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sea lillies and feather stars (Crinoidea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Max		99.57		97.89		99.95		99.58		87.58		100		82.24		100		82.48
Min		80.59		84.4		73.67		72.89		76.61		78.9		71.28		82.91		72.01

Table A2.3 | Power-mean estimates of the proportion of each VME indicator taxon in areas closed to bottom trawling for modified BTMA boundaries to achieve the 70% protection target. Values are percent (%) Habitat Suitability Index that is closed to bottom trawl fishing within each FMA using Power-mean from the unimpacted baseline for taxa with > 1% of their Habitat Suitability Index within the FMA. Cell shading refers to taxa with more (green) than 70% of their distribution in closed areas or less (yellow) than 1% of their Habitat Suitability Index within the FMA. Taxa with < 1% of their HSI within the FMA excluded from Max and Min calculation. NOTE: Power-mean estimates are not available (NA) for six taxa.

	West Norfolk		North Lord Howe		Central Lord Howe		Northwest Challenger		Westpac Bank		South Tasman Rise		North Louisville		Central Louisville		South Louisville	
VME Indicator Taxon	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**
Sponges (Porifera Demospongiae)	84.83%	100.00	0.58%	99.05	0.00%	75.98	5.96%	99.93	0.45%	100.00	0.01%	100.00	0.76%	51.13	0.03%	100.00	0.00%	99.78
Sponges (Porifera Hexactinellida)	2.34%	99.45	1.03%	99.84	5.23%	99.96	1.29%	87.55	0.03%	99.97	0.00%	99.72	2.40%	83.57	0.34%	99.95	0.02%	96.78
Stony corals (*Enallopsammia rostrata*)	1.84%	72.81	8.01%	96.71	48.58%	75.07	12.31%	76.53	3.73%	86.07	16.23%	70.10	0.01%	78.97	0.00%	99.88	0.00%	72.35
Stony corals (*Goniocorella dumosa*)	2.91%	91.66	5.37%	90.43	5.63%	84.35	13.52%	92.40	1.18%	90.77	6.47%	96.88	1.68%	77.86	1.54%	91.19	2.36%	79.11
Stony corals (*Madrepora oculata*)	5.76%	93.86	0.91%	96.77	6.61%	74.89	19.59%	83.57	4.16%	87.97	9.92%	96.26	0.47%	69.00	0.24%	97.57	0.41%	88.47
Stony corals (*Solenosmilia variabilis*)	0.00%	98.87	0.00%	100.00	0.00%	84.72	0.00%	100.00	0.02%	73.71	0.66%	99.95	47.73%	77.85	25.21%	96.15	8.64%	90.99
Black corals (Antipatharia)	7.39%	90.35	13.61%	83.59	27.00%	73.66	15.74%	75.64	2.87%	78.05	2.34%	91.38	2.99%	76.66	1.73%	84.74	2.53%	73.21
True soft corals (Alcyonacea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gorgonians (Gorgonian Alcyonacea)	5.74%	89.45	12.32%	82.81	9.69%	71.13	4.54%	93.06	2.00%	72.89	21.05%	96.77	2.57%	83.66	0.71%	92.33	0.60%	89.00
Sea pens (Pennatulacea)	0.02%	96.01	1.41%	99.86	1.38%	99.58	9.66%	99.89	0.79%	100.00	3.13%	100.00	0.02%	87.88	0.00%	100.00	0.00%	90.94
Anemones (Actiniaria)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexacorals (Zoantharia)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydroids (Hydrozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrocorals (Stylasteridae)	37.81%	99.77	0.01%	98.27	0.00%	44.49	0.24%	99.51	0.00%	84.75	5.97%	93.94	3.26%	78.84	1.43%	100.00	0.20%	98.72
Bryozoans (Bryozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
'Armless' Stars (Brisingida)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sea lillies and feather stars (Crinoidea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Max		100		99.86		99.96		100.00		90.77		100.00		83.66		100.00		90.99
Min		72.81		82.81		71.13		75.64		72.89		70.1		76.66		84.74		73.21

Table EA2.4 | Power-mean estimates of the proportion of each VME indicator taxon in areas closed to bottom trawling for modified BTMA boundaries to achieve the 70% protection target. Values are percent (%) Habitat Suitability Index that is closed to bottom trawl fishing within each FMA using Power-mean from the impacted baseline for taxa with > 1% of their Habitat Suitability Index within the FMA. Cell shading refers to taxa with more (green) than 70% of their distribution in closed areas or less (yellow) than 1% of their Habitat Suitability Index within the FMA. Taxa with < 1% of their HSI within the FMA excluded from Max and Min calculation. NOTE: Power-mean estimates are not available (NA) for six taxa.

	West Norfolk		North Lord Howe		Central Lord Howe		Northwest Challenger		Westpac Bank		South Tasman Rise		North Louisville		Central Louisville		South Louisville	
VME Indicator Taxon	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**	**% within FMA**	**% closed**
Sponges (Porifera Demospongiae)	84.92%	100.00	0.58%	99.08	0.00%	95.96	5.95%	99.93	0.45%	100.00	0.01%	100.00	0.66%	48.39	0.03%	100.00	0.00%	99.78
Sponges (Porifera Hexactinellida)	2.35%	99.45	1.03%	99.85	5.23%	99.96	1.22%	89.17	0.03%	99.97	0.00%	99.73	2.40%	83.58	0.34%	99.95	0.02%	96.78
Stony corals (*Enallopsammia rostrata*)	1.87%	73.32	8.23%	96.74	48.88%	76.40	11.29%	80.99	3.79%	86.83	16.38%	70.98	0.01%	79.03	0.00%	99.90	0.00%	72.02
Stony corals (*Goniocorella dumosa*)	2.92%	91.85	5.41%	90.59	5.61%	85.22	13.04%	93.96	1.18%	91.40	6.51%	97.08	1.66%	78.43	1.44%	91.16	2.33%	79.14
Stony corals (*Madrepora oculata*)	5.83%	94.04	0.93%	96.80	6.58%	76.46	18.37%	86.84	4.21%	88.24	10.10%	96.30	0.47%	69.24	0.25%	97.56	0.42%	88.50
Stony corals (*Solenosmilia variabilis*)	0.00%	98.87	0.00%	100.00	0.00%	85.10	0.00%	100.00	0.02%	73.73	0.70%	99.96	48.60%	79.03	23.08%	95.79	8.72%	91.05
Black corals (Antipatharia)	7.49%	90.52	13.79%	83.90	27.11%	74.62	14.96%	77.75	2.88%	79.20	2.37%	91.86	2.99%	77.18	1.67%	84.59	2.53%	73.14
True soft corals (Alcyonacea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gorgonians (Gorgonian Alcyonacea)	5.73%	89.74	12.32%	83.12	9.56%	72.34	4.46%	94.19	1.98%	74.09	21.14%	96.95	2.56%	83.71	0.69%	92.68	0.60%	88.96
Sea pens (Pennatulacea)	0.02%	96.01	1.41%	99.86	1.38%	99.58	9.65%	99.90	0.79%	100.00	3.13%	100.00	0.02%	87.87	0.00%	100.00	0.00%	90.94
Anemones (Actiniaria)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexacorals (Zoantharia)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydroids (Hydrozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrocorals (Stylasteridae)	37.88%	99.77	0.01%	98.54	0.00%	59.09	0.24%	99.69	0.00%	85.78	5.95%	94.36	3.19%	79.16	1.36%	100.00	0.20%	98.71
Bryozoans (Bryozoa)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
'Armless' Stars (Brisingida)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sea lillies and feather stars (Crinoidea)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Max		100		99.86		99.96		100		91.4		100		83.71		100		91.05
Min		73.32		83.12		72.34		77.75		74.09		70.98		77.18		84.59		73.14