9th MEETING OF THE SCIENTIFIC COMMITTEE

Held virtually, 27 September to 2 October 2021

SC9-DW09_rev1

New Zealand 2020 VME Encounter Review

New Zealand

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South Pacific Regional Fisheries Management Organisation

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New Zealand 2020 VME encounter review

Marco Milardi[1], Tiffany Bock[1], Shane Geange[2]

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1 – Fisheries New Zealand - Tini a Tangaroa, Ministry for Primary Industries - Manatū Ahu Matua, Wellington, New Zealand

2 – Department of Conservation – Te Papa Atawhai, Wellington, New Zealand

Contents

1. Purpose

The purpose of this paper is to provide a Member review of the vulnerable marine ecosystem (VME) encounter that occurred in 2020 on a New Zealand flagged vessel that was bottom trawling in the SPRFMO area (North Lord Howe Rise Fisheries Management Area). The purpose of the review is to provide a detailed description of the encounter and suggest management actions to prevent significant adverse impacts (SAIs) on VMEs to meet requirements of CMM03-2021. This information will be used to inform a review of the encounter by the Scientific Committee (SC) and development of SC advice to the Commission on management actions proposed within this review.

2. Background

In 2020, a New Zealand flagged vessel that was bottom trawling in the North Lord Howe Rise Fisheries Management Area (FMA) caught an amount of Gorgonian Alcyonacea estimated to be above the 15 kg VME encounter threshold identified in Annex 6A of CMM 03-2020, which was in force at the time of the encounter. Table 1 provides further details on this encounter.

Table 1. Details of the encounter event, based on Annex 7 table of CMM 03-2020.

1. General Information:

   a. Nationality   New Zealand

   b. Fishing gear used   Bottom Trawl

2. Location Information:

   Bottom trawl or mid-water trawl

   a. Start and end position of trawl (to nearest 0.01 decimal degree)
      Start: 34.1940'S 162.6529'E
      End: 34.2085'S 162.6525'E

   b. Encounter trawl tow length
      Approximately 0.8 nautical miles

3. VME Information:

   a. Summary information:

      i. Number of VME Indicator taxa encountered   One

      ii. Total weight of VME Indicator taxa encountered
          Estimated 18-20 kg

   b. Detailed information:

      i. Weight of each VME Indicator taxa in tow (including any under threshold)
         GGW – Gorgonian Alcyonacea - Estimated 18-20 kg

As a result of this VME encounter, the encounter protocol was triggered, requiring the vessel to move away at least one (1) nautical mile either side of the trawl track extended by one (1) nautical mile at each end. The encounter was notified to the Secretariat and the encounter area closed to further bottom fishing by all Members and Cooperating Non-Contracting Parties (CNCPs), according to paragraph 31 of CMM 03-2020, until the Commission determines management actions for the encounter area to prevent SAIs on VMEs, after consideration of advice from the SC.

In accordance with paragraphs 31 and 32 of CMM 03-2021, a detailed review of the encounter including a comparison of the encounter with the existing habitat suitability model predictions for VME indicator taxa and suggested management actions to prevent SAIs on VMEs are provided below. The structure of this paper follows the review process proposed in SC9-DW08 (Design of a review process for VME encounters in bottom fisheries in the SPRFMO Area) submitted by New Zealand to the 9th meeting of the SPRFMO Scientific Committee[1]. Annex 1 and 2 include a checklist identifying how elements included in the review process described in SC9-DW08 are met within this review.

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[1] We note that currently the SPRFMO Scientific Committee has not agreed on a process for reviewing VME encounters, but it seemed sensible to undertake the review according to this proposed process.

Pursuant to paragraph 32 of CMM 03-2021, the SC is required to review this encounter at its 2021 annual meeting, determine the extent to which the encounter is consistent or inconsistent with VME habitat suitability model predictions, and provide advice to the Commission on management actions proposed within this review or any other management actions it considers appropriate to prevent SAIs on VMEs. The SC's review is required to include consideration of:

a) the detailed analyses provided within this review;
b) historical fishing events within 5 NM of the encounter tow, in particular, any previous encounters, and all information on benthic bycatch;
c) model predictions for all VME indicator taxa;
d) details of the relevant fishing activity, including the bioregions in which the encounter occurred; and
e) any other information the SC considers relevant.

Taking into account the SC's review of each encounter, and advice on management actions to prevent SAIs on VMEs, at its next annual meeting, the Commission is required to determine management actions for the encounter area. Management actions determined by the Commission will apply as appropriate, unless otherwise determined, from the conclusion of the relevant Commission meeting.

3. New Zealand detailed description of the encounter

Some details relative to the encounter were withheld to prevent identification of the vessel, pending an ongoing compliance investigation on the case by the New Zealand fisheries authorities. Once the investigation is complete, or if a formal prosecution is instigated, the full details of the encounter will be publicly available and communicated to the SPRFMO Secretariat for circulation to Members and CNCPs. These details were considered not relevant to this review.

Figures in this revision have been adjusted to comply with national rules on commercially sensitive data release.

Historic bycatch data used in the analysis were extracted from the Fisheries New Zealand Centralized Observer Database (*cod*) (accessed 28 May 2021). Bycatch data were collected by scientific observers (the New Zealand bottom trawl fleet has 100% observer coverage in the SPRFMO Convention Area) and included 1,217 New Zealand trawl tows (including both bottom and mid-water trawls) over the period 2008–2020 targeting black oreo (*Allocyttus niger*), alfonsinos (*Beryx splendens* and *B. decadacylus*), cardinal fish (*Epigonus telescopus*), orange roughy (*Hoplostethus atlanticus*) and spiky oreo (*Neocyttus rhomboidalis*) from within or adjacent to the N. Lord Howe - South Bottom Trawl Management Area (hereafter referred to as the open area) within which the encounter occurred[2]. This open area is one of three within the North Lord Howe Rise Fisheries Management Area (FMA). These data consisted of tow-by-tow observer data with one record per benthic taxon caught on each tow (corrected for differences between the location of the vessel and the gear), and included trip number, tow number, fishing method, trawl type, benthic species code, common name, bycatch weight, method of weight analysis, information on whether the benthic material was encrusting anything or encrusted by something else, and observer comments.

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[2] These data include bycatch from areas that were closed to fishing under SPRFMO CMM03-2020 (and CMM03-2019), but that were previously open to bottom fishing.

For trawl tows containing VME indicator taxa as bycatch, individual VME indicator species were aggregated into higher-order VME indicator taxa identified in CMM03-2020 using taxonomic designations from the World Register of Marine Species (WoRMS Editorial Board 2021). Other benthic bycatch within tows was aggregated into the taxonomic designations of Order.

The dataset was interrogated to describe the spatial distribution of historical trawl effort and quantify the number of trawls and associated weight of benthic bycatch for each of the VME indicator taxa. This analysis was done at four spatial scales:
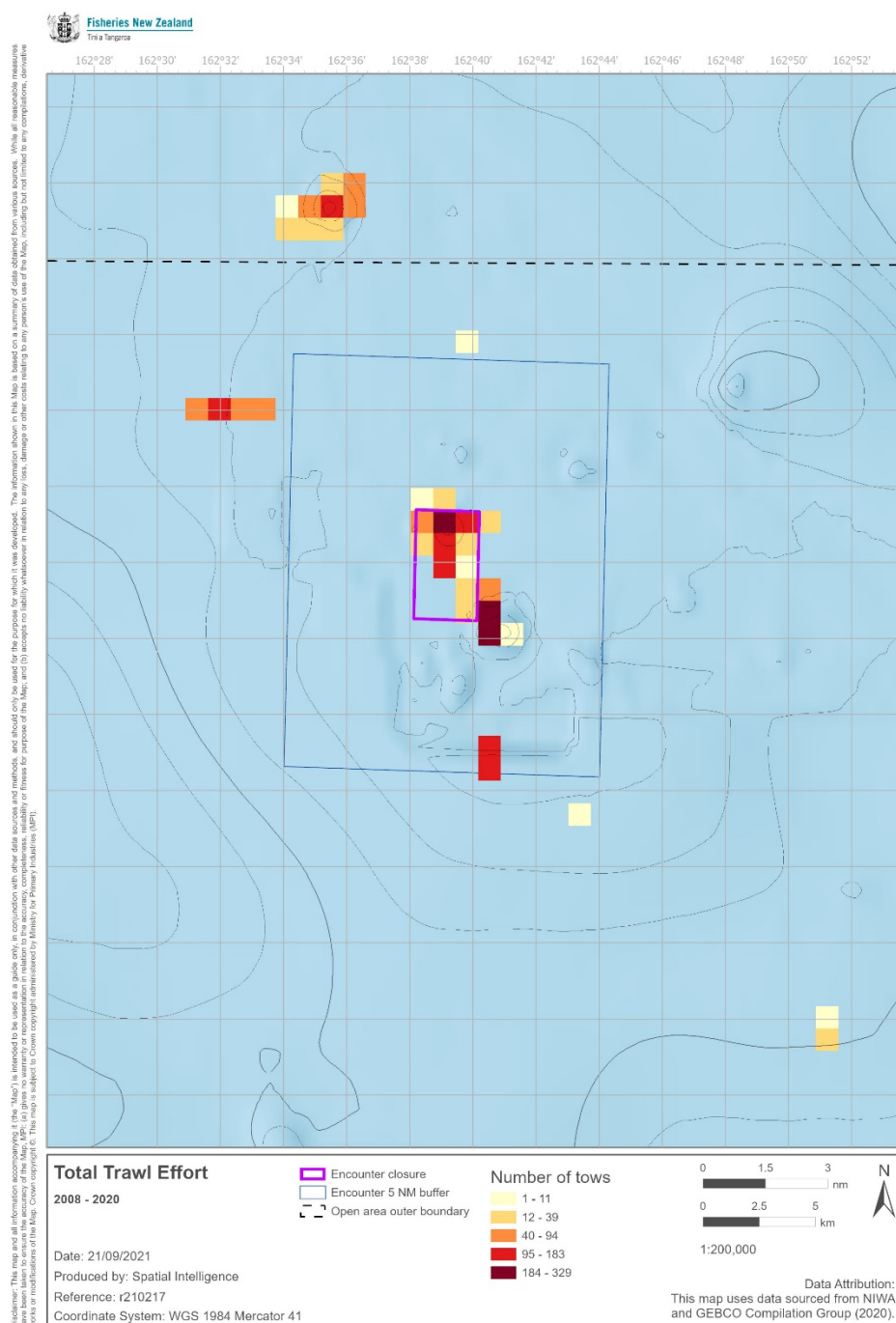
   (i)   within and adjacent to the open area;
   (ii)   within the open area;
   (iii)   within a 5 NM buffer around the encounter; and
   (iv)   within the 1 NM closed area around the encounter.

Figure 1 details the location of the encounter within the North Lord Howe Rise FMA and the wider Tasman Sea. The area of the encounter is within the Tasman Sea to SW Pacific Bioregion (also called Bioregion 15) as defined by Costello et al. 2017 and used in the Bottom Fishing Impact Assessment (BFIA) (SC8-DW07_Rev1). With reference to other bioregional schemes, the encounter occurred within the Temperate Western Pacific Ocean benthic Large Marine Region (Dunstan et al. 2020).
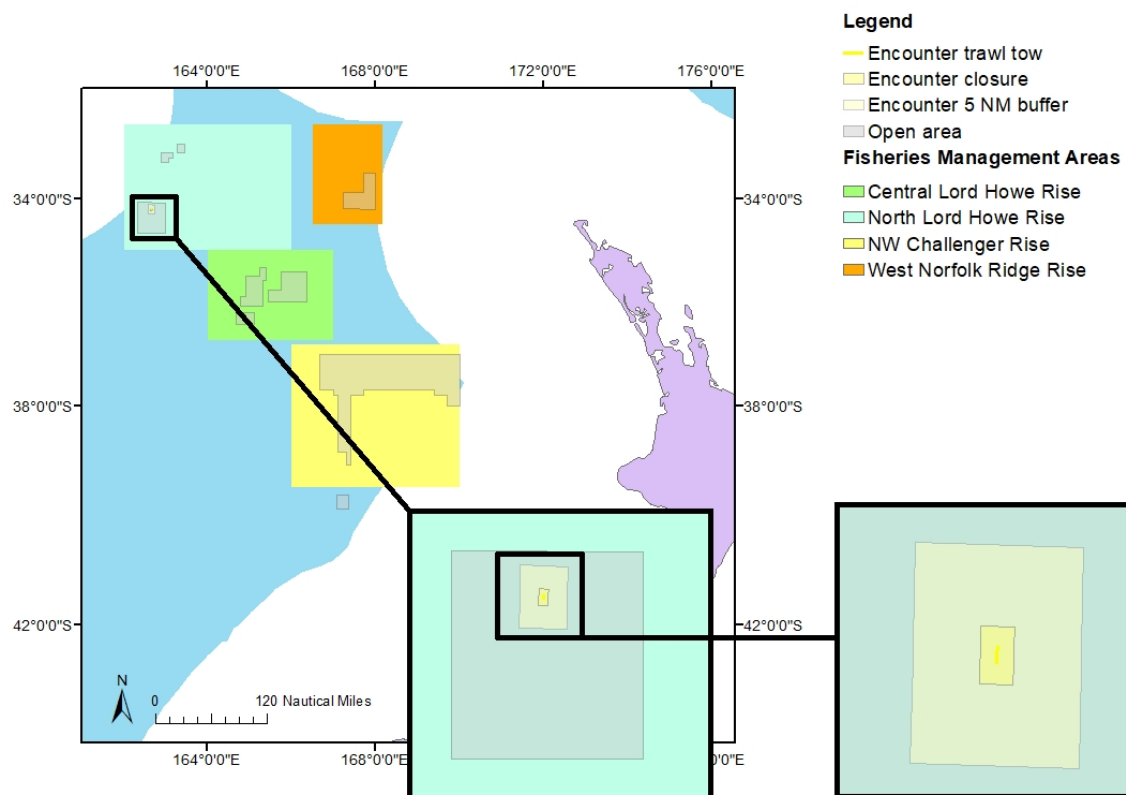
Figure 1. Location of the open area (grey polygon, inset) within the North Lord Howe Rise FMA (teal polygon main figure) within which the encounter occurred, and corresponding 1 nautical mile (NM) closure (yellow polygon, inset) and 5 NM buffer (light yellow polygon, inset) around the encounter trawl tow.

The location of the encounter trawl tow relative to the location of all historical bottom trawl tows within and adjacent to the open area within which the encounter occurred is shown with Figure 2. The encounter occurred in one of several clusters of historical trawl tows within the open area which have targeted underwater features (Fig 3).

Figure 2. Location of the encounter trawl tow relative to the distribution of historical bottom trawl tows within and adjacent to the open area with which the encounter occurred.
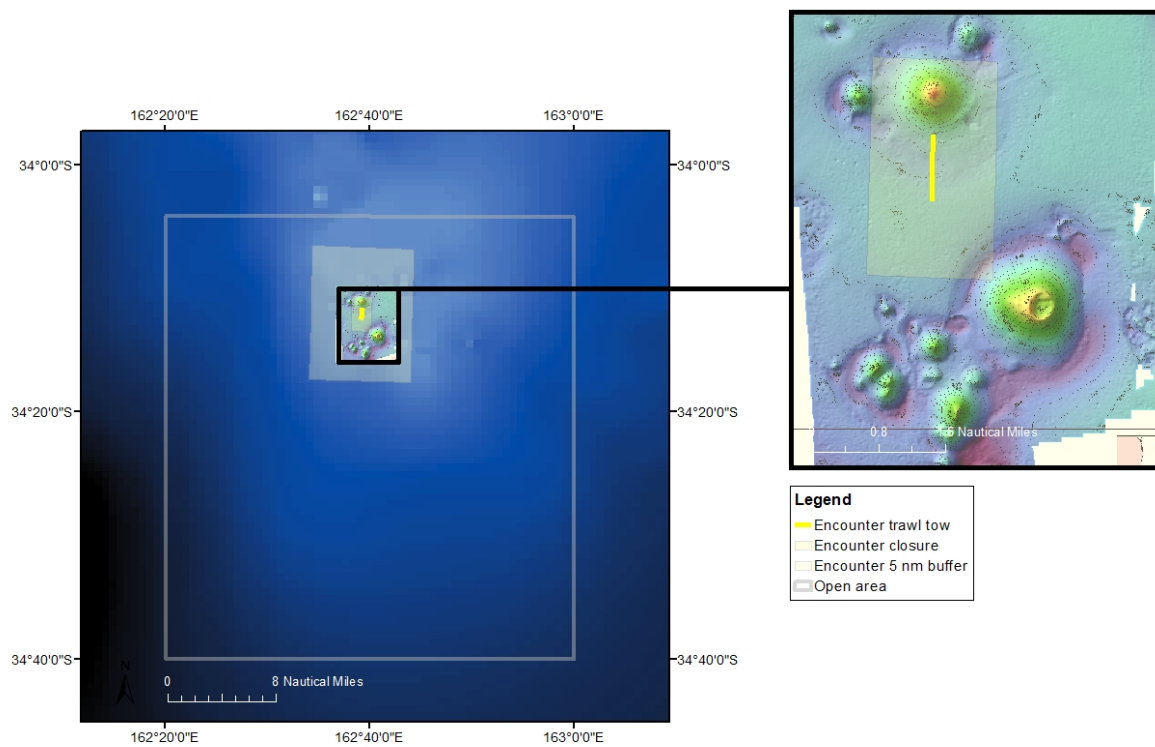
Figure 3. Location of the encounter trawl tow superimposed upon available bathymetric data.

Details of the bycatch weight from historical fishing trawl tows for all benthic invertebrate species, including VME indicator taxa, at the spatial scale of the open area and its surroundings (i.e., 5 NM from the open area boundary), the open area, 5 NM around the encounter trawl tow, and the 1 NM encounter closure around the encounter trawl tow (encounter area), are provided in Table 2. Note that historical trawl tows do not include the encounter trawl tow.

Table 2. Summary of the number of historical benthic invertebrate bycatch records (n), percent of tows containing bycatch (%), range in bycatch weight (r) and total bycatch weight (kg) of VME indicator taxa according to CMM 03-2020 (in italics) and other benthic bycatch at the scale of the open area and surroundings, the open area, 5 nautical miles (NM) around the encounter trawl tow, and the 1 NM encounter area around the encounter trawl tow. See Figure 2 for the distribution of historical trawl tows, and Figures 4 and Annex 1-7 for the distribution of taxon-specific bycatch. Taxa with zero historical bycatch have been omitted.

| Taxon	Open Area and Adjacent Trawls				Open Area				5 NM Around Encounter Track				Encounter Area			
	n	%	r	kg	n	%	r	kg	n	%	r	kg	n	%	r	kg
Porifera (Sponges)	27	2.2%	0.1-8.7	42.1	24	2.2%	0.1-8.7	40.6	13	1.6%	0.1-5.0	12.9	7	1.9%	0.1-2.2	3.2
Alcyonacea (Soft corals)	1	0.1%	0.3	0.3	1	0.1%	0.3	0.3	0	0.0%	NA	0.0	0	0.0%	NA	0.0
Gorgonian Alcyonacea (Sea fans, sea whips, bottlebrush)	103	8.5%	0.0-3.0	36.9	64	6.0%	0.0-3.0	24.2	33	4.1%	0.0-2.7	11.6	20	5.3%	0.0-2.7	10.6
Scleractinia (Stony corals)	7	0.6%	0.1-1.7	3.0	6	0.6%	0.1-1.7	2.8	2	0.2%	0.1	0.2	1	0.3%	0.1	0.1
Antipatharia (Black corals)	73	6.1%	0.0-1.0	18.7	46	4.3%	0.0-1.0	12.7	28	3.5%	0.0-1.0	7.3	17	4.5%	0.0-1.0	4.7
Actiniaria (Anemones)	28	2.3%	0.0-4.0	15.5	21	2.0%	0.0-4.0	13.7	15	1.8%	0.0-3.0	8.6	4	1.1%	0.0-0.3	0.6
Pennatulacea (Sea pens)	4	0.3%	0.1	0.4	2	0.2%	0.1	0.2	0	0.0%	NA	0.1	1	0.3%	0.1	0.1
Crinoidea (Sea lilies)	22	1.8%	0.1-0.5	3.0	3	0.3%	0.1	0.3	1	0.1%	0.1	0.1	0	0.0%	0.1	0.0
Asteroidea (Starfish)	1	0.1%	0.1	0.1	1	0.1%	0.1	0.1	0	0.0%	NA	0.0	0	0.0%	NA	0.0
Echonoidea (Sea urchins)	20	1.7%	0.0-2.0	12.7	17	1.6%	0.0-2.0	11.4	5	0.6%	0.1-1.0	4.1	2	0.5%	1.0	2.0
Hexanauplia (Barnacles)	1	0.1%	0.1	0.1	1	0.1%	0.1	0.1	0	0.0%	NA	0.0	0	0.0%	NA	0.0
Malacostraca (Crabs, prawns)	2	0.2%	0.2-2.0	2.2	1	0.1%	2.0	2.0	0	0.0%	NA	0.0	0	0.0%	NA	0.0
Ophiuroidea (Brittle stars)	11	0.9%	0.0-1.0	5.1	4	0.4%	0.0-1.0	2.1	3	0.4%	0.1-1.0	2.1	2	0.5%	0.1-1.0	1.1
Pycnogonida (Sea spiders)	1	0.1%	1.0	1.0	1	0.1%	1.0	1.0	1	0.1%	1.0	1.0	1	0.3%	1.0	1.0
Thaliacea (Tunicates)	1	0.1%	1.3	1.3	1	0.1%	1.3	1.3	0	0.0%	NA	0.0	0	0.0%	NA	0.0

Figures 4-8 show the location of the encounter trawl tow relative to the existing habitat suitability model predictions for Gorgonian Alcyonacea in the open area within which the encounter occurred. These figures show the HSI values unadjusted for naturalness (i.e., assuming unimpacted by bottom trawling), the uncertainty estimates for the HSI values (Figures 4 and 5), the HSI values adjusted for naturalness, HSI values above the model ROC thresholds (assuming a linear relationship between HSI and abundance above the threshold) adjusted for naturalness, and the power transformed HSI values (i.e. discounted for impact by bottom trawling) adjusted for naturalness (Figures 6–8). Naturalness-adjusted HSI values were used to inform the initial design of spatial boundaries for open areas (CMM 03-2019). Where available, estimated uncertainty associated with the layers is also shown. In these figures, the bycatch weight for Gorgonian Alcyonacea in historical trawl tows is colour-coded according to weight. Historical tows included Gorgonian Alcyonacea bycatch weight up to 3 kg per tow.
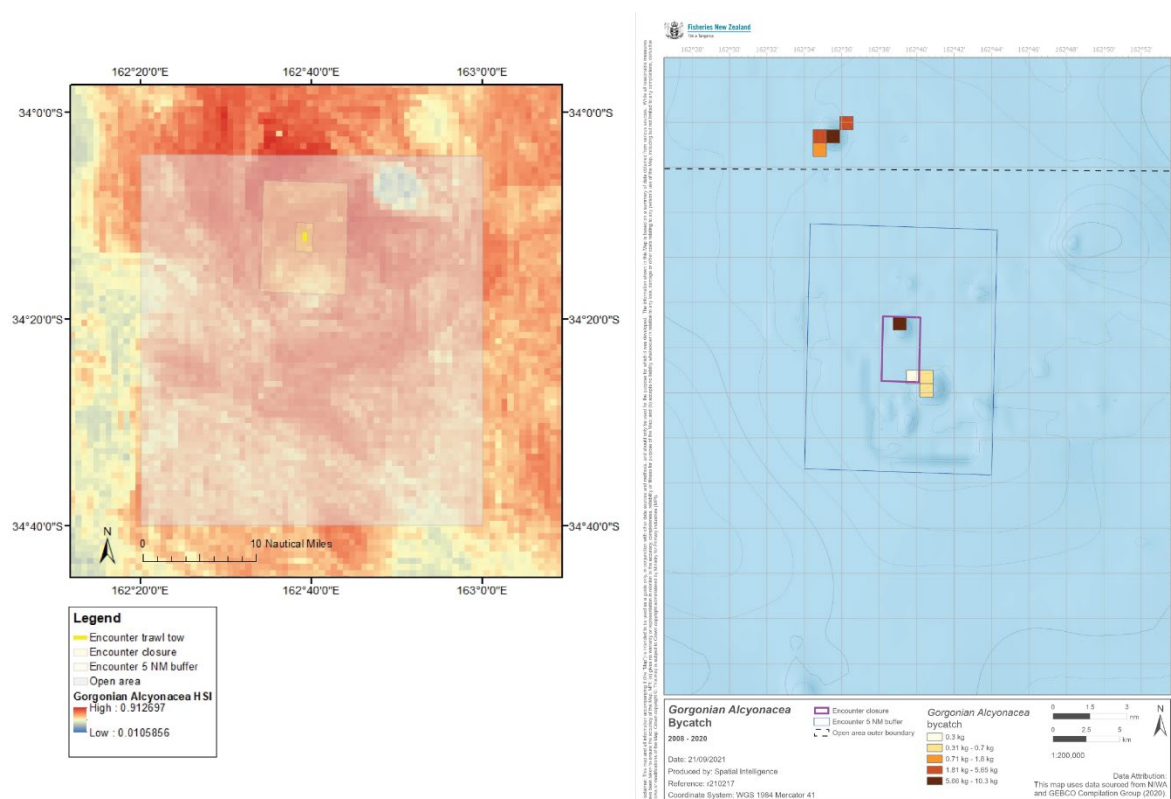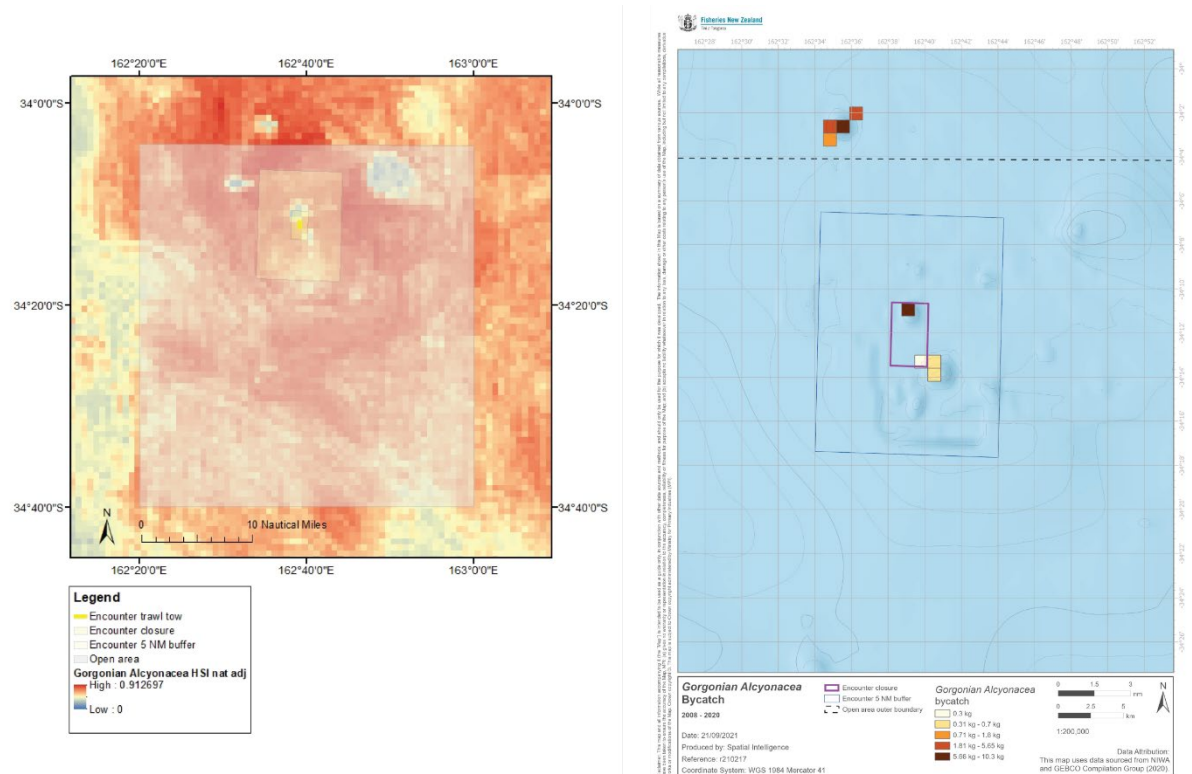

Figure 4: Location of the encounter and historic bycatch of Gorgonian Alcyonacea relative to the **habitat suitability model predictions** for Gorgonian Alcyonacea. Image resolution was reduced to comply with national regulations around commercially sensitive data release.
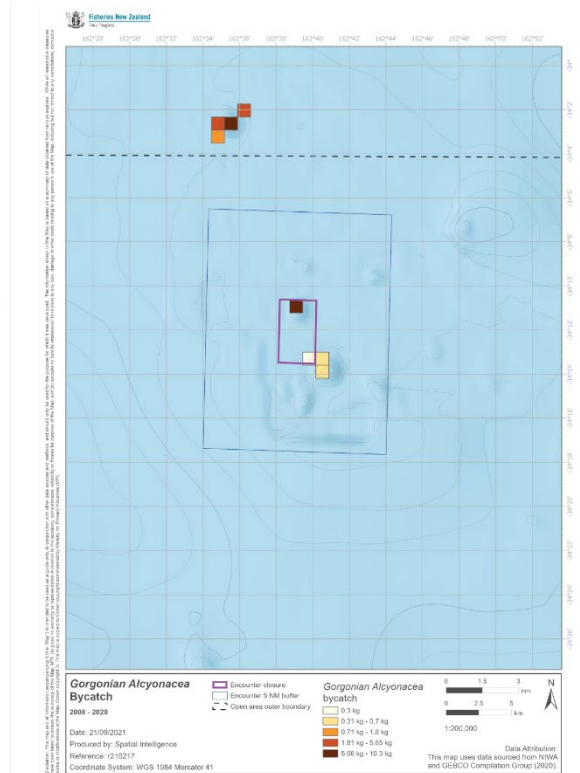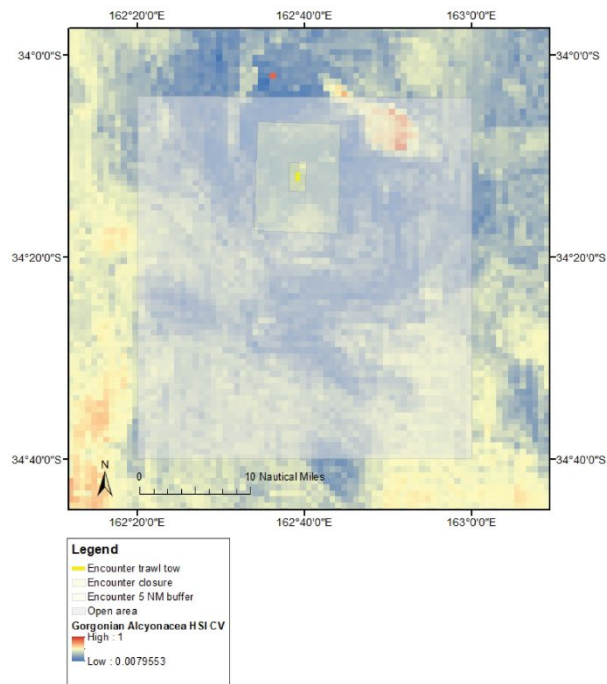
Figure 5: Location of the encounter and historic bycatch trawl tows of Gorgonian Alcyonacea relative to the **uncertainty estimates for habitat suitability model predictions** for Gorgonian Alcyonacea. Image resolution was reduced to comply with national regulations around commercially sensitive data release.

Figure 6: Location of the encounter and historic bycatch of Gorgonian Alcyonacea relative to the **naturalness adjusted** habitat suitability model predictions for Gorgonian Alcyonacea. Image resolution was reduced to comply with national regulations around commercially sensitive data release.

Figure 7: Location of the encounter and historic bycatch trawl tows of Gorgonian Alcyonacea relative to the **naturalness adjusted ROC 0-linear** habitat suitability model predictions for Gorgonian Alcyonacea Image resolution was reduced to comply with national regulations around commercially sensitive data release.
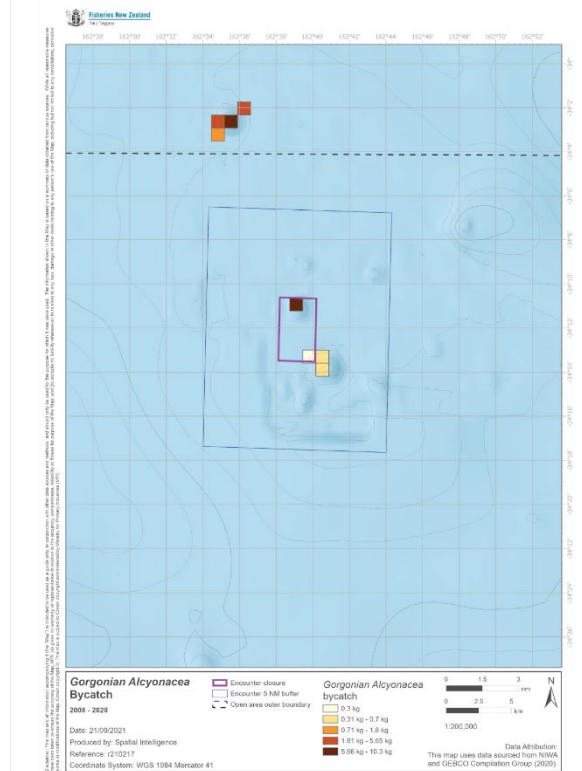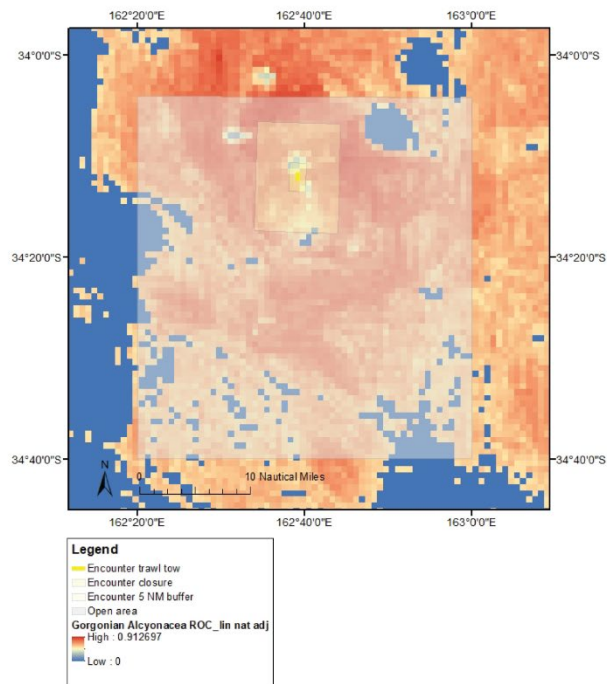
Figure 8: Location of the encounter and historic bycatch trawl tows of Gorgonian Alcyonacea relative to the **naturalness adjusted Power Mean** habitat suitability model predictions for Gorgonian Alcyonacea. Image resolution was reduced to comply with national regulations around commercially sensitive data release.
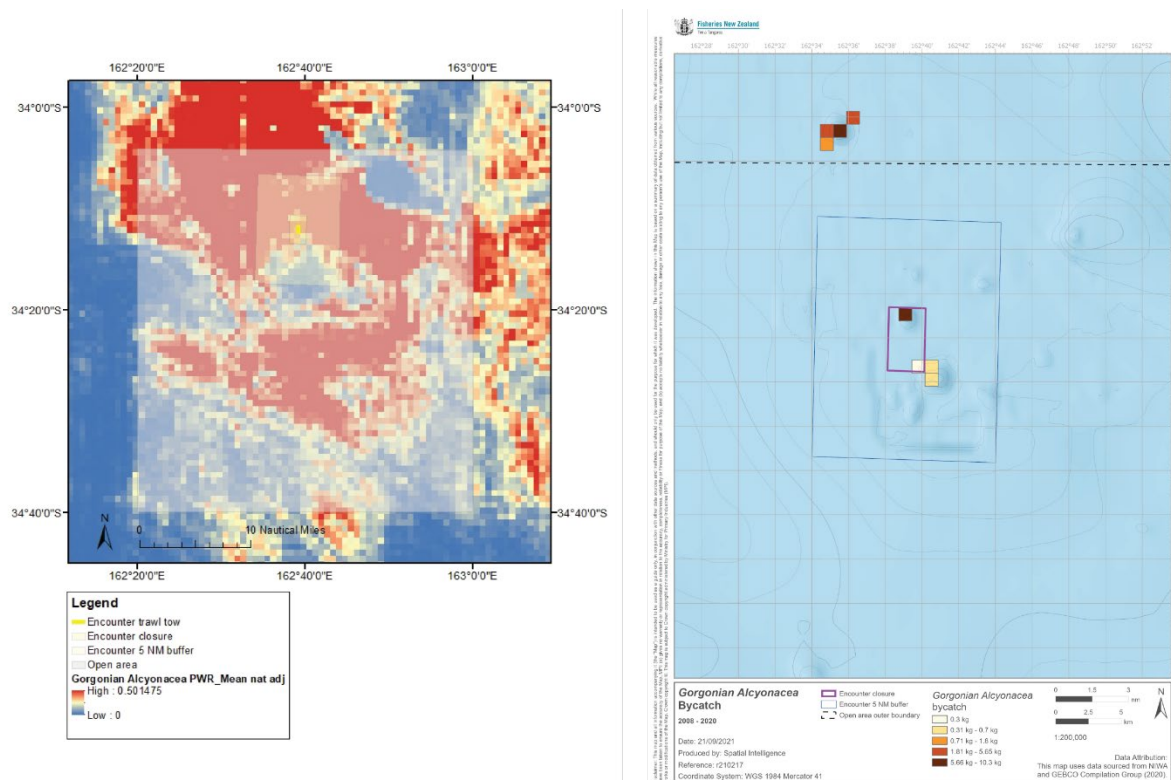
Based on these data, the encounter was deemed consistent with the outputs from the habitat suitability models. That is, the naturalness unadjusted model predicted a high likelihood of presence for the taxon around the encounter, and therefore the encounter record does not represent a false positive for the model. Furthermore, the encounter occurred in an area where model uncertainty was relatively low. The naturalness adjusted models, which were used to design the CMM, predict that the area in the immediate vicinity of the encounter would have a lower current condition for Gorgonian Alcyonacea after the effects of historic trawling have been accounted for, which is consistent with the relatively low bycatch weights recorded for Gorgonian Alcyonacea in tows prior to the encounter.

4. New Zealand assessment of whether the encounter constitutes evidence of a VME

The list of VME indicator taxa included in Annexes 5 and 6 of CMM 03-2020 has previously been assessed against the Food and Agriculture Organisation of the United Nations (FAO) VME criteria, so the triggering of the encounter protocol indicates the potential presence of a VME. However, merely detecting the presence of a VME indicator taxon itself is not sufficient to identify a VME (FAO 2009 Annex), and identification should be made on a case-by-case basis through application of relevant provisions in the International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO 2009), particularly Sections 3.2 and 5.2.

Two complementary approaches are available for determining whether an encounter constitutes evidence of a VME: a direct assessment or an indirect assessment. A direct assessment involves surveying and mapping the encounter area to directly determine the presence and extent of a potential VME. An indirect assessment should be undertaken when there are insufficient resources to complete a direct assessment, or in support of a direct assessment.

New Zealand is unable to fund a direct survey of the encounter area, and a previous scientific survey in the region did not obtain imagery of the seafloor with either a headline camera or towed camera at sampling stations within the encounter area (2003 NORFANZ survey; Clark & Roberts, 2008). Thus, the assessment presented here uses two different indirect sources of data to estimate whether the encounter constitutes evidence of a VME presence: historical bycatch data (as described above); and data from previous research undertaken within the area of the encounter.

Assessment of historic bycatch data

This assessment evaluates the taxa, weight and catch density and frequency of all species at a series of spatial scales to identify consistent spatial and taxonomic patterns that would suggest VME presence. Because VMEs are likely represented by high densities/biomass of VME indicator taxa in discrete areas, data were analysed from sets of spatially concentrated tows (i.e., clusters) as these are most likely to reveal the presence of a VME. For example, coral gardens/reefs (which are considered VMEs, FAO 2009) occur where an indicator taxon is in high densities/biomass, and where coral reefs/coral gardens comprise discrete patches (167 – 6,099 m^2, Bullimore et al. 2013; 625-42,500 m^2, Rowden et al. 2017; 20,000 – 1,160,000 m^2, Williams et al. 2020) that can occur in clusters that extend to larger areas (e.g., 243,000 – 1,222,000 m^2; estimated from Rowden et al. 2017). For each of the clusters the number of trawls and associated weight of benthic bycatch for each of the VME indicator taxa was quantified. In addition to examining data within five clusters of historic bottom trawl tows, as identified in Figure 9 (the encounter occurred within Cluster 3), bycatch data for trawls from within 5 NM of the encounter, and within the encounter area were also examined.

Sixty-four of 1,073 (0.06%) historical bottom trawl tows within the open area reported Gorgonian Alcyonacea as bycatch, of these most had bycatch weights below 1 kg, with two tows within the encounter area reporting bycatch weights between 1 and 5 kg (Figure 4). Overall, Gorgonian Alcyonacea was the VME indicator taxa most frequently reported as bycatch in the open area (Table 2).
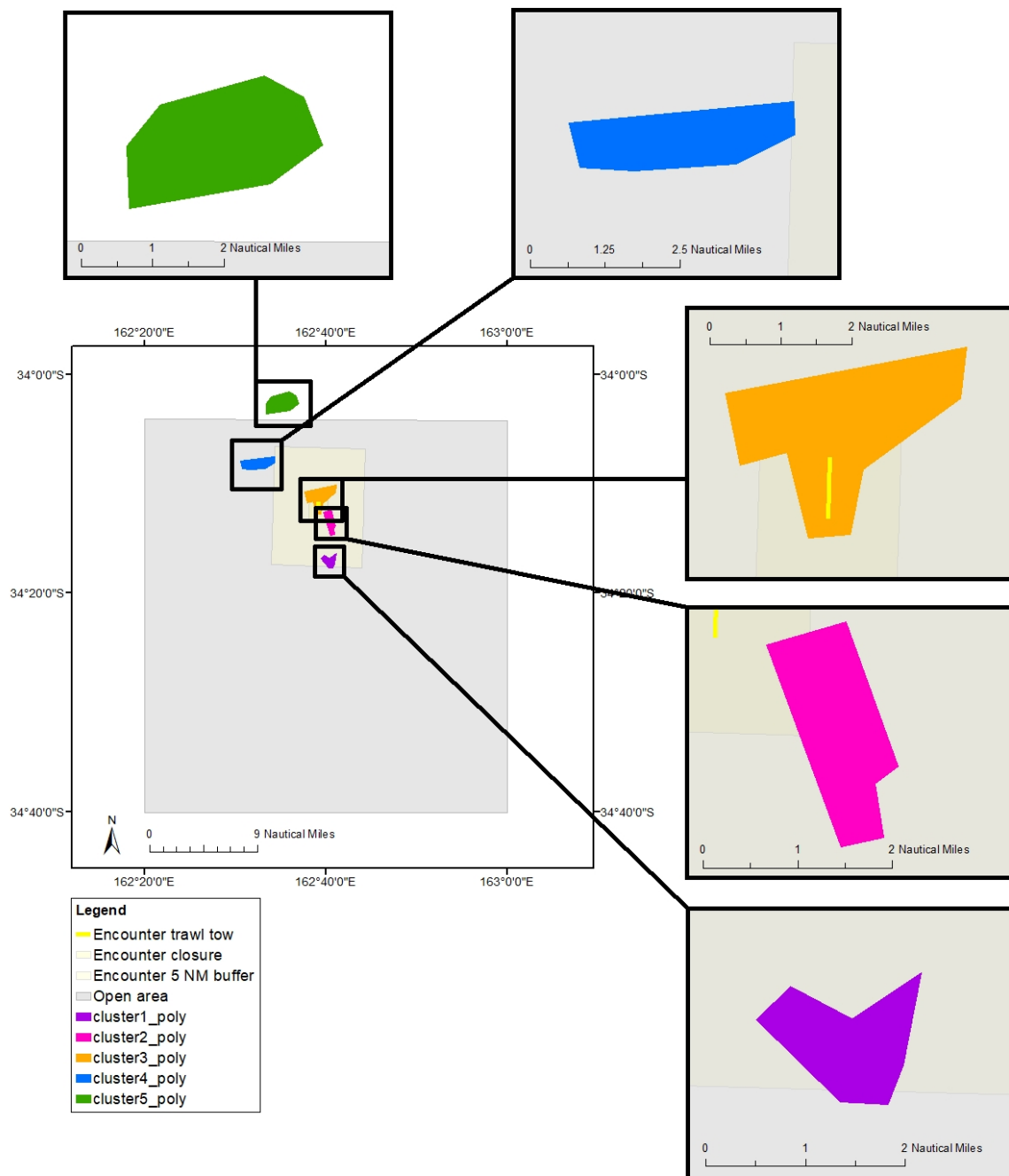
Figure 9. Five historic bottom trawl tow clusters, identified within the open area based on their spatial distribution, highlighting the previous trawl tows (two shades of blue) and the encounter tow (yellow) with Gorgonian Alcyonacea. Image resolution was reduced to comply with national regulations around commercially sensitive data release.

Table 3 details the historical bycatch records (n) and cumulative bycatch weight (kg), excluding the encounter trawl tow. Within the trawl tow cluster of the encounter (Cluster 3), Gorgonian Alcyonacea was the most abundant bycatch taxon, but the cumulative weight of all historical bycatch for this taxon

did not exceed the encounter threshold of 15 kg and was barely above 10 kg. Accounting for fishing effort within the clusters, 5% of tows in Cluster 3 caught Gorgonian Alcyonacea, which was marginally higher than clusters 1 and 2 (around 2.5% of tows caught Gorgonian Alcyonacea), similar to Cluster 4 (where 8% of tows caught Gorgonian Alcyonacea) but less than Cluster 5 (where 25% of tows caught Gorgonian Alcyonacea). Besides being more frequent, historical bycatch of Gorgonian Alcyonacea was also higher in Cluster 5, but the area where this cluster occurs was closed to fishing when CMM 03-2019 came into force.

These results indicate that bycatch of Gorgonian Alcyonacea has historically been frequent, but at very low bycatch weights (less than 1 kg on average) at the spatial scale of the encounter area, the 5 NM around the encounter tow (Table 2) and the cluster of historical tows within which the encounter occurred (Table 3). A similar pattern in historical bycatch of Gorgonian Alcyonacea (i.e., relatively frequent but at very low weights) was evident across the historic trawl footprint within the open area.

Except for Cluster 5 (which is now closed to bottom trawling), the analysis of historical bycatch within bottom trawling clusters provided no evidence of consistently high bycatch weights of Gorgonian Alcyonacea at the cluster scale. As noted previously, multiple tows with high bycatch weights of Gorgonian Alcyonacea would be expected in the cluster if a VME was present at spatial scales larger than a single trawl tow.

Recognizing that the presence of several VME indicator taxa in a single tow may indicate that the tow has encountered an area with a diverse seabed fauna, potentially constituting evidence of a VME (e.g., other coral VME indicator taxa and sponges are often found in relatively high numbers within a VME formed by corals; Bullimore et al. 2013), we also assessed the number of VME taxa per tow within Cluster 3. Of the 362 tows within Cluster 3, 26 (7%) and 7 (2%) reported 1 and 2 VME indicator taxa as bycatch, respectively (Figure 10). No tows reported more than two VME indicator taxa as bycatch, and across all 362 tows in the Cluster a total of seven different VME indicator taxa (as defined in CMM03-2020) were reported as bycatch[3]. Historical bycatch data also indicated that where other taxa are retained as bycatch with Gorgonian Alcyonacea their bycatch weights are low (see also Appendix 1). Annexes 1 to 8 report spatial distribution of tows with recorded bycatch for other VME indicator taxa, where this could be released, and suggests low spatial overlap of Gorgonian Alcyonacea bycatch with high bycatch densities of other taxa in the encounter area. Such an assessment broadens the evaluation of the encounter beyond the VME indicator taxon that triggered the move-on rule to include additional VME indicator taxa within the encounter area and provides for the application of an ecosystem approach to fisheries management.

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[3] Noting that most bycatch is reported at the taxonomic level of Order or higher
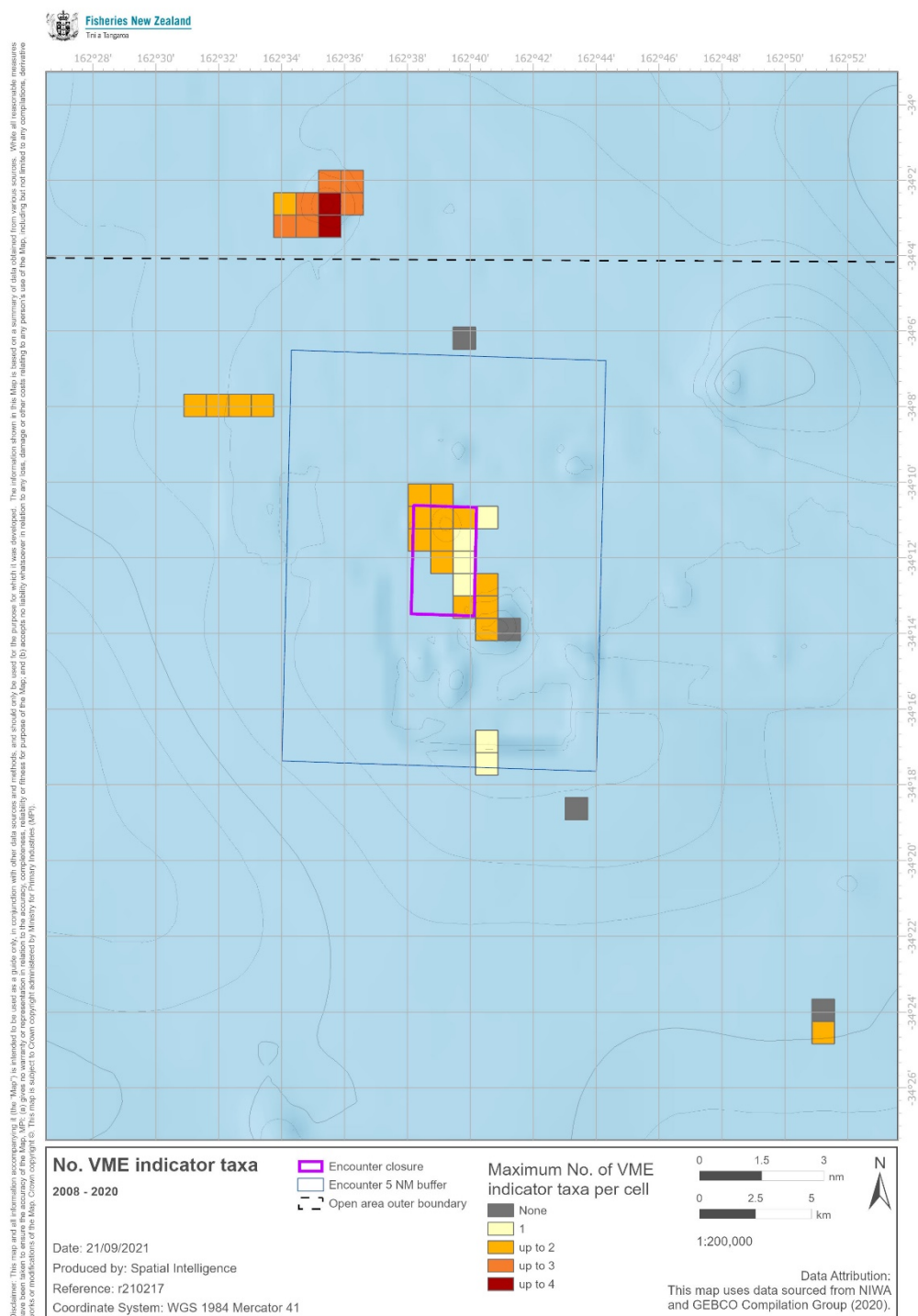
Figure 10. Spatial representation of the encounter trawl tow (yellow) and the number of VME indicator taxa reported as bycatch per trawl tow. Image resolution was reduced to comply with national regulations around commercially sensitive data release.

Table 3. Summary of the number of historical bycatch catches (n), percent of tows containing bycatch (%), range in bycatch weight (r) and bycatch weight (kg) of VME indicator taxa according to CMM 03-2020 (in italics) and other benthic bycatch within 5 clusters of historical trawl tows, as presented in Figure 9. See Figure 4 and Appendix 1-7 for the spatial distribution of taxon-specific bycatch. Taxa with zero historical bycatch have been omitted.

Taxon	Cluster 1				Cluster 2				Cluster 3				Cluster 4				Cluster 5			
	n	%	r	kg	n	%	r	kg	n	%	r	kg	n	%	r	kg	n	%	r	kg
Porifera (Sponges)[1]	2	1.3%	0.9-1.0	1.9	5	1.9%	0.2-0.5	8.0	6	1.7%	0.1-2.2	3.0	4	3.0%	0.2-4.3	6.4	3	2.1%	0.5	1.5
Gorgonian Alcyonacea (Sea fans, sea whips, bottlebrush)[2]	4	2.5%	0.0-0.2	0.3	7	2.6%	0.1	0.7	17	4.7%	0.01-2.7	10.3	12	8.9%	0.01-1.0	4.1	36	25.5%	0.1-1.5	12.5
Scleractinia (Stony corals)[3]	0	0.0%	NA	0.0	1	0.4%	0.1	0.1	1	0.3%	0.1	0.1	3	2.2%	0.1-1.7	2.1	1	0.7%	0.2	0.2
Antipatharia (Black corals)	1	0.6%	0.0	0.0	8	3.0%	0.01-1.0	2.5	16	4.4%	0.0-1.0	4.6	7	5.2%	0.0-1.0	2.2	26	18.4%	0.1-0.6	5.9
Actiniaria (Anemones)	3	1.9%	0.1-3.0	3.9	6	2.2%	0.1-3.0	3.9	4	1.1%	0.0-0.3	0.6	4	3.0%	0.02-4.0	4.3	7	5.0%	0.1-1.8	1.8
Pennatulacea (Sea pens)	0	0.0%	NA	0.0	0	0.0%	NA	0.0	1	0.3%	0.1	0.1	0	0.0%	NA	0.0	2	1.4%	0.1	0.2
Crinoidea (Sea lillies)	0	0.0%	NA	0.0	0	0.0%	NA	0.0	1	0.3%	0.1	0.1	0	0.0%	NA	0.0	19	13.5%	0.1-0.5	2.7
Echonoidea (Sea urchins)	2	1.3%	1.0	2.0	0	0.0%	NA	0.0	2	0.6%	1.0	2.0	3	2.2%	0.0-2.0	2.1	3	2.1%	0.3-0.5	1.3
Hexanauplia (Barnacles)	0	0.0%	NA	0.0	0	0.0%	NA	0.0	0	0.0%	NA	0.0	1	0.7%	0.1	0.1	0	0.0%	NA	0.0
Ophiuroidea (Brittle stars)	1	0.6%	1.0	1.0	0	0.0%	NA	0.0	2	0.6%	0.1-1.0	1.1	0	0.0%	NA	0.0	7	5.0%	0.1-1.0	3.0
Pycnogonida (Sea spiders)	0	0.0%	NA	0.0	0	0.0%	NA	0.0	1	0.3%	1.0	1.0	0	0.0%	NA	0.0	0	0.0%	NA	0.0

Bullimore et al. (2013) note that one possible criterion to use to detect a coral garden (i.e., a VME) is where the density of the dominant coral is 10 times greater than background densities. Without, conducting a detailed analysis that would be required to determine what trawl tows could be used to provide reliable background data, the weight of Gorgonian Alcyonacea in the encounter tow is >10 times greater than the majority of the other bycatch weights for this taxon, which are typically less than 1 kg. This criterion is implicit in the design of the threshold itself, which is intended to trigger encounter protocols when bycatch weights are high relative to the range of historical bycatch weights, suggesting that the encounter could represent a VME at the scale of the trawl tow. Therefore, a further investigation was conducted evaluating the encounter at the spatial scale of the trawl tow. This analysis was based on the information in Bullimore et al. (2013), who describe the characteristics of coral gardens (i.e., VMEs), including those where gorgonian corals are the dominant taxa, and indicate that patch size can be up to ~6000 m^2.

Figure 11 details the spatial distribution of trawl tows around the encounter tow, with a buffer of 78 m applied around the encounter tow, representing the diameter of a theoretical coral garden of ~6000 m^2 (the approximate size of the largest coral garden recorded by Bullimore et al. 2013). This figure highlights that none of the other trawl tows near or crossing the encounter tow and the buffer had high weights of Gorgonian Alcyonacea (maximum bycatch weight was 1 kg). This finding, and the fine-scale spatial distribution of these tows, suggests that the encounter tow contacted a single high-density area of Gorgonian Alcyonacea that is likely constrained to the southern portion of the tow, and is estimated to be within the patch area range reported by Bullimore et al. (2013). However, it is possible that other high-density areas of Gorgonian Alcyonacea could occur where no trawling has taken place to date.

[image withheld to comply with national regulations around commercially sensitive data release]

Figure 11. Fine-scale representation of trawl tows (straight lines) with trawl tows with Gorgonian Alcyonacea (in blue) around the encounter trawl tow (yellow line). The pale red box around the encounter trawl tow is a buffer that represents the expected lateral extent of a coral garden VME (i.e., 78 m) which is extended the full length of the tow. The red ellipse indicates the approximate position and extent of a VME patch contacted in the encounter, as constrained by the location of the trawl tows with no or low catch weights of Gorgonian Alcyonacea.

The data used in the above analysis are for weights of bycatch caught in a trawl tow. Although the recent catchability analyses presented in the BFIA (SC8-DW07_Rev1) represent the best available estimates of catchability for VME indicator taxa within the SPRFMO Convention Area, these estimates should be interpreted with caution for a number of reasons, including differences between the types of fishing gear incorporated in these analyses and bottom trawling gear used within the SPRFMO Commission Area, spatial mismatches between data from benthic surveys and bycatch from benthic trawls, and high uncertainty in the estimates of seafloor biomass. Consequently, inferences from those analyses are limited as gear-specific, taxon-specific and ideally location-specific estimates of catchability are required if catchability is to be incorporated into the encounter review, and these were not available for the area where the encounter occurred. Thus, the raw bycatch weights were used for the analysis in this encounter review.

Assessment of other benthic research data

Historical research data from within the open area were compiled by combining the existing data for the ten taxa modelled for the BFIA (SC8-DW07_Rev1)[4], (*Solenosimilia variabilis, Medrepora oculata, Goniocorella dumosa, Enallopsammia rostrata*, Antipatharia, Alcyonacea (gorgonians), Stylasteridae, Demospongiae, Hexactinellida and Pennatulacea) with new data extracts from *niwainvert* (research records over the period 1905–2021) and the international OBIS database (records from open-access global data on marine biodiversity over the period 1924–2020)[5]. Because data used in the above analysis from the New Zealand centralised observer database are included in this data compilation, these data were then removed before subsequent analysis. From this dataset, 84 benthic taxa records from 18 benthic sampling stations were identified from within or adjacent to the open area. For samples containing VME indicator taxa as bycatch, individual VME indicator species were aggregated into higher-order VME indicator taxa identified in CMM03-2020 using taxonomic designations from the World Register of Marine Species (WoRMS Editorial Board 2021). Other benthic bycatch within tows was aggregated into higher taxonomic designations to ensure consistency in the reporting of taxonomic detail. Details of the presence of all benthic invertebrate species, including VME indicator taxa are provided in Table 4 and Figure 12. Note that these data included counts of benthic taxa only and do not include biomass (weight data).

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[4] The SPRFMO VME dataset used in the BFIA included up-to-date data from trawl, cod, NIWAinvert, and Australian datasets and databases.

[5] *NIWAinvert* is a NIWA database that contains biodiversity records, mainly those associated with the NIWA Invertebrate Collection; OBIS is a global open-access data and information clearing-house on marine biodiversity

Six research trawl tows from the 2003 NORFANZ survey (TAN0308/082, 083, 086, 087, 088, 089) and a single sample from an observer trip on a fishing vessel in 1998 (Trip 1152/48) were near or crossed the encounter tow. Data from these research samples reported between zero and nine Gorgonian Alcyonacea individuals per sample (Table 4). Using a conversion factor for Gorgonians presented in Rowden et al. (2010; Table 2, 93.63 grams wet weight per individual 'live' colony) to convert count data to biomass, results in estimates of between 0 and 0.843 kg of Gorgonian Alcyonacea per research sample within the area of the encounter tow. Given these weight estimates, none of these independent benthic data indicate the presence of a VME formed by Gorgonian Alcyonacea in or near the encounter area.

Recognizing that the presence of several VME indicator taxa in a single tow may indicate that the sample has encountered an area with a diverse seabed fauna, potentially constituting evidence of a VME, we also assessed the number of VME taxa per research sample (see also above analysis of historical bycatch data from *cod*). As for historical bycatch data, such an assessment broadens the evaluation of the encounter beyond the VME indicator taxon that triggered the move-on rule to include additional VME indicator taxa of the wider marine ecosystem within the area of the encounter trawl tows and provides for the application of an ecosystem approach to fisheries management. For the six research trawl tows and the single fishing event that were near or crossed the encounter tow, the number of VME indicator taxa per sample ranged between 1 and 5. As a reference, this evidence suggests that bycatch would not exceed the thresholds set out in CMM 03-2021, Annex 6B.
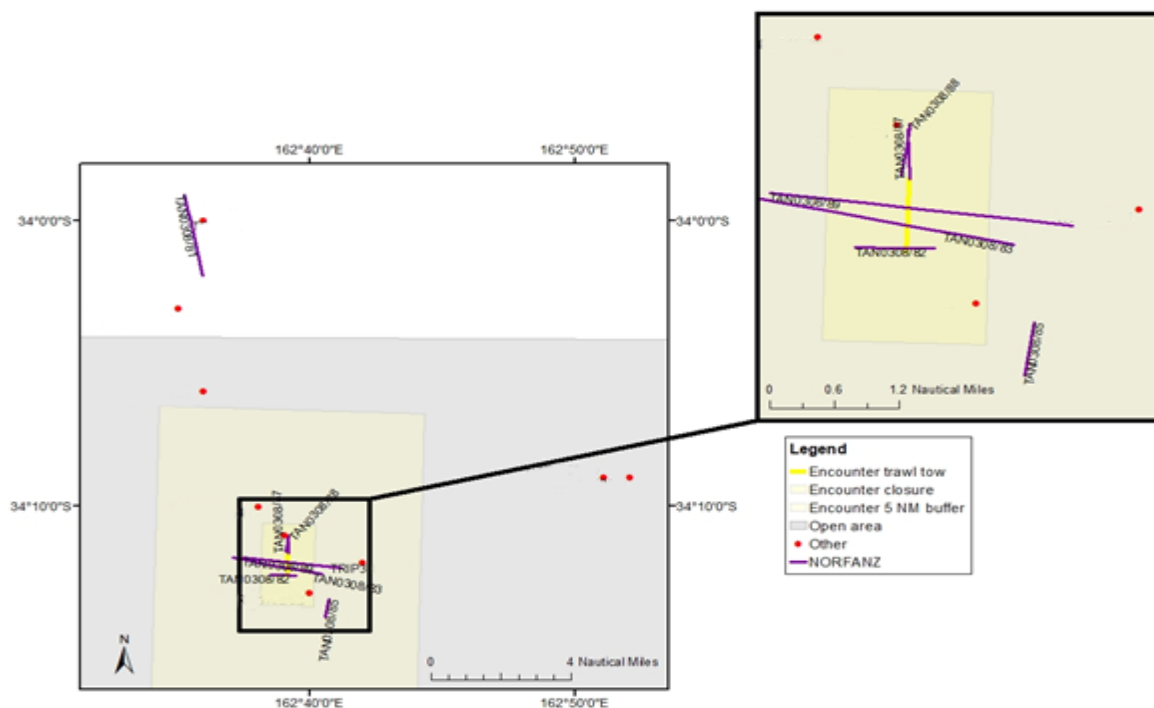
Figure 12. The location of research trawl tows from NORFANZ data and other benthic data from the *niwainvert* database included within Table 4.

Table 4. Summary of the number of benthic invertebrates recorded from sampling locations shown in Figure 12 for VME indicator taxa according to CMM 03-2020 and other benthic bycatch. Taxa with zero historical bycatch have been omitted. Gear type: 10 = Orange Roughy trawl; 11 = Wing trawl; 13 = Beam trawl; 21 = Sherman sled; BT = bottom fish trawl.

Station	TAN0308/81	TAN0308/82	TAN0308/83	TAN0308/85	TAN0308/86	TAN0308/87	TAN0308/88	TAN0308/89	TRIP3883/55	TRIP4823/44	TRIP4823/63	TRIP 1152/29	TRIP 1152/45	TRIP 1152/48	TRIP 1152/49	TRIP 1152/30	TRIP 1152/29	TRIP 1152/52
Gear type	11	13	10	21	21	10	10	11	BT	BT	BT	BT	BT	BT	BT	BT	BT	BT
VME indicator taxa																		
Porifera (Sponges)	4	26	3	1	0	0	0	0	0	0	0	4	0	0	0	0	1	0
Gorgonian Alcyonacea (Sea fans, sea whips, bottlebrush)	0	2	1	0	2	0	1	9	0	0	0	0	1	1	1	0	0	0
Scleractinia (Stony corals)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antipatharia (Black corals)	1	2	0	0	2	0	0	6	0	0	0	0	0	0	0	0	0	0
Actiniaria (Anemones)	34	14	0	0	1	1	0	11	0	0	0	0	0	0	0	0	0	0
Pennatulacea (Sea pens)	4	5	1	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
Zoantharia (Hexacorals)	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stylasteridae (Hydrocorals)	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Crinoidea (Sea lilies)	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0
Bryozoa (Bryozoans)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Total no. VME taxa	4	6	4	1	4	1	1	5	1	1	1	1	1	1	1	1	1	1
Other benthic bycatch																		
Echinoidea (Sea urchins)	0	9	0	65	1	9	1	7	0	0	0	0	0	0	0	0	0	0
Holothuroidea (Sea cucumbers)	8	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0
Ophiuroidea (Brittle stars)	1	23	0	19	4	0	0	4	0	0	0	0	0	0	0	0	0	0
Scleractinia – non VME indicator taxa	2	61	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	2
Polychaeta (Bristle worms)	1	16	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0
Total no. other benthic bycatch taxa	4	4	0	4	4	1	1	5	0	0	0	0	0	0	0	0	0	1

Overall summary of evidence of encounter constituting presence of a VME

The evidence compiled so far suggests that the encounter derived from contacting an area with a high density of Gorgonian Alcyonacea, with an estimated extent smaller than the spatial scale of the encounter trawl tow (see Figure 11). Evidence suggests that this area was likely to constitute a VME. However, there was no evidence that suggested that other areas with high density of Gorgonian Alcyonacea (or combinations of other VME indicator taxa) were present within the historic trawl footprint in the proximity of the encounter, or at larger spatial scales within the historic trawl footprint. Therefore, based on this analysis of the encounter and the historical bycatch, the encounter was deemed to constitute evidence of the presence of a VME at the trawl tow scale, but not at the scale of the encounter area, at 5 NM, or of the trawl tow cluster.

5. New Zealand assessment of the scale and significance of historical and likely future fishing impacts

The scale and significance of historical and likely future fishing impacts was assessed by considering the six factors outlined in paragraph 18 of the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas for assessing SAIs to VMEs (FAO 2009).

18 i. The intensity or severity of the impact at the specific site being affected; At the open area scale, the trawl tow Cluster scale, the 5 NM scale, and at the encounter area scale the cumulative historical trawling impacts were considered unlikely to have caused SAIs. However, the impact was considered significant at the scale of the individual encounter trawl tow, likely leading to the complete loss of the VME patch contacted by the trawl. Therefore, the intensity and severity of the impact is very spatially confined. It is worth noting that this level of impact at a trawl tow scale (likely sub-trawl scale) is not unexpected, as encounter thresholds are designed to trigger encounter protocols when bycatch weights are at the higher end of the known bycatch weight range (97% of the cumulative distribution of historical bycatch weights of Gorgonian Alcyonacea – SC9-DW10 Table 3) but accordingly should happen only rarely.

18 ii. The spatial extent of the impact relative to the availability of the habitat type affected; According to the most conservative metric of habitat suitability (Power Mean adjusted for naturalness) the current CMM protects 84.95% of the suitable habitat for Gorgonian Alcyonacea outside of the open areas within the North Lord Howe Rise FMA. By the same metric, the encounter area constitutes only 0.08% of the suitable habitat for Gorgonian Alcyonacea. Similarly, all other VME indicator taxa recorded from within the vicinity of the encounter have more than 85% of suitable habitat within the North Lorde Hose Rise FMA that is protected by the current spatial management measures (CMM03-2021, see SC8-DW07_Rev1). Therefore, the spatial extent of the encounter impact relative to the availability of the VME indicator taxa habitat affected is very small.

18 iii. The sensitivity/vulnerability of the ecosystem to the impact; The VME indicator taxa included in Annex 5 of CMM03-2020 have all previously all been evaluated against the FAO criteria for identifying vulnerable marine ecosystems and classified as vulnerable to the impacts of bottom fishing gear due to either their sensitivity to impacts, their life history traits (e.g., slow growth, late maturity, unpredictable recruitment or longevity), functional significance, and structural complexity (SC7-DW09, SC8-DW11). However, while the sensitivity and vulnerability of Gorgonian Alcyonacea to impact from bottom trawling is clearly established, the risk of a SAI occurring to a marine ecosystem is determined not only by vulnerability, but also by the probability of a threat occurring and mitigation means applied to the threat (paragraph 16, FAO 2009). Under the latter two conditions, and using the findings from the assessment of the above criteria (with regard to the extent of the threat and the mitigation measures already in place), the risk of a SAI to the VME would appear to be low at spatial scales larger than the encounter tow.

18 iv. The ability of an ecosystem to recover from harm, and the rate of such recovery; Given that there exists populations of gorgonian corals in the vicinity of the encounter tow, and what is currently known about the dispersal/connectivity of such corals (basin scale, with some evidence of depth stratification; see e.g., Baco & Shank 2005, Baco et al. 2006, Herrera et al. 2012, Quattrini et al. 2013, Duenas et al. 2016), it is possible for the impacted VME to recover from the harm caused to it if fishing on that specific area is not continued. However, the recovery of this patch of VME will likely take decades to hundreds of years (assuming recovery includes individual gorgonians of ages estimated for individual colonies from South Pacific Ocean; Thresher et al. 2004, Noe & Dullo 2006, Tracey et al. 2007, Noe et al. 2008).

18 v. The extent to which ecosystem functions may be altered by the impact; At the scale of the encounter it would be reasonable to assume that the trawl tow has altered the ecosystem functions that derive from the habitat provided by gorgonian corals. For example, apparently obligate habitat associations have been observed between anemones and zoanthids and gorgonian bamboo corals (Ocaña et al. 2004, Sinniger et al. 2013). Given the assessments against other criteria above, the extent of this alteration is minimal compared to the unaltered functions presumably provided by gorgonians that are predicted to occur in suitable habitat elsewhere in protected parts of the FMA.

18 vi. the timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life-history stages; In addition to the apparent obligate associations between gorgonian corals noted above, there is some limited evidence that these corals may provide habitat for other species during one or more of their life-history stages. For example, some fish species have an association with gorgonian habitat in the deep sea of the NW Atlantic Ocean (Edinger et al. 2007). Although these associations could be coincident, it could be hypothesised that this habitat may be important to fish and crustaceans at different life-history stages.

Overall assessment of the scale and significance of historical and future impacts

The precautionary approach as outlined in Article 3 of the Convention prescribes *inter alia* to (i) be more cautious when information is uncertain, unreliable, or inadequate; (ii) not use the absence of adequate scientific information as a reason for postponing or failing to take conservation and

management measures; and (iii) take account of best international practices regarding the application of the precautionary approach, including Annex II of the 1995 Agreement and the Code of Conduct.

To give effect to the precautionary approach, the risk of future SAIs was evaluated at a range of different spatial scales with varying levels of scientific information to inform the assessment, ranging from habitat suitability models at the spatial scale of the FMA to historic bycatch and research data at the spatial scale of the open area and encounter. Given the fairly high amount of information from historical tows and research samples around the encounter trawl tow with no or low bycatch weights of Gorgonian Alcyonacea and no or low numbers of VME indicator taxa, there is little evidence of other areas with high density of Gorgonian Alcyonacea (or combinations of other VME indicator taxa) being present in the immediate proximity of the encounter trawl tow. However, there are substantial areas around the encounter for which is no benthic data is available. On that basis, and taking a precautionary approach, the risk of future SAIs occurring at fine spatial scales was estimated to be moderate. Using the best available scientific information, and accounting for the uncertainty in these data, the risk of the future encounters representing a SAI to a VME was deemed to be very low at the FMA scale.

Given the small scale of historical impacts at most spatial scales, applying the ecosystems approach and the precautionary principle, and taking into account the assessments against the FAO's scale and significance criteria above, there is little evidence that resuming fishing would result in SAIs to VMEs at the spatial scale of their distribution within the North Lord Howe FMA.

6. Conclusions and management advice

Based on the modelled presence/abundance in the cells contacted by the encounter trawl tow, the encounter was considered consistent with the habitat suitability models for Gorgonian Alcyonacea. This finding supports the usefulness of the habitat suitability models for the design of the spatial management measures and does not suggest the need for any modification of the current CMM boundaries arising from this encounter. However, note the ongoing work on the development of spatial management scenarios for bottom trawling (SC9-DW06).

Without the possibility of conducting a direct assessment, the analysis of historical bycatch at different spatial scales around the encounter trawl tow was deemed to be the strongest line of evidence to indirectly investigate the presence of a potential VME. Historical bycatch indicated an overall low density of Gorgonian Alcyonacea and other VME indicator taxa in the encounter area and surrounding areas. Additional data from research surveys supported these conclusions. However, the encounter bycatch weight of Gorgonian Alcyonacea was relatively high compared to those of other trawl tows and coupled with a fine-scale analysis of the distribution of tows around the encounter tow, this suggests that the encounter trawl contacted a VME patch. The main conclusion that can be drawn from this evidence is that while the encounter does constitute evidence of the presence of a VME, there is little evidence from available data for VME presence elsewhere within the encounter area and at larger spatial scales within the open area.

Overall, there was a fairly high amount of scientific information available to conduct an indirect assessment. Historical bycatch was considered to be the strongest evidence that could be used to

estimate the scale and potential significance of historical impacts from bottom trawling given the large amount of data available. Infrequent bycatch, with small catch weights, suggests that the potential significance of historical cumulative impacts was low. Based on available data, the likelihood of future SAIs at the scale of the FMA was estimated to be low if fishing was resumed within the encounter area.

It is relevant to note in this encounter review that different spatial management options have been evaluated recently to ensure avoiding significant adverse impacts to VMEs. This evaluation was performed within the analysis of spatial boundaries for open areas presented in paper SC9-DW06 (Development of spatial management scenarios for bottom trawling). The location of the encounter area has been investigated in relation to draft boundaries developed for the protection of 90% and 95% of all VME indicator taxa, respectively (Annex 9). In both scenarios, the encounter area was retained within the open area as of high value to fisheries and non-essential to achieve the most restrictive protection targets (90% and 95% of the distribution of suitable habitat for Gorgonian Alcyonacea). However, it is important to note that these draft boundaries are still subject to refinement as the spatial scenarios are further developed leading to the next Commission meeting.

Based on the information above, combining the different lines of evidence and considering different management options as well as the precautionary principle regarding the amount of scientific information available, New Zealand's recommendation is that reopening the area to bottom trawling is unlikely to cause SAI to VMEs at the FMA scale. While it cannot be completely excluded that reopening the area to trawling could result in encounters with other VMEs at the sub-tow spatial scale, this risk is considered to be low.

7. Recommendations

It is recommended that the Scientific Committee:

- **Notes** that New Zealand provided a Member review of its encounter, including details of the encounter and its consistency with habitat suitability models, and an evaluation of impacts and management actions to prevent significant adverse impacts on vulnerable marine ecosystems;
- **Notes** that, given the small scale of historical impacts and the assessment of a low likelihood of VME presence based on available data, New Zealand recommended that reopening the area to fishing was unlikely to cause further SAIs to VMEs at the FMA spatial scale;
- **Considers** this Member review to develop its advice to Commission on management actions to prevent significant adverse impacts on vulnerable marine ecosystems.

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Annex 1 Porifera historic bycatch

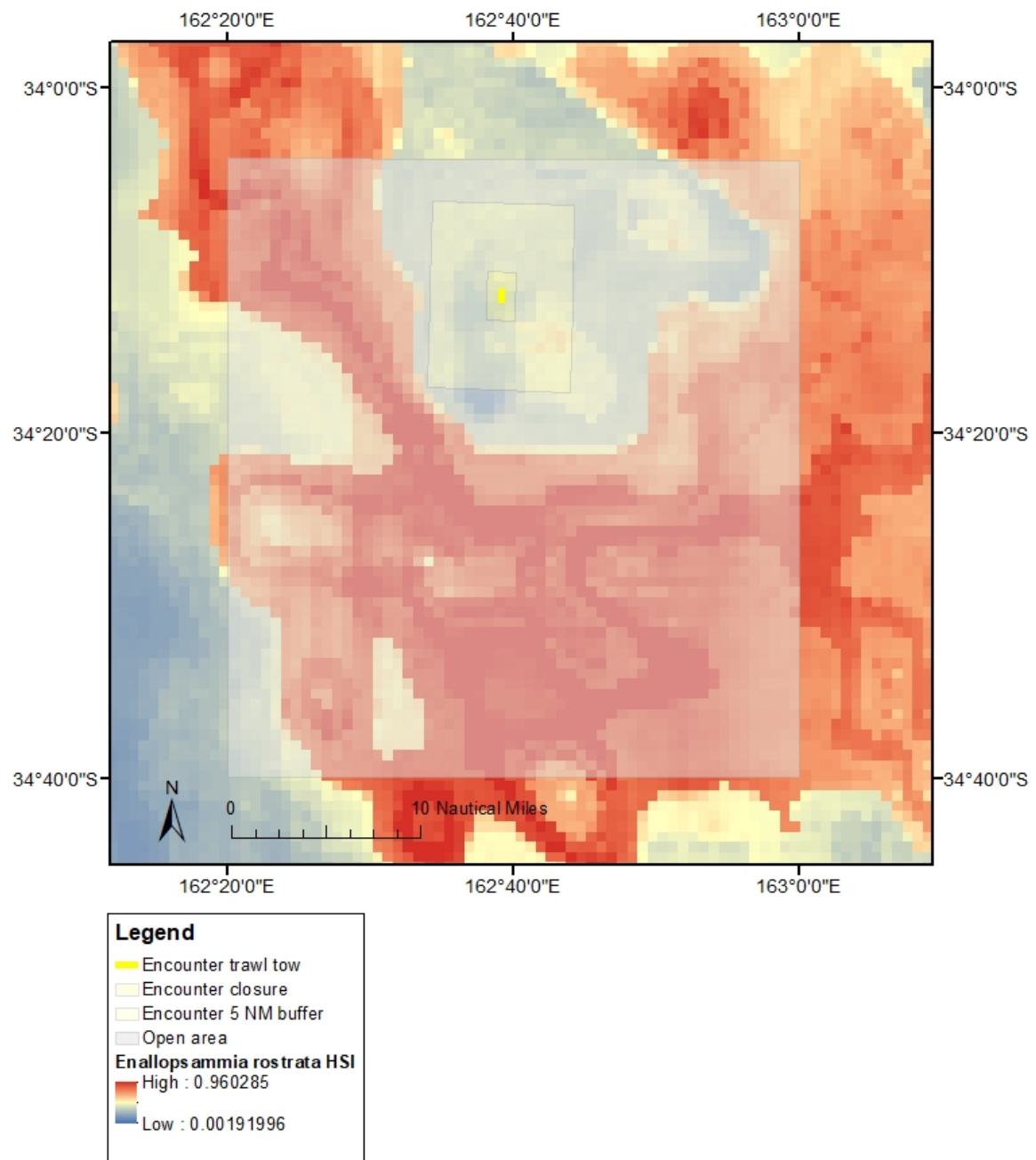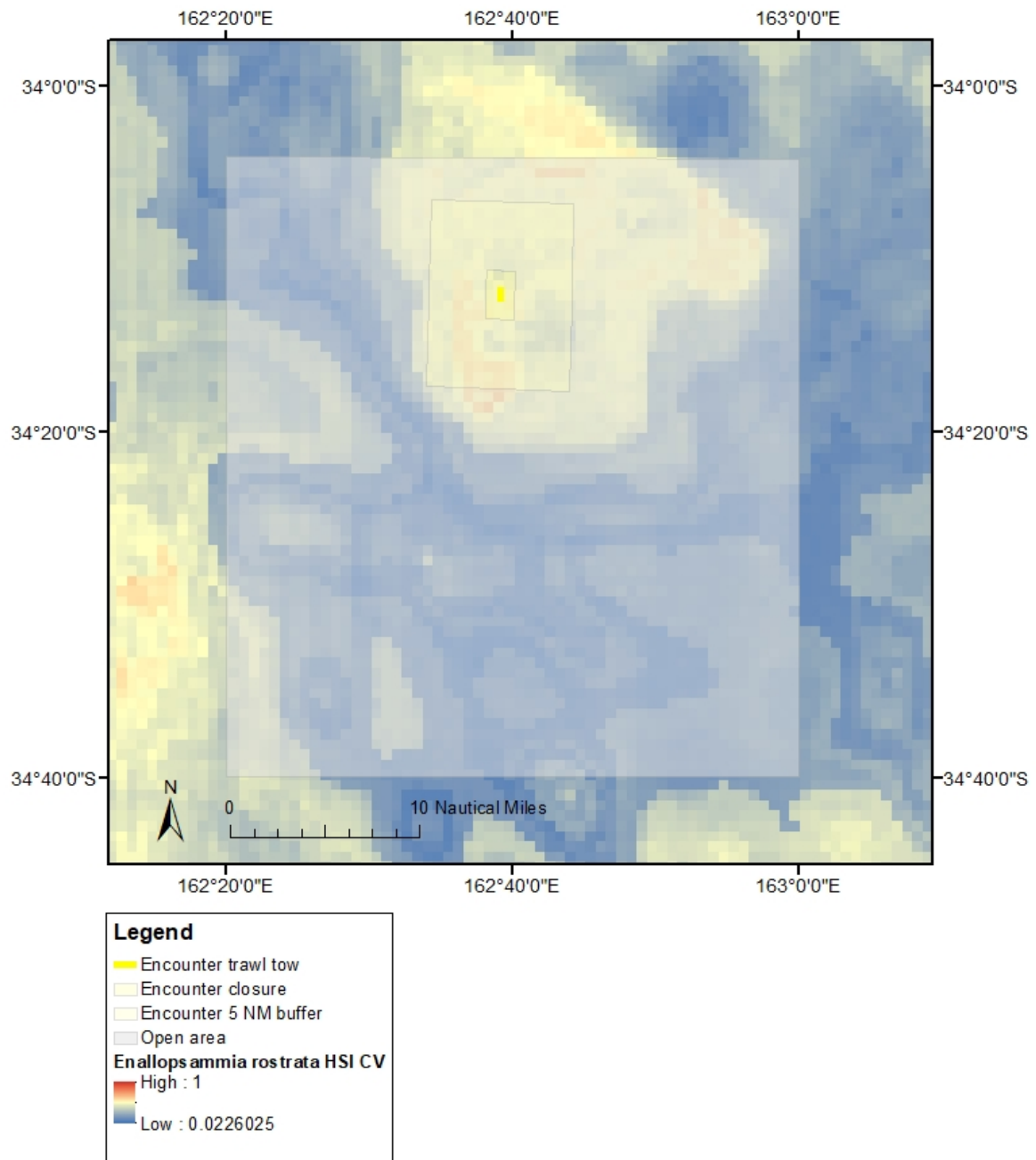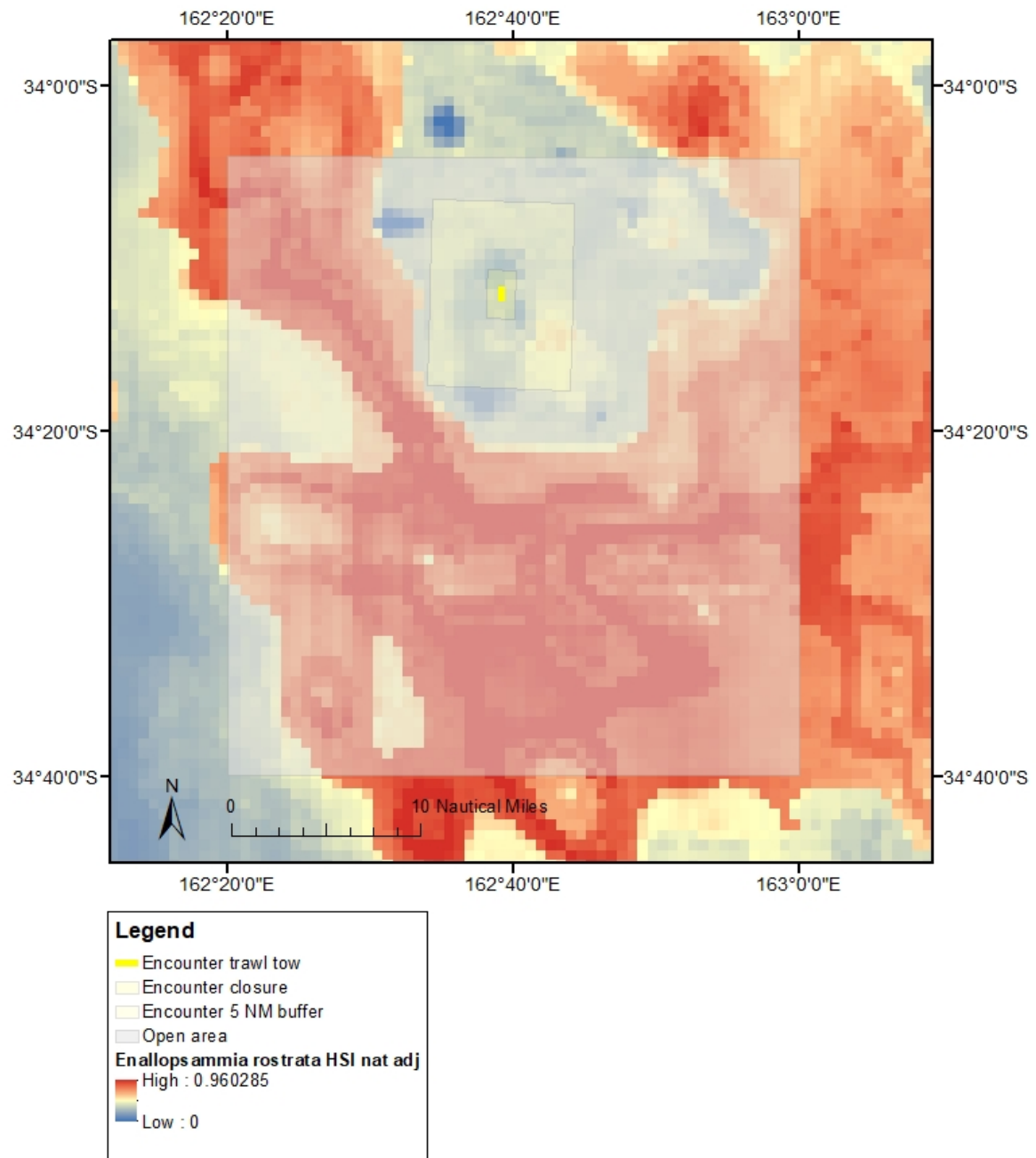[image withheld to comply with national regulations around commercially sensitive data release]

Figure A1.1. Spatial distribution of historical bycatch of **Porifera** (that have only been identified to the taxonomic level of Phyllum) within and adjacent to the open areas within which the encounter occurred.
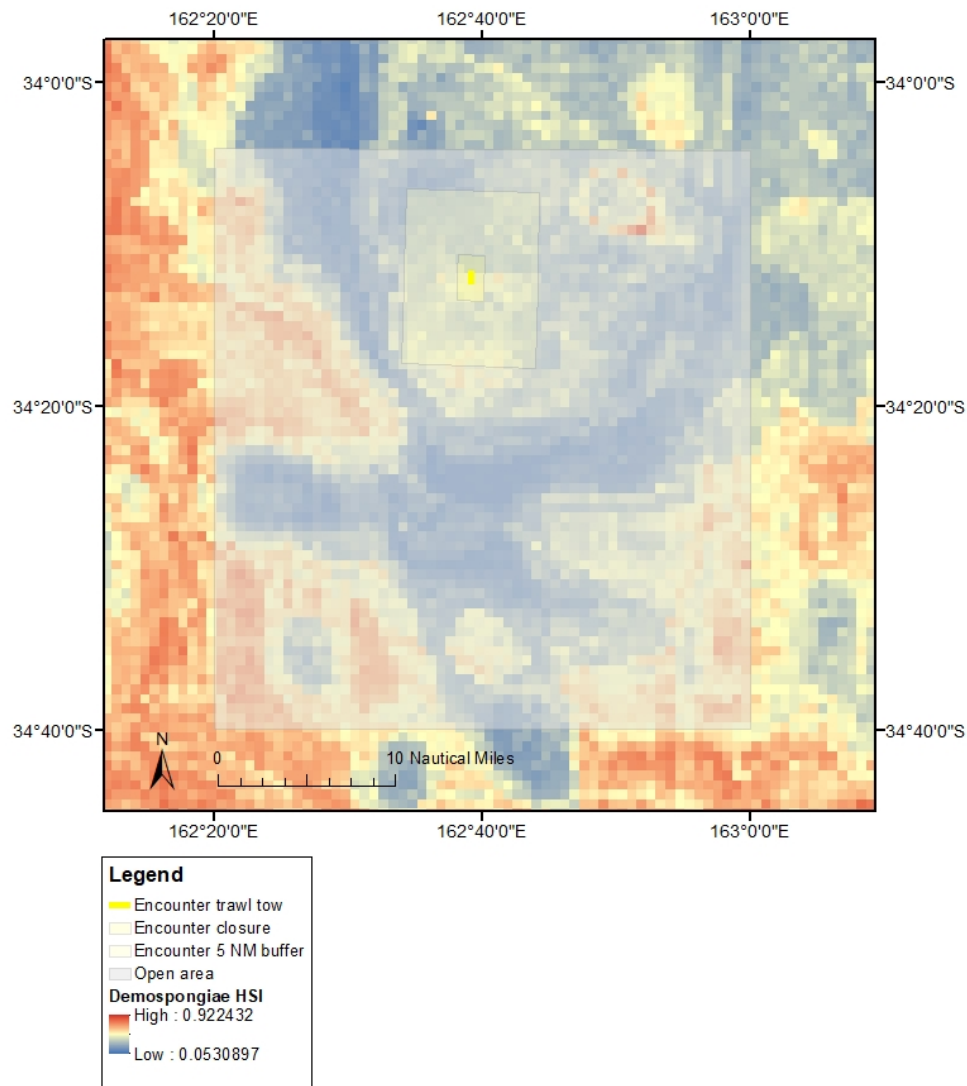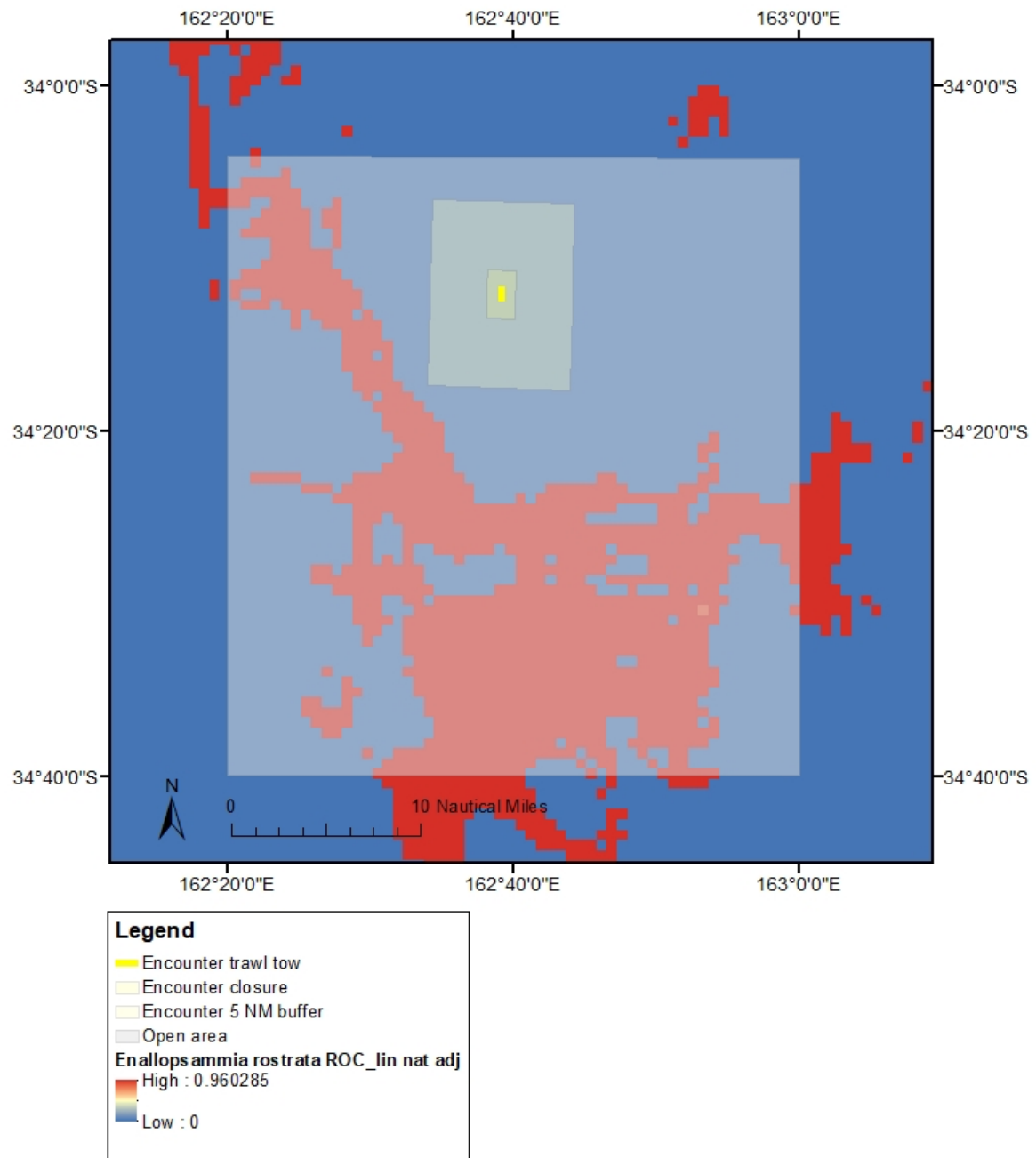

Figure A1.2. Spatial distribution of historical bycatch of **Demospongiae** relative to the **habitat suitability model predictions** for Demospongiae. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
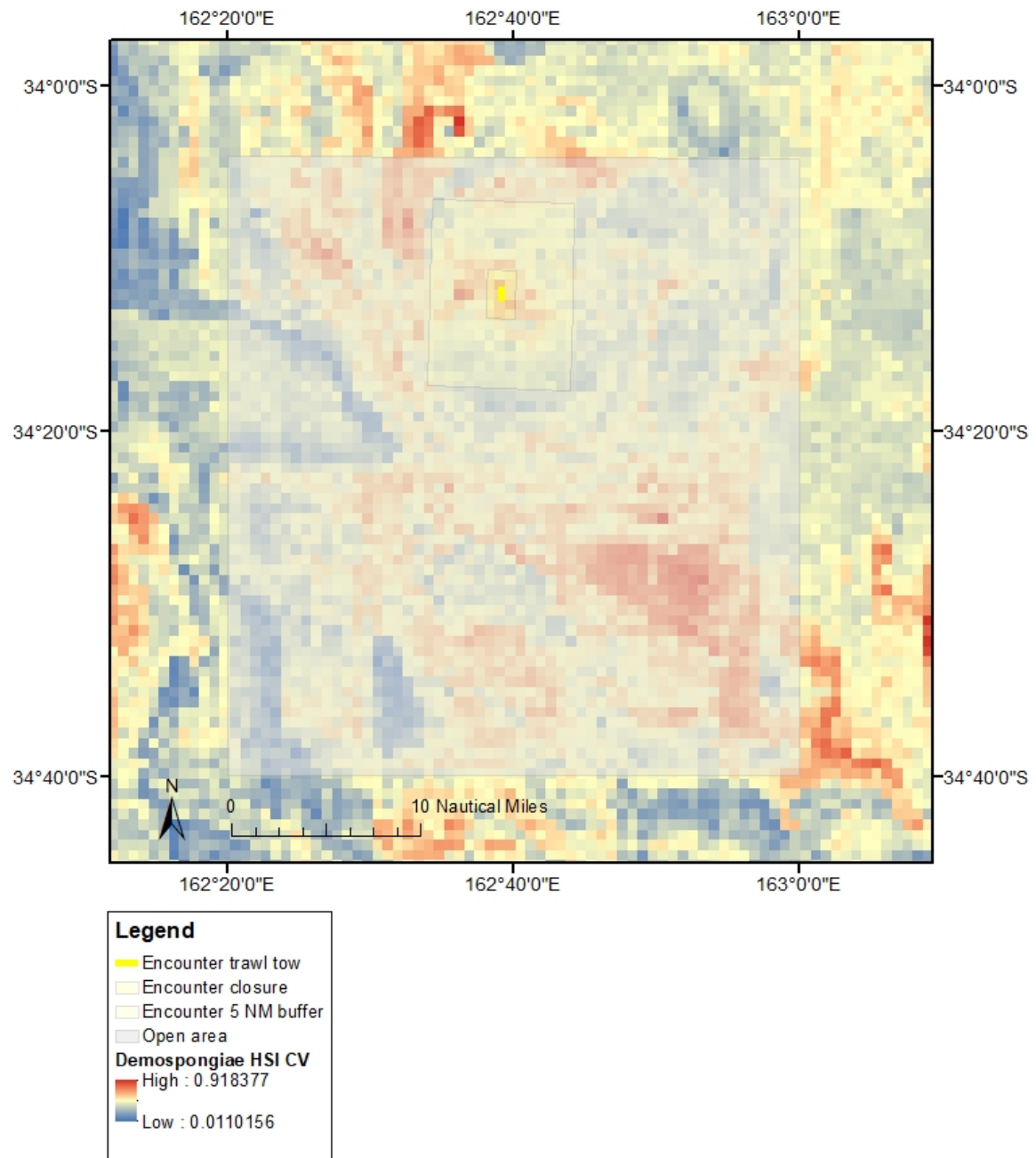
Figure A1.3. Spatial distribution of historical bycatch of **Demospongiae** relative to the **uncertainty estimates for habitat suitability model predictions** for Demospongiae. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
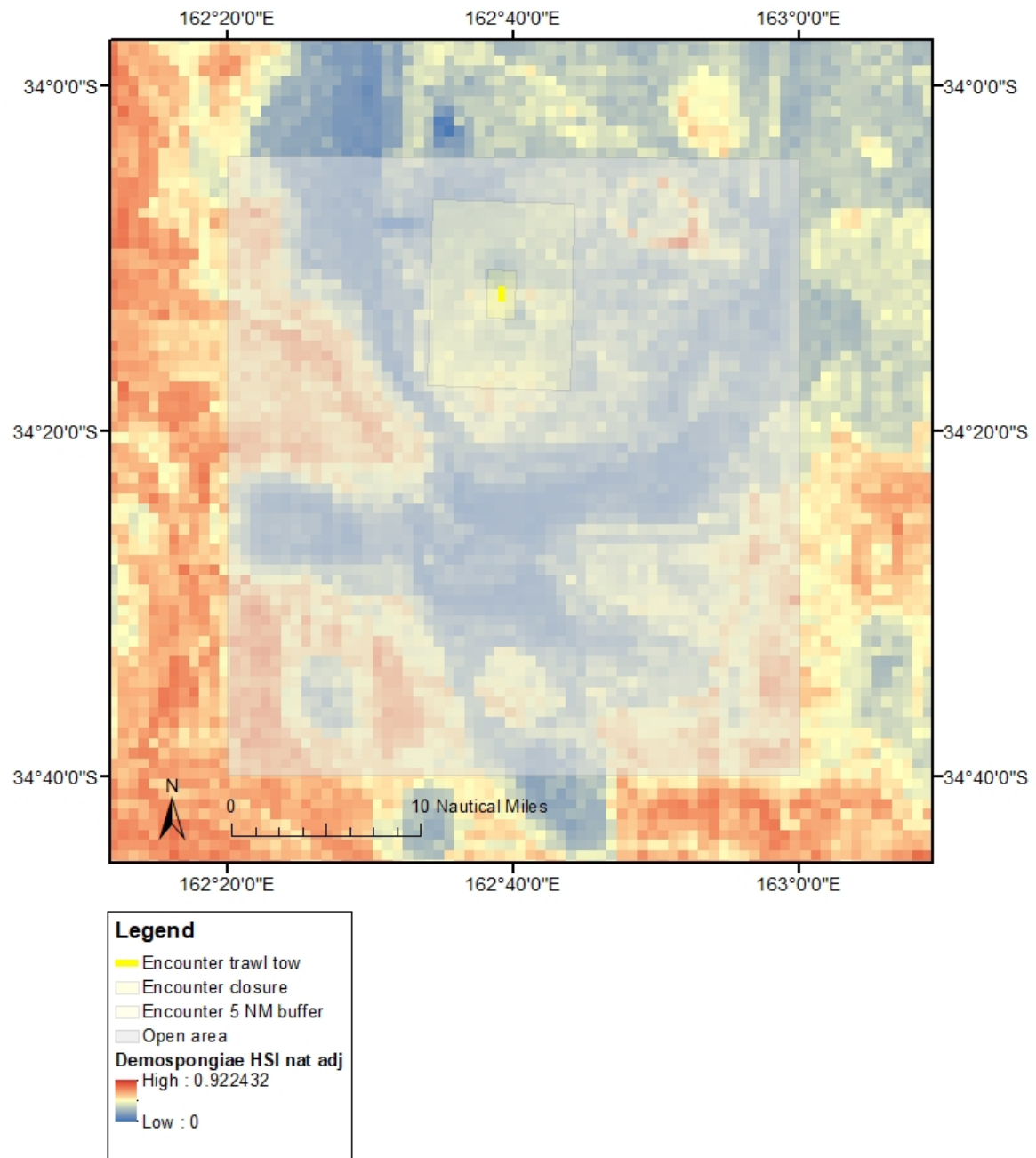
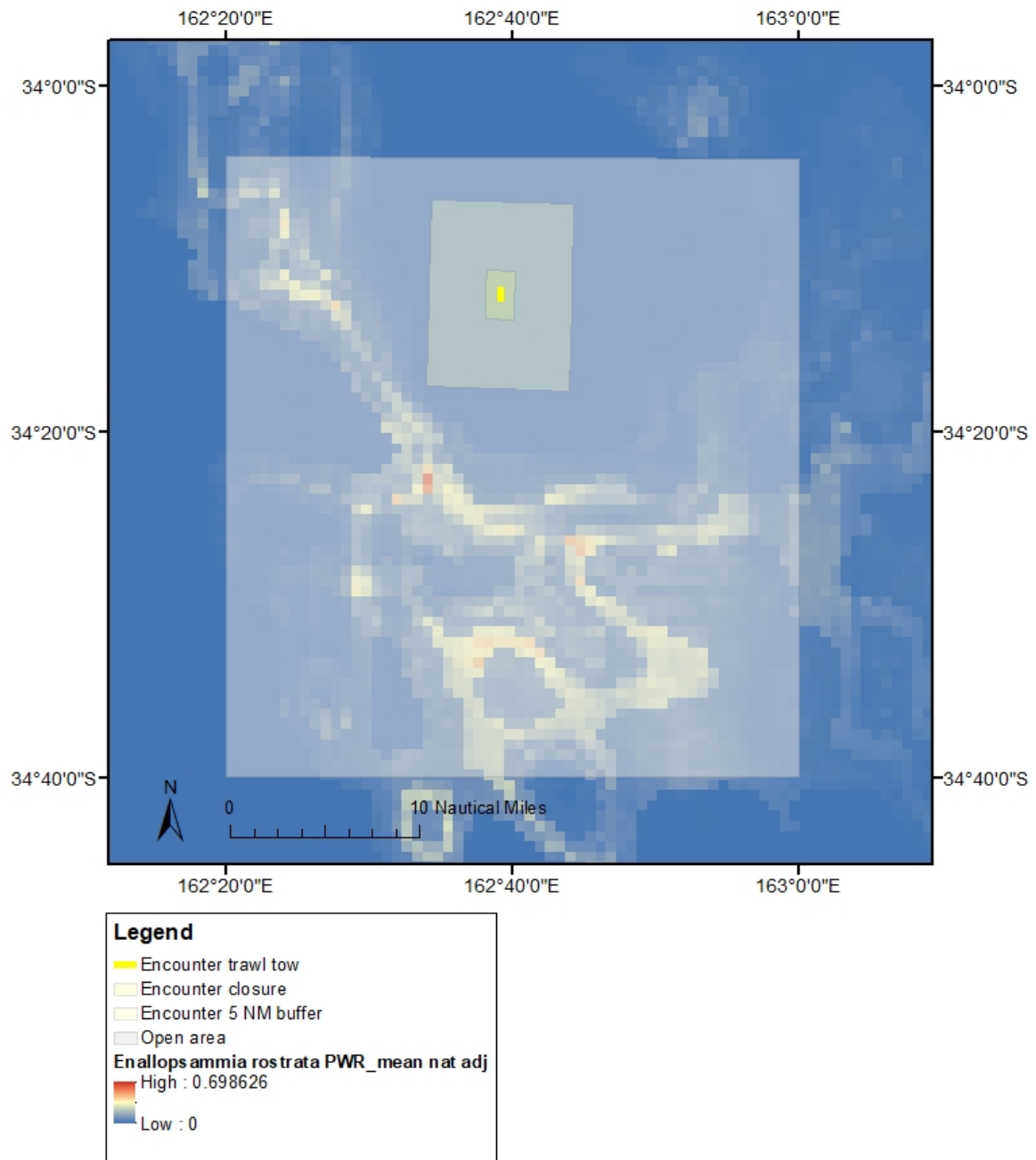**Figure A1.4.** Spatial distribution of historical bycatch of **Demospongiae** relative to the **naturalness adjusted habitat suitability model predictions** for Demospongiae. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
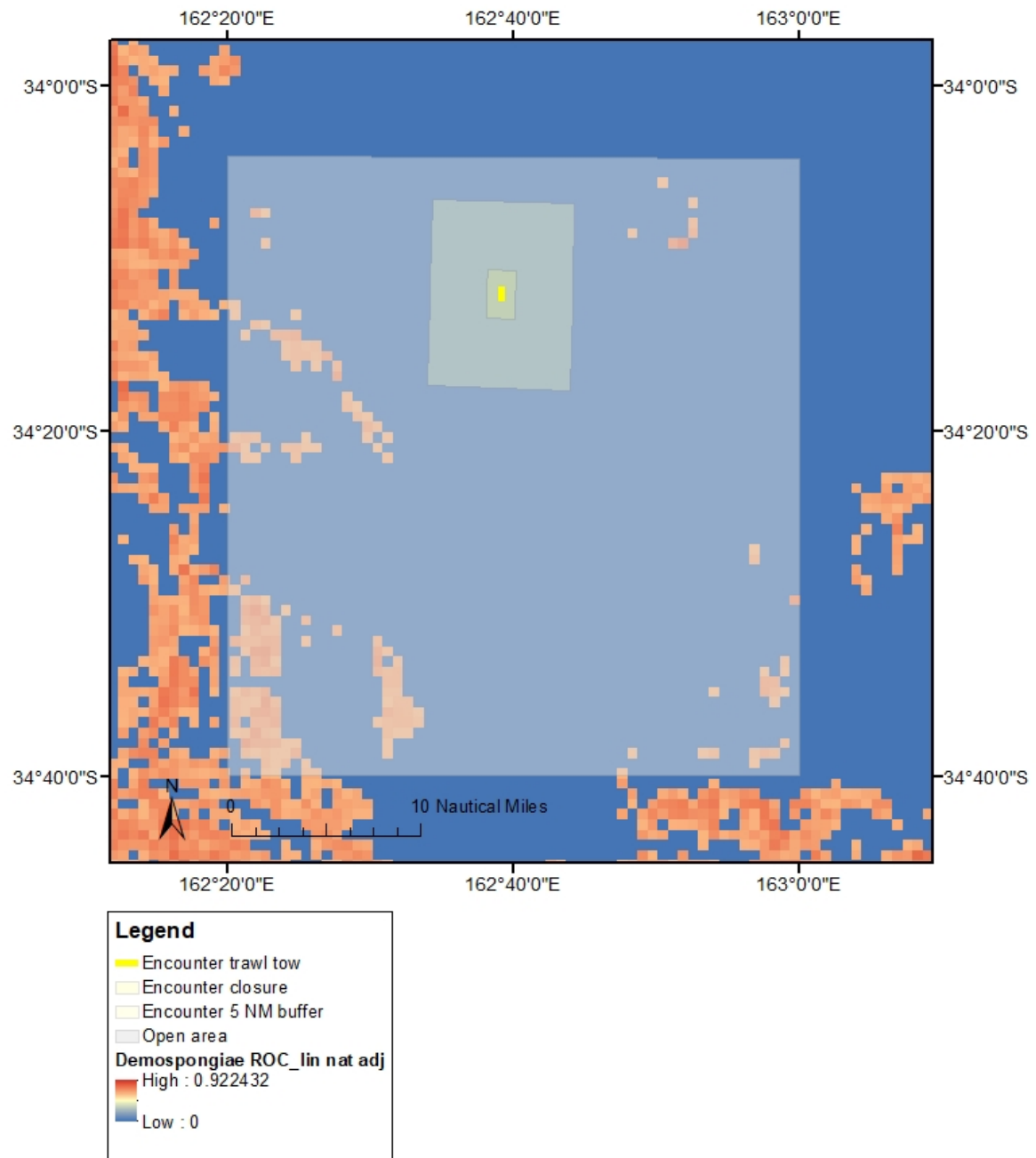
Figure A1.5. Spatial distribution of historical bycatch of **Demospongiae** relative to the **naturalness adjusted ROC_linear** habitat suitability model predictions for Demospongiae. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
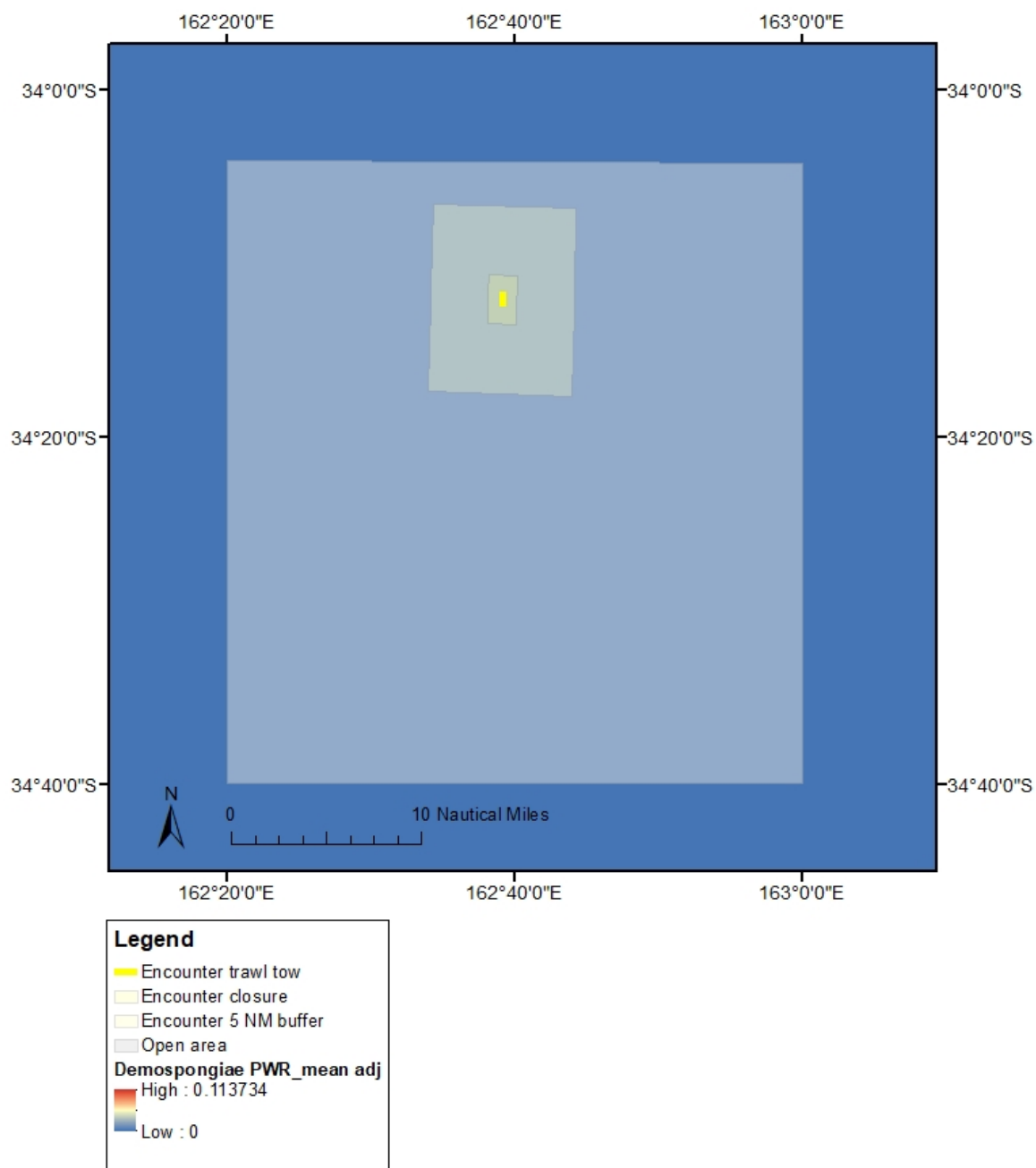
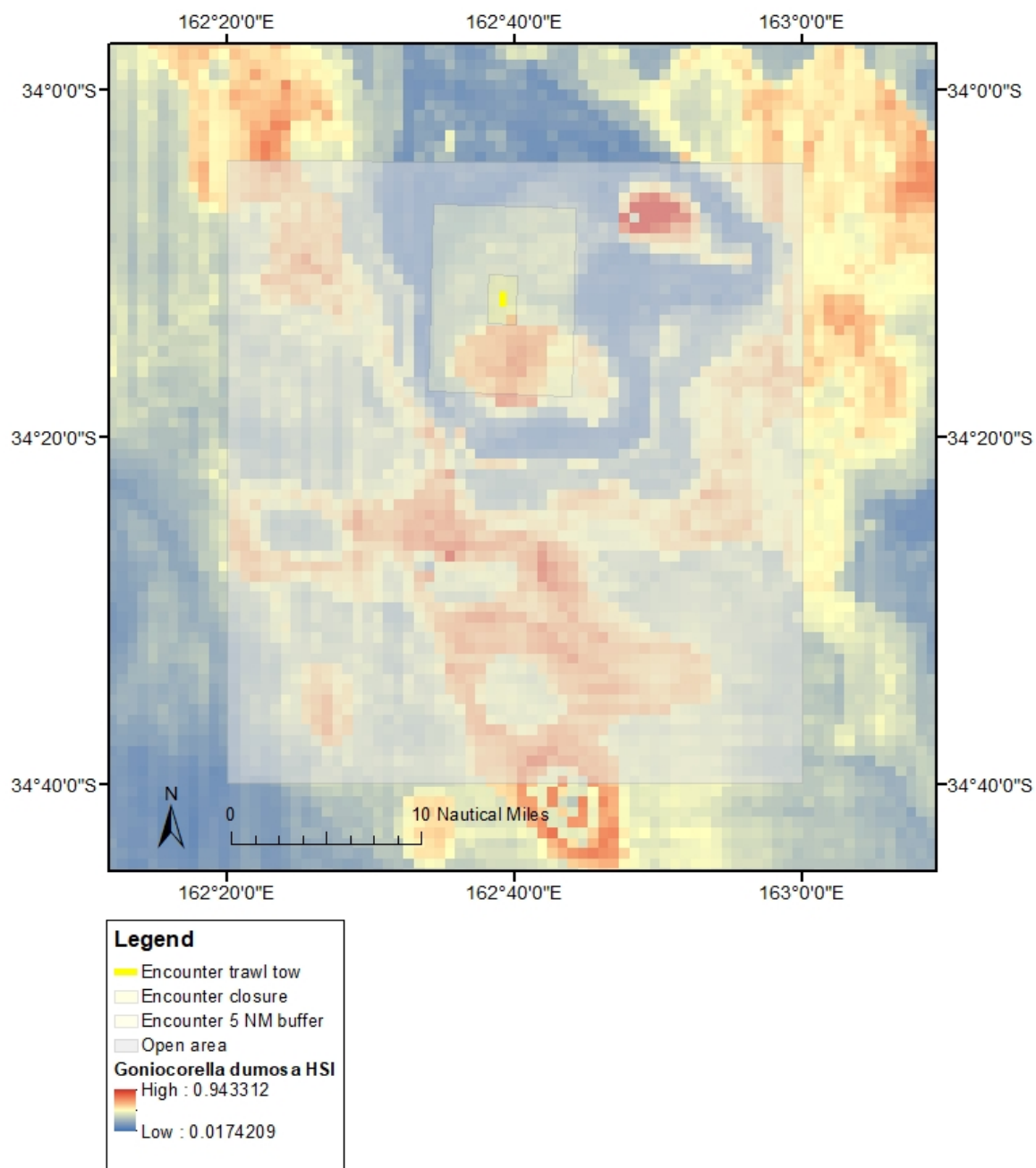**Figure A1.6.** Spatial distribution of historical bycatch of **Demospongiae** relative to the **naturalness adjusted PWR_mean** habitat suitability model predictions for Demospongiae. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

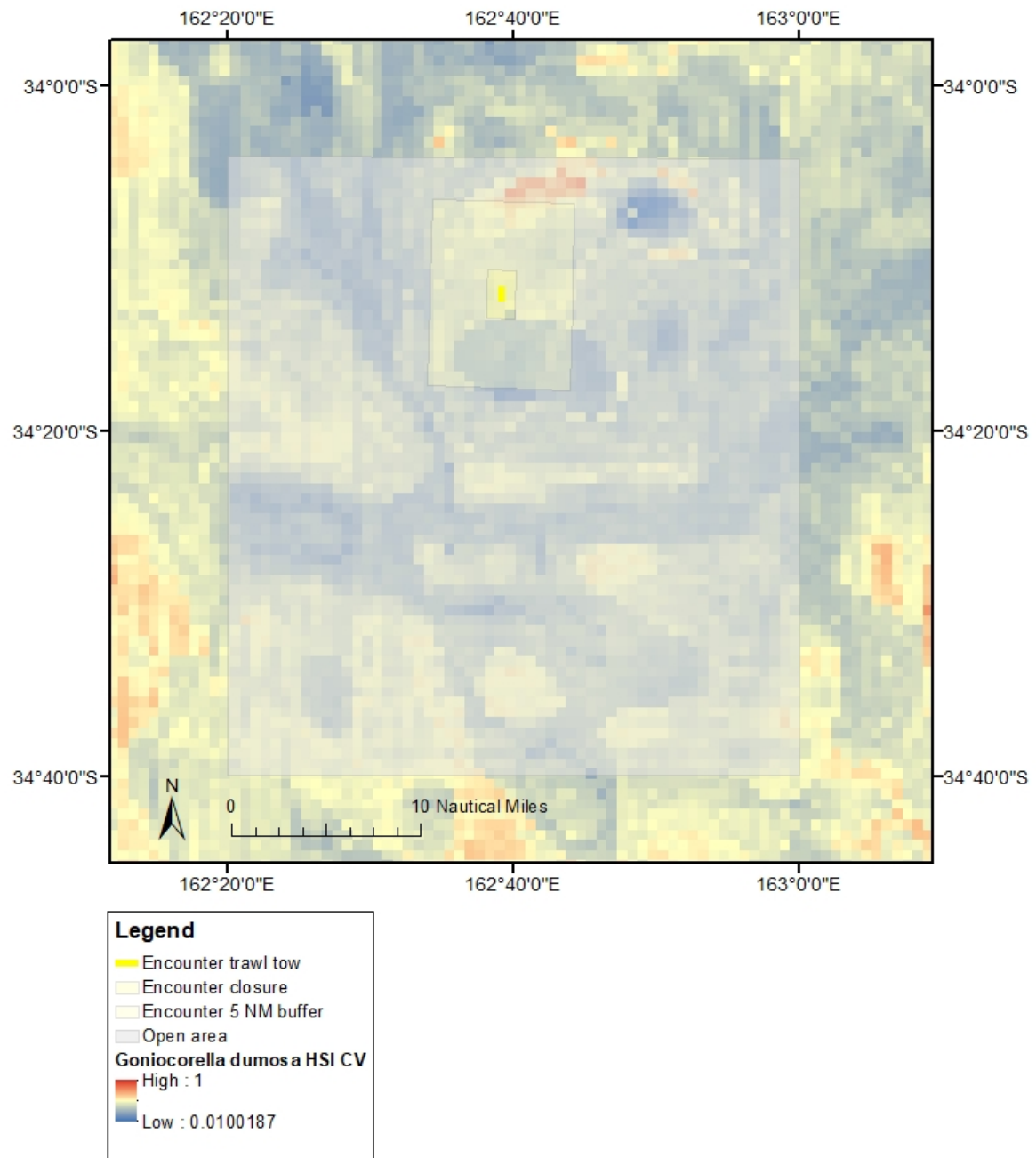## Annex 2 Alcyonacea historic bycatch

[image withheld to comply with national regulations around commercially sensitive data release]

Figure A2.1. Spatial distribution of historical bycatch of **Alcyonacea** within and adjacent to the open areas within which the encounter occurred. Note, habitat suitability models do not exist for Alcyonacea.

Annex 3 Scleractinia historic bycatch

[image withheld to comply with national regulations around commercially sensitive data release]

Figure A3.1. Spatial distribution of historical bycatch of **Scleractinia** (that have only been identified to the taxonomic level of Order) within and adjacent to the open areas within which the encounter occurred.

Annex 3 Scleractinia historic bycatch

Figure A3.2. Spatial distribution of historical bycatch of *Enallopsammia rostrata* relative to the **habitat suitability model predictions** for *Enallopsammia rostrata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
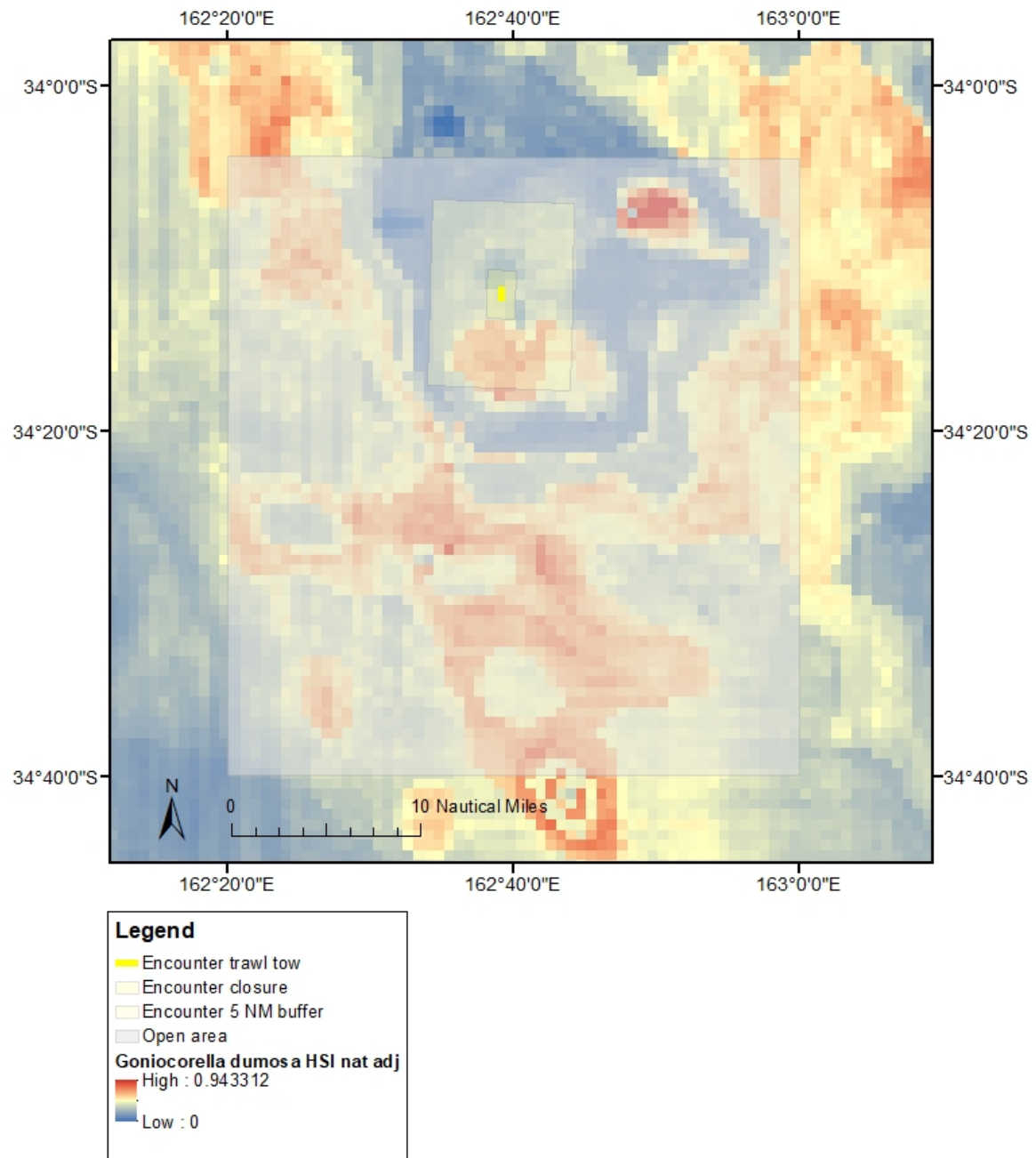
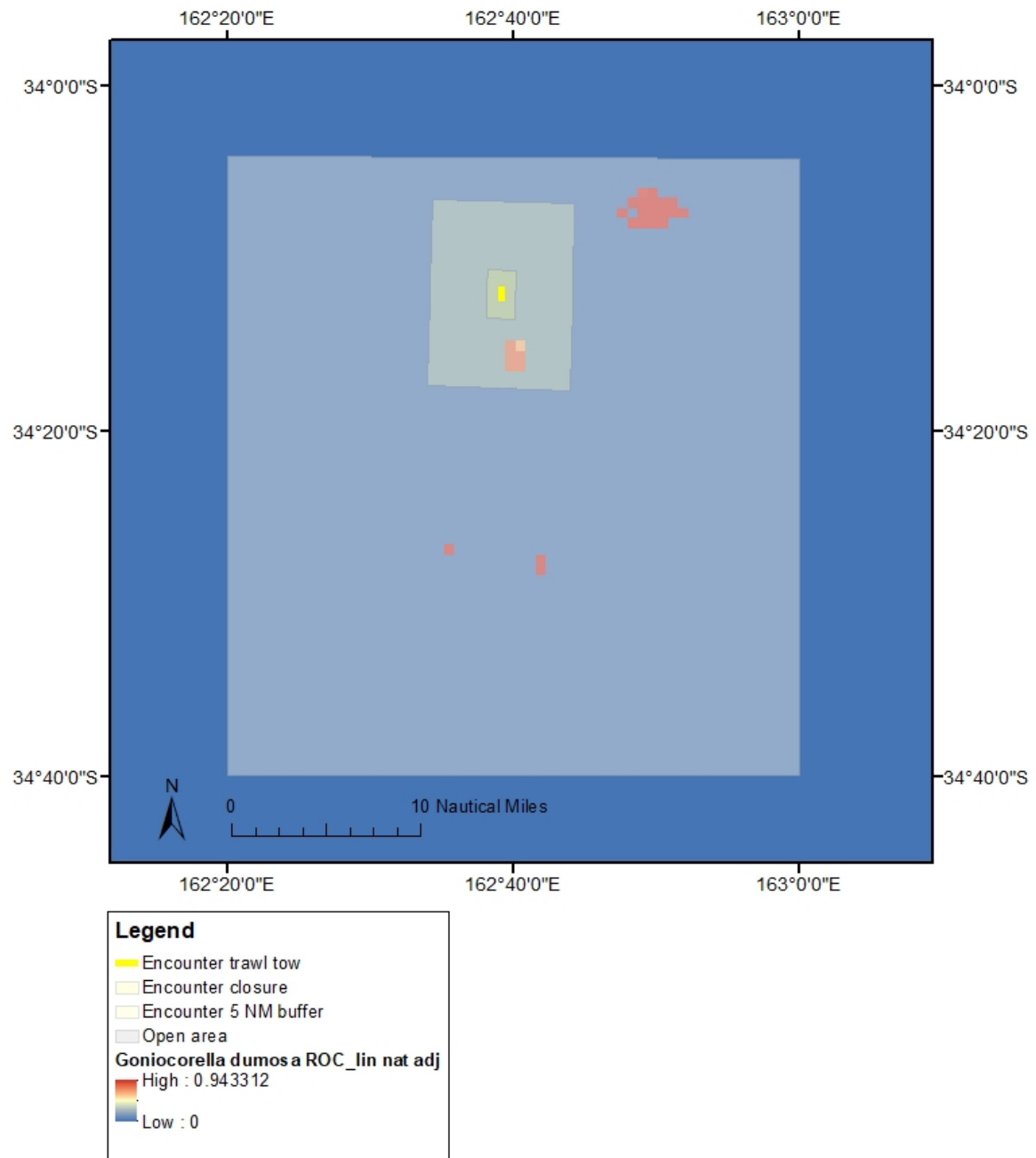**Figure A3.3.** Spatial distribution of historical bycatch of *Enallopsammia rostrata* relative to the **uncertainty estimates for habitat suitability model predictions** for *Enallopsammia rostrata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A3.4. Spatial distribution of historical bycatch of *Enallopsammia rostrata* relative to the **naturalness adjusted habitat suitability model predictions** for *Enallopsammia rostrata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
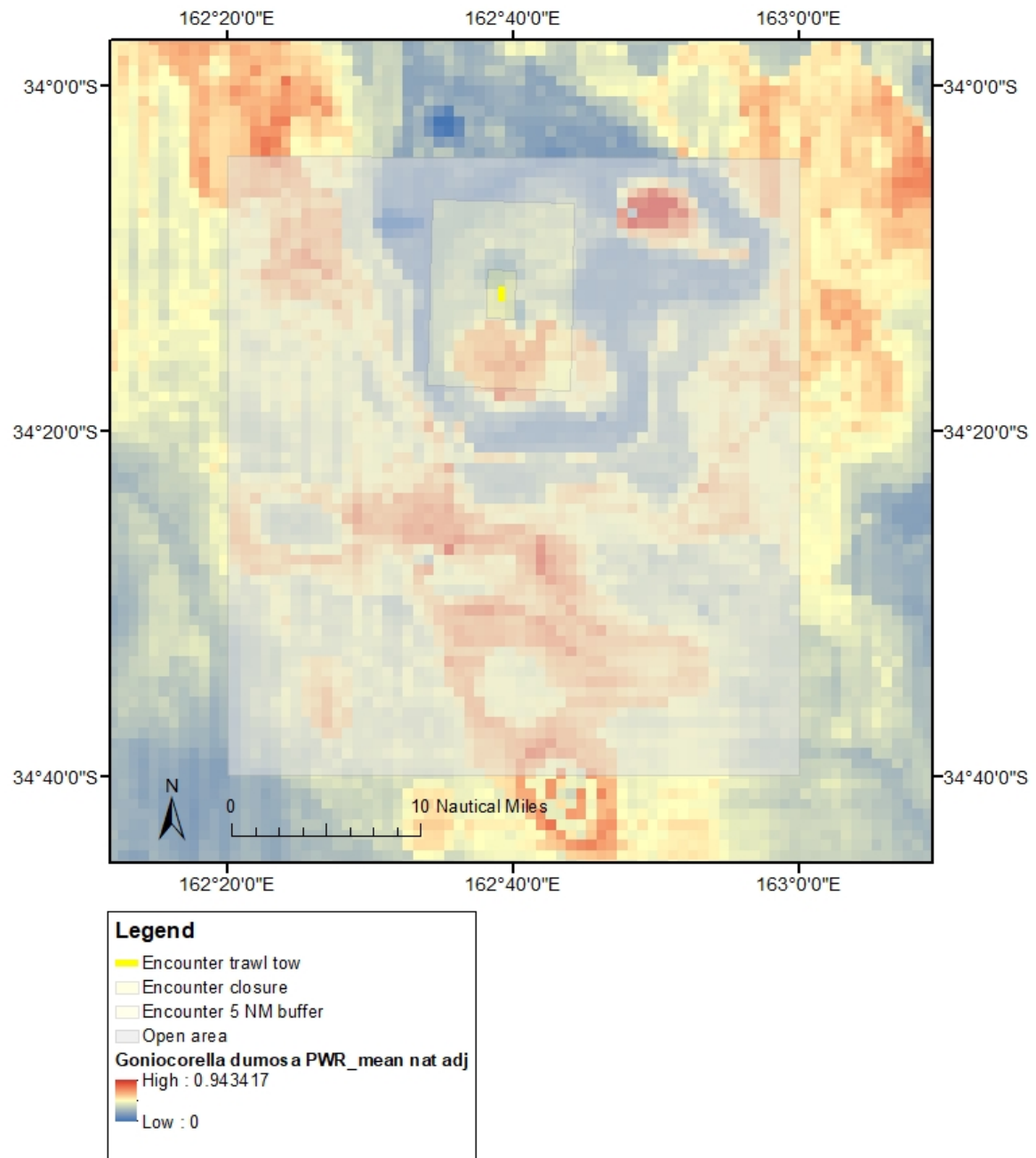
Figure A3.5. Spatial distribution of historical bycatch of *Enallopsammia rostrata* relative to the **naturalness adjusted ROC_linear** habitat suitability model predictions for *Enallopsammia rostrata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
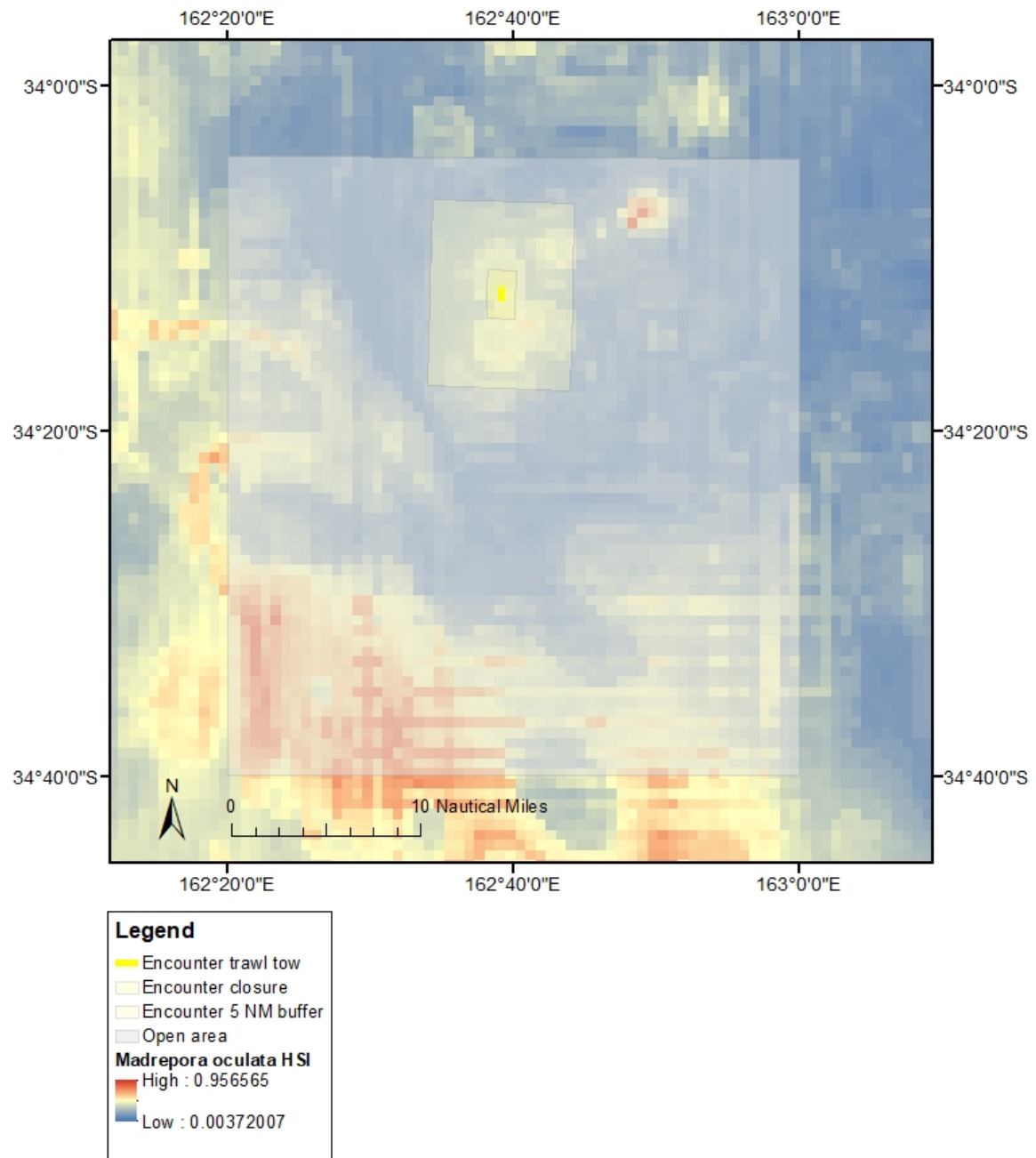
Figure A3.6. Spatial distribution of historical bycatch of *Enallopsammia rostrata* relative to the **natural adjusted PWR_mean** habitat suitability model predictions for *Enallopsammia rostrata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A3.7. Spatial distribution of historical bycatch of *Goniocorella Dumosa* relative to the **habitat suitability model predictions** for *Goniocorella dumosa*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
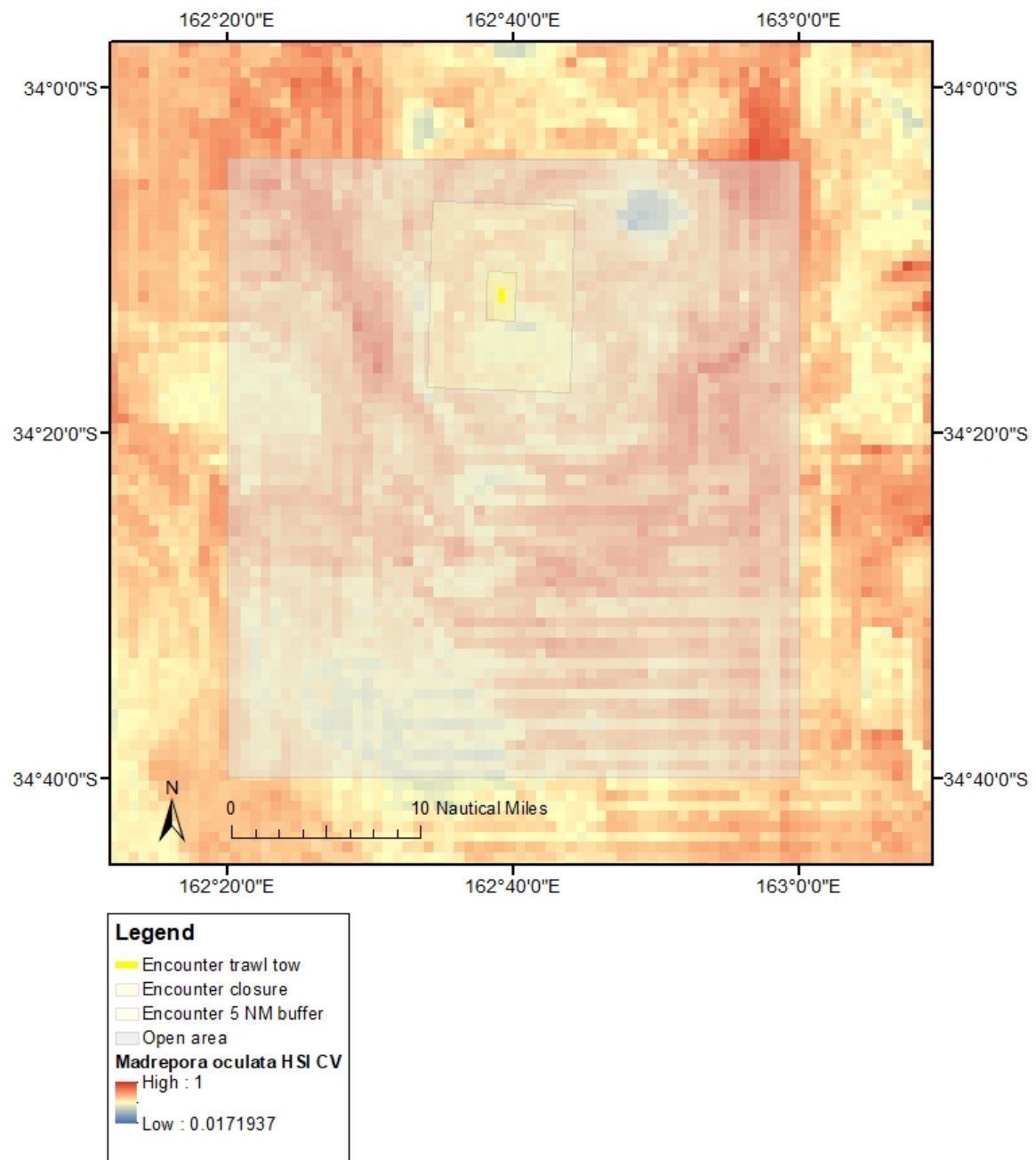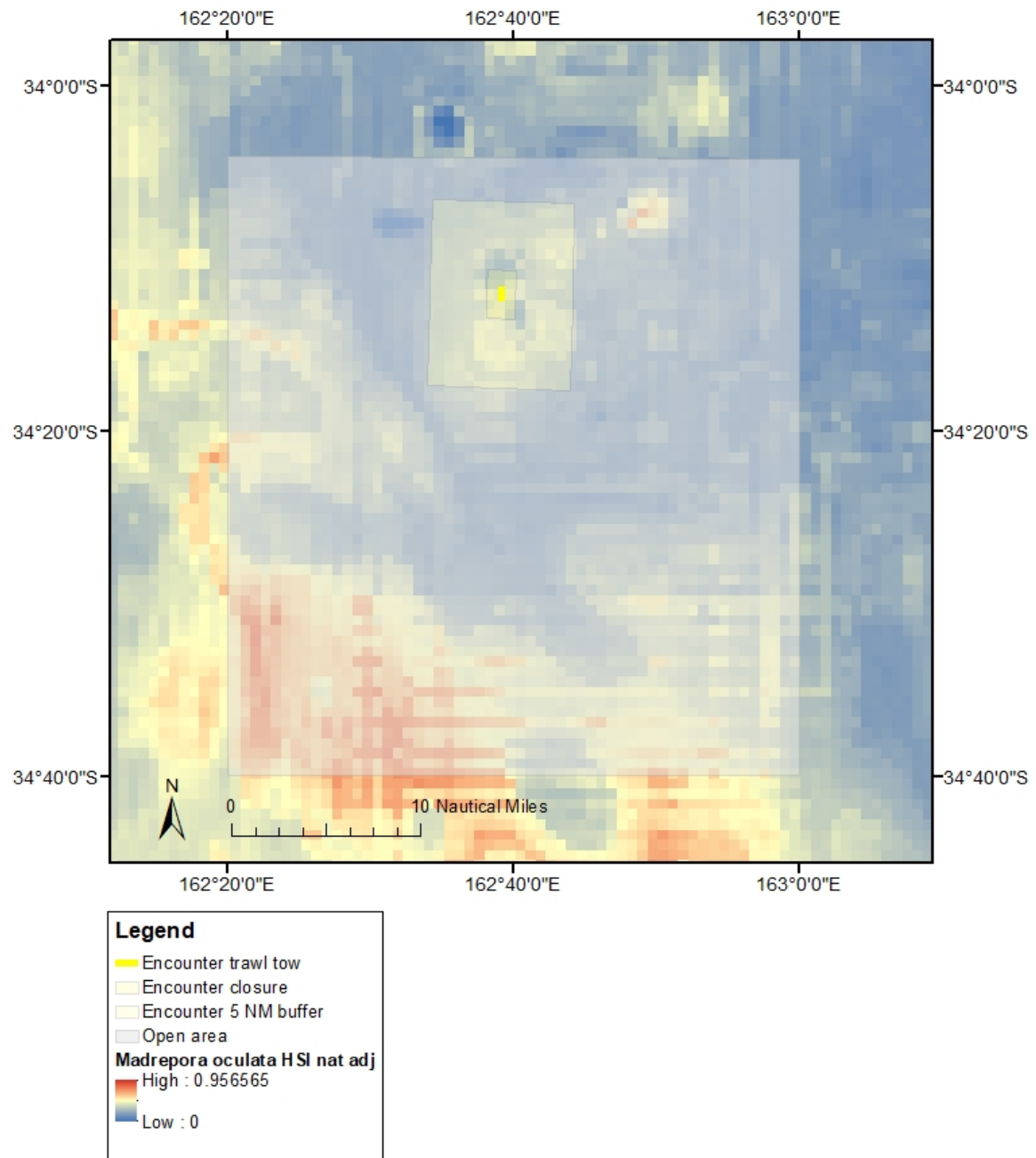
Figure A3.8. Spatial distribution of historical bycatch of ***Goniocorella Dumosa*** relative to the **uncertainty estimates for habitat suitability model predictions** for *Goniocorella dumosa*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A3.9. Spatial distribution of historical bycatch of ***Goniocorella Dumosa*** relative to the **naturalness adjusted habitat suitability model predictions** for *Goniocorella dumosa*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
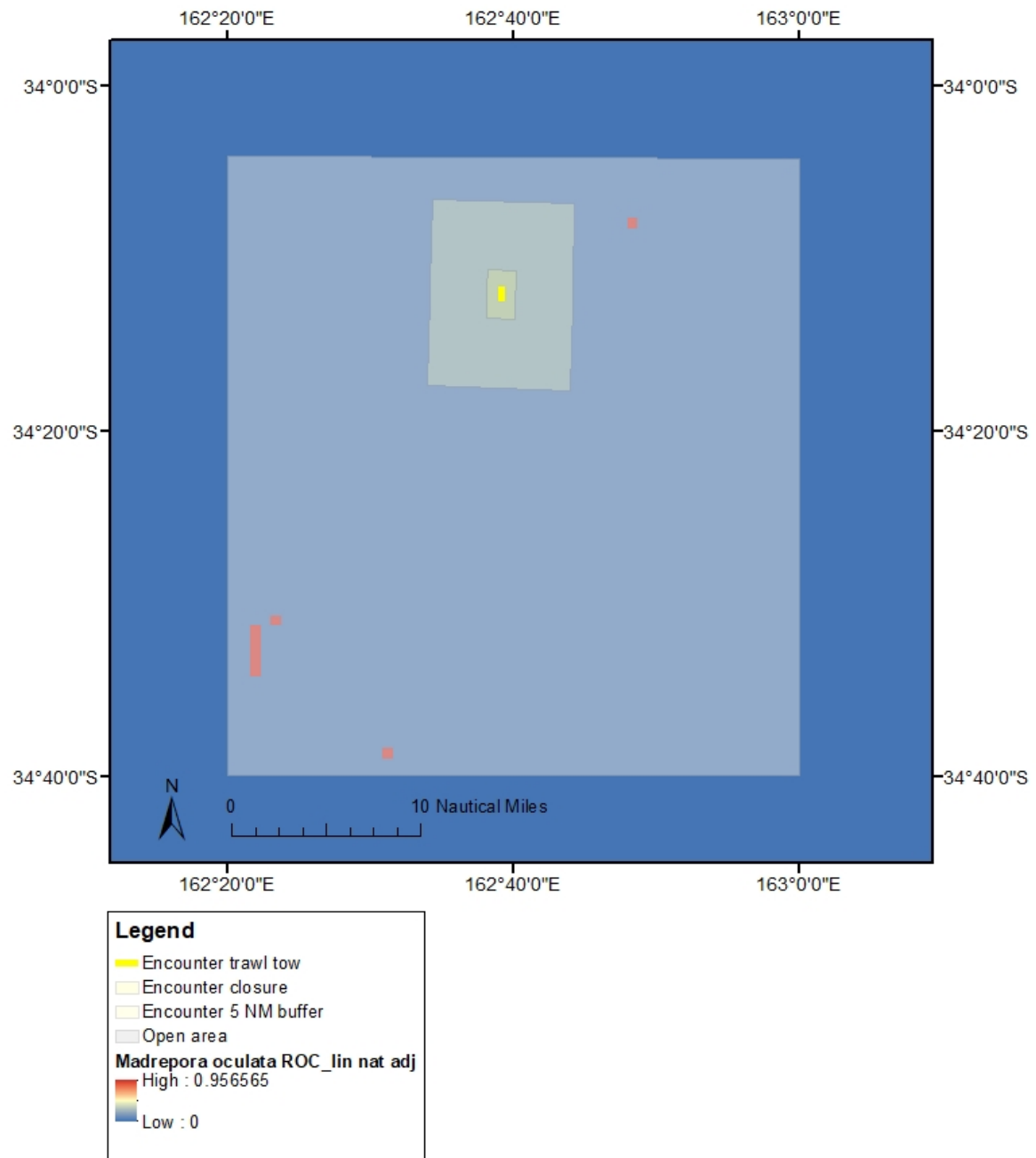
Figure A3.10. Spatial distribution of historical bycatch of ***Goniocorella Dumosa*** relative to the **naturalness adjusted ROC_linear** habitat suitability model predictions for *Goniocorella dumosa*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

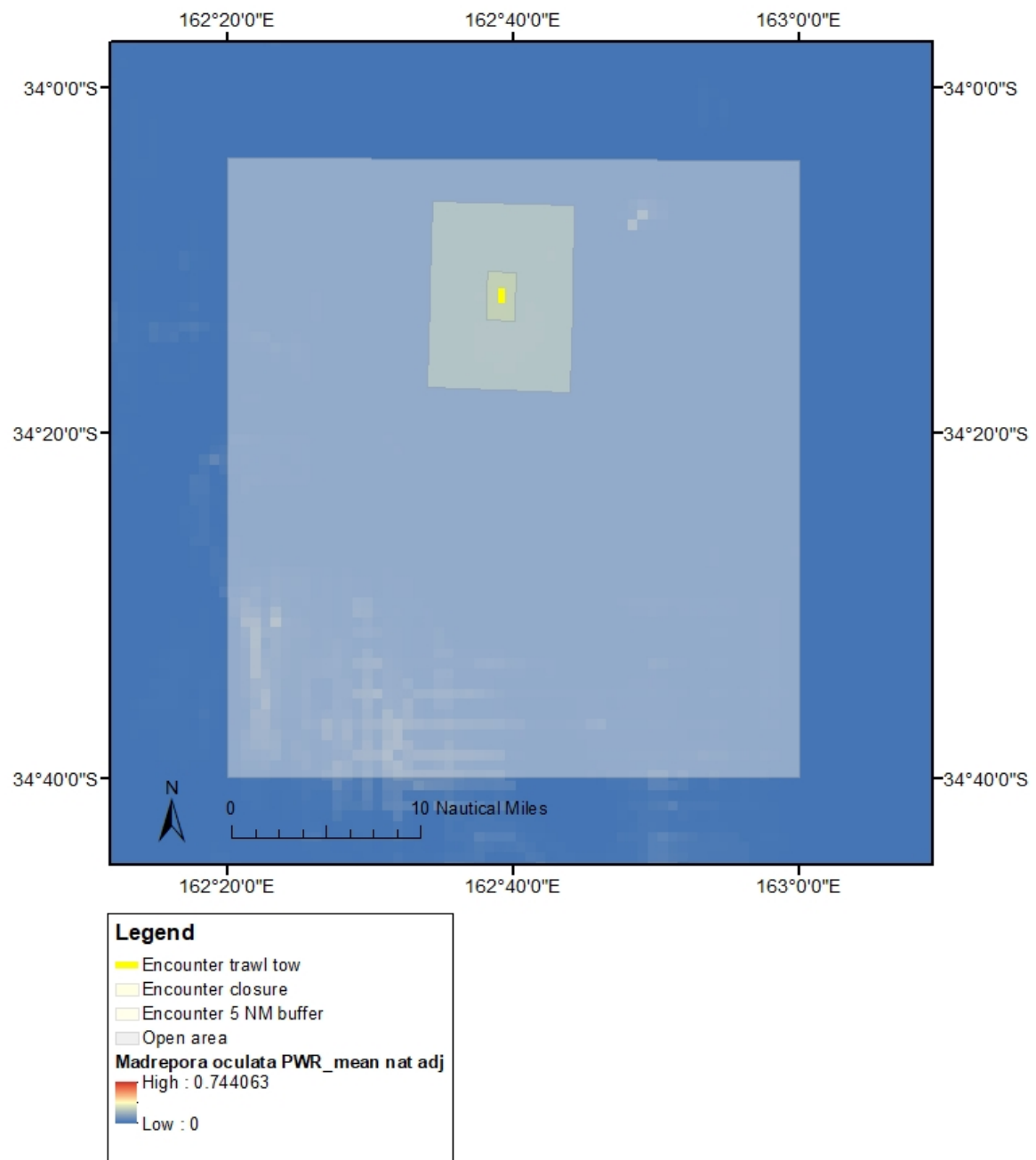**Figure A3.11.** Spatial distribution of historical bycatch of *Goniocorella Dumosa* relative to the **naturalness adjusted PWR_mean** habitat suitability model predictions for *Goniocorella dumosa*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A3.12. Spatial distribution of historical bycatch of *Madrepora oculata* relative to the **habitat suitability model predictions** for *Madrepora oculata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
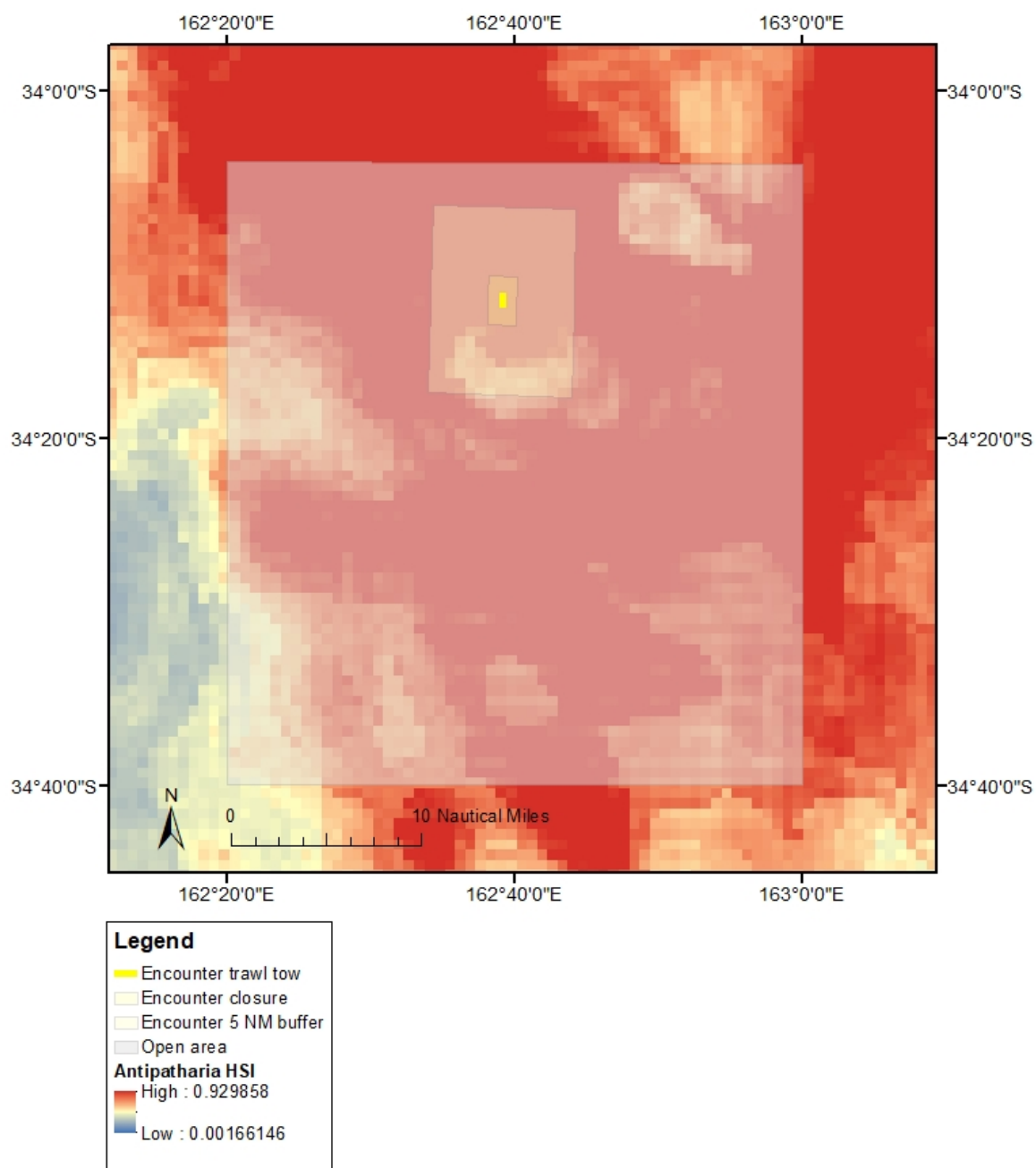
Figure A3.13. Spatial distribution of historical bycatch of ***Madrepora oculata*** relative to the **uncertainty estimates for habitat suitability model predictions** for *Madrepora oculata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A3.14. Spatial distribution of historical bycatch of ***Madrepora oculata*** relative to the
naturalness adjusted habitat suitability model predictions for *Madrepora oculata*. Historical
distribution of taxa is withheld to comply with national regulations around commercially sensitive
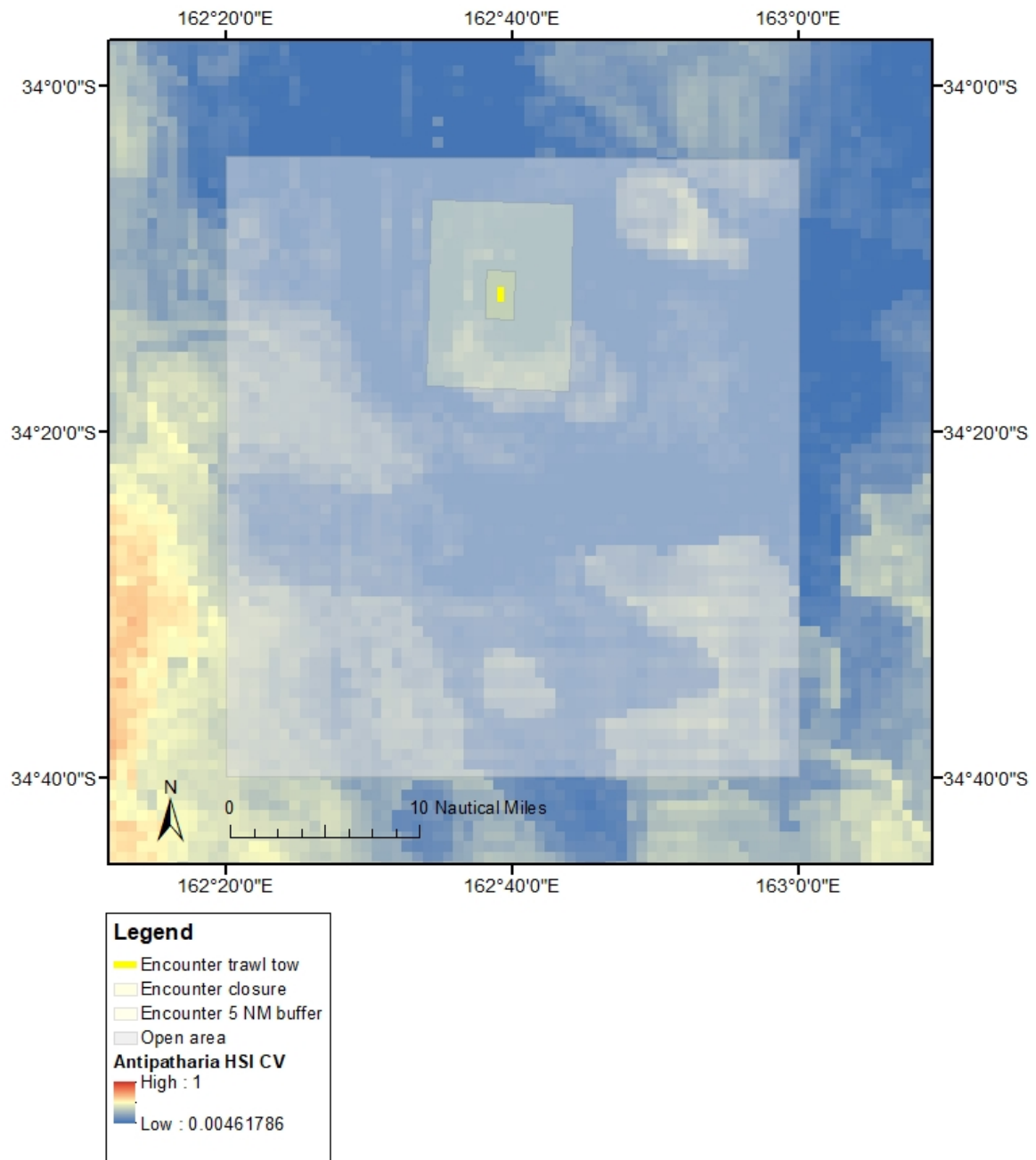data release.

Figure A3.15. Spatial distribution of historical bycatch of *Madrepora oculata* relative to the **naturalness adjusted ROC_linear** habitat suitability model predictions for *Madrepora oculata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
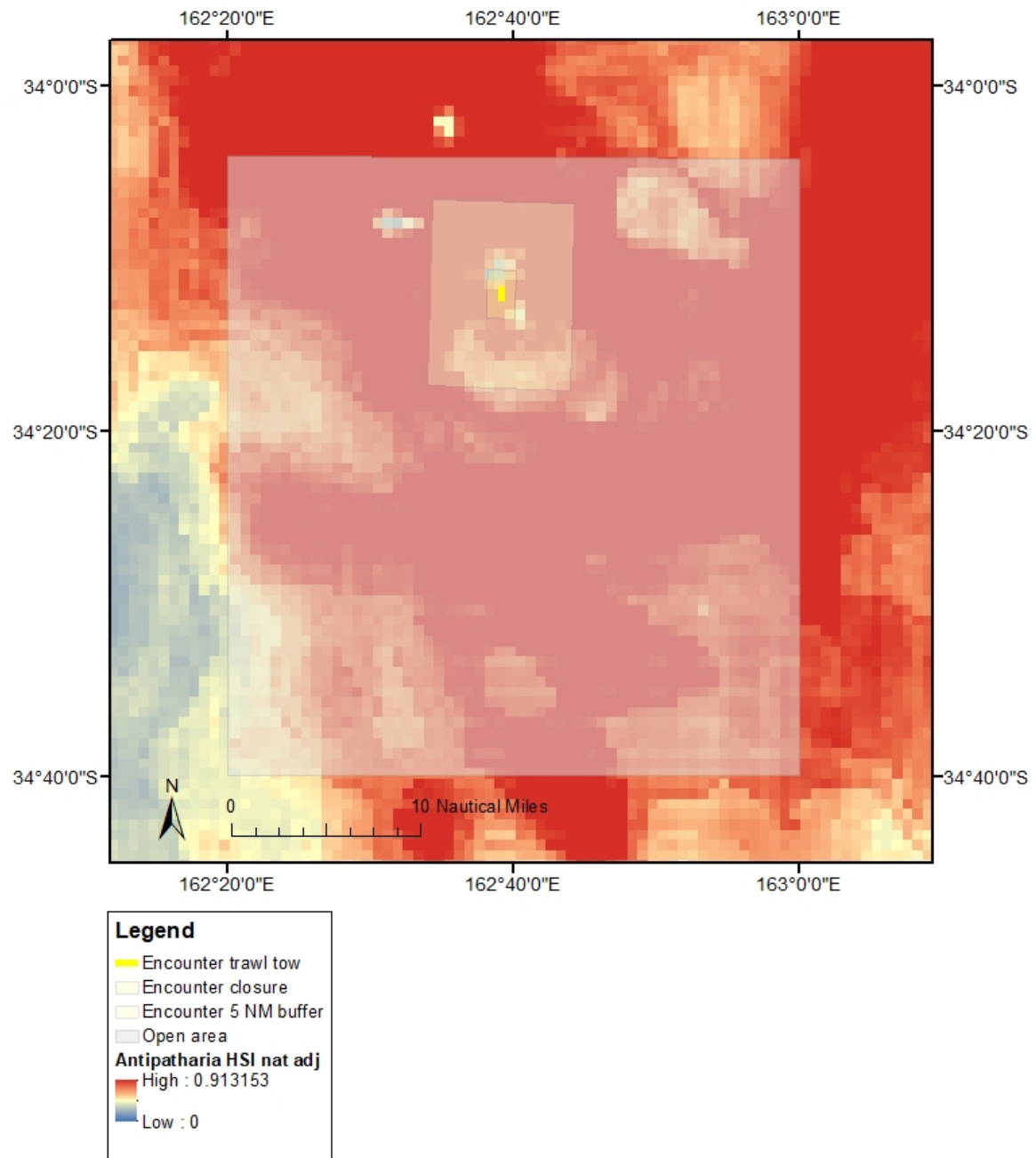
Figure A3.16. Spatial distribution of historical bycatch of *Madrepora oculata* relative to the **natural adjusted PWR_mean adjusted** habitat suitability model predictions for *Madrepora oculata*. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
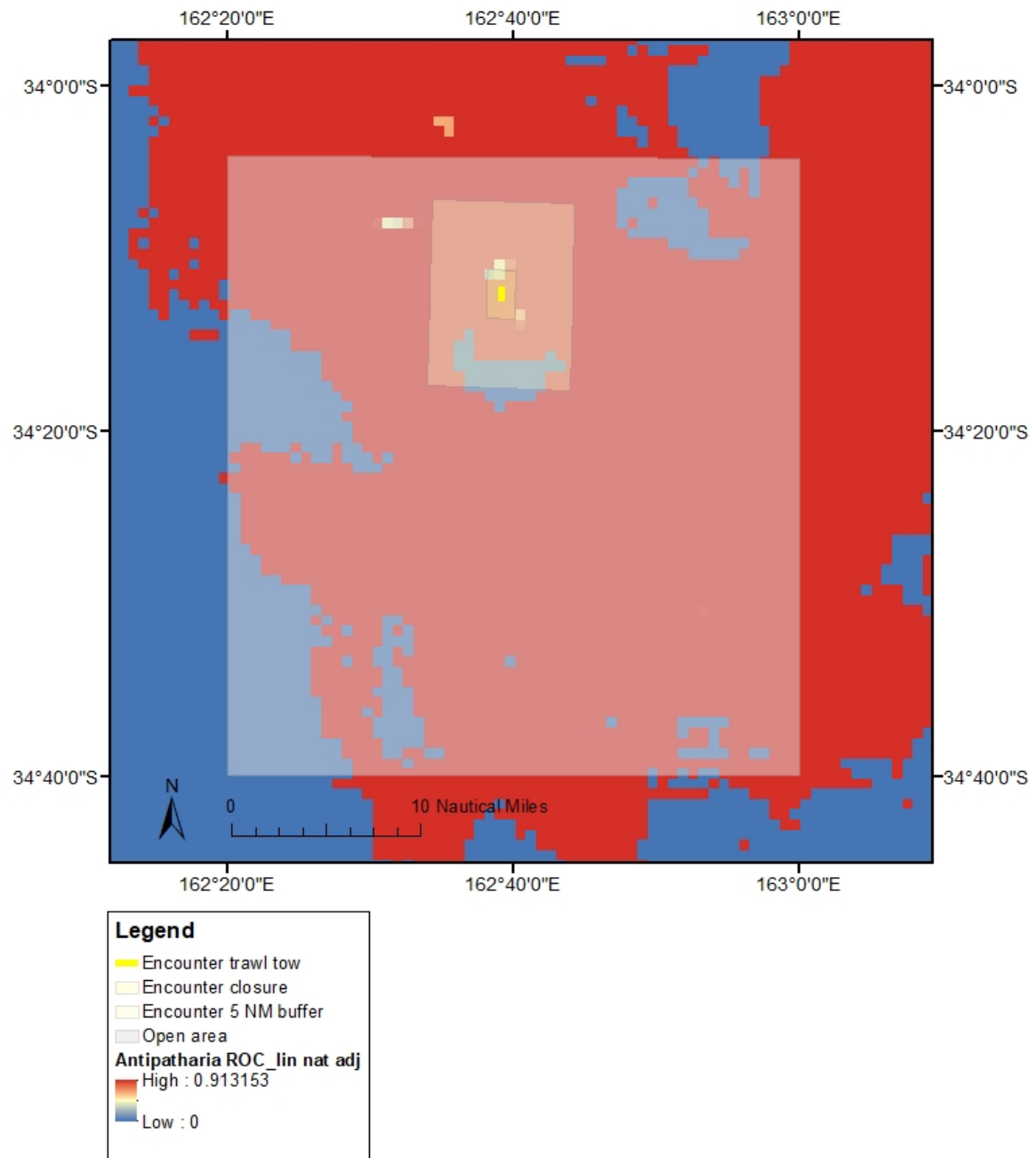
Annex 4 Antipatharia historic bycatch

Figure A4.1. Spatial distribution of historical bycatch of **Antipatharia** relative to the **habitat suitability model predictions** for Antipatharia Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
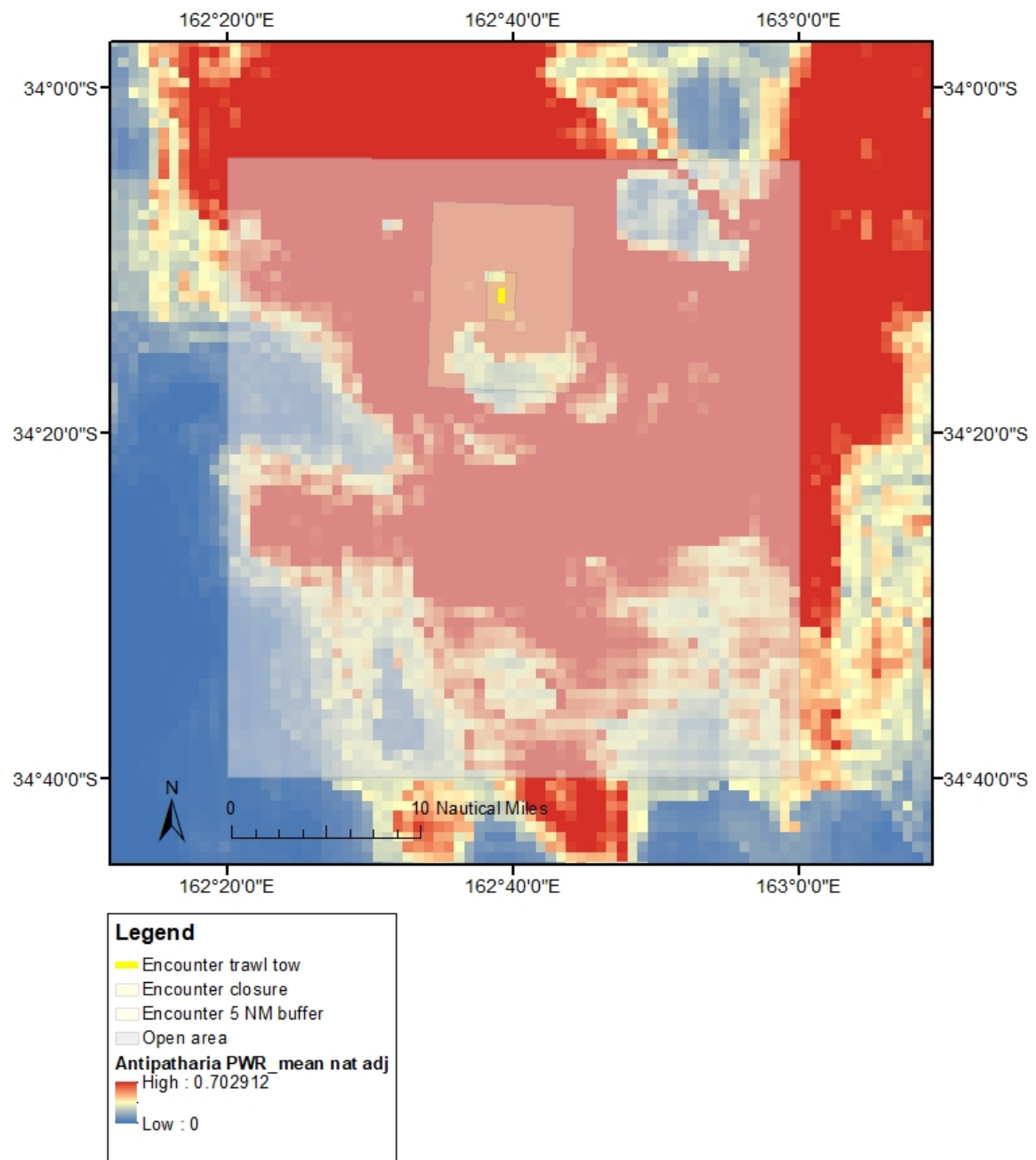
Figure A4.2. Spatial distribution of historical bycatch of **Antipatharia** relative to the **uncertainty estimates for habitat suitability model predictions** for Antipatharia. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A4.3. Spatial distribution of historical bycatch of **Antipatharia** relative to the **naturalness adjusted habitat suitability model predictions** for Antipatharia. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A4.4. Spatial distribution of historical bycatch of **Antipatharia** relative to **the naturalness adjusted ROC_linear** habitat suitability model predictions for Antipatharia. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
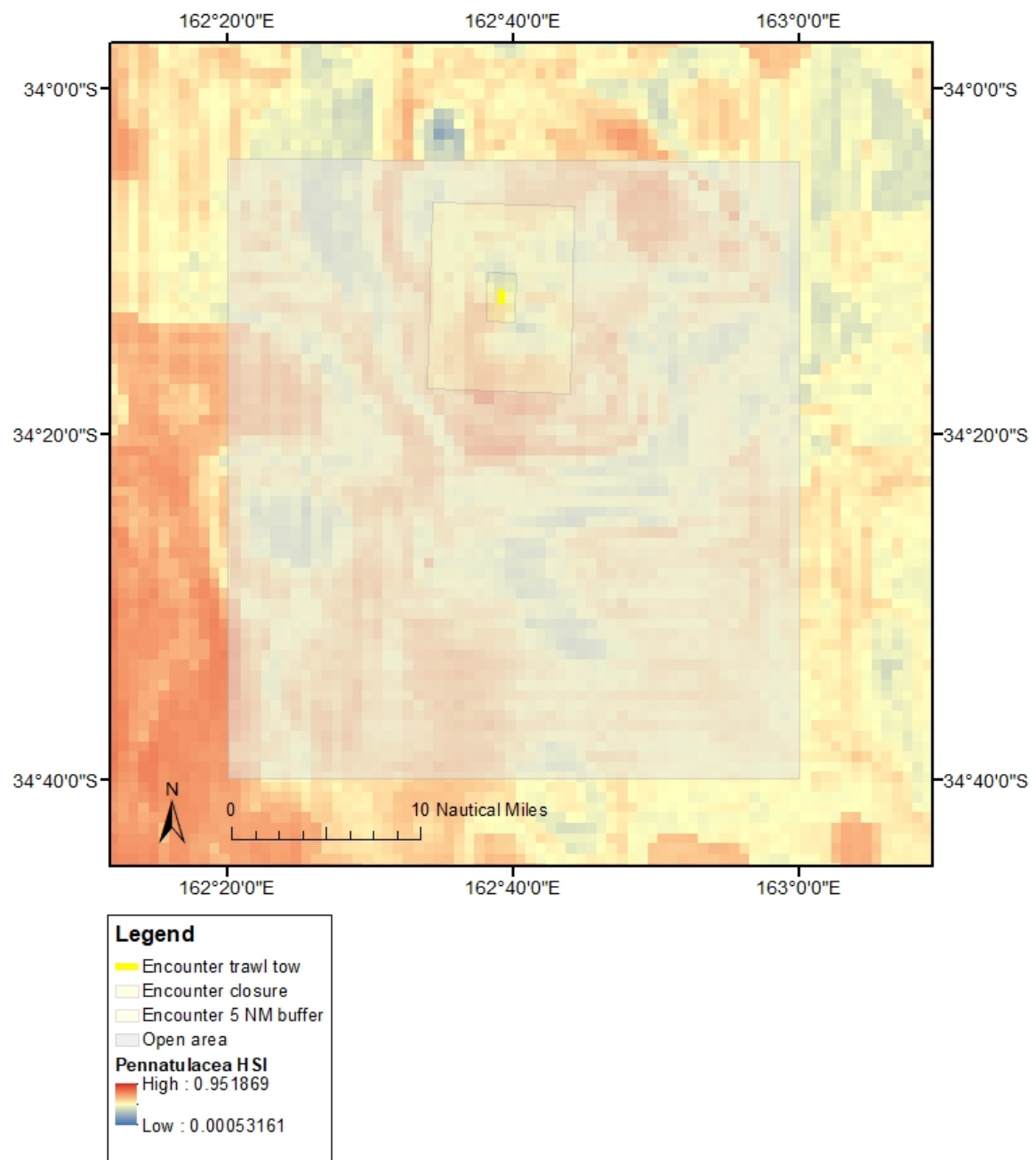
Figure A4.5. Spatial distribution of historical bycatch of **Antipatharia** relative to the **naturalness adjusted PWR_mean** habitat suitability model predictions for Antipatharia Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
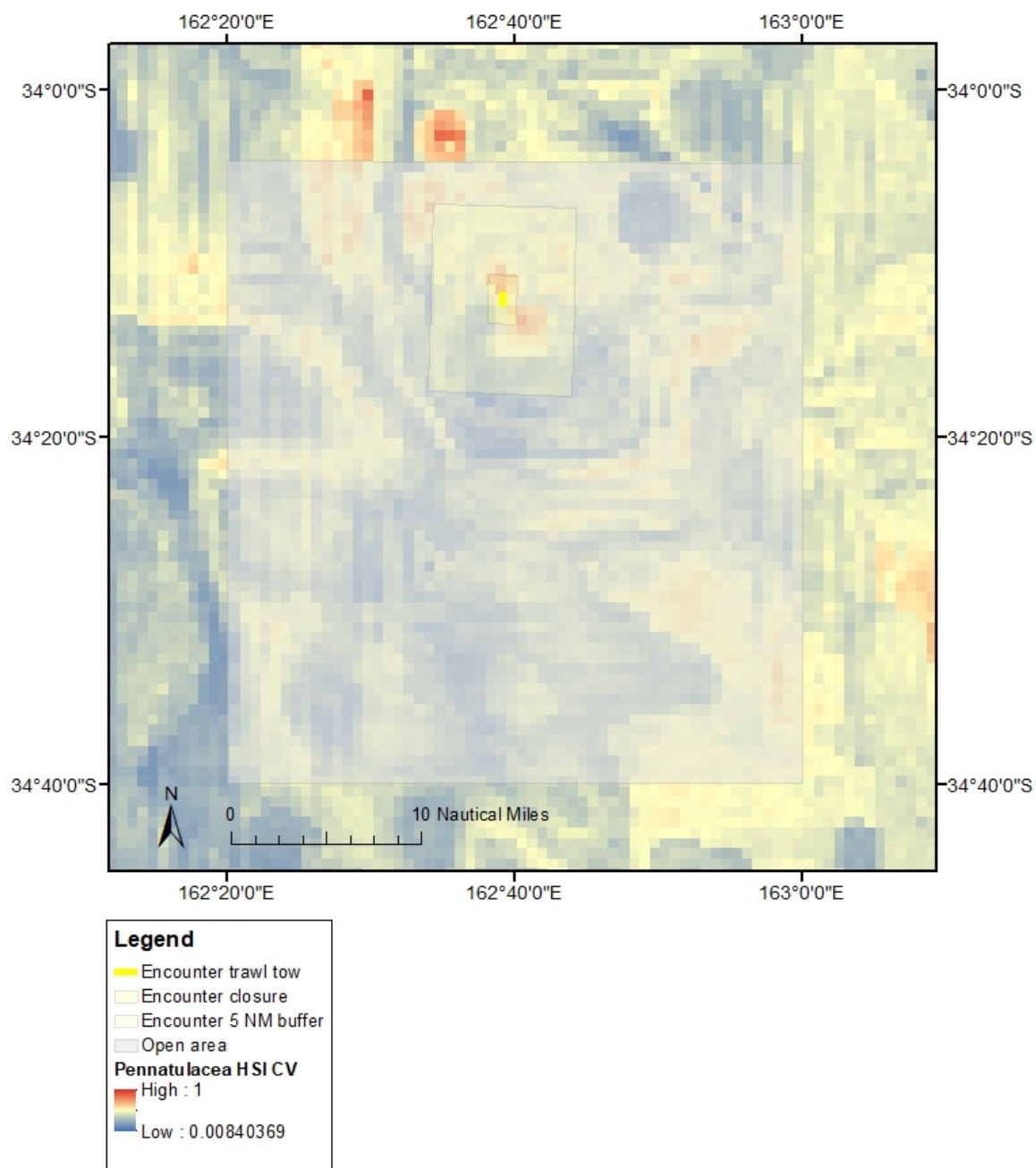
Annex 5 Actiniaria historic bycatch

[image withheld to comply with national regulations around commercially sensitive data release]

Figure A5.1. Spatial distribution of historical bycatch of **Actiniaria** within and adjacent to the open areas within which the encounter occurred. Note, habitat suitability models do not exist for Actiniaria.

Annex 5 Actiniaria historic bycatch
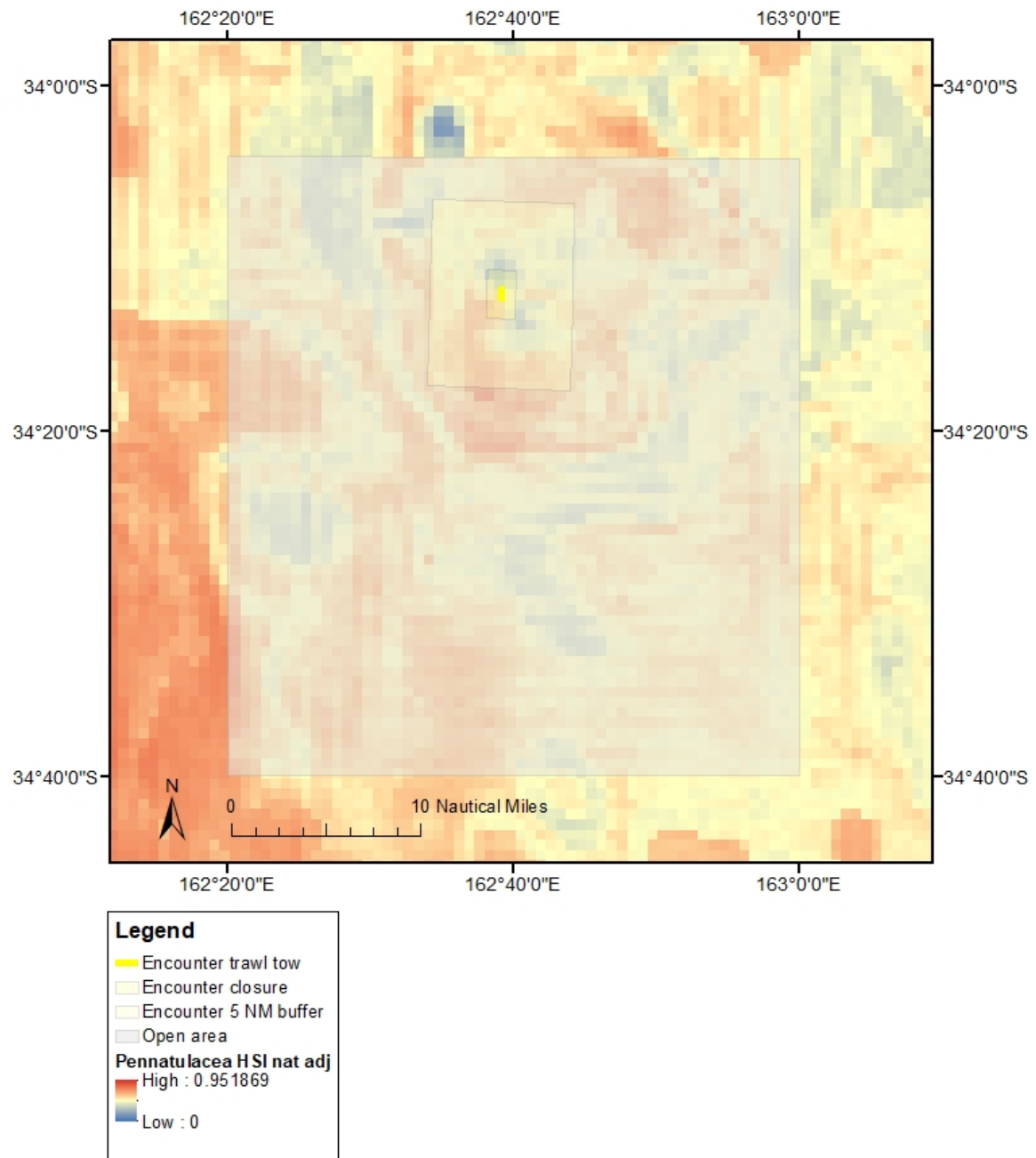
Annex 6 Pennatulacea historic bycatch

Figure A6.1. Spatial distribution of historical bycatch of **Pennatulacea** relative to the **habitat suitability model predictions** for Pennatulacea. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A6.2. Spatial distribution of historical bycatch of **Pennatulacea** relative to the **uncertainty estimates for habitat suitability model predictions** for Pennatulacea. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
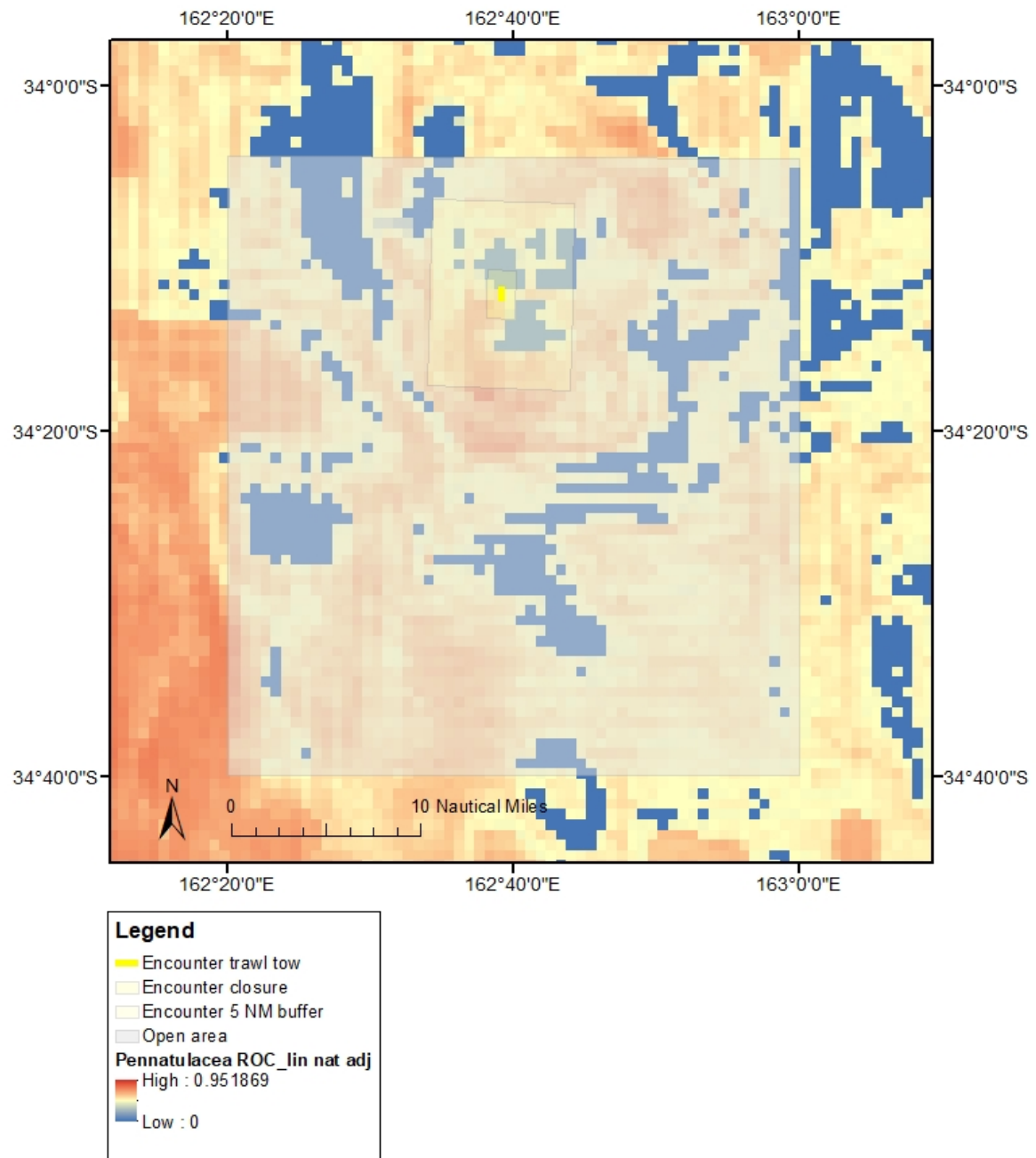
Figure A6.3. Spatial distribution of historical bycatch of **Pennatulacea** relative to the **naturalness adjusted habitat suitability model predictions** for Pennatulacea. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.
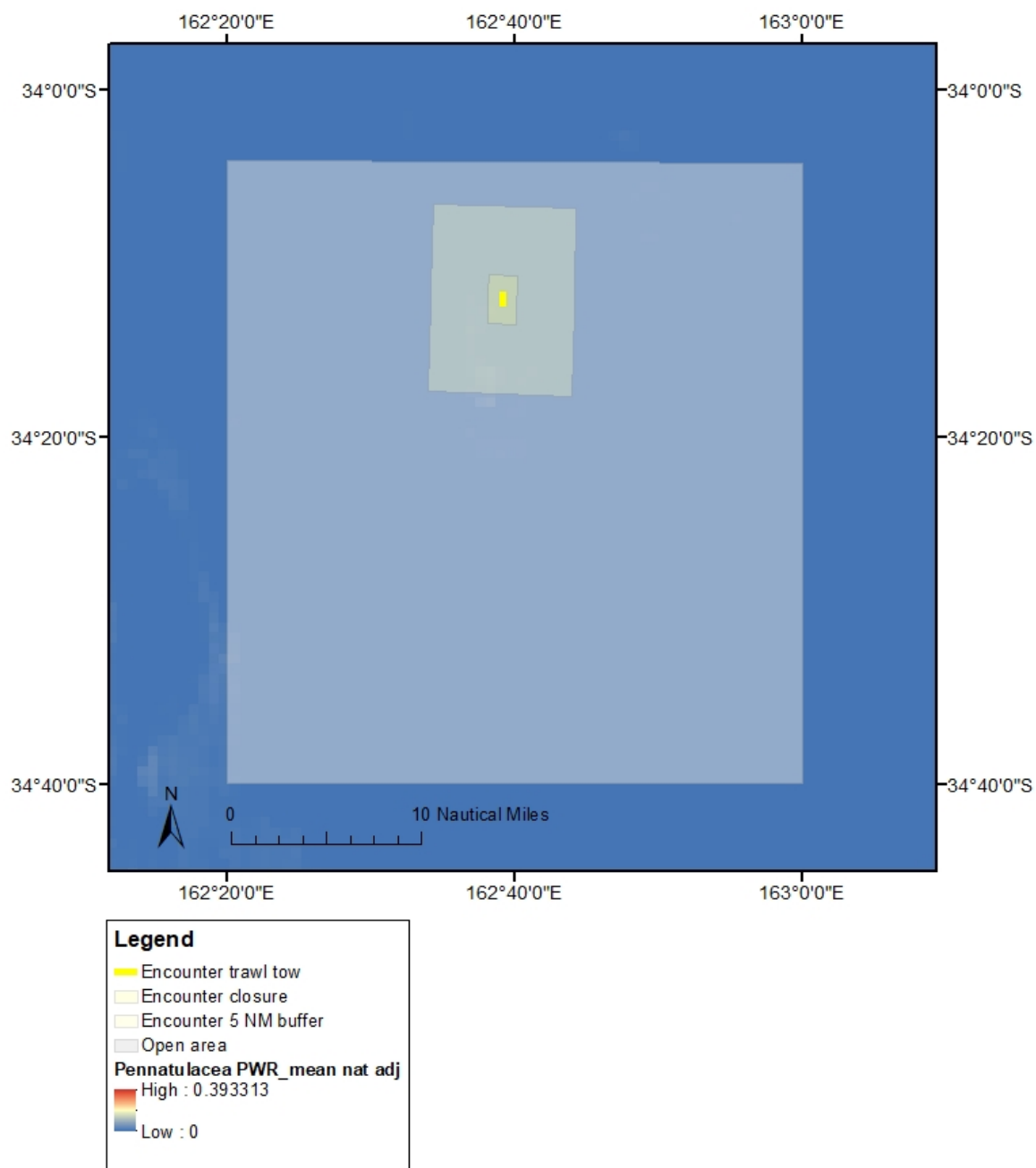
Figure A6.4. Spatial distribution of historical bycatch of **Pennatulacea** relative to the **naturalness adjusted ROC_linear** habitat suitability model predictions for Pennatulacea. Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Figure A6.5. Spatial distribution of historical bycatch of **Pennatulacea** relative to the **naturalness adjusted PWR_mean** habitat suitability model predictions for Pennatulacea Historical distribution of taxa is withheld to comply with national regulations around commercially sensitive data release.

Annex 7 Crinoidea historic bycatch

[image withheld to comply with national regulations around commercially sensitive data release]

Figure A7.1. Spatial distribution of historical bycatch of **Crinoidea** within and adjacent to the open areas within which the encounter occurred. Note, habitat suitability models do not exist for Crinoidea.

Annex 7 Crinoidea historic bycatch

Annex 8 Non-VME historic bycatch

[image withheld to comply with national regulations around commercially sensitive data release]

Figure A8.1. Spatial distribution of historical bycatch of **non VME indicator taxa** within and adjacent to the open area within which the encounter occurred.

Annex 9 Position of encounter relative to spatial scenarios for high protection targets
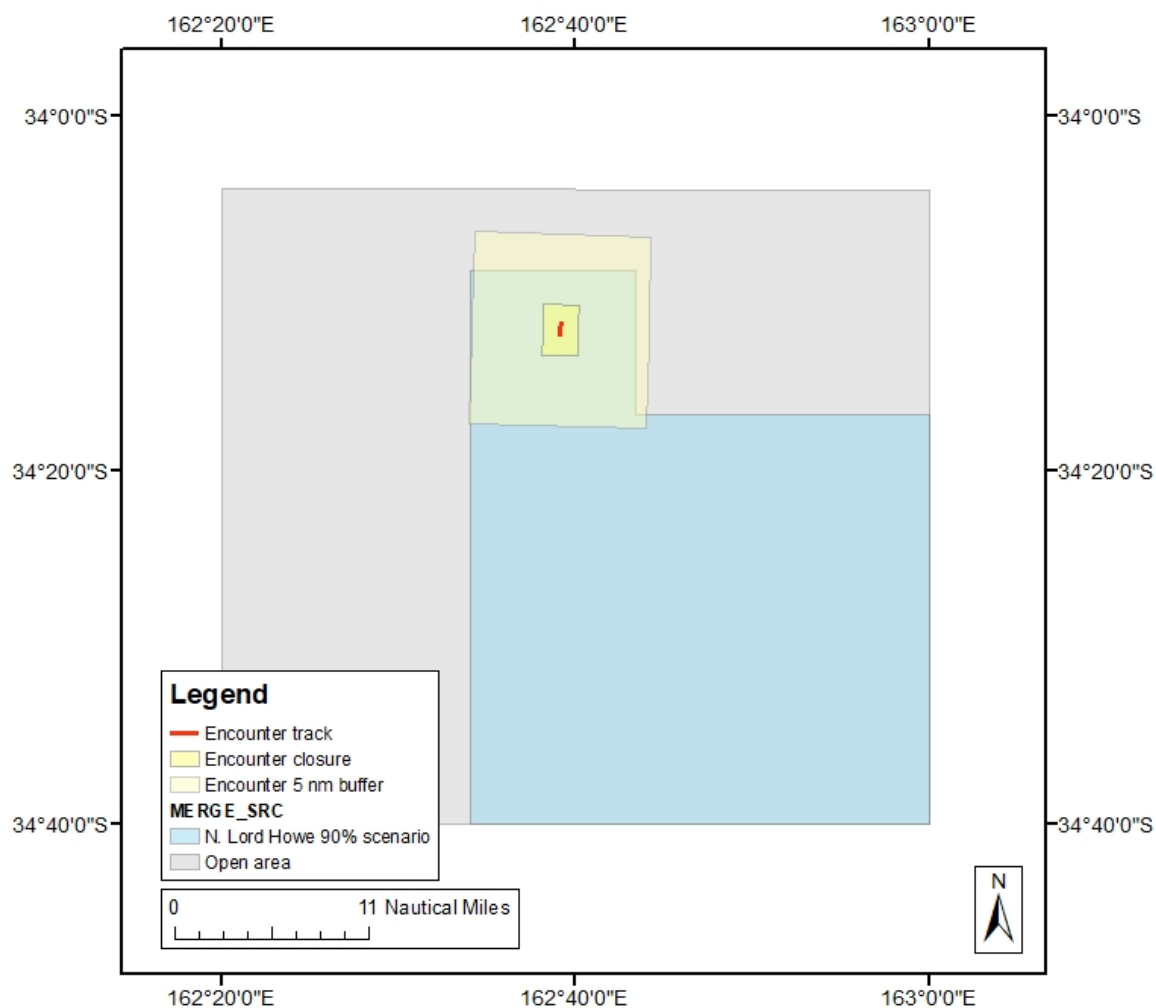
Figure A9.1. Location of the encounter area relative to the spatial scenario boundaries for the 90% protection target
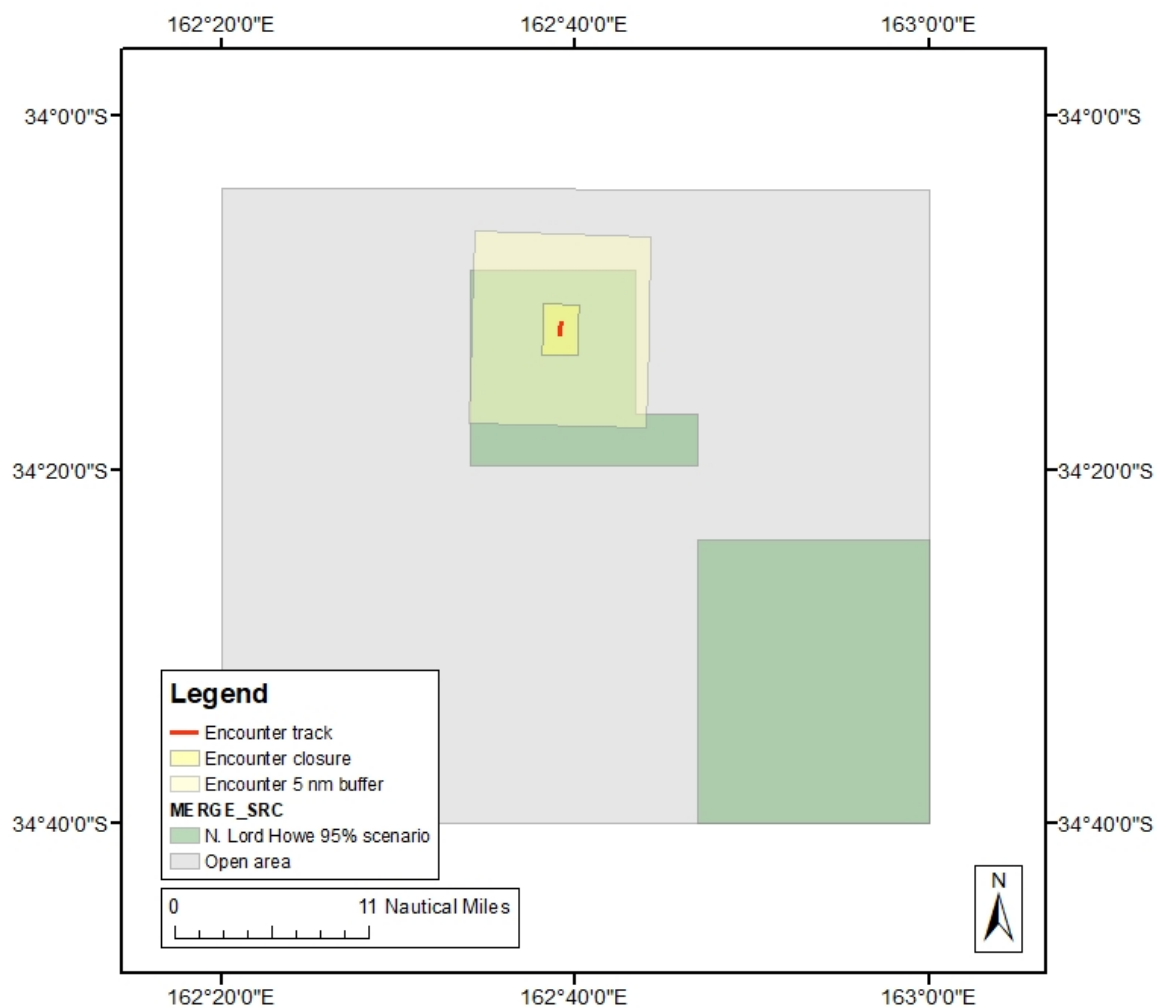
Figure A9.2. Location of the encounter area relative to the spatial scenario boundaries for the 95% protection target

Annex 10 – Proposed Member review process

Step 1: Member or CNCP provides a detailed description of each encounter

Has the Member or CNCP provided the following information for the consideration of the SC?

The date that the event was completed	✔
The start and finish locations of the event	✔
The start and finish depths of the event	✔
Details of the relevant fishing activity, including the bioregion	✔
The location of all historical bottom fishing events (all methods) within at least 5 NM of the encounter tow, or preferably, for the entire open area within which the encounter occurred	✔
The catch weight of all benthic invertebrate species, including but not limited to, VME indicator taxa, in the encounter and all other historical fishing events within at least 5 NM of the encounter or preferably in the entire open area in which the encounter occurred (to the extent that these data are available to the Member)	✔
The existing model predictions of VME indicator taxa within 5 NM of the encounter or preferably for the open area in which the encounter occurred, using the full range of HSI values, HSI values above the model ROC thresholds, and either the power transformed HSI, or thresholds based on that approach	✔
The estimated uncertainty associated with HSI layers	✔
The existing model predictions of VME indicator taxa, discounted for historical fishing impacts	✔

For each encounter event, have maps been provided having the following characteristics?

Oceanographic features (e.g. bathymetry) as available	
A colour scale indicating the predicted HSI for each VME indicator taxon within the area that has an HSI model available, at a scale (granularity) of 1 km, and within at least 5 NM of the encounter	✔
Predictions, using the HSI values, the HSI values above the model ROC thresholds, and either the power transformed HSI, or thresholds based on that approach, until robust abundance models become available	✔
The estimated uncertainty associated with HSI layers	✔
Predictions that correct for estimated "naturalness", i.e., areas already impacted by fishing	✔
Overlay of the encounter track, corrected, to the extent practicable, for differences between the location of the vessel and the gear	✔
Overlay of historical fishing events within at least 5 NM of the encounter, corrected, to the extent practicable, for differences between the location of the vessel and the gear	✔

Step 2: Member or CNCP provides an assessment of whether the encounter constitutes evidence of a VME

Has the Member or CNCP provided a direct and/or indirect assessment of potential VME presence?

A direct assessment involving surveying and mapping the encounter area to directly determine the presence and extent of a potential VME has been undertaken	X
An indirect assessment evaluating the taxa, weight and catch frequency of all species within at least 5 NM of the encounter to identify consistent spatial and taxonomic patterns that would suggest VME presence has been undertaken	✔

Step 3: Member or CNCP determines the scale and significance of historical and likely future fishing impacts

Has the Member or CNCP evaluated whether reopening the area will expose any VMEs to SAIs?

An assessment of the scale and significance of historical and likely future fishing impacts has been provided	✔
Management actions to prevent significant adverse impacts on VMEs have been identified, and include:	
Maintaining closure of the encounter area/s	X
Re-opening the area/s to fishing	✔
Changing the boundaries of the open area/s	X
Other changes (specify below)	X