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**Preliminary evaluation of density levels of VME indicator taxa**

**to define VMEs**

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**Preliminary evaluation of density levels of VME indicator taxa**

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**Abstract**

Of the two officially approved methods of VME-defining frameworks in the NPFC, the Japanese-proposed method evaluates density of VME indicator taxa into three levels (Low, Medium, and High). As the lack of scientific evidence regarding these levels was pointed out by some NPFC Members, we examined the adequacy of each density level in this document. By using the segmented method of cumulative distributions for the density of each VME indicator taxa, we revealed that the current density levels were adequate, or even more precautional, than the calculated results for most taxa. Therefore, application of the current density levels would be recommended to define VMEs using the Japanese-proposed method from a precautional point of view.

**Background**

Currently, the NPFC has approved two methods as a framework for defining VMEs: the method proposed by Japan (NPFC-2019-SSC VME04-WP02) and the one by Canada (NPFC-2021-SSC BFME02-WP05). Both methods use the population density of VME indicator taxa as a part of the assessment process.

In the Japanese method, the density of each VME indicator taxa is categorized into three levels (Table 1), and these categories are used in the screening process for identifying VME sites. However, it was pointed out in SSC BFME04 that the density thresholds should be further explored (NPFC-2023-SSC BF-ME04-Final Report), as the values were determined by a rule of thumb based on expert opinion, not by quantitative analyses. In this study, we examined the adequacy of each density level using the segmented method.

Table 1: Density categories of VME indicator species for screening potential VME sites (based on 7.5 m2 view angle)

|  |  |  |
| --- | --- | --- |
|  | gorgonianssoft corals AntipathariaPorifera | Scleractinia |
| Zero | 0 | 0 |
| Low | 0 < n ≤ 5 | 0 < n ≤ 5 |
| Medium | 5 < n ≤10 | 5 <n ≤ 15 |
| **High** | **10 <** | **15 <** |

**Methods**

Our analysis focused on five taxonomic groups (soft corals, Antipatharia, gorgonians, Scleractinia, Porifera) out of six “VME indicator taxa” in the convention text of the North Pacific Fisheries Commission (NPFC; CMM 2024-05, CMM 2024-06). The occurrence of pennatulacean, an octocorallian taxon included in the list of VME indicator taxa by the commission since 2023, is very limited in the NW Convention Area (total number of pennatulaceans-presence data = 17). We decided to eliminate this taxon from further assessments due to the lack of sufficient data. For classifying cold-water corals into four groups (Antipatharia, Scleractinia, gorgonians, and soft corals), we followed the translation table (Yamaguchi et al., 2024). Hexactinellida (glass) sponges and Demospongiae were classified as the phylum Porifera, as it is difficult to identify sponges to the class level by visual surveys.

In total, 1,759 (with/without VME indicator taxa) points of visual survey data collected in Emperor Seamounts via R/V Kaiyo-Maru from 2009 to 2024 were used for the evaluation. Firstly, data with no VME indicator taxa (which will be categorized into the "Zero" category for the density classification) and/or data with no density records were excluded. For faster and easier evaluation in the field, we evaluated all density data based on the visual angle, thus the following assessments were done based on the same unit of density (no. individuals per 7.5m2). As our method is categorizing VME indicator presence data into three levels with two breaking points (Low, Medium, and High), we applied 2-parameter segmented regression to the cumulative frequency distribution for the density of each VME indicator taxa and figured out the changing points of density cumulative curves. Fitting of segmented regressions for the VME indicator data was completed using the segmented package in R ver. 4.4.1 (Vito and Muggeo 2008, R Core Team 2022).

**Results & Discussion**

The estimated breaking-point density values were comparable with the current density-levels (Fig. 1, Table 1, 2). For example, in Porifera, whose current density levels having the thresholds of 5 and 10, first and second segmented points of the fitted regressions appeared in 3.32 and 10.42 individuals/7.5m2, respectively. In gorgonians and Antipatharia, their second segmented points of the regressions appeared at larger values (23.45 and 15.89 individuals/7.5m2, respectively) than the current ones (10 individuals/7.5m2 for both taxa). These results imply that the current density levels are mostly set at the appropriate, or even much more precautional, levels. For Scleractinia, though, our calculated values were slightly lower than the current ones, nevertheless, this difference was less than 5. The lowest value was observed for soft corals, whose first and second segmented points were observed the nearest to 2 and 7 individuals, respectively. Since the amount of data is limited in soft corals (n < 300), these values might be unreliable.

Given that the density is likely to be related to FAO criteria such as “rarity/uniqueness”, “structural complexity” and “functional significance of the habitat”, our approach using density patterns can contribute to the science-based choice of density thresholds, although it may not be conclusive. Our results showed that the current density category used to sort the potential VME sites is suitable to evaluate the sites in a precautionary way. Thus, continual use of the current density levels would be recommended for the Japanese method. For Scleractinia, our calculated results showed slightly lower density levels than the current ones. However, this result does not immediately deny the validity of current thresholds. Since most of Scleractinia colonies found during the visual surveys are much smaller (with few exceptions) than other dominant VME indicator taxa, such as gorgonians and/or Antipatharia, it is reasonable to assume that they require a higher density to be functionally significant. Thus, the use of current thresholds is still reasonable for Scleractinia, while some attention should be paid to sites with intermediate density of this taxa. Possible interaction between density and size of VME indicator colonies/individuals should be explored in the future.

Lastly, we emphasize that the density levels studied here are only part of the process in the Japanese method of VME definition and SAI assessment. Although our VME defining procedures are using these density levels to screen out the “high-density-level areas” as “potential VME sites”, scientists evaluate images from all candidate sites (VME-indicator-present sites) to detect possible VME occurrence with respect to each of the VME criteria.



Figure 1. Cumulative proportional curves (grey line) of the density of VME indicator taxa of visual survey data from 2009 to 2024 and 2-parameter segmented regressions (black solid line). Blue and red dash lines represent the first and second segmented points.

Table 2: Results of calculated segment points per VME indicator taxa (no. individuals per 7.5m2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 　 | gorgonians | Antipatharia | Porifera | Scleractinia | soft corals |
| no. data | 731 | 270 | 307 | 344 | 103 |
| 1st segment point | 8.70  | 4.40  | 3.32  | 3.80  | 1.76 (\*) |
| 2nd segment point | 23.45  | 15.89  | 10.42  | 10.29  | 7.38 (\*) |
| (\*Limited reliability of the results due to the data limitation.) |

**Conclusion**

* Current density levels of most VME indicator taxa were reasonable, or rather precautional. Thus, continual application of current density levels is recommended to define VMEs by Japanese-proposed method.

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