PAEWG-01-12

First Meeting of the Protected Areas and Ecosystems Working Group (PAEWG1)

18-19 March 2019

Spatial and biophysical analysis of the SIOFA area as a background to complement the Benthic Protected Areas Designation Protocol

Relates to SC4 agenda item: 6.1 Protected Areas and Ecosystems Working Group

(PAEWG 3.3 Protected area protocols) Working paper ☒ Info paper ☐

Delegations of France (Territoires) and Australia

Abstract

This document is a draft to be discussed and completed within the PAEWG, and finalized during the PAEWG 2019 physical meeting. This document presents an example of implementation of "the proposal of methodological approach to complement the SIOFA's Benthic Protected Areas Designation Protocol". Ecological regions have been highlighted for the SIOFA area, based on the clusterisation of various statistical spatial datasets. BPA proposals have been projected into the model to obtain a series of statistics allowing their analysis regarding various conservation issues.

Recommendations *(working papers only)*

This document is to be discussed within the PAEWG-01 and during the PAEWG-01 physical meeting.

Introduction

Bioregionalisation is a process that aims to divide a large spatial area into distinct spatial regions, using a range of environmental and biological information. The process results in a set of bioregions, each with homogeneous and predictable ecosystem properties (Grant et al. 2006). Bioregions can be divided at different spatial scales, depending on their physical and environmental characteristics. The properties of a given bioregion should differ from those of regions such other bio in terms of species composition and the attributes of its physical and ecological habitats. Bioregionalization provide information on the location and distribution of species and their habitats through an objective zoning, and constitutes a basis for efforts to better understand future changes, understand, conserve and manage activities in the marine environment (Grant et al., 2006).

At the global scale, ocean zone classification attempts have been made for coastal and continental shelf areas, for example in the definition of Large Marine Ecosystems (LMEs) (Sherman & Alexander 1986, Sherman & Duda 1999). Morevore, Longhurst conducted a biogeographic classification of the world's oceans, mainly from satellite data (Coastal Zone Color Scanner: CZCS), which provided both a global and dynamic description of surface phenomena (seasonal climatology and specific phenomena). It has also integrated studies of major oceanographic physical phenomena (general currentology, oceanographic campaigns) by coupling them with telemetry data.

The general objective of this study is to delineate caracterise bioregions in SIOFA area where attempts to delimit marine bioregions are rare. This study will amend the site designation protocol based on a scientific approach.

Material and methods

Contexte

In 2018, the Third Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement recommended to consider five sites could be designated as protected area reviewed against the revised SIOFA standard protocol for future protected area designation. The Meeting of the Parties requested the Scientific Committee to review the interim protocol for the designation of protected areas. In particular, the Scientific Committee is requested to clarify the use of the criteria and provide in particular a ranking and a key for using these criteria in view to developing appropriate management plans/measures.

The scientific approach presented in this document may allow us to amend this site designation protocol in order to have a more relevant site analysis. In addition, this scientific approach can help to clarify the use of the criteria of the site designation protocol and provide, in particular, a ranking and a key for the use of these criteria in the development of appropriate management plans/actions.

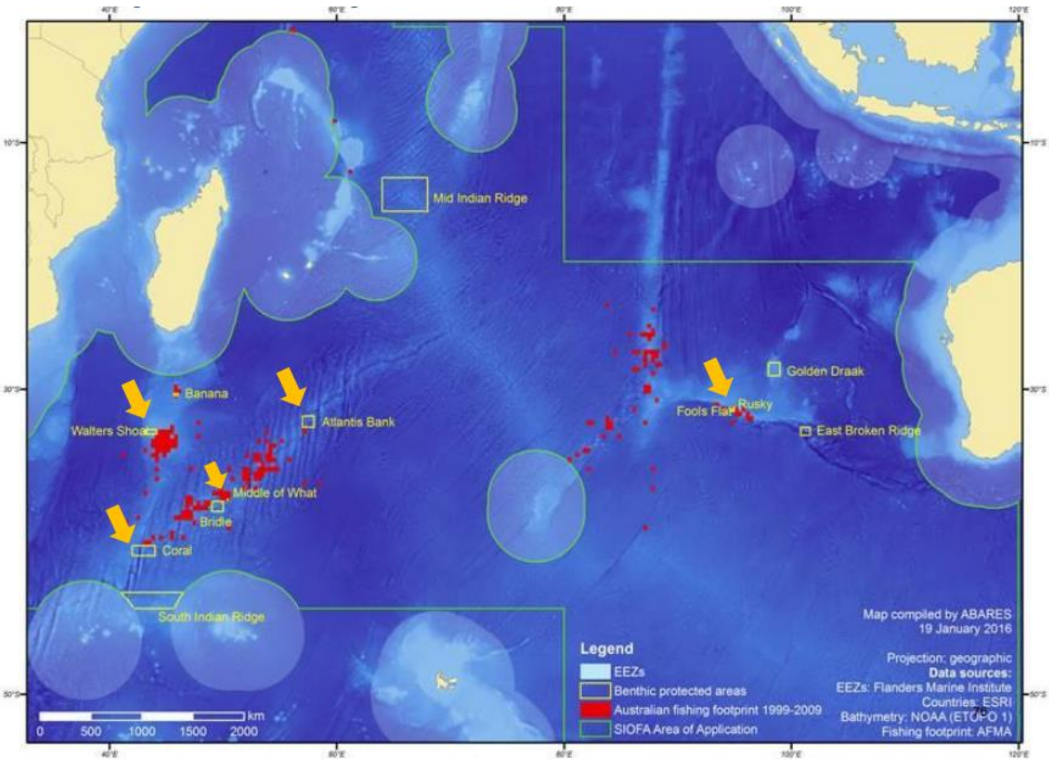


Figure 1-Map of the SIOFA area with the 12 BPAs proposals

The proposed method consists of analyzing, using a standardized grid, the spatial, physical and biological parameters of the entire study area. A series of statistics is derived for each grid cell that in this approach has been defined to a series of squares of one degree.

We have chosen a number of basic parameters that we consider relevant (for example: chlorophyll - which is a proxy for organic production, velocity - which represents areas of high turbulence...) and which can be considered separately as conservation issues (for example, connectivity of seamounts, representativeness of upper bathomes on slopes...). The choice of parameters can be discussed at the CP, there can be an addition of parameters if necessary, it is not a fixed model.

Spatial layer

12 spatial layers have been created (all layers were created from Qgis):

- Bathomes: 6 layers (from GEBCO's raster: https://www.gebco.net/)
  (0-200m ; 201-700m ; 701-1000m; 1001-1500m; 1501-2000m; +2001m)
- Distance matrices : 2 layers (Minimum distance to the closest continent – Minimum distance to the closest large island) (from territory layers and seamounts layers)
- Slope: 1 layer (from GEBCO's raster: https://www.gebco.net/)
- Rugosity: 1 layer (from GEBCO's raster: https://www.gebco.net/)
- Seamounts connectivity : 2 layers (Quantity of seamounts within each statistical square - close connectivity; Quantity of seamounts within a larger region - large connectivity) (from Global Distribution of Seamounts and Knolls (2011)
  http://data.unep-wcmc.org/pdfs/41/ZSL-002-ModelledSeamounts2011.pdf?1533031546)

Biophysical layer

Biophysical data were uploaded to the Bio-Oracle website (http://www.bio-oracle.ugent.be/-oracle.ugent.be/). The data were produced with climate data describing monthly averages for the period 2000-2014, obtained from new pre-processed analyses of the world's oceans combining satellite and in situ observations with regular spatial grids (Tyberghein et al. 2012; Assis et al. 2017).

Table 1- Characteristic of biophysical parameters

Environmental parameters	Units	Spatial Resolution
Bottom [Chlorophyll]	mg.m-3	The spatial resolution is 5 arc minutes (about 0.08° or 9.2 km at the equator).
Surface [Chlorophyll]	mg.m-3	The spatial resolution is 5 arc minutes (about 0.08° or 9.2 km at the equator).
Bottom Temperature	°C	The spatial resolution is 5 arc minutes (about 0.08° or 9.2 km at the equator).
Bottom Currents velocity	m-1	The spatial resolution is 5 arc minutes (about 0.08° or 9.2 km at the equator).
Bottom Salinity	PPS	The spatial resolution is 5 arc minutes (about 0.08° or 9.2 km at the equator).

Biodiversity data

To carry out the state of biodiversity knowledge we collected all the GBIF data (https://www.gbif.org/) present in the SIOFA area, in order to see the number of occurrences present in each square of the grid. We then classified these occurrences by major group (Benthos, fish, algae, plankton, bacteria, mammals).

Data processing and statistical analyses

All statistical analyses and the maps were done in the Rstudio and QGIS

The first step in the "bioregionalisation" procedure was to conduct a Principal Component Analysis (PCA, Legendre and Legendre, 1998) on the spatial parameters (slope, roughness, quantity of seamounts, distance to mainland and island and different depths) then to the biophysical parameters (bottom temperature, bottom salinity, bottom chlorophyll concentration, bottom velocity and bottom dissolved oxygen as well as chlorophyll surface concentration). The second step consisted in clustering sites by applying the method of K-means (MacQueen, 1967) on their coordinates on the two first PCA axes. The optimal number of clusters was chosen using the elbow method. The final step was to create two maps of "bioregions", based on spatial data clusterisation and a biophysical data clusterisation.

Results

Characterization of bioregions

We identified an optimal number of bioregions of seven for spatial clusters and biophysical clusters on the basis of our PCA of spatial and biophysical conditions (Figure 2 et 4). Therefore, we identified seven distinct bioregions that differed in terms of spatial parameters (slope, roughness, quantity of seamounts, distance to mainland and island and different depths) and biophysical parameters (bottom temperature, bottom salinity, bottom chlorophyll concentration, bottom velocity and bottom dissolved oxygen as well as chlorophyll surface concentration).

Spatial clusters:

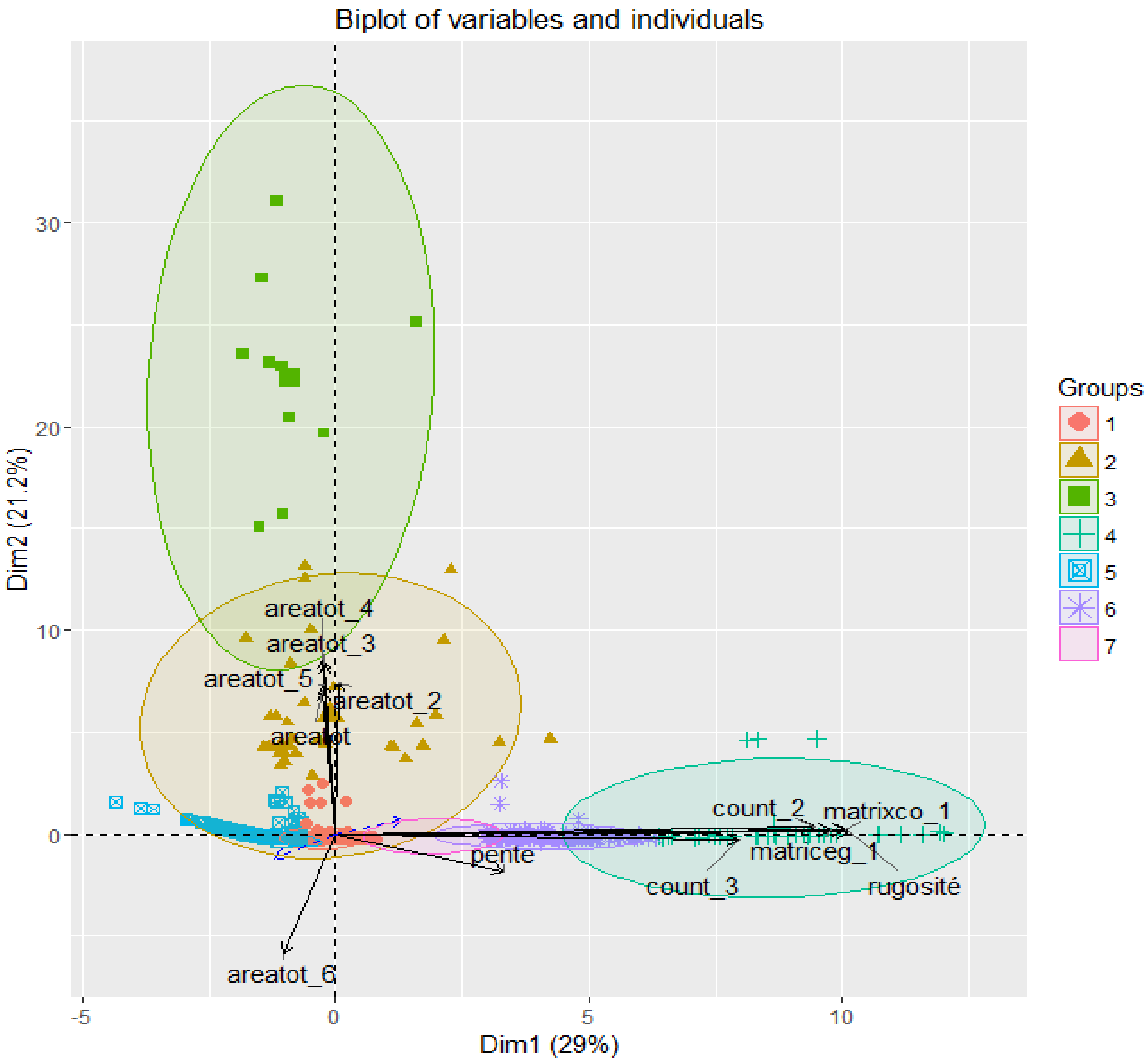


Figure 2-PCA of spatial parameters with color by cluster

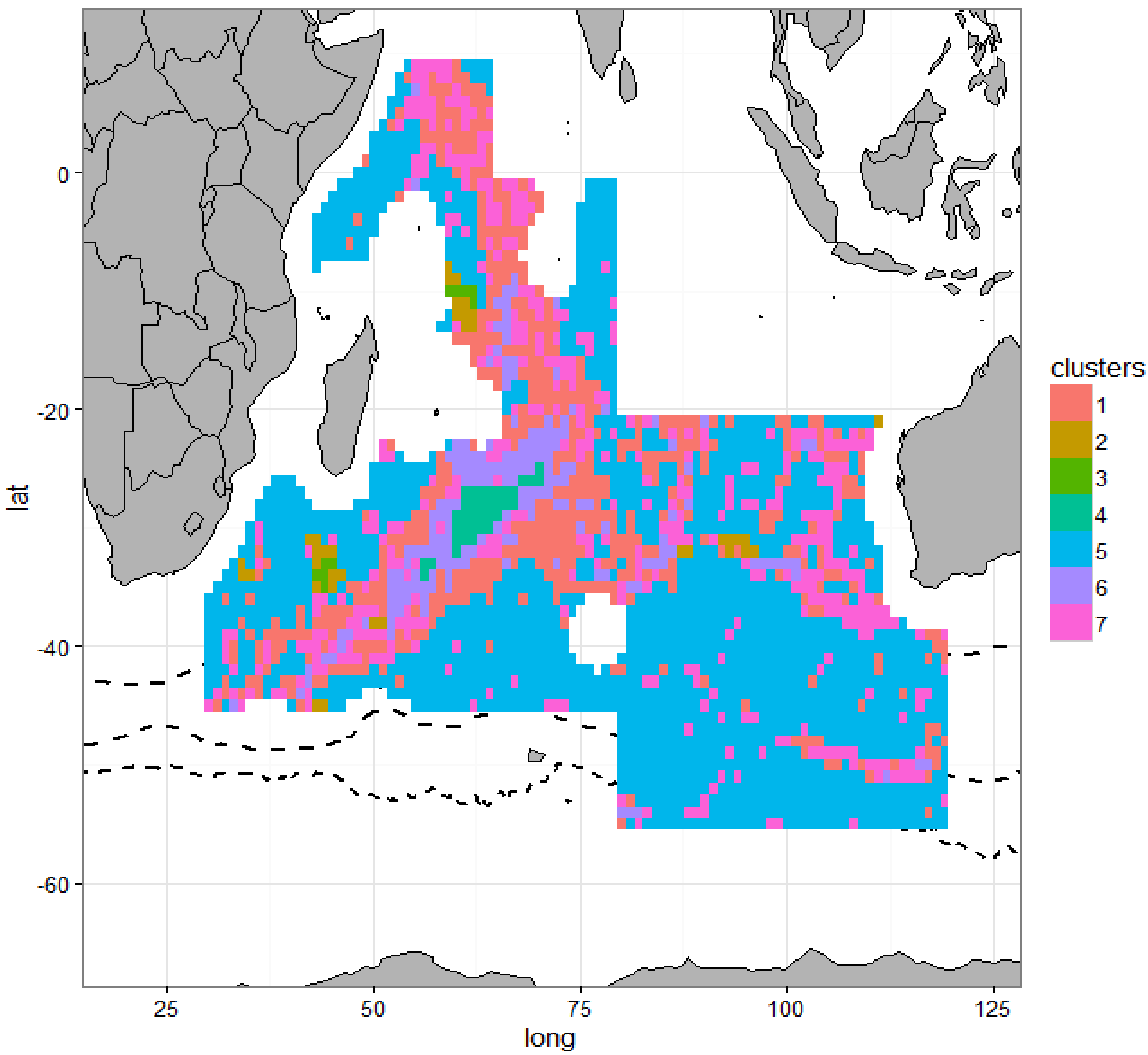
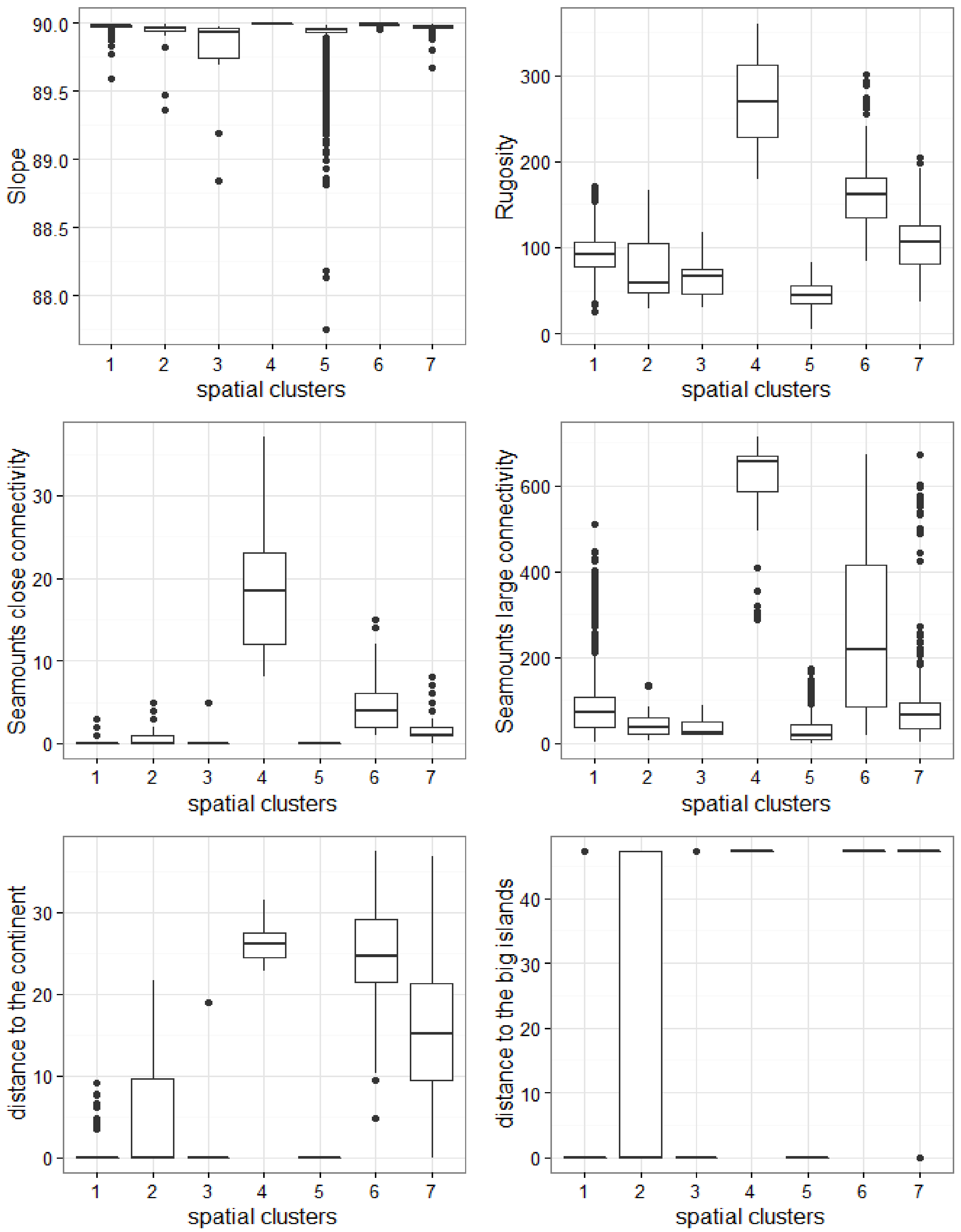
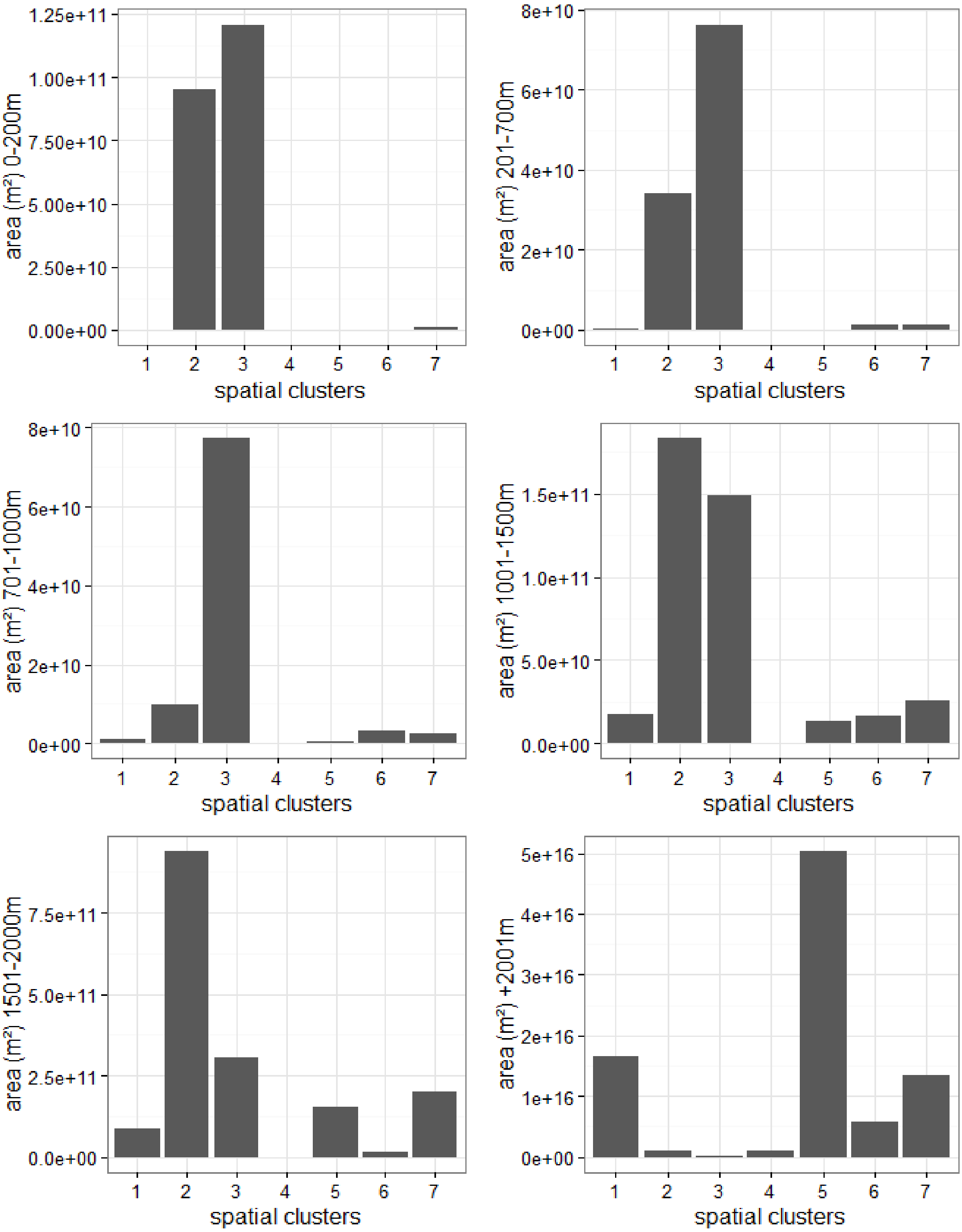


Figure 3-Map of spatial clusters

Spatial parameters by cluster:





1.25e+11
1.00e+11
7.50e+10
5.00e+10
2.50e+10
0.00e+00
area (m²) 0-200m
1 2 3 4 5 6 7
spatial clusters
8e+10
6e+10
4e+10
2e+10
0e+00
area (m²) 201-700m
1 2 3 4 5 6 7
spatial clusters
8e+10
6e+10
4e+10
2e+10
0e+00
area (m²) 701-1000m
1 2 3 4 5 6 7
spatial clusters
1.5e+11
1.0e+11
5.0e+10
0.0e+00
area (m²) 1001-1500m
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spatial clusters
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5.0e+11
2.5e+11
0.0e+00
area (m²) 1501-2000m
1 2 3 4 5 6 7
spatial clusters
5e+16
4e+16
3e+16
2e+16
1e+16
0e+00
area (m²) +2001m
1 2 3 4 5 6 7
spatial clusters

Summary table of spatial parameters:

	1	2	3	4	5	6	7
Slope	high	high	low	high	low	high	high
Rugosity	low	low	low	high	low	medium	medium
Seamounts close connectivity	low	high	low	high	low	medium	low
Seamounts large connectivity	low	low	low	very high	low	high	low
mdcc	low	low	low	high	low	high	high
mdcli	low	medium	low	high	low	high	high
0-200m	low	low	high	low	low	low	low
201-700m	low	low	high	low	low	low	low
701-1000m	low	low	high	low	low	low	low
1001-1500m	low	medium	high	low	low	low	low
1501-2000m	low	high	high	low	low	low	low
+2001m	high	high	medium	high	high	high	high

Biophysical clusters:

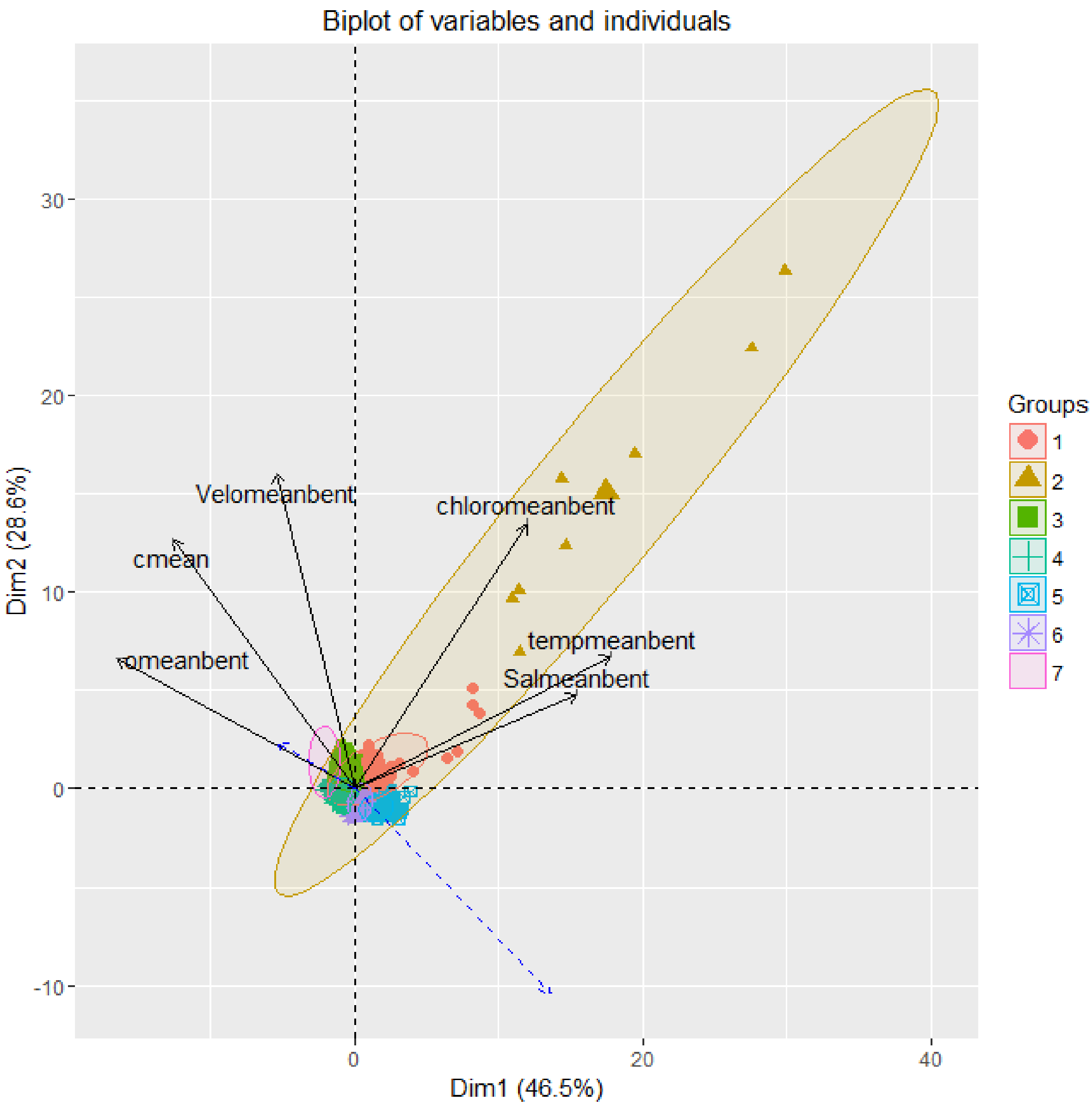


Figure 4-PCA of biophysical parameters with color by cluster

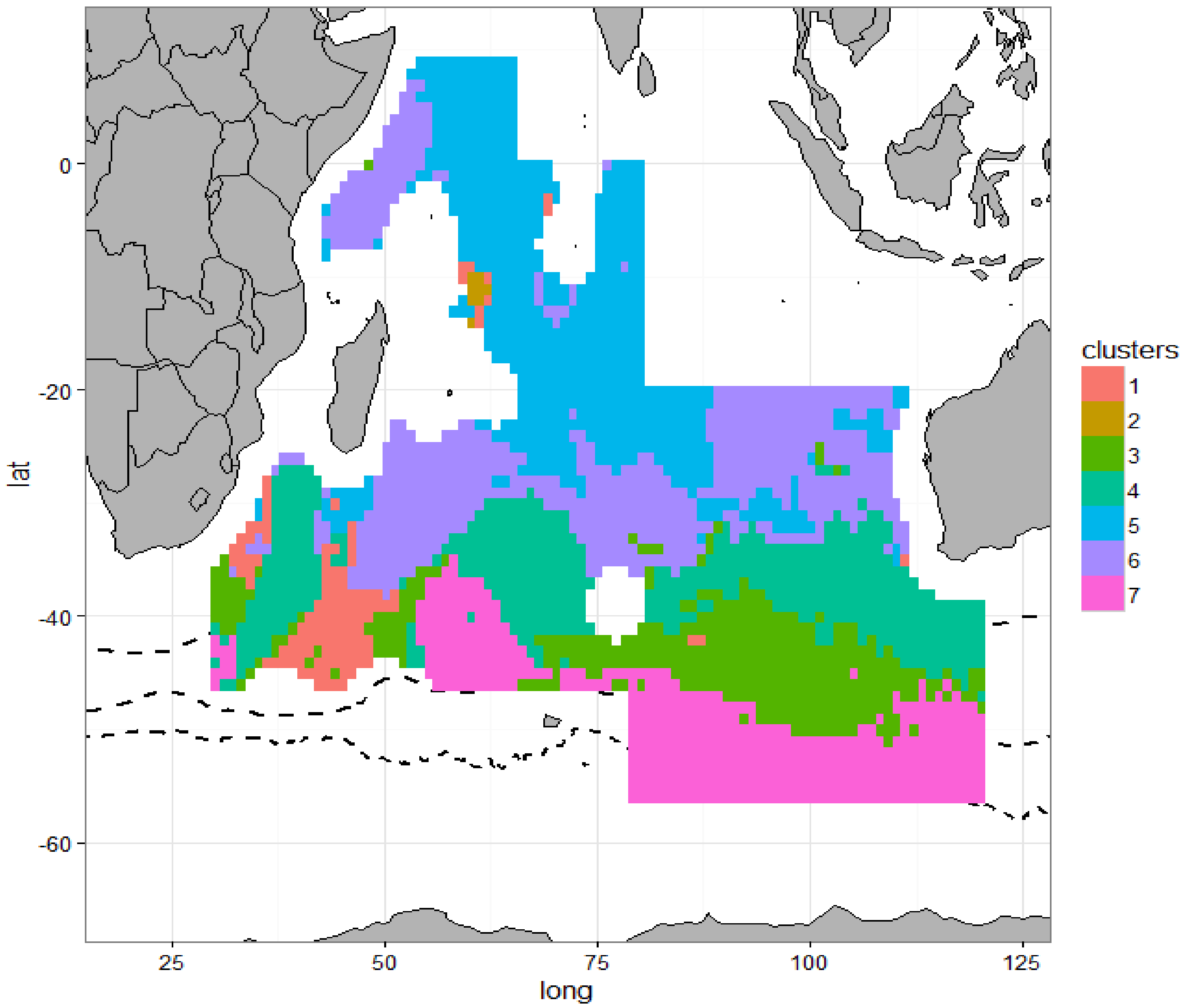
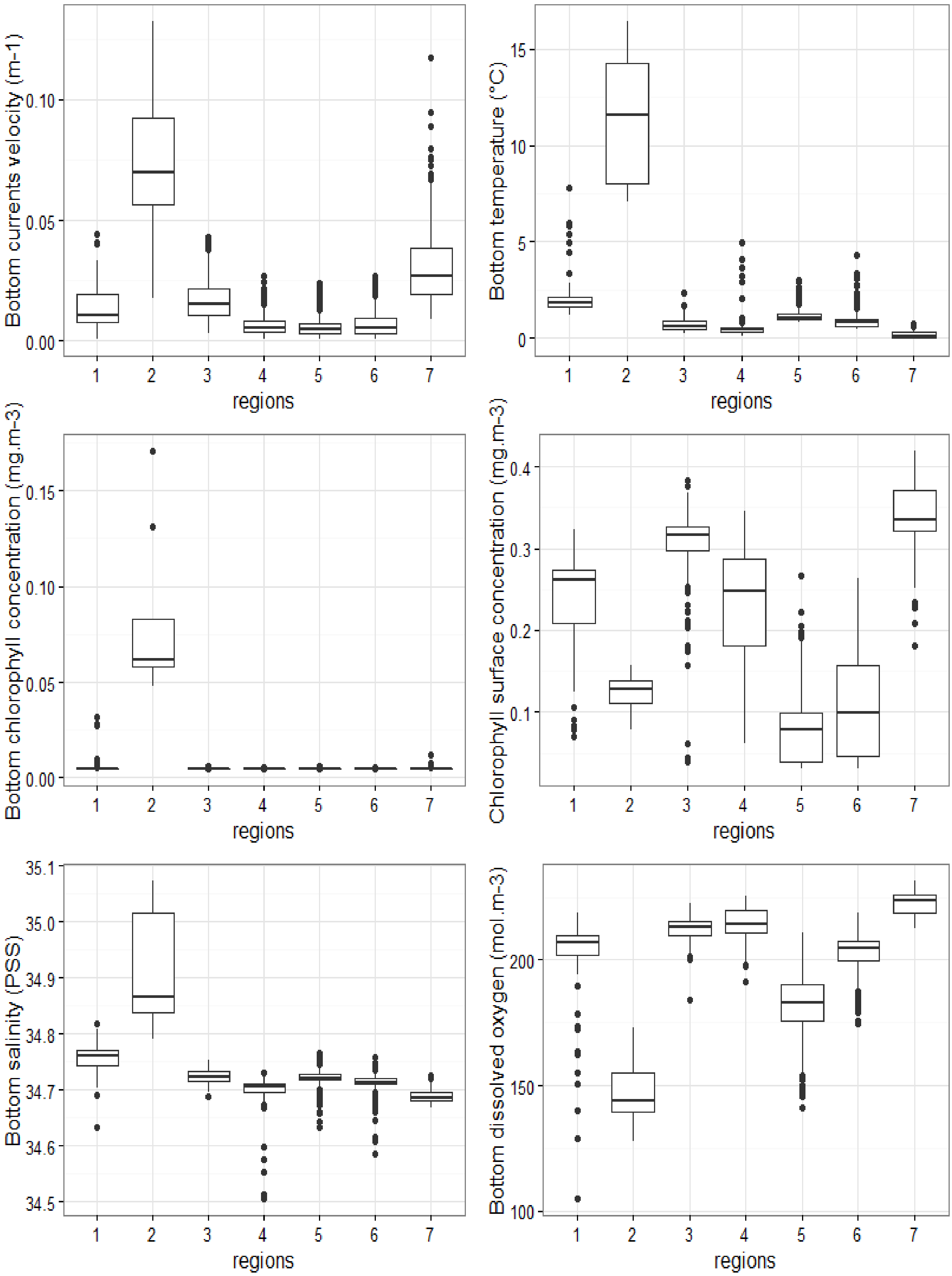


Figure 5-Map of biophysical clusters

Biophysical parameters by clusters:



Summary table of biophysical parameters:

	1	2	3	4	5	6	7
Bottom currents velocity (m-1)	low	high	low	low	low	low	quite high
Bottom chlorophyll concentration (mg.m-3)	low	high	low	low	low	low	low
Bottom salinity (PSS)	medium	high	medium	medium	medium	medium	medium
Bottom temperature (°C)	low	very high	low	low	low	low	low
Chlorophyll surface concentration (mg.m-3)	quite high	low	high	high	low	high	high
Bottom dissolved oxygen (mol.m-3)	high	low	high	high	low	medium	very high

Biodiversity

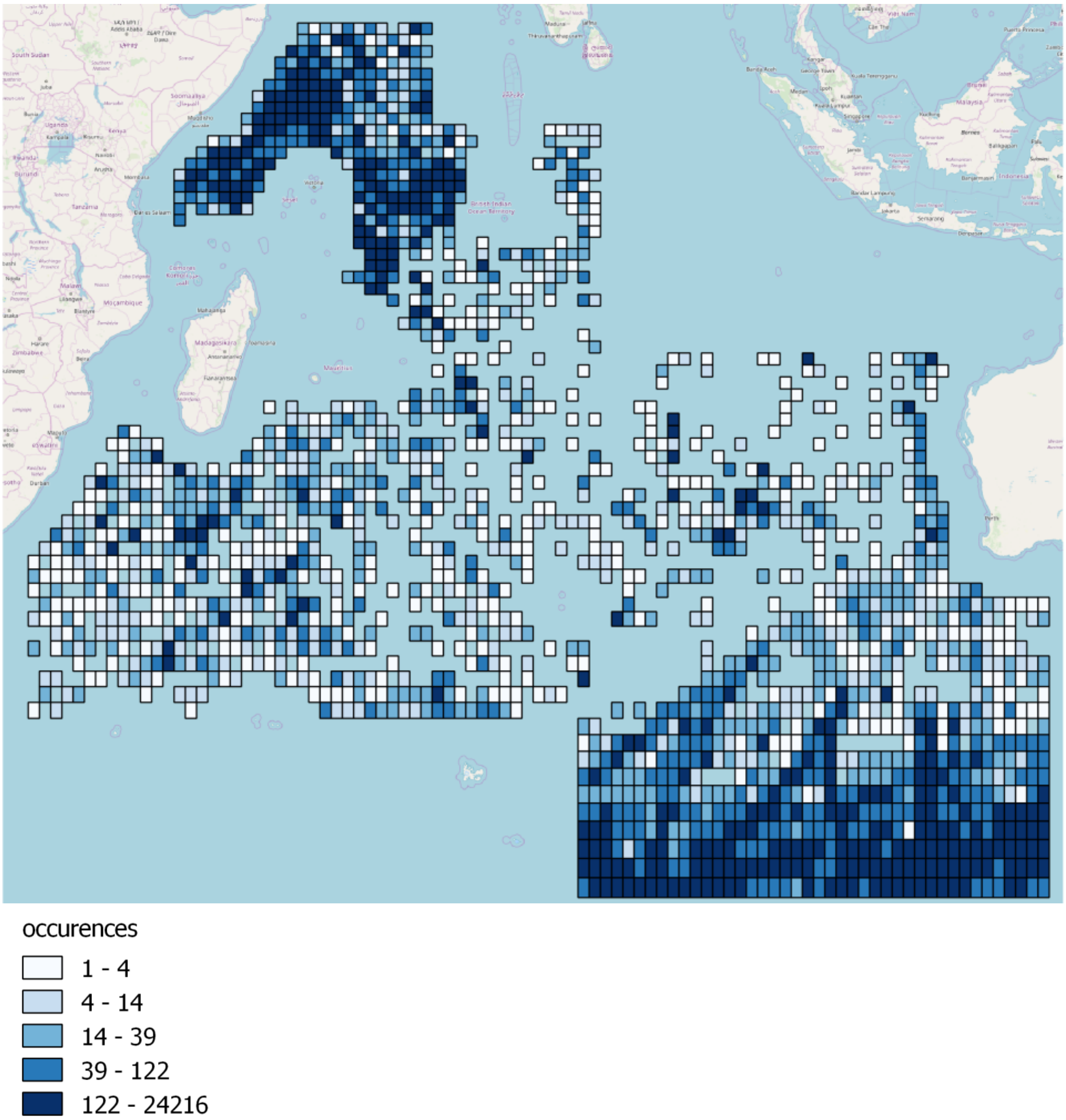


Figure 6-Map with occurrences by square in SIOFA area

Application of the analysis on five BPAs

- ## Walters Shoal

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix 1)	Biophysical parameters (Appendix 2)	Biodiversity (Appendix 3)
Walters Shoal	**Specific parameters:** - Large variation in slope - Large depth variation - Close to islands and continents **Common parameters :** - Low roughness - Seamounts rather isolated **Spatial clusters:** Locate in cluster 3 it represents about 20% of cluster 3	**Specific parameters** -Very high concentration of chlorophyll in depth -High temperature **Common parameters :** -Low salinity -High dissolved O2 content - Chlorophyll surface concentration mean -Low velocity **Biophysical clusters:** Locate in cluster 1 it represents about 1.7% of cluster 1	- Good knowledge of benthos and biodiversity - Good scientific knowledge because several campaigns have been carried out

Walters Shoal is located on a plateau area spread out with canyons, seamounts and ridges, which explains the great variation in slope and depth (from 15m to 4500m deep). There is therefore a great diversity of habitats, which makes Walters Shoal unique. In addition, Walters Shoal is located south of Madagascar and east of the tip of Africa. So there may be an island or mainland effect, which can lead to an increase in planktonic biomass due to the iron supply from the territories (Guyomard et al. 2006). It represents about 0.07% of SIOFA area. Walters Shoal is the only site in cluster 3 of the space clusters, it represents about 20% of cluster 3. The cluster 3 represents 0.4% of SIOFA area.

An area with a high concentration of chlorophyll-a is an area with very good organic production that promotes the development of biodiversity. In addition, it is a rather isolated bench that can have a fauna and flora endemic to the area. The good scientific knowledge comes from the fact that many scientific campaigns (mentioned above) have been carried out on Walters Shoal.

All these parameters make it important to protect and maintain this site in good condition.

- ## Atlantis Bank

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix1)	Biophysical parameters (Appendix2)	Biodiversity (Appendix3)
Atlantis Bank	**Specific parameters:** -High slope and roughness -Large depth variation -Seamount very connected **Common parameters :** -Far from islands and continents **Spatial clusters:** Locate in cluster 4 it represents about 0.3% of cluster 4	**Common parameters :** -Rather high velocity -Low temperature -Low chlorophyll concentration -High dissolved O2 content **Biophysical clusters:** Locate in cluster 6 it represents about 0.15% of cluster 6	-Good knowledge of benthos -Good scientific knowledge because there are several scientific campaigns carried out

Atlantis Bank is a seamount (Rogers et al. 2012) located on the South West Indian ridge, which explains the great variation in slope and depth (from 700m to 4000m deep). There is therefore a great diversity of habitats, which makes Atlantis Bank unique. It represents about 0.04% of SIOFA area. Atlantis Bank is the only site in cluster 4 of the space clusters, it represents about 0.3% of cluster 2. The cluster 4 represents 1.3% of SIOFA area.

Moreover, it is a very connected seamount so it has a lot of flow with neighbouring seamounts. It may be part of a biological corridor. In addition, a site very connected to a contribution of new species. The good scientific knowledge comes from the fact that many scientific campaigns (mentioned above) have been carried out on Atlantis Bank.

All these parameters make it important to protect and maintain this site in good condition.

- **Coral**

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix1)	Biophysical parameters (Appendix2)	Biodiversity (Appendix3)
Coral	**Specific parameters:** -High slope and variation in roughness -Depth variation **Common parameters:** -A little connected area -Far from continents and islands **Spatial clusters:** Locate in clusters 6 and 7 it represents about 0.6% of cluster 6 and about 0.2% of cluster 7	**Specific parameters :** -High velocity -High surface chlorophyll -High salinity **Common parameters :** -Low temperature -High dissolved O2 content **Biophysical clusters:** Locate in cluster 1 it represents about 1.7% of cluster 1	-Pretty good knowledge of benthos -Some campaigns carried out on the site

Coral is located on seamounts and ridges on the South West Indian ridge, between the ascent of Del Cãno and the bridle, hence the great variation in slope and depth (from 200m to 4500m deep) (Read and Pollard 2017). There is therefore a great diversity of habitats, which makes Coral special. It represents about 0.07% of SIOFA area. Coral is the only site in clusters 6 and 7 of the space clusters, it represents about 0.6% of cluster 6 and about 0.2% of cluster 7. The cluster 6 represents 6.4% and cluster 7 represents 15.2% of SIOFA area.

An area with a high concentration of chlorophyll-a is an area with very good organic production that promotes the development of biodiversity. In addition, it is a rather isolated bench that can have a fauna and flora endemic to the area.

There is scientific knowledge because there have been some scientific campaigns carried out on Coral.

All these parameters make it important to protect and maintain this site in good condition.

- ## Middle of what (MOW)

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix1)	Biophysical parameters (Appendix2)	Biodiversity (Appendix3)
Middle of What	**Specific parameters:** -High slope with average roughness -Present in deep bathomes **Common parameters:** -Moderately connected site -Far from the islands and mainland **Spatial clusters:** Locate in cluster 2 it represents about 2.7% of cluster 2	**Specific parameters:** -High surface chlorophyll concentration **Common parameters :** -Average velocity -Average temperature -High dissolved O2 content **Biophysical clusters:** Locate in cluster 6 it represents about 0.15% of cluster 6	-Pretty good knowledge of benthos -Some campaigns carried out

Middle of What (MOW) is located on seamounts and ridges on the southern tip of South West Indian ridge, resulting in great variation in slope and depth (in deeper bathomes). There is therefore a great diversity of habitats, which makes Middle of What special. It represents about 0.04% of SIOFA area. MOW is the only site in cluster 1 of the space clusters, it represents about 2.7% of cluster 2. The cluster 2 represents 1.3% of SIOFA area.

An area with a high concentration of chlorophyll-a is an area with very good organic production that promotes the development of biodiversity.

There is scientific knowledge because there have been some scientific campaigns carried out on MOW.

All these parameters make it important to protect and maintain this site in good condition.

- **Fools Flat**

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix1)	Biophysical parameters (Appendix2)	Biodiversity (Appendix3)
Fools flat	**Specific parameters :** -High slope and average roughness -Depth variation -Isolated site **Common parameters :** -Far from continents and islands **Spatial clusters:** Locate in cluster 1 it represents about 0.2% of cluster 1	**Specific parameters**: -Low salinity -Average velocity **Common parameters :** -Low temperature -Low chlorophyll concentration -High dissolved O2 content **Biophysical clusters:** Locate in cluster 6 it represents about 0.15% of cluster 6	-Pretty good knowledge of fish -Some campaigns carried out

Fools Flat is located on the south side of the Broken Ridge Plateau to Vancouver Island and on a seamount, resulting in a wide variation in slope and depth (from 700m to 4500m deep). There is therefore a great diversity of habitats, which makes Fools Flat special. It represents about 0.04% of SIOFA area. Fools Flat is the only site in cluster 1 of the space clusters, it represents about 0.2% of cluster 1. The cluster 1 represents 18,7% of SIOFA area.

In addition, it is a rather isolated bench that can have a fauna and flora endemic to the area.

There is little scientific knowledge because there have been few scientific campaigns carried out on Fools Flat.

All these parameters make it important to protect and maintain this site in good condition.

Comparison of the analyses carried out on the 5 BPAs compared to the SIOFA area

In the SIOFA area, we can be seen that six out of seven spatial clusters are represented by the five BPAs. Walters Shoal represents about 20% of cluster 3, Atlantis Bank represents about 0.3% of cluster 4, Coral represents about 0.6% of cluster 6 and about 0.2% of cluster 7, Middle of What represents about 2.7% of cluster 2 and Fools Flat represents about 0.2% of cluster 1. Only group 5 is not represented, it is the largest of the clusters that represent the abyssal zones.

Moreover, we can be seen that only two out of seven biophysical clusters are represented by the five BPAs. Walters Shoal represents about 1.7% of cluster 1, Atlantis Bank represents about 0.15% of cluster 6, Coral represents about 1.7% of cluster 1, Middle of What represents about 0.15% of cluster 6 and Fools Flat represents about 0.15% of cluster 6. Only group 5 is not represented, it is the largest of the clusters that represent the abyssal zones. Clusters 2, 3, 4, 5 and 7 are not represented by BPAs.

However, It is important that as many clusters as possible be represented because they have different spatial and biophysical parameters from one cluster to another.

First of all, it would be interesting to perform the analysis on Del Cano Rise because this site represents the spatial cluster 5 and is present in biophysical clusters that are not represented by BPAs. We could also carry out BPA propositions in clusters not represented by current BPAs, for example in the biophysical cluster 2.

Analysis on Del Cano Rise

Spatial and environmental analysis

BPAS	Spatial parameters (Appendix 1)	Biophysical parameters (Appendix 2)	Biodiversity (Appendix 3)
Del Cano Rise	**Specific parameters:** -Large variations in deep bathomes -Area isolated -Large slope variation **Common parameters :** - More or less distant from continents and islands - Low rugosity **Spatial clusters:** Locate in clusters 1,2,5 and 7 it represents about 0.2% of cluster 1, about 5.4% of cluster 2, about 0.3% of cluster 5, about 0.23% of cluster 7	**Specific parameters** -High Velocity -High bottom chlorophyll concentration -High chlorophyll surface concentration -High salinity **Common parameters :** -Low temperature -High dissolved oxygen content **Biophysical clusters:** Locate in clusters 1 and 3 it represents about 4.95% of cluster 1, about 0.25% of cluster 3	-Low knowledge -Some scientific campaigns

Del Cano Rise is an area of seamounts, the zone comprises the northern flank of the west-east orientated Del Caño Rise. The Del Caño Rise has diverse and complex bathymetry which explains the great variation in slope and depth (from 700m to 3500m deep). There is therefore a great diversity of habitats, which makes Del Cano Rise unique. It represents about 0.25% of SIOFA area. It represents about 0.2% of cluster 1, about 5.4% of cluster 2, about 0.3% of cluster 5, about 0.23% of cluster 7. It locates in many spatial clusters. Del Cano is the only site which represents the cluster 5 of the space clusters, it represents about 0.3% of cluster 5.

An area with a high concentration of chlorophyll-a is an area with very good organic production that promotes the development of biodiversity. In addition, there is a high velocity, so it is a very turbulent area that are preferential areas for biological productivity.

It is a rather isolated bench that can have a fauna and flora endemic to the area. The good scientific knowledge comes from the fact that many scientific campaigns (mentioned above) have been carried out on Del Cano Rise. Del Cano is the only site in cluster 3 of the biophysical clusters, it represents about 0.25% of cluster 5.

All these parameters make it important to protect and maintain this site in good condition.

Conclusion for Del Cano Rise

In the SIOFA area, Del Cano Rise represents 4 spatial clusters (clusters 1, 2, 5 and 7) including cluster 5 not represented by the current BPAs. Moreover, Del Cano Rise represents 2 biophysical clusters (cluster 1 and 3) including cluster 3 not represented by the current BPAs.
It represents a large number of clusters so it is a very heterogeneous area with several emerging from habitats.

At a minimum, it is important to carry out a management plan (fishing) on this site

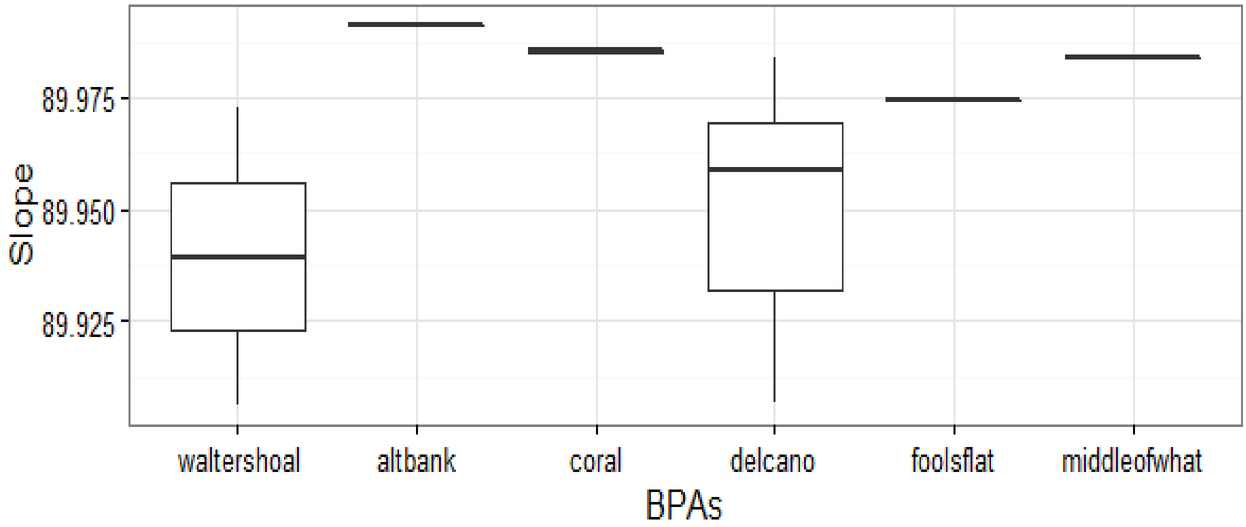
Future Prospects

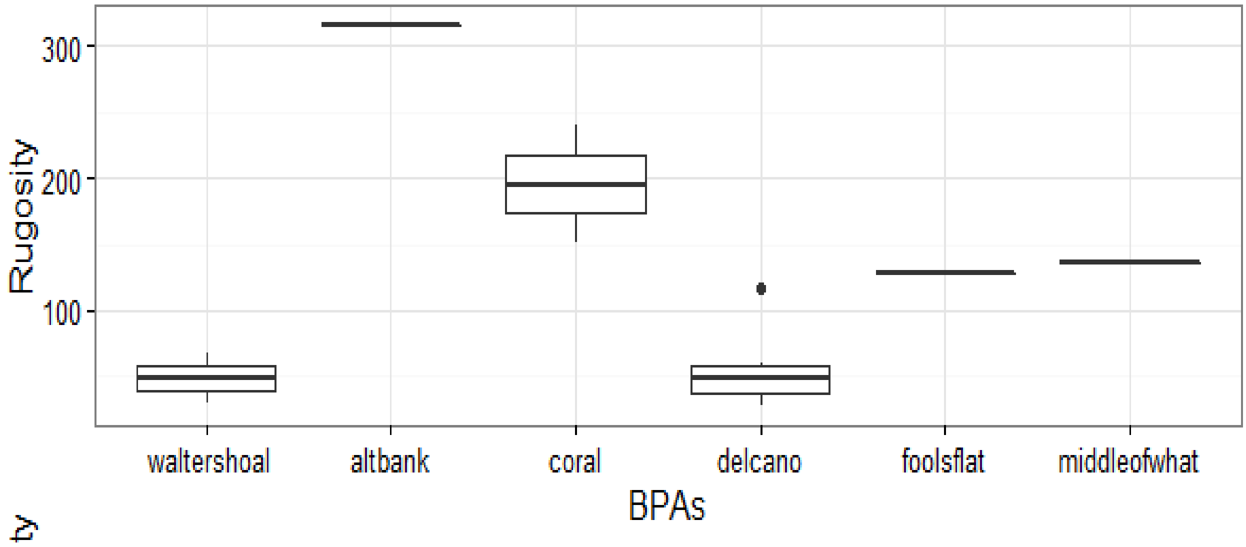
Secondly, to obtain a more functional protocol, the parties will have to agree on the thresholds and the weighting of the criteria to be adopted or added in order to make the method more robust.

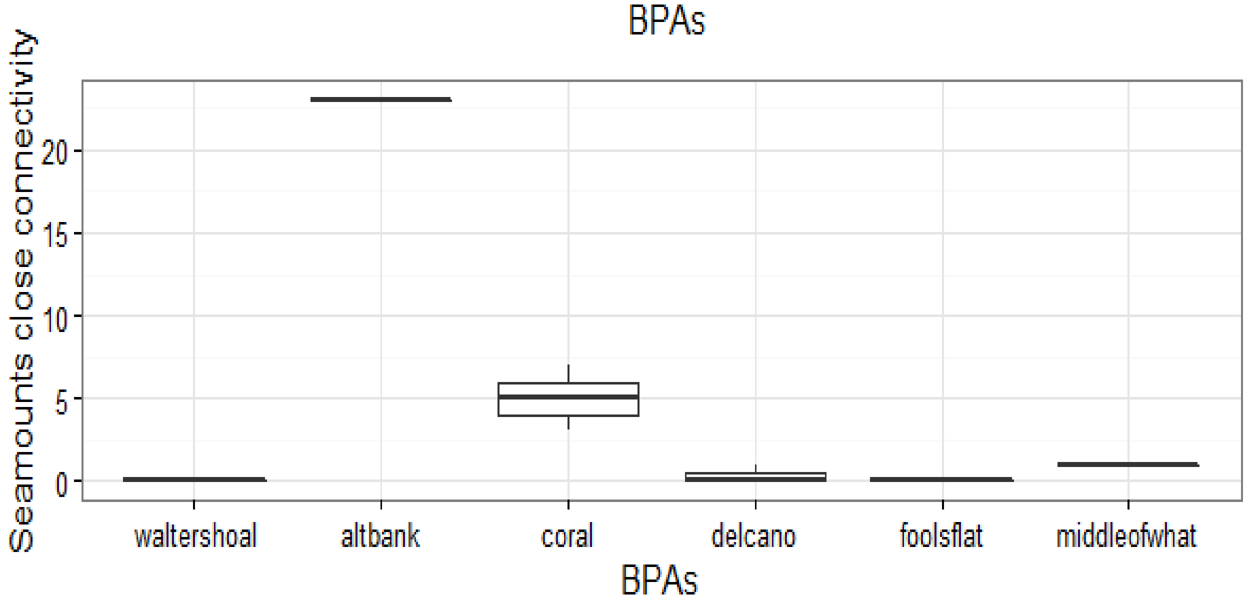
Moreover, this analysis does not replace data collection, which is essential and is therefore part of the development of management and research plans to collect this data in the various benthic protected areas.

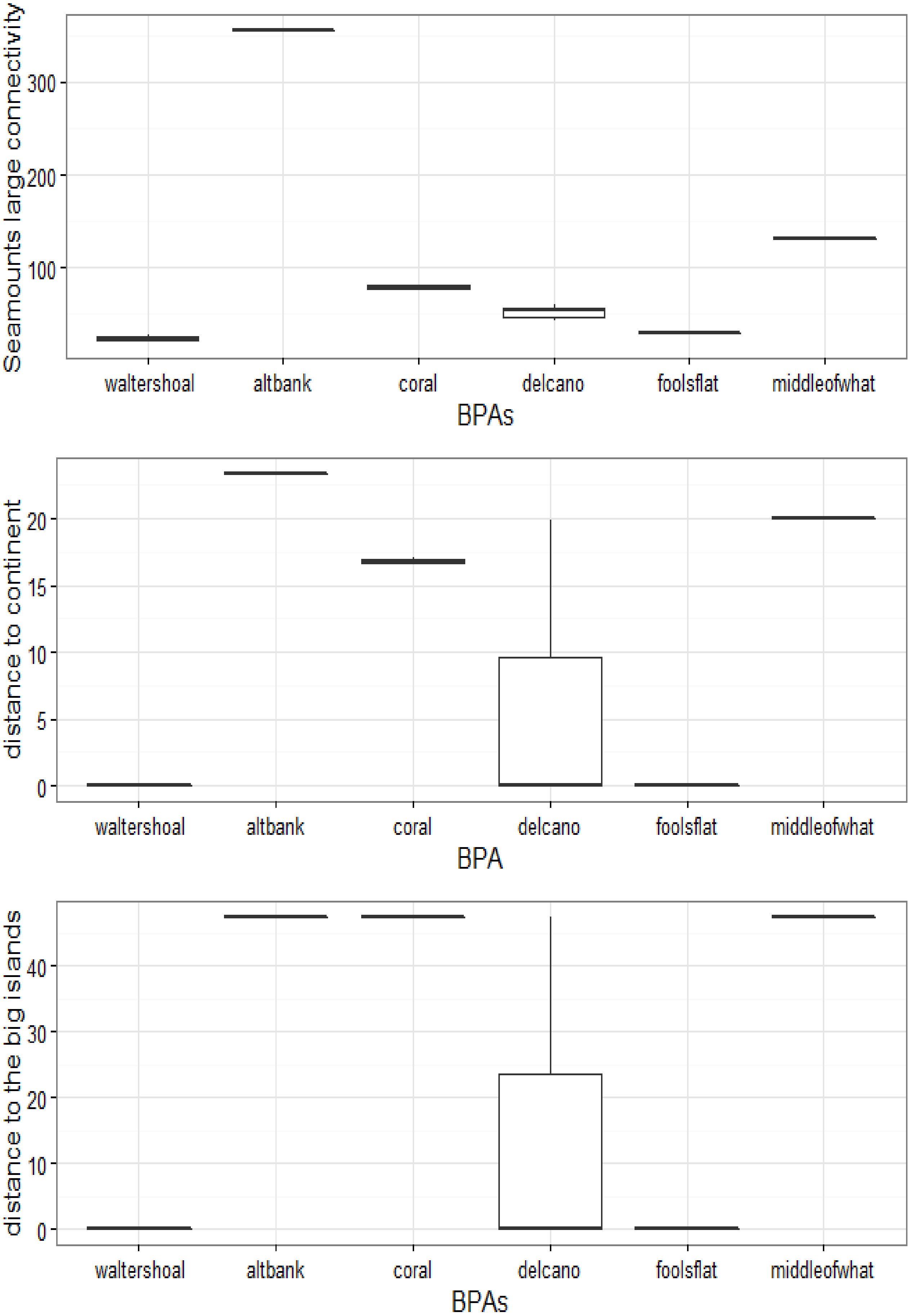
Appendices

Appendix 1: Spatial parameters by BPAs








Seamounts large connectivity
300
200
100
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs
distance to continent
20
15
10
5
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waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPA
distance to the big islands
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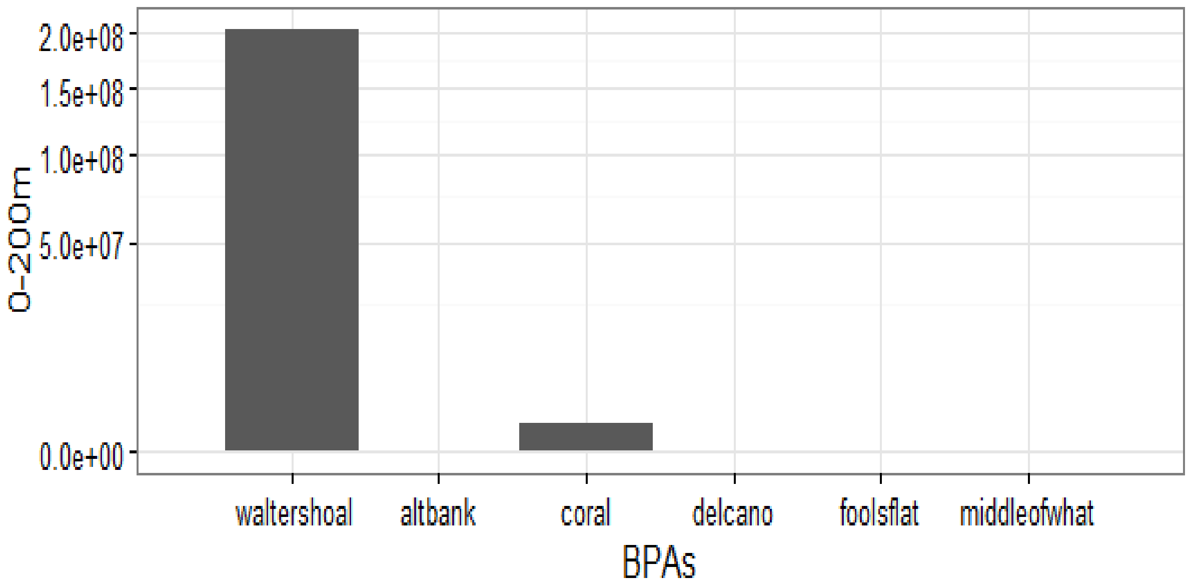
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs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waltershoal
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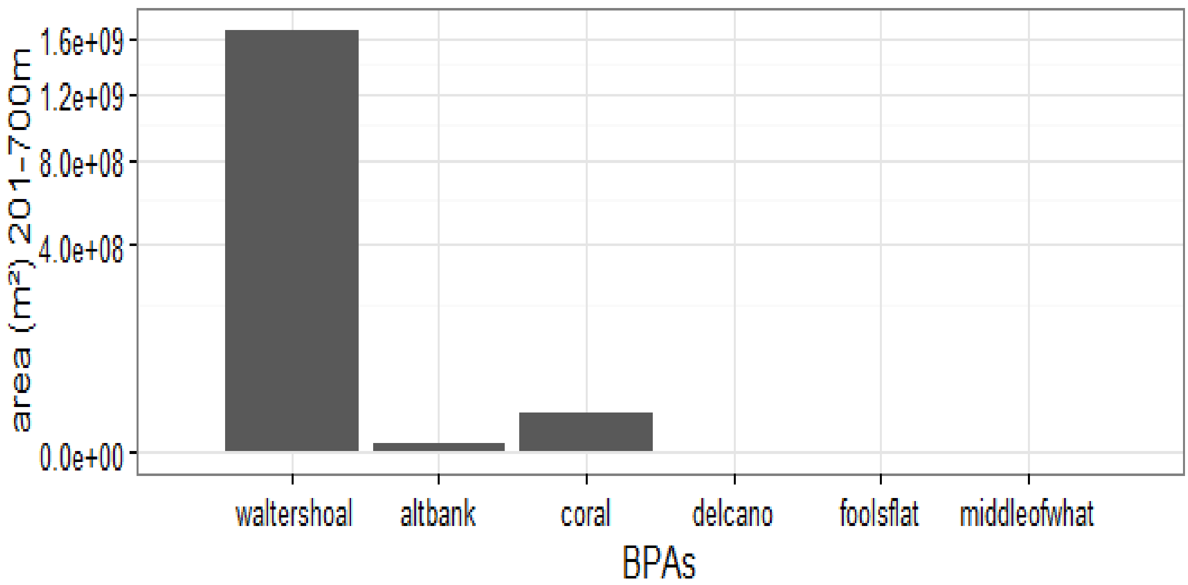
BPAs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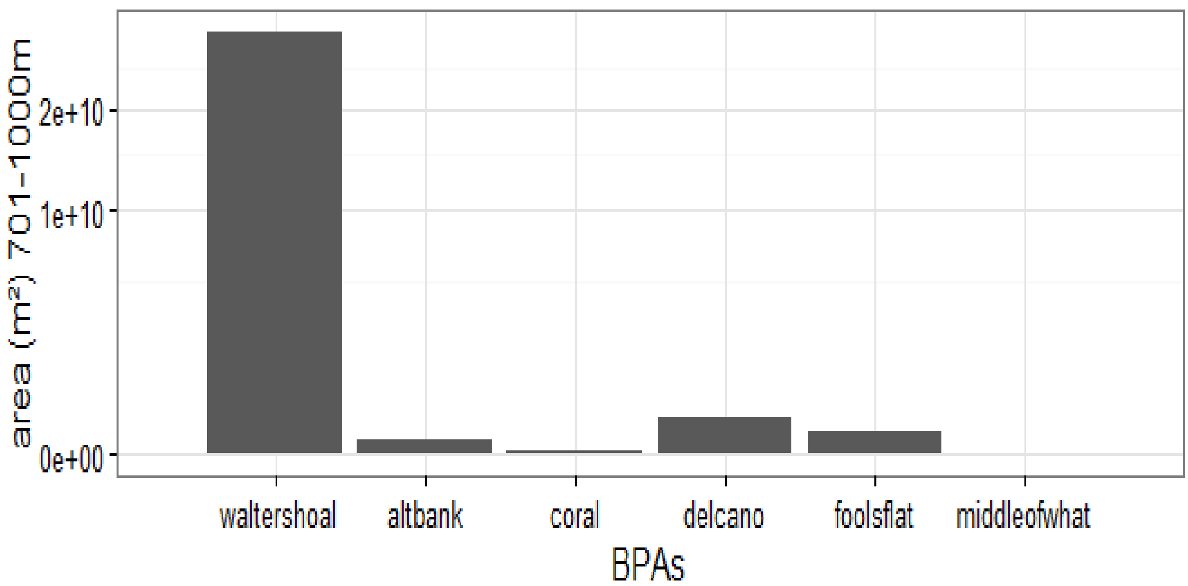
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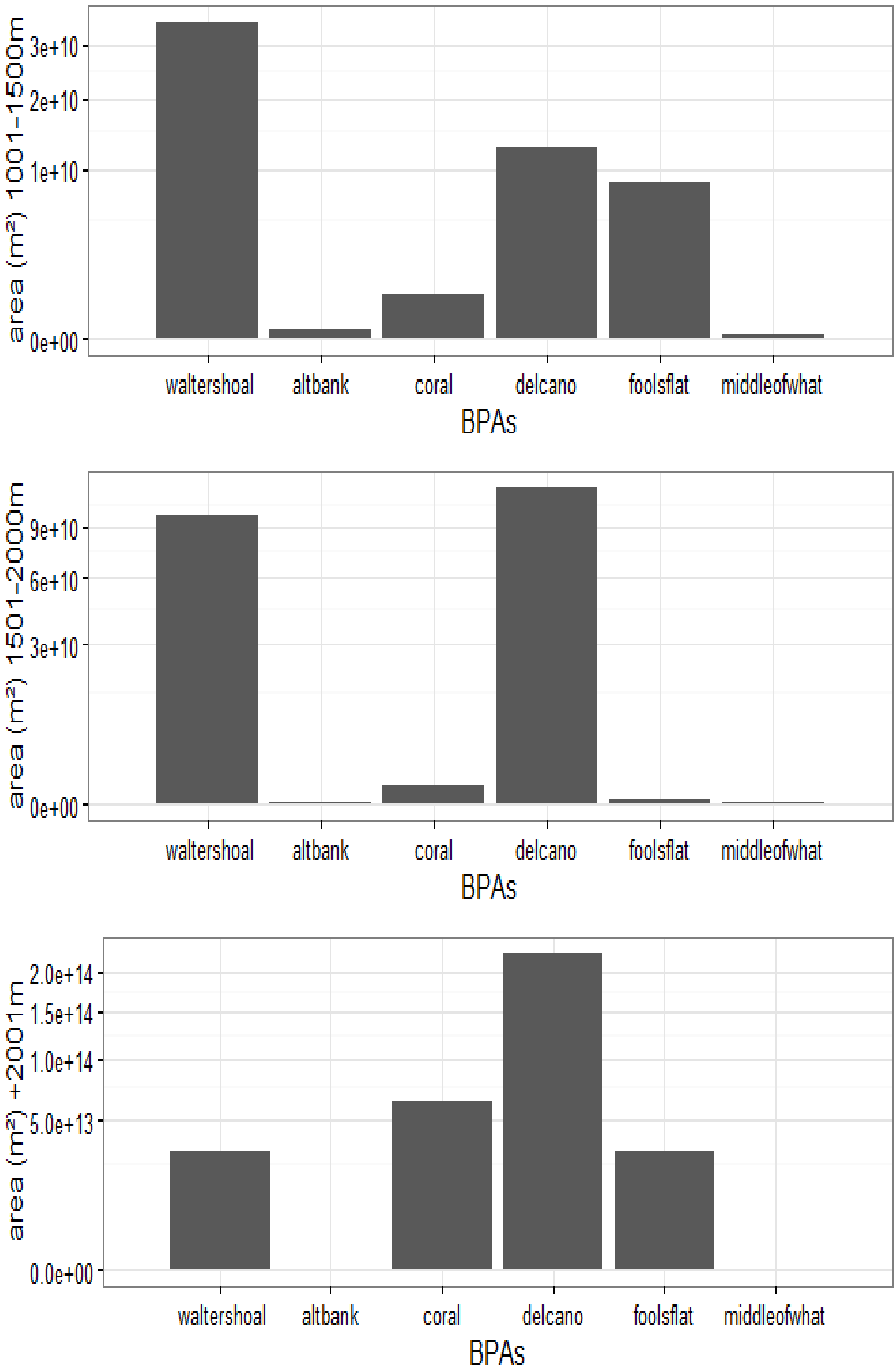
area (m²) 1001-1500m
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BPAs
area (m²) 1501-2000m
9e+10
6e+10
3e+10
0e+00
waltershoal
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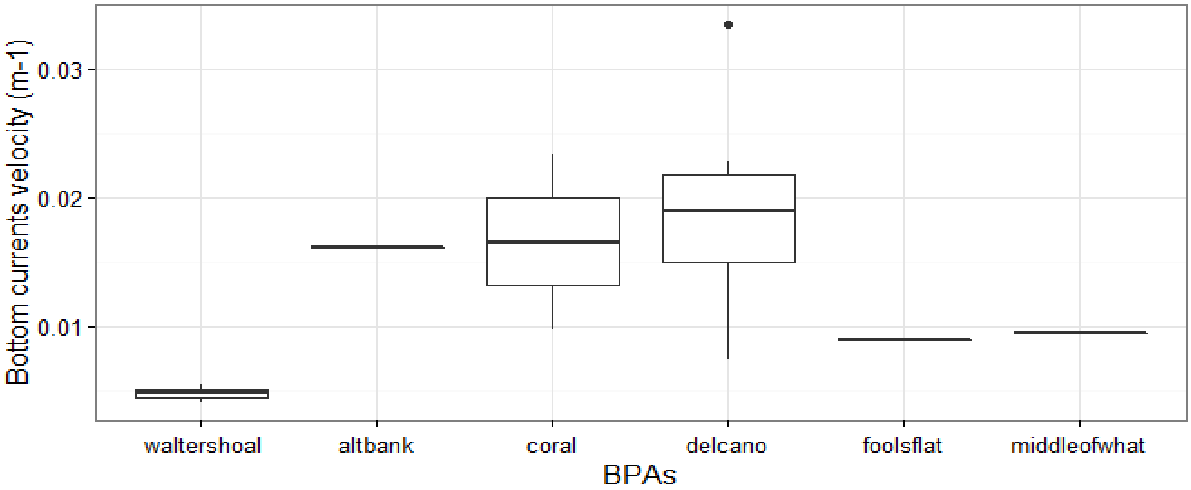
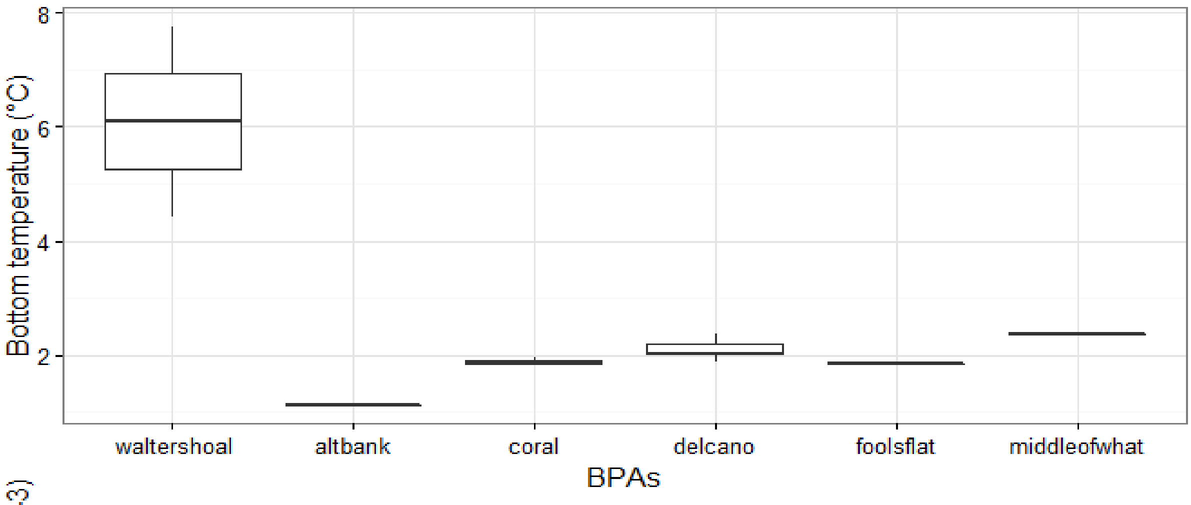
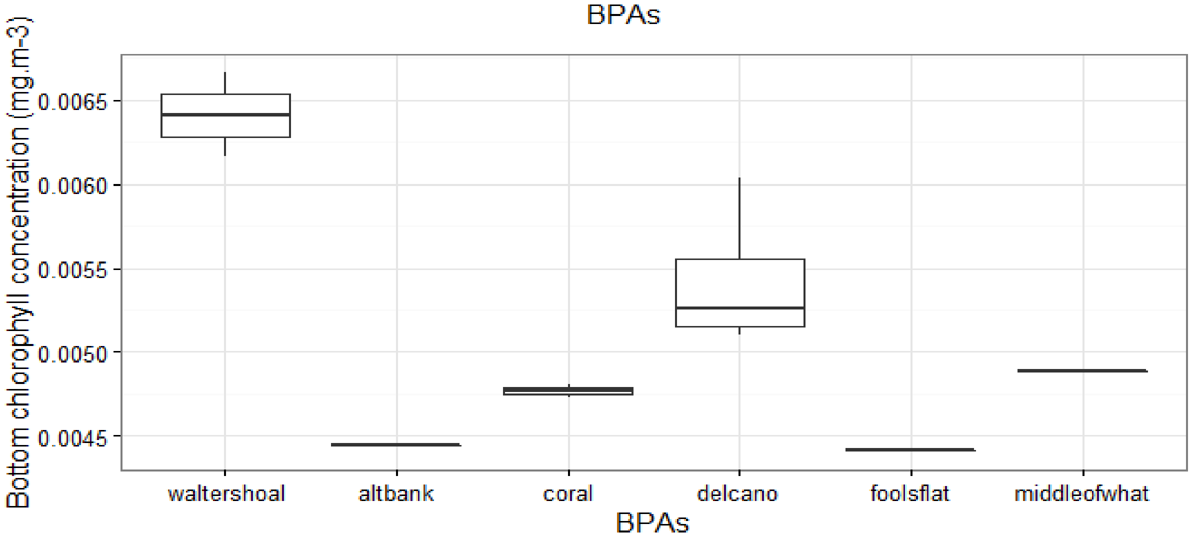
1.5e+14
1.0e+14
5.0e+13
0.0e+00
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs

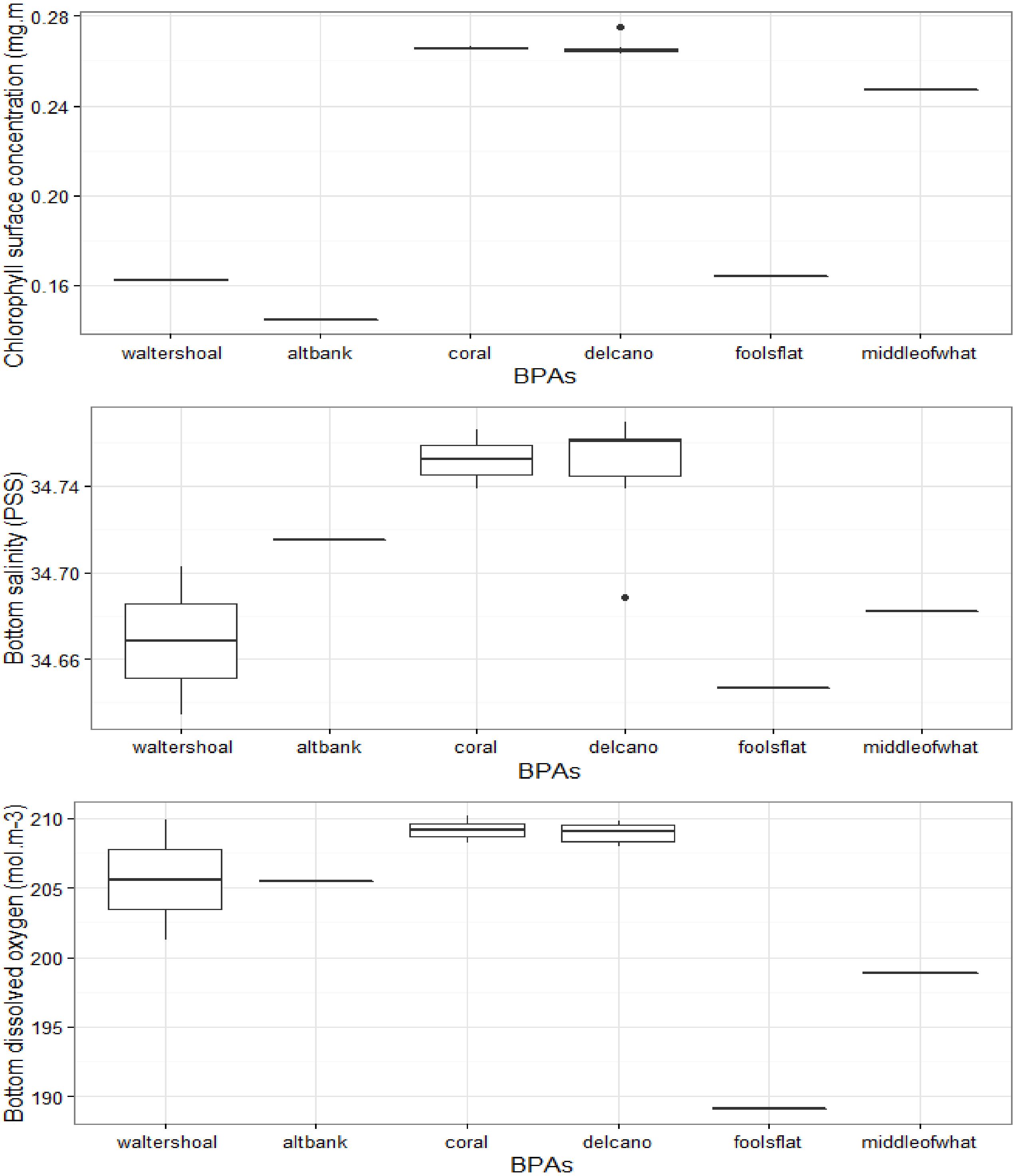
	Walter shoal	Atlantis bank	Fools flat	Middle of what	Coral	Del cano
Slope	Low (large variation)	high	high	high	high	Low (large variation)
Rugosity	low	Très high	medium	medium	high	low
Seamounts close connectivity	low	Très high	low	low	high	low
Seamounts large connectivity	low	Très high	low	high	medium	low
mdcc	low	high	low	high	high	medium
mdcli	low	high	low	high	high	medium
0-200m	high	low	low	low	low	low
201-700m	high	low	low	low	low	low
701-1000m	high	low	low	low	low	low
1001-1500m	high	low	medium	low	low	low
1501-2000m	high	low	low	low	low	medium
+2001m	medium	low	high	low	high	high

Appendix 2: Biophysical parameters by BPAs








Chlorophyll surface concentration (mg.m
0.28
0.24
0.20
0.16
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs
Bottom salinity (PSS)
34.74
34.70
34.66
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs
Bottom dissolved oxygen (mol.m-3)
210
205
200
195
190
waltershoal
altbank
coral
delcano
foolsflat
middleofwhat
BPAs

	Walter shoal	Atlantis bank	Fools flat	Middle of what	Coral	Del cano
Bottom currents velocity (m-1)	low	high	medium	medium	high	high
Bottom chlorophyll concentration (mg.m-3)	very high	low	low	medium	medium	high
Bottom salinity (PSS)	low	medium	low	low	very high	very high
Bottom temperature (°C)	high	low	medium	low	medium	medium
Chlorophyll surface concentration (mg.m-3)	medium	medium	medium	high	very high	very high
Bottom dissolved oxygen (mol.m-3)	high	high	medium	high	very high	very high

Appendix 3 : Biodiversity

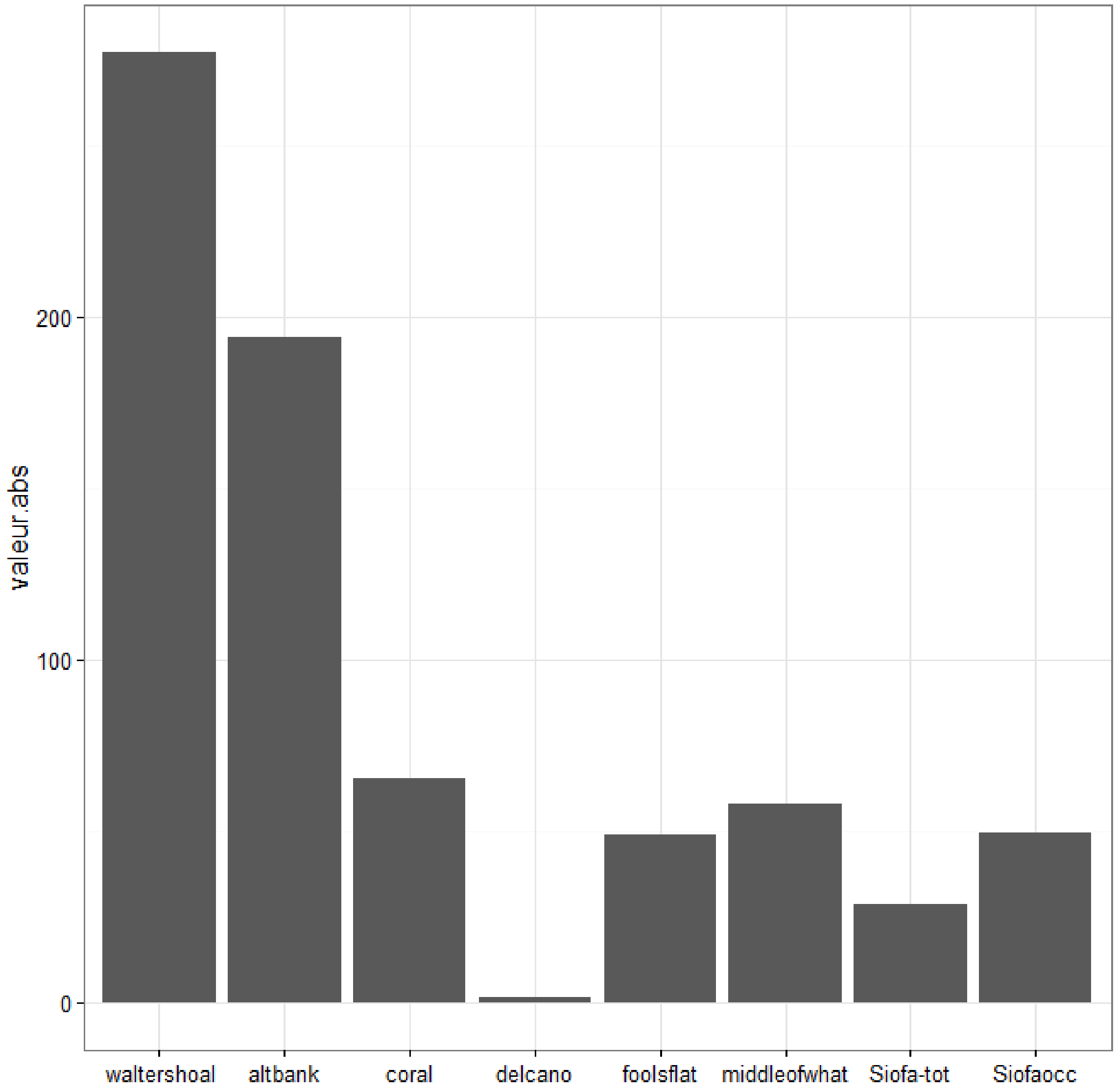


Figure 7- barplot with number of occurrences by square of BPAs or square of the SIOFA zone (Siofa-tot) or square only with occurrence in the SIOFA zone (Siofaocc)

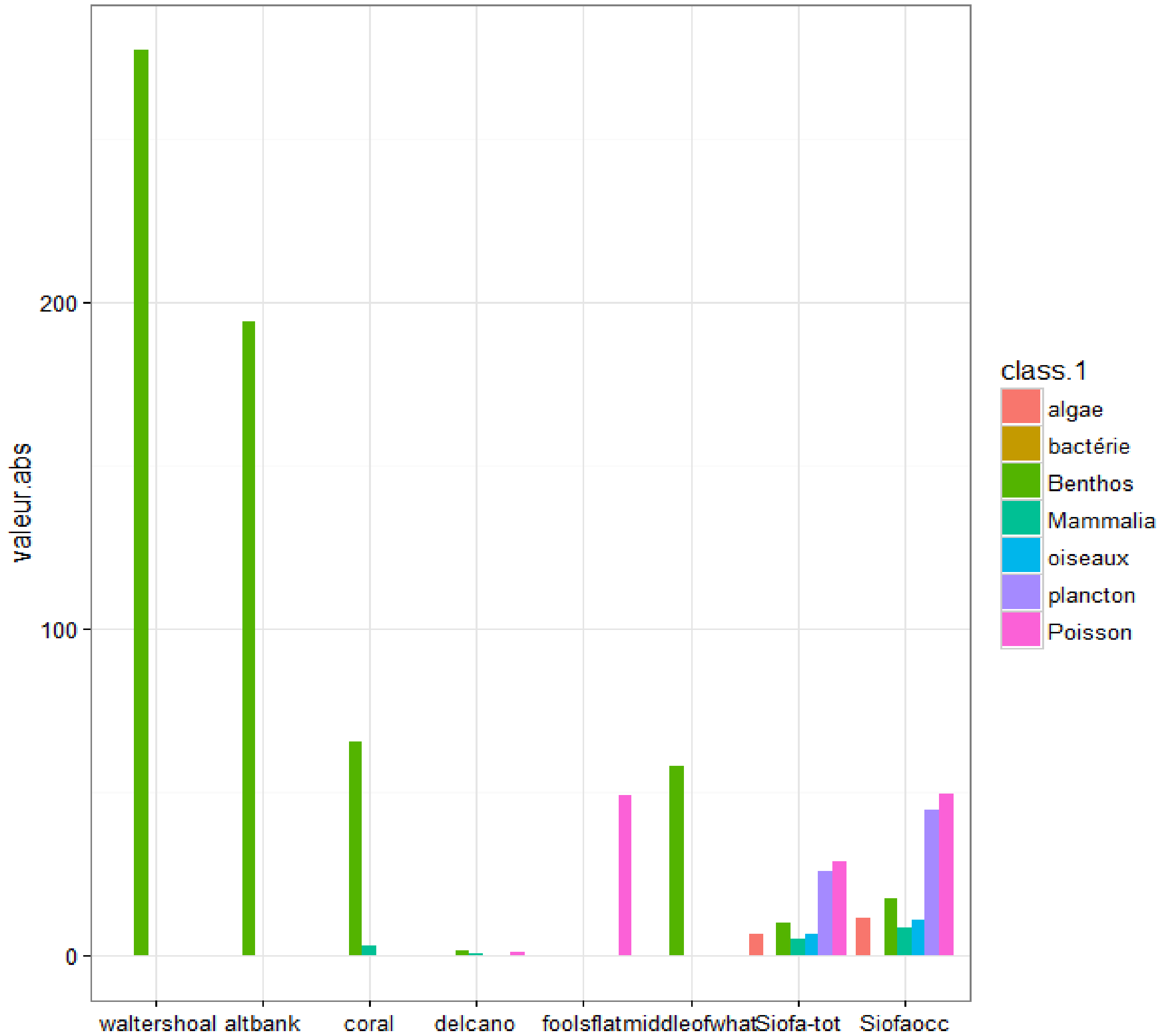


Figure 8-barplot with number of occurence by differents taxons by square of BPAs, by square of the SIOFA zone (Siofa-tot), by square only with occurrence in the SIOFA zone (Siofaocc)

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