User Manual for the New Zealand Marine Environment Classification

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by

Contents

1. Introduction

This manual provides a brief introduction to the use and manipulation of the Marine Environment Classification using various software, including ESRI's ArcView 3.2 GIS software. There are two classifications on the DVD. The first classification is a low resolution (1 km grid) of the whole of New Zealand's exclusive economic zone (EEZ). The second classification is a higher resolution (200m grid) of the Hauraki Gulf region. This manual assumes that the user has a reasonable understanding of ArcView, eg. how to add layers, join tables and display maps.

2. Data supplied

The Marine Environment Classification DVD contains a large number of data files that enable the Marine Environment Classification to be used for various purposes. Table 1 lists the structure of the files and folders on the DVD.

Table 1.   Structure of the Marine Environment Classification DVD

Main folder	Subfolder	Files	Description
Reports/	Overview	MEC Overview Report.pdf MEC User Manual.pdf	Overview report and user manual.
	Development	Thirteen reports in pdf format and a readme file describing each report	All reports produced during the development and testing of the MEC
AcrobatReader7/		AdbeRdr70_enu_full.exe	Software for viewing pdf files.
EEZ/MEC/	Pdfs/	MEC_EEZ_05class.pdf MEC_EEZ_10class.pdf MEC_EEZ_20class.pdf MEC_EEZ_40class.pdf MEC_EEZ_cts.pdf	Four A0 size pdfs of the EEZ Marine Environment Classification at selected classification levels and one pdf showing the continuous colour scheme.
	Shapefiles/	MEC_EEZ_05class.shp MEC_EEZ_10class.shp MEC_EEZ_20class.shp MEC_EEZ_40class.shp	ESRI shape files of the EEZ MEC at selected classification levels.

Main folder	Subfolder	Files	Description
	Gridfiles/esri/	Eezmec Eezmec_cts.lyr Eezmec_cts.avl	ESRI grid file of the EEZ MEC at the 290-class level. Layer file (for ArcMap) and avl file (for ArcView) to enable viewing of the continuous colour MEC.
	Gridfiles/ascii/	Eez_mec_grid.txt Eez_mec_rgb.txt	Ascii grid file of the EEZ MEC at the 290-class level. Text file containing rgb colour definitions for viewing the MEC using the continuous colour scheme.
	Gridfiles/ joining_files/	Eez full joining.txt Eez sml joining.txt	Text files to be joined to the EEZ MEC grid file. The full text file contains the EEZ MEC at every level of the classification. The small joining file contains a selection of levels.
EEZ/Classification Information/		Analysis_EEZ.mdb EEZ 290 Grp association matrix.txt	Database containing environmental variable values and class membership for a subset of 6% of the classification grid-cells. Pairwise distance matrix for all classes at the 290-class level.
EEZ/ Coastline&isobaths/		Nz_coastandislands_merc .shp EEZ_boundary.shp 1000m isobaths.shp	NZ coastline, EEZ boundary and 1000m isobaths.

Main folder	Subfolder	Files	Description
EEZ/Env_vars/	esri/final	Depth_bands Orbv_mean Rad_mean Sst_amp Sst_grad Sst_wint Tidal_curr Bed_slope	ESRI grid files of environmental variables used to define the EEZ MEC.
	esri/extra	Rad_wint Bed_prof Bed_plan Bed_curv Fresh Orb_v_95 Sed_eez Sst_anom	ESRI grid files of other EEZ environmental variables that were not used to define the MEC.
	ascii/final	Depth_bands Orbv_mean Rad_mean Sst_amp Sst_grad Sst_wint Tidal_curr Bed_slope	Ascii grid files of environmental variables used to define the EEZ MEC.
	ascii/extra	Rad_wint Bed_prof Bed_plan Bed_curv Fresh Orb_v_95 Sed_eez Sst_anom	Ascii grid files of other EEZ environmental variables that were not used to define the MEC.

Main folder	Subfolder	Files	Description
Hauraki/MEC/	Pdfs/	MEC_haur_05class.pdf MEC_haur_10class.pdf MEC_ haur_20class.pdf MEC_haur_40class.pdf MEC_haur_cts.pdf	Four A0 size pdfs of the Hauraki Gulf Marine Environment Classification at selected classification levels and one pdf showing the continuous colour scheme.
	Shapefiles/	MEC_haur_05class.shp MEC_haur_10class.shp MEC_haur_20class.shp MEC_haur_40class.shp	ESRI shape files of the Hauraki Gulf MEC at selected classification levels.
	Gridfiles/esri/	Haurakimec Haurakimec_cts.lyr Haurakimec_cts.avl	ESRI grid file of the Hauraki Gulf MEC at the 281-class level. Layer file (for ArcMap) and avl file (for ArcView) to enable viewing of the continuous colour MEC.
	Gridfiles/ascii/	Haur_mec_grid.txt Haur_mec_rgb.txt	Ascii grid file of the Hauraki Gulf MEC at 281-class level. Text file containing rgb colour definitions for viewing the MEC using the continuous colour scheme.
	Gridfiles/ joining_files/	Haur_full_joining.txt Haur_sml_joining.txt	Text files to be joined to the MEC grid file. The full text file contains the Hauraki Gulf MEC at every level of the classification. The small joining file contains a selection of levels.

Main folder	Subfolder	Files	Description
Hauraki/ Classification Information/		Analysis_Hauraki.mdb Hauraki 281 Grp association matrix.txt	Database containing environmental variable values and class membership for all classification grid-cells. Pairwise distance matrix for all classes at the 281-class level.
Hauraki/Coastline /		Nz_coast_nzmg.shp	NZ coastline in NZ map grid projection to match the Hauraki Gulf MEC.
Hauraki/Env_vars/	esri/final	Orbv_mean Slope Sst_ann_phase Sst_mth_std Sst_sann_ampl Tidal_curr Depth_haur Fresh_fract	ESRI grid files of environmental variables used to define the Hauraki Gulf MEC.
	esri/extra	Orbv_95 Sst_ann_ampl Sst_mean Hau_curb Hau_plan Hau_prof	ESRI grid files of other environmental variables not used to define grid files of environmental variables used to define the Hauraki Gulf MEC.
	ascii/final	Orbv_mean Slope Sst_ann_phase Sst_mth_std Sst_sann_ampl Tidal_curr Depth_haur Fresh_fract	Ascii grid files of environmental variables used to define the Hauraki Gulf MEC.

Main folder	Subfolder	Files	Description
	ascii/extra	Orbv_95 Sst_ann_ampl Sst_mean Hau_curb Hau_plan Hau_prof	Ascii grid files of other environmental variables not used to define grid files of environmental variables used to define the Hauraki Gulf MEC.

3. Map projections

The projection used for the EEZ Marine Environment Classification is:

Mercator Projection
Central Meridian = 100
Standard Parallel = -46
False Easting = 0
False Northing = 0
Spheroid/Datum = Clarke 1866

The projection for the Hauraki Gulf Marine Environment Classification is New Zealand Map Grid (NZMG).

4. Marine Environment Classification

4.1   Viewing the Marine Environment Classification as pdf files

Using the pdf files is the easiest way to view the Marine Environment Classification. The pdfs have been produced at A0 size to provide high resolution. Adobe acrobat reader is required to view these files. The setup file for this reader is included on the DVD in the AcrobatReader7 folder. Once Acrobat is installed, open the maps by navigating to the following files:

- EEZ/MEC/pdfs
- Hauraki/MEC/pdfs

4.2   Viewing the Marine Environment Classification as ESRI shape files

The simplest way to view the Marine Environment Classification in a GIS is as shape files. The DVD has four shape files for each classification that display the Marine Environment Classification at the 5, 10, 20 and 40-class levels. These shape files are intended to be viewed in ESRI's GIS software ArcView, however other GIS programs such as MapInfo will also import shapefiles. The shape files can be loaded and displayed in a GIS by navigating to the following locations:

- EEZ/MEC/shapefiles/
- Hauraki/MEC/shapefiles/

In general terms, a GIS data layer is made up of two components:

- the geospatial data describing the position of the features such as lines, points or polygons
- the attributes of the individual features.

The Marine Environment Classification shape files consist of closed polygons with various attributes attached to them e.g. class number. The attribute data is stored as a standard dBase 4 file (*.dbf) and can be loaded into other analysis packages such as Microsoft Excel.

WARNING! Manipulation of the dBase file using a 3rd party package (such as Microsoft Excel) could result in the file becoming unreadable by ArcView. It is advisable to make a copy of the file before analysis.

Table 2.   **The basic components of an ESRI shapefile**

File name	Description
Layer1.shp	Main file: contains the geospatial data for each feature
Layer1.shx	Index file: used internally for locating features within the *.shp file
Layer1.dbf	DBase file: contains the attribute information for each feature

Note: that there might be additional files (with other extensions) associated with the shape file depending on how the shapefile has been used. These could include default legends, other indexes and metadata.

4.3   **Viewing the Marine Environment Classification as a grid file**

The Marine Environment Classification can be viewed and manipulated as a grid in a GIS that has grid capability. Viewing the Marine Environment Classification as a grid gives you access to any level of the classification from 2 classes up to 290 classes. The Marine Environment Classification grids are included as both ESRI grids and ascii grids. A grid file works by covering the working area with regularly sized grid cells. Each grid cell has a unique identifier that we will call the Grid-cell-number. This allows text files of attributes to be attached to the grid using the Grid-cell-number as the means of joining the data. The grid cells in the EEZ scale Marine Environment Classification are 1 km and the regional scale cells are 200 m.

ESRI grids

ESRI grids appear as folders. They also require a folder called 'info' that contains information for all the grids within that folder. To view ESRI grids using ArcView you will need to activate the 'spatial analyst' extension by going to the 'file' menu, then to 'extensions'. Once spatial analyst has been activated, these grids can be loaded by navigating to the following locations:

- EEZ/gridfiles/esri/
- Hauraki/gridfiles/esri.

Ascii grids

The ascii (text) versions of the grids are a universal file format that have been included on the DVD to allow viewing of the Marine Environment Classification using GIS software other than ESRI software. The ascii files for the classification are located in the following folders:

- EEZ/gridfiles/ascii/
- Hauraki/gridfiles/ascii/.

The header lines at the beginning of each ascii file give information on the size and spatial location of the grid, the cellsize and the nodata value. Information on the projections used for the different classifications is in section 0 of this report.

Joining the other class levels

The basic Marine Environment Classification grids contain the highest class level only, i.e. 290 classes for the EEZ and 281 for the Hauraki Gulf. The text file containing all other class levels can be joined to these grids in order to enable viewing of the Marine Environment Classification at any class level. Join the largest class level (gp-290) of the text file to the 'value' field of the grid. The smaller joining file contains a selection of about 80 class levels and should be sufficient for most purposes. The full joining file contains all class levels (290 levels for the EEZ and 281 for the Hauraki Gulf).

- EEZ/gridfiles/joiningfiles/
- Hauraki/gridfiles/joiningfiles/

<u>Viewing the continuous colour scheme for the Marine Environment Classification</u>

The Marine Environment Classification can be viewed using a continuous colour scheme. In ArcView, first load the Marine Environment Classification grid, then load the .avl file (an ArcView Legend file). In ArcMap, load the layer file (.lyr) instead of the Marine Environment Classification grid. These files are contained in the following directories:

- EEZ\MEC\Gridfiles\esri\

- Hauraki\MEC\Gridfiles\esri\

The rgb colour definitions for each class are also included in text format in the following directories:

- EEZ\MEC\Gridfiles\ascii\

- Hauraki\MEC\Gridfiles\ascii\

5. Environmental variables

All the environmental data that was developed by the Marine Environment Classification project is included on the DVD even though not all of these variables were used to define the final classification. The environmental variables are provided as text files that give the value of each environmental variable in each grid cell. The environmental variables actually used in the Marine Environment Classification classification are in the /final subfolder. Other environmental variables produced but not used in the final classification are in the /extra subfolder. Note that the depth grid for the EEZ has been provided as a categorical description of depth variation. The classification was defined using a continuous description of depth, but this data remains the property of NIWA Ltd. The environmental variables are located in the following folders:

- EEZ/env_vars/
- Hauraki/env_vars/.

6. Overlaying other data

6.1   Adding coastline and isobaths

For the EEZ classification there is a shapefile of the New Zealand coastline (including outlying islands), shapefile of the EEZ boundary and a shapefile containing 1000 m isobaths (contour lines of equal depth). For the Hauraki Gulf classification there is a shapefile of the New Zealand coastline. These can be overlaid on the Marine Environment Classification by navigating to the following locations:

- EEZ/Coastline&Isobaths/
- Hauraki/Coastline/.

6.2   Adding your own data

Any other data can be overlayed on the Marine Environment Classification in a GIS provided the projections are the same. See section 3 for information about the Marine Environment Classification projections.

7. Classification Information

The environmental distance matrices for all pairs of classes at the highest level of the classifications are included to enable the user to conduct further investigations. There are also databases containing the values of the classification variables and class membership of the grid-cells. These databases can be used to evaluate the environmental character of each class. Due to the size of the EEZ grid, the database contains a sub-sample of 6% of the cells. These files are contained in the following directories:

- EEZ\Classification Information\
- Hauraki\Classification Information\

8. Case study – application of the Hauraki Gulf Marine Environment Classification to assessment of representativeness of marine protected areas

8.1 Introduction

This case study is reported in full in (Wild et al., 2003) and provides a simple example of how the Marine Environment Classification can be used with other data to undertake assessment and mapping work. The study used a prototype version of the Hauraki Gulf Marine Environment Classification and some details of this classification are different to the classification on the DVD. The aim of the assessment was to:

- show how the environmental representativeness of various marine protected areas (MPAs) can be assessed.

- illustrate the resolution of environmental pattern by the Marine Environment Classification within the Hauraki Gulf and to compare the resolution with the size of individual MPAs.

The MPAs that were analysed comprised a number of protection mechanisms including areas of significant conservation value in the Coromandel, recommended areas for protection, sites of natural significance, marine reserves, sites of special wildlife interest, coastal protection areas and commercial fishing restrictions. The environmental representativeness (i.e. the amount of the total environmental variation within the Hauraki Gulf that was contained within an MPA, or MPAs) of each MPA was determined from the proportion of each Marine Environment Classification class occupying that MPA.

8.2 Method

The representativeness of the various MPAs was determined by calculating the percentages of the total area of each class (at the 5, 10 and 20-class levels) that falls within each MPA category. This analysis was undertaken using the ArcView spatial analyst extension. The following process was followed:

1   The area located within the boundary of each MPA shape file was converted into a 200 m grid that was aligned with the classification grids.

2   The area of each class located inside each MPA category was then calculated.

8.3   Results

Figure 1 shows the 10-class level of the Hauraki Gulf Marine Environment Classification with the marine reserve boundaries superimposed. An example of the spatial resolution of the Hauraki Gulf Marine Environment Classification compared to the smallest MPAs (marine reserves) is shown in Figure 2 and

Figure 3.

Table 3 shows the results of the analysis for the 5, 10 and 20-class levels of the Hauraki Gulf Marine Environment Classification. Because most of the MPAs have some areas in common, the total protected area for each class is not the accumulated total of all MPAs within that class. However, it would be possible to create a layer that identifies areas having at least one form of protection and perform the analysis using this.

The analysis shows:

- As the Hauraki Gulf is subdivided into a greater number of classes, the number of classes that are not covered by the existing MPAs increases (eg. Class 29 is not covered by any MPAs at the 20-class level).

- The number of classes with a proportion of protected coverage exceeding any given threshold (eg. >10%) is likely to increase as the number of classes increases. However, this increase in protected classes occurs at the expense of other classes that have little or no MPA coverage when they are subdivided from a larger class. For example CPA1, at the 5-class level, protects 25.8 km^2 (1%) of Class 2. At the 10-class level, Class 2 subdivides into Class 2 and 10, protecting 6.8 km^2 (0.3%) and 19 km^2 (21%), respectively. Thus in this case, subdivision of the higher-level classes result in a high representation of one of the smaller classes, while the other class has negligible coverage. Note that because of this, the level of the classification that is used to subdivide an area is important. Recommendations on the appropriate level of subdivision for analyses of representativeness should consider the testing of the Marine Environment Classification that is reported in the overview report (Snelder et al. 2005) in order to identify levels of the classifications that are differentiating biologically distinctive areas.

- Some MPAs do not cover a significant area of any specific class. For example marine reserves never cover greater than 4.6% of any class at the 5, 10 or 20-class level.

- At the 5-class level, only 2 of the classes have MPA protection of greater than 2.5%. These are classes located in the uppermost/south-east corner of the Firth of Thames and the protected waters of the inner Firth of Thames. The other three classes, covering progressively more open waters from the middle to outer Hauraki Gulf, are generally protected by less than 1% of any MPA, with the exception of CPA2, which protects up to 2.1% of these classes.

8.4   Conclusion

Results show that classes that are characterised by shallow depth are better represented by existing MPAs, reflecting the bias of, for example, marine reserves and RAPs towards coastal locations.

The Marine Environment Classification discriminated variation in environment even at the scale of the smallest MPAs in Hauraki Gulf (for example, Tawharanui Marine Park, a marine reserve with an area of 3.55 km^2). Thus, the test indicates that, provided a sufficient number of classes are selected to define the classification, the Marine Environment Classification is able to delineate patterns at a scale that is compatible with the relatively small spatial units that comprise MPAs within the Hauraki Gulf.
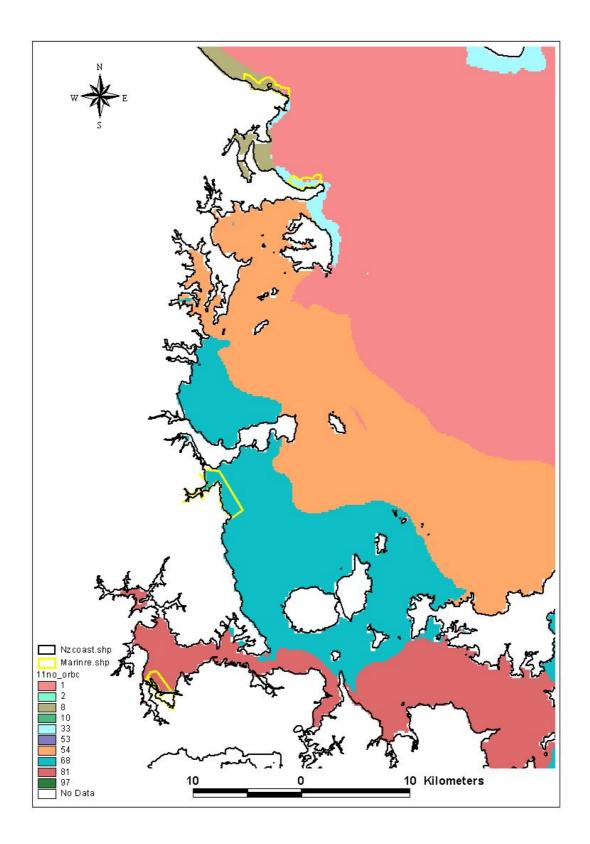
Figure 1: **The 10-class level of the Hauraki Gulf Marine Environment Classification with marine reserve boundaries superimposed.**
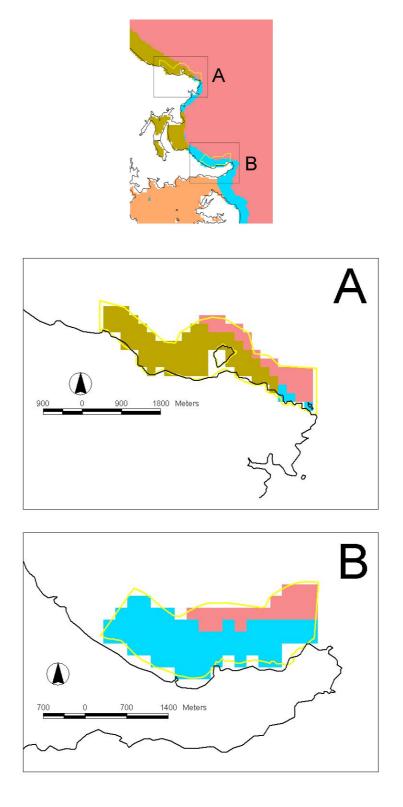
Figure 2: Spatial resolution of the Hauraki Gulf Marine Environment Classification (based on the 10-class level) compared to the size of (A) Goat Island (or Leigh) Marine Reserve and (B) Tawharanui Marine Park.
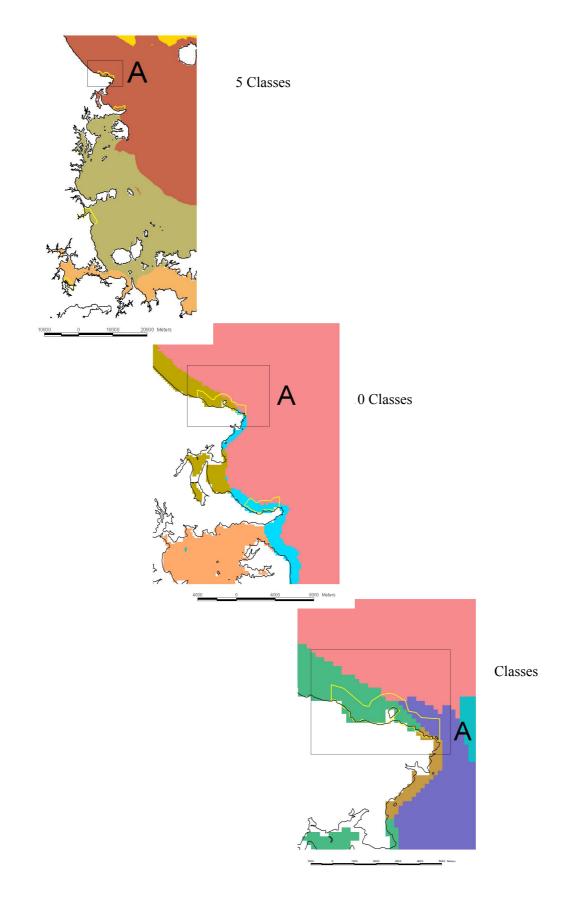
Figure 3: **Increasing discrimination of environmental variation (i.e. increasing number of Marine Environment Classification classes) compared to the size of the Goat Island (or Leigh) Marine Reserve.**

Table 3: **Area, in km² (and %), of Marine Environment Classification classes located within Marine Protected Areas (MPAs) (at the 5, 10 and 20-class levels of the Hauraki Gulf Marine Environment Classification). Source: Wild et al., 2003**

5 Environments	Total Area (km²)	Marine Reserves	ASCV Coromandel	RAPs	Snatsig	SSWIs	CPA1	CPA2
1	3286	7.7 (0.2)	9.8 (0.3)	19.4 (0.6)	20.5 (0.6)	8.6 (0.3)	31.8 (1)	66.8 (2)
2	2536				0.1 (0)		25.8 (1)	8.8 (0.3)
54	1936	8.4 (0.4)	8.5 (0.4)	12.8 (0.7)	17.2 (0.9)	21 (1.1)	8.6 (0.4)	39.9 (2.1)
81	778	2.9 (0.4)	42.9 (5.5)	16.7 (2.1)	65.5 (8.4)	91.7 (11.8)	10.1 (1.3)	31.6 (4.1)
97	123		62 (50.3)			30.9 (25.1)		

10 Environments	Total Area (km²)	Marine Reserves	ASCV Coromandel	RAPs	Snatsig	SSWIs	CPA1	CPA2
1	2711	1.9 (0.1)		1.6 (0.1)	1.5 (0.1)		4.8 (0.2)	1.1 (0)
2	2445						6.8 (0.3)	3.6 (0.1)
8	397	3 (0.8)	5 (1.3)	16.2 (4.1)	16.3 (4.1)	7.4 (1.9)	6.6 (1.7)	55.3 (13.9)
10	91				0.1 (0.1)		19 (21)	5.2 (5.8)
33	169	2.8 (1.6)	4.8 (2.9)	1.6 (0.9)	2.8 (1.6)	1.3 (0.8)	20.4 (12.1)	9.5 (5.6)
53	9							1 (10.8)
54	1373		8.5 (0.6)	10.6 (0.8)	9.9 (0.7)	15.7 (1.1)	2.6 (0.2)	24.5 (1.8)
68	563	8.4 (1.5)		2.2 (0.4)	7.3 (1.3)	5.3 (0.9)	6 (1.1)	15.4 (2.7)
81	778	2.9 (0.4)	42.9 (5.5)	16.7 (2.1)	65.5 (8.4)	91.7 (11.8)	10.1 (1.3)	31.6 (4.1)
97	123		62 (50.3)			30.9 (25.1)		

20 Environments	Total Area (km²)	Marine Reserves	ASCV Coromandel	RAPs	Snatsig	SSWIs	CPA1	CPA2
1	1306	0.3 (0)		0.4 (0)	0.4 (0)		4 (0.3)	0.3 (0)
2	1369						6.6 (0.5)	3.6 (0.3)
5	1076						0.2 (0)	
8	236	3 (1.3)		16.2 (6.9)	14.4 (6.1)	4.9 (2.1)	0.6 (0.3)	10.5 (4.5)
10	79						17.4 (21.9)	2.6 (3.3)
12	11				0.1 (1.1)		1.6 (14.9)	2.6 (23.6)
23	161		5 (3.1)		1.8 (1.1)	2.5 (1.5)	5.9 (3.7)	44.8 (27.9)
29	342							
33	47				1.3 (2.8)	1.3 (2.7)	17 (36.2)	
35	42		4.8 (11.4)		0.2 (0.5)		0.1 (0.2)	5.4 (12.7)
41	80	2.8 (3.5)		1.6 (2)	1.2 (1.6)		3.3 (4.2)	4.1 (5.1)
49	1063	1.6 (0.2)		1.2 (0.1)	1.1 (0.1)		0.8 (0.1)	0.8 (0.1)
53	9							1 (10.8)
54	351		8.5 (2.4)	10.6 (3)	9.9 (2.8)	15.7 (4.5)	2.2 (0.6)	23.7 (6.7)
62	1022						0.4 (0)	0.8 (0.1)
68	563	8.4 (1.5)		2.2 (0.4)	7.3 (1.3)	5.3 (0.9)	6 (1.1)	15.4 (2.7)
81	63	2.9 (4.6)			47.6 (75.6)	47.7 (75.7)	7.7 (12.3)	15 (23.9)
87	481			16.7 (3.5)	17.6 (3.7)	15 (3.1)	2.4 (0.5)	15.8 (3.3)
90	234		42.9 (18.3)		0.4 (0.2)	29 (12.4)		0.8 (0.4)
97	123		62 (50.3)			30.9 (25.1)		

ASCV – Areas of Significant Conservation Value

RAPs – Recommended Areas for Protection

Snatsig – Sites of Natural Significance.

SSWI - Sites of Significant Wildlife Interest

CPA1 - Coastal Protection Area 1

CPA2 - Coastal Protection Area 2

9. References

Snelder, T.; Leathwick, J.; Dey, K.; Weatherhead, M.; Wild, M. (2005). The New Zealand Marine Environment Classification. 70 p. ME number: 594, ISBN: 0-478-25908-5

Wild, M.; Weatherhead, M.; Snelder, T. (2003). Prototype regional-scale marine environment classification for the Hauraki Gulf and its application to assessment of representativeness of various marine protected areas. *NIWA Report. CHC2003-067.* 33 p.