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4 HOMOGENEOUS ZONES

The zones that have been delineated on the basis of the bathymetry and slope of the seabed are basically homogeneous in terms of their morphology (ref. geophysical zonation). The value of the delineation process would be strongly increased if it could be shown that they are also, more or less, homogeneous in terms of sediment nature, and ultimately in terms of their biology.

The zones, resulting from the geophysical zonation, have been used as query polygons of a variety of variables such as sedimentological parameters and in later phase macrobenthic groups. For the purpose of spatial planning, it was preferred to present the data and its associated scatter as it is in the original databases. This means that no interpolations have been done. Figure I.1.4a is a synthesis of the sedimentological nature (median grain-size) of the different zones. Generally, this figure shows that some zones clearly have another median grain-size range than others.

It needs emphasis that only the spread of the median grain-size is given per zone. This means that a cumulative count of occurrence is given whereby each count refers to a median grain-size falling in the range of respectively mud or very-fine, fine, medium and coarse sand. The overall range over which the median grain-size varies is however not solely natural. It must be remembered that the sedimentological database covers a period from 1976 to the present implying that the database is largely scattered. This is partly naturally caused, but also related to the different methodologies used in the grain-size analyses, different calculation procedures for the sedimentological parameters and generally human bias. Nevertheless, it gives a rough indication of the sediments that can be expected. As a synthesis, the average median grain-size per zone is also given in Figure I.1.4a, but purely as a qualitative measure. It is clear that the surface areas of the different zones vary significantly. This means that the spreading around the median grain-size will be for some zones more significant than in other zones. As such, this value is also given and pleads to evaluate the results in a more relative way. Finally, the density of the sampling points per zone is indicated and is one measure of reliability. Table I.1.4a gives a sorting of the zones according to their average median grain-size. Note that there is clear spatial trend with the sediments coarsening in an offshore direction.

Figure I.1.4a. Evaluation of the zones in terms of their surficial sediment characteristics. The Figure shows the spread of the median grain-size (µm) per zone (based on sedisurf@ database, Gent University, RCMG).

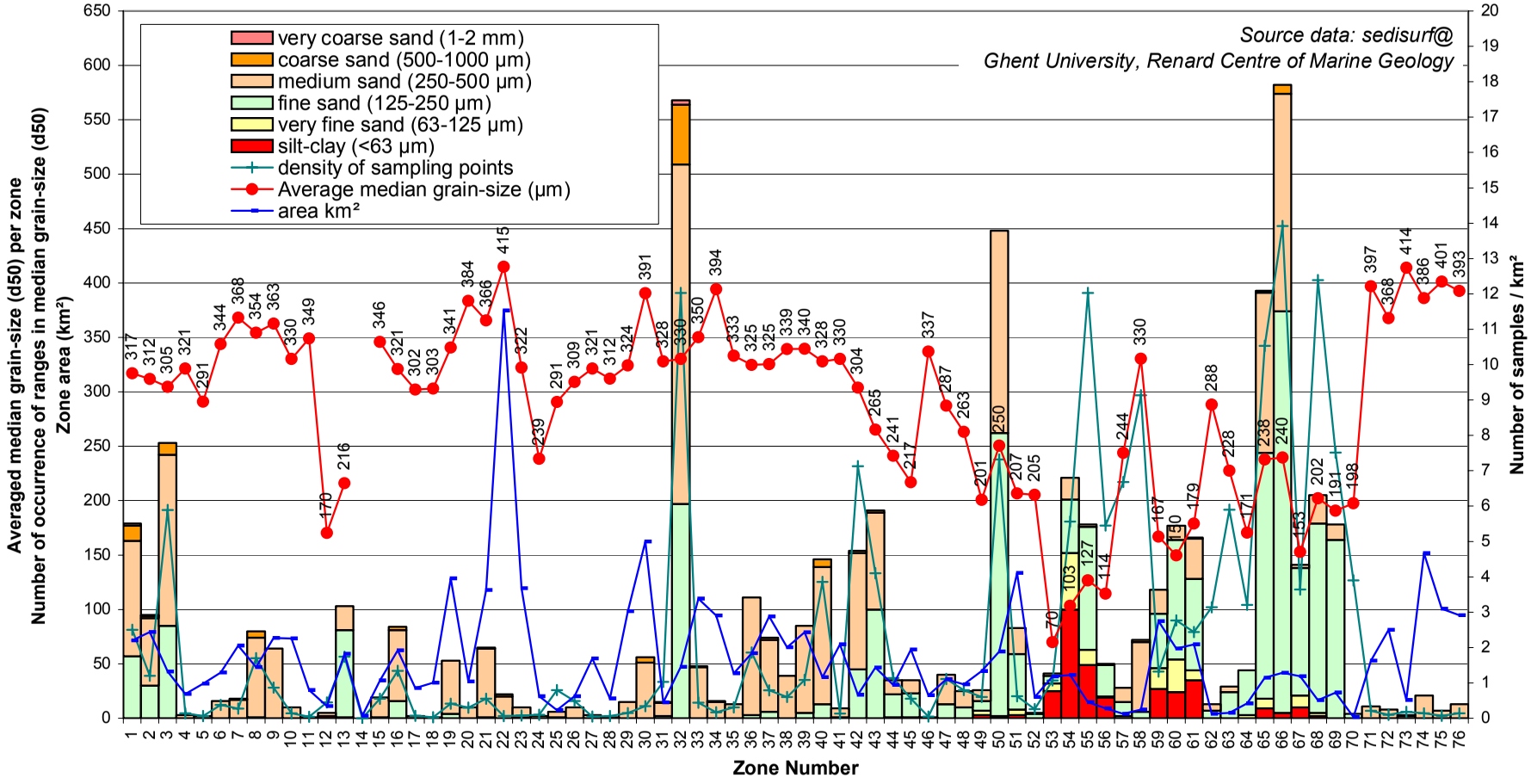

Table I.1.4a. Sorting of zones according to their average median grain-size. The dominant group in which the median grain-size falls is indicated (M: mud; FS: fine sand; MS: medium sand) as well as the number of observations in that group (based on sedisurf@ database, Gent University, Renard Centre of Marine Geology).

Zone	Morphological unit	Name of morphological unit	Dominant group (number of observations)	Average d50 (µm)	Remark
53	swale	Scheur	M (25)	70	N of Zeebrugge
54	sandbank	Wielingen	M (1)	103	
56	swale	Appelzak	FS (29)	114	
55	sandbank	Paardenmarkt	FS (113)	127	
60	sandbank	Wenduine Bank	FS (110)	150	
67	shoreface	deeper shoreface Nieuwpoort-Oostende	FS (117)	153	
59	sandbank	Wandelaar and western prolongation	FS (50)	167	
12	swale	swale Breed Bank - Smal Bank	MS (3)	170	
64	shoreface	deeper shoreface Oostende-Zeebrugge	FS (41)	171	
61	swale	swale south of Wenduine Bank	FS (84)	179	
69	shoreface	shoreface French Border - Oostende	FS (164)	191	
70	shoreface	shoreface west of Zeebrugge	FS (4)	198	
49	swale	swale north of Wandelaar	MS (10)	201	
68	swale	Potje	FS (174)	202	Near coastal area
52	sandbank	Droogte van Schooneveld	FS (4)	205	
51	sandbank	Vlakte van de Raan	FS (51)	207	
13	sandbank	Smal Bank	FS (80)	216	
45	swale	swale south of Akkaert Bank	FS (22)	217	
63	shoreface	shoreface Oostende-Zeebrugge	FS (24)	228	
65	swale	Westdiep - Kleine Rede	FS (226)	238	
24	swale	swale south of the Bergues Bank-In Ruytingen system	FS (2)	239	
66	sandbank	Trapegeer - Broers Bank - Den Oever	FS (369)	240	
44	swale	Grote Rede	FS (21)	241	
57	shoreface	shoreface east of Zeebrugge	MS (13)	244	
50	sandbank	Nieuwpoort Bank - Stroombank system	FS (260)	250	
48	sandbank	Oostende Bank	MS (15)	263	
43	swale	Negenvaam	FS (1)	265	
47	swale	swale Middelkerke bank - Oostende Bank	MS (27)	287	
62	sandbank	Br&W Oostende	FS (7)	288	
25	swale	swale Dijck - In Ratel Bank	MS (5)	291	
5	sandbank	sandbank north of Thornton Bank	MS (2)	291	
17	swale	swale west of In Ruytingen	MS (2)	302	
18	sandbank	ebb parabola connecting the Bergues Bank-In Ruytingen system with the Fairy Bank	MS (1)	303	
42	sandbank	Middelkerke Bank	MS (107)	304	Mainly Flemish Banks
3	swale	Kwinte	MS (157)	305	
26	sandbank	Dijck	MS (10)	309	
2	swale	swale Oostdijck - Buiten Ratel	MS (62)	312	
28	swale	Ruytingen Pas	MS (1)	312	
1	sandbank	Buiten Ratel	MS (106)	317	
16	sandbank	Oostdijck	MS (65)	321	
4	sandbank	western part Rabsbank	MS (3)	321	
27	sandbank	In Ruytingen	MS (3)	321	
23	swale	swale south of Fairy Bank	MS (9)	322	
29	sandbank	Out Ruytingen - Bergues Bank	MS (15)	324	
36	sandbank	Thornton Bank	MS (108)	325	
37	swale	swale south of Goote Bank	MS (66)	325	
40	sandbank	Goote Bank	MS (126)	328	
31	swale	swale south of Flemish Banks	MS (12)	328	
41	sandbank	Akkaert Bank	MS (8)	330	
10	sandbank	Fairy Bank	MS (10)	330	Mainly area of Zeeland Ridges
32	sandbank	Kwinte Bank	MS (312)	330	
58	sandbank	Ravelingen	MS (64)	330	
35	sandbank	western prolongation Goote Bank	MS (13)	333	
46	sandbank	topographic hight south of Akkaert Bank	MS (1)	337	
38	swale	swale north of Buiten Ratel - Kwinte Bank	MS (39)	339	
39	swale	swale Goote Bank - Thornton Bank	MS (80)	340	

Table I.1.4a. Sorting of zones according to their average median grain-size. The dominant group in which the median grain-size falls is indicated (M: mud; FS: fine sand; MS: medium sand) as well as the number of observations in that group (based on sedisurf@ database, Gent University, Renard Centre of Marine Geology) (continuing).

Zone	Morphological unit	Name of morphological unit	Dominant group (number of observations)	Average d50 (µm)	Remark
19	swale	swale Westhinder - Oosthinder	MS (49)	341	
6	sandbank	Bligh Bank	MS (16)	344	
15	swale	swale Bergues Bank - Oostdijck	MS (18)	346	
11	sandbank	Binnen Ratel - Breed Bank	MS (1)	349	
33	swale	swale north of Thornton Bank	MS (47)	350	
8	sandbank	Westhinder	MS (73)	354	
9	sandbank	Noordhinder	MS (64)	363	
21	swale	swale Noordhinder - Westhinder	MS (63)	366	Mainly Hinder Banks region
72	sandbank	sandbank N of Fairy Bank - Noordhinder	MS (8)	368	
7	sandbank	Oosthinder	MS (17)	368	
20	swale	swale Fairy Bank - Noordhinder	MS (10)	384	
74	shoal	shoal outmost N	MS (21)	386	
30	swale	swale Oosthinder - Bligh Bank	MS (51)	391	
76	swale	swale outmost N	MS (13)	393	
34	swale	swale east of Bligh Bank	MS (15)	394	
71	swale	swale N of Noordhinder	MS (11)	397	
75	sandbank	sandbank outmost N	MS (7)	401	
73	swale	swale of sandbank N of Fairy Bank - Noordhinder	MS (2)	414	North of BPNS
22	swale	outmost northern sandwave field	MS (20)	415	

The same querying process can be performed on the biological dataset. The results are encouraging and show that zones exist that are clearly dominant in a particular macrobenthic group. Figure I.1.4b gives the number of observed macrobenthic groups per zone. In Table I.1.4b the zones are grouped according to their dominant macrobenthic group if more than 1 observation is available (n>1). From this a clear S-N and W-E trend can be observed: Group A mainly occurs around Zeebrugge; Group C is dominant in the deeper parts of the near coastal area and on the Smal Bank and Middelkerke Bank; Group E is representative for the sandbank areas and the western shorefaces; Group G is mainly found in the Hinder Banken region and towards the north of the BPNS. It is clear that this trend resembles the trend in the median grain-size distribution.

The query of the macrobenthic groups per zone has been repeated on the extended biological dataset that resulted from the prediction of macrobenthic groups on the basis of the large sedimentological database using the Habitat model (see also ecological zonation). A resume of the predicted macrobenthic groups per zones is now largely dominated by Group E. This implies that the zones show similar macrobenthic groups and no clear delineations can be made; this in contrast to what was expected from the observations. The reasons for this homogeneous result are at least threefold:

Firstly, it needs emphasis that the sediment variables that were used to set-up the predictive Habitat model result from a well-defined and uniform methodology and as such a narrow correlation could be found between the occurrence of macrobenthic groups and their sediment characteristics. This narrow correlation has later been used for predictions using sediment parameters from the sedisurf@ database. As mentioned before, the latter is a compilation of sedimentologcial variables from 1976 onwards and is based on a variety of methodological approaches. Future research will try to find a correlation between both datasets and try to compensate for this difference. The results will likely improve significantly.

Table I.1.4b. Synthesis of the dominant macrobenthic group per zone (A, C, E or G) and its number of occurrence () (based on macrodat@ database, Gent University, Marine Biology Section).

zone	morphological unit	Name of morphological unit	Dominant macrobenthic group (n>1)	Spatial coverage
61	swale	swale south of Wenduine Bank	A (19)	Near coastal area around Zeebrugge
55	sandbank	Paardenmarkt	A (3)	
60	sandbank	Wenduine Bank	A (7)	
43	swale	Negenvaam	C (12)	Mainly the deeper parts of the near coastal area; also some of the Flemish Banks (*Smal Bank and Middelkerke Bank*)
45	swale	swale south of Akkaert Bank	C (13)	
68	swale	Potje	C (15)	
12	swale	swale Breed Bank - Smal Bank	C (2)	
53	swale	Scheur	C (2)	
65	swale	Westdiep - Kleine Rede	C (21)	
37	swale	swale south of Goote Bank	C (3)	
49	swale	swale north of Wandelaar	C (4)	
59	sandbank	Wandelaar and western prolongation	C (4)	
13	sandbank	Smal Bank	C (5)	
44	swale	Grote Rede	C (5)	
42	sandbank	Middelkerke Bank	C (9)	
3	swale	Kwinte	C-E (2-2)	
47	swale	swale Middelkerke bank - Oostende Bank	C-E (2-2)	
62	sandbank	Br&W Oostende	C-E-G (1-1-1)	
51	sandbank	Vlakte van de Raan	E (12)	Mainly on sandbanks and sandy shorefaces
66	sandbank	Trapegeer - Broers Bank - Den Oever	E (18)	
36	sandbank	Thornton Bank	E (2)	
48	sandbank	Oostende Bank	E (2)	
69	shoreface	shoreface French Border - Oostende	E (2)	
32	sandbank	Kwinte Bank	E (27)	
2	swale	swale Oostdijck - Buiten Ratel	E (3)	
31	swale	swale south of Flemish Banks	E (3)	
33	swale	swale north of Thornton Bank	E (3)	
1	sandbank	Buiten Ratel	E (4)	
16	sandbank	Oostdijck	E (5)	
34	swale	swale east of Bligh Bank	E (5)	
50	sandbank	Nieuwpoort Bank - Stroombank system	E (6)	
67	shoreface	deeper shoreface Nieuwpoort-Oostende	E (7)	
9	sandbank	Noordhinder	E-G (4-4)	
30	swale	swale Oosthinder - Bligh Bank	G (10)	Hinder Banken and area north of the Belgian shelf
8	sandbank	Westhinder	G (3)	
20	swale	swale Fairy Bank - Noordhinder	G (3)	
22	swale	outmost northern sandwave field	G (4)	
21	swale	swale Noordhinder - Westhinder	G (5)	
19	swale	swale Westhinder - Oosthinder	G (6)	
10	sandbank	Fairy Bank	G (7)	
72	sandbank	sandbank N of Fairy Bank - Noordhinder	G (8)	
74	shoal	shoal outmost N	G (9)	

Secondly, it is not surprising that a bias occurs towards Group E as most of the sampling points of the sedimentological database are focussed on the sandbank areas and the deeper parts are often undersampled. Moreover, the BPNS is predominantly sandy and as such Group E will allways tend to dominate. Furthermore, Group C is likely to occur in a more patchy way and as such it is rather unlikely that a complete large-scale zone is dominated by this group. As Group C is the most diverse and rich group, any occurrence is very valuable and is preferentially accounted for in any spatial planning activitiy.

Thirdly, one could argument that a zonation on a broad-scale, as in this case, might have limited ecological relevance. This pleads for a more detailed approach which also implies the availability of good quality data. Crucial in this is a detailed and holistic substrate map as this determines, in highest rank, the occurrence of macrobenthic communities. On-going research is heading into this direction.

CONCLUSION

A zonation of the Belgian part of the North Sea has been performed on the basis of morphologically homogeneous areas. This has resulted in 76 zones that are clearly identifiable towards end-user communities. In a later phase, it was shown that per zone the surficial sediments have more or less similar sedimentological characteristics. The tables that are provided can be used as a first rough estimate of the median grain-size per zone and give a better insight into the spatial distribution of the surficial sediments.

Given the strong link between the sedimentological variation and the occurrence of macrobenthos, it was demonstrated that the delineated zones have relevance towards the occurrence of macrobenthic groups. This information is highly valuable in qualitative terms to any spatial planning project.

However, it was not possible to attribute sedimentological or macrobenthic variables to locations in a uniform way throughout the BPNS. As such, it is presently not possible to upgrade the zoning process of geophysical and ecological data into a quantitative base map, which can be used for the evaluation of anthropogenic activities and impact analysis. On-going research activities on the parameterisation and modelling of both physical and biological variables and their interaction will help the development of a more quantified and holistic approach in the future.

Figure I.1.4b: Evaluation of the zones in terms of the occurrence of macrobenthic groups; number of occurrences of observed macrobenthic groups per zone (based on macrodat database, Gent University, Section Marine Biology).

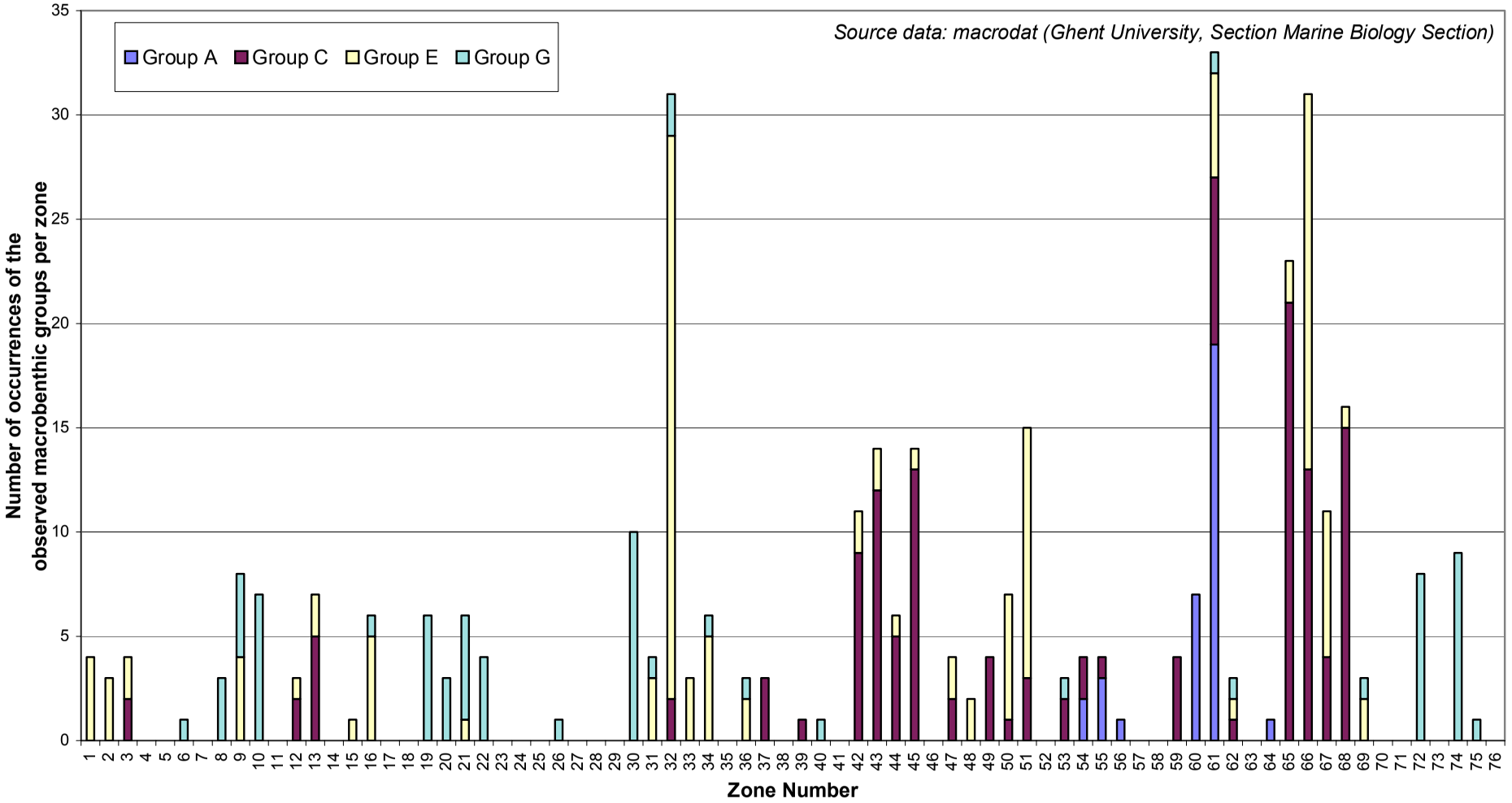

Figure I.1.4c: Evaluation of the zones in terms of the occurrence of macrobenthic groups; number of occurrences of predicted macrobenthic groups per zone (based on a prediction of macrobenthic groups using the sedimentological database of Gent University, Renard Centre of Marine Geology).