Aalborg Universitet

Review on available Information on Flora, Fauna and Environment (DanWEC Vaekstforum 2011)

Azzellino, Arianna; Margheritini, Lucia; Pedersen, Morten Lauge

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

Review on available information on flora, fauna and environment
(DanWEC Vaekstforum 2011)

Arianna Azzellino
Lucia Margheritini
Morten Lauge Pedersen

ISSN 1901-726X
DCE Technical Report No. 143

AALBORG UNIVERSITY
Department of Civil Engineering

Aalborg University
Department of Civil Engineering
Water and Soil

DCE Technical Report No. 143

Review on available information on flora, fauna and environment
(DanWEC Vaekstforum 2011)

by

Arianna Azzellino
Lucia Margheritini
Morten Lauge Pedersen

March 2012

Scientific Publications at the Department of Civil Engineering

Technical Reports are published for timely dissemination of research results and scientific work carried out at the Department of Civil Engineering (DCE) at Aalborg University. This medium allows publication of more detailed explanations and results than typically allowed in scientific journals.

Technical Memoranda are produced to enable the preliminary dissemination of scientific work by the personnel of the DCE where such release is deemed to be appropriate. Documents of this kind may be incomplete or temporary versions of papers—or part of continuing work. This should be kept in mind when references are given to publications of this kind.

Contract Reports are produced to report scientific work carried out under contract. Publications of this kind contain confidential matter and are reserved for the sponsors and the DCE. Therefore, Contract Reports are generally not available for public circulation.

Lecture Notes contain material produced by the lecturers at the DCE for educational purposes. This may be scientific notes, lecture books, example problems or manuals for laboratory work, or computer programs developed at the DCE.

Theses are monograms or collections of papers published to report the scientific work carried out at the DCE to obtain a degree as either PhD or Doctor of Technology. The thesis is publicly available after the defence of the degree.

Latest News is published to enable rapid communication of information about scientific work carried out at the DCE. This includes the status of research projects, developments in the laboratories, information about collaborative work and recent research results.

Published 2011 by
Aalborg University
Department of Civil Engineering
Sohngaardsholmsvej 57,
DK-9000 Aalborg, Denmark

Printed in Aalborg at Aalborg University

ISSN 1901-726X
DCE Technical Report No. 143

ISSN 1901-726X
DCE Technical Report No. 143

Preface

The Danish Wave Energy Centre (DanWEC) has been established in 2009 because of participated desire to market the trial wave energy projects which are already in Hanstholm and others to come. The DanWEC is a part of Hanstholm harbour in the North-West of Denmark.

The Center will contribute at creating a local base for knowledge, education and possibly a workplace which will be leased out to trial projects. It is therefore likely that different developers will deploy their wave energy devices during the next years in this location and therefore detailed knowledge on a number of environmental and physical parameter is necessary.

The present report has been prepared by Lucia Margheritini (lm@civil.aau.dk). Morten Lauge Pedersen (mlp@civil.aau.dk) is responsible for the data fetching and review; Arianna Azzellino (ara@civil.aau.dk) is responsible for preliminary data analysis. The report should function as a review and assessment of the existing documents and present knowledge on information at the DanWEC location.

The present report has been prepared under the project No. 834101 “DanWEC Vaekstforum 2011”, task 4: “Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm”.

Contents

Introduction

Marine Environmental Data are collected as a part of the routine monitoring programme of the marine environment. The programme includes a physical / chemical component and a biological programme. The biological and the physical / chemical parameters are not necessarily sampled at the same stations (Fig. 1). The monitoring data are historical and covers a 20 year span from app. 1987 to 2007. Newer data are probably available but we need to contact local environmental offices to get access to data.

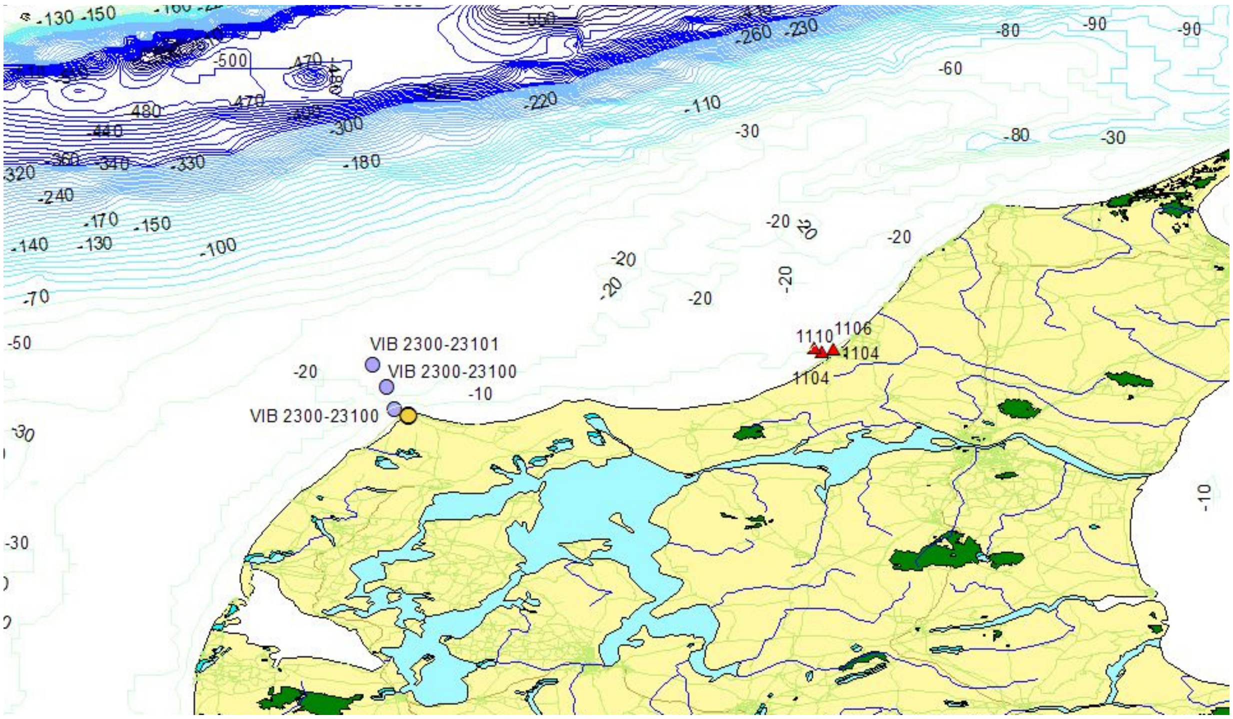

Figure 1. Map of North-Jutland with highlighted data stations of relevance of the DanWEC and Hanstholm.

- **Physical / chemical programme**

Four are the stations of interest for the Danwec (Table 1). All parameters are sampled in different depths: Top /5-10m/10-15m/15-20m/20-25m (Table 2). All data is available for online database http://www.miljoeportal.dk/Overfladevand/ (Fig 2).

Table 1. Relevant stations for acquisition of marine physical and chemical Environmental Data at Hanstholm.

Station	*Name*	*Position*	
VIB 2300-23100	1 NM NNW of Hanstholm	8° 35,3' E	57° 08' N
VIB 2300-23101	4 NM NNW of Hanstholm	8° 34' E	57° 11' N
VIB 2300-23102	7 NM NNW of Hanstholm	8° 32' E	57° 14' N
VIB1100-00002	Hanstholm/Thyborøn (Nørre Vorupør)		

Table 2. Physical and Chemical parameters available at the stations.

Parameters	
Physical	*Chemical*
Depth	pH
Wave height	Suspended sediment
Air temperature	TOC
Air pressure	NH_4-N
Wind speed	NO_{23}-N
Wind direction	Tot-N
Density	PO_4-P
Salinity	Tot-P
Oxygen	Chloride
Temperature	Silicon
Fluorescence	Chlorophyl

Table 3. Station, period and number of samples (physical and chemical parameters).

Samples		
Station	*Sampling period*	*Number of samples*
VIB 2300-23100	1989 – 2009	162 – 219
VIB 2300-23101	1989 – 1997	104
VIB 2300-23102	1989 – 1997	104
VIB1100-00002	-	-

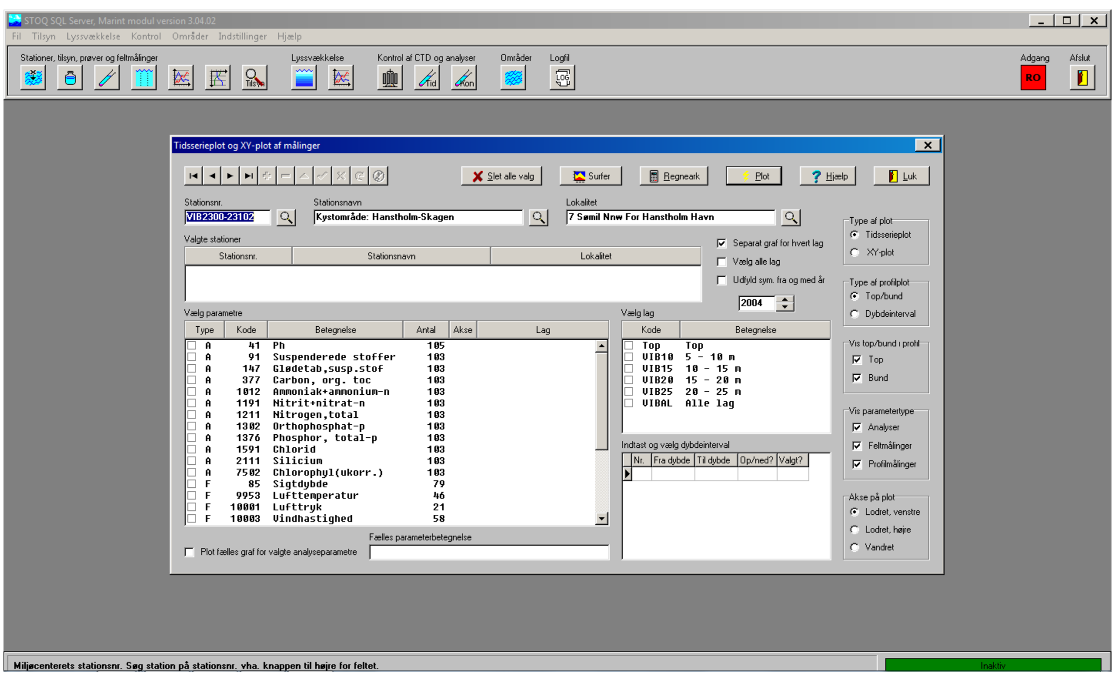

Figure 2. *Screen dump from the online database of physical / chemical parameters*

- **Biological programme**

The biological parameters are: <u>taxonomic composition</u> and <u>abundance of marine bed invertebrates</u>. Samples are standardized grab samples of equal size. All data is available for online database (Fig 3). http://www.miljoeportal.dk/Overfladevand/

Table 4. Relevant stations for acquisition of marine biological Environmental Data at Hanstholm.

Station	*Name*	*Position*	
1104	Jammerbugt 1	9° 34,16’ E	57° 15,73’ N
1106	Jammerbugt 2	9° 35,59’ E	57° 16,02’ N
1110	Jammerbugt 3	9° 33,05’ E	57° 16,30’ N

Table 5. Station, period and number of samples (biological parameters).

	Samples	
Station	*Sampling period*	*Number of samples*
1104	1989 – 1996	12
1106	1989 – 1996	12
1110	1989 – 1996	12

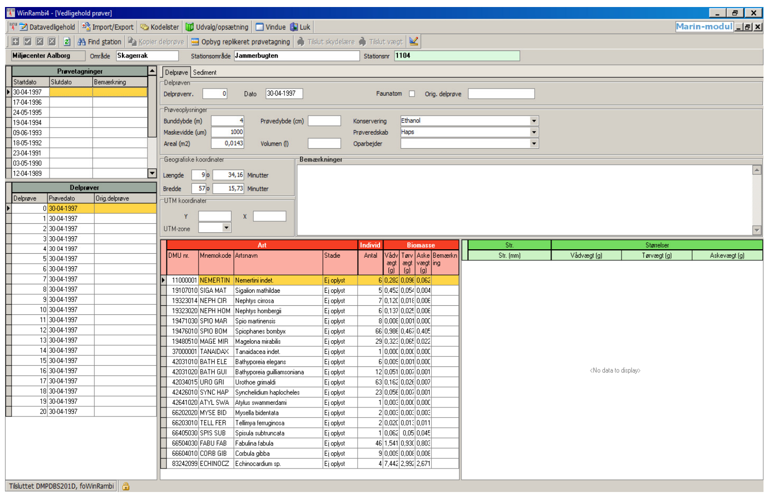

Figure 3. ***Screen dump from the online database of biological parameters***

Biological programme

In this report only the available information about benthos community will be analysed.

Preliminary exploration of the abundance data.

Different different kinds of benthos abundance data are available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes) but they are strongly correlated (see the correlation matrix shown in Table 6) so all the following analysis concern the Biomasse vådvægt). Due to the strongly asymmetrical distribution of the biomass values a logarithmic transformation (e.g. Log10) was applied obtaining a much more symmetrical distribution which was further splitted by year and by month (Fig. 4).

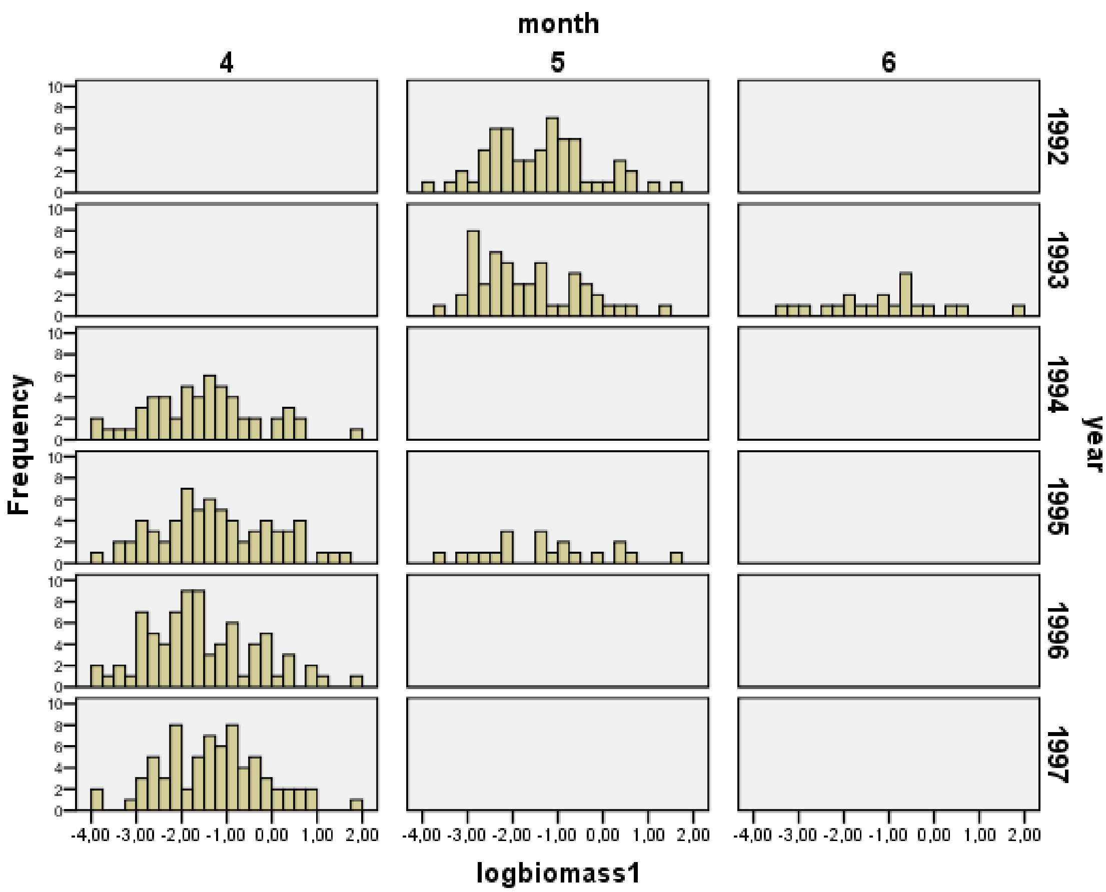

Figure 4. Frequency distribution of logbiomass 1 by year (rows) and by month (columns). The presence of empty crosstabulations is due to missing data.

Afterwards, by means of a One-Way ANOVA (Rutherford, 2001), the hypothesis that the biomass varies yearly or monthly was tested. ANOVA showed clearly that the biomass values did not significantly change by year or month in the used dataset (Tables 7, 8). Moreover, it was also tested whether the three sampled stations (i.e. 1104, 1106 and 1110) were homogenous in terms of biomass. In this case One-Way ANOVA showed significant differences (Table 9).

Table 6. Matrix of the Pearson's correlation coefficients (available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes). The significance level (i.e. Sig.) and number of cases (i.e. N) are also shown. The correlation coefficients highly significant (Sig.<0.01) are labeled with the "" symbol.**

Correlations				
		biomass1	biomass2	biomass3
biomass1	Pearson correlation	1	,994**	,995**
	Sig. (2-tails)		,000	,000
	N	420	420	420
biomass2	Pearson correlation	,994**	1	,996**
	Sig. (2-tails)	,000		,000
	N	420	592	592
biomass3	Pearson correlation	,995**	,996**	1
	Sig. (2-tails)	,000	,000	
	N	420	592	592

Table 7. One.-way ANOVA results: the logbiomass1 was tested against the year. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.

One-Way ANOVA (Fixed Factor: Year)					
logbiomass1					
	Sum of the Squares	df	Mean of the Squares	F	Sig.
Between	6.788	5	1.358	.921	.467
Within	610.129	414	1.474		
Totale	616.917	419			

Table 8. One.-way ANOVA results: the logbiomass1 was tested against the month. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.

One-Way ANOVA (Fixed Factor: Month)					
logbiomass1					
	Sum of the Squares	df	Mean of the Squares	F	Sig.
Between	2.560	2	1.280	.869	.420
Within	614.358	417	1.473		
Totale	616.917	419			

Table 9 One.-way ANOVA results: the logbiomass1 was tested across the sampling stations. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). A statistical difference was assessed.

One-Way ANOVA (Fixed Factor: Stations)					
logbiomass1					
	Sum of the Squares	Df	Mean of the Squares	F	Sig.
Between	13.351	2	6.676	4.612	.010
Within	603.566	417	1.447		
Totale	616.917	419			

A following Tukey test for multiple comparisons (Tukey, 1949) showed that station 1110 has a biomass significantly lower (depth: -10 m) that station 1104 (which is the station closer to the shore). While station 1106 (depth:-7 m) is somewhat intermediate between these two and is not significantly different from these (Table 10).

Table 10 Tukey Multiple comparison test. The three stations are compared pairwise. The Significance levels are shown. A signifcant difference was found between station 1110 and 1104 (in blue).

Multiple comparaisons			
dependent: logbiomass1			
Test: Tukey HSD (Sig. Are shown)			
	(J) Stationsnr		
(I) Stationsnr	1104	1106	1110
1104		,222	,007
1106	,222		,273
1110	,007	,273	

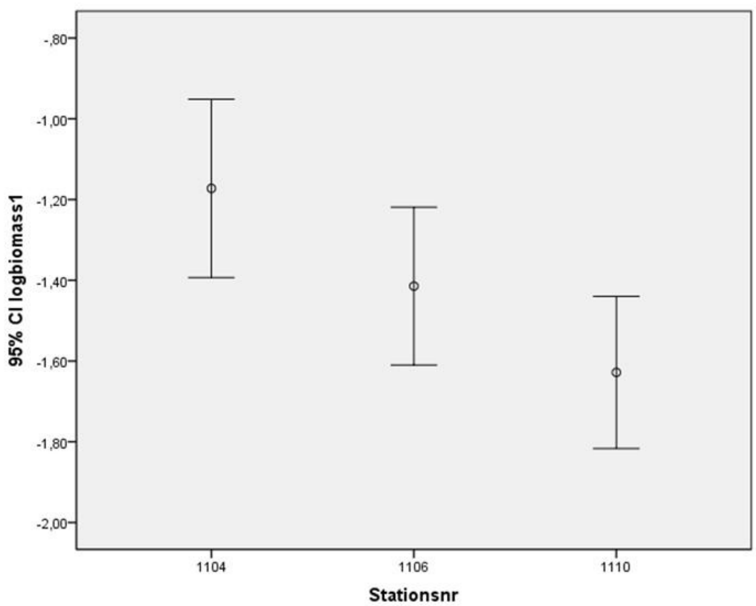

Figure 5 95% Confidence intervals of the means of the three stations. It can be observed that the 95%CI intervals of the stations 1104 and 1110 do not overlap at all. Station 1106 is in between.

Preliminary exploration of the Taxonomic composition.

To explore the differences of the Taxonomic composition a Cluster Analysis was used and a data matrix was prepared to analyze the similarities (see Table 11). A code was created for each station*year combination and the number of individuals belonging to the species (Arstnr.) was counted. In this way the species composition profile per each sample was used to compare the similarities among the stations.

Table 11. Example of the data matrix used as input of the Cluster Analysis. Column header show the "year_station" codes whereas Artsnr. Is the code for the species.

Artsnr.	1986_04	1987_04	1990_04	….	1992_06	1993_06	1994_06	….	1996_10	1997_10
2010005							2			
3421010										
11000001	6		2	8	8	10	8	6	8	12
18000001							2		0	0
19051535						0				
19106007								2		
19107010	0	0		2	0	4	0	0	4	10
……….										
66405020				0						
66405030	0	48	4	0		0		0		2
66405099							2		2	0
66501010	12	14	22	16	22	2	4	20	4	0
66501099						0		14	0	
66503030		0								
66504030	426	218	56	6	32	416	172	42	228	92
66532010						0				
66532099				0						
66560000			0							
66561010	16	0	0	0	0	0	0	0	2	0
66604010								2		18
75101099			0					0	0	0
81000010						0				

103 spp

Hierarchical Cluster Analysis was used (Afifi and Cark, 1996). As metric of similarity the Euclidean Distance was used. The Ward method was chosen as agglomeration criterion.

As the attached dendrogram shows (Fig. 6) the stations are quite homogeneous in terms of taxonomic composition, since the "ouliers" seem to be confined to some years (e.g. 1994, 1995, 1996 and 1997) and to station 1110.

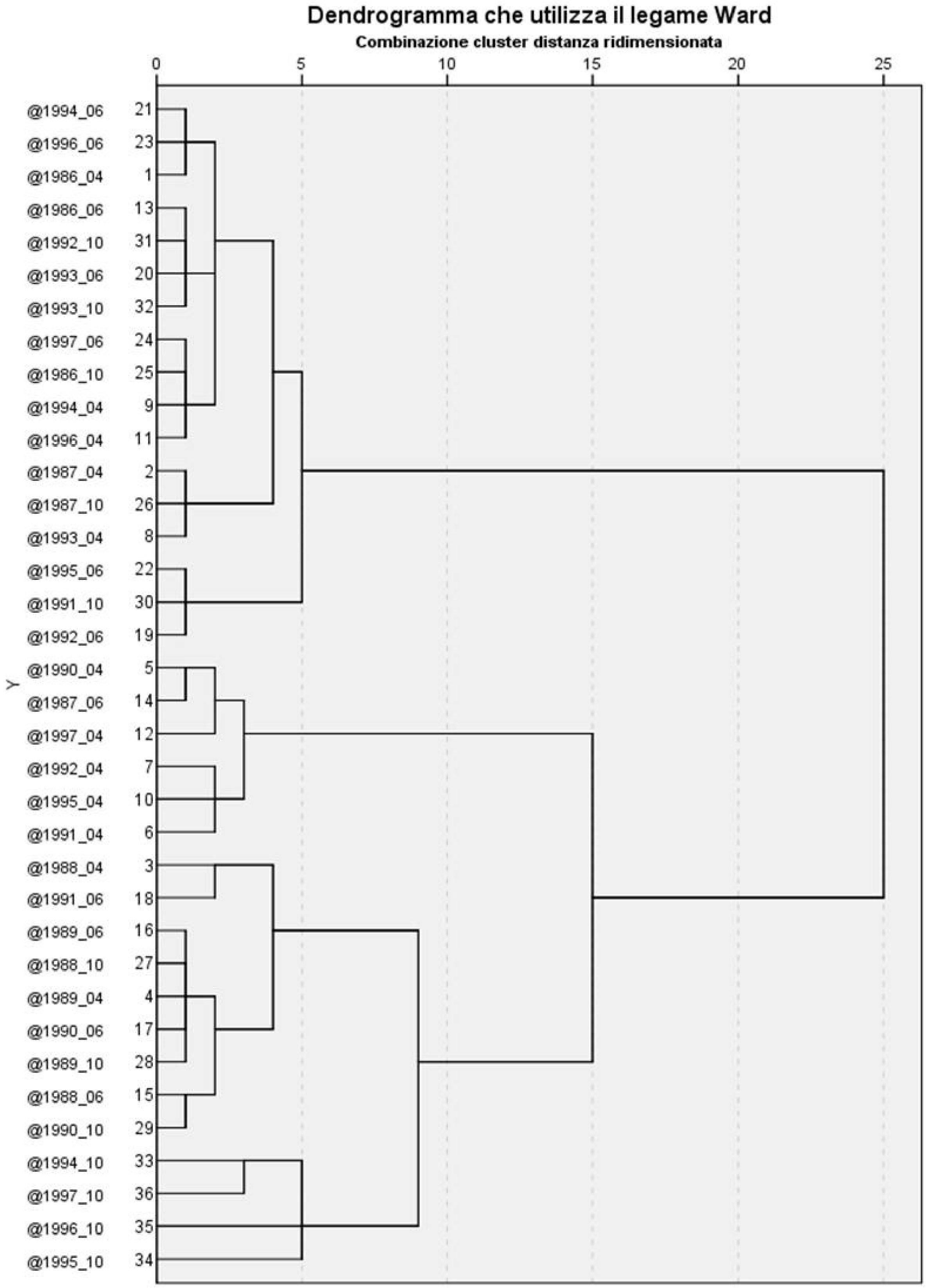

Figure 6. Dendrogram stemming from the Cluster Analysis applied to Table 11.

Future Work

All the available information about the environmental background in the Hanstholm area will be used to provide a sensitivity map of the area that could be used to predict the impact of the future human activities in the area. This knowledge could also be used as reference baseline in future studies aimed to assess the environmental impact of wave energy installations using a BACI (i.e. Before and After Control Impact) design approach.

If dedicated funds would be available the Hanstholm test site could be used as a pilot area to to study environmental impacts and interactions with marine organisms, ranging from small bottom dwelling organisms living in the seabed, organisms involved in biofouling (and therefore of interest to mechanical wear and maintenance) to vertebrates, including fish, seabirds and marine mammals.

Concerning the sea bottom fauna, sediment cores could be collected on seasonal basis in the sites chosen for deploying WEC devices allowing a site-specific quantitative analysis of the macrofauna to assess the percent gain of hard bottom habitat offered by WEC foundations or mooring devices.

Dedicated monitoring campaigns could be designed to assess fish, seabirds and marine mammals abundances in the area.

All the future sampling campaigns should be designed using a BACI approach (e.g. before and after the pilot WEC deployment).

An additional element for the impact assessment would be, after the deployment of WEC devices needing antifouling treatments, the use of biomarker organisms (e.g. Noventa and Pavoni, 2011) to evaluate the contamination due to the antifouling compounds. This analysis would require the collection of additional data for at least a couple of years after WEC deployment and budget for the needed chemical analysis.

Conclusions

This report presents a preliminary assessment of the environmental background of the DanWEC site and is part of the task 4: “Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm” of the project No. 834101 “DanWEC Vaekstforum 2011”. The available data on the bethonic community collected in the area of the Port of Hanstholm have been analysed. No seasonality effect has been assessed in the available biomass data series whereas a bathymetry effect was detected (i.e. the deepest station has a lower biomass value).

References

Afifi, A., Clark, V. (1996). Computer-Aided Multivariate Analysis. Texts in Statistical Science, fourth ed. Chapman & Hall./CRC Press.

Noventa, S. Pavoni, B. 2011. Periwinkle (Littorina littorea) as a Sentinel Species: A Field Study Integrating Chemical and Biological Analyses. *Environmental Science & Technology* : 45 (7): 2634-2640.

Rutherford, A. (2001) Introducing Anova and Ancova: A GLM Approach (Introducing Statistical Methods series) SAGE Publications 2001. ISBN: 076195161X.

Tukey J.W. 1948 “Comparing Individual Means in the Analysis of Variance” Biometrics, Vol. 5, No. 2 (Jun., 1949), pp. 99-114.