Compilation of benthic metrics and their suitabiliy for the assessment of the ecological status of coastal and transitional water in Germany
- macrozoobenthos-

This study is part of the project *, Assessment of the eutrophication status of transitional and coastal waters of the North Sea (OSPAR and WFD)'* from Uwe Brockmann and is supported by the Environmental Agency of Germany (UBA).

Assessment methods were compiled from the literature and possibly suitable metrics were choosen to test, whether they are useful for an assessment of the ecological status of the Wadden Sea.

- Is the macrozoobenthos a useful indicator for the assessment of the ecological status of an ecosystem?
- What are the metrics, how do they work and what are they able to afford?
- Which ones are the assessement methods from other EU-Memberstates and other countries?
- Presentation of results and classifications from some Wadden Sea stations received with different metrics.
- Summary and lack of knowledge.
- US assessment method for the Chesapeake Bay

Is the macrozoobenthos a useful parameter for the assessement of the ecological status?

Yes, because

- it has generally limited mobility and can‘t avoid adverse conditions. Therefore it reflects local environmental conditions.
- Partly the organisms are long-lived, so they integrated for a longer period.
- Species determination is comparable simple.
- There is a lot of knowledge in autecology.
- There are much more data, than for other animal groups.

But there is a great difficulty because the structure of the benthos reflects also anthropogenic stress and natural variation e.g. sediment characterics. Mostly it is impossible to separate the causes for the variation to anthopogenic or natural (e.g. serve winters) impacts.

How do the zoobenthos community react on different disturbances?

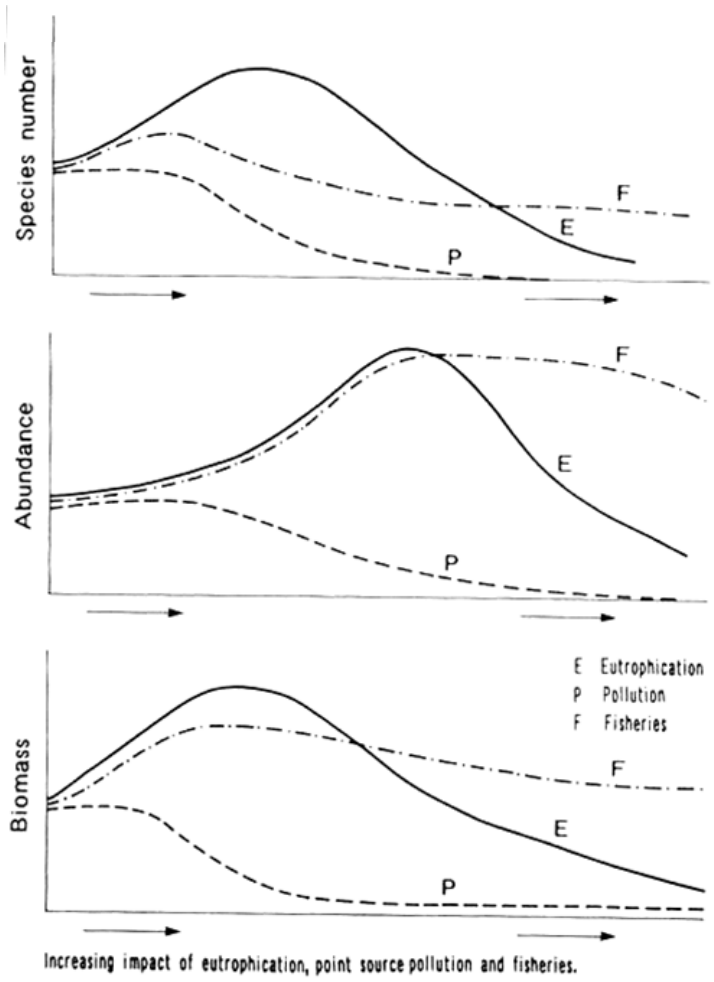
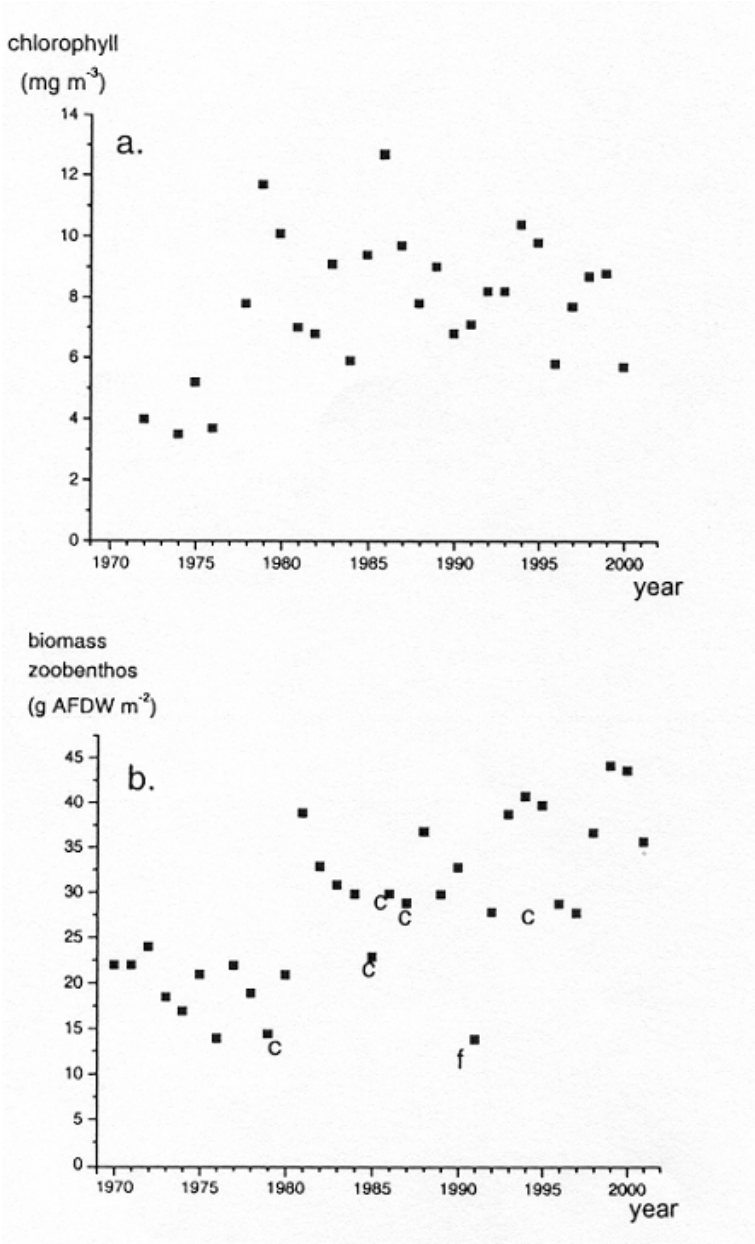


Fig. 1. The impact of increasing eutrophication, point source pollution and fisheries on the species number, abundance and biomass of macrofaunal communities.

- Species number
- Abundance
- Biomass



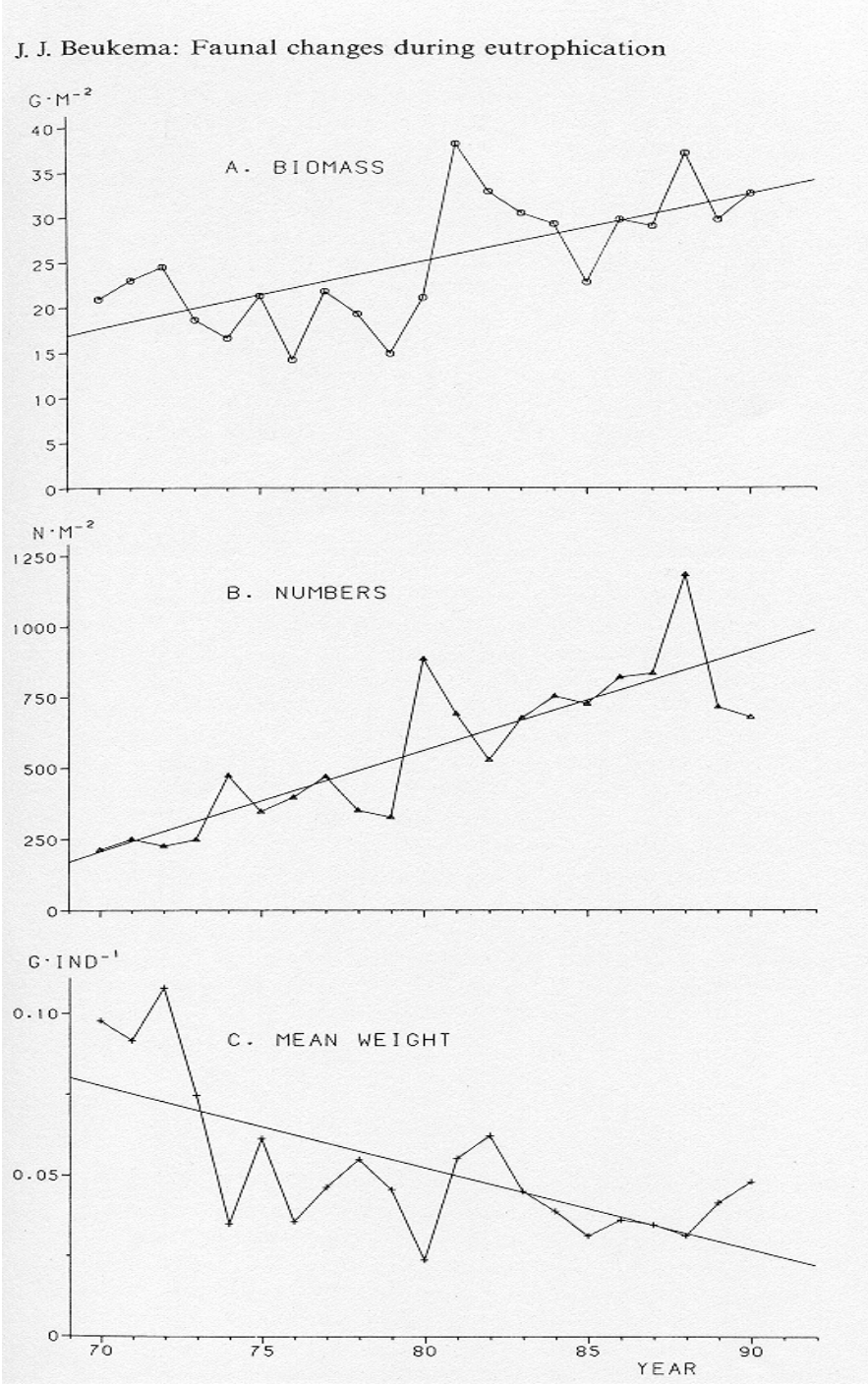
Beukema et al. 2002

Netherland Wadden Sea

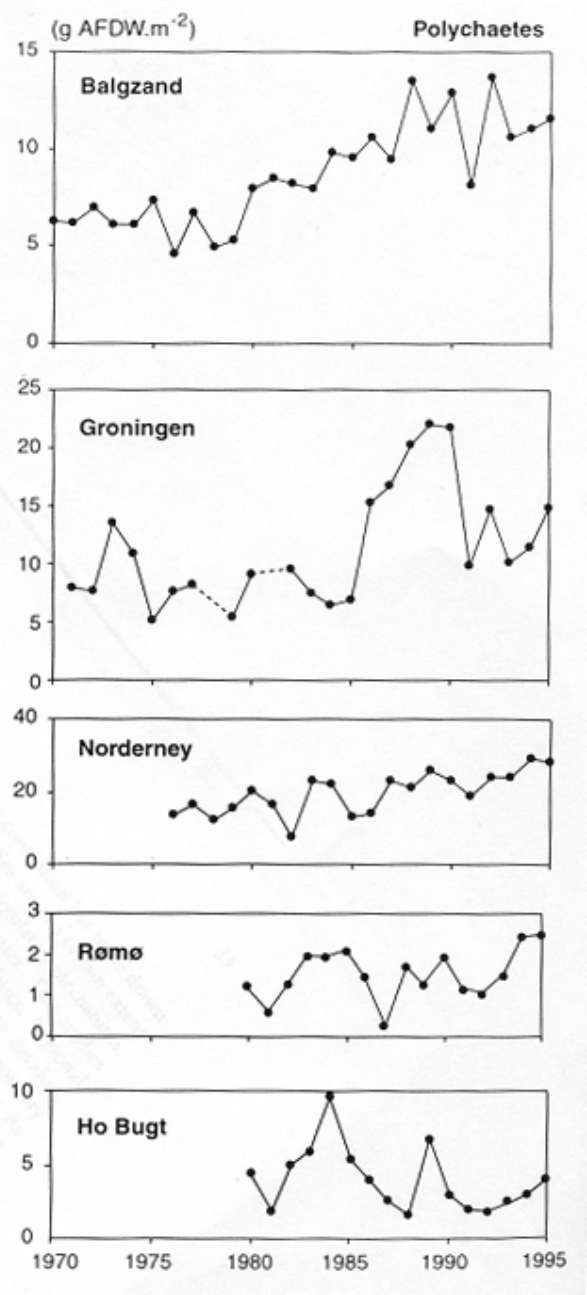
With increasing chorophyll concentration in the pelagic zone the zoobenthos biomass is also increasing.

f = strong fisheries

c = cold winters



The species composition of the zoobenthos has changed.

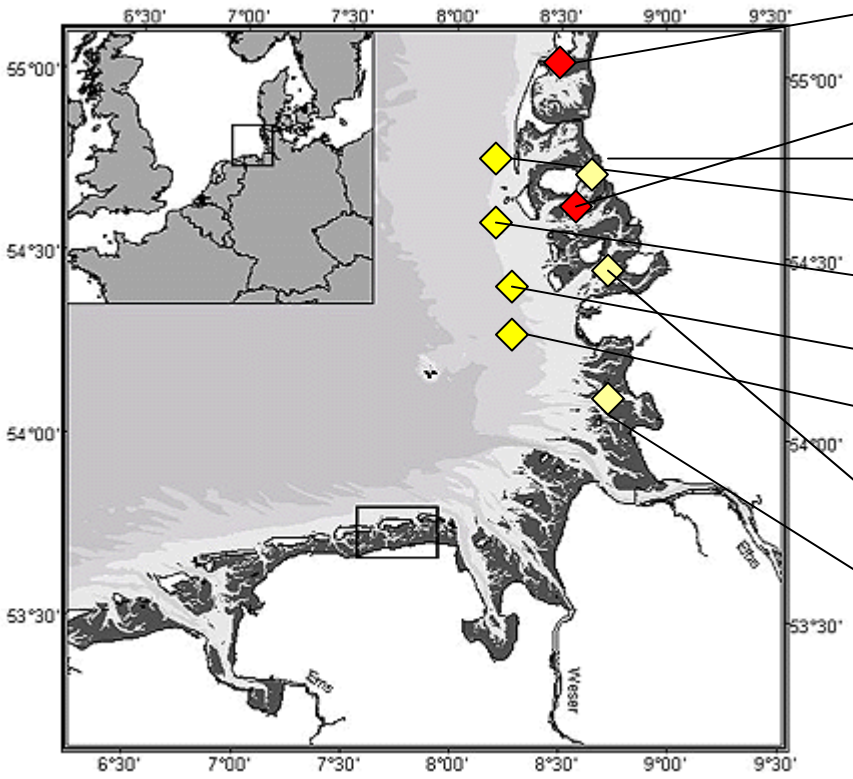


But not in all regions of the Wadden Sea an increase of the zoobenthos biomass and abundance or species composition is detectable ..

From Essink et al. 1998.

Metric	**Principle**	**Examples**
Diversity indices	Undisturbed habitats are more diverse than disturbed habitats, therefore a high value for diversity indicates good ecolocial quality. *Norwegian and Swedish assessment methods*	Shannon-Weaver Index, Hurlbert Index
Indices, which are based on indicator species	Species are classified according to their tolerance or sensitivity e.g. to organic pollutions. The proportion of tolerante and sensitive species at a station is used for the classification. *Norwegian and Swedish, and Spanish and Greek assessment methods, UK tests the AMBI*	AMBI, Bentix, Index of pollution (different species of polychaets), Freshwater: Acidity Index, Benthic Quality index (based on larvae of *Chironomidae*)
Taxonomic Distinctness	Taxonomic distictness is reduced in disturbed habitats.	Taxonomic Distinctness
Indices based on sediment photographs	Surface structurs and depth of the reduce layer were analysed and assessed.	Benthic Habitat Quality (Baltic Sea)
Multimetric indices	Results from different indices are put together and for the assessment an single multi index is calculated. (*US*)	Ecological Quality Ratio (Borja); B-IBI

Station locations for the tests of the indices (AMBI and diversity indices)



Riesen & Reise 1982

Reise & Schubert 1987

LANU DAGEBÜLL

LANU NS1

LANU NS2

LANU NS3

LANU NS4

LANU NORDSTRAND

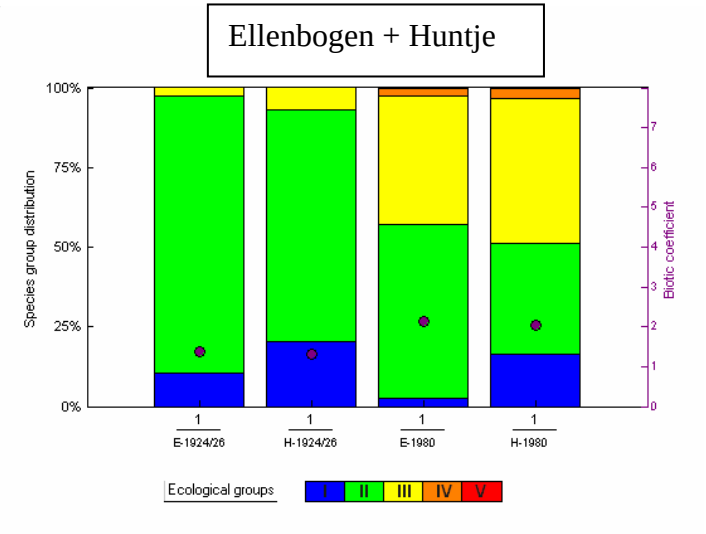
LANU BÜSUM

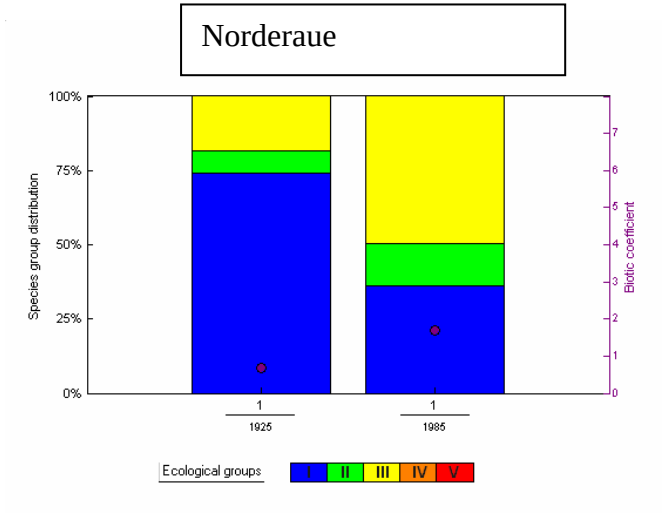
AMBI
Example Büsum 2.2.1988

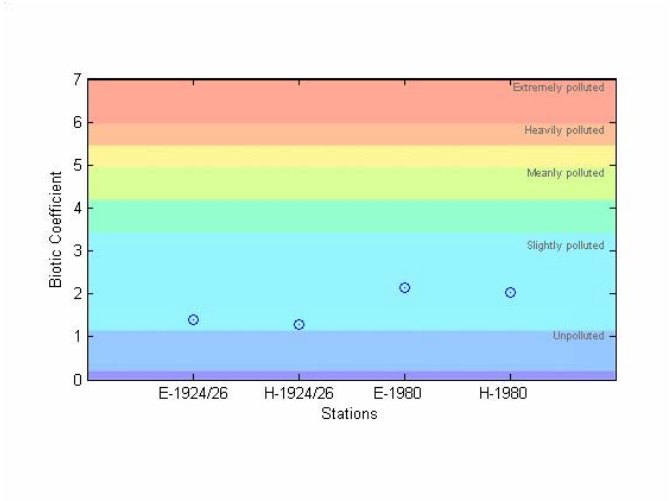
Species name	sensitivity value	individuals*m-^{2}	procent	weighted
Aricidea suecica	1	6		
Crangon crangon	1	19		
Macoma balthica	1	1219		
Scoloplos armiger	1	6		
Arenicola marina	1	38	4,4	
Eteone cf. longa	2	250		
Mya arenaria	2	44		
Nephtys hombergii	2	25		
Phyllodoce mucosa	2	69	1,3	2,0
Cerastoderma edule	3	2081		
Corophium arenarium	3	13		
Hydrobia ulvae	3	238		
Neanthes virens	3	288		
Pygospio elegans	3	1850	15,5	46,4
Heteromastus filiformis	4	17963		
Polydora cornuta	4	19	62,2	279,9
Capitella capitata	5	219		
Oligochaeta indet.	5	4544	16,5	98,9
Bylgides sarsi	?	19	0,1	
	sum	28906		
	species number	19		
	AMBI	4,27		

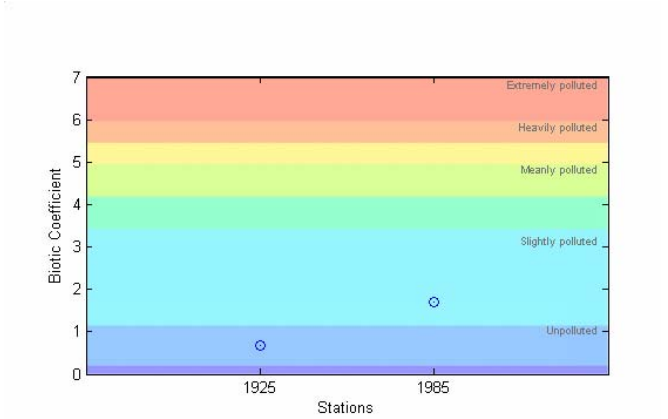
AMBI = Sum of the weighted procent values divided through 100

Ecological assessment from 3 Stations in the Wadden Sea in comparison of 1924/25 : 1980/85

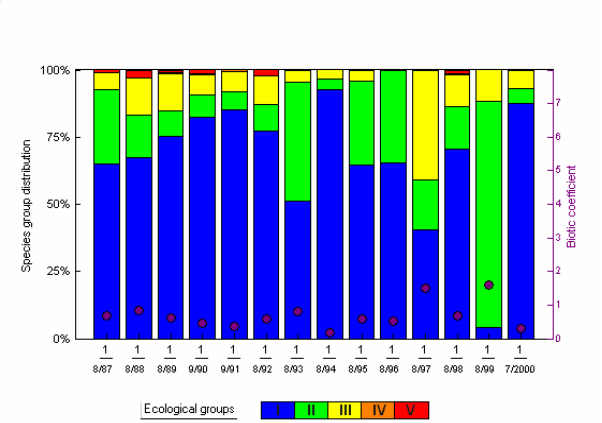




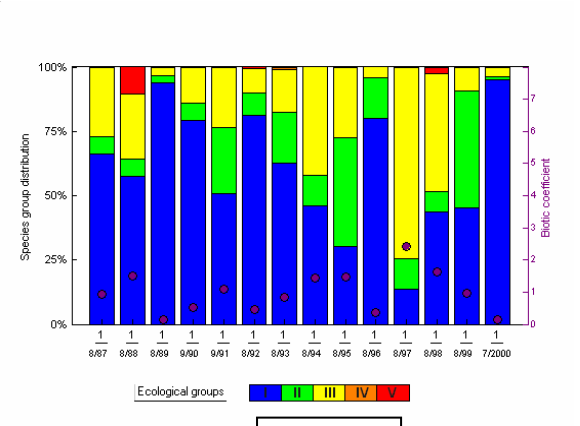




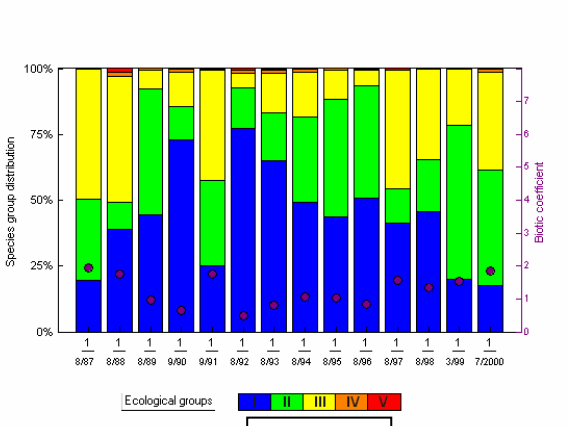
Sublittoral North Sea stations LANU



NS 1

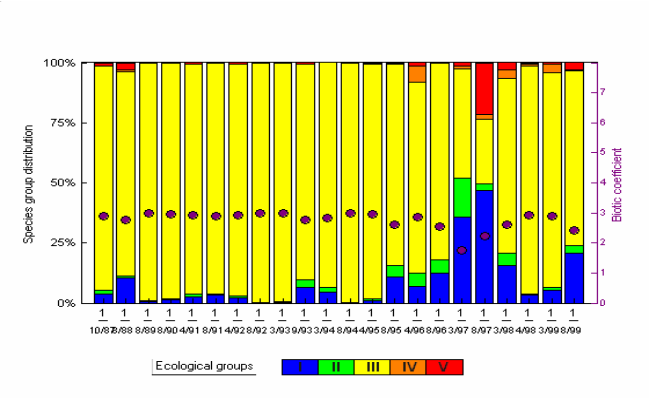


NS 2

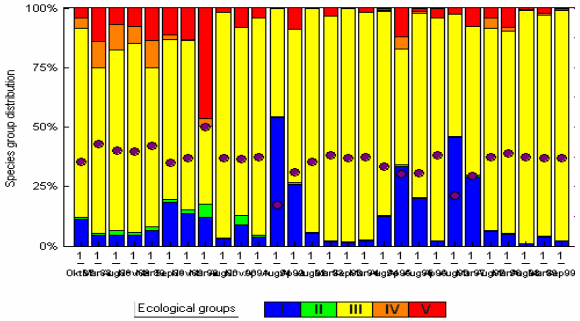


NS 3

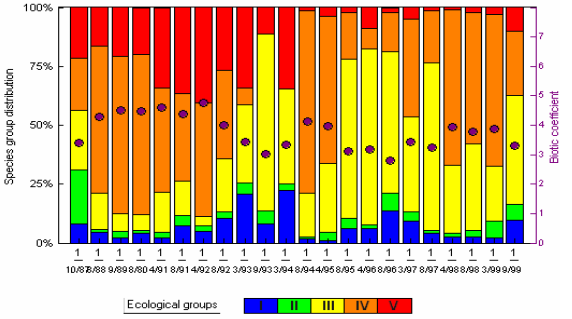
Eulittoral Wadden Sea stations LANU



Dagebüll



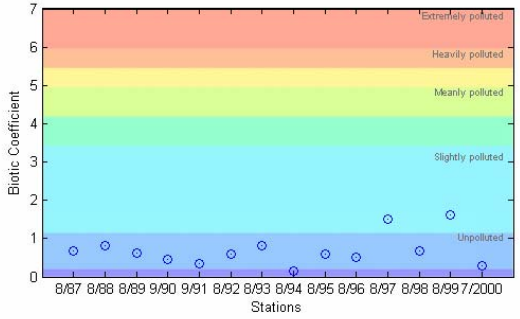
Nordstrand



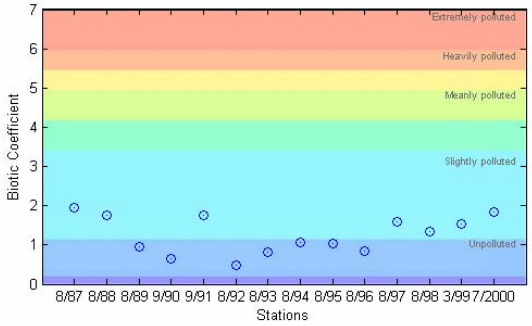
Büsum

Assessment of the LANU Stations

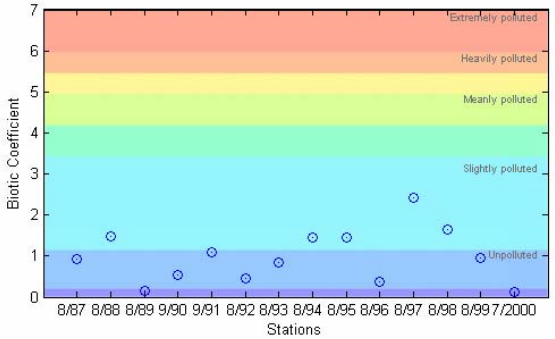
NS 1



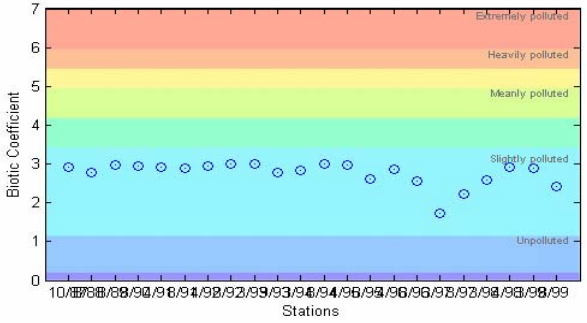
NS 2



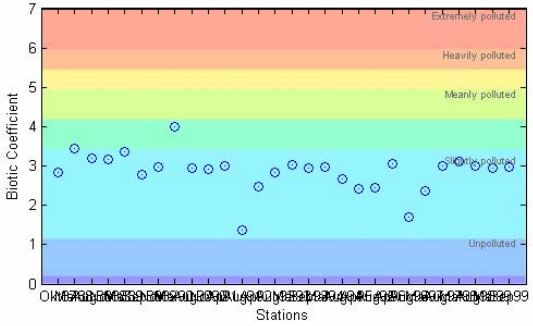
NS 3



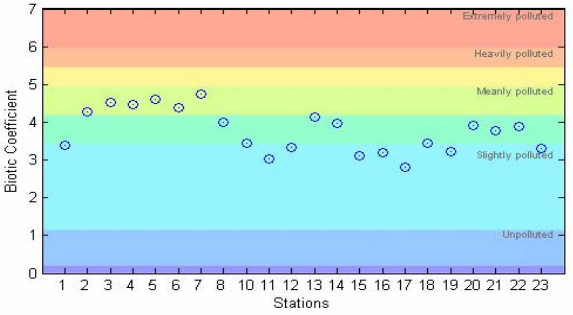
Dagebüll

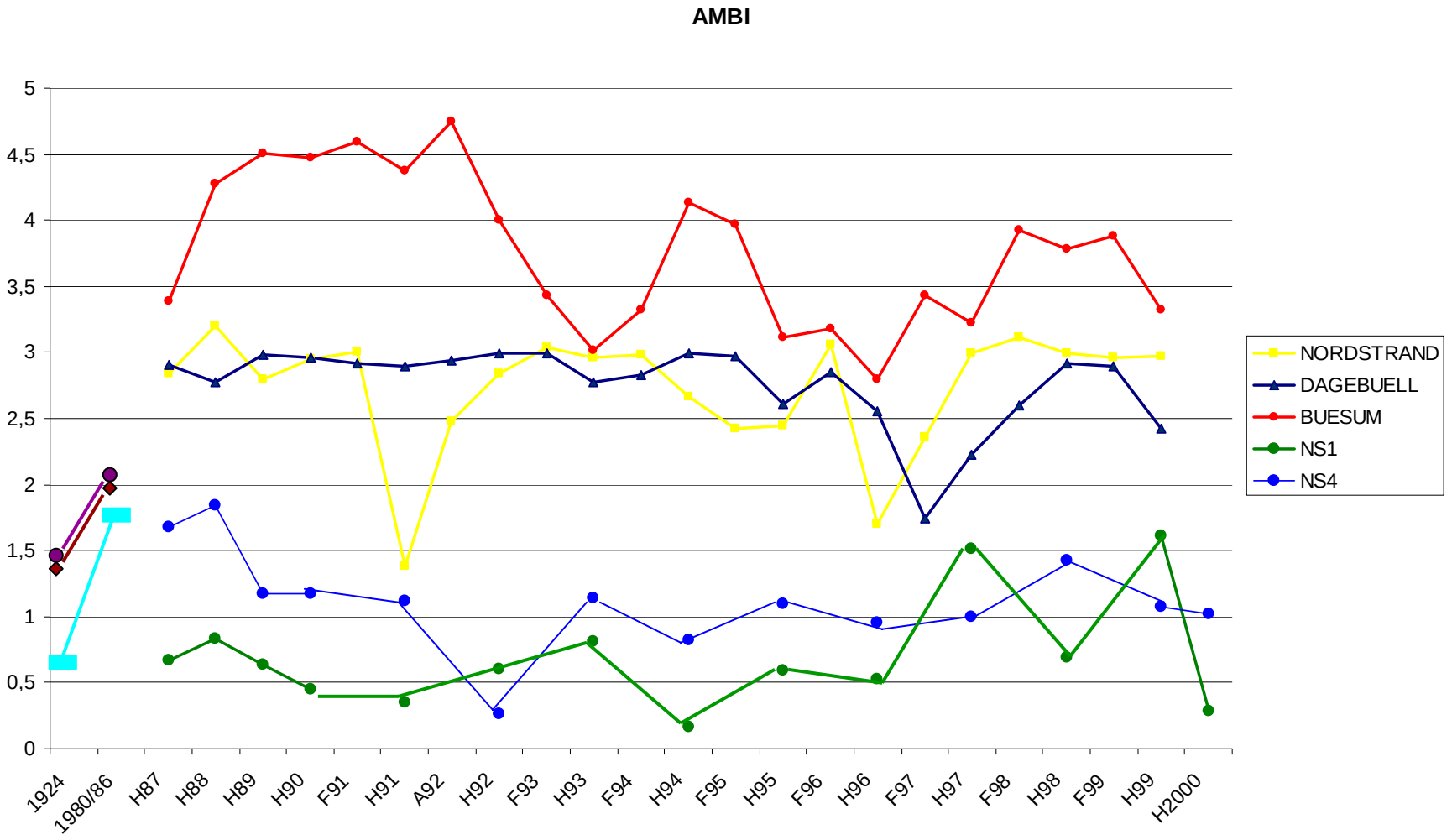


Nordstrand

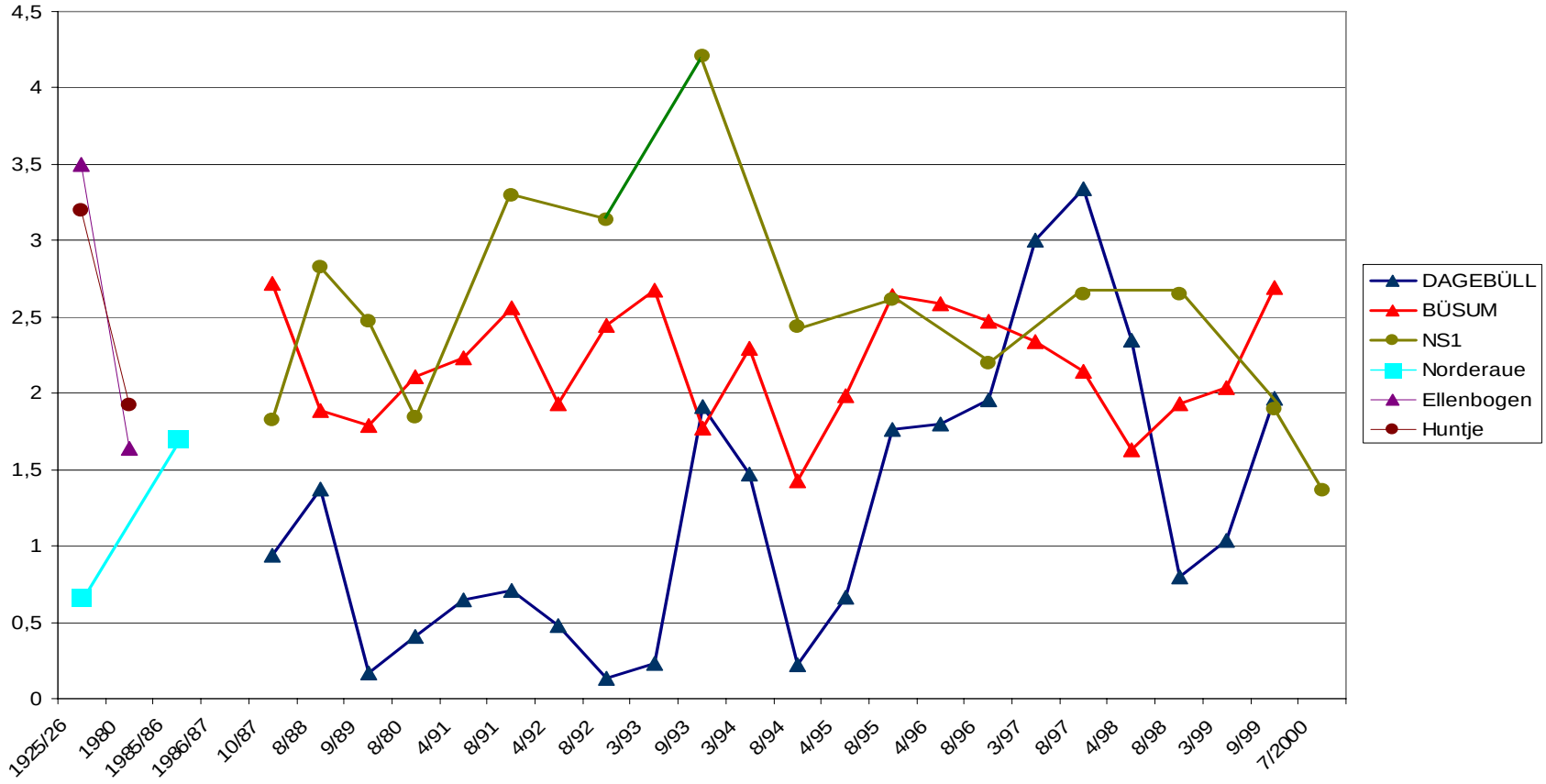


Büsum




AMBI
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
1924
1980/86
H87
H88
H89
H90
F91
H91
A92
H92
F93
H93
F94
H94
F95
H95
F96
H96
F97
H97
F98
H98
F99
H99
H2000
NORDSTRAND
DAGEBUELL
BUESUM
NS1
NS4

Shannon-Weaver-Index LANU Stationen NS1, Dagebüll, Büsum and ‚historical' comparison 20s : 80s Jahre



Classifications

BÜSUM

LANU Büsum	ES(100)	HS	AMBI
10/87			
8/88			
9/89			
8/80			
4/91			
8/91			
4/92			
8/92			
3/93			
9/93			
3/94			
8/94			
4/95			
8/95			
4/96			
8/96			
3/97			
8/97			
4/98			
8/98			
3/99			
9/99			

DAGEBÜLL

LANU Dagebüll	ES(100)	Hs (log2)	AMBI
Okt 87	6,6	0,9	2,9
Aug 88	8,7	1,4	2,8
Aug 89	2,4	0,2	3
Aug 90	4,1	0,4	3
Apr 91	5,4	0,6	2,9
Aug 91	5,3	0,7	2,9
Apr 92	4,8	0,5	2,9
Aug 92	2,1	0,1	3
Mrz 93	2,8	0,2	3
Sep 93	8,1	1,9	2,8
Mrz 94	6,7	1,5	2,8
Aug 94	2,6	0,2	3
Apr 95	4,1	0,7	3
Aug 95	10,5	1,8	2,6
Apr 96	9	1,8	2,9
Aug 96	10,8	2	2,6
Mrz 97	11,6	3	1,7
Aug 97	13,5	3,3	2,2
Mrz 98	12,1	2,3	2,6
Aug 98	5,6	0,8	2,9
Mrz 99	7,2	1	2,9
Aug 99	11	2	2,4

II

III

IV

V

Summary and lack of knowledge

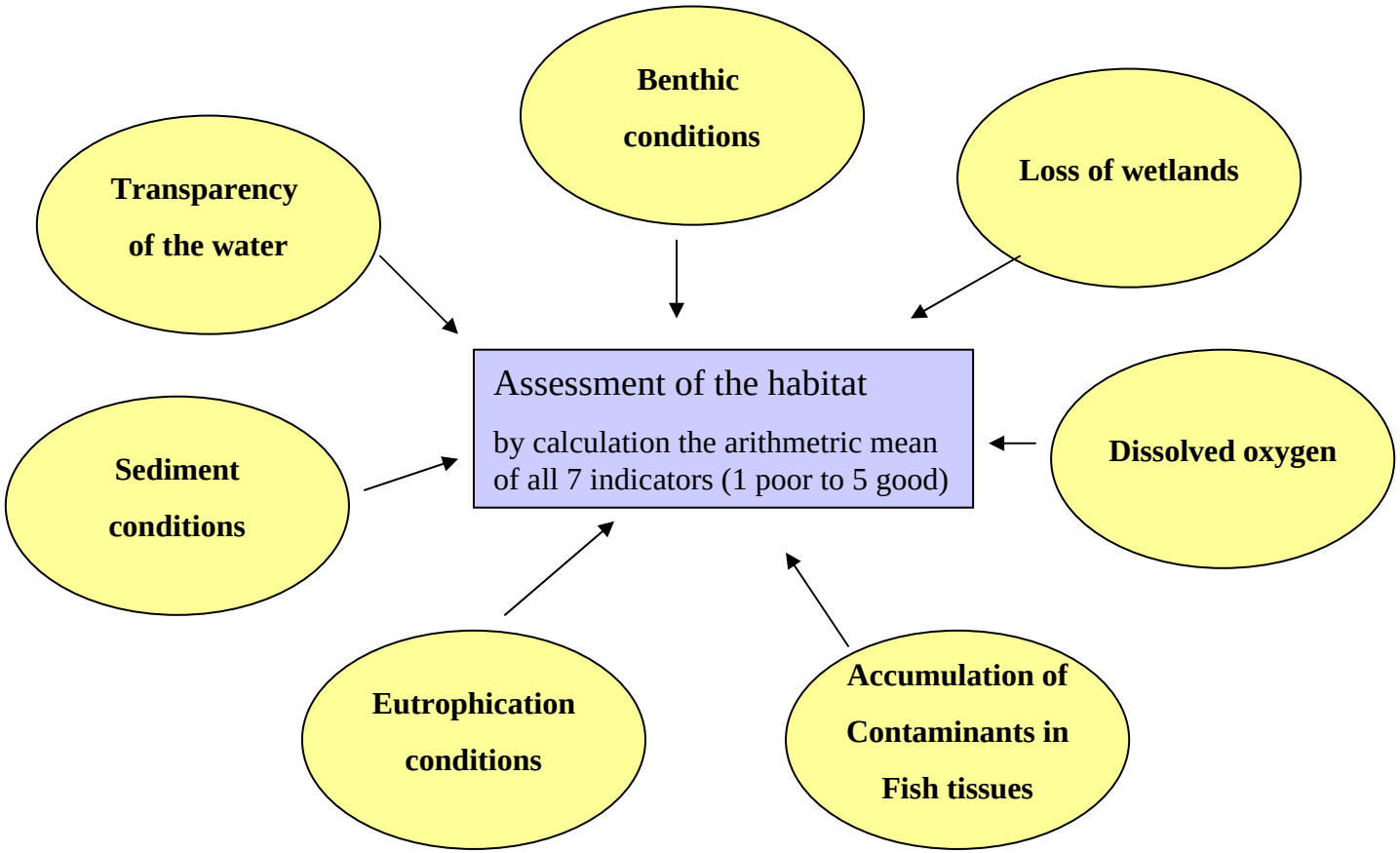
- Changes in the macrobenthos due to anthropogenic impacts are measurable, but not in all regions in the same way.
- !!On the basis of index values it is not possible to draw conclusions on the sort of impact.
- Only the AMBI index gives for all stations and dates plausible results, but not the Shannon-Weaver Index.
- Reference conditions have to be defined, because a high level of the parameters biomass, species or individual numbers can result from very good ecological situation as well as at the beginning of an impact.
- Species lists have to be checked for the Wadden Sea
- Classification schemes and classification of the species to the 5 groups have to be adapted to the Wadden Sea conditions.
- The AMBI should be tested at more Wadden Sea stations and should be correlated with other parameters e.g. TOC or grain sizes.

prospects for the future

Proposal of Borja

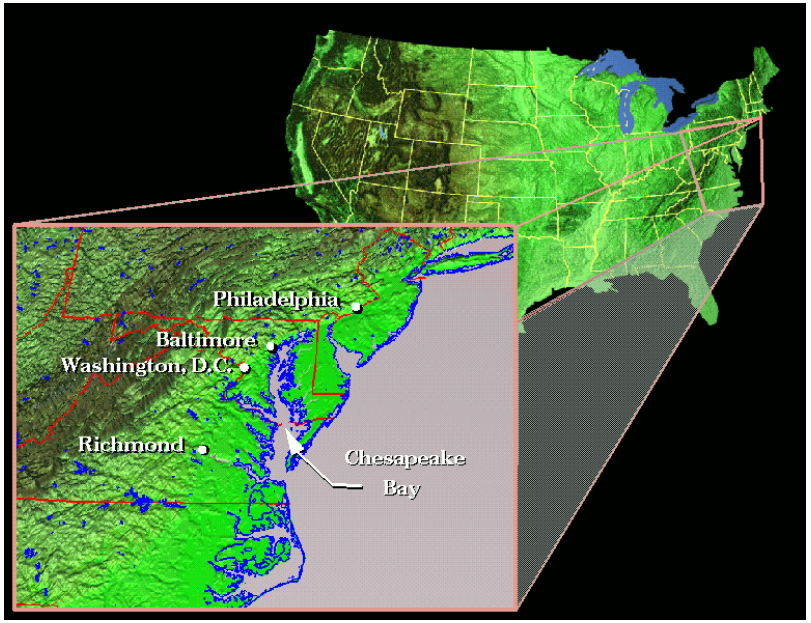
Diverstiät	Richness	AMBI	EAV	EQR	Ecological Status
0-1.2	0-15	5.5-7	0	0-0,25	BAD
1.2-2.4	15-30	4.4-5.5	0,25	0,25-0,5	POOR
2.4-3.6	30-45	3.3-4.3	0,5	0,5-0,7	MODERATE
3.6-4.8	45-60	1.2-3.3	0,75	0,7-0,9	GOOD
>4.8	>60	0-1.2	1	0.9-1	HIGH

US EMAP (Environmental Monitoring and Assessment Programme)

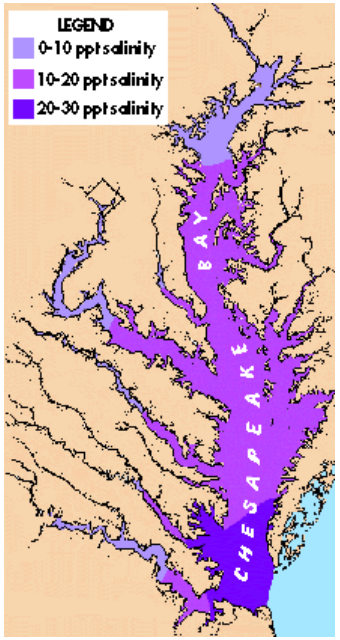


Chesapeake Bay, as an example for an assessment method

Location of Chesapeake Bay



Salinity conditions



Estuarine Benthic Index of Biotic Integrity (B-IBI)

(after Weisberg et al. 1997)

<u>1st Step:</u>

Division in habitats:

Clustering 115 stations

→

7 Habitats:

-freshwater;

-oligohaline;

- low mesohaline;

- high mesohaline –sand;

-high mesohaline – mud;

-polyhaline-sand;

-polyhaline- mud

<u>2nd Step:</u>

Reference stations, choosen from the data set

Criteria: TOC < 2%, no O_2 depletion, sediment concentrations of contaminants below thresholds

→

For each of the 7 habitats ca. 10 stations were choosen as reference sites

3rd Step:

Calculation of 17 metrics for each habitat and the corresponding reference sites:

→

Diversity:

Shannon-Weaver

Productivity:

abundance, biomass

Species composition:

% pollution indicative-taxa and pollution-sensitive biomass and abundance

Trophic composition:

% abundance carnivores or omnivores, deep deposit feeders, suspension feeders, interface feeders

Depth distribution below sediment-water interface:

% taxa, abundance and biomass deeper than 5 or 10 cm.

4th Step:

Statistical tests: U-Test and Kolmogorov Smirnov test

→

Calculted metrics were compared with the appropiate reference sites

5th Step:

Selection of metrics for the final assessment

→

Only those metrics were choosen for the assessment, which gave significant differences between habitat and the appropiate reference sites, so that for the 7 habitats different metrics were selected:

Biomass, abundance and Shannon-Weaver is calculated for each habitat, but % abundance of pollution-indicative taxa (5), abundance of feeding types (4) and biomass of pollution sensitve taxa (3) only for some of the habitats

6th Step:

Comparison of the metrics from the habitat with thresholds of reference sites.

→

3 classes: 1, 3 and 5

1 if habitats deviated greatly from reference stations.

Assemblages with an average score less than 3 are considered stressed.

7th Step:

Validation of the method

→

-with new data for the reference sites and habitates

- with data from the whole year.