



ECASA

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Benthic indicators for aquaculture (analyses across ECASA sites)

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1.- Introduction

- There is an increasing need of **assessing marine water quality** when different **pressures and impacts** are produced within the coast
- One of these pressures is **aquaculture**, and ECASA project is facing this problem by checking different indicators able to detect impacts and assess environmental quality
- In estuarine and coastal waters **benthic communities** are one of the most important biological quality elements in assessing such quality.



1.- Introduction

Advantages in using soft-bottom benthic communities as disturbance indicators:

- **R** Real effect on the biota (species-community level)
- **G** Global indicator of pollution or disturbance
- **I** Integrated information throughout time
- **S** Short life-cycle species: fast recovery (good indicators of change)
- **E** Easy to sample and work with them

Disadvantages:

- **T**axonomy specialists needed
- **H**igh economic cost
- **S**low to obtain results



1.- Introduction

Which kind of benthic indicators can be used in assessing quality?:

- **B**asic structural parameters: taxonomy lists, richness, density, biomass, diversity, evenness, etc.
- **O**ther approaches: ABC curves, Infaunal Trophic Index, etc.
- **M**ultivariate analysis: MDS, Canoco, Primer, etc.
- **B**iotic indices: old methods, but recently refreshed by new indices, such as AMBI (AZTI Marine Biotic Index)



2.- Indicators selected

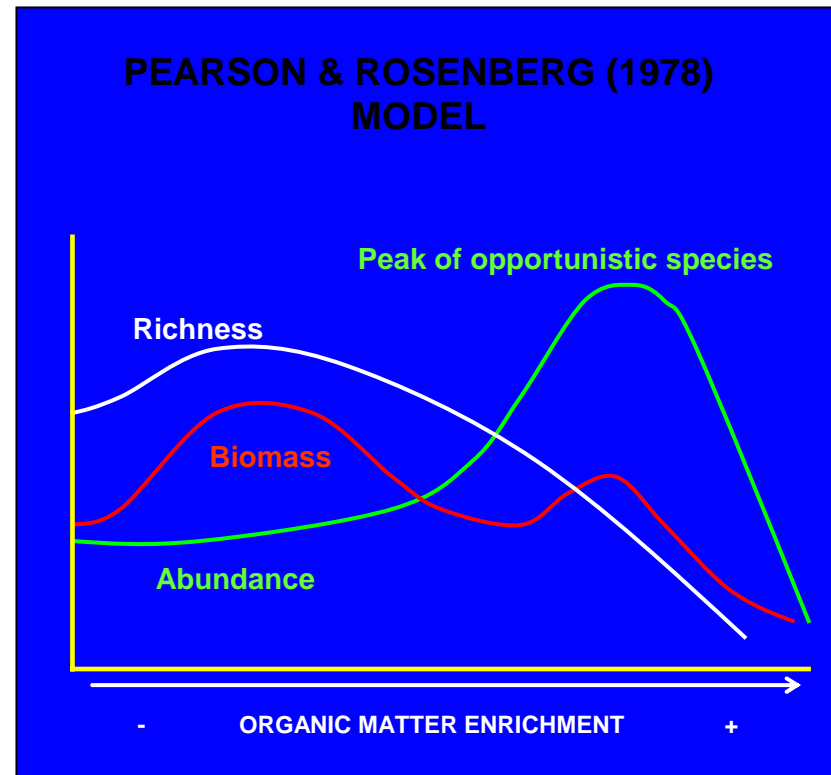
Indicators	Status
AMBI	Green
Macrofauna-univariate	Green
Macrofauna-multivariate	Yellow
Infaunal Trophic Index	Yellow
Benthic Trophic Groups	Red
Biomass Fractionation Index	Red
Meiofaunal diversity	Magenta
Sediment test on meiofauna	Magenta



2.- Indicators selected

- **Adaptive strategies**

- **Reproductive (r)**: short life-cycle, fast growth, early sexual maturity, larvae throughout the year and direct development = opportunists
- **Competitive (k)**: long life-cycle, slow growth, high biomass.
- **Tolerant (T)**: species not affected
- **Not viable**: azoic situation



2.- Indicators selected

AMBI was designed to assess the **ecological quality** of European coasts, investigating the response of soft-bottom communities to natural and man-induced changes in water quality. AMBI offers a '**pollution or disturbance classification**' of a particular site, representing the **benthic community 'health'**.

Based upon **sensitivity/tolerance** to pollution (**disturbance**), **five ecological groups** can be established:

Group I - Sensitive species

Group II - Indifferent species

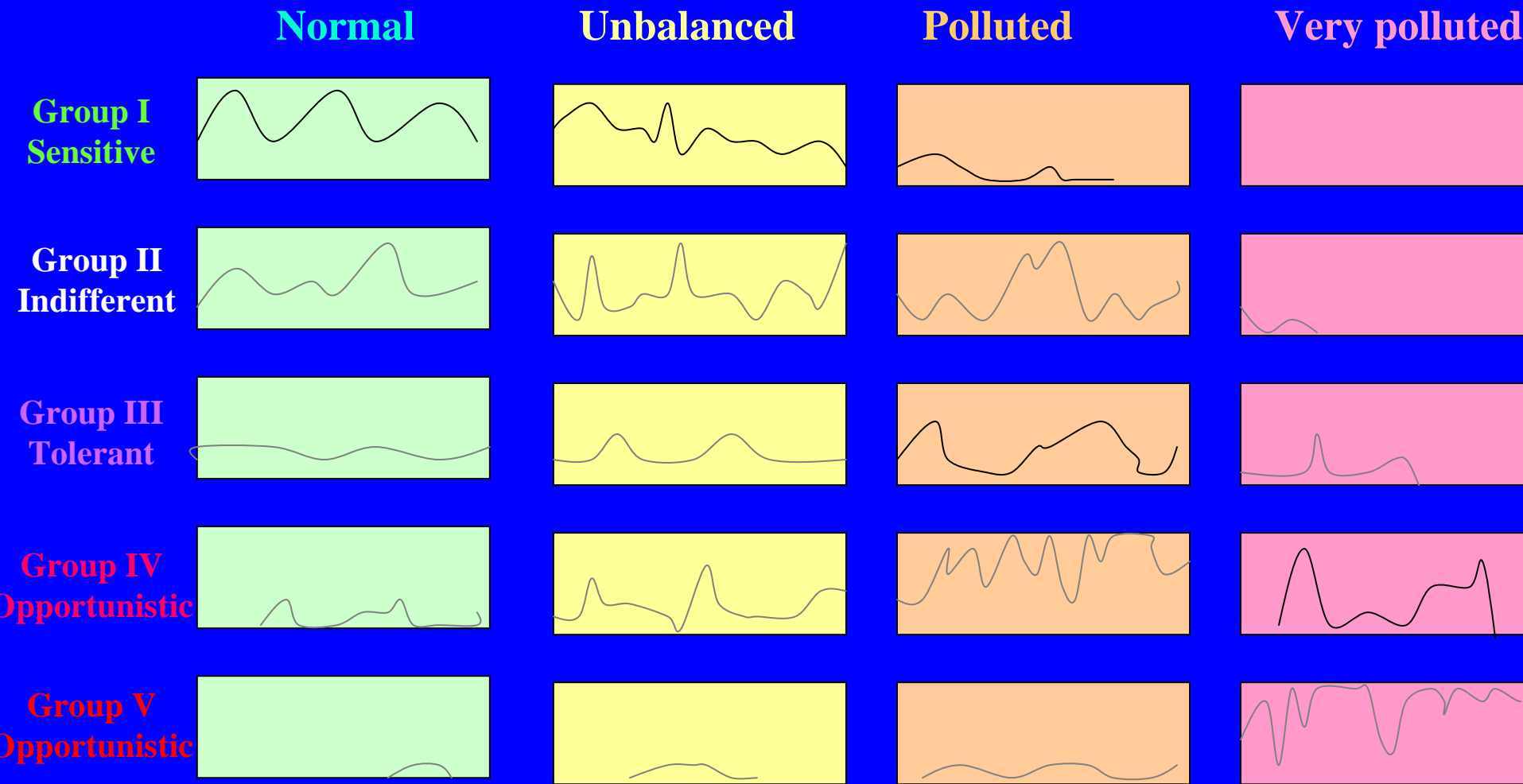
Group III - Tolerant species

Group IV - Second order opportunistic species

Group V - First order opportunistic species



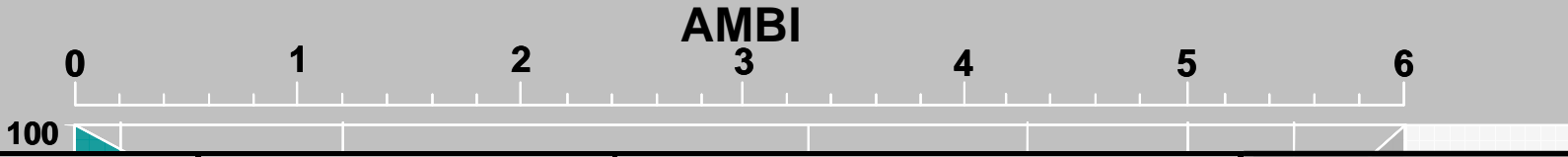
2.- Indicators selected



Increasing gradient of impact or disturbance →

2.- Indicators selected

$$AMBI = ((0 * \%GI) + (1.5 * \%GII) + (3 * \%GIII) + (4.5 * \%GIV) + (6 * \%GV))/100$$



AMBI	Dominating Ecological Group	Benthic Community Health	Site Disturbance Classification
0.0 < AMBI ≤ 0.2	I	Normal	Undisturbed
0.2 < AMBI ≤ 1.2		Impoverished	
1.2 < AMBI ≤ 3.3	III	Unbalanced	Slightly disturbed
3.3 < AMBI ≤ 4.3		Transitional to pollution	Meanly disturbed
4.3 < AMBI ≤ 5.0	IV-V	Polluted	
5.0 < AMBI ≤ 5.5		Transitional to heavy pollution	Heavily disturbed
5.5 < AMBI ≤ 6.0	V	Heavy polluted	
Azoic	Azoic	Azoic	Extremely disturbed

POLLUTION	GOOD	MODERATE	POOR	POLLUTED	POLLUTED
	WFD HIGH STATUS	WFD GOOD STATUS	WFD MODERATE STATUS	WFD POOR STATUS	WFD BAD STATUS

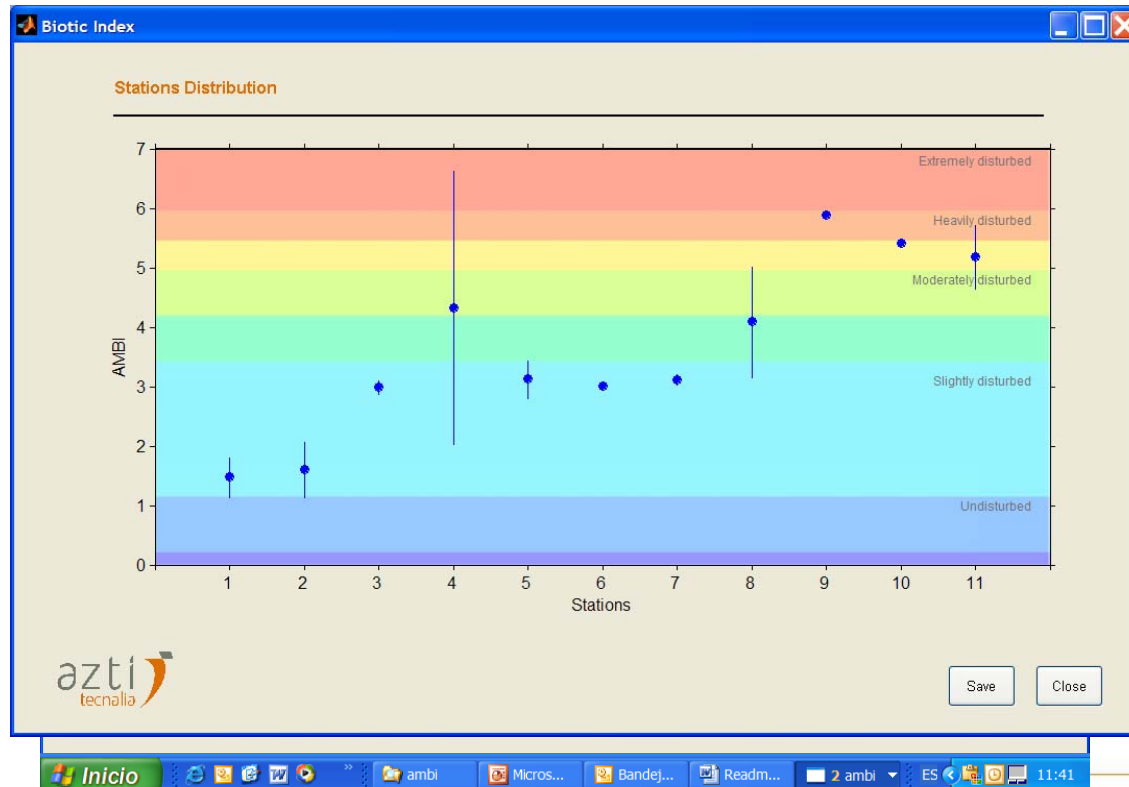
INCREASING POLLUTION





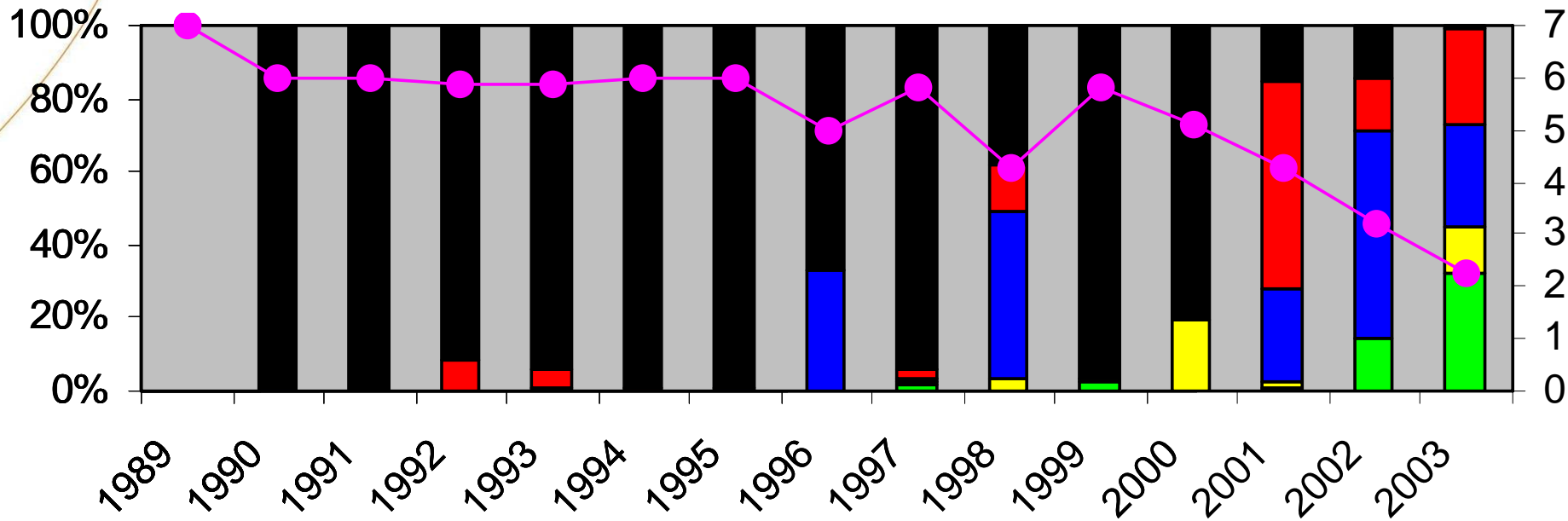
2.- Indicators selected

- You can consult our **web page** (www.azti.es) and obtain our free **AMBI software** to calculate and represent the index.
- This approach includes the classification of **4.169 taxa** along the **Atlantic** and **Mediterranean** coasts of Europe (it is regularly updated).

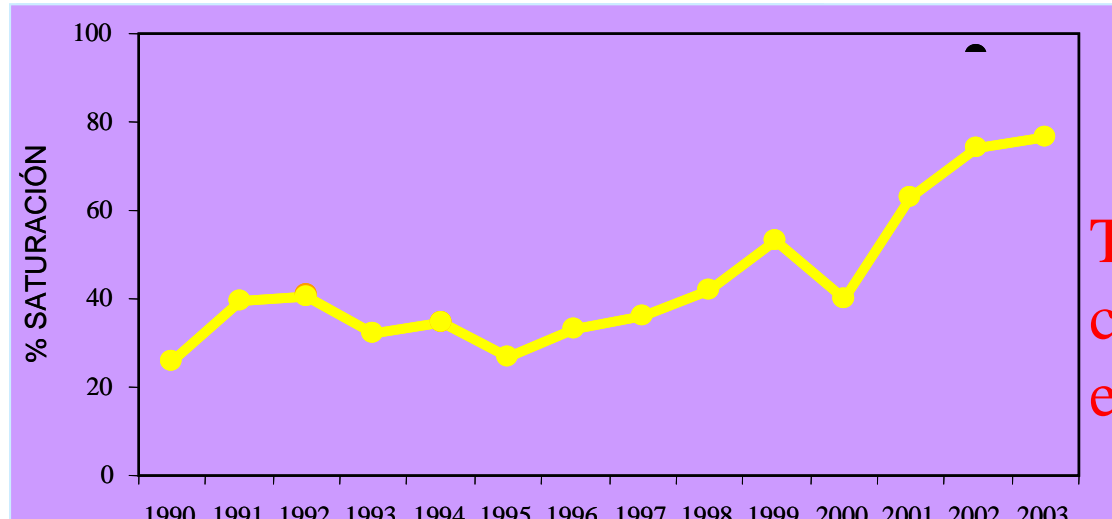


2.- Indicators selected

Water clean-up plan in the Basque Country (Atlantic, Spain): Borja et al. (2006)



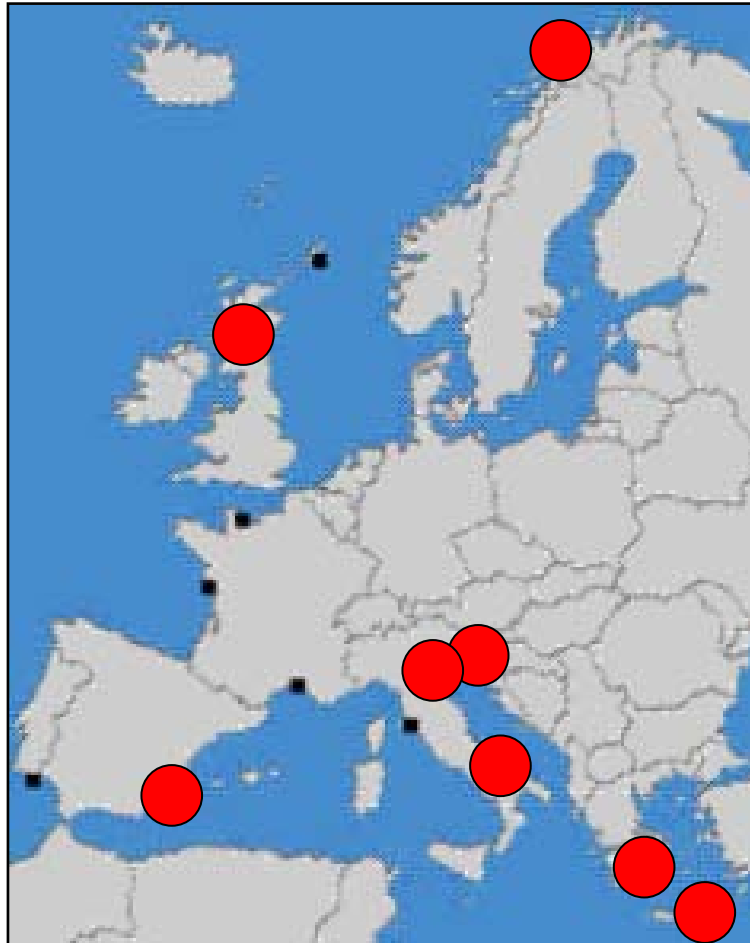
- V
- IV
- III
- II
- I
- AMBI



No water treatment
 Biological treatment
 Physico-chemical treatment
 The most polluting company in the estuary starts



3.- ECASA study sites



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Location	Stations (nº)
• Sounio:	6
• Cephalonia:	6
• Slovenia:	8
• Bisceglie:	7
• Chioggia:	4
• Garrucha:	10
• Creran:	7
• Norway:	4
Total	52

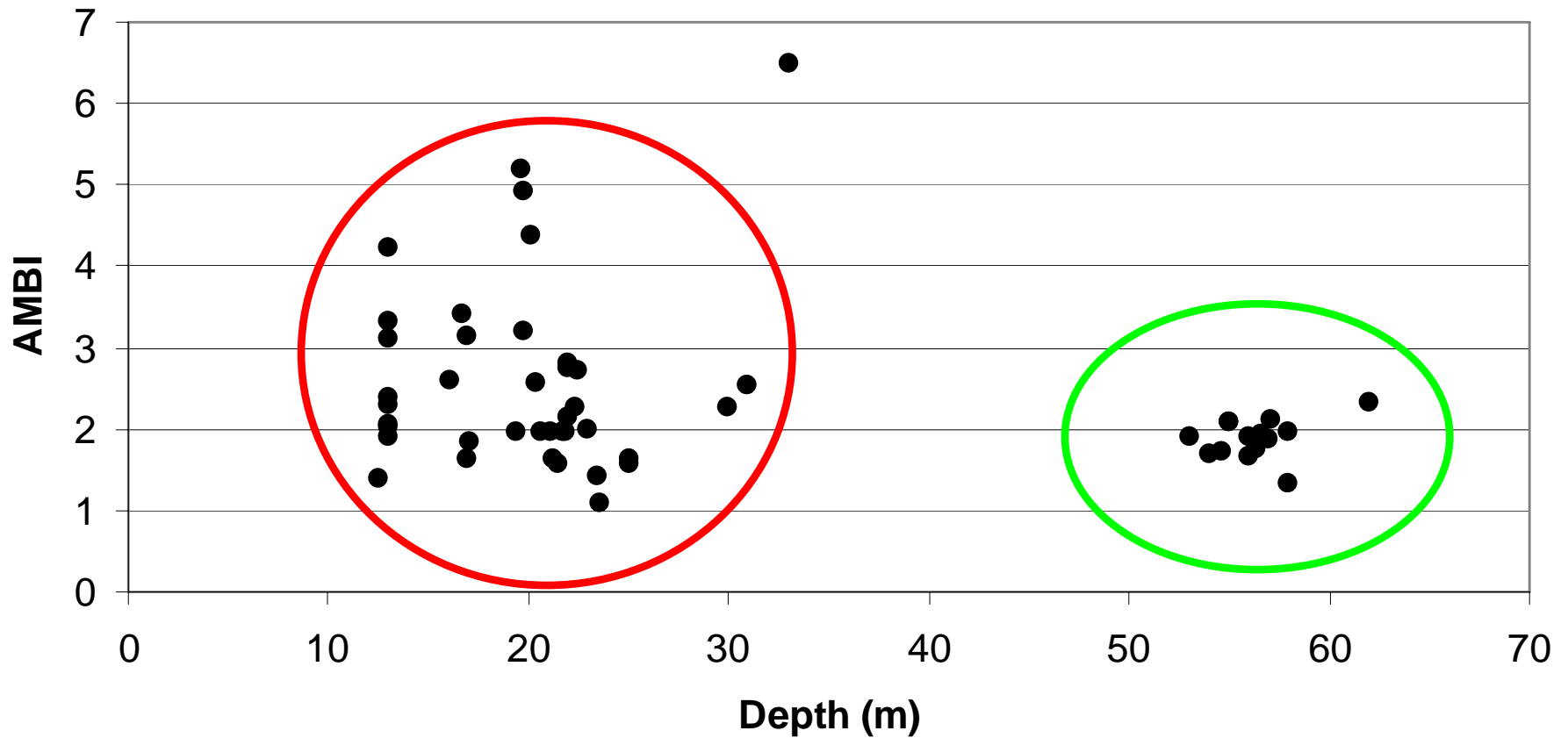


4.- Results (correlations)

	Current Production	AMBI	Density	Diversity	Richness	Depth	Distance	Gravel	Mud	Sand	redox	TOC	
Production	-0.202												
AMBI	-0.495	0.257											
Density	-0.554	-0.119	0.340										
Diversity	0.467	-0.427	-0.791	-0.120							p<0.001		
Richness	0.324	-0.159	-0.420	0.090	0.675						0.001<p<0.005		
Depth	0.636	-0.176	-0.259	-0.431	0.418	0.513					0.005<p<0.05		
Distance	0.061	0.229	-0.239	-0.120	0.156	0.186	0.151						
Gravel	-0.221	0.028	0.080	0.491	-0.039	0.058	-0.254	0.059					
Mud	-0.589	0.122	0.332	-0.132	-0.460	-0.461	-0.513	0.042	-0.439				
Sand	0.660	-0.134	-0.365	0.032	0.494	0.479	0.585	-0.055	0.303	-0.989			
redox	0.166	0.009	-0.325	0.184	0.367	0.313	0.330	0.047	0.489	-0.744	0.708		
TOC	-0.812	-0.285	0.433	0.877	-0.056	0.435	-0.648	-0.276	0.400	-0.351	0.297	0.501	
TOM	-0.779	0.667	0.671	0.399	-0.679	-0.319	-0.615	-0.014	0.117	0.697	-0.767	-0.388	0.423

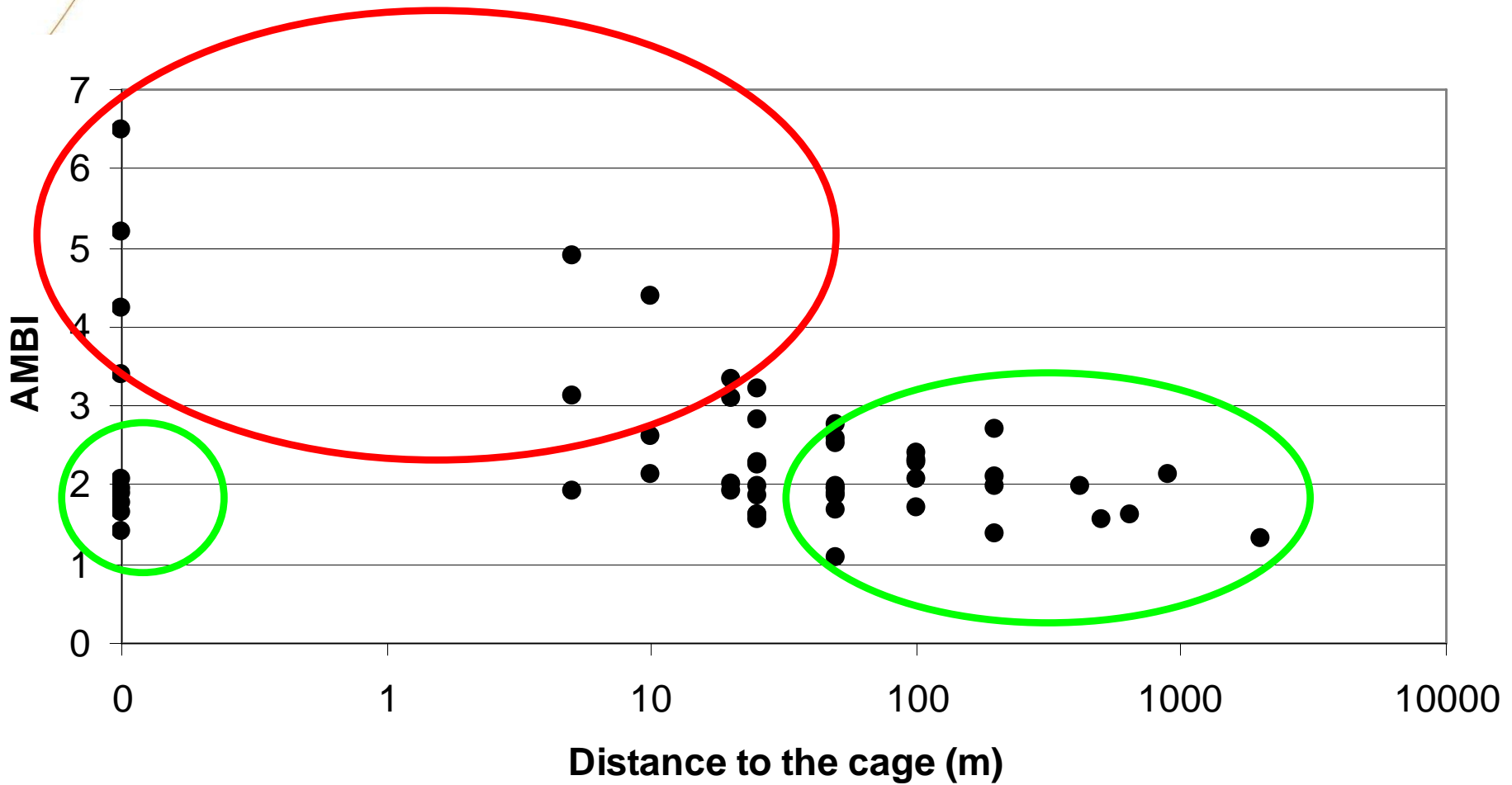


4.- Results (AMBI as indicator)

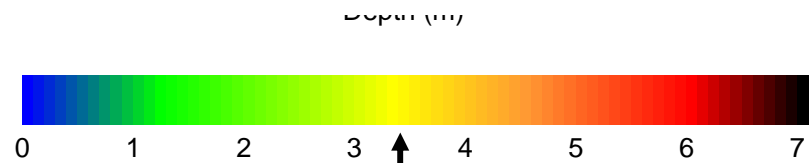
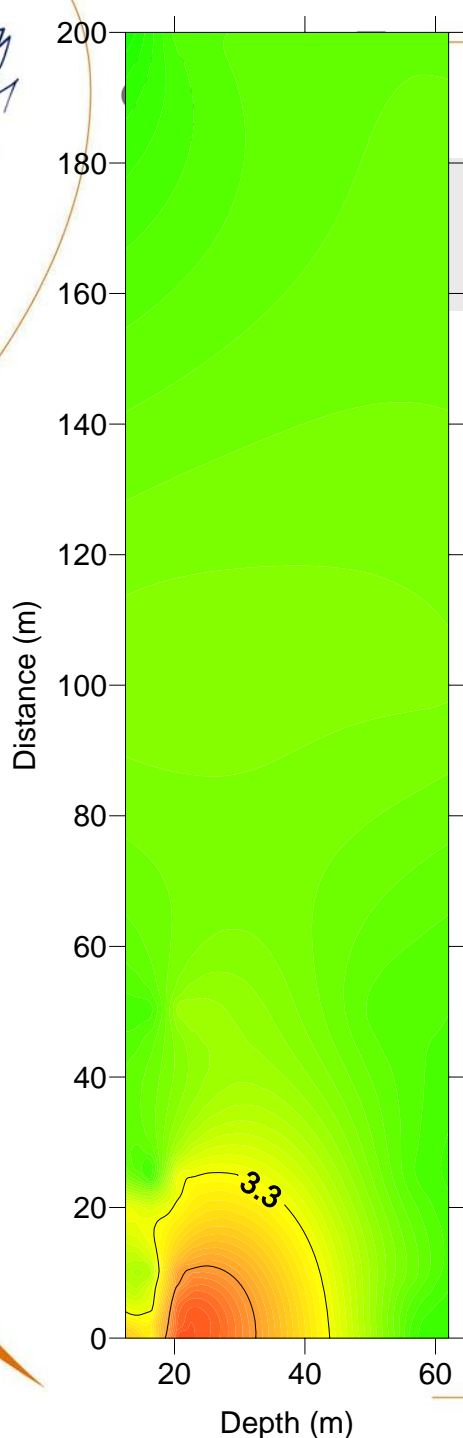




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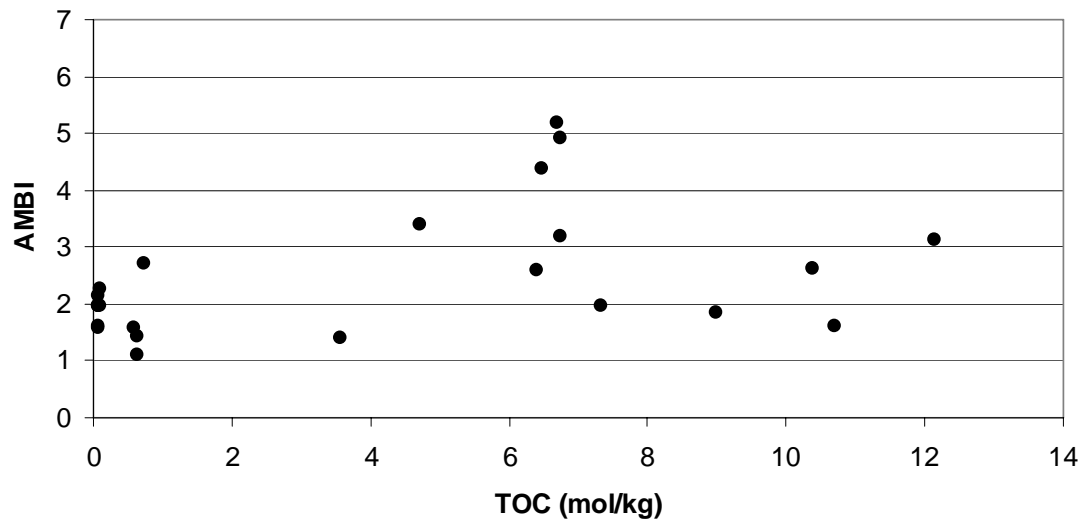
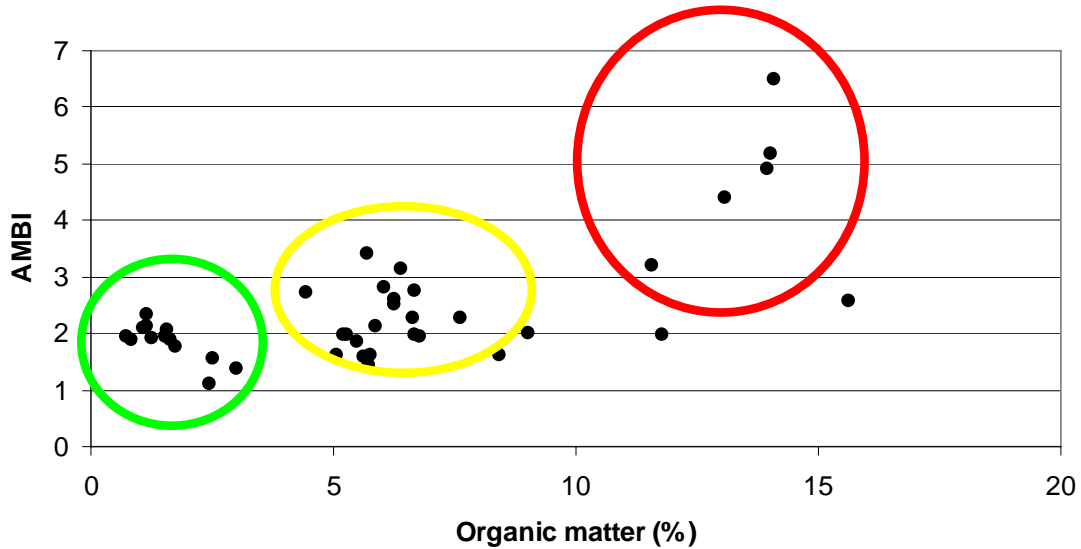


Undisturbed
or slightly
disturbed

Moderately
to heavily
disturbed

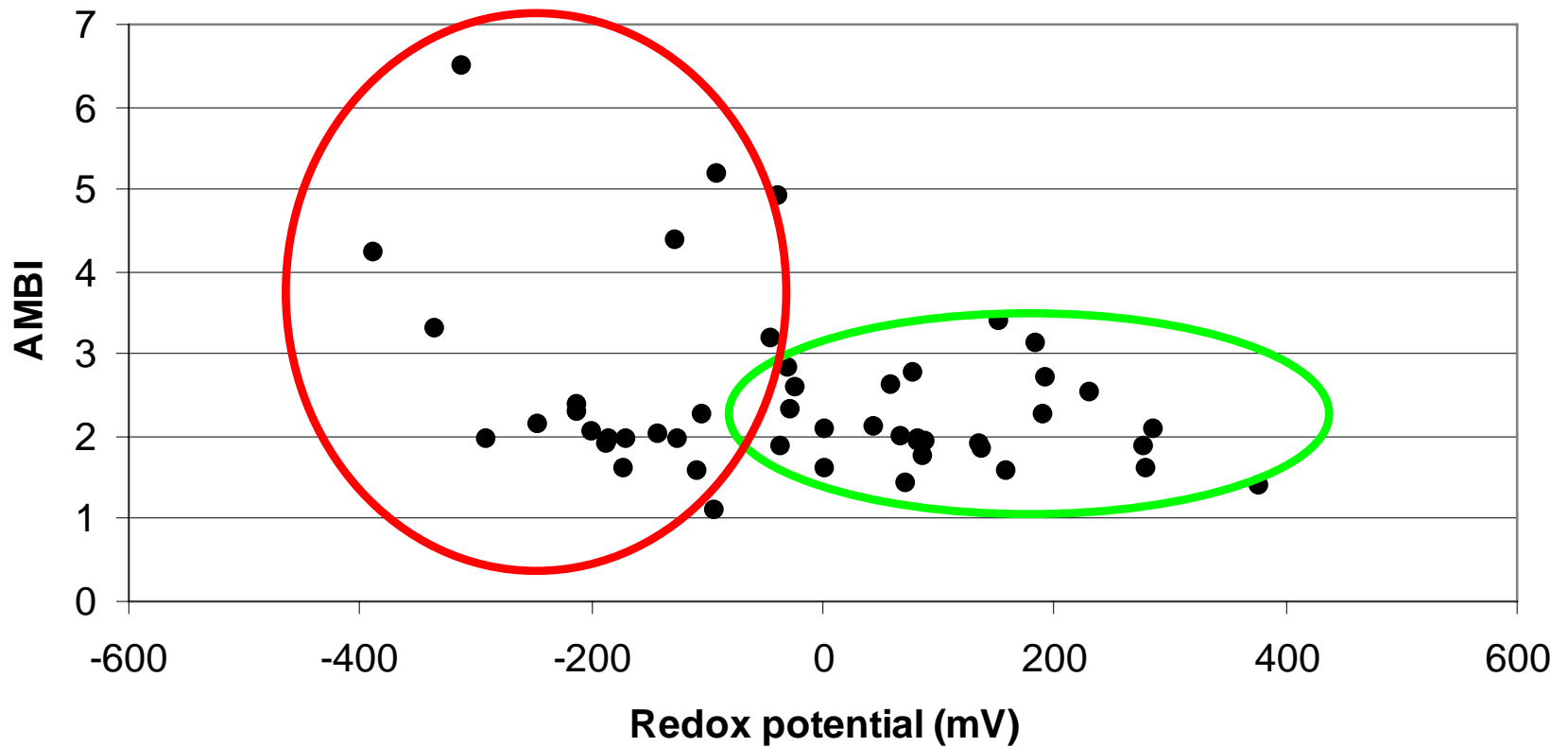


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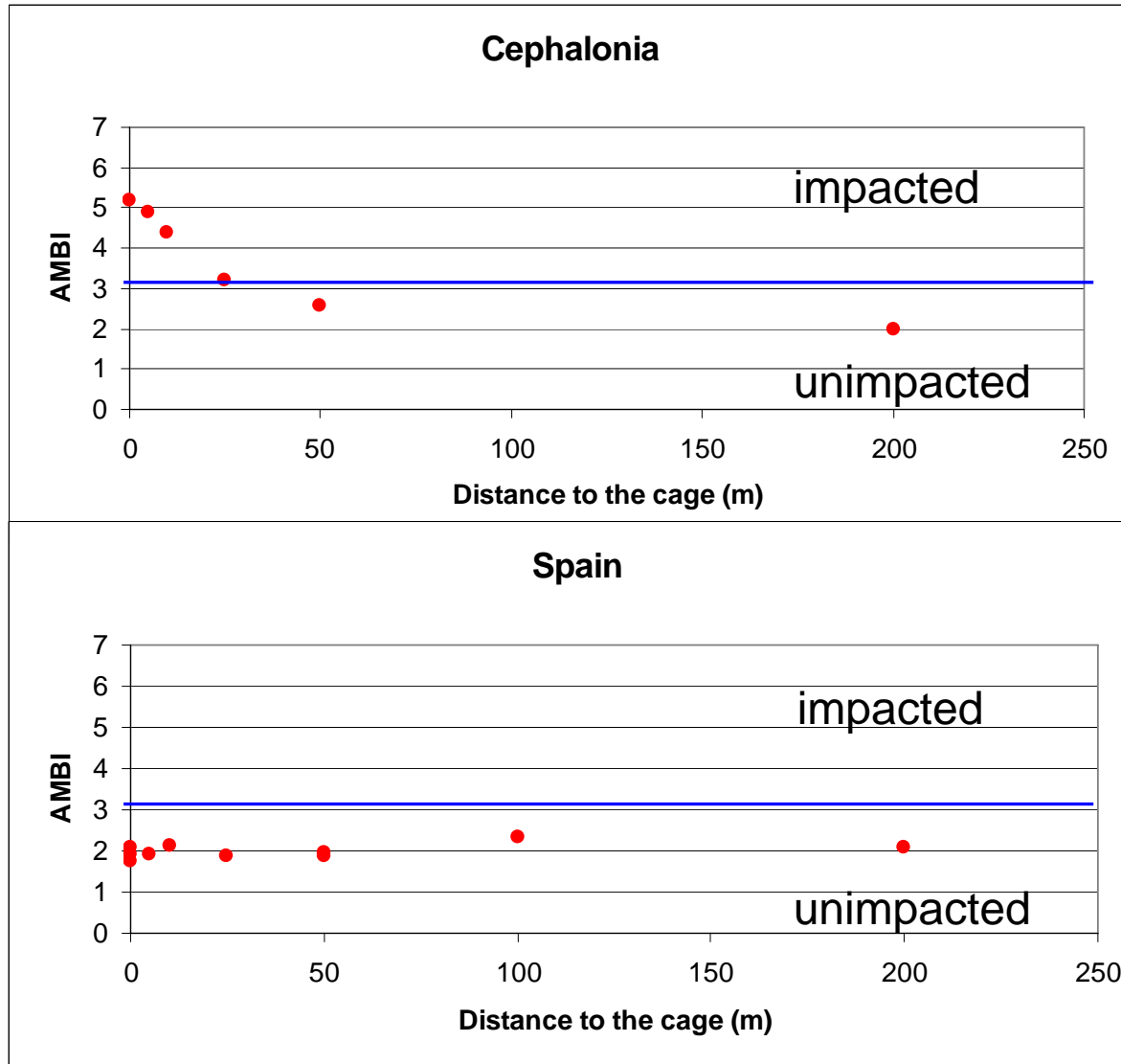


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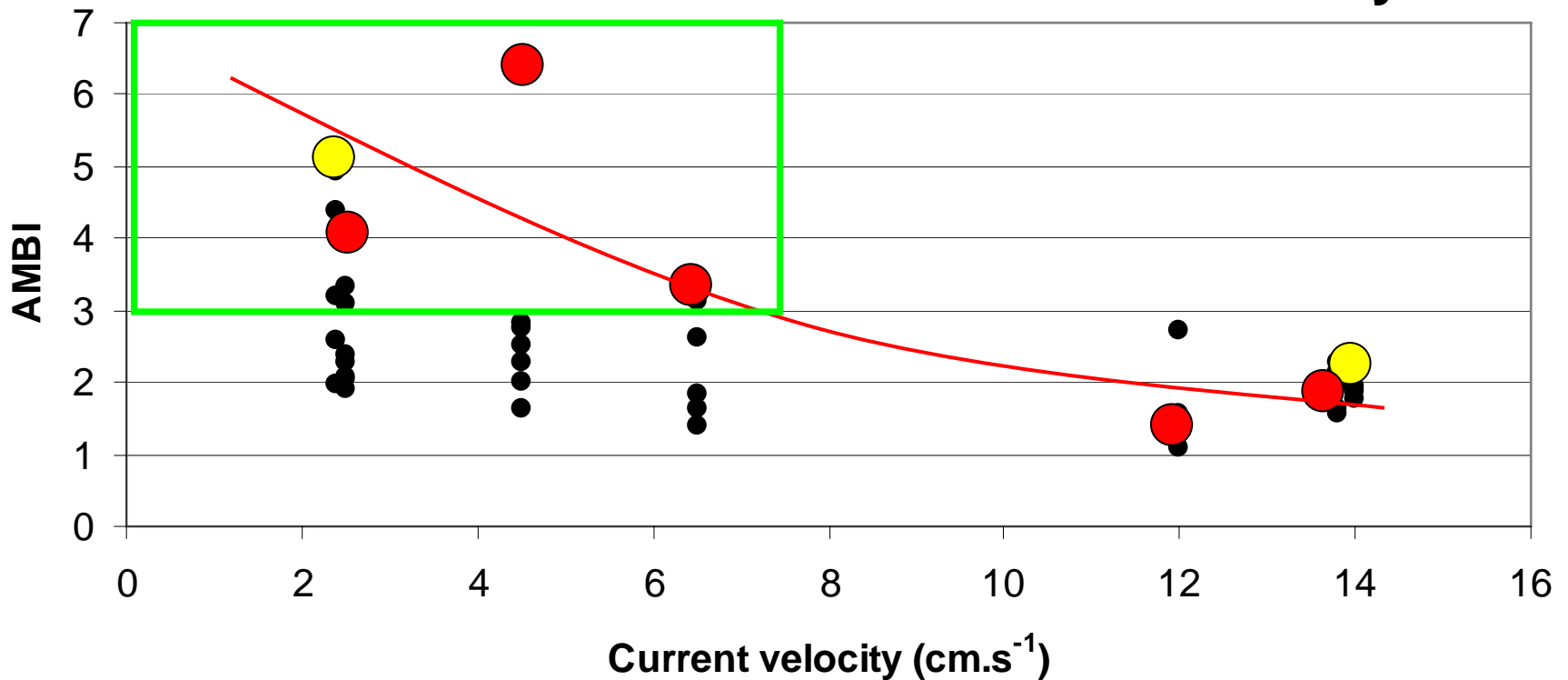


4.- Results (AMBI as indicator)



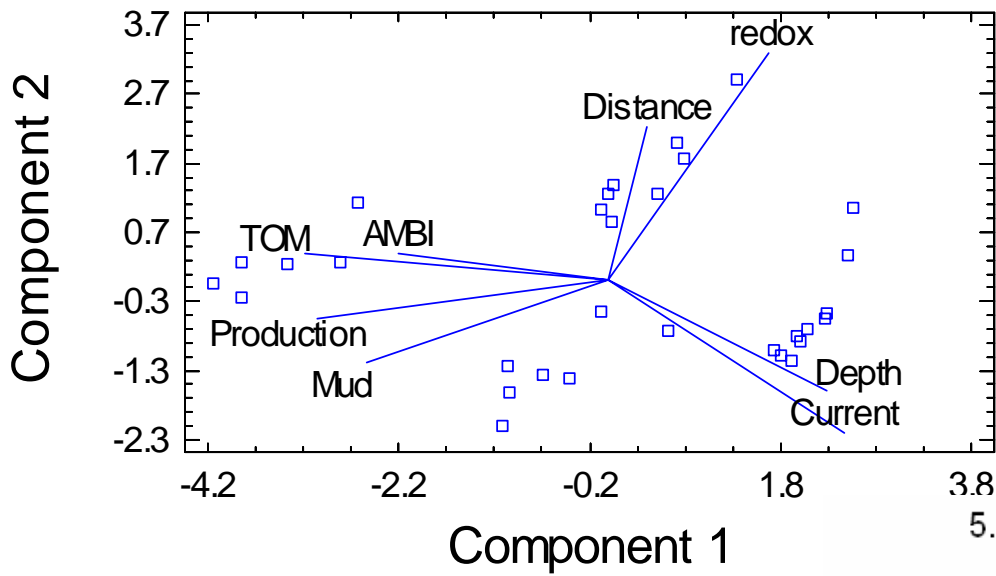
4.- Results (AMBI as indicator)

- **Cephalonia:** 20 m – 1,000 t.y⁻¹
- **Garrucha:** 60 m – 218 t.y⁻¹

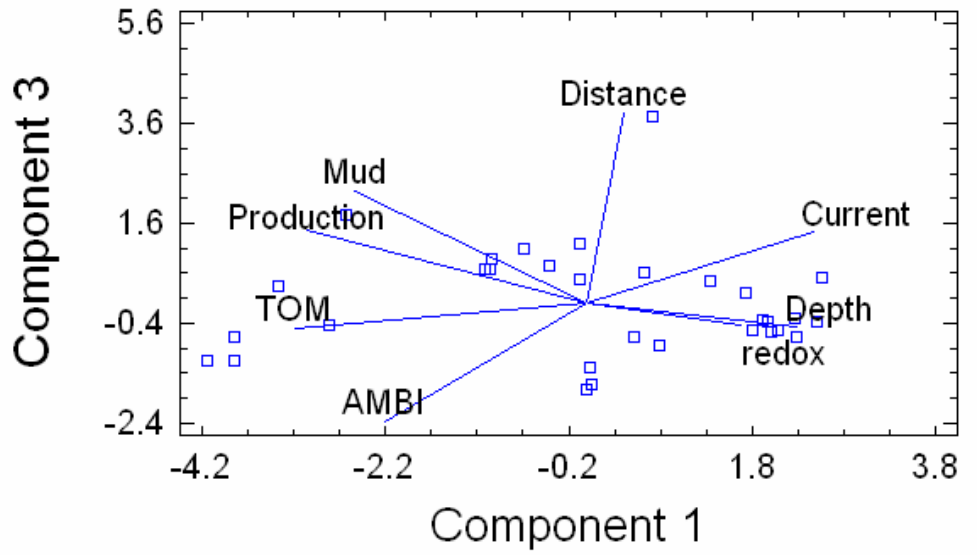




4.- Results (multivariate analysis)

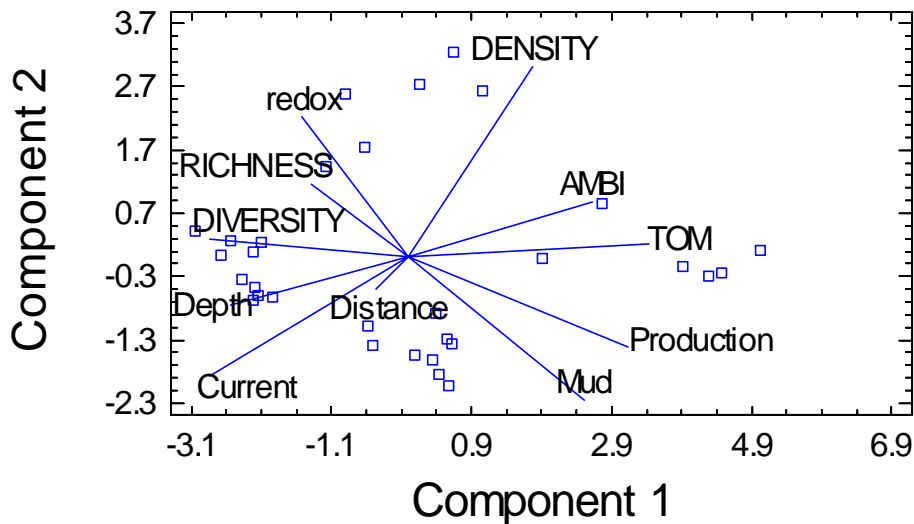


Component	Explained variability	Variables
First	52.3%	TOM, Production
Second	18.5%	Redox
Third	15.3%	Distance, AMBI
Total	86.1%	



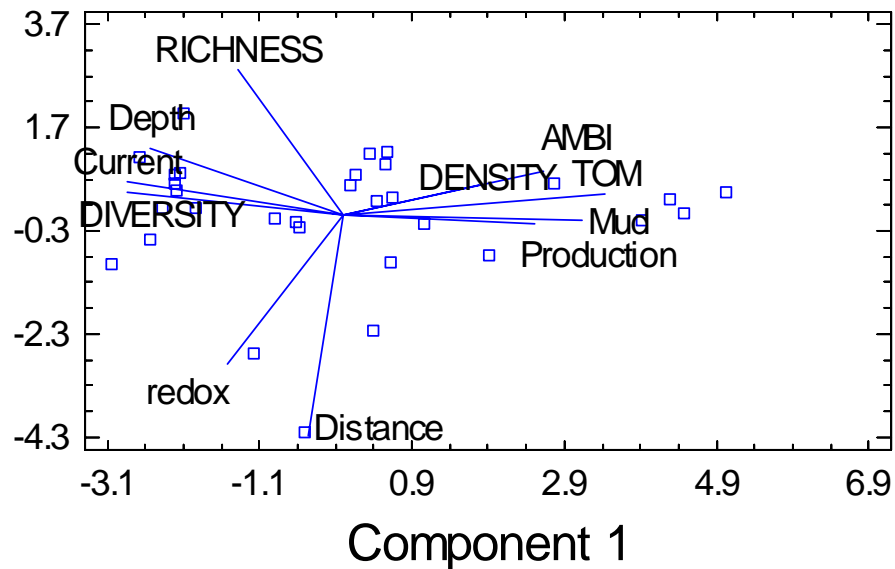


4.- Results (multivariate analysis)



Component	Explained variability	Variables
First	46.2%	TOM, Production
Second	18.0%	Density, mud
Third	13.7%	Distance, redox
Total	77.9%	

Component 3





5.- Conclusions

- **Some locations do not show clear gradients** of impact, in terms of the benthic indicators selected in ECASA.
- In these cases it seems that the **good dispersion** of the discharges from the cages avoids any damage to the benthic communities.
- This good dispersion seems to be **related with**:
 - the situation of the cages on **high water depths** (>40-50 m), such as in Spain or Norway;
 - the **strong dynamics** of the area e.g. currents, such as in Spain and Bisceglie.



5.- Conclusions

- The **gradients of impact** are related with the **distance to the cage, depth and current velocity**, being the most impacted area that extending until 25-50 m from the cages.
- Most **structural parameters** are **correlated** between them.
- **AMBI** seems to be a good indicator of the benthic stress, related with **organic matter** percentages. This is also related with **redox potential** (showing the oxygen consumption under the cages).



5.- Conclusions

- Hence, if you have **cages** in **shallow waters** (<30 m), with **low current** velocity (< 7 cm.s⁻¹), and **high production** (> 500 t.y⁻¹), **probably** you will get **impact** on benthic communities **under the cages** and in the **immediate vicinity** (25-50 m)



Thanks!