ECO-PHYSIOLOGICAL CHARACTERIZATION OF THE MACROINVERTEBRATE COMMUNITIES OF AN URBAN STREAM (RIO TINTO, PORTUGAL)

Teresa Jesus

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Introduction

Study of some parameters relating to the ecological status of the Tinto river

- a small urban watercourse in the north of Portugal belonging to the Douro river basin with about 11 km long;

- has many sources of environmental disturbance such as: channelization, waste disposal, effluent reception of sewage treatment plants and of untreated urban or industrial effluents.
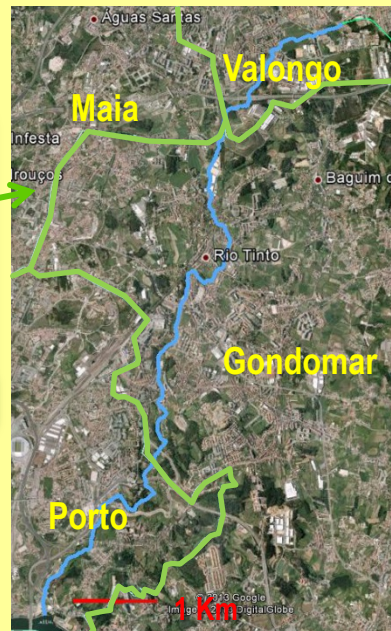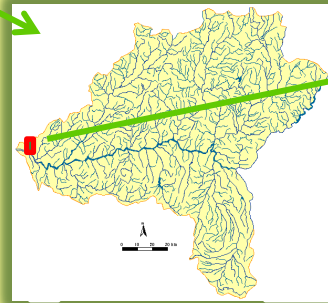
- is a project proposed by LIPOR, an inter municipal company and developed by the Fernando Pessoa University with the support of:
  - ✓ four municipalities in which integrates the river basin;
  - ✓ three water companies;
  - ✓ the Portuguese Environmental Agency
- The study is carried out taking account the established by the WFD

Main objectives:
- Characterization of the Tinto river ecological state;
- Detection of the main sources of environmental disturbance;
- Preparation of proposals for measures to improve the ecological status of the river.

Objectives

☞ **Ecological and physiological characterization of the macroinvertebrate communities of an urban stream;**

☞ **Study the impact of effluents discharges on the benthic macroinvertebrate communities of the Tinto river.**

Methodology

Parameters
(10 sampling sites: B. C, D, E, F, G, H, I, J, K)

Sampling site characterization

- **Hydro-morphological parameters:**
  - ✓ slope, substrate composition, habitat quality, % macrophytes, canopy and flow
- **Physical and chemical parameters:**
  - ✓ pH, conductivity, % oxygen saturation, BOD, NH_4^+, NO_3^- and P_{total}

Benthic macroinvertebrates

- **Sampling:**
  - ✓ With a hand net
  - ✓ Every 3 months between October'13 and march'15

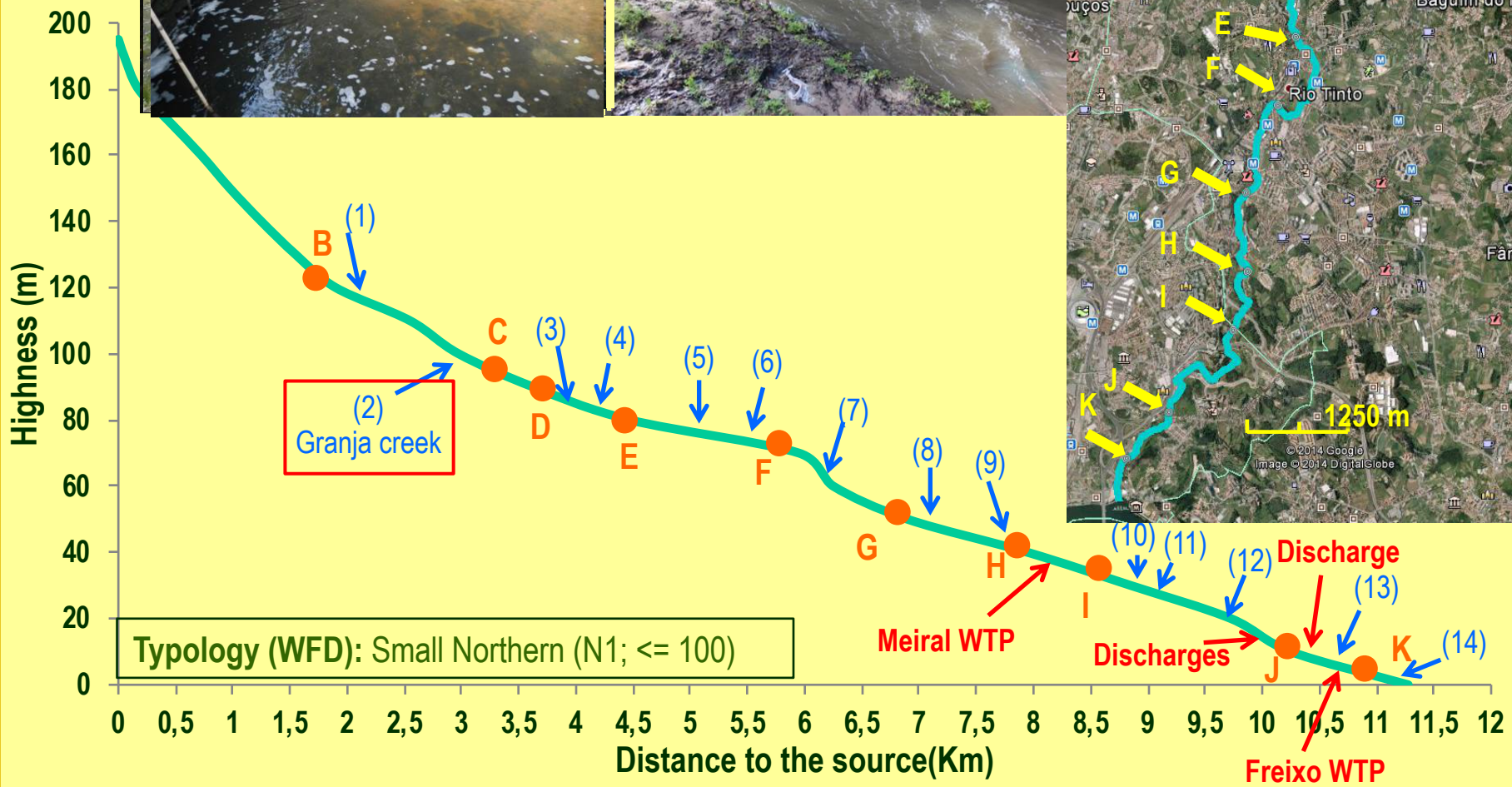## Data analysis

Index and metrics:
- Hydromorphological parameters: Habitat quality
- Macroinvertebrate communities:
  - ✓ Number of organisms and taxa
  - ✓ Biotic indexes: IPtIN and IBMWP
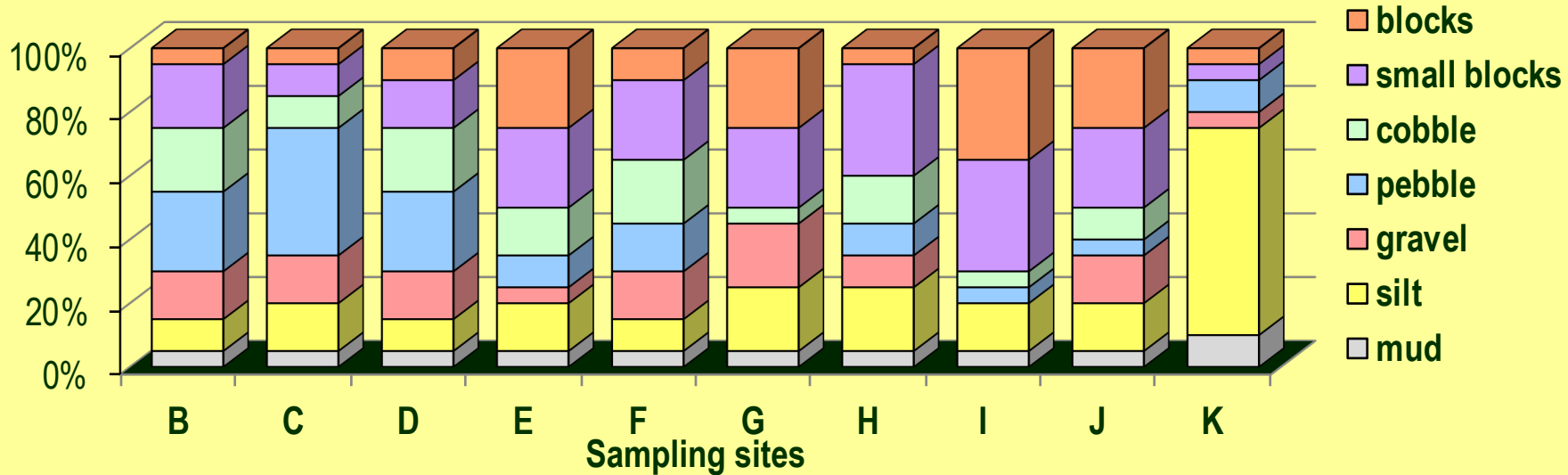 - ✓ Shannon´s diversity index and Pielou evenness index
  - ✓ Some metrics

- Spatial and temporal variation of all parameters
- N-MDS analysis of macroinvertebrates grouped into their functional groups
- Validation and determination of the main groups responsible for the differentiation of the sample points using ANOSIM and CLUSTER analysis

Sampling site characterization
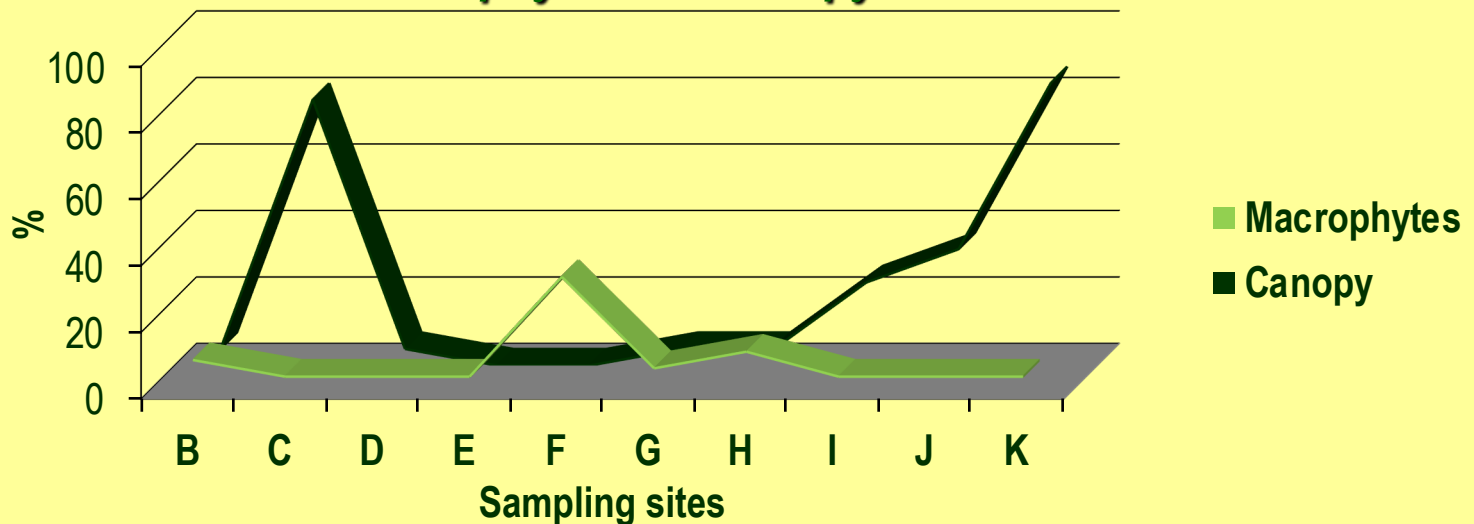

Typology (WFD): Small Northern (N1; <= 100)
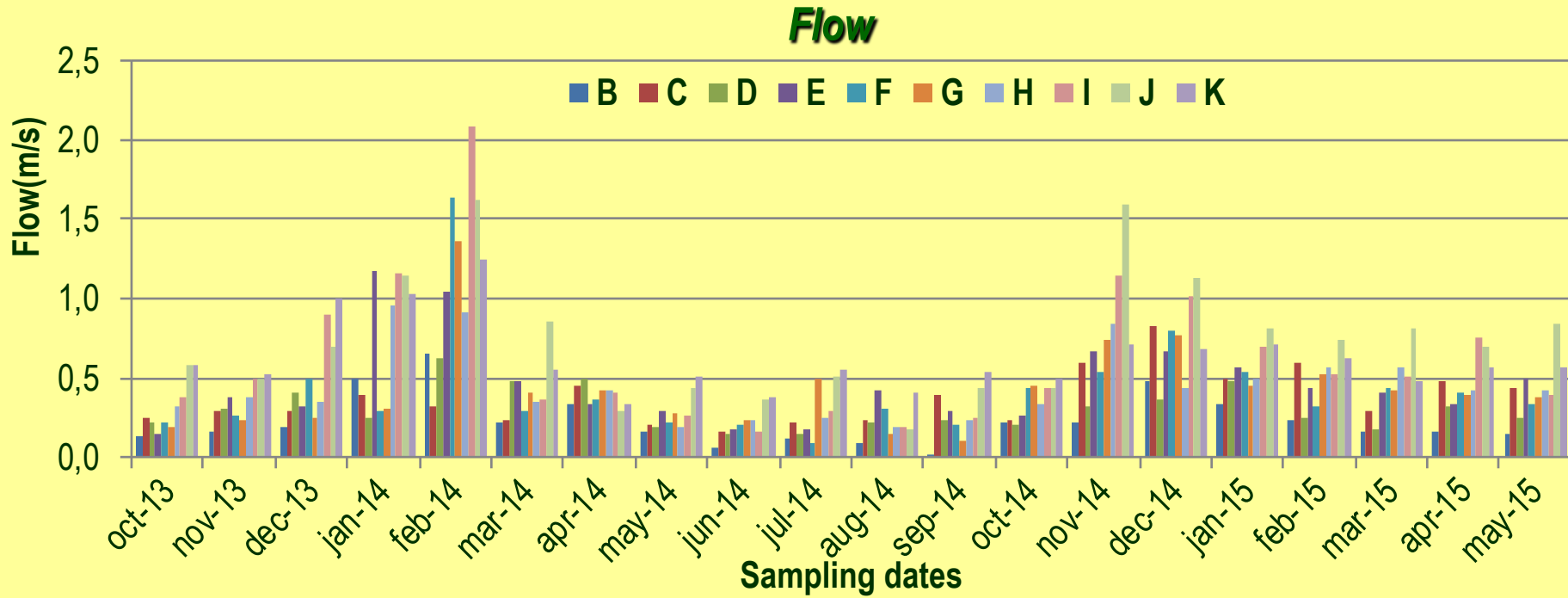
Granja creek

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14)

B C D E F G H I J K

Meiral WTP

Discharge

Discharges

Freixo WTP

Highness (m)

Distance to the source(Km)

1250 m

Sampling site characterization

Substrate composition

Legend: blocks, small blocks, cobble, pebble, gravel, silt, mud

X-axis: Sampling sites (B, C, D, E, F, G, H, I, J, K)

Macrophytes and canopy

Legend: Macrophytes, Canopy

X-axis: Sampling sites (B, C, D, E, F, G, H, I, J, K)

Sampling site characterization

Flow

Legend (series): B, C, D, E, F, G, H, I, J, K

Y-axis: Flow(m/s), ranging 0,0 to 2,5

X-axis: Sampling dates — oct-13, nov-13, dec-13, jan-14, feb-14, mar-14, apr-14, may-14, jun-14, jul-14, aug-14, sep-14, oct-14, nov-14, dec-14, jan-15, feb-15, mar-15, apr-15, may-15

Habitat Quality

	B	C	D	E	F	G	H	I	J	K
Riparian quality (QBR)	5	70	50	10	5	25	0	65	40	70
Habitat quality (EPA)	86	121	139	131	117	118	106	146	137	121

Very Good · Good · Medium · Bad · Very bad

Sampling site characterization

pH and conductivity
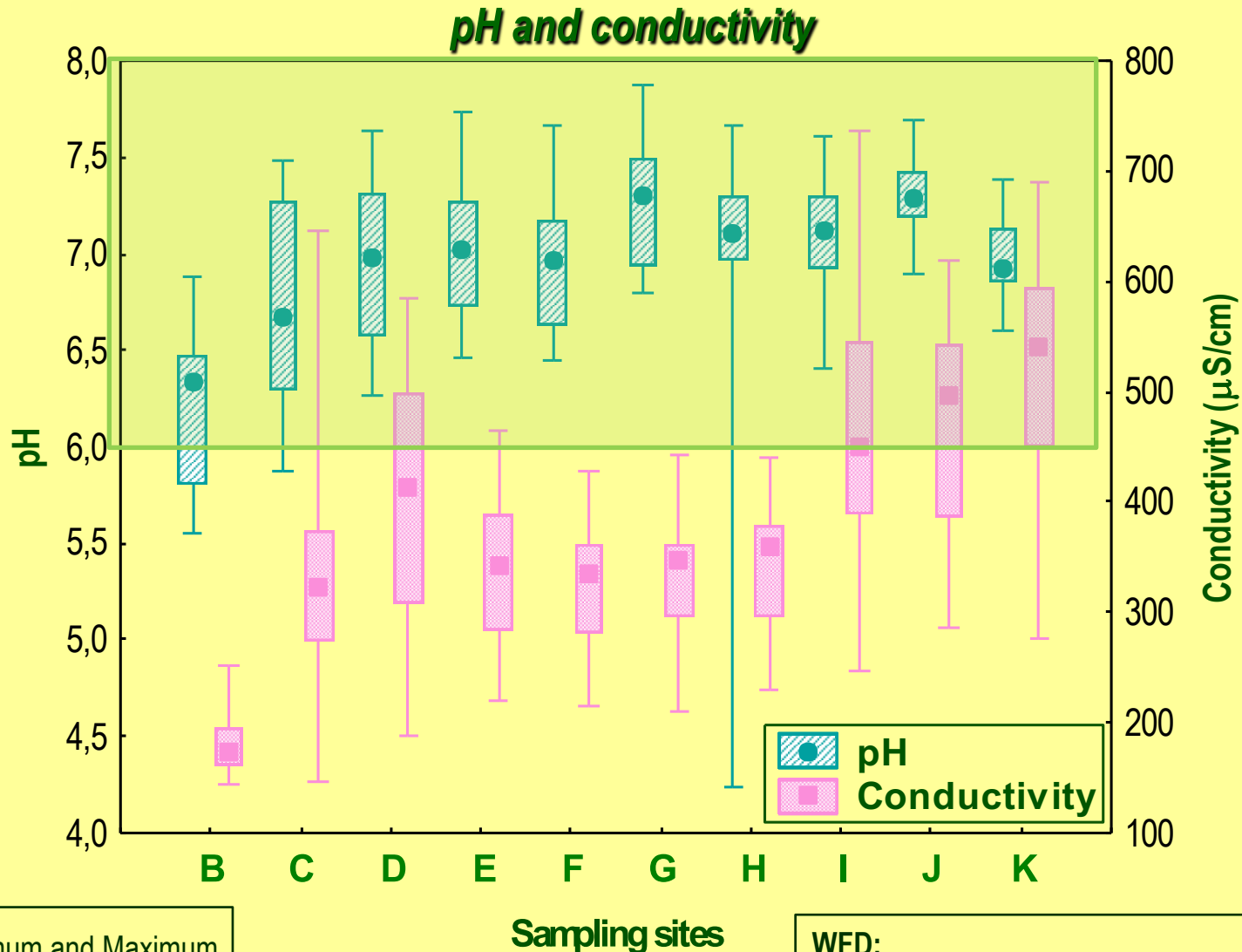
WFD:
pH: between 6 and 9
(The limits may be exceeded if naturally occurring)

Minimum and Maximum
Median and percentiles

Sampling site characterization

% Oxygen saturation and Biochemical Oxygen Demand

Legend:
- Minimum and Maximum
- Median and percentiles

% O₂ — $\% O_2$
BOD₅ — BOD_5

Y-axis (left): % Oxygen Saturation (O_2)
Y-axis (right): Biochemical Oxygen Demand (mg O_2/L) (BOD_5)
X-axis: Sampling Sites (B, C, D, E, F, G, H, I, J, K)
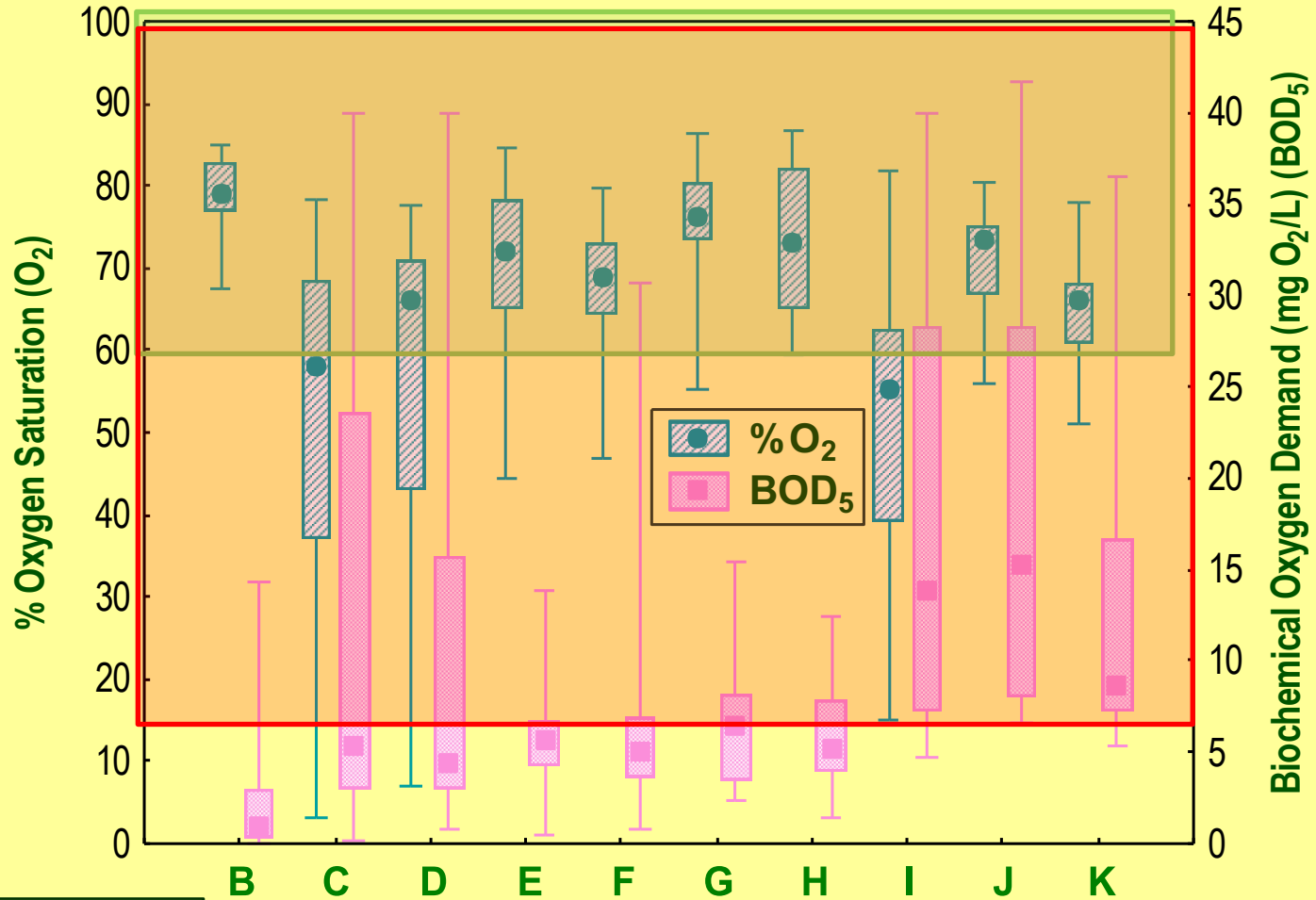
WFD:
$\% O_2$ between 60% and 120%

Sampling site characterization

Ammonium, Nitrates and Total Phosphorous
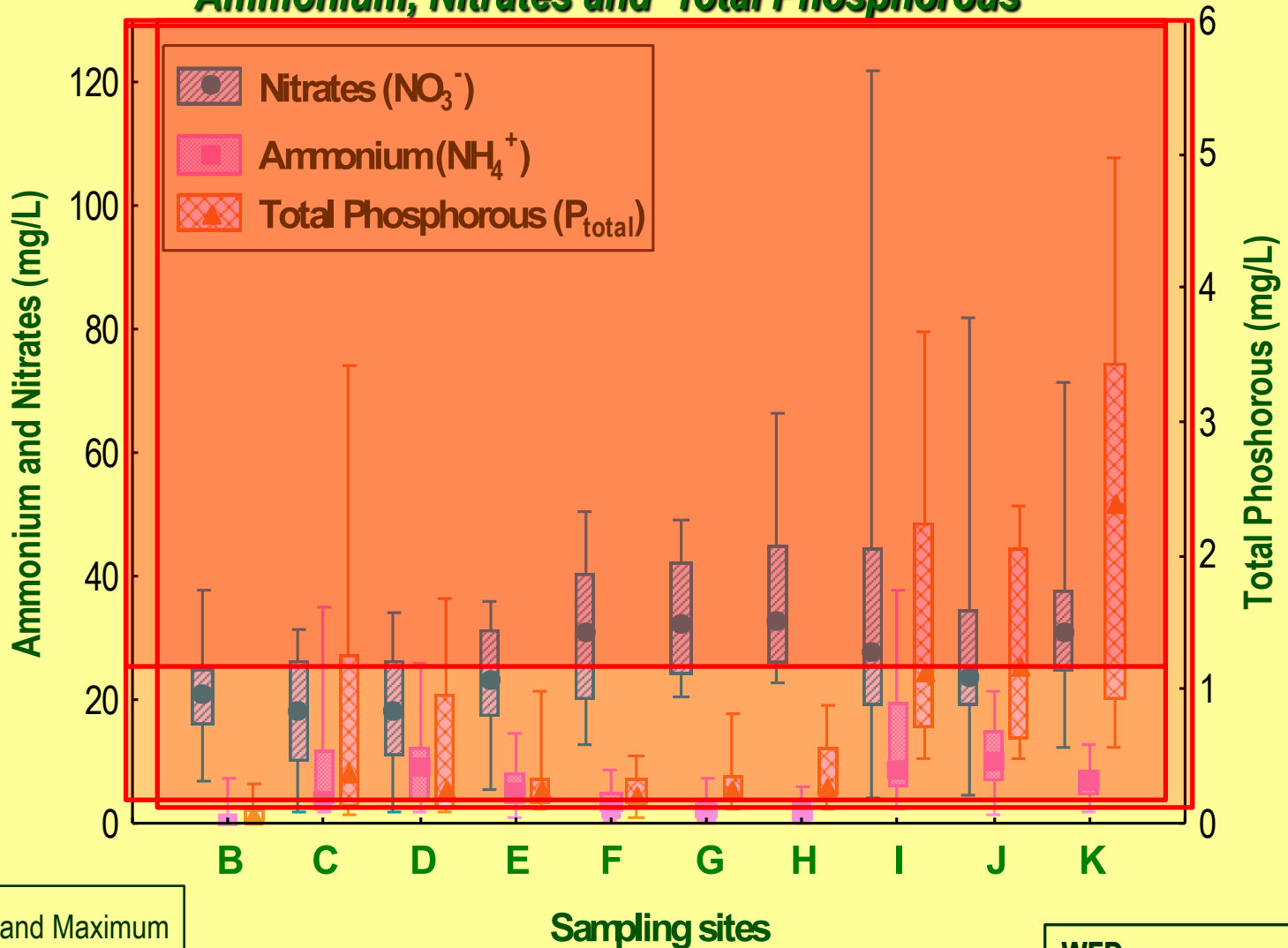
Macroinvertebrate communities

Abundance and richness

Legend:
- ● Number of organisms
- ■ Number of taxa
- I Minimum and Maximum
- ⊙ Median and percentiles

WFD reference value:
Number of taxa = 30

Macroinvertebrate communities

Diversity and evenness

Legend:
- Shannon's diversity
- Pielou evenness
- Minimum and Maximum
- Median and percentiles

WFD reference value:
Evenness = 0,71
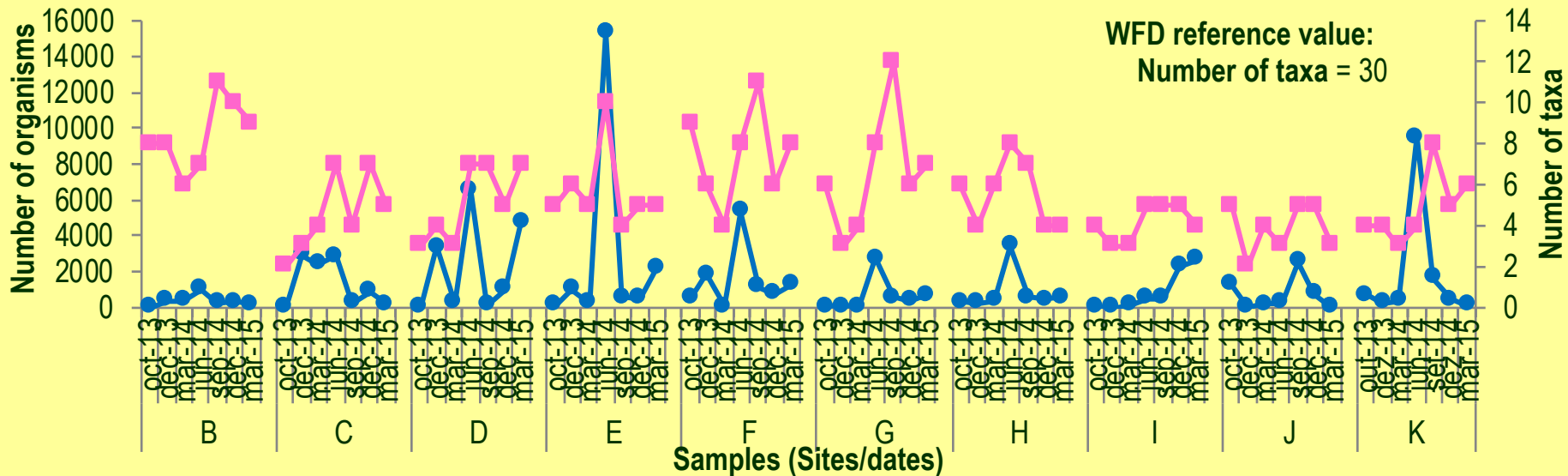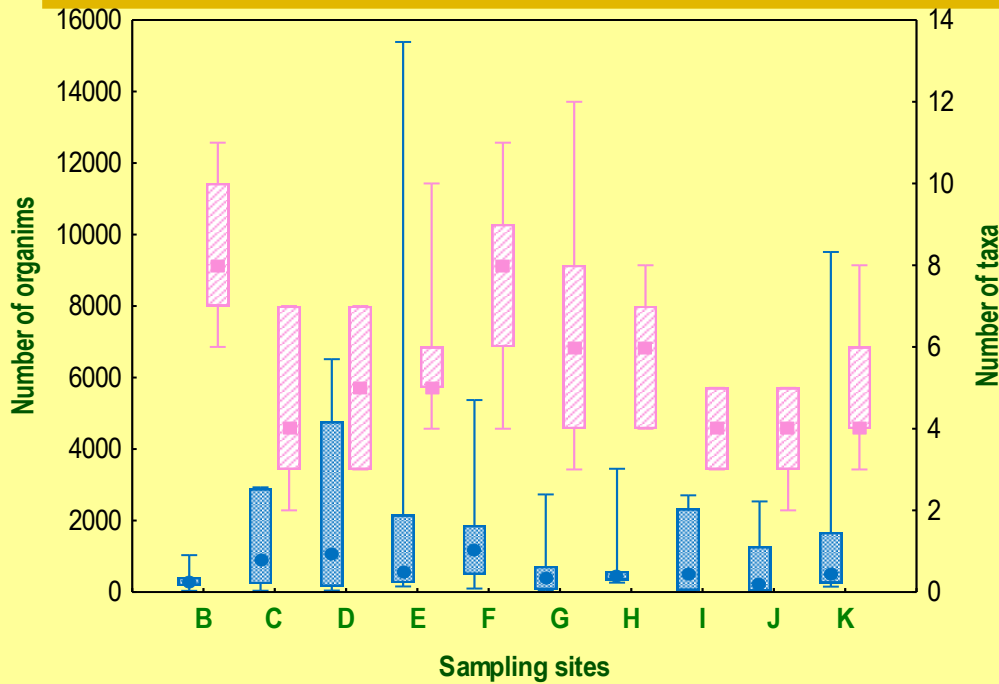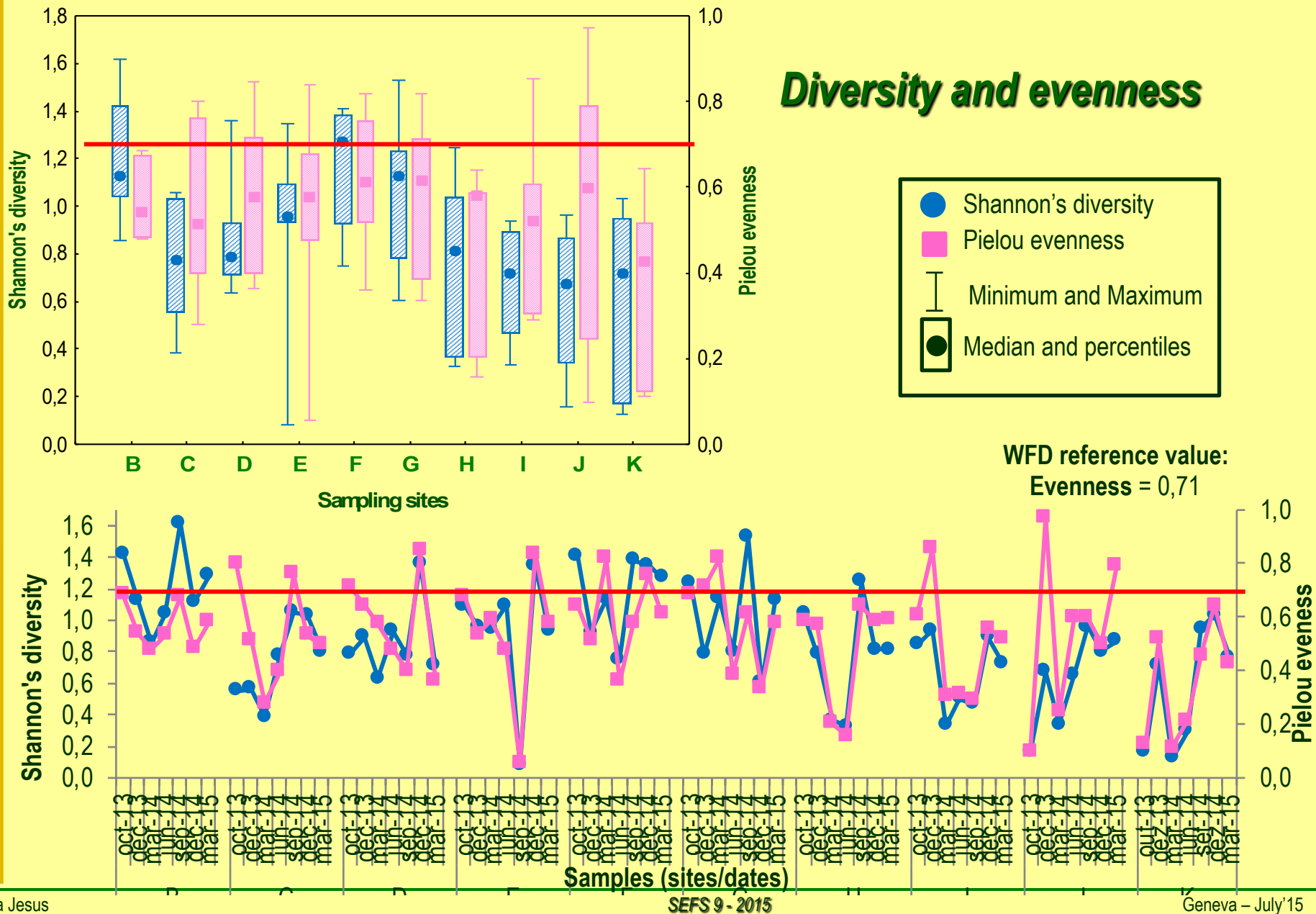
Macroinvertebrate communities

Metrics
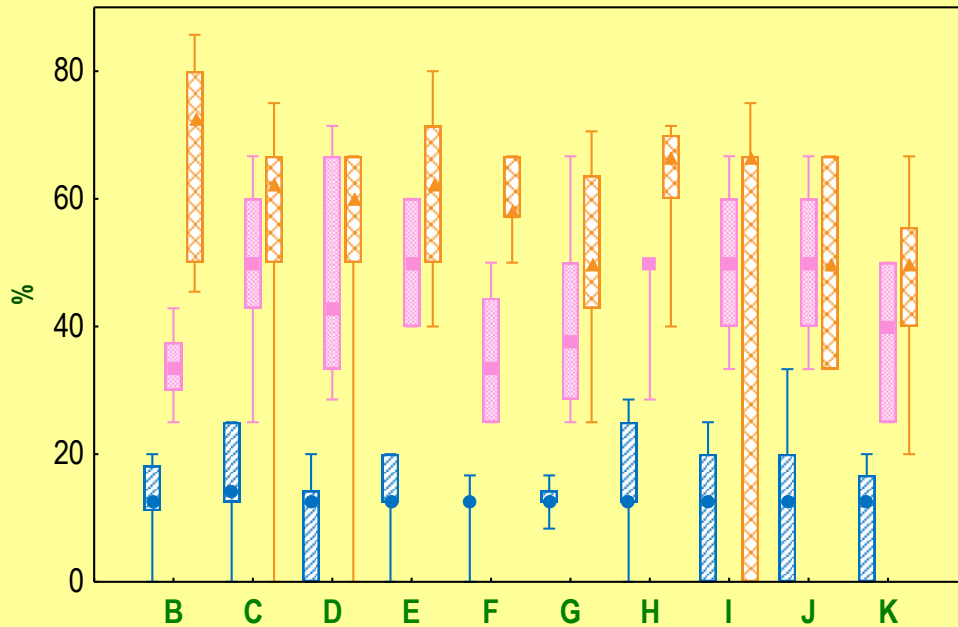
- ● % EPT (Ephemeroptera, Plecoptera e Trichoptera)
- ■ % Diptera
- ▲ % branchial and cutaneaous breathing
- I Minimum and Maximum
- ▣ Median and percentiles
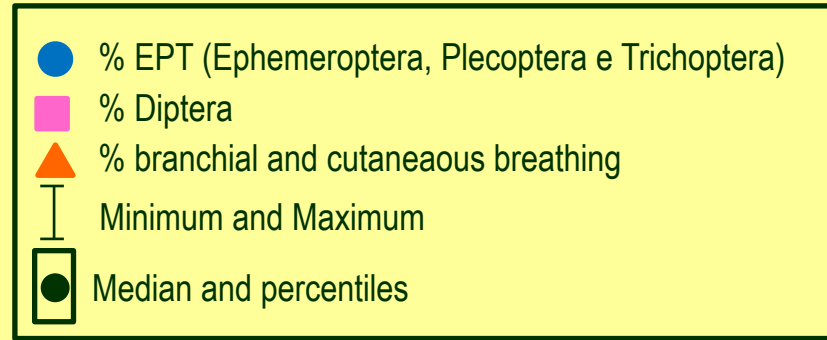
Sampling sites
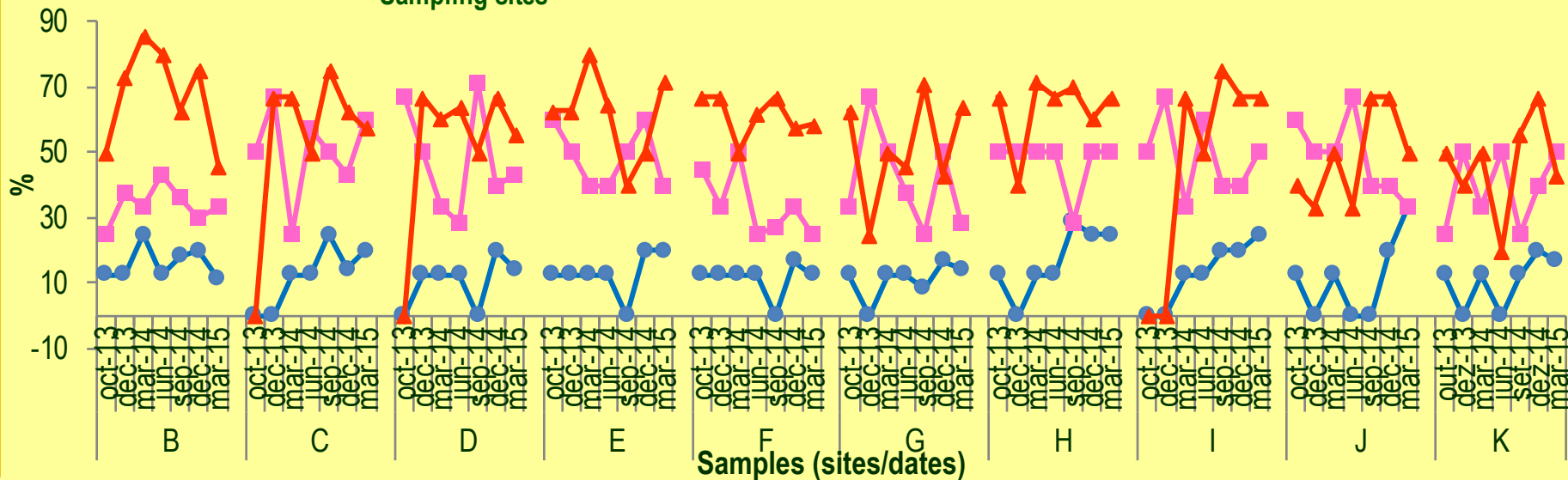
Samples (sites/dates)

Macroinvertebrate communities

Taxa composition
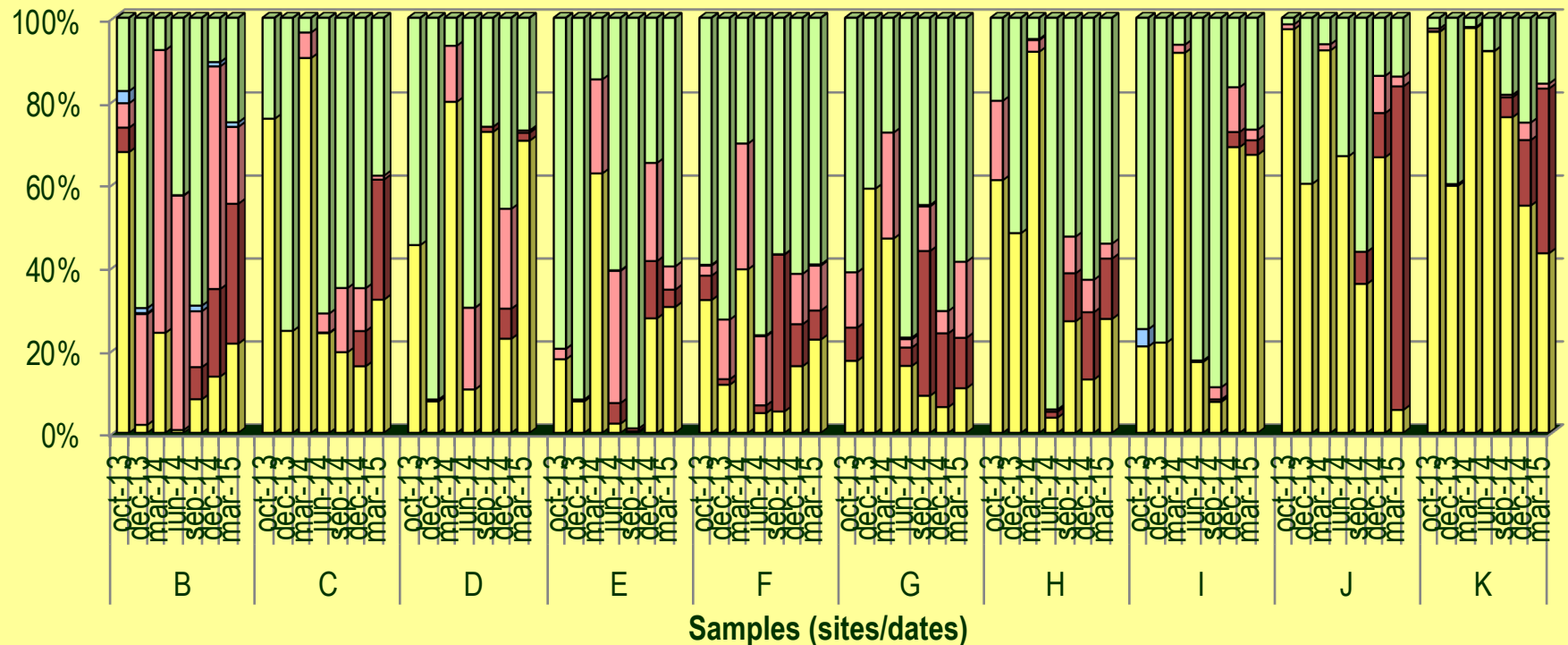
Legend:
- □ **Annelida**
- ■ **Platyhelminthes, Crustacea e Mollusca**
- ■ **Ephemeroptera e Trichoptera**
- □ **Odonata**
- ■ **Heteroptera e Coleoptera**
- □ **Diptera**

Macroinvertebrate communities

Cluster 2

Cluster 3

Cluster 1

Stress: 0,04

● *Autumn* ● *Winter* ● *Spring* ● *Summer*
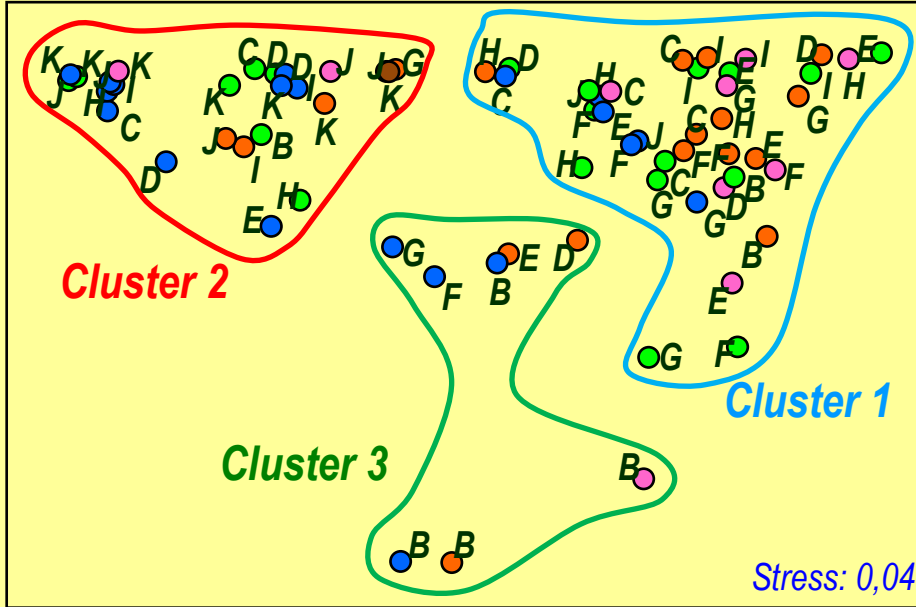
Taxonomic composition

ANOSIM test: R$_{global}$ = 0,902

Mean of each taxa in each cluster

— Cluster 1
— Cluster 2
— Cluster 3

	B	C	D	E	F	G	H	I	J	K
oct-13	2	2	1	1	1	1	2	1	2	2
dec-13	1	1	1	1	1	2	1	1	2	2
mar-14	3	2	2	2	3	3	2	2	2	2
jun-14	3	1	1	1	1	1	1	1	2	2
sep-14	1	1	2	1	1	1	1	1	1	1
dec-14	3	1	3	3	1	1	1	2	2	2
mar-15	3	1	2	1	1	1	1	2	1	2

Macroinvertebrate communities

Breathing groups

Samples (sites/dates)
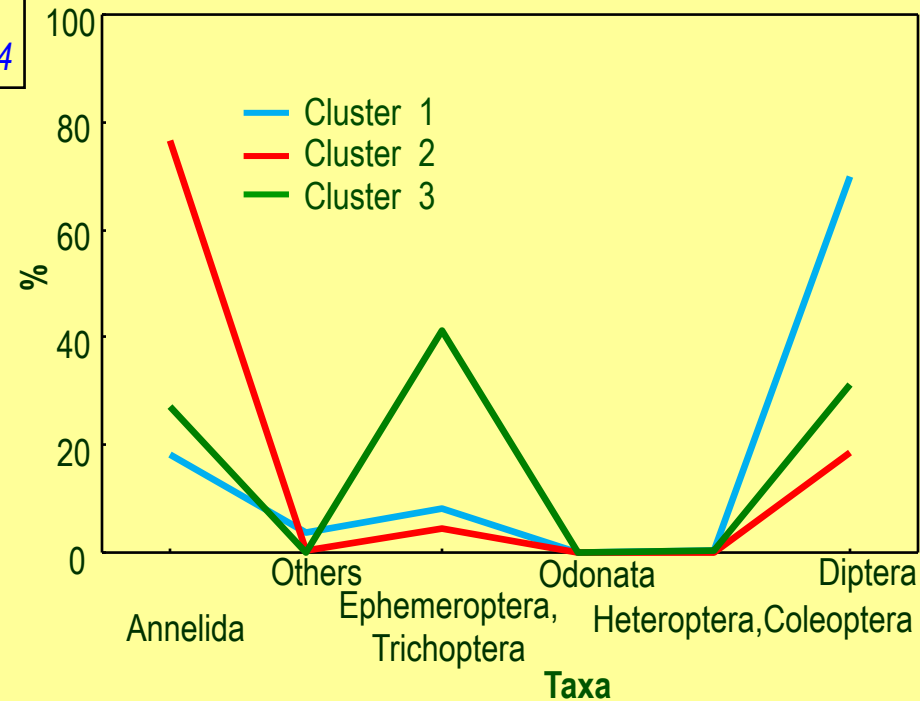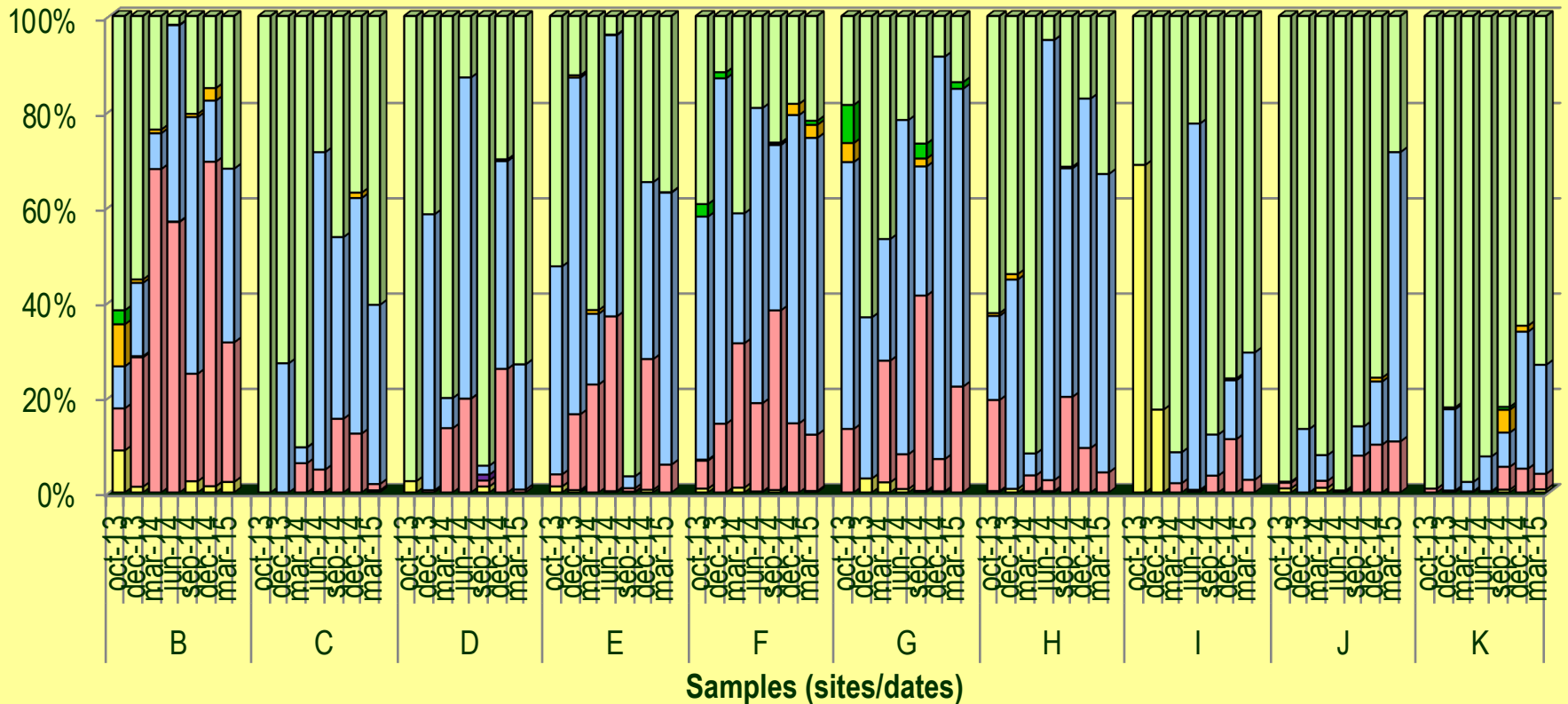
Legend: ☐ **Aerial** ☐ **Branchial** ☐ **Branchial & Aerial** ☐ **Branchial & Cutaneous** ☐ **Cutaneous** ☐ **Pulmonar** ☐ **Special**

Macroinvertebrate communities

Breathing groups

ANOSIM test: R$_{global}$ = 0,880
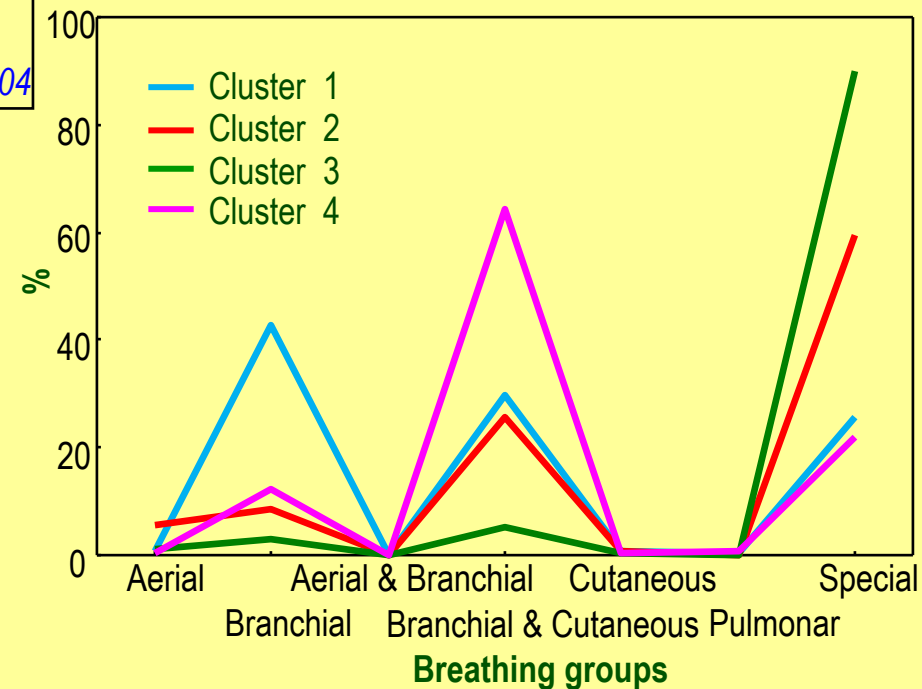
Macroinvertebrate communities

Feeding groups

Macroinvertebrate communities

Cluster 1

Cluster 2

Cluster 3

Stress: 0,07

● *Autumn*   ● *Winter*   ● *Spring*   ● *Summer*

Feeding groups

ANOSIM test: R$_{global}$ = 0,857

Mean of each taxa in each cluster

	B	C	D	E	F	G	H	I	J	K
oct-13	1	1	2	2	2	3	1	2	1	1
dec-13	2	2	2	3	3	1	3	2	1	1
mar-14	2	1	1	1	2	1	1	1	1	1
jun-14	2	3	3	3	3	3	3	3	1	1
sep-14	2	2	1	2	2	2	3	2	2	1
dec-14	2	3	2	2	3	3	3	1	1	1
mar-15	3	3	1	3	3	3	3	1	3	1
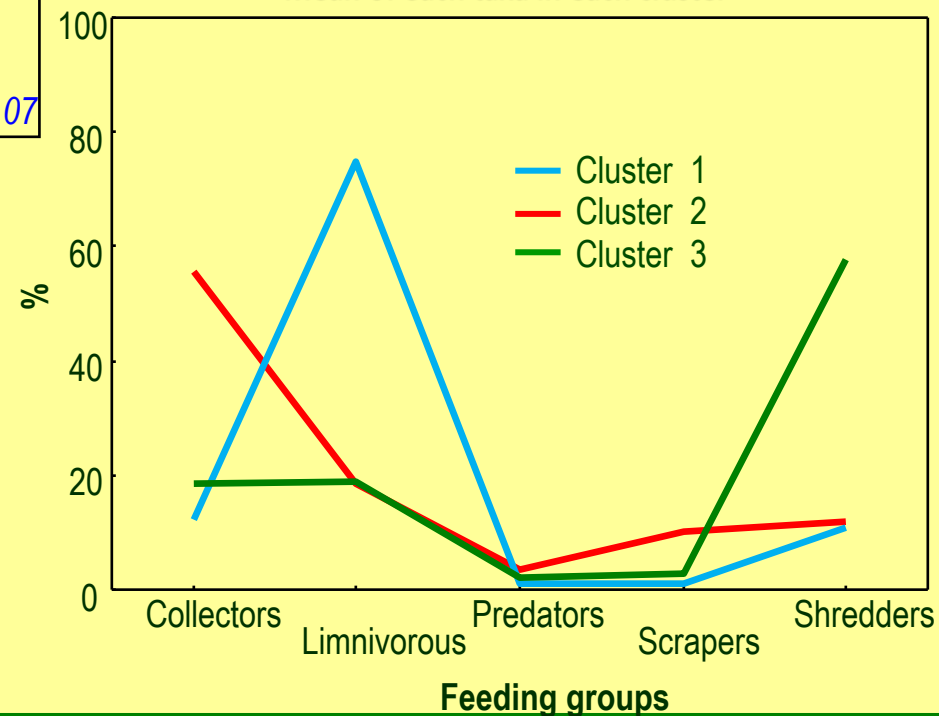
Macroinvertebrate communities

Habitat / Locomotion

Samples (Sites/dates)
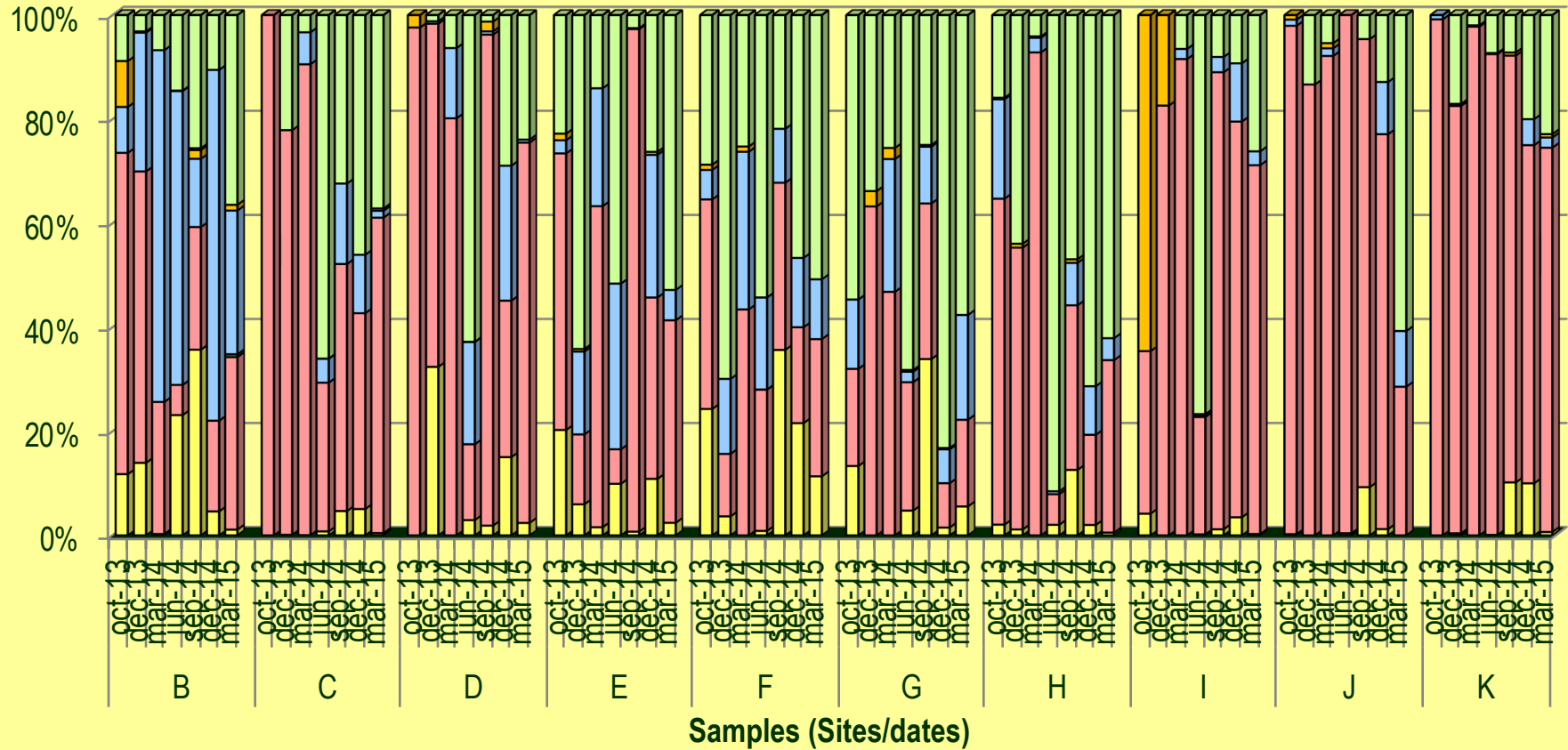
Legend: □ Clingers ■ Burrowers ■ Divers ■ Swimmers ■ Sprawlers □ Skaters □ Climbers

Macroinvertebrate communities

Stress: 0,06

Cluster 3

Cluster 2

Cluster 1

● *Autumn* ● *Winter* ● *Spring* ● *Summer*

Habitat / Locomotion

ANOSIM test: R_{global} = 0,867

Mean of each taxa in each cluster

— Cluster 1
— Cluster 2
— Cluster 3

	B	C	D	E	F	G	H	I	J	K
oct-13	1	1	1	2	2	3	1	2	1	1
dec-13	2	1	1	3	3	1	3	1	1	1
mar-14	2	1	1	2	2	2	1	1	1	1
jun-14	2	3	3	3	3	3	3	3	1	1
sep-14	2	2	1	1	2	2	3	1	1	1
dec-14	2	3	2	2	3	3	3	1	1	1
mar-15	2	1	1	3	3	3	3	1	3	1
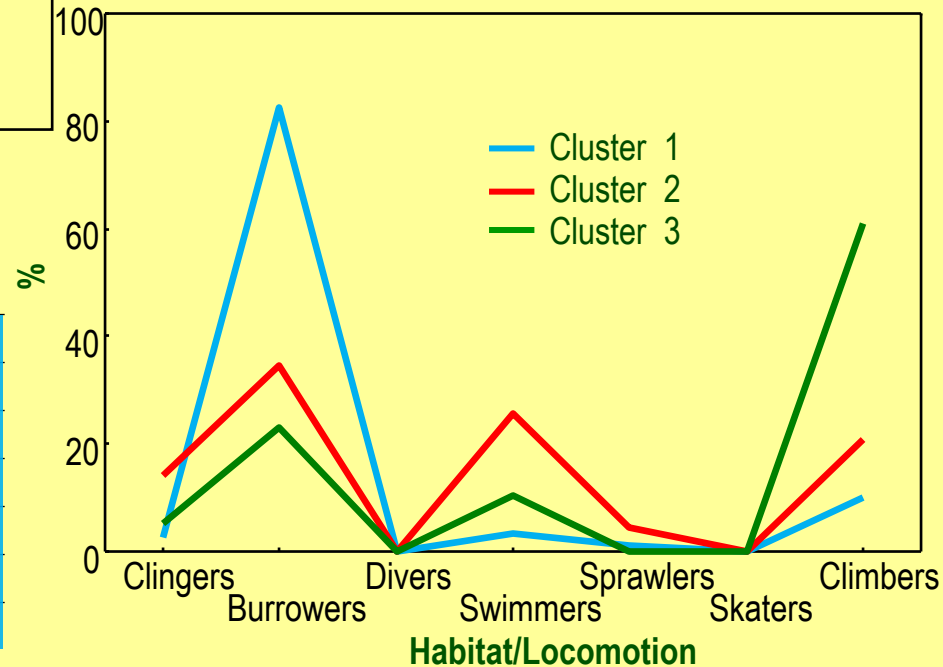
Macroinvertebrate communities

Flow preferences

Samples (Sites/dates)

B C D E F G H I J K

□ Limnophiles   ■ Most limnophiles   ■ Reophiles   □ Most reophiles

Flow preferences

ANOSIM test: R_{global} = 0,852

Mean of each taxa in each cluster

Cluster 3

Cluster 2

Cluster 1

Stress: 0,05
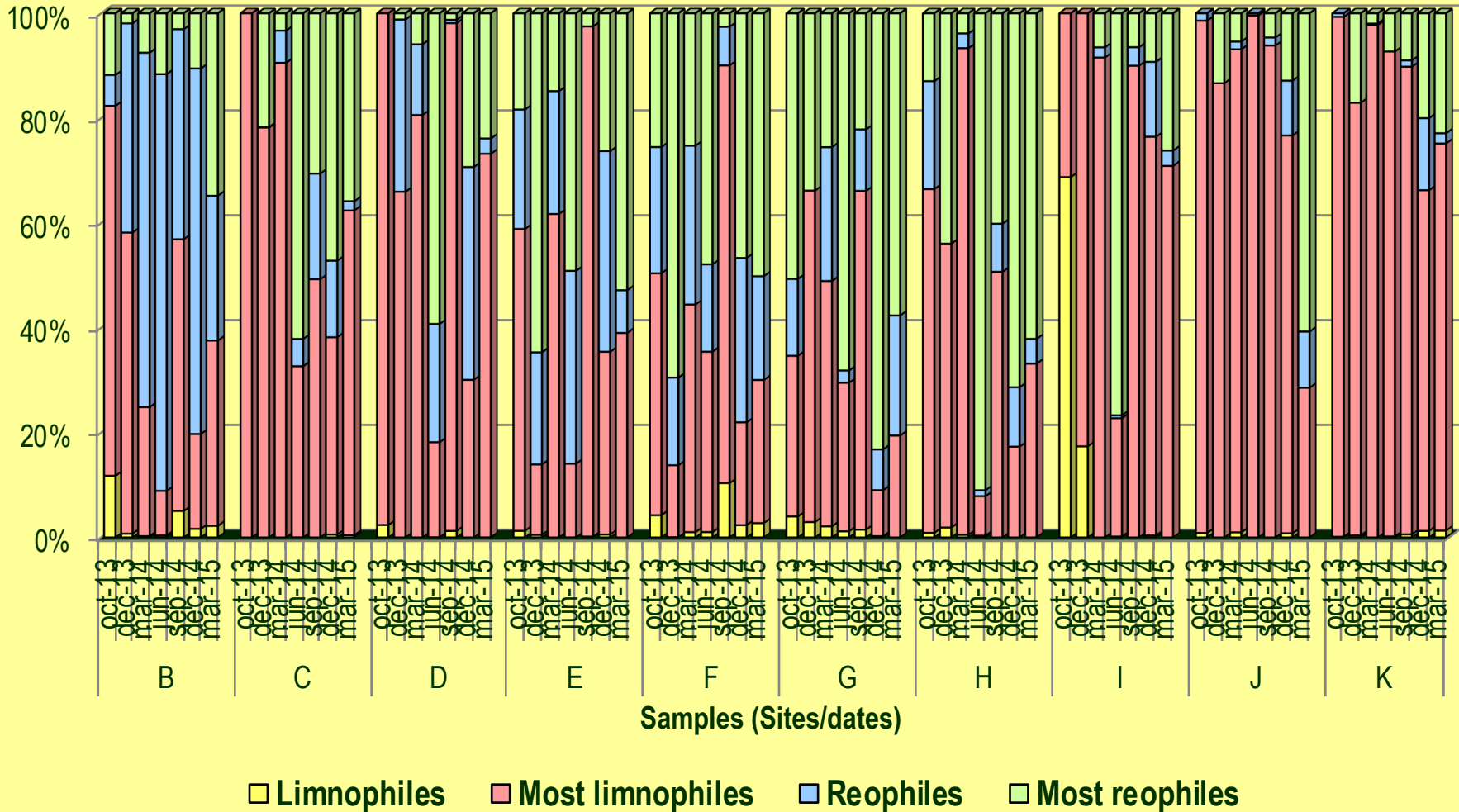
● *Autumn* ● *Winter* ● *Spring* ● *Summer*

	B	C	D	E	F	G	H	I	J	K
oct-13	3	3	3	1	1	2	3	1	3	3
dec-13	1	3	1	2	2	3	2	3	3	3
mar-14	1	3	3	1	1	1	3	3	3	3
jun-14	1	2	2	2	2	2	2	2	3	3
sep-14	1	1	3	3	3	3	2	3	3	3
dec-14	1	2	1	1	2	2	2	3	3	3
mar-15	1	3	3	2	2	2	2	3	2	3

Cluster 1
Cluster 2
Cluster 3

%

100

80

60

40

20

0

Limnophiles   Rheophiles
Most limnopiles   Most rheophiles

Flow preferences
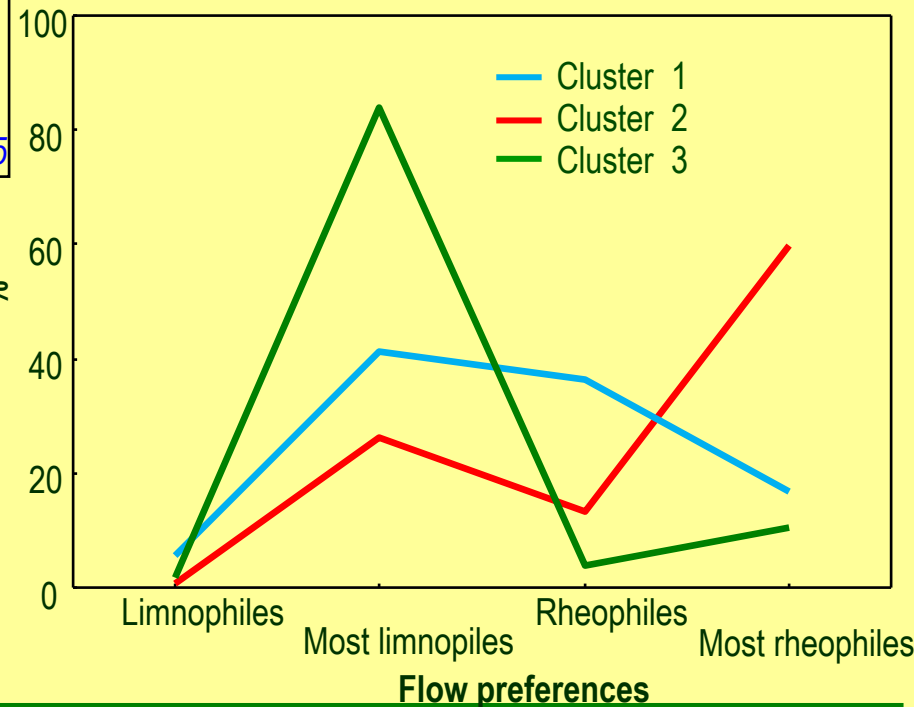
Macroinvertebrate communities

Biological Water Quality

		B	C	D	E	F	G	H	I	J	K
IBMWP	oct-13	23	3	7	16	35	18	19	9	16	10
	dec-13	31	8	12	19	23	7	10	7	3	12
	mar-14	23	10	7	15	11	11	24	7	11	7
	jun-14	28	23	26	40	29	26	27	16	8	10
	sep-14	41	12	16	7	39	49	21	15	14	27
	dec-14	39	23	15	16	18	19	12	15	15	15
	mar-15	30	16	22	17	27	21	12	12	7	19
RQE	oct-13	0,23	0,09	0,15	0,22	0,29	0,22	0,21	0,13	0,14	0,09
	dec-13	0,27	0,14	0,20	0,21	0,25	0,14	0,14	0,16	0,12	0,17
	mar-14	0,25	0,11	0,13	0,20	0,20	0,20	0,22	0,10	0,12	0,07
	jun-14	0,27	0,24	0,24	0,29	0,23	0,21	0,19	0,17	0,15	0,09
	sep-14	0,31	0,21	0,13	0,02	0,27	0,33	0,23	0,16	0,18	0,23
	dec-14	0,29	0,22	0,23	0,24	0,23	0,18	0,19	0,19	0,18	0,20
	mar-15	0,25	0,20	0,19	0,22	0,25	0,21	0,19	0,18	0,16	0,19

Conclusions

➢ **After analyzing the data collected it turns out that the ecological status of the Tinto river varies between insufficient and bad**

➢ **This classification is due to:**

▪ **Problems on the water quality level as seems to indicate the analysis of physical-chemical parameters and benthic macroinvertebrate communities;**

▪ **Sectors of the Tinto river in which the hydro-morphological characteristics "natural" are quite changed;**

▪ **Existence of areas along the watercourse where placement and structure of the banks also lead to this type of classification.**

Conclusions

➢ **The communities of macroinvertebrates present along the Tinto river are:**

    ✓ **Poor of the taxonomic point of view;**

    ✓ **Presenting relatively low values of diversity;**

    ✓ **Are dominated by organisms belonging to Annelida and Diptera with some presence of other faunal groups such as Ephemeroptera and Mollusca.**

➢ **From a functional point of view the communities are constituted by:**

    ✓ **Organisms dependent of dissolved oxygen in the water to breathe but where there are also great amount of individuals with adaptations that allow them to survive in anoxic environment,;**

    ✓ **Collectors shredders and limnivorous organisms;**

    ✓ **Macroinvertebrates that prefer living buried in the substrate or in the water column (swimmer organisms).**

➢ **Despite the lack of diversity of organisms found is achieved through the analysis of benthic macroinvertebrate community differentiate the various sampling sites according to their different levels of environmental disturbance.**

Conclusions

	Moderately disturbed	Disturbed	Very disturbed
Conductivity	150 to 250 µS/cm	200 to 400 µS/cm	250 to 750 µS/cm
% O_2 saturation	65 to 85%	45 to 85%	2 to 75%
Maximum BOD_5	15 mg O_2/L	30 mg O_2/L	45 mg O_2/L
Maximum NH_4^+	5 mg/L	15 mg/L	35 mg/L
Maximum P_{total}	0,5 mg/L	1 mg/L	5 mg/L
Taxa diversity	All groups	Diptera>Annelida>Diptera	Annelida>Diptera
Breathing groups	Branchial>=Branchial/cutaneous=special	Branchial & cutaneous>special>branchial	Special>Branchial
Feeding groups	Collectors>Shredders	Shredders>Limnivorous>Collectors	Limnivorous
Habitat preference	Swimmmers≈Burrowers>clingers and climbers	Climbers≈burrowers>Swimmers	Dominance of burrowers
Flow preference	Dominance of reophiles	Dominance of most reophiles	Dominance of most limnophiles

1250 m

Thank you!