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Marine Matters

Temporal variations in the zooplankton community at 4 European coastal stations: a 10 years time-series comparison

D. Eloire [1, 2, *], A. De Olazabal [3], S. Fonda Umani [4], R. Harris [1], S. Hay [5], M.G. Mazzocchi [6], B. Mostajir [2], J. Rasmussen [5], P. Somerfield [1], V. Tirelli [3], D. Bonnet [2]

presented by: Damien Eloire

* Corresponding author: dmelo@pml.ac.uk
[1] Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth, PL1 3DH, Devon, United Kingdom
[2] Université Montpellier II – CNRS (UMR 5119), Case 093, Place Eugène Bataillon, 34095 Montpellier, France
[3] OGS, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Dipartimento di Oceanografia Biologica, Via Auguste Piccard 54, 34014 Santa Croce, Trieste, Italia
[4] Dipartimento di Biologia, Università di Trieste, 34127 Trieste, Italia
[5] Fisheries Research Services Marine Laboratory Aberdeen, PO Box 101, Victoria Road, Aberdeen AB11 9DB, Scotland, United Kingdom
[6] Stazione Zoologica "Anton Dohrn", Villa Comunale, 80121 Napoli, Italia

Joint ICES/CIESM Workshop to compare Zooplankton Ecology and Methodologies between the Mediterranean and the North Atlantic

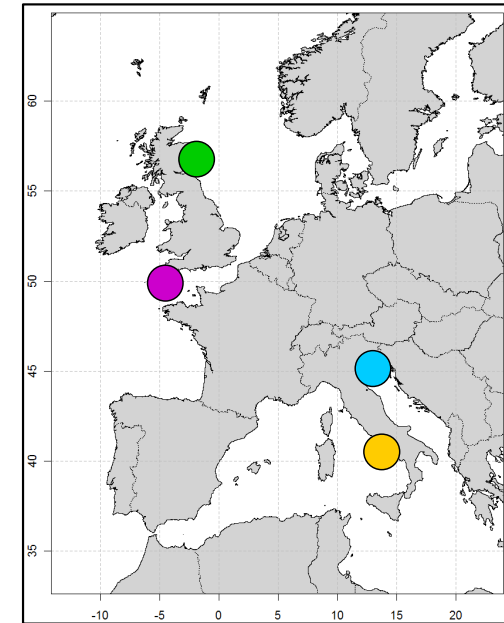*Heraklion – October 2008*

Sites location

- **Stonehaven (Aberdeen)**
  Northern North Sea

- **L4 (Plymouth)**
  Western Channel

- **C1 (Gulf of Trieste)**
  Adriatic Sea

- **MC (Gulf of Naples)**
  Tyrrhenian Sea
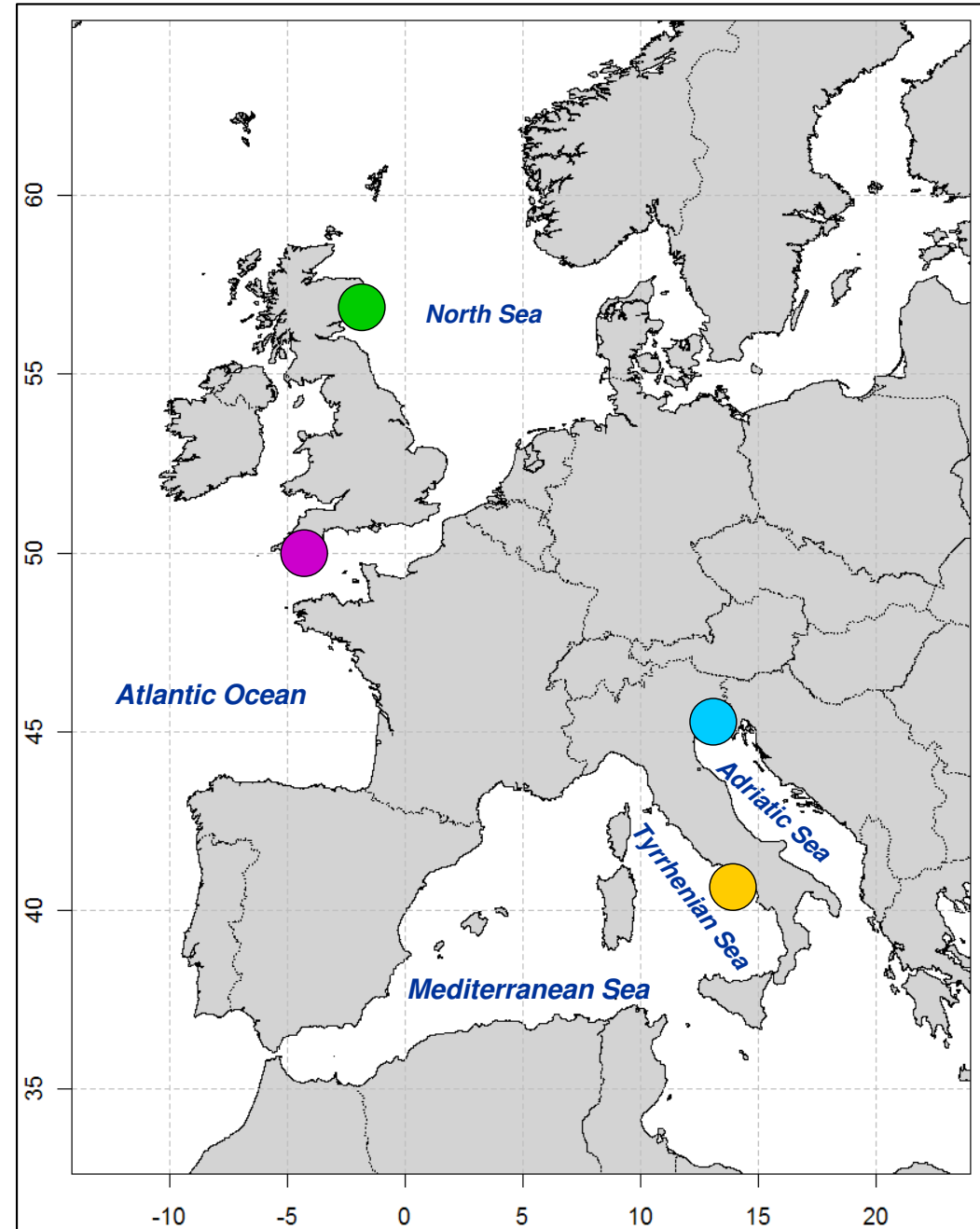
Stations features: *similarities*

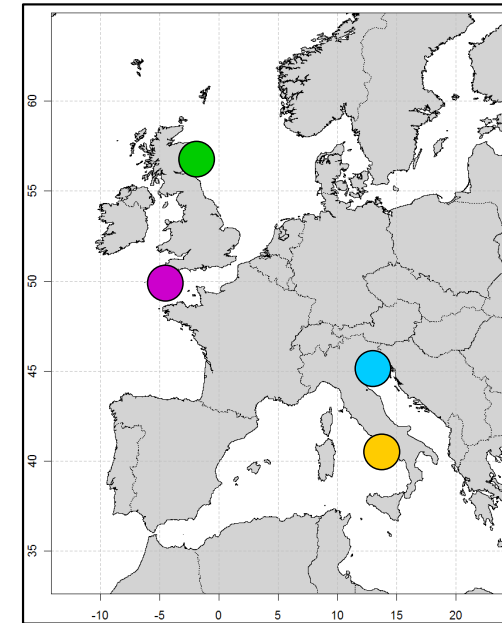|	net mesh size	net tow	sampling frequency	missing month	max. depth	start
• **Aberdeen**	200µm	vertical	weekly	0	50 m	1997
• **Plymouth**	200µm	vertical	weekly	1	55 m	1988
• **Trieste**	200µm	vertical	monthly	1	18 m	1970
• **Naples**	200µm	vertical	weekly	1	80 m	1984

The same sampling method and the combination of the taxonomic levels allow both qualitative and quantitative comparison of other 500 different zooplankton categories when including all taxonomic levels.

Stations features: *accessibility*

	net mesh size	net tow	sampling frequency	missing month	max. depth	start
Aberdeen	200µm	vertical	weekly	0	50 m	1997
Plymouth	200µm	vertical	weekly	1	55 m	1988
Trieste	200µm	vertical	monthly	1	18 m	1970
Naples	200µm	vertical	weekly	1	80 m	1984

Problems:

different sampling frequencies

missing data if no sample

different taxonomic identifications

data availability

Solutions:

➡ study based on monthly averages

➡ data interpolation

➡ combination of taxonomic levels

➡ "R toolkit" analysis program

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Data analysis

- "R toolkit" for time-series analysis:

  averages, climate anomalies, seasonality, trends, community structure/composition, diversity indices, phenology, correlations, filtering …

- Data harmonisation:

  overlapping periods: 1998/2007

  taxonomic homogenisation: ~75 different categories

  calculation of monthly averages

  estimation of missing month's value

Results presented here →
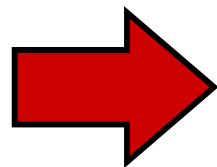
Aberdeen: 1999/2007
Plymouth: 1998/2007
Trieste: 1998/2007
Naples: 1998/2006
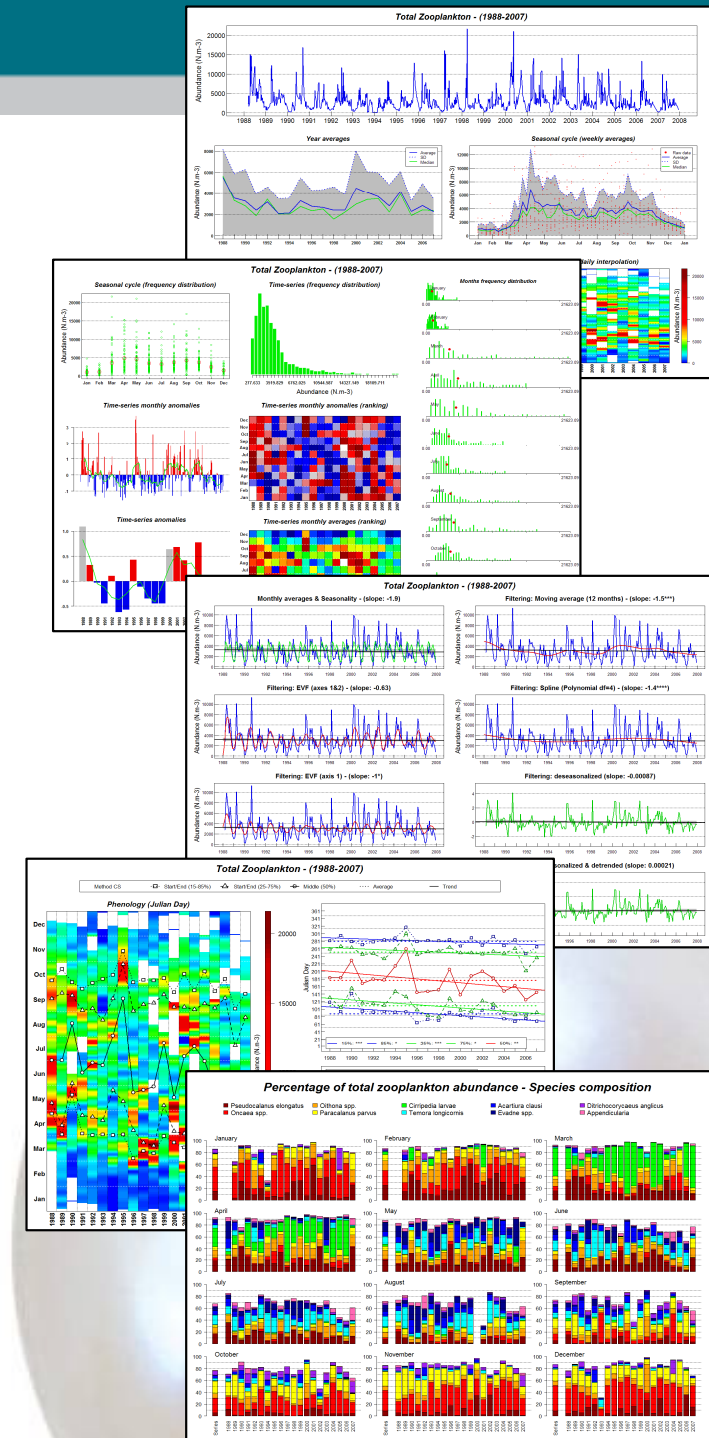
Seasonality

- ## Zooplankton
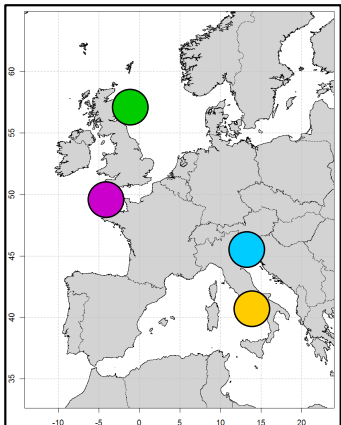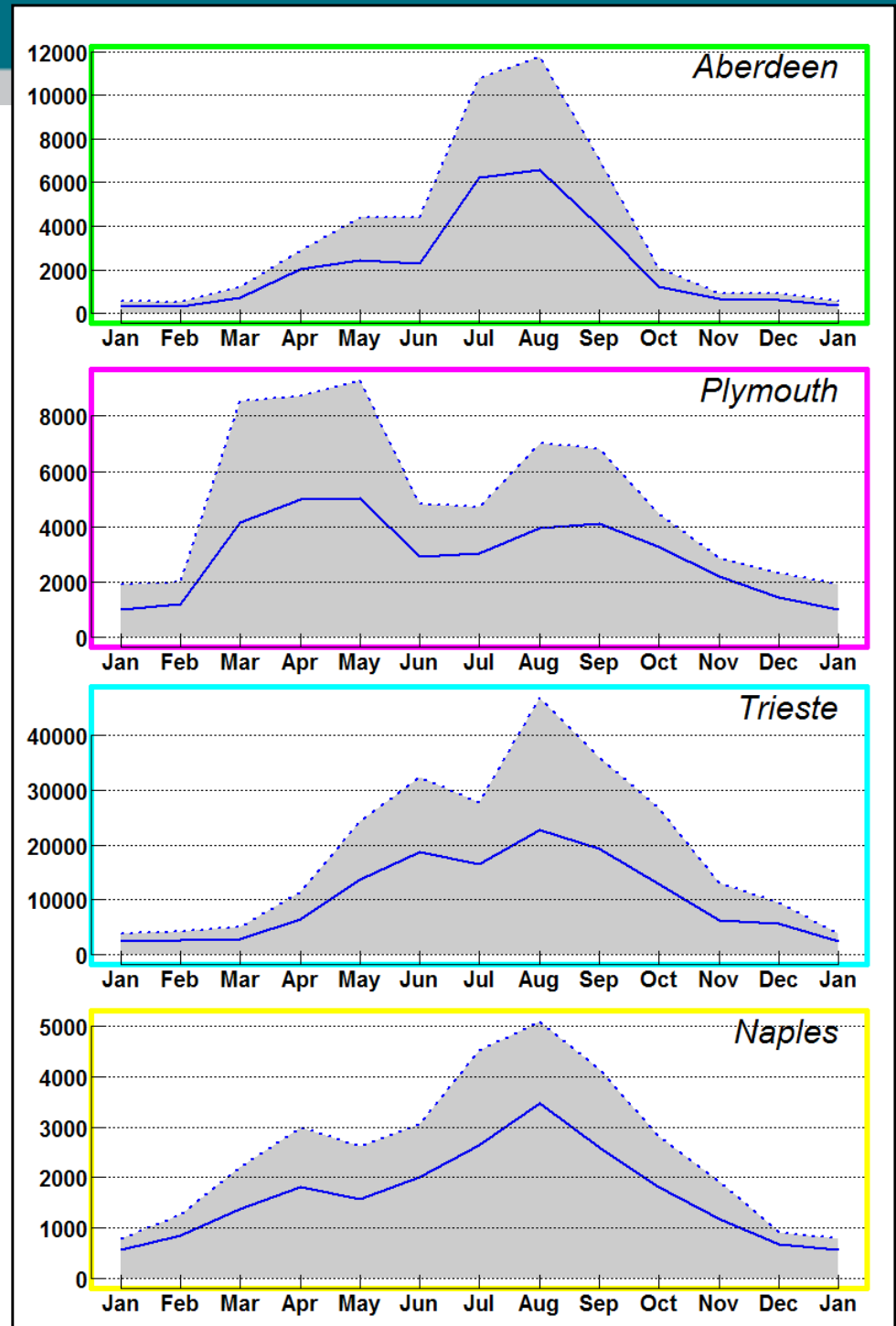 ### total abundance (N.m^{-3})

figure: average seasonal cycle of the total zooplankton abundances based on monthly averages (solid line) – seasonal cycle plus the standard deviation (dotted line)

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Seasonality

- **Aberdeen**
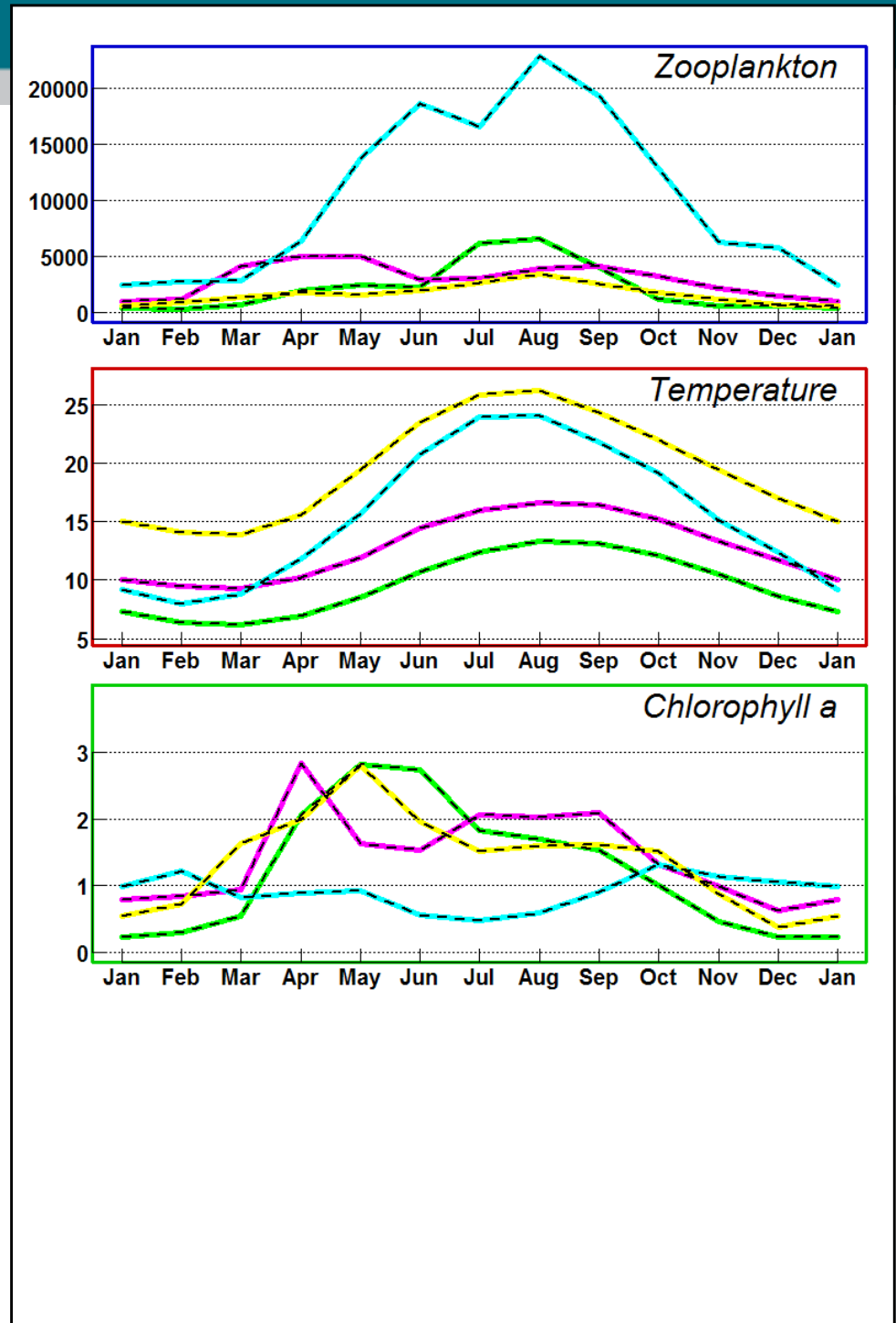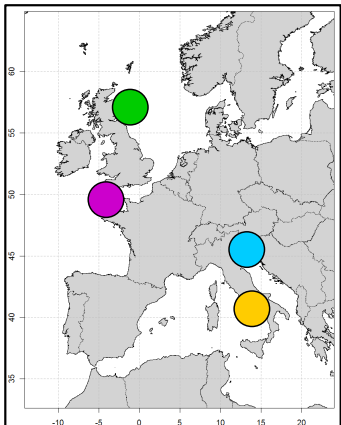- **Plymouth**
- **Trieste**
- **Naples**

figure: average seasonal cycle based on monthly averages at the 4 stations for the total zooplankton abundances ($N.m^{-3}$) top panel – the surface temperature (^oC) middle panel – Chlorophyll a ($mg.m^{-3}$) bottom panel

Seasonality

- **Zooplankton**

  total abundance (N.m⁻³)

- **Sea Surface Temperature**

  temperature (ºC)

- **Surface Chlorophyll**

  chlorophyll *a* (mg.m⁻³)

figure: *average seasonal cycle based on monthly averages (solid line)*

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Seasonality

- **Zooplankton**
  total abundance (N.m^{-3})

- **Copepods**
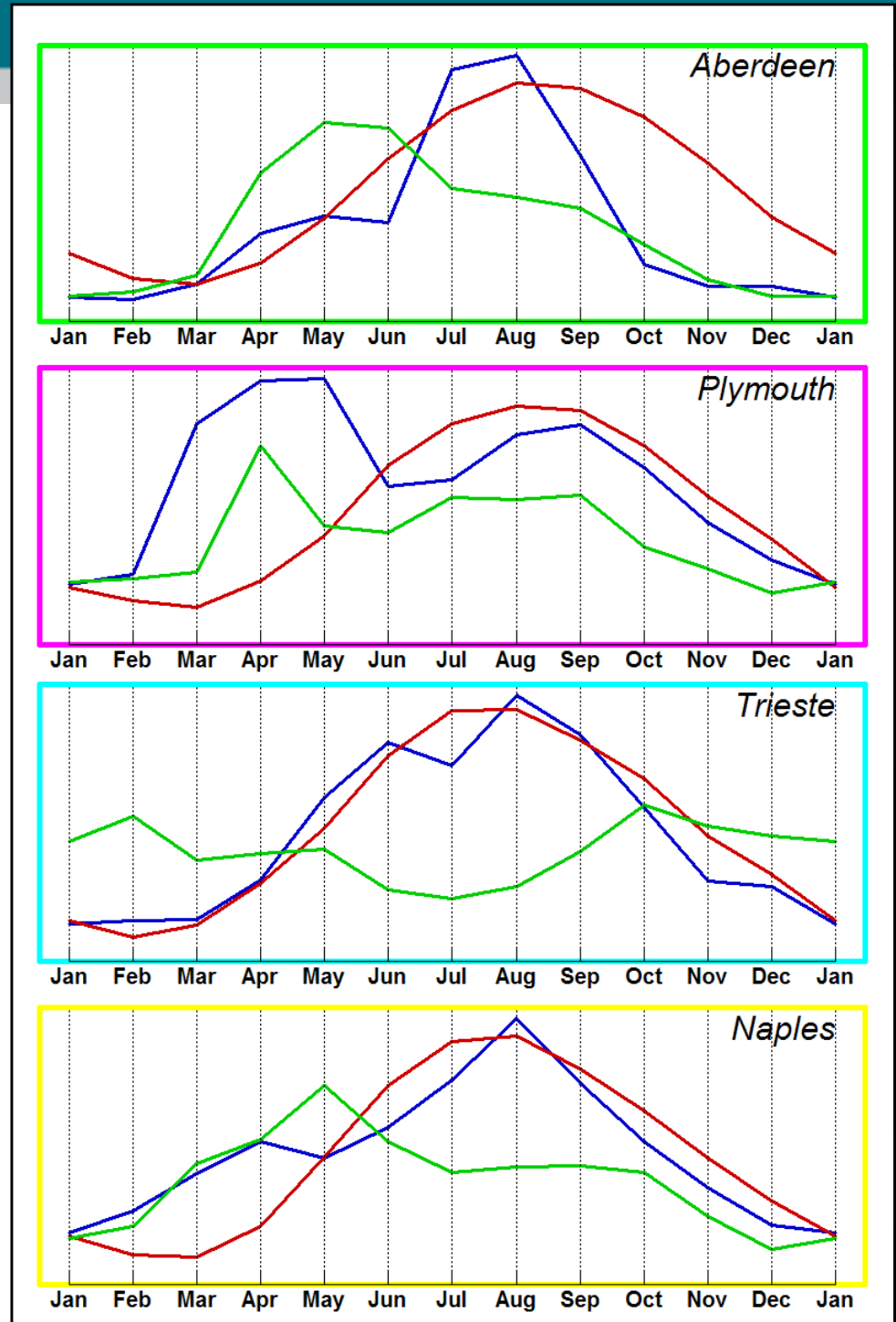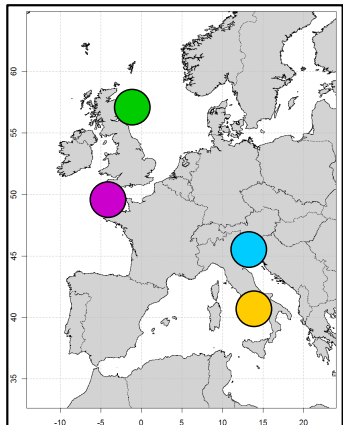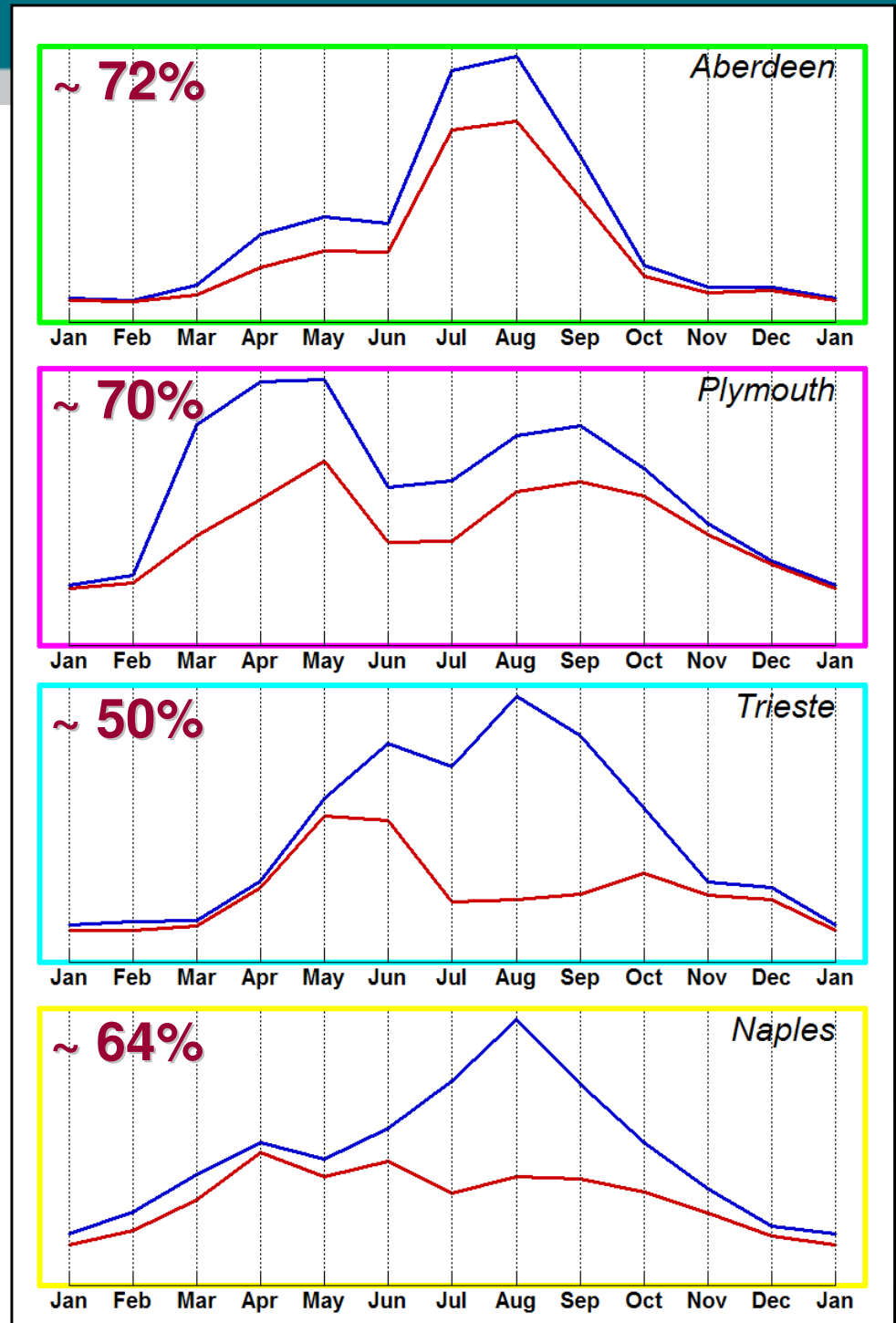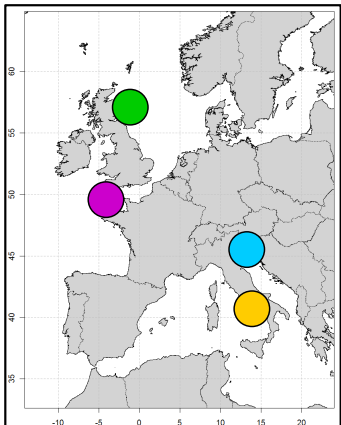 **total abundance (N.m^{-3})**

figure: *average seasonal cycle based on monthly averages (solid line)*

Seasonality

- **Zooplankton**

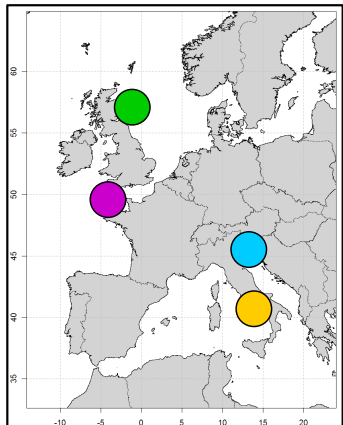 **total abundance (N.m^{-3})**

- **Copepods**

  total abundance (N.m^{-3})

figure: *average seasonal cycle based on monthly averages (solid line)*

Aberdeen

Plymouth

~ 12% Cirripedia larvae

Trieste

~ 30% Penilia avirostris

Naples

~ 14% Penilia avirostris

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

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Anomaly

- ## Zooplankton
   ### annual anomalies

figure: annual anomaly of the total zooplankton abundances based on monthly anomalies averages – 3-year moving average (black line)

Anomaly

- ## Zooplankton
  ### annual anomalies
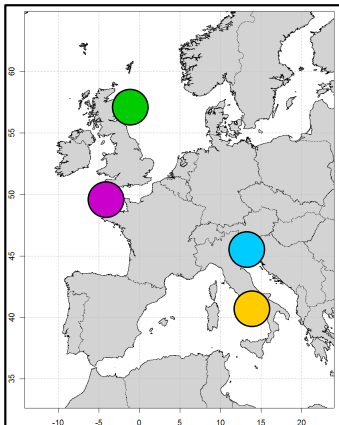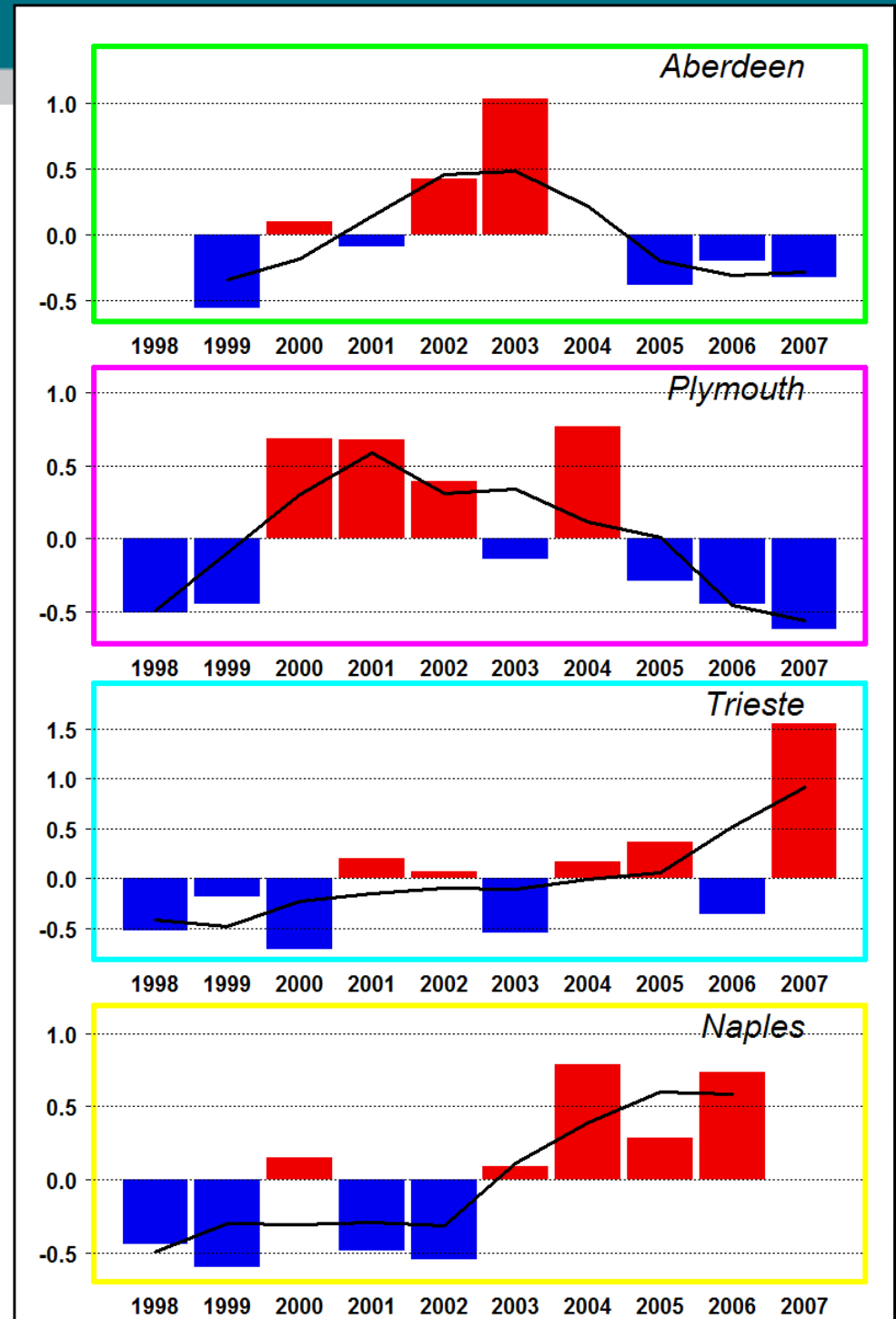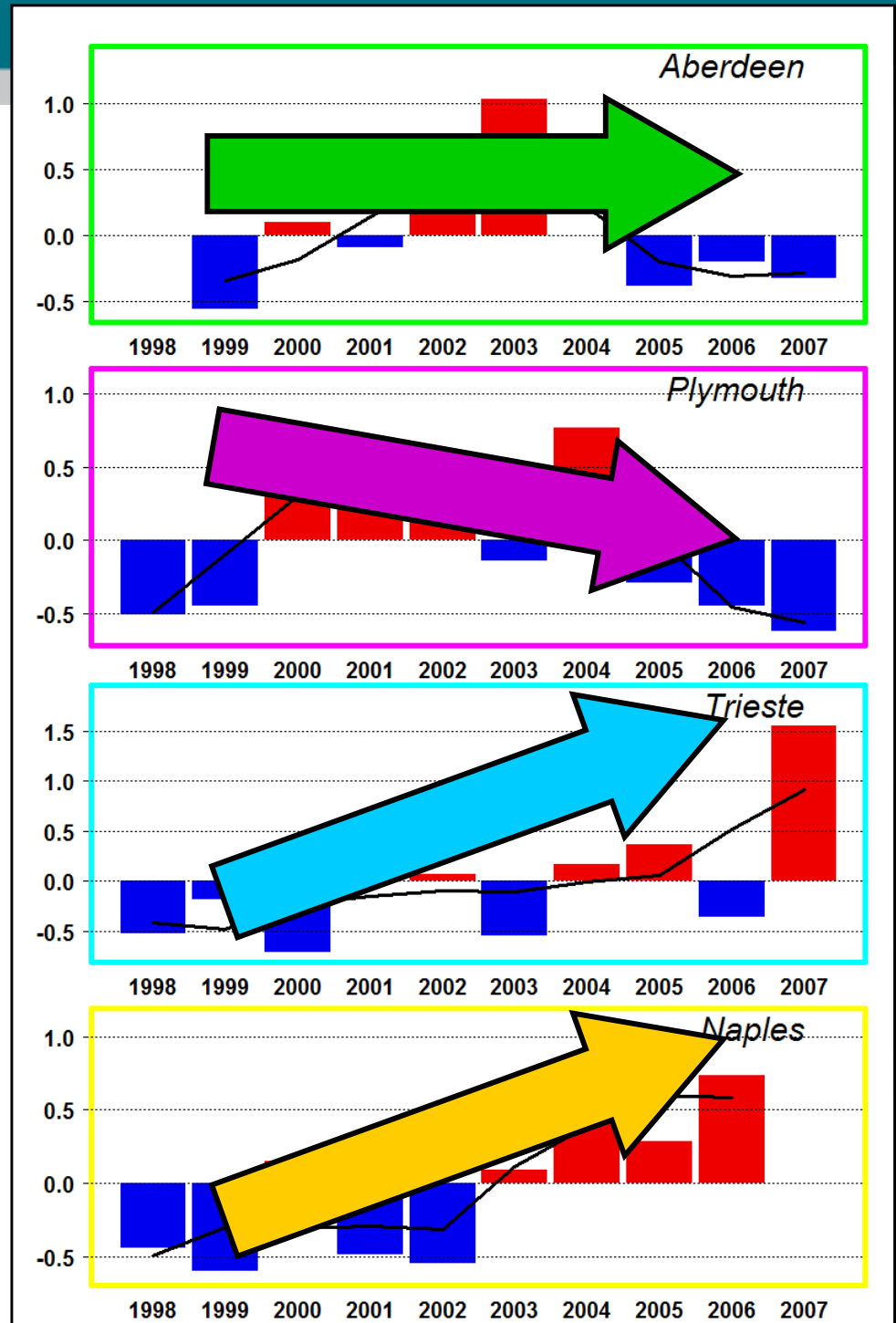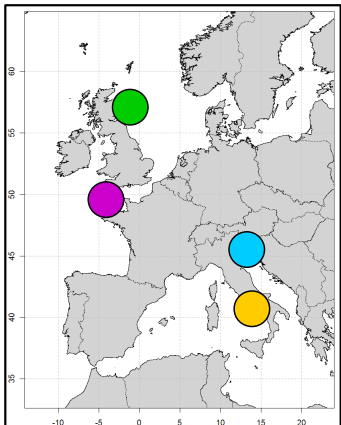
figure: annual anomaly of the total zooplankton abundances based on monthly anomalies averages – 3-year moving average (black line)

K-dominance curves

- **Aberdeen**
- **Plymouth**
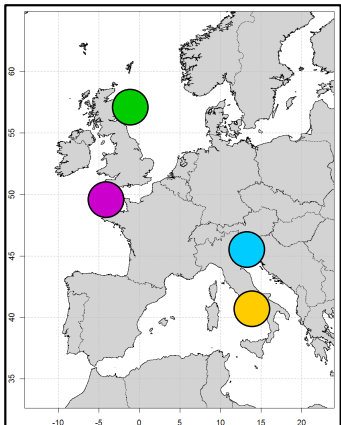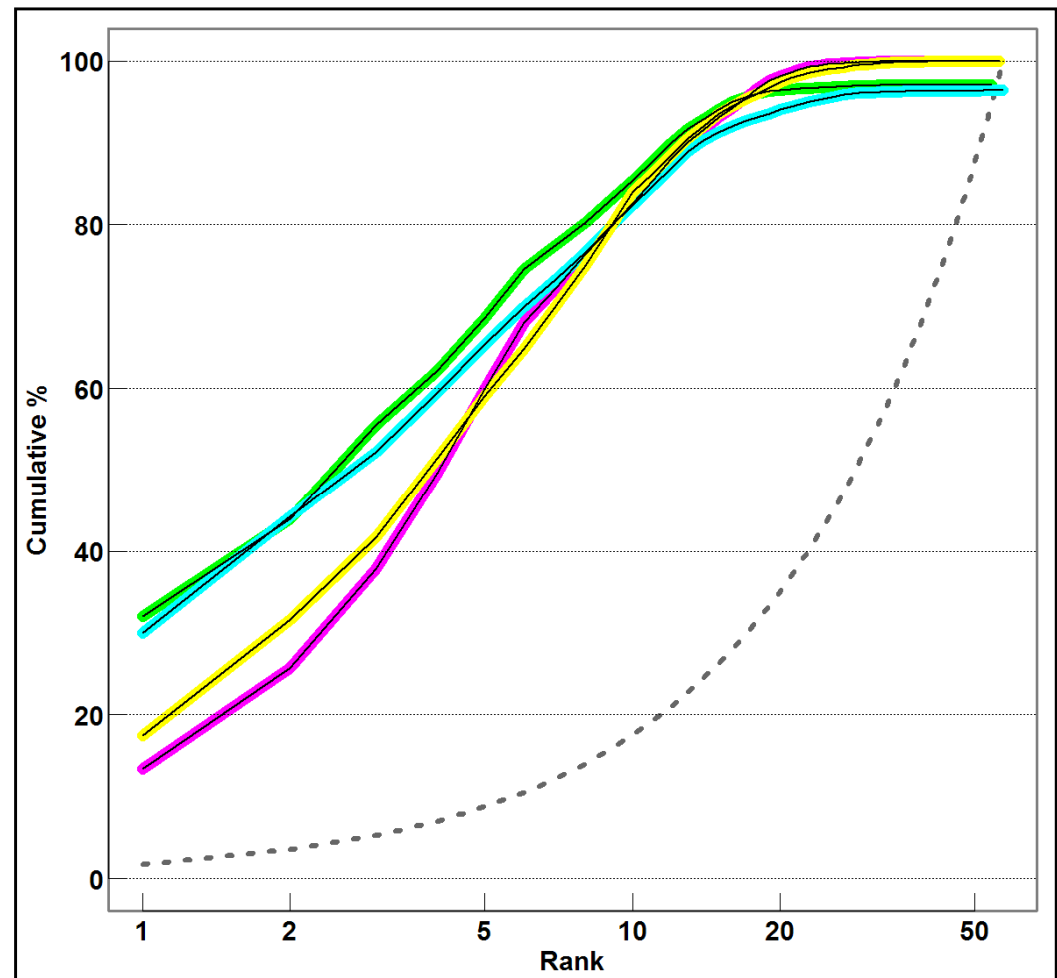- **Trieste**
- **Naples**

figure: k-dominance curves for the zooplankton community at the 4 stations

K-dominance curves

- 10 first ranks represent more than 80% of the total community

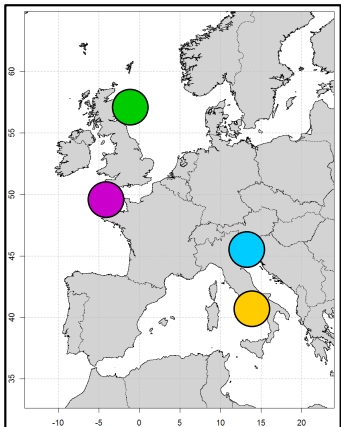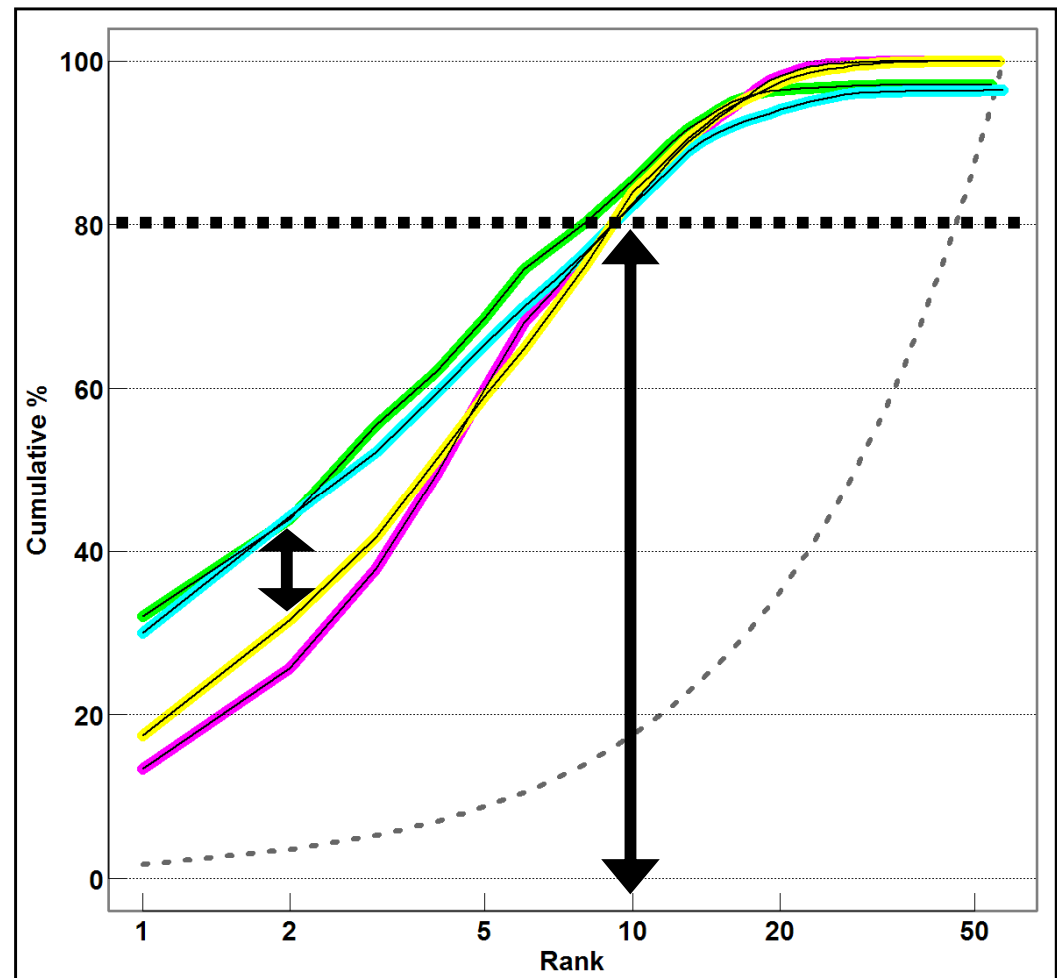- community dominated by only few species: Aberdeen & Trieste

figure: k-dominance curves for the zooplankton community at the 4 stations

Damien ELOIRE - dmelo@pml.ac.uk

Ranking

rank	Aberdeen	Plymouth	Trieste	Naples
1	Acartia spp.	Pseudocalanus spp.	Penilia avirostris	Penilia avirostris
2	Pseudocalanus spp.	Oithona spp.	Acartia spp.	Acartia spp.
3	Oithona spp.	Cirripedia	Paracalanus parvus	Appendicularia
4	Appendicularia	Oncaea spp.	Oithona spp.	Paracalanus parvus
5	Temora spp.	Paracalanus parvus	Oncaea spp.	Oithona spp.
6	Mollusca	Temora spp.	Echinodermata	Evadne spp.
7	Polychaeta	Evadne spp.	Appendicularia	Centropagidae
8	Paracalanus parvus	Acartia spp.	Mollusca	Clausocalanus spp.
9	Calanidae	Mollusca	Evadne spp.	Temora spp.
10	Cirripedia	Echinodermata	Siphonophorae	Decapoda

18 different categories

table: *ranking of the dominant zooplankton species and groups at the 4 stations*

Damien ELOIRE - dmelo@pml.ac.uk

Dominant copepods

rank	**Aberdeen**	**Plymouth**	**Trieste**	**Naples**
1	Acartia spp.	Pseudocalanus spp.	Penilia avirostris	Penilia avirostris
2	Pseudocalanus spp.	Oithona spp.	Acartia spp.	Acartia spp.
3	Oithona spp.	Cirripedia	Paracalanus parvus	Appendicularia
4	Appendicularia	Oncaea spp.	Oithona spp.	Paracalanus parvus
5	Temora spp.	Paracalanus parvus	Oncaea spp.	Oithona spp.
6	Mollusca	Temora spp.	Echinodermata	Evadne spp.
7	Polychaeta	Evadne spp.	Appendicularia	Centropagidae
8	Paracalanus parvus	Acartia spp.	Mollusca	Clausocalanus spp.
9	Calanidae	Mollusca	Evadne spp.	Temora spp.
10	Cirripedia	Echinodermata	Siphonophorae	Decapoda

ranking: ~ **67%**   ~ **59%**   ~ **35%**   ~ **55%**

Total: ~ **72%**   ~ **70%**   ~ **50%**   ~ **64%**

table: *ranking of the dominant zooplankton species and groups at the 4 stations*

Damien ELOIRE - dmelo@pml.ac.uk

Species in common

rank	Aberdeen	Plymouth	Trieste	Naples
1	**Acartia spp.**	Pseudocalanus spp.	Penilia avirostris	Penilia avirostris
2	Pseudocalanus spp.	**Oithona spp.**	**Acartia spp.**	**Acartia spp.**
3	**Oithona spp.**	Cirripedia	**Paracalanus parvus**	Appendicularia
4	Appendicularia	Oncaea spp.	**Oithona spp.**	**Paracalanus parvus**
5	Temora spp.	**Paracalanus parvus**	Oncaea spp.	**Oithona spp.**
6	Mollusca	Temora spp.	Echinodermata	Evadne spp.
7	Polychaeta	Evadne spp.	Appendicularia	Centropagidae
8	**Paracalanus parvus**	**Acartia spp.**	Mollusca	Clausocalanus spp.
9	Calanidae	Mollusca	Evadne spp.	Temora spp.
10	Cirripedia	Echinodermata	Siphonophorae	Decapoda

table: ranking of the dominant zooplankton species and groups at the 4 stations

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Species in common

rank	Aberdeen	Plymouth	Trieste	Naples
1	Acartia spp.	Pseudocalanus spp.	Penilia avirostris	Penilia avirostris
2	Pseudocalanus spp.	Oithona spp.	Acartia spp.	Acartia spp.
3	Oithona spp.	Cirripedia	Paracalanus parvus	**Appendicularia**
4	**Appendicularia**	Oncaea spp.	Oithona spp.	Paracalanus parvus
5	**Temora spp.**	Paracalanus parvus	Oncaea spp.	Oithona spp.
6	**Mollusca**	**Temora spp.**	Echinodermata	**Evadne spp.**
7	Polychaeta	**Evadne spp.**	**Appendicularia**	Centropagidae
8	Paracalanus parvus	Acartia spp.	**Mollusca**	Clausocalanus spp.
9	Calanidae	**Mollusca**	**Evadne spp.**	**Temora spp.**
10	Cirripedia	Echinodermata	Siphonophorae	Decapoda

table: *ranking of the dominant zooplankton species and groups at the 4 stations*

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Interannual variations

- **Aberdeen**
- **Plymouth**
- **Trieste**
- **Naples**

Acartia spp.
Pseudocalanus spp.
Oithona spp.
Appendicularia
Temora spp.
Mollusca
Polychaeta
Paracalanus parvus
Calanidae
Cirripedia
Oncaea spp.
Evadne spp.
Echinodermata
Penilia avirostris
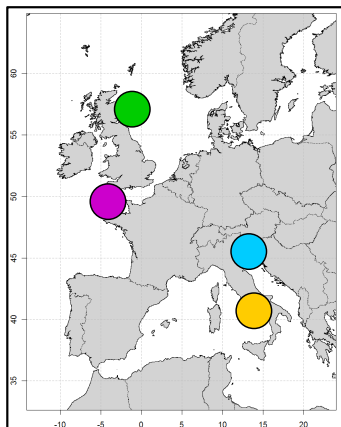Siphonophorae
Centropagidae
Clausocalanus spp.
Decapoda
Copepodite unid.
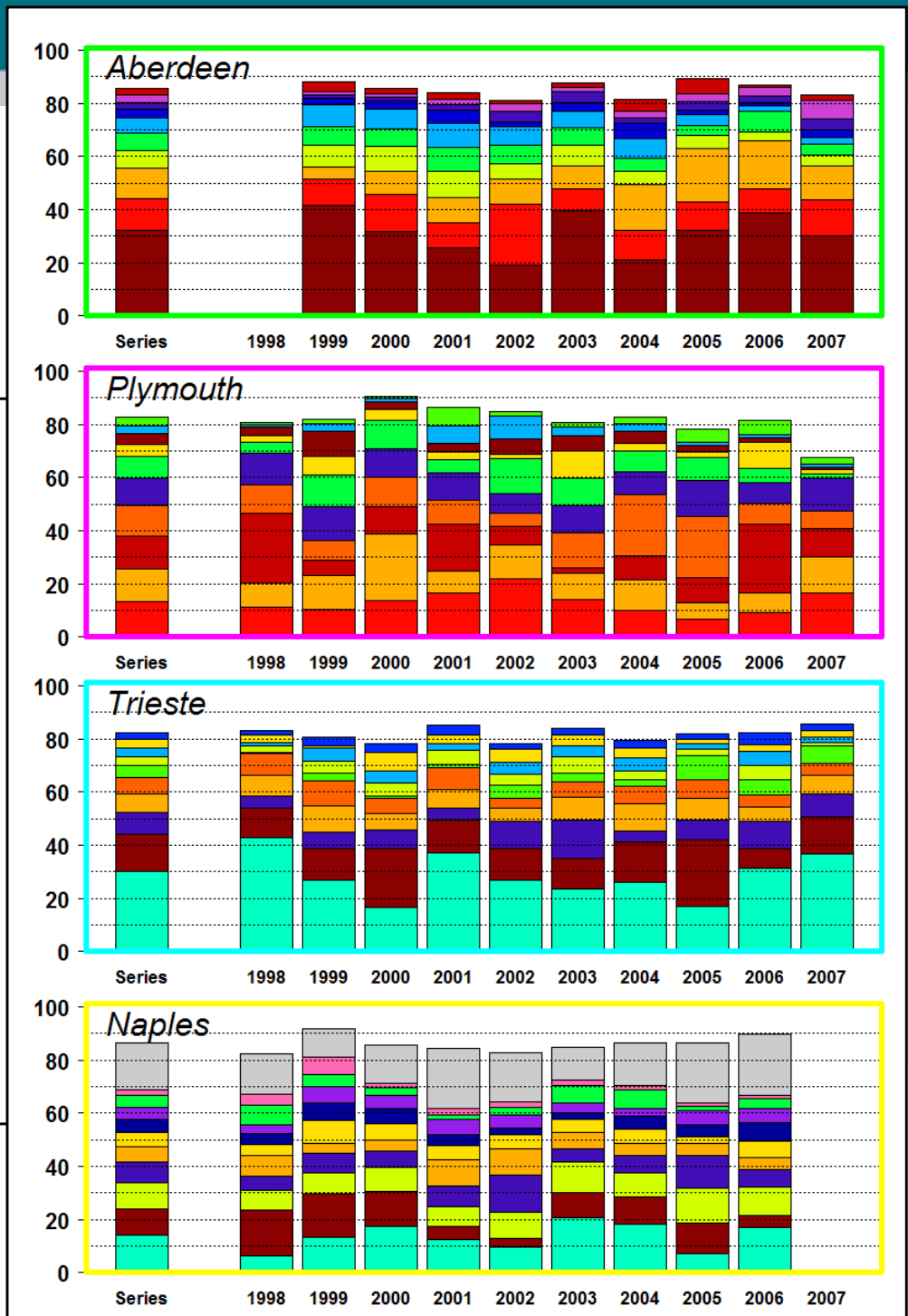
figure: *interannual variations of the contribution of the dominant species and groups to the zooplankton community at the 4 stations*

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Interannual variations

- dominant species and groups represent a continuous contribution to the total community

- specific contributions of species and groups to the total community are variable whereas their cumulative contribution remains stable
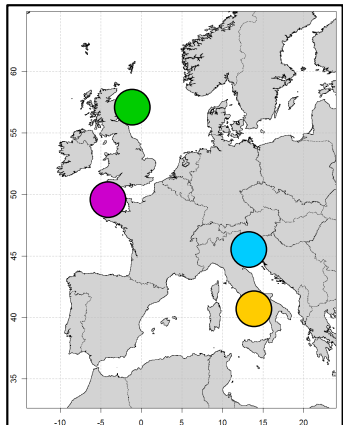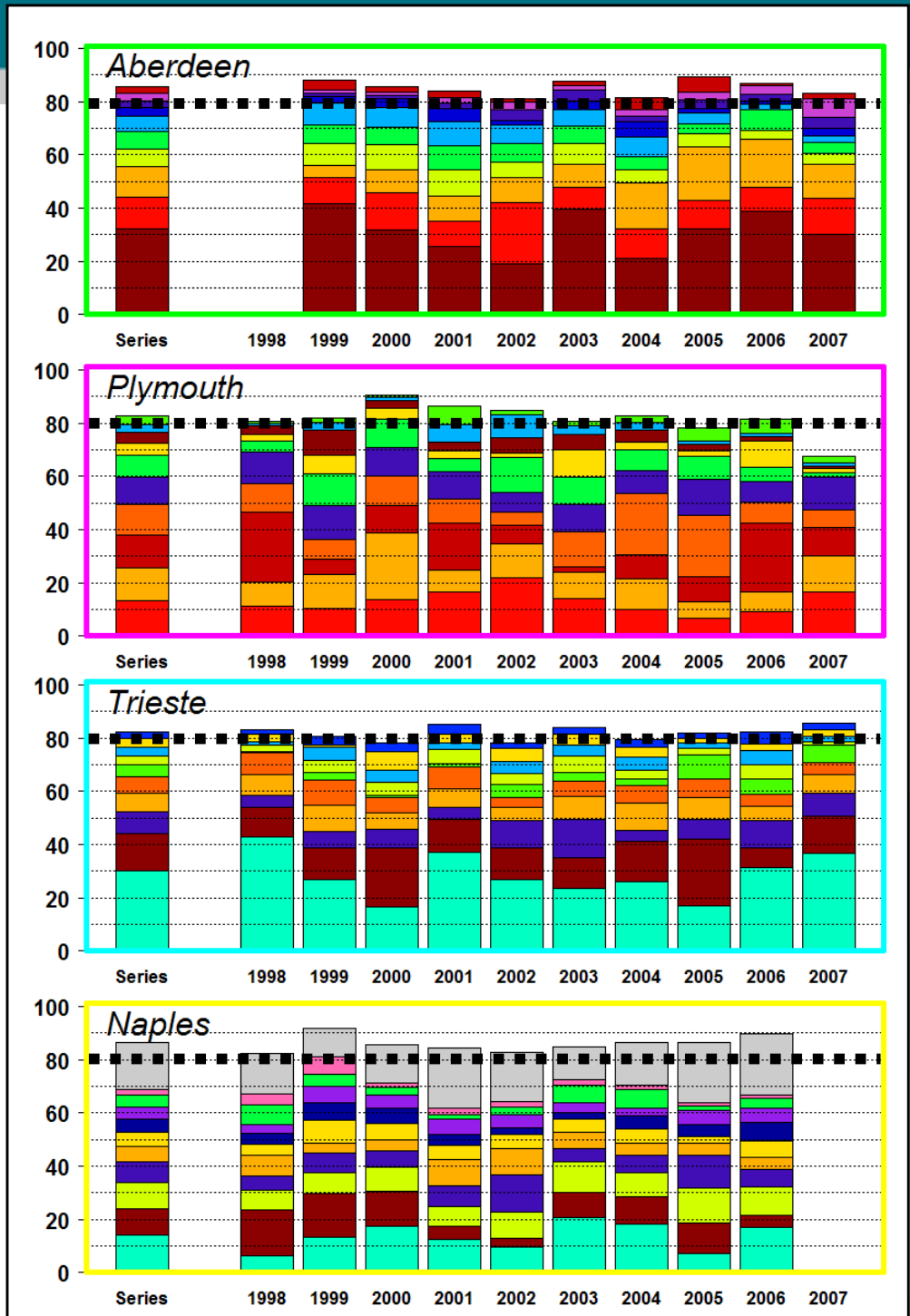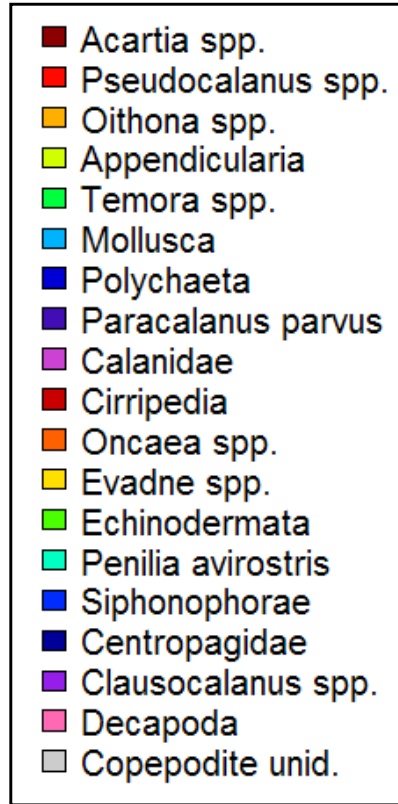
figure: _interannual variations of the contribution of the dominant species and groups to the zooplankton community at the 4 stations_

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Seasonal variations

- **Aberdeen**
- **Plymouth**
- **Trieste**
- **Naples**

Legend:
- Acartia spp.
- Pseudocalanus spp.
- Oithona spp.
- Appendicularia
- Temora spp.
- Mollusca
- Polychaeta
- Paracalanus parvus
- Calanidae
- Cirripedia
- Oncaea spp.
- Evadne spp.
- Echinodermata
- Penilia avirostris
- Siphonophorae
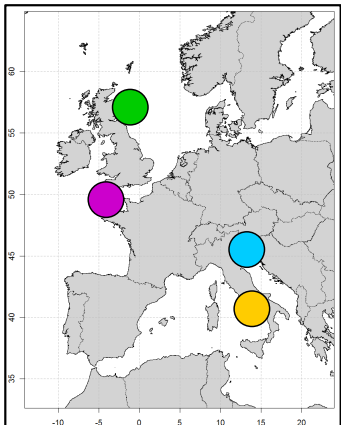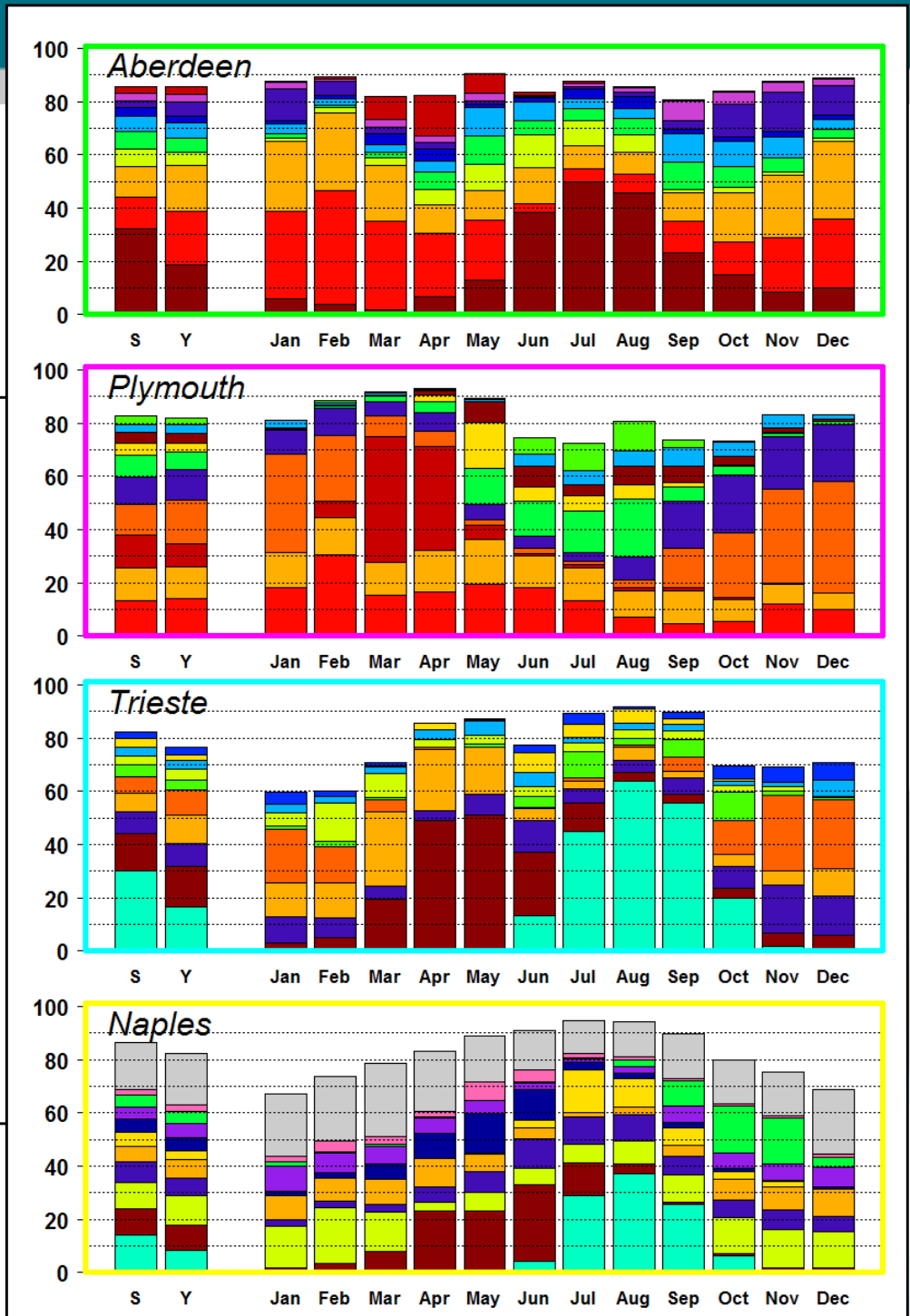- Centropagidae
- Clausocalanus spp.
- Decapoda
- Copepodite unid.

figure: *seasonal variations of the contribution of the dominant species and groups to the zooplankton community at the 4 stations*

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Seasonal variations

- specific contributions of dominant species and groups are highly variable due to the seasonal succession of the species and groups

- their cumulative contribution to the total community also vary along the year especially for Trieste & Naples
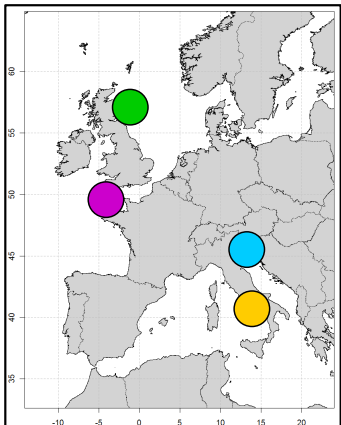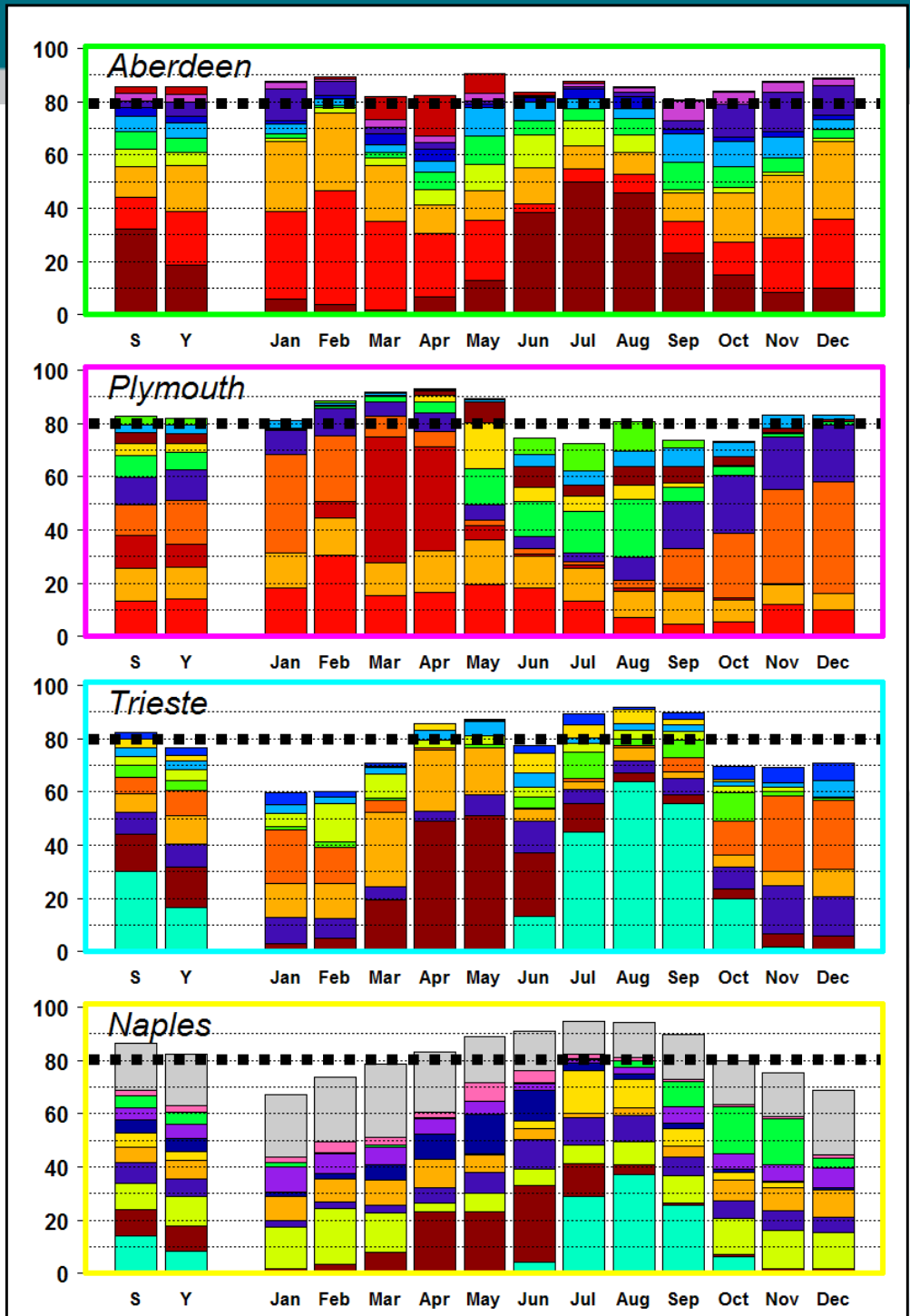

figure: *seasonal variations of the contribution of the dominant species and groups to the zooplankton community at the 4 stations*

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Trends

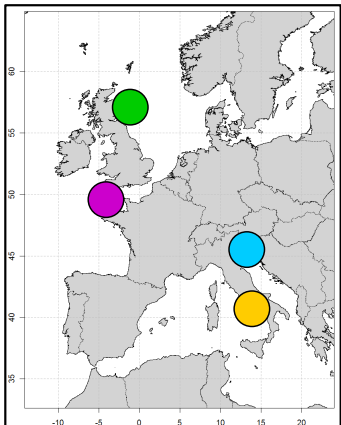| %	Aberdeen		Plymouth		Trieste		Naples	
> 15%	Acartia spp.	→	Pseudocalanus spp.	↓	Penilia avirostris	↑	Penilia avirostris	↑
> 25%	Pseudocalanus spp.	↓	Oithona spp.	↓	Acartia spp.	↑	Acartia spp.	↓
> 40%	Oithona spp.	↑	Cirripedia	↓	Paracalanus parvus	↑	Appendicularia	↑
> 50%	Appendicularia	↓	Oncaea spp.	↑	Oithona spp.	↑	Paracalanus parvus	↑
> 60%	Temora spp.	↓	Paracalanus parvus	↓	Oncaea spp.	↑	Oithona spp.	→
	Mollusca	↓	Temora spp.	↓	Echinodermata	↑	Evadne spp.	↑
	Polychaeta	↓	Evadne spp.	→	Appendicularia	↑	Centropagidae	↑
> 80%	Paracalanus parvus	↑	Acartia spp.	↓	Mollusca	↑	Clausocalanus spp.	↑
	Calanidae	↑	Mollusca	→	Evadne spp.	↑	Temora spp.	↑
	Cirripedia	↓	Echinodermata	↑	Siphonophorae	↑	Decapoda	↓
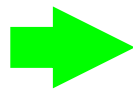
table: *ranking of the dominant zooplankton species and groups at the 4 stations*

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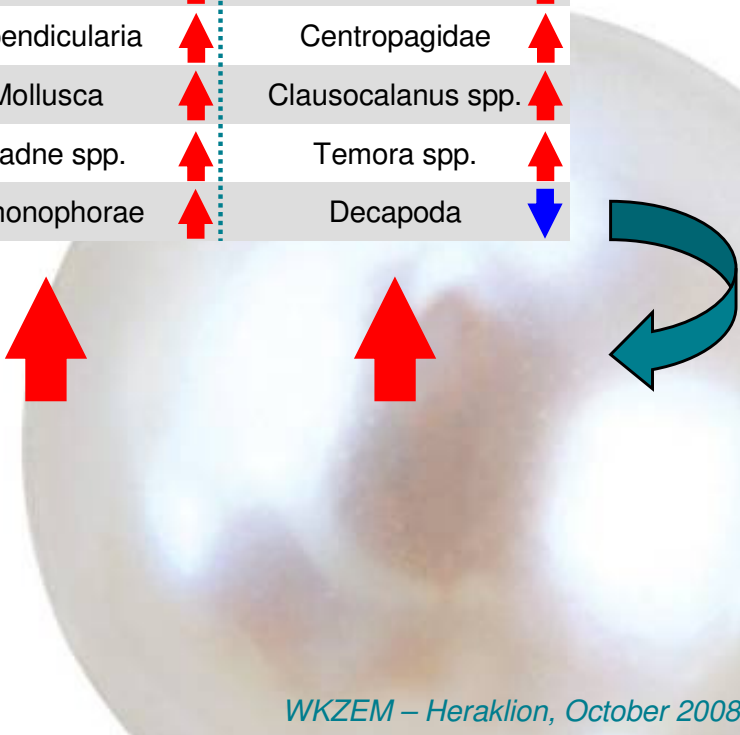
Summary

- the 4 stations show different patterns:
  - seasonality – related to the availability of resources
  - trend – northern communities abundances decrease whereas southern communities abundances increase
  - community composition – nature and structure

- the use of the dominant species and groups is a simple way to study the zooplankton community and its functioning…
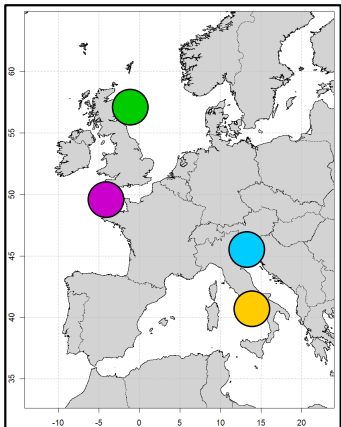
… but can be limited if a species is **very** dominant during a short period of the year
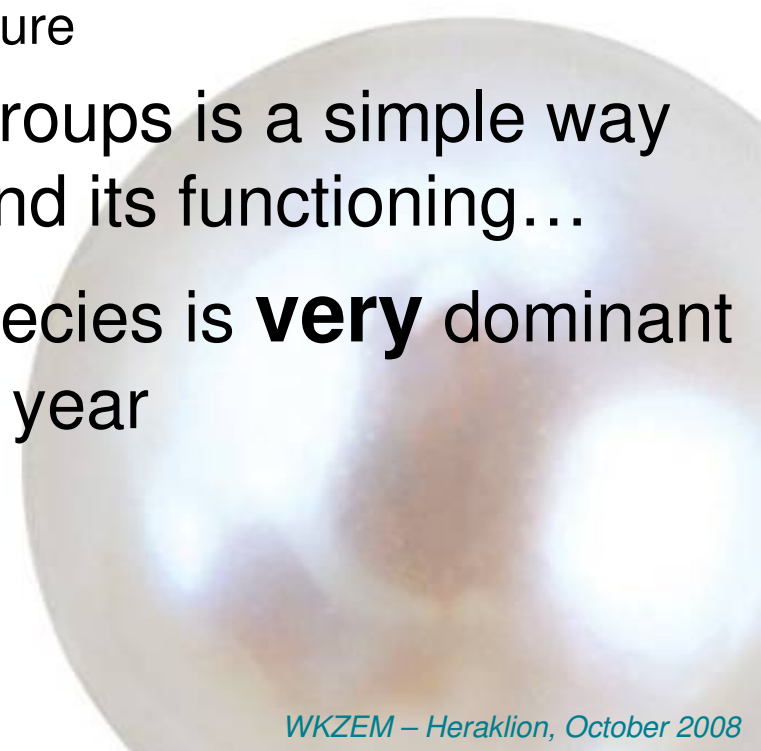
In progress

- link with the environment & climate
- focus on common species – need to select "key" species
- phenology – need to improve the analysis
- diversity – realistic?

Damien ELOIRE - dmelo@pml.ac.uk