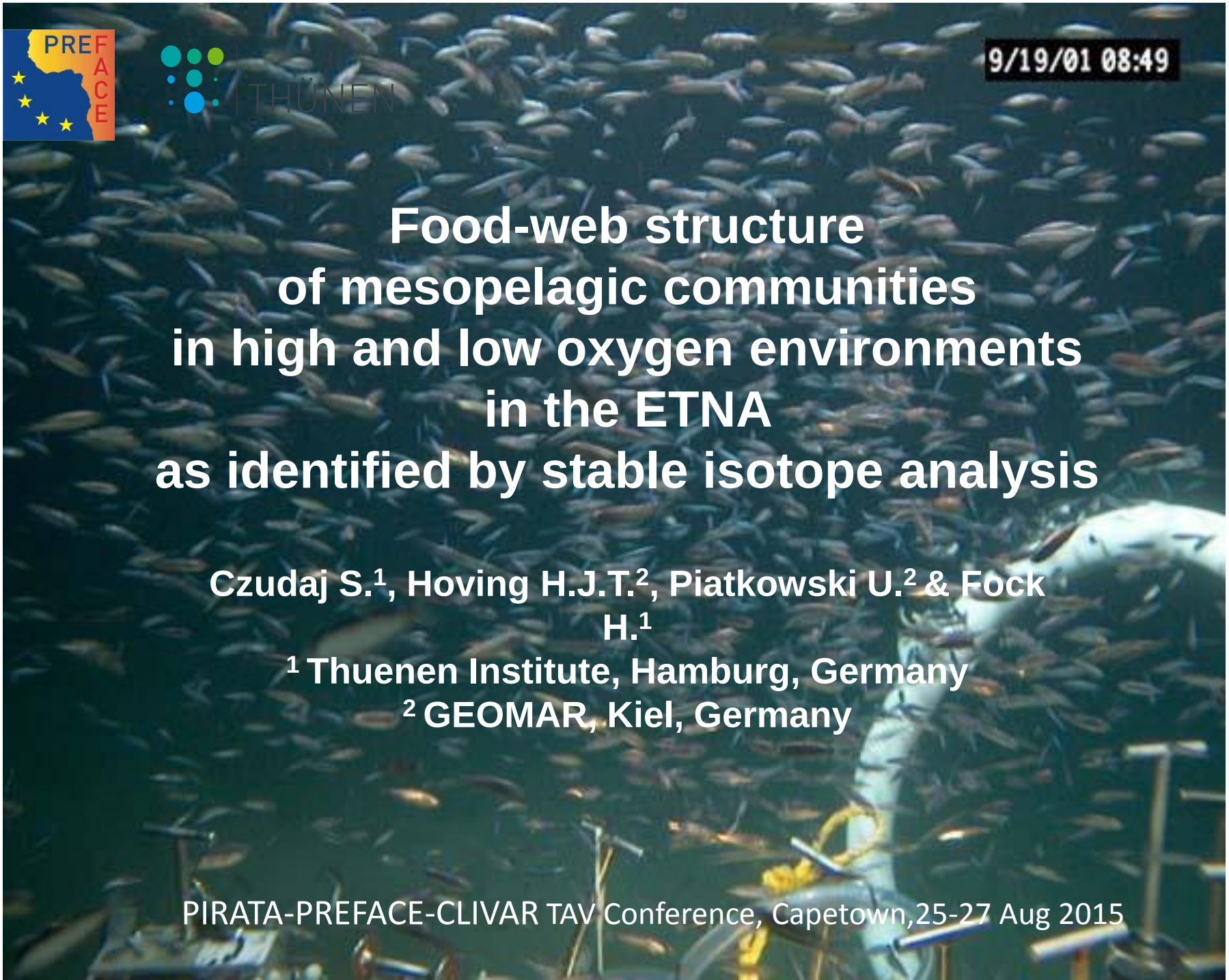


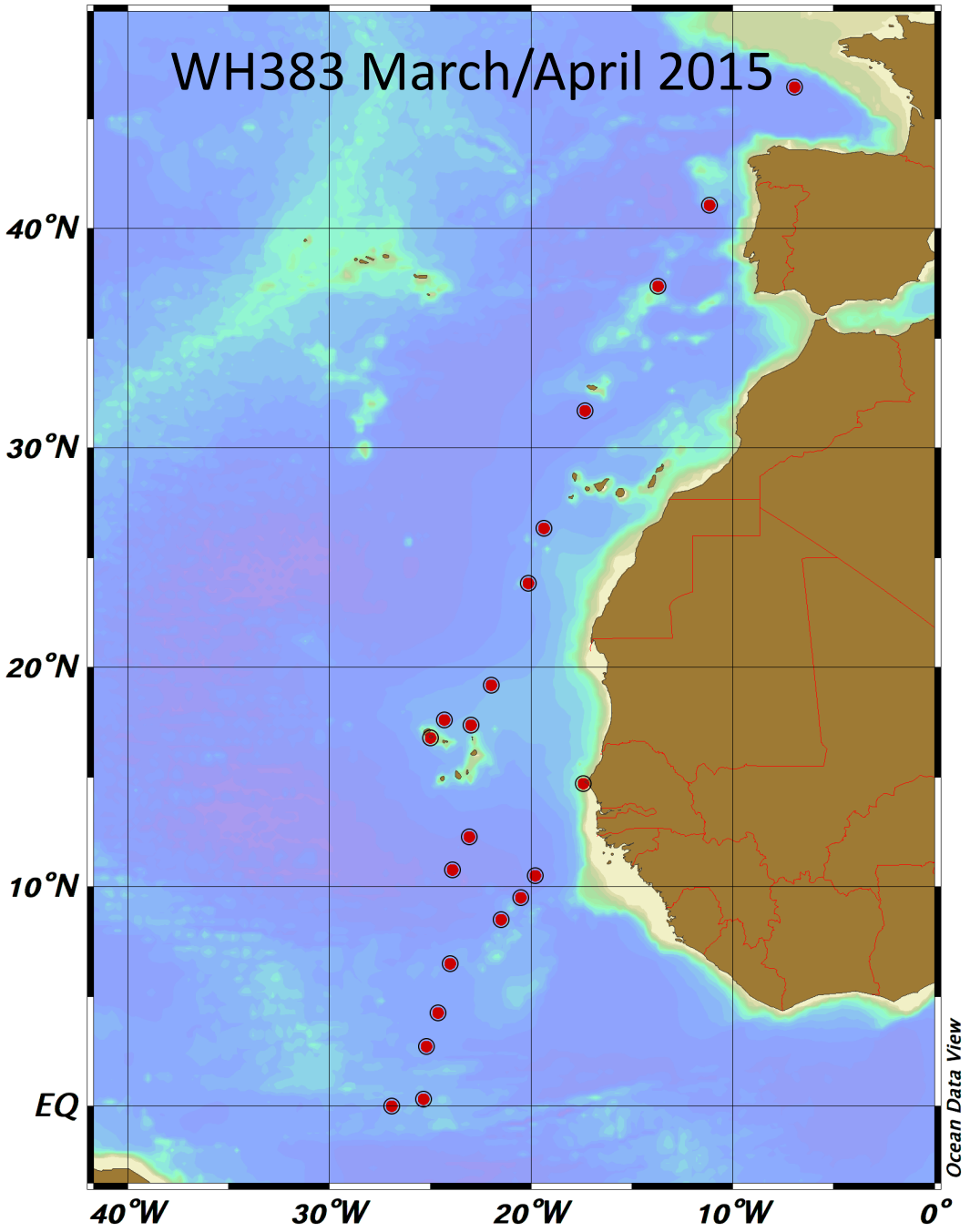
Food-web structure of mesopelagic communities in high and low oxygen environments in the ETNA as identified by stable isotope analysis

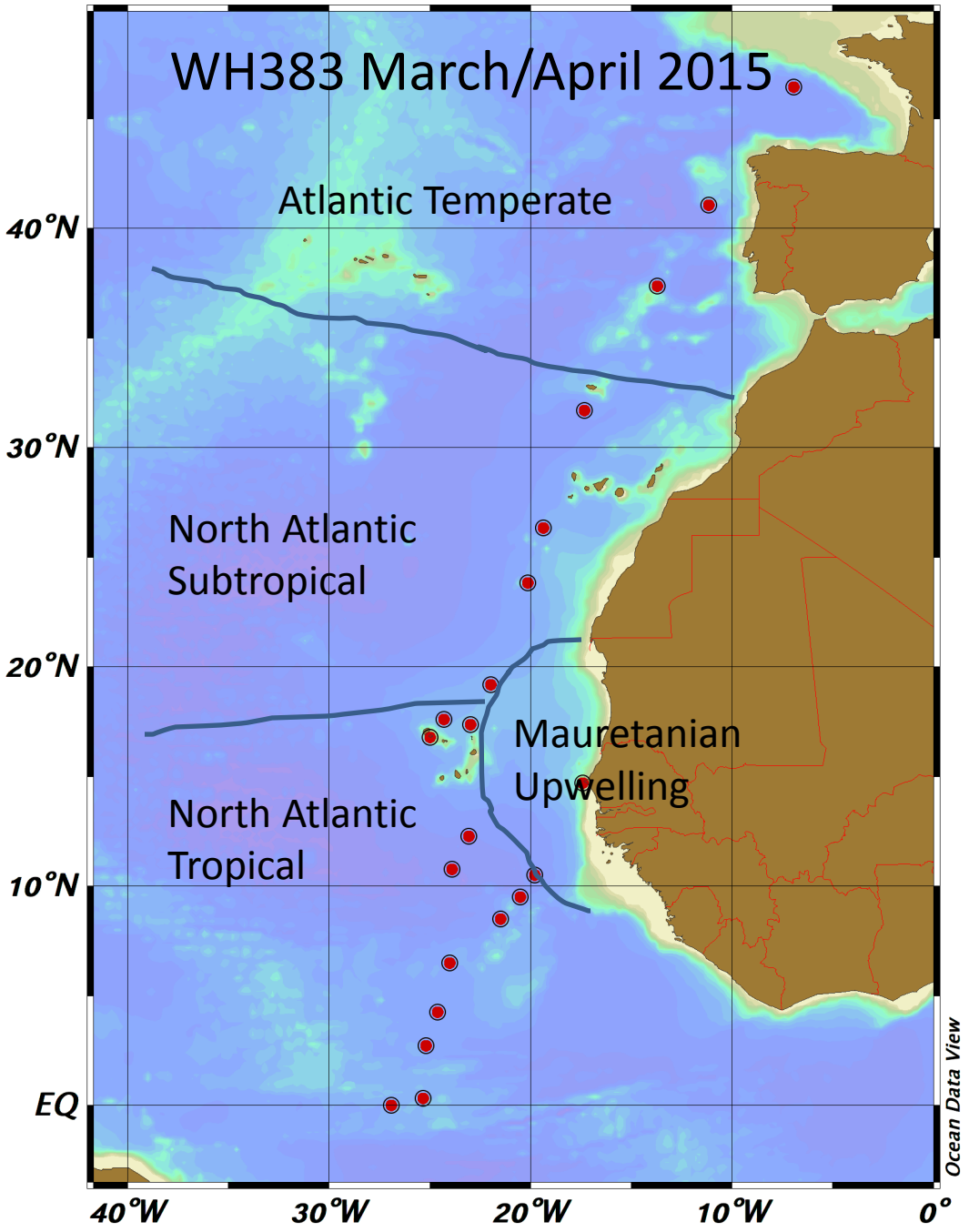
Czudaj S.[1], Hoving H.J.T.[2], Piatkowski U.[2] & Fock H.[1]

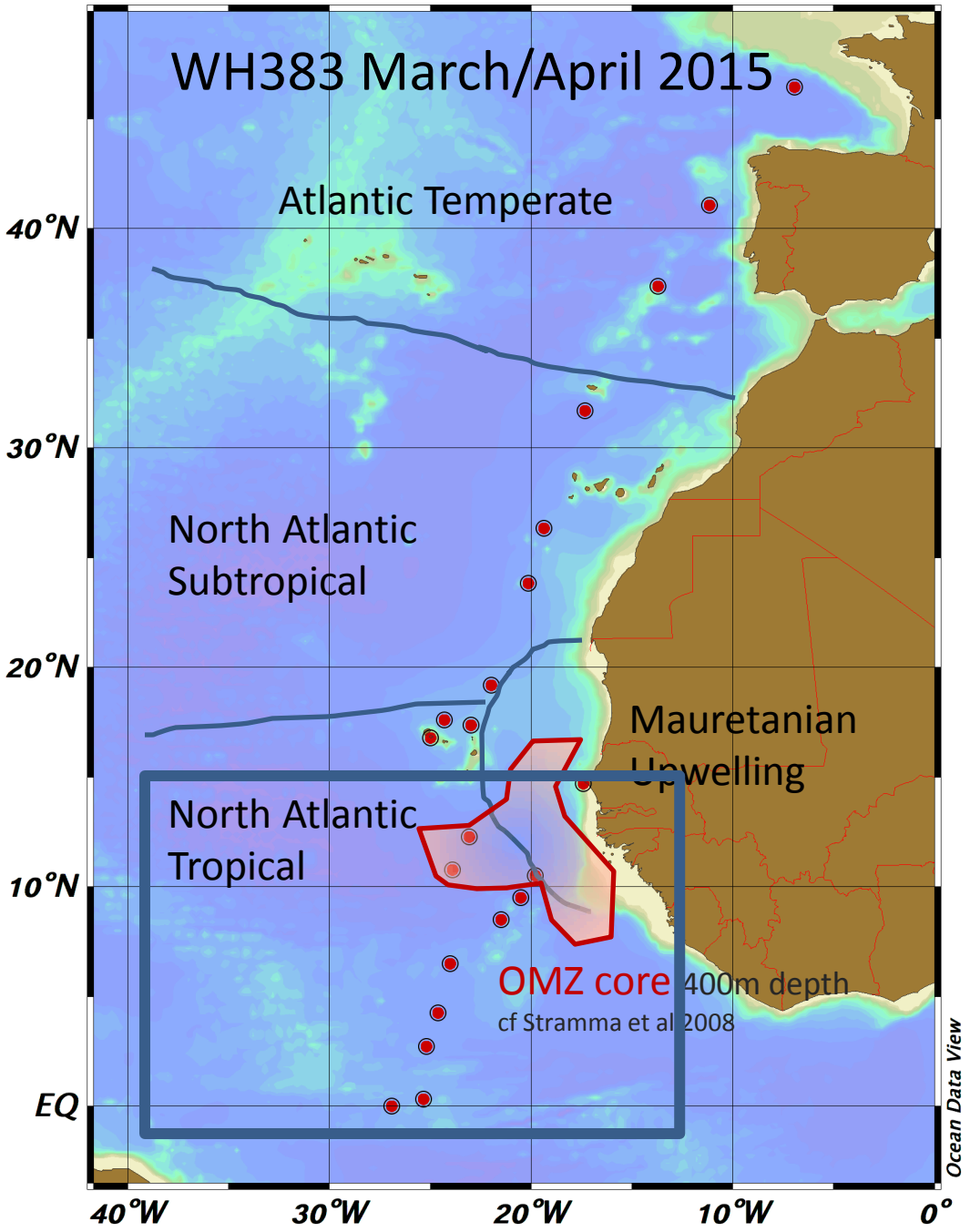
[1] Thuenen Institute, Hamburg, Germany

[2] GEOMAR, Kiel, Germany

PIRATA-PREFACE-CLIVAR TAV Conference, Capetown,25-27 Aug 2015

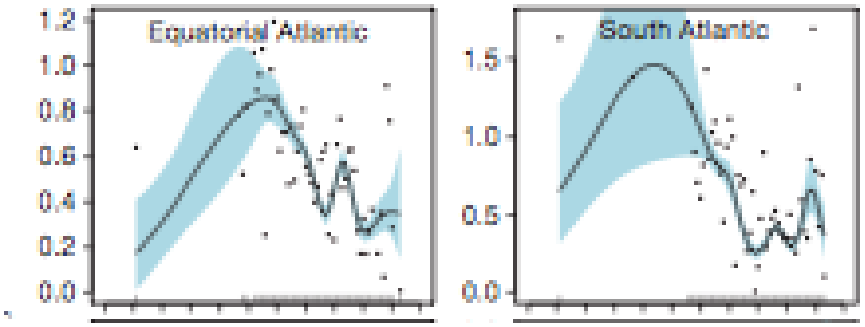

WH383 March/April 2015
40°N
30°N
20°N
10°N
EQ
40°W
30°W
20°W
10°W
0°
Ocean Data View


WH383 March/April 2015
Atlantic Temperate
North Atlantic
Subtropical
Mauretanian
Upwelling
North Atlantic
Tropical
40°N
30°N
20°N
10°N
EQ
40°W
30°W
20°W
10°W
0°
Ocean Data View


WH383 March/April 2015
Atlantic Temperate
North Atlantic Subtropical
Mauretanian Upwelling
North Atlantic Tropical
OMZ core 400m depth
cf Stramma et al 2008
40°N
30°N
20°N
10°N
EQ
40°W
30°W
20°W
10°W
0°
Ocean Data View

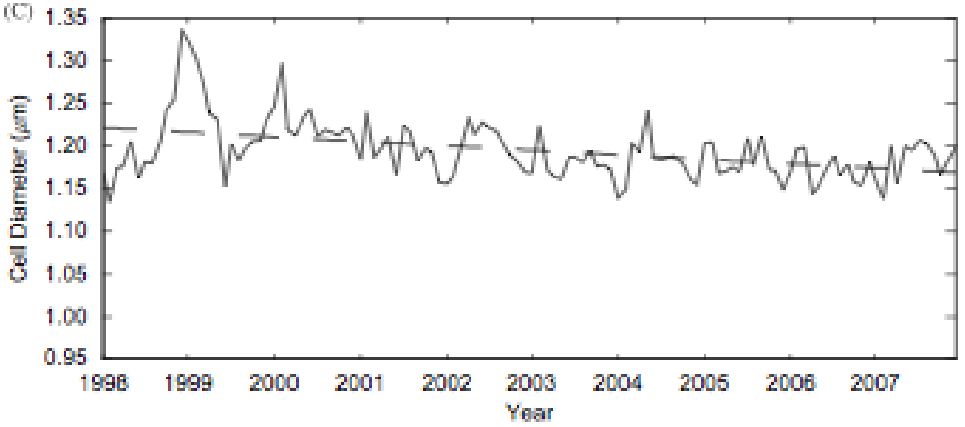
Biological TAV – decreasing trends

phytoplankton Chl conc



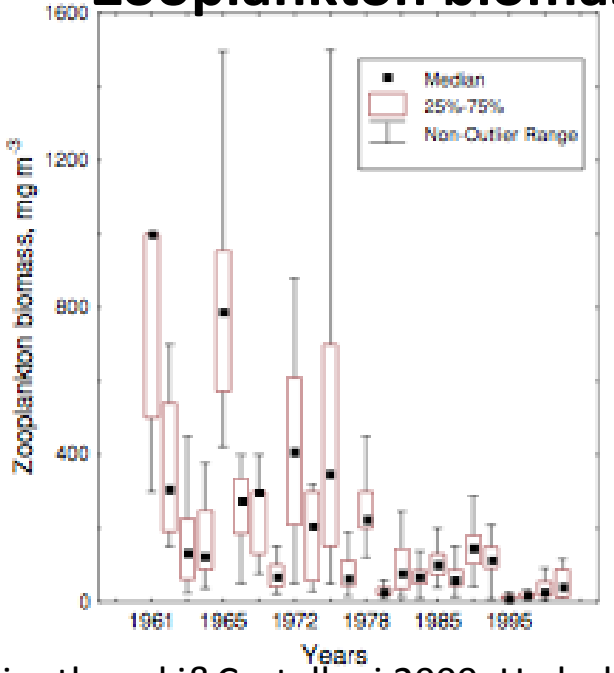
Boyce et al 2010, Nature

phytoplankton cell size



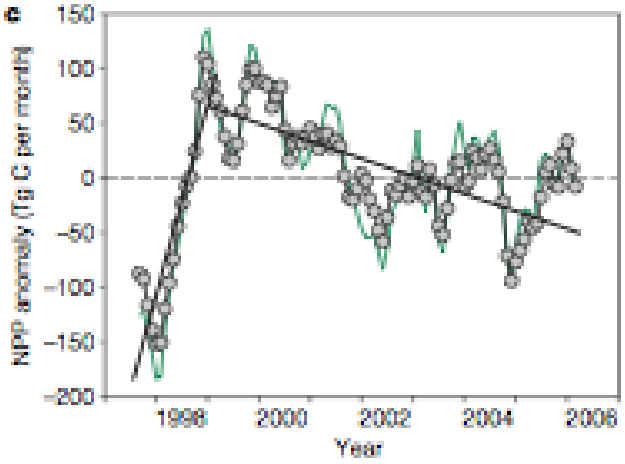
Polovina & Woodworth 2012, Deep-Sea Research II

Zooplankton biomass



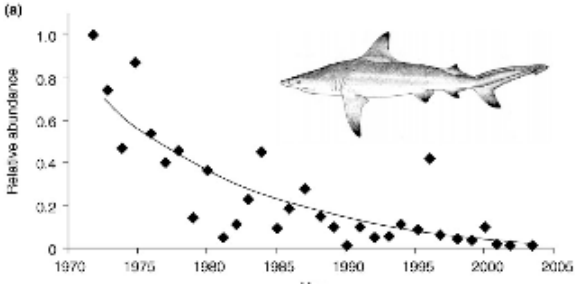
Piontkowski&Castellani 2009, Hydrobiologia

PP



Behrenfeld et al 2006, Nature

Top Predators



Heithaus et al 2008, Trends in Ecol and Evol

Biological TAV – increasing trends

- increasing abundance of gelatinous zoolpankton (Richardson 2009)
- increasing abundance of cephalopods (e.g. Piontkowski et al 2003)

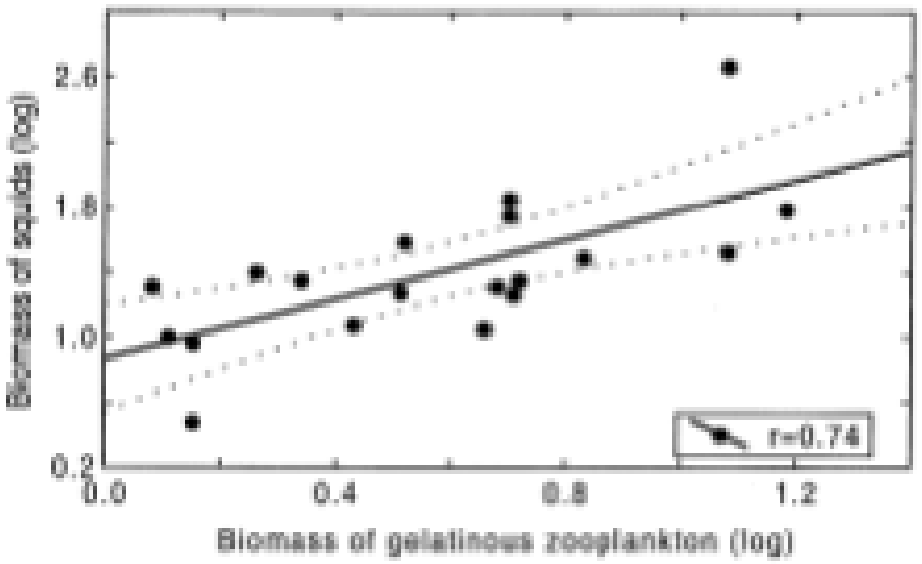


Fig. 6. Relationship between biomass of squid observed in the upper layer and biomass of the gelatinous zooplankton.

Piontkowski et al 2003, J. Plankton Res.

Midwater communities?

Biological TAV – increasing trends

- increasing abundance of gelatinous zoolpankton (Richardson 2009)
- increasing abundance of cephalopods (e.g.

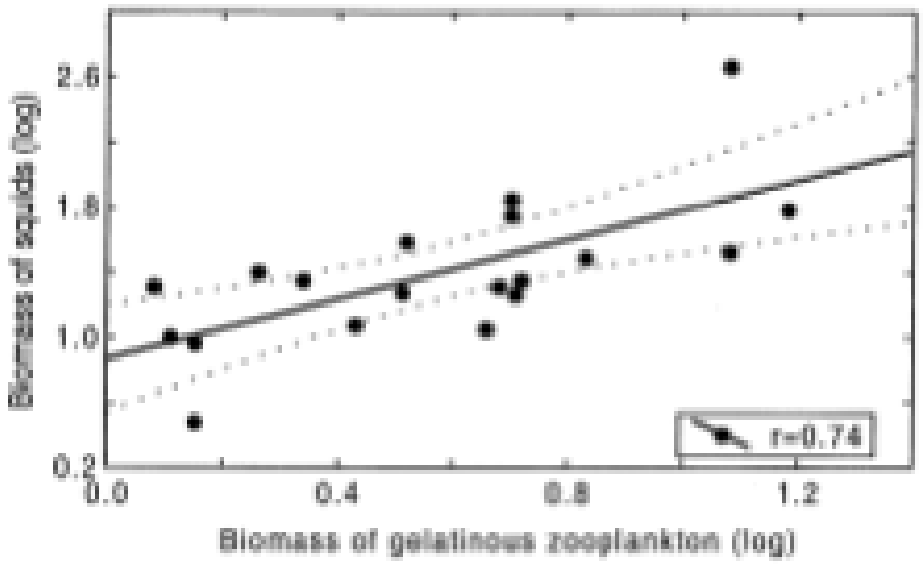


Fig. 6. Relationship between biomass of squid observed in the upper layer and biomass of the gelatinous zooplankton.

Large mesopelagic fishes biomass and trophic efficiency in the open ocean

Xabier Irigoien[1], T.A. Klevjer[1], A. Røstad[1], U. Martinez[2], G. Boyra[2], J.L. Acuña[3], A. Bode[4], F. Echevarria[5], J.I. Gonzalez-Gordillo[5], S. Hernandez-Leon[6], S. Agusti[7,8], D.L. Aksnes[9], C.M. Duarte[7,8] & S. Kaartvedt[1]

Nature 2014

- Food-web

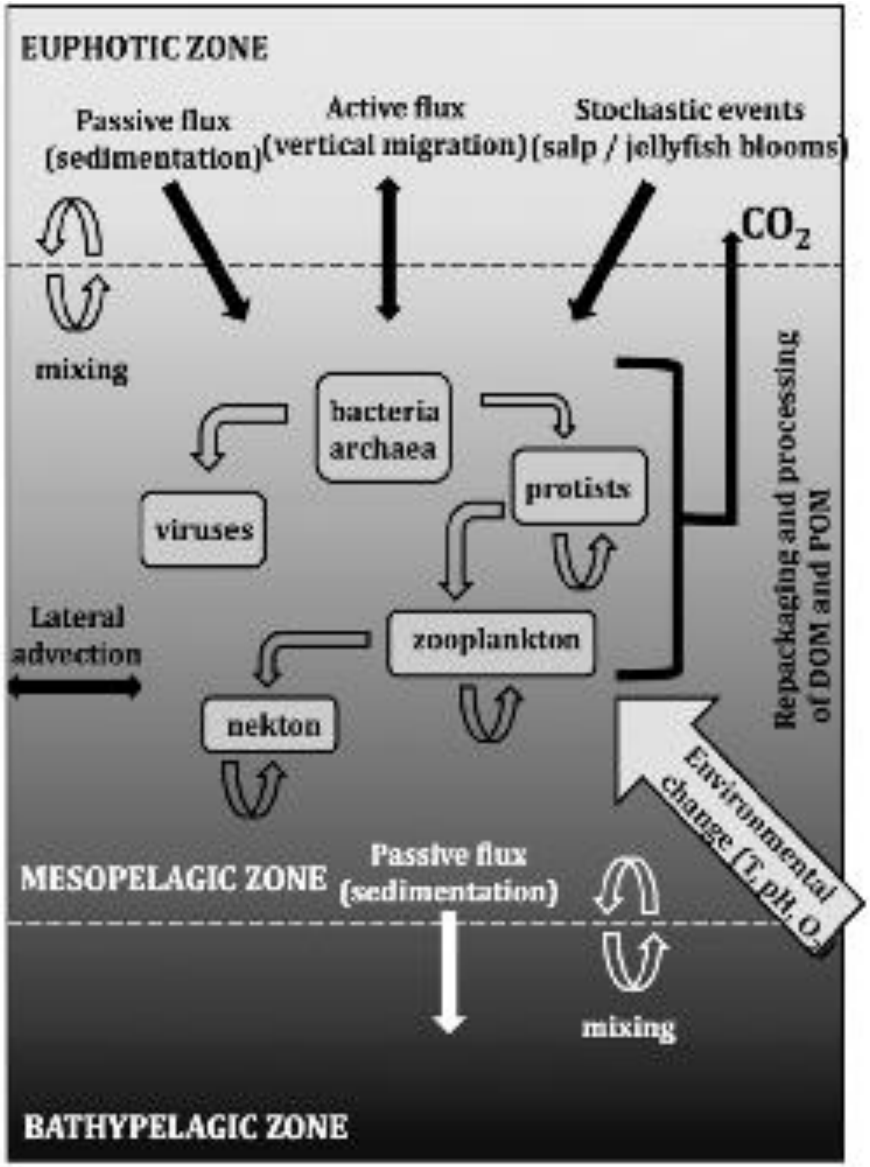
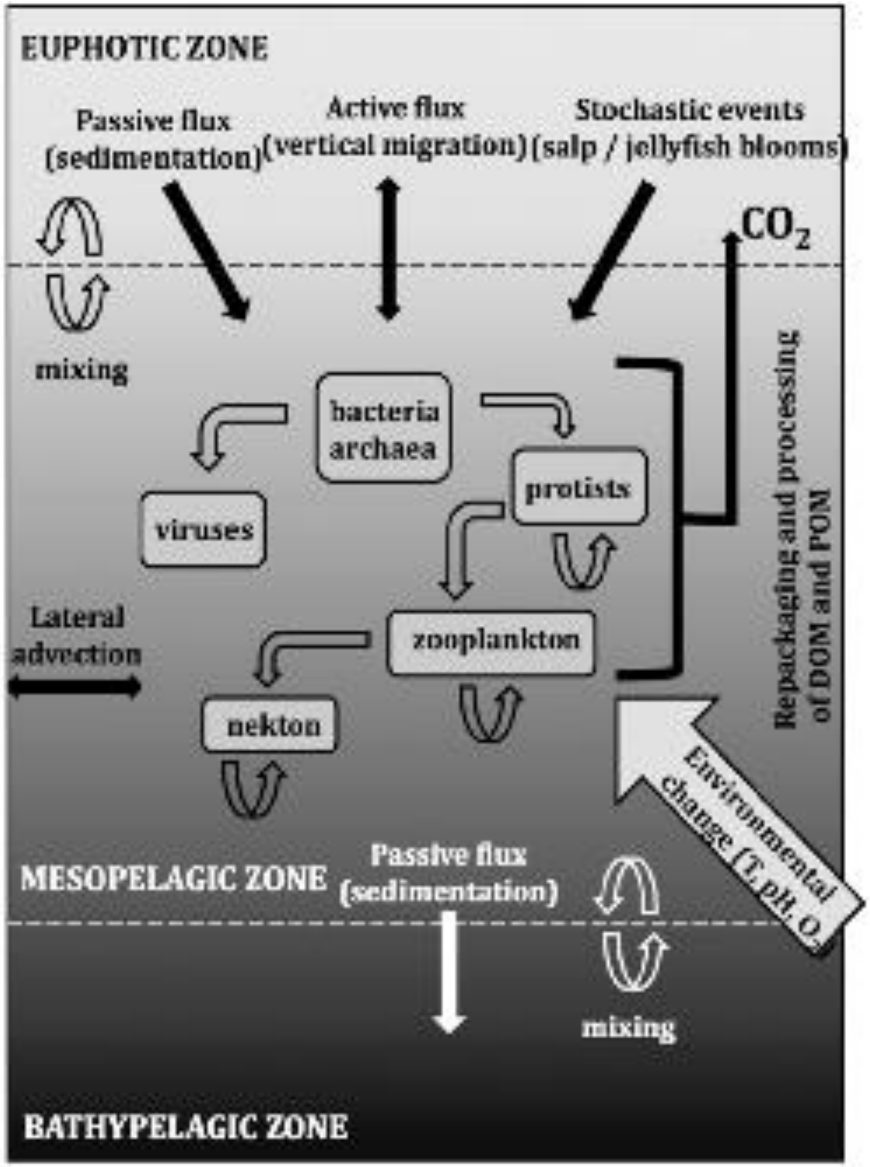


Fig. 1. Microbial and metazoan functional groups and interactions in the mesopelagic zone. Adapted from Koppelmann and Frost (2008) and Arístegui et al. (2009).

Robinson et al 2010, Deep-Sea Research II

- Food-web

External forcing
- anthopogenic
- environmental



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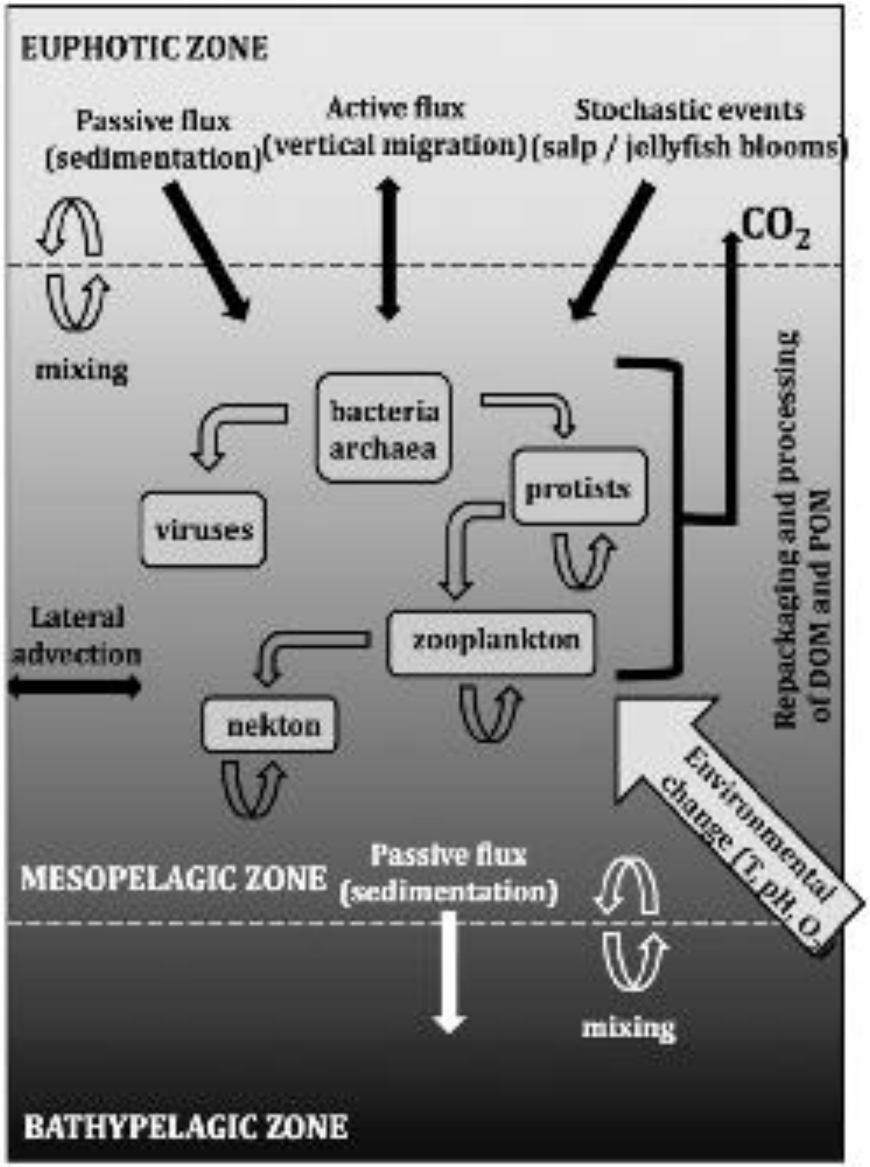
Robinson et al 2010, Deep-Sea Research II

- Food-web

External forcing
- anthopogenic
- environmental

Internal forcing
- competition
- predation
- interaction
- energy transfer



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Robinson et al 2010, Deep-Sea Research II

Food web structure: stability hypothesis

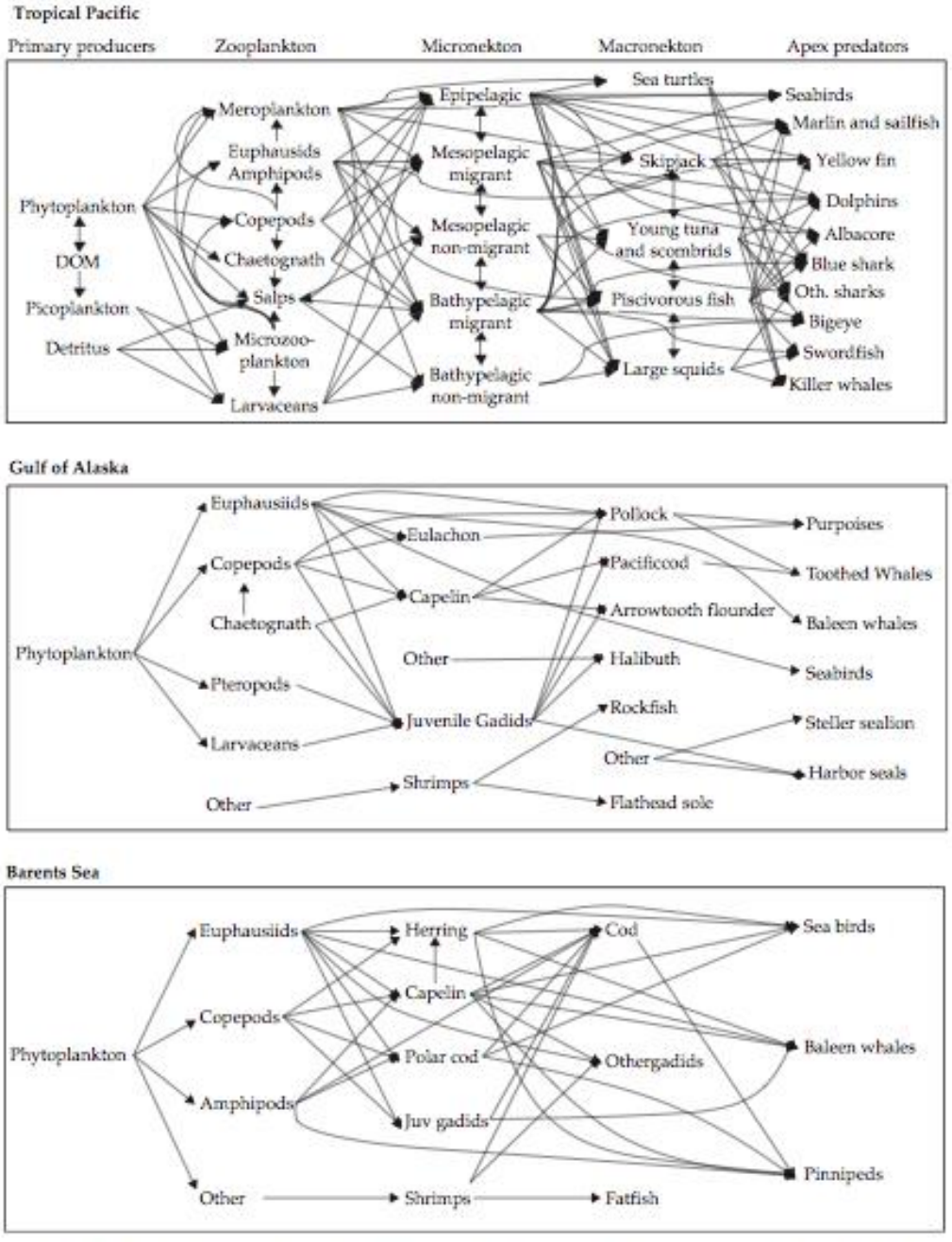
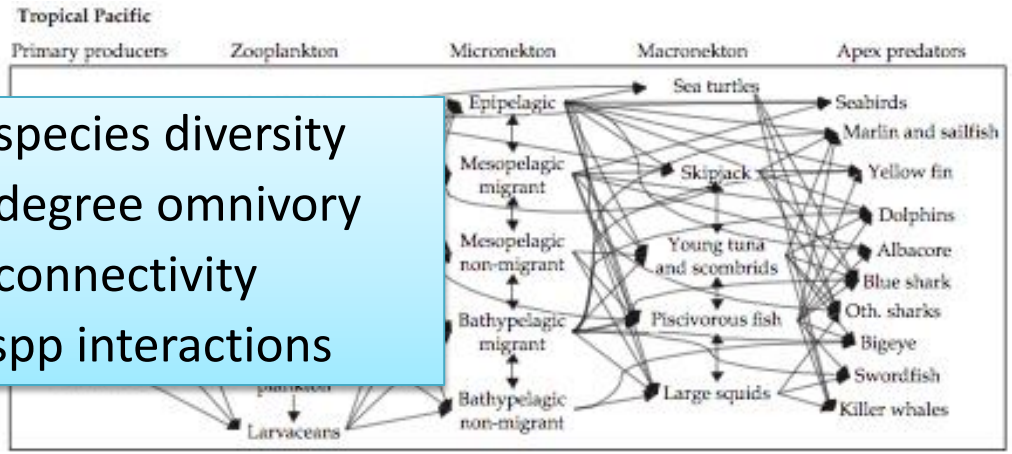


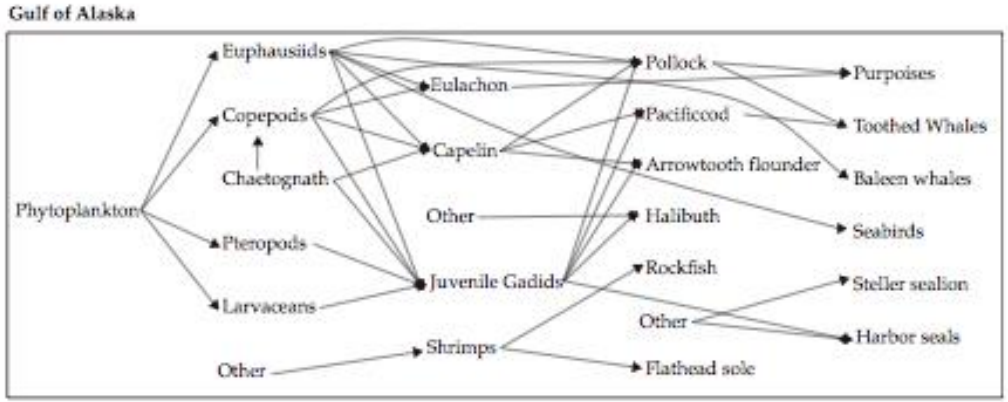
Figure 12.4 Simplified representation of the food web for each studied system. Arrows point from the prey to the predator DOM: Dissolved Organic Matter

Cianelli et al 2005

Food web st
stability hyp

+++ species diversity
+++ degree omnivory
+++ connectivity
+ spp interactions





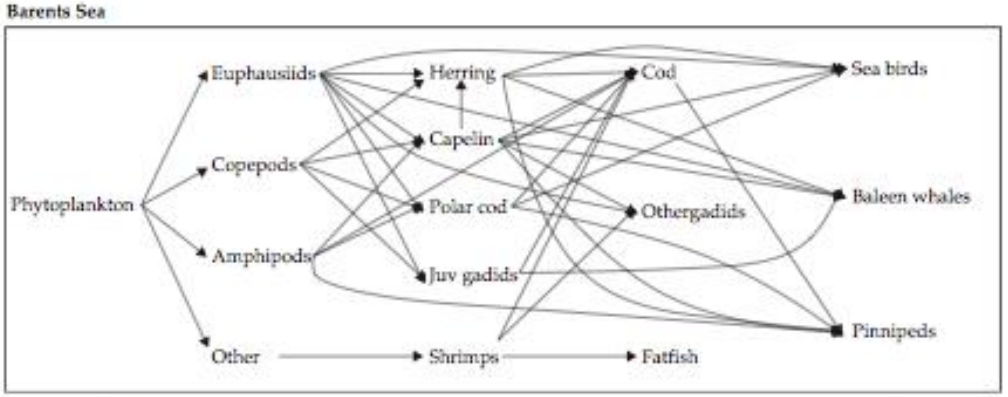


Figure 12.4 Simplified representation of the food web for each studied system. Arrows point from the prey to the predator DOM: Dissolved Organic Matter

Cianelli et al 2005

Keystone species / nodal trophic links

Tropical Pacific - Nodal trophic link

Small-size scombrids — epipelagic micronekton

Large-size scombrids — epi- and mesopelagic micronekton

Cianelli et al 2005

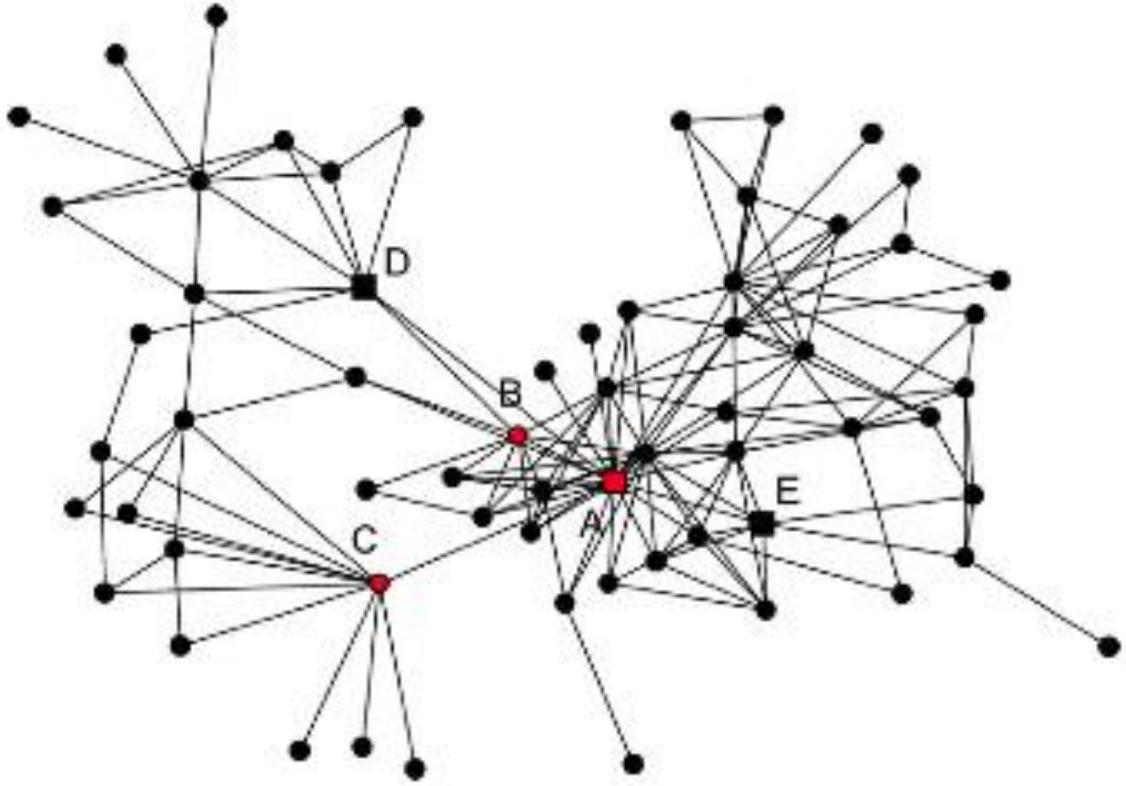
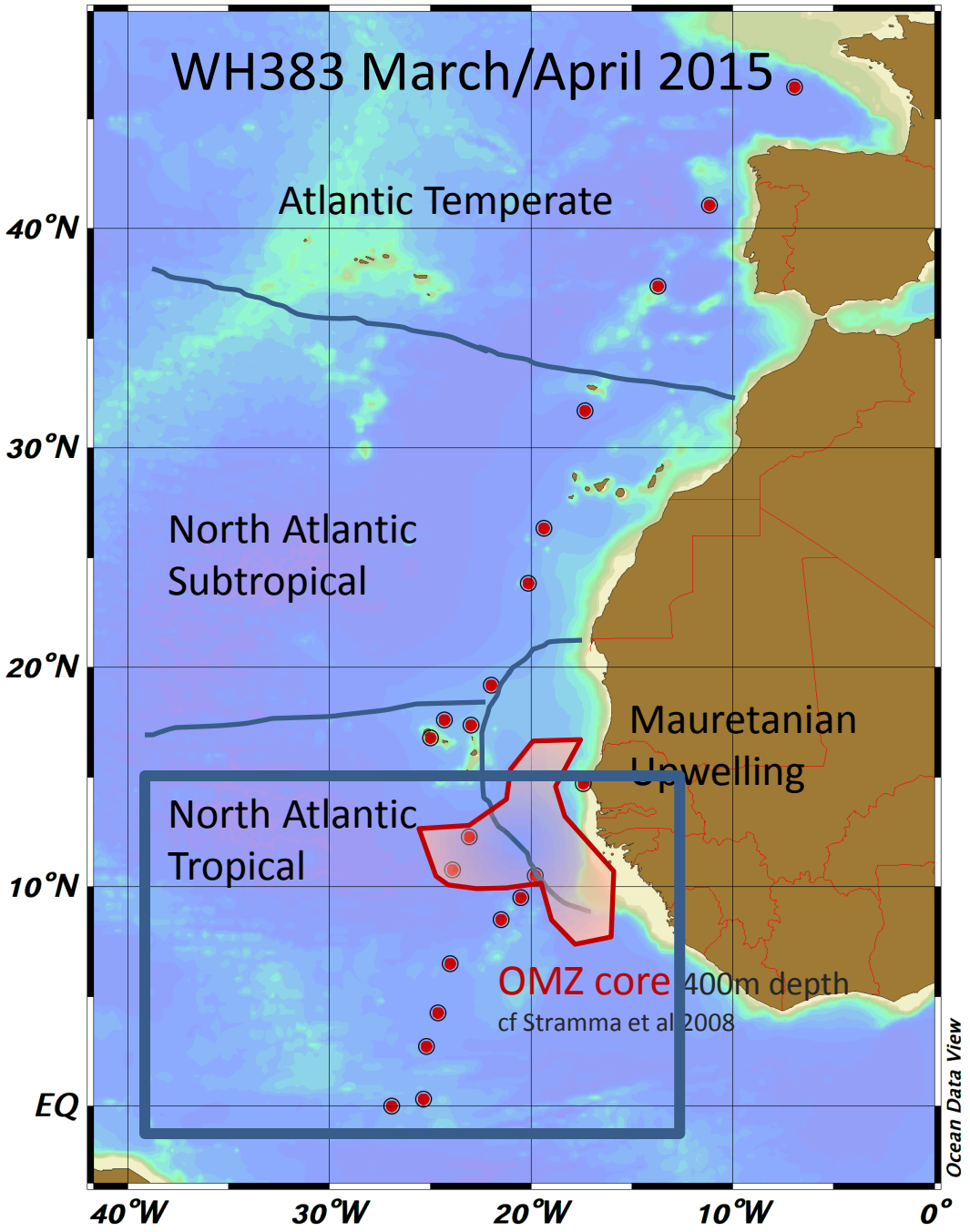
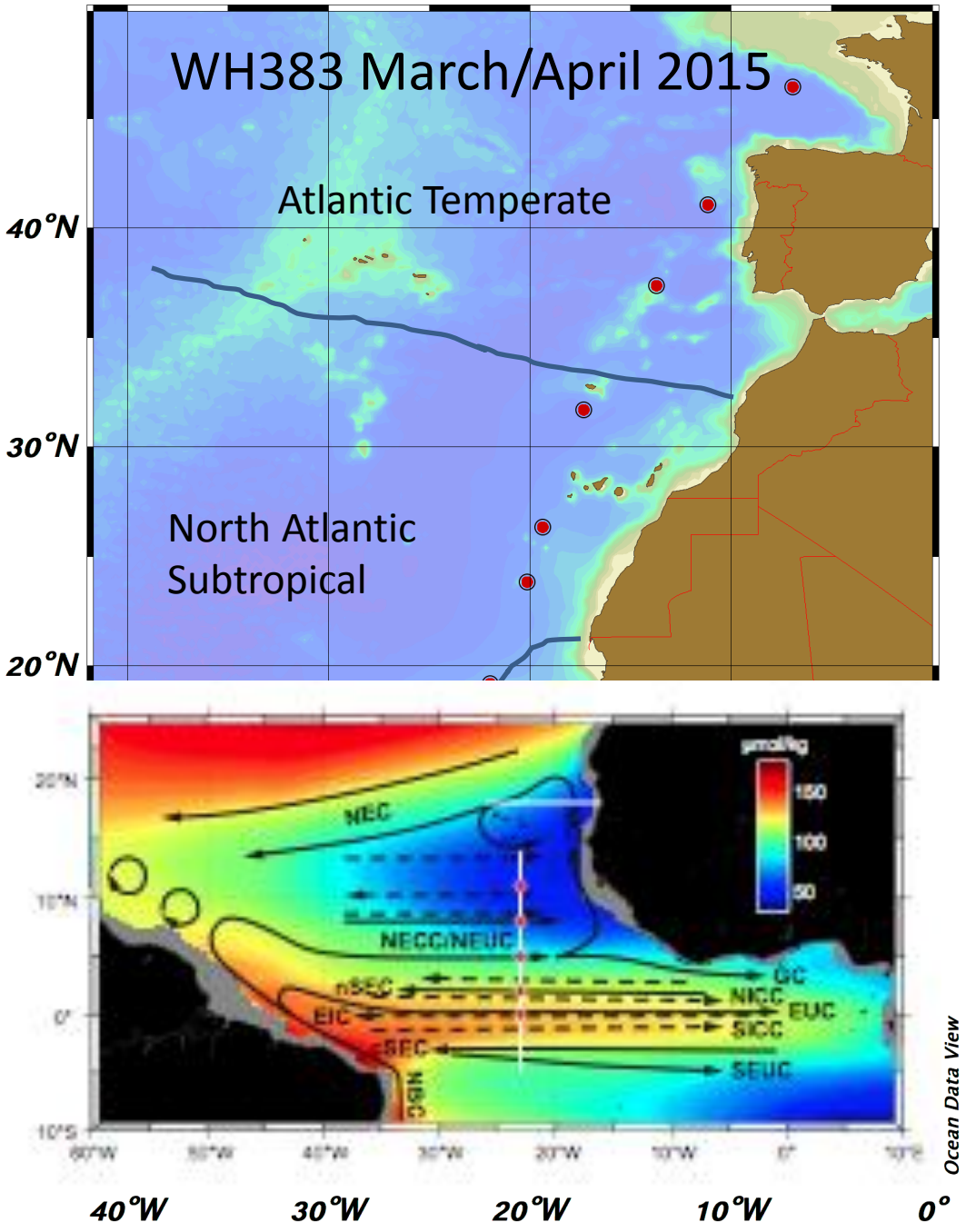
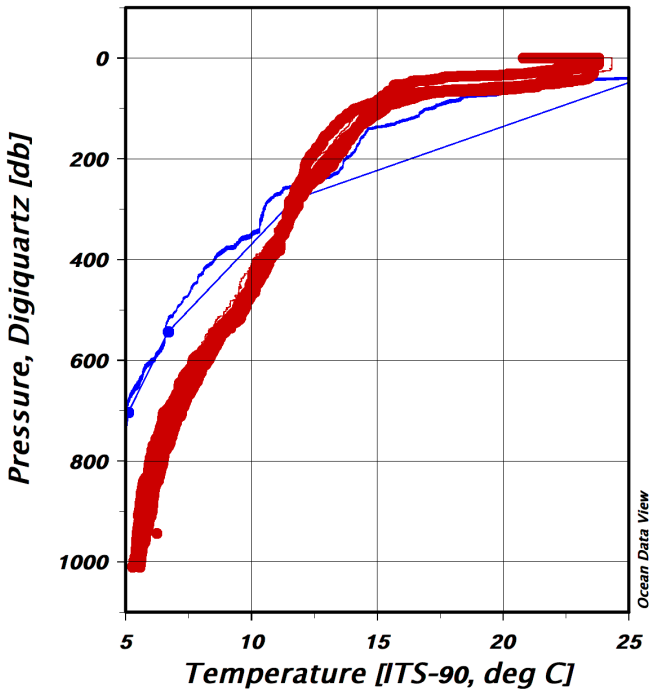


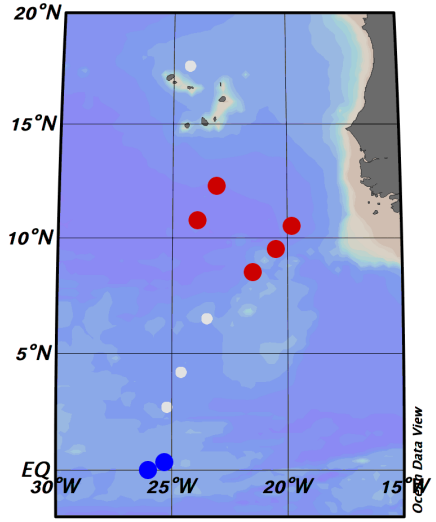
Fig. 7 Terrorist network compiled by Krebs (2002)

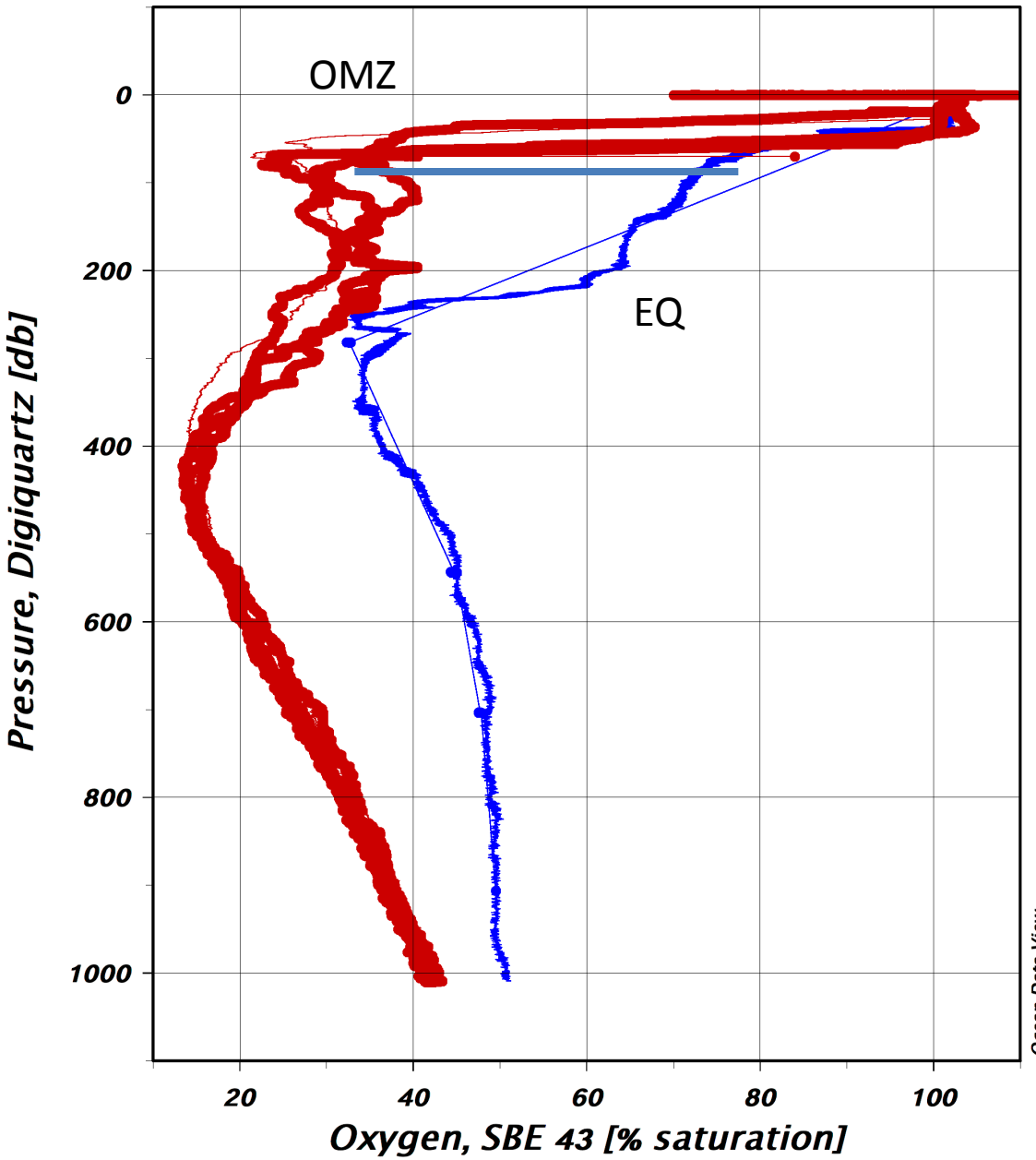

WH383 March/April 2015
Atlantic Temperate
North Atlantic Subtropical
Mauretanian Upwelling
North Atlantic Tropical
OMZ core 400m depth
cf Stramma et al 2008
40°N
30°N
20°N
10°N
EQ
40°W
30°W
20°W
10°W
0°
Ocean Data View

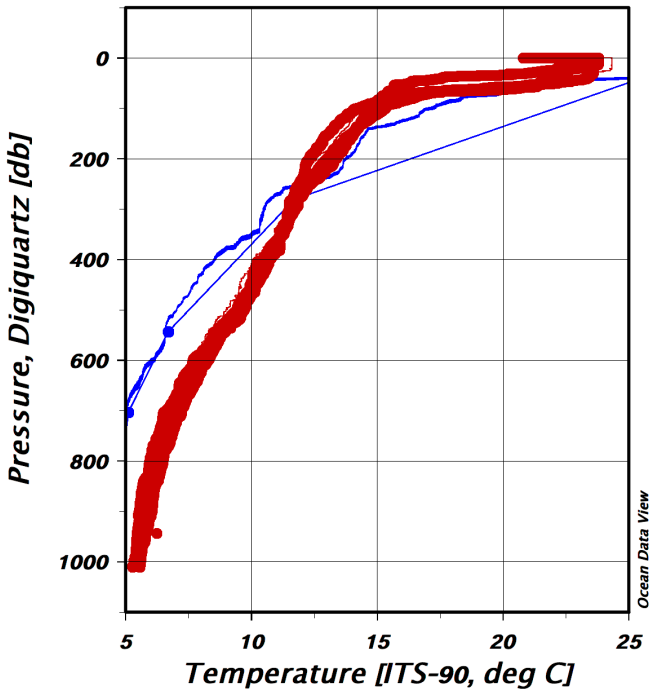


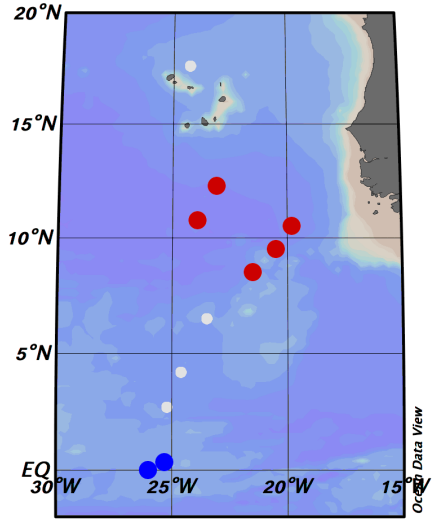
Brandt et al 2015, Biogeosciences

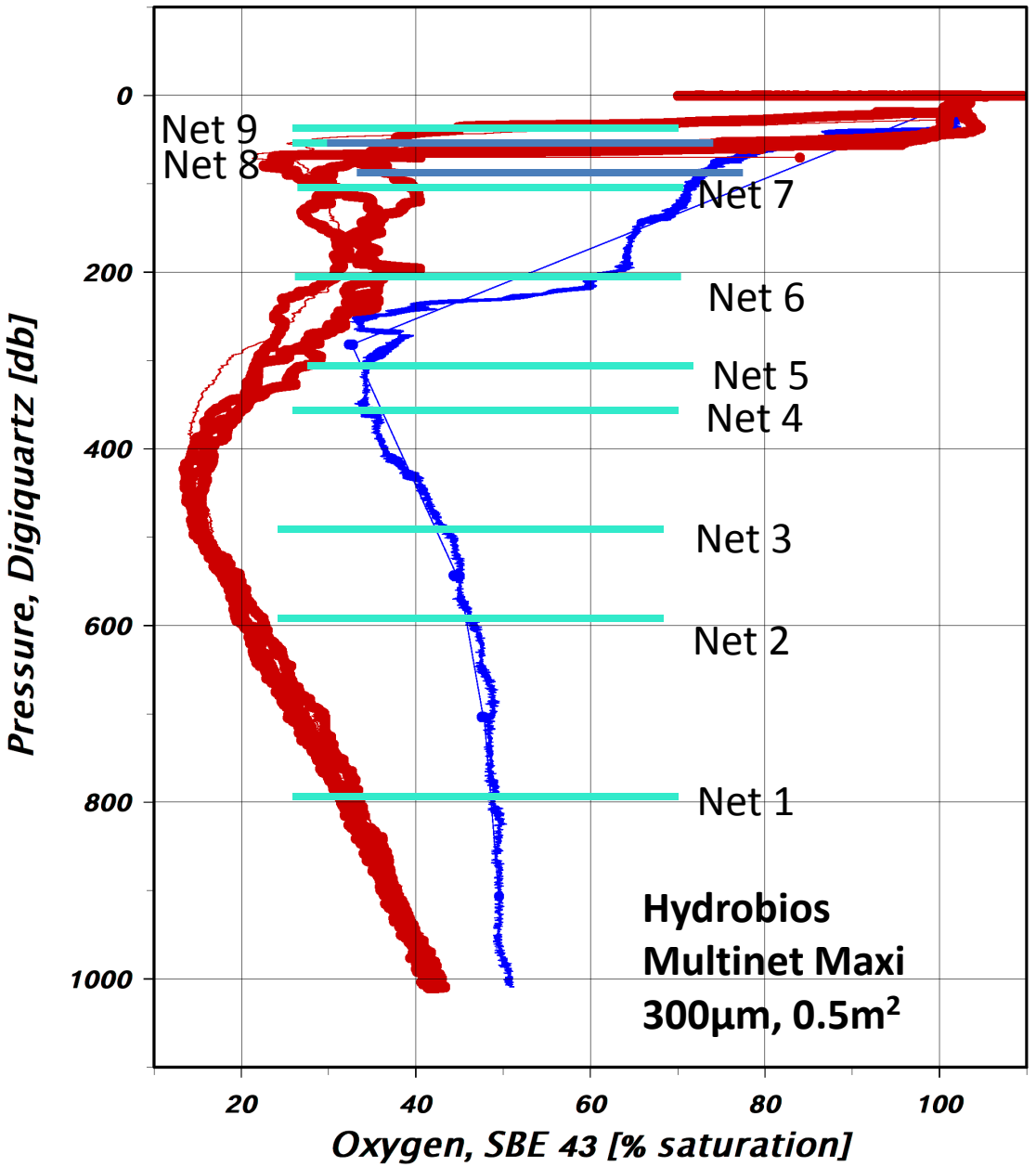

Pressure, Digiquartz [db]
0
200
400
600
800
1000
5
10
15
20
25
Temperature [ITS-90, deg C]
Ocean Data View

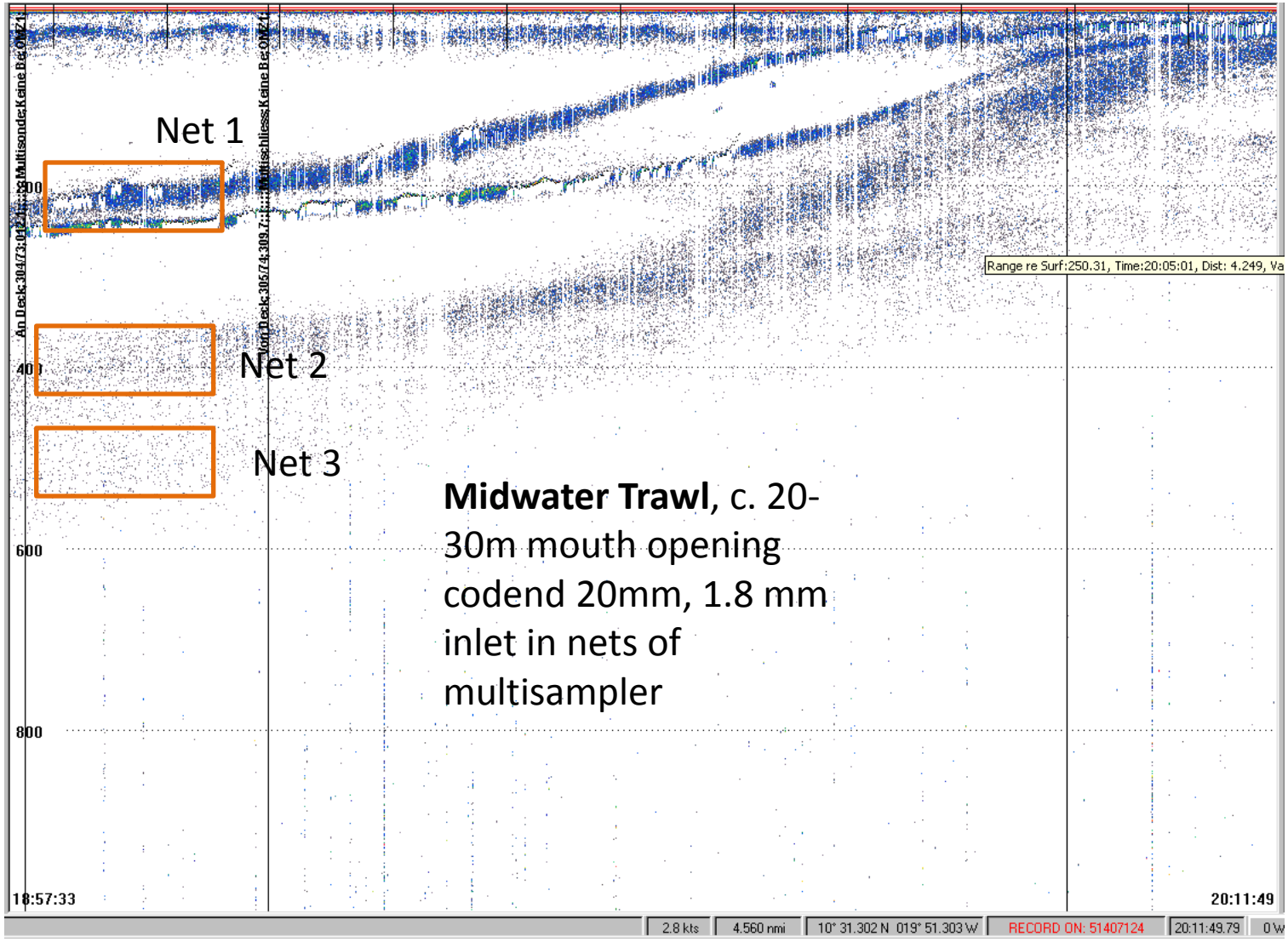

20°N
15°N
10°N
5°N
EQ
30°W
25°W
20°W
15°W
Ocean Data View


OMZ
EQ
Pressure, Digiquartz [db]
0
200
400
600
800
1000
20
40
60
80
100
Oxygen, SBE 43 [% saturation]
Ocean Data View


Pressure, Digiquartz [db]
0
200
400
600
800
1000
5
10
15
20
25
Temperature [ITS-90, deg C]
Ocean Data View


20°N
15°N
10°N
5°N
EQ
30°W
25°W
20°W
15°W
Ocean Data View


Pressure, Digiquartz [db]
0
200
400
600
800
1000
Net 9
Net 8
Net 7
Net 6
Net 5
Net 4
Net 3
Net 2
Net 1
Hydrobios
Multinet Maxi
300µm, 0.5m²
20
40
60
80
100
Oxygen, SBE 43 [% saturation]
Ocean Data View



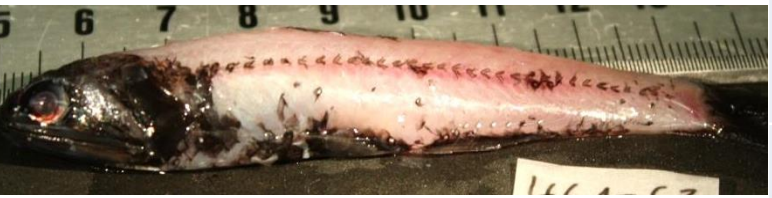
Midwater Trawl, c. 20-30m mouth opening codend 20mm, 1.8 mm inlet in nets of multisampler


DATE 30/3
TIME 22:00
ST 327/96
WH383 Aalnetz
Netz I


DATE 30/3
TIME 22:00
ST 327/96
WH383 Aalnetz
Netz II


DATE 30/3
TIME 22:00
ST 327/96
WH383 Aalnetz
Netz III

Myctophids



	migratory type	Night/Day Depth	trophic guild
Hygophum macrochir	M	50 / 400-1200	Euph, Copep, small crusta
Notoscopelus resplendens	M	50 / 700-1200	Euph, Copep, small crusta
Nannobrachium isaacsi	M / NM	50-600 / 550-750	Euph, larg crusta
Electrona risso	WM / NM	350-600 / 350-650	Copep

Sternoptychidae, Stomiidae, Melamphaidae

	migratory type	Night/Day Depth	trophic guild
Argyropelecus affinis	WM	150-500 / 350-600	Euph, Salps, Chaetog
Chauliodus spec	[PM]	350/600 / 350-1000	piscivorous
Melamphaes spec	M	150 / 800-1000	gelatinous prey, small crusta

Cephalopods

X

	migratory type	Night/Day Depth	trophic guild
Heliocranchia pfefferi	non-migrator/shifter/spreader/true DVM?		
Octopoteuthis sicula	non-migrator/shifter/spreader/true DVM?		
Liocranchia reinhardtii	non-migrator/shifter/spreader/true DVM?		
Bathyteuthis abyssicola	M	700-2000	

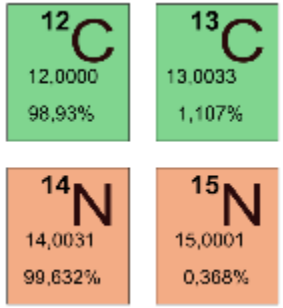
other food-web components

- Pelagic Shrimp
- Cnidaria

- Appendicularia
- Salpa
- Pyrosoma

Primary consumers

Stable Isotope Analysis



- integrates biochemical signatures of al assimilated prey components

  vs SC → snapshot in time

- fractionation factor

  $\delta^{15}N_{predator} = 3.4 + \delta^{15}N_{prey}(‰)$

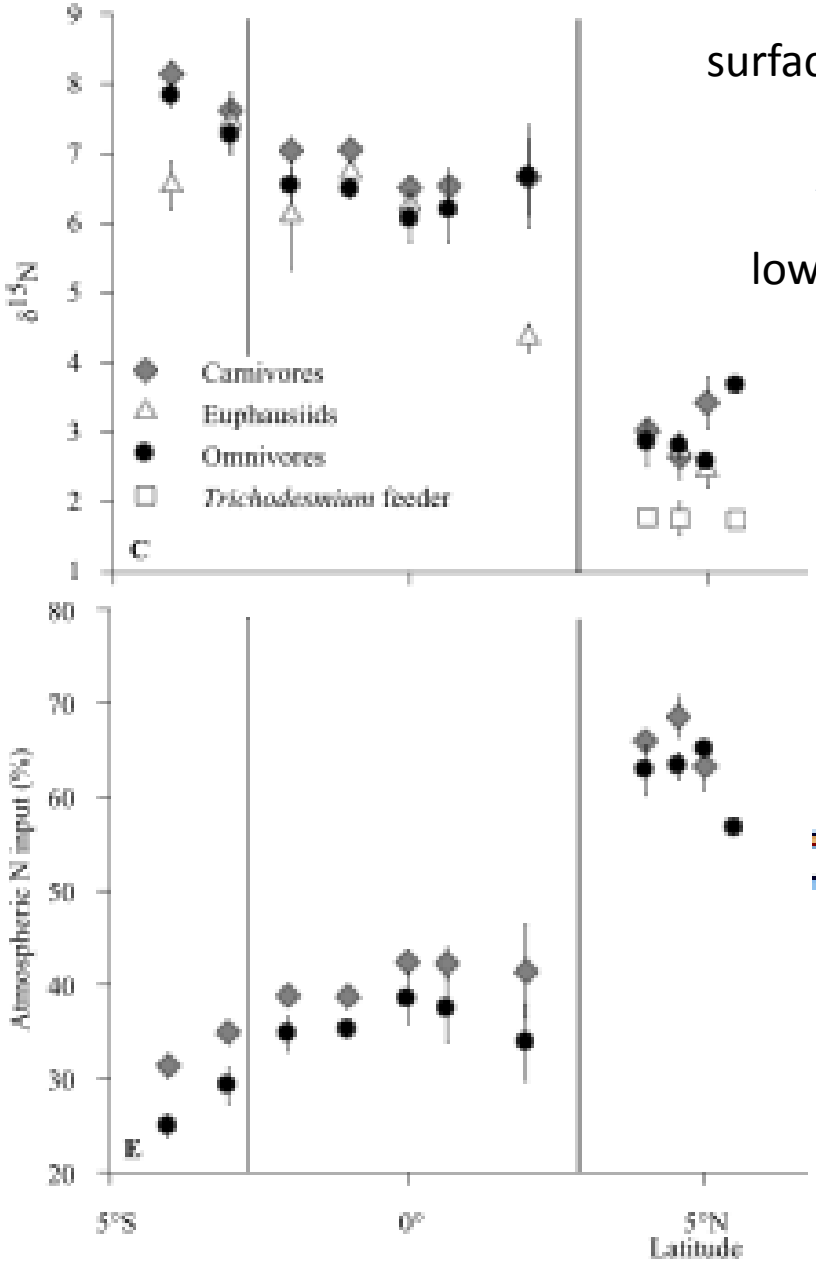
- Trophic Position estimates

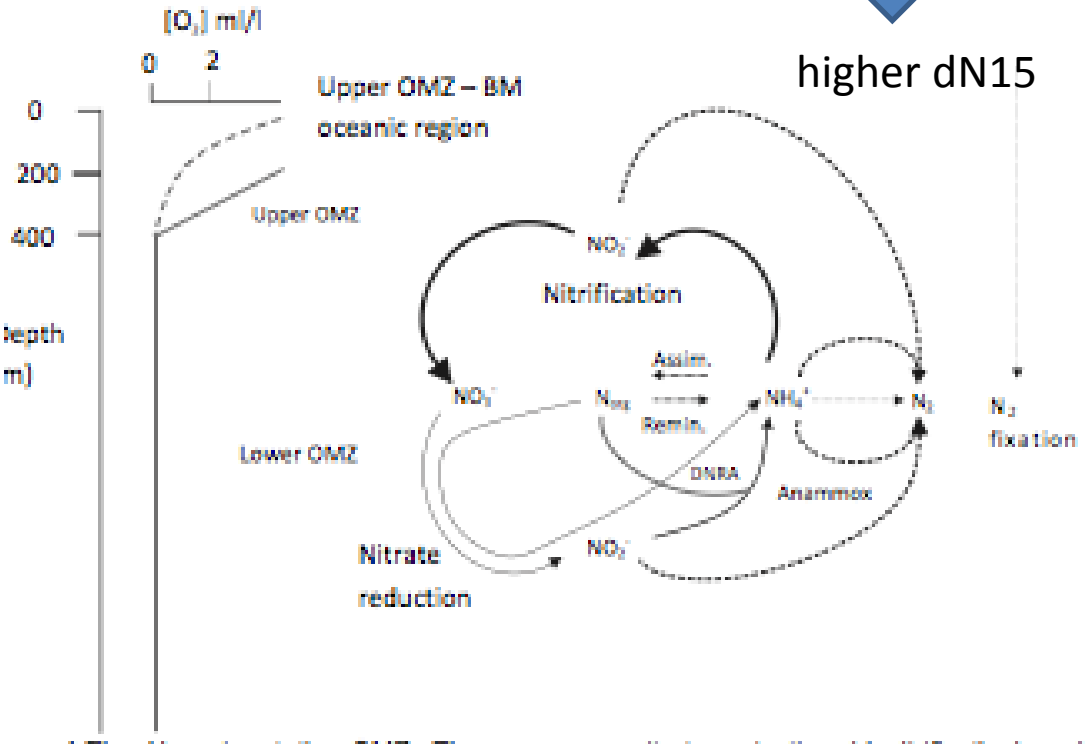
surface: atmospheric nitrogen fixing

lower dN15

OMZ depth: bacterial nitrogen removal processes

higher dN15



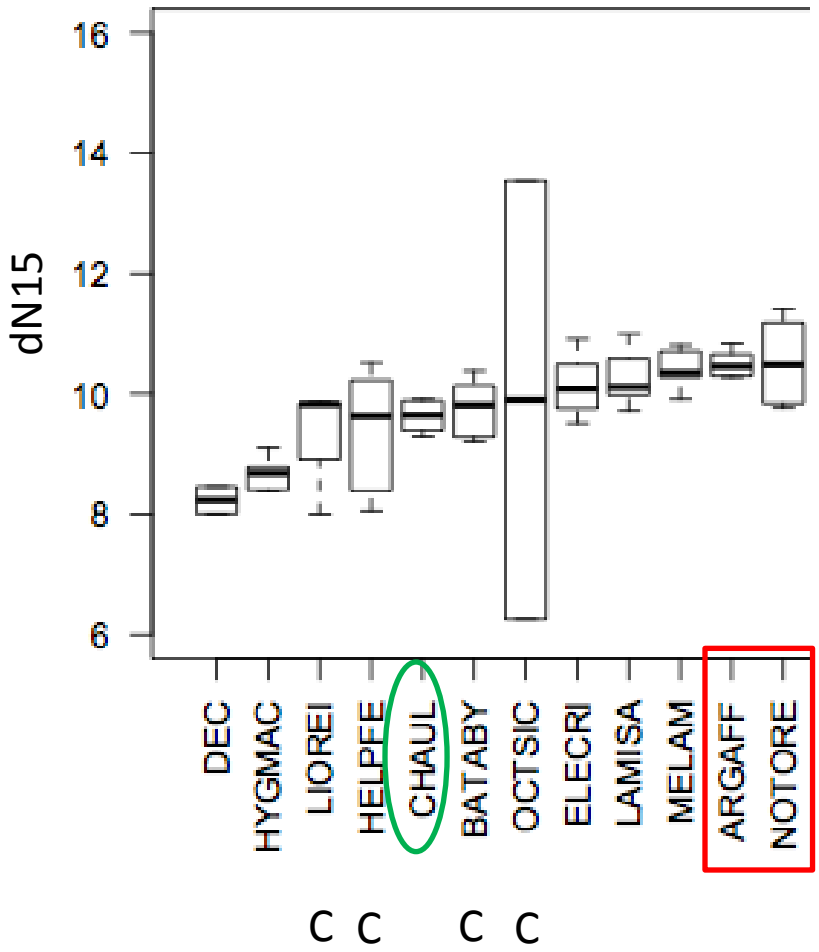


Sandel et al 2015

Camalich et al 2012

First results

OMZ region



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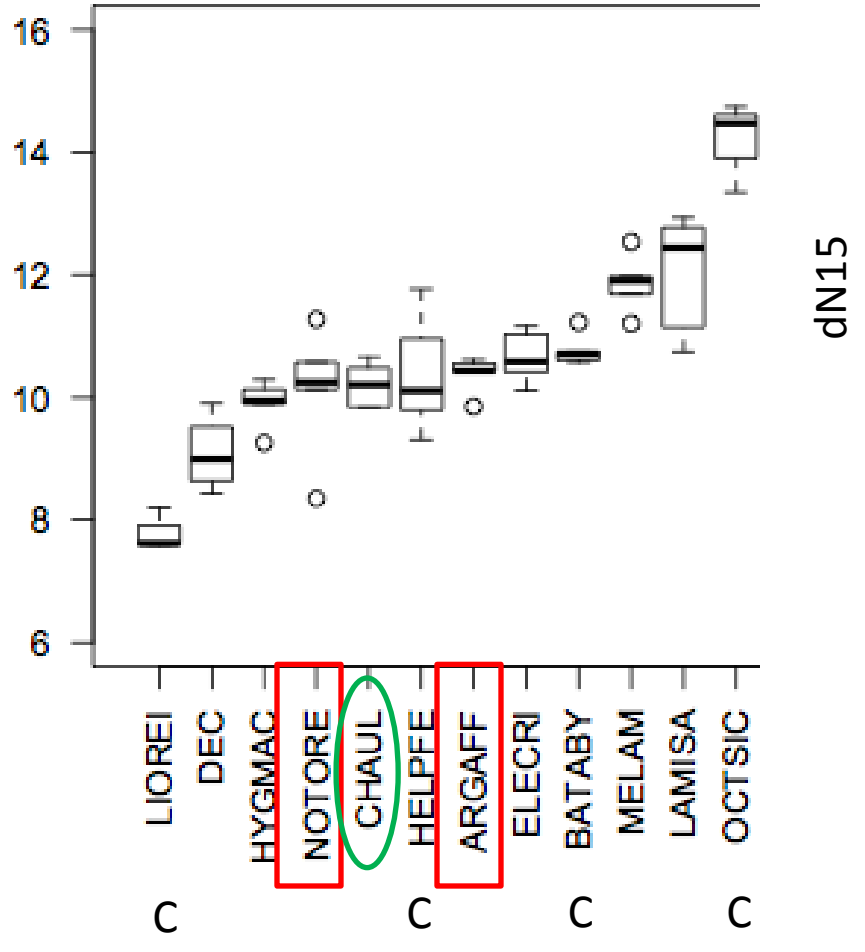

continuation of study

- SI mixing models (SIAR)
- concomittant fatty acid analysis

  → Ana Marta Goncalves, University of Aveiro
- net trawled samples
- vertical resolution using backscatter profiles from EK60/LADCP to investigate depth distribution of prey species (zooplankton) and mesopelagic components in relation to hydrography → Gerd Krahmann, Geomar
- investigate same species caught in surface + deeper waters → effect of depth on tissue $\delta^{15}N$


Thank you