atlas

UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS

Does food quality control the distribution of cold-water corals?

Sabena J. Blackbird[1], George A. Wolff[1], Kostas Kiriakoulakis[2], Rachel Jeffreys[1,3], Izzy Hassall[1], Elizabeth H. Fisher[4] and Dick van Oevelen[3]

[1]University of Liverpool, [2]John Moores University, [3]NIOZ, [4]GH Geochem

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

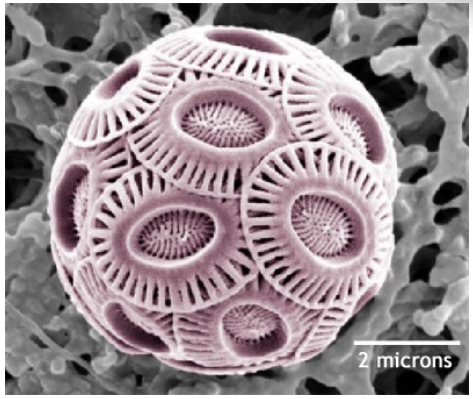
Controls on development of these ecosystems?

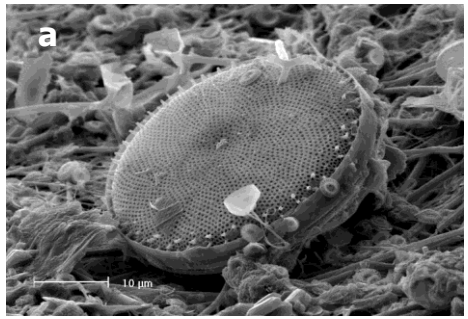
- Restricted T range 4 – 12° C, in N.E. Atlantic *ca.* 6.5 – 9.9° C
- CWCs in N.E. Atlantic all appear to occur within the density (σ_θ) envelope 27.45 to 27.65 kg m^{-3} Dullo et al (2008)
- Link to intermediate nepheloid layers? Larval dispersion?
- Other factors
  - Sea-bed substratum
  - Sea-bed slope
  - Current speeds
  - Suspended sediment
  - Particulate organic matter (food) supply

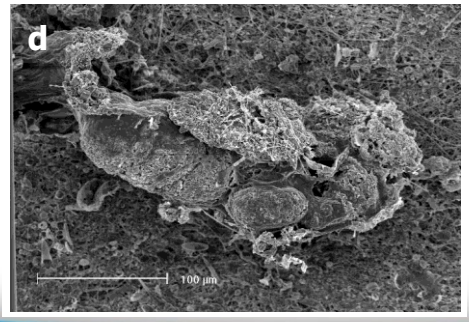
Huvenne et al., 2011 – Whittard Canyon 1880 m (σ_θ – 27.74–27.84 kg m^{-3})

Feeding habit of *Lophelia pertusa*?

- Feeding dependent on current velocities and particulate loading (Purser *et al*., 2010; Orejas *et al*., 2016).
- Optimal feeding by *L. pertusa* current velocity 2 - 5 cm s^{-1}.
- Observations, isotopic, biomarker and aquarium experiments indicate a mixed diet ranging from live zooplankton to diatoms to detrital POM (Duineveld *et al*., 2004, Kiriakoulakis *et al*., 2005, 2007; Carlier, 2009; Orejas *et al*., 2016)
- ***How does food supply limit distribution of L. pertusa?***

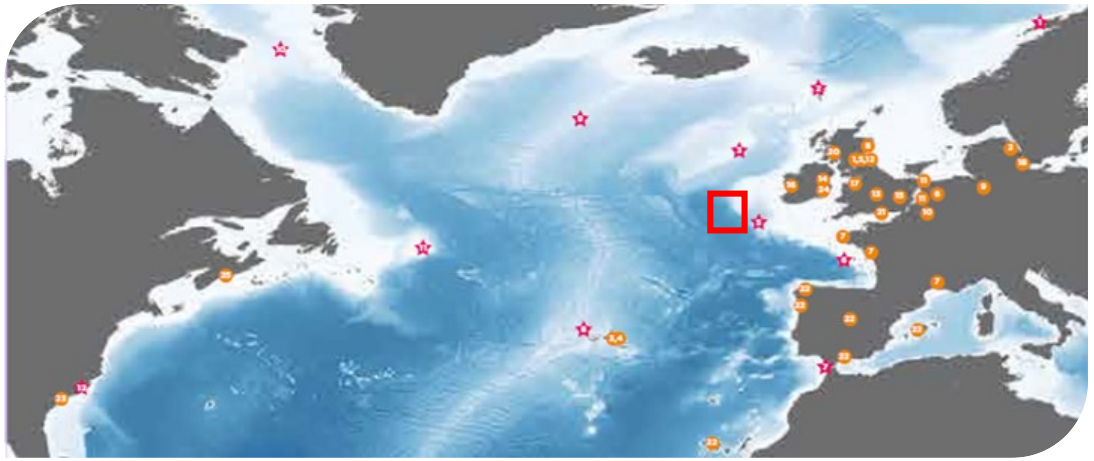


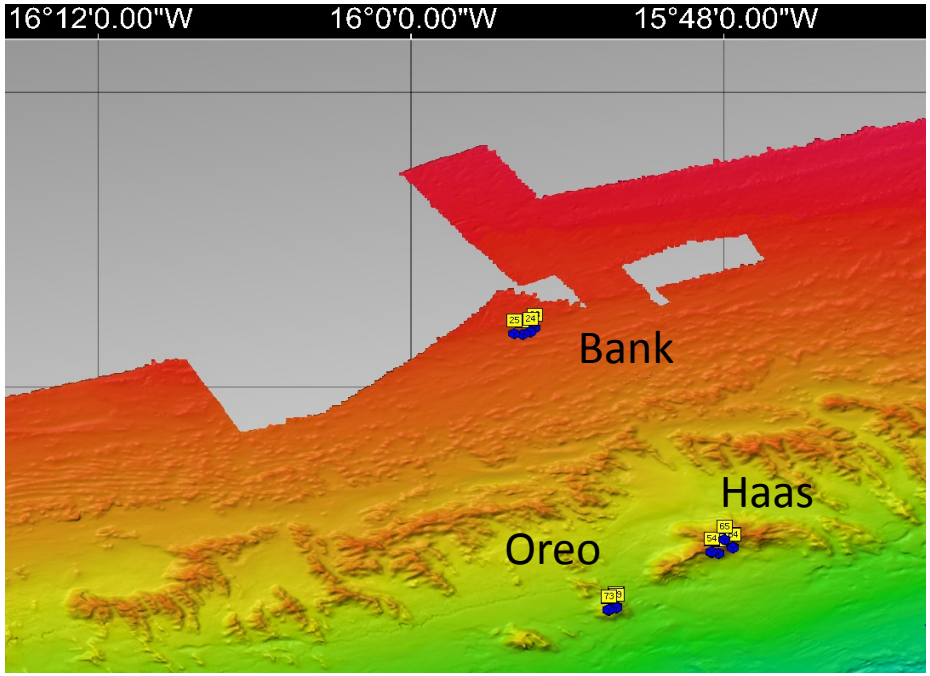




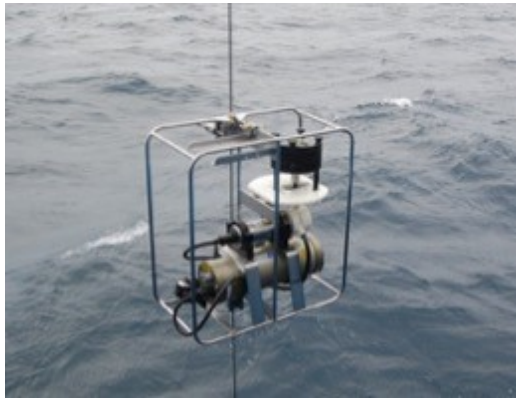
WP2 Functional Ecosystems

- **Determine hydrodynamic mechanisms that transport OM and its sources to CWC reefs, sponge grounds and coral gardens.**
- **Participants in 64PE420 cruise to Rockall Bank (2017).**
- **Haas Mound**
- **Orio Mound**
- **Bank (N)**



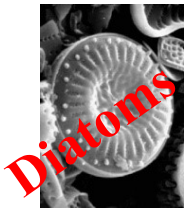


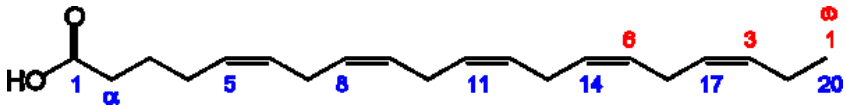
- **SAP used to collect suspended particulate organic matter (sPOM) from large volume water samples**
- **(10^2 L +)**
  - **Surface**
  - **100 mab**
  - **10 mab**

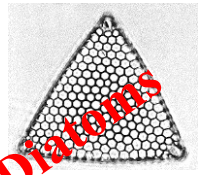


- Lipid composition of POM provides information on source and quality.

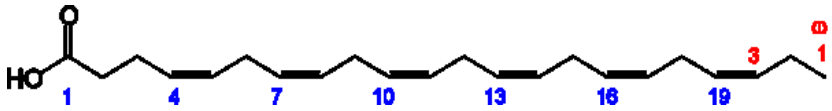
Eicosapentaenoic acid: $C_{20:5(n-3)}$ - EPA







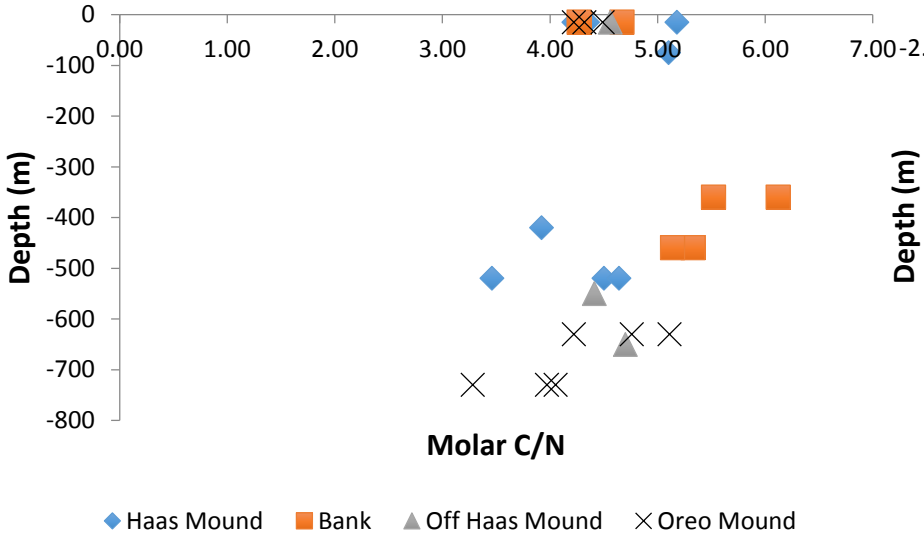
Docosahexaenoic acid: $C_{22:6(n-3)}$ - DHA

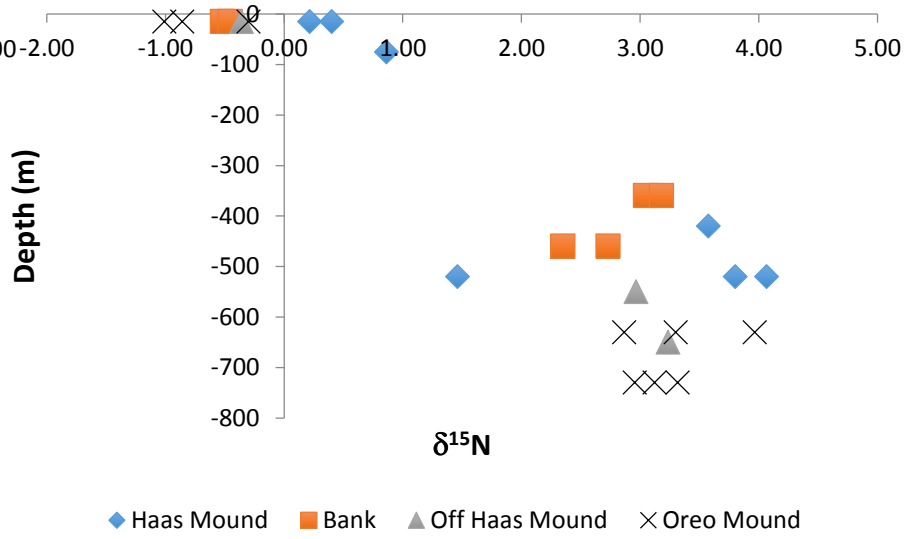


Chemical structure of two PUFAs (polyunsaturated fatty acids).
EPA is a diatom biomarker and DHA is common in dinoflagellates.

- >100 individual lipids may be identified, not all specific
- multivariate statistical approach adopted, reducing data set to 38 lipids based on occurrence and source specificity

Rockall Bank.



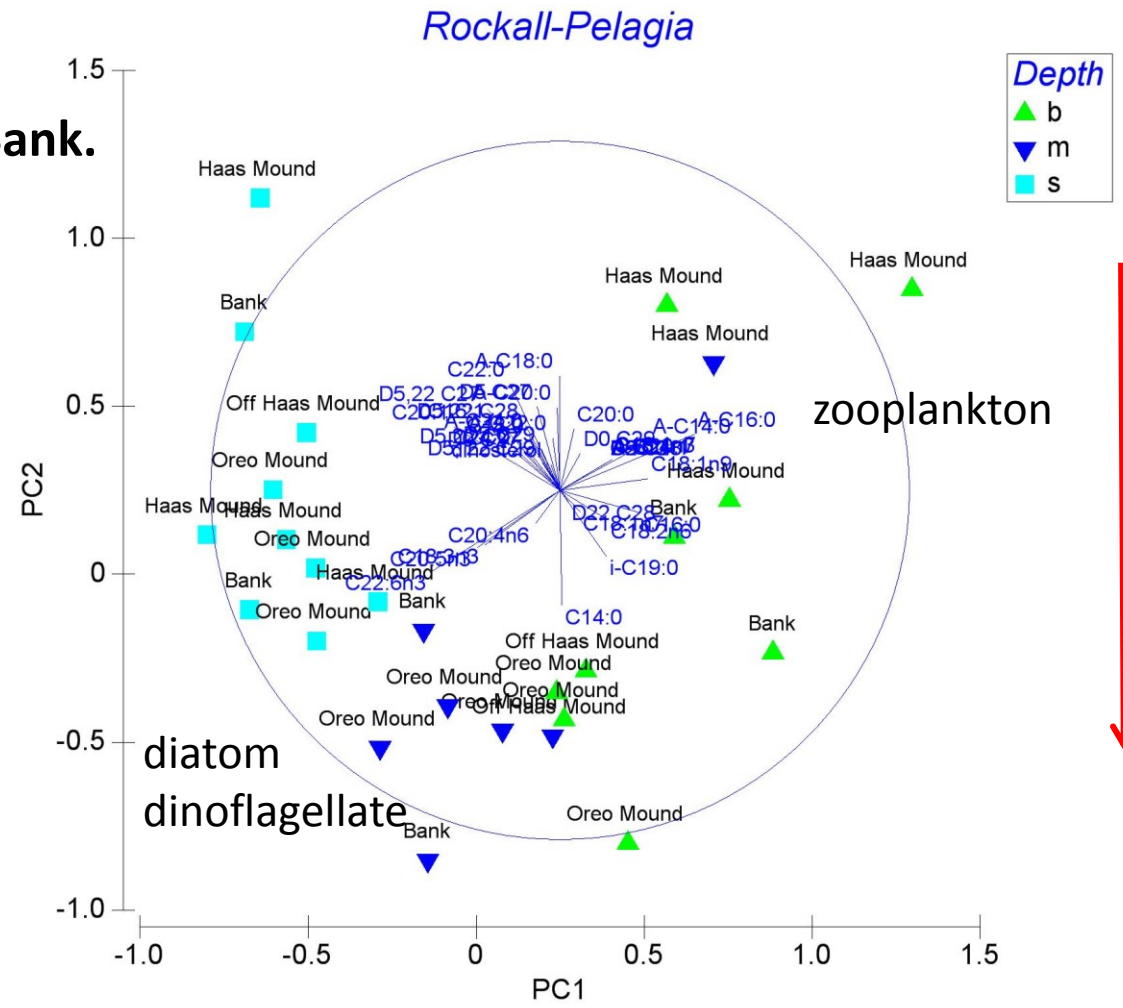


- Variable POM composition at depth - reworking
- Low C/N
- Patchiness

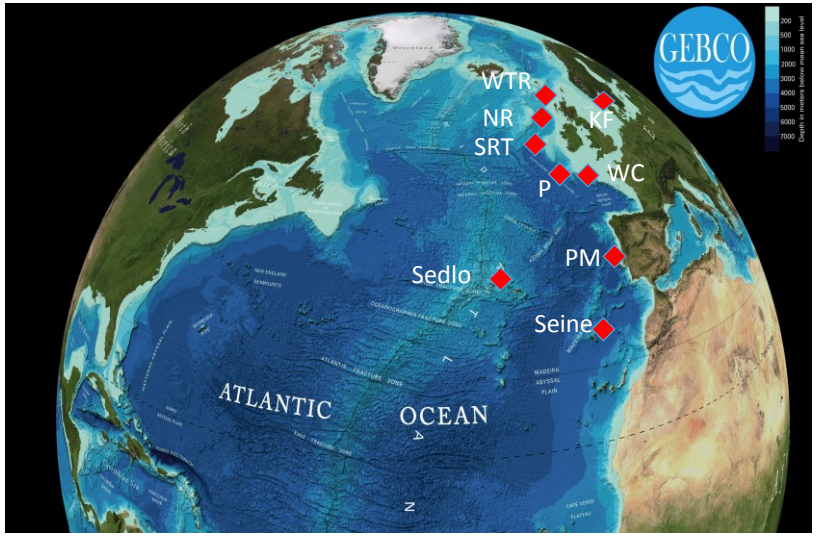
Food sources as ascribed from lipid biomarkers

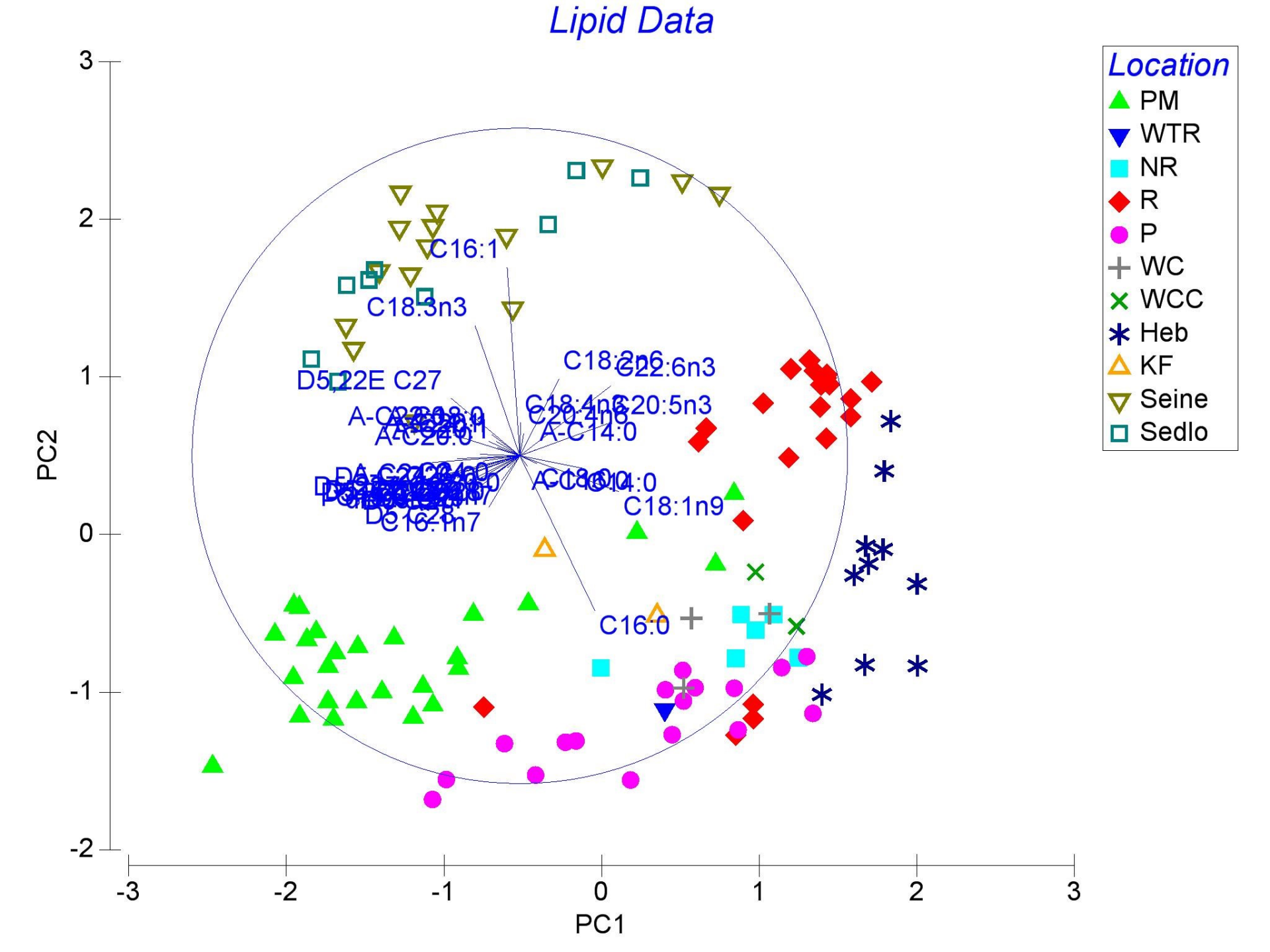
- Principal Component Analysis (PCA) of reduced lipid data (mole %; transformed to 4th root for normal distribution) to simplify and discern the drivers of variability
- *Pelagia* 2017 Oreo Mound, Haas Mound, Bank - surface *vs.* deep composition
- Broader link to presence/absence of *L. pertusa* in N.E. Atlantic

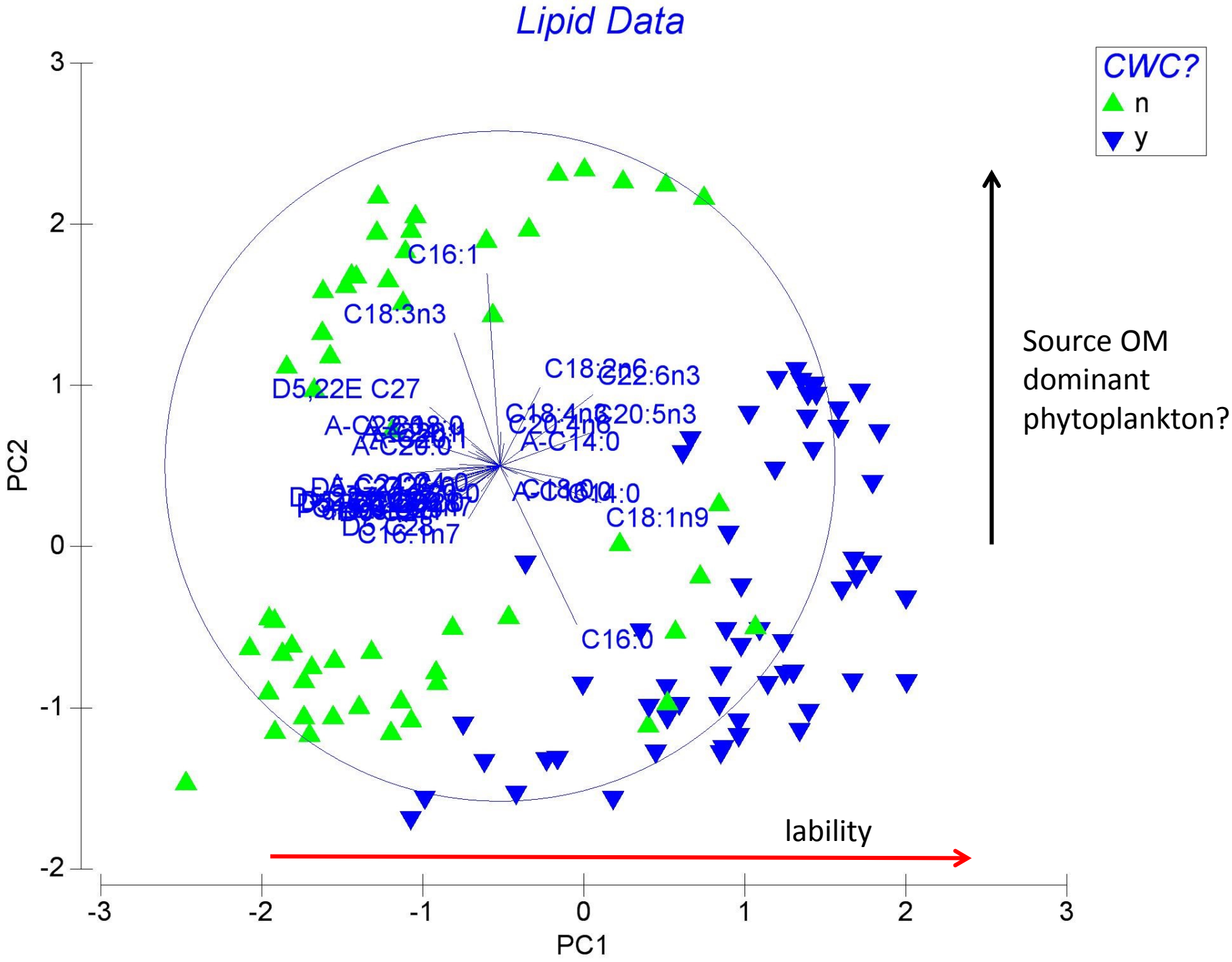
Rockall Bank.

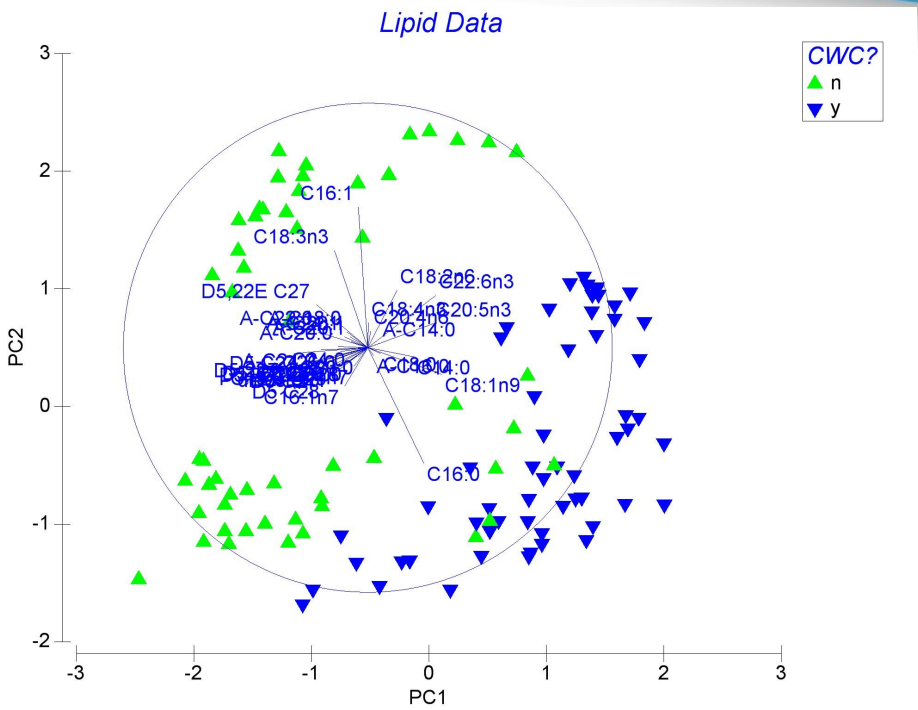


- Large compositional data set (n=111) for bottom water sPOM collected across NE Atlantic continental margin and MAR
- Link to *L. pertusa* occurrence
- ACES, ECOMOUND, OASIS, HERMES, HERMIONE, ATLAS (Pelagia, 2017)
- *Snapshot data – mitigated by large number of replicate samples collected at different times, seasons*




Lipid Data
Location
PM
WTR
NR
R
P
WC
WCC
Heb
KF
Seine
Sedlo
C16:1
C18:3n3
C22:6n3
C20:5n3
C20:4n6
A-C14:0
C18:1n9
C16:0
D5,22E C27
PC1
PC2
3
2
1
0
-1
-2
-3


Lipid Data
CWC?
n
y
C16:1
C18:3n3
D5,22E C27
C18:2n6
C22:6n3
C18:4n3
C20:5n3
C20:4n6
A-C14:0
C18:1n9
C16:0
Source OM dominant phytoplankton?
lability
PC1
PC2
3
2
1
0
-1
-2
-3



- Composition of POM at *L. pertusa* colonies varies considerably (PC1 & PC2, 45% variation) – varied diet
- Strongest positive contribution to PC1 driven by PUFAs (18:2, 20:5 n3, 22:6 n3), MUFAs (16:1 , 18:1 n9), FAs (14:0, 16:0, 18:0). Y & N significantly different (ANOSIM; r = 0.43, $p<0.01$).
- Positive contributions to PC2 largely driven by PUFAs (18:3, 18:2, 22:6), MUFAs (16:1) and sterol ($C_{27}\Delta^{5,22}$).

How does food supply limit distribution of *L. pertusa?*

- **Clear regional trends linked to plankton ecology?**

- Essential fatty acids (EFAs; e.g. $C_{20:5\ n3}$) or their precursors (e.g. $C_{18:3\ n3}$) diatoms, dinoflagellates
- High calorific value seems to be good for *L. pertusa*

- **Implies that concentrations of certain particulate lipids are crucial for *L. pertusa.* Plankton + physics driven.**

Acknowledgements

- Funding from the European Commission *via* ACES (*EVK3-CT-1999-00008*), ECOMOUND (*EVK3-CT-1999-00013*), OASIS (*EVK3-CT-2002-00073*), HERMES (*GOCE-CT-2005-511234-1*), HERMIONE (*FW7-226354*) and ATLAS (*Horizon 2020 – 678760*)

- All Project Partners

- Anu Thompson for assistance with mass spectrometry