



Royal Netherlands Institute for Sea Research



INSITE

Measuring the “SHADOW” of artificial structures in the North Sea and its effect on the surrounding soft bottom community

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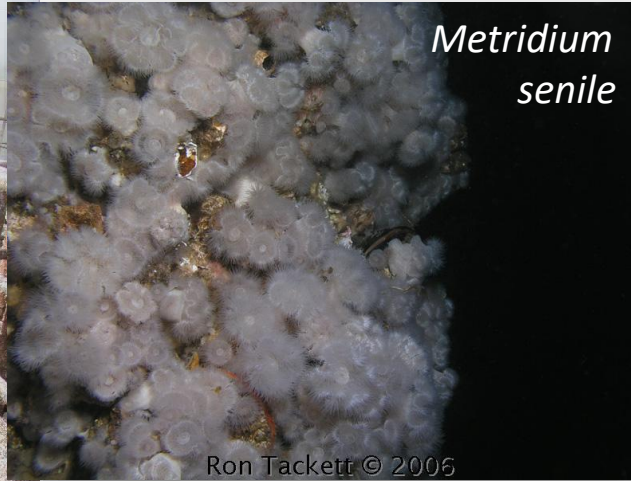
“trawlers have transformed life on the seabed, converting three-dimensional, complex habitats rich in coral, sponge and sea fan to endless monotonous expanses of shifting gravel, sand and mud...”.

Roberts (2010)

Mytilus edulis



Metridium senile



Ron Tackett © 2005

Coral growing on North Sea oil rigs

These installations are home to thriving colonies of an endangered cold-water coral.

This summer the coral *Lophelia pertusa* was found growing on oil platforms in the North Sea and on the Brent Spar oil-storage buoy during its decommissioning. The findings indicate that *Lophelia* has a wider distribution and a more rapid rate of growth than previously believed. The discovery also has implications for the debate over oil exploration in the Atlantic Ocean and the perceived benefits of onshore dismantling of deep-water platforms.

When Brent Spar was raised out of the



The occurrence of the coral raises questions about how to deal with this species, which is listed under the Convention on International Trade in Endangered Species (CITES), when platforms are decommissioned. At a meeting in Sintra in 1998 of countries belonging to the Oslo-Paris (Ospar) convention on protecting the marine environment, Ospar decision 98/3

Lophelia pertusa



Artificial structures offer hard substrate for sessile epifauna

Biomass is estimated to be up to 500-fold the biomass as found on soft sediment (*Picken et al., 2000*)

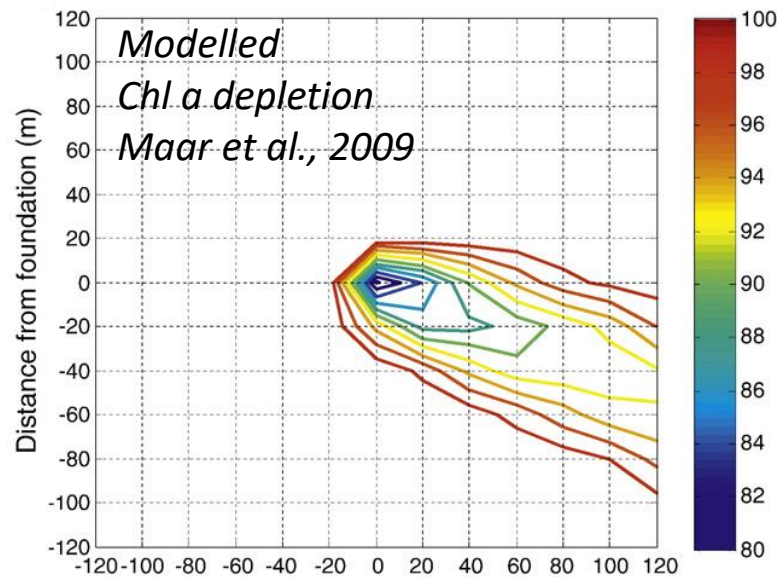
Very little is known about the effect these locally extreme biomass levels have on their surroundings (e.g. concentrations of particles and nutrients in their vicinity)

Hypothesis

Through the presence of a rich epifaunal community, oil/gas platforms in the North Sea may act as:

Biofilters creating a “SHADOW” affecting the water column and soft-bottom benthic surrounding

Proof of principle



Relevance

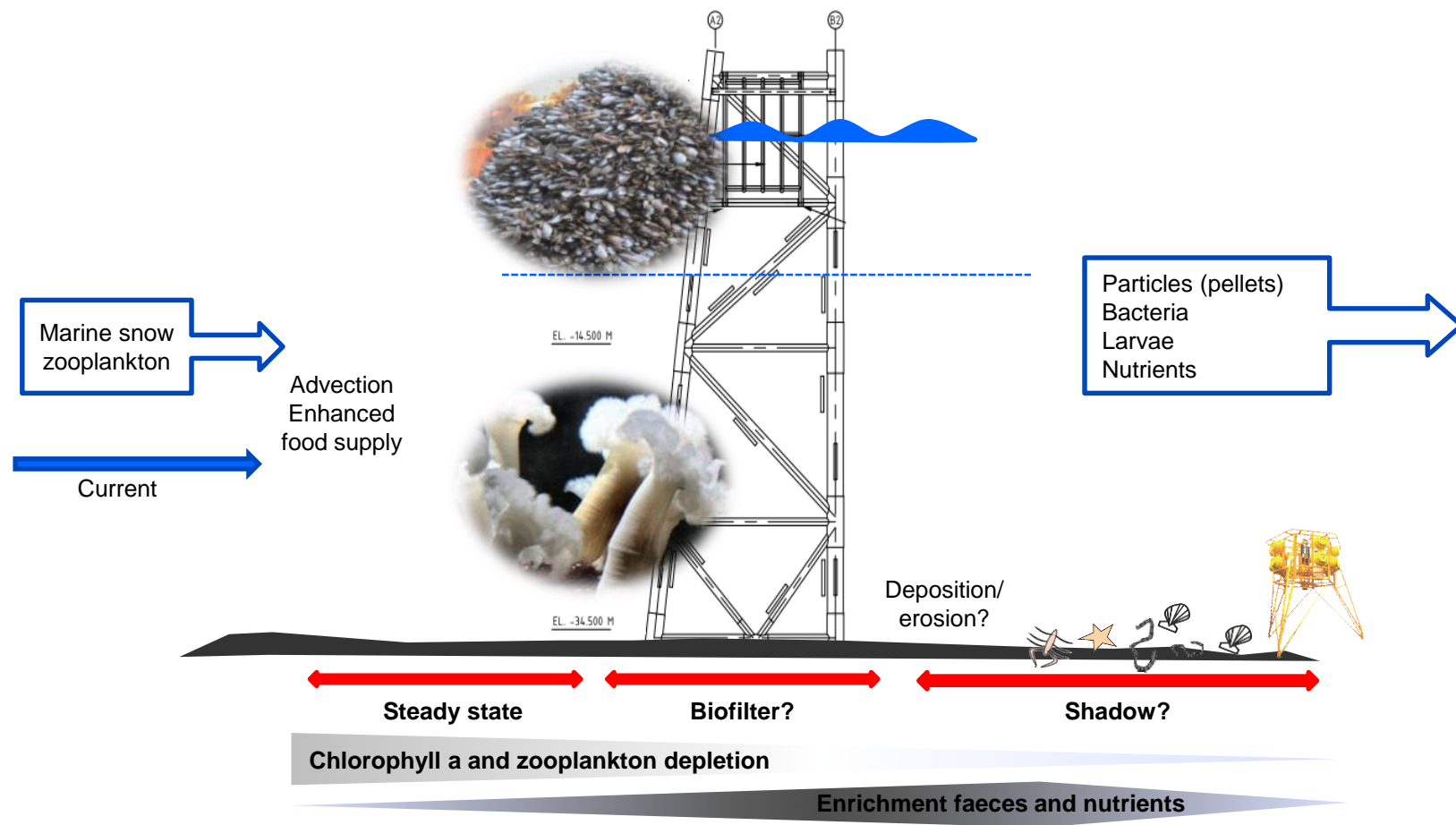
1. *“establish the magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”*

Following a multi-disciplinary approach, whereby biological, geological, physical and chemical data will be combined, the influence will be assessed of man-made structures on the benthic ecosystems surrounding these platforms in space and time -> field data and models

2. *“to what extent, if any, the man-made structures in the North Sea represent a large inter-connected hard substrate system”*

Our data i.e. larvae and their barcodes, will be combined with barcode data collected by other consortia studying epifauna communities on several other platforms in the North Sea.





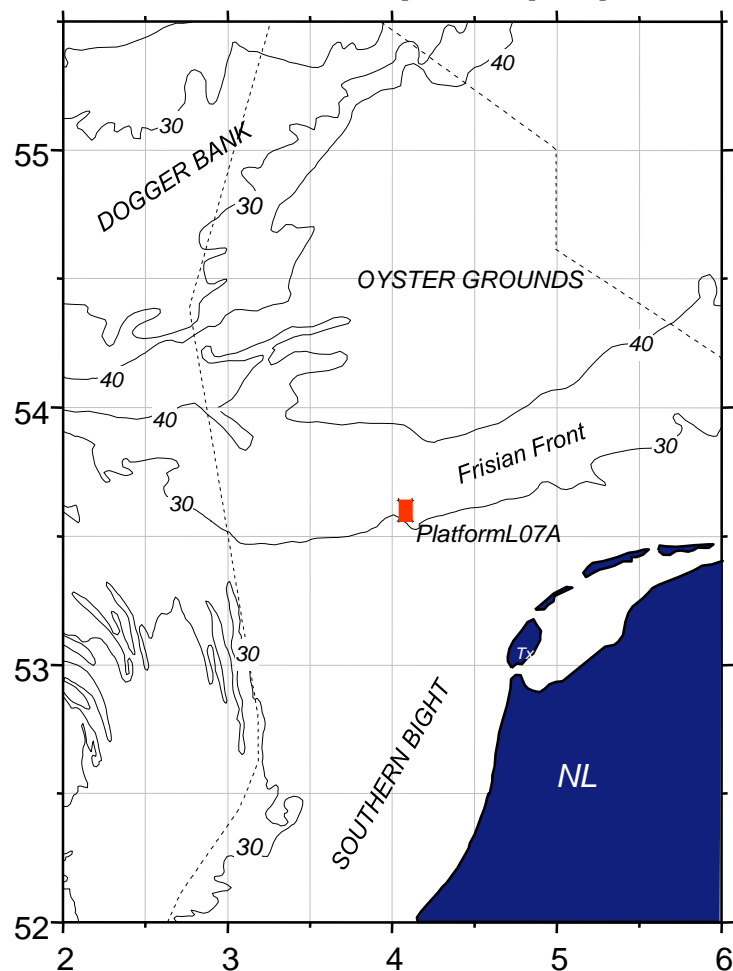
- Examine whether artificial structures act as biofilter and create a “SHADOW”
- Examine whether the “SHADOW” has an impact on the surrounding benthic community
- Model the “SHADOW” affect
- Define whether platforms are stepping stones

Magnitude of
Effects (Obj1)

Interconnected
System (Obj2)



Position of study area (red)



- Platform clear of discharge of toxic waste
- Non trawling zone of 500 m



Platform L7-A

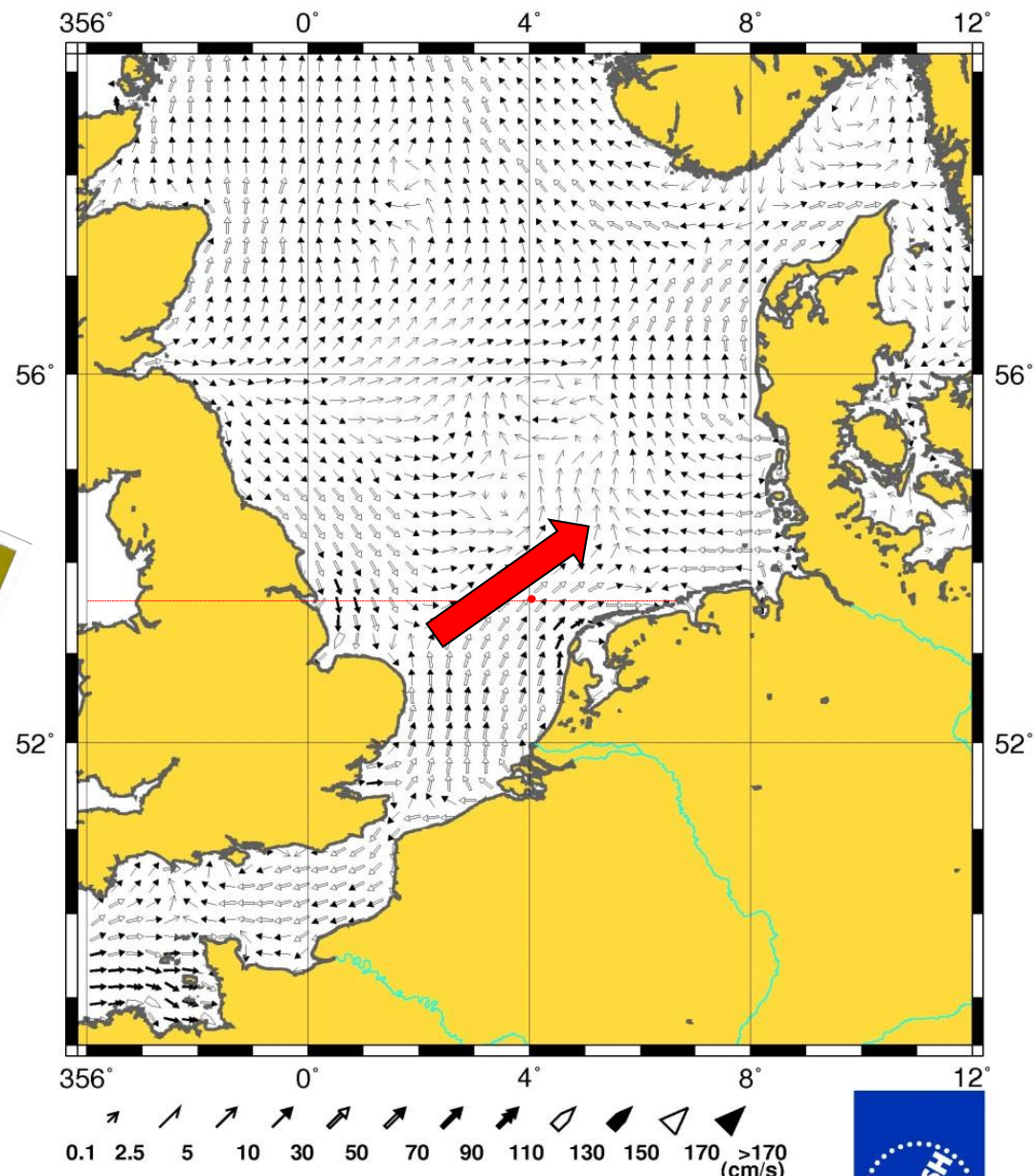
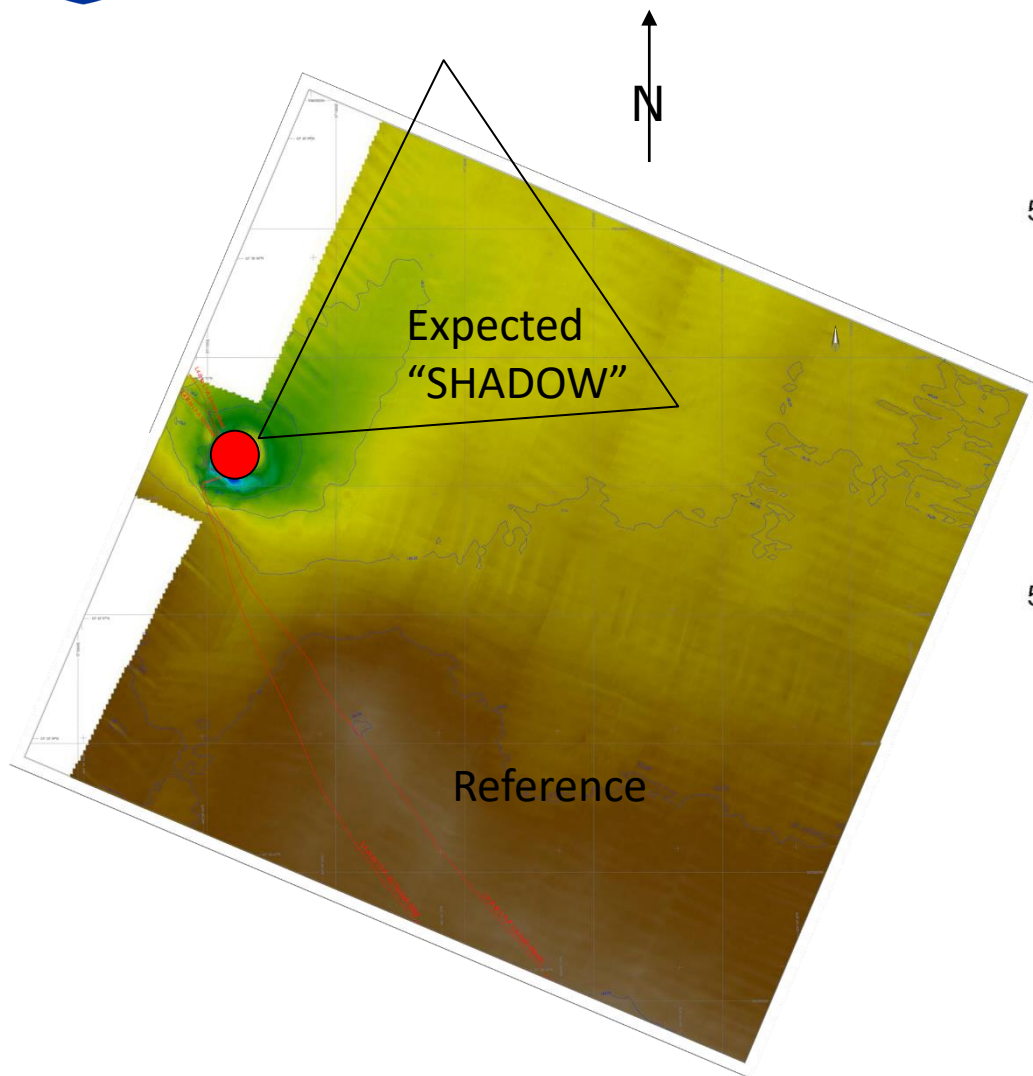


Facts and figures

- Location: 47 nautical miles northwest of Den Helder
- Platform is no longer in use
- Length x breadth: 20 m x 6 m
- Height of helideck: approx. 30 m
- Water depth: 40 m
- First gas produced: October 1988
- Last gas produced: February 1999

Cruise with the RV Pelagia
7-12 May 2016





Berechnete Stroemung am 29.03.2016 um 22:00 Uhr (MESZ) 1.Schicht (0-5m)

Current on 29.03.2016 at 22:00 (UTC+2) 1.Layer (0-5m)

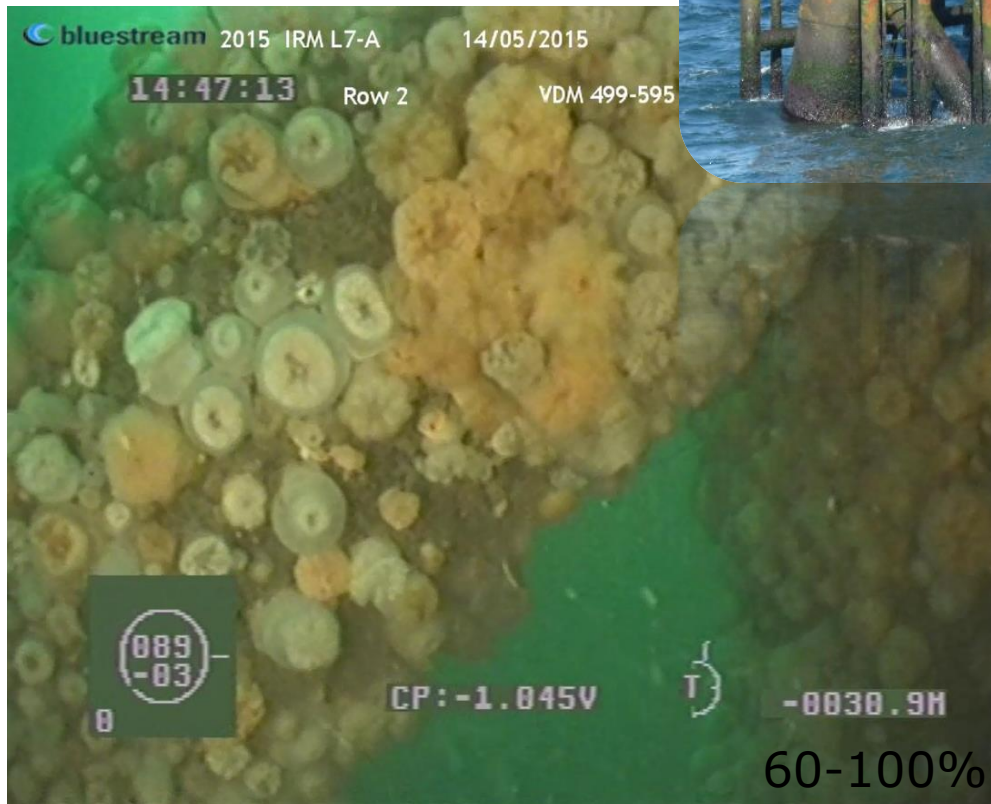
Das Bundesamt fuer Seeschifffahrt und Hydrographie uebernimmt fuer die hier wiedergegebenen Informationen keine Gewaehr.



ROV footage

0-4 m *Mytilys Edilus*

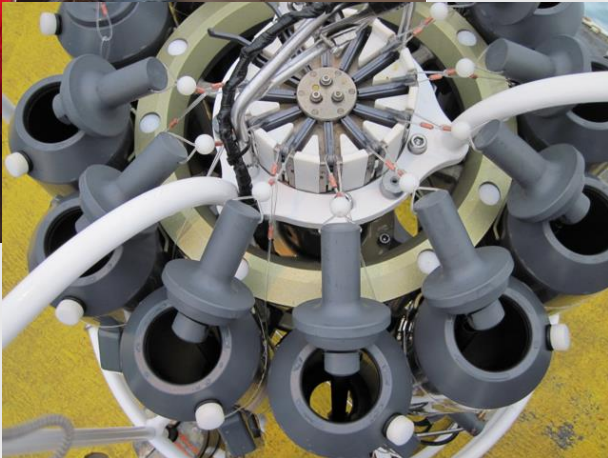
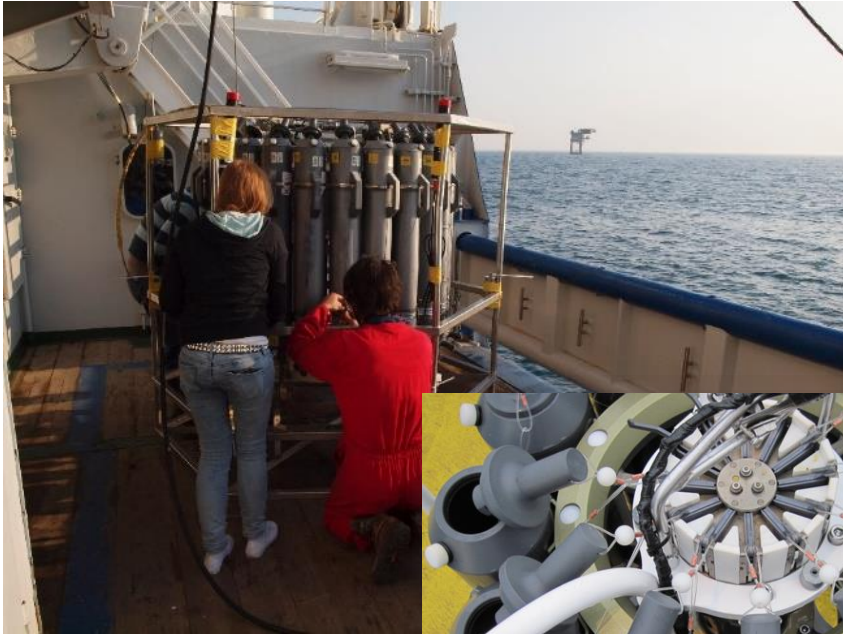
10-bottom *Metridium senile* ->
Density calculations of epifauna





Examine whether artificial structures act as biofilter and create a “SHADOW”

- Hydrodynamics
- Biogeochemistry (particulate and dissolved matter)



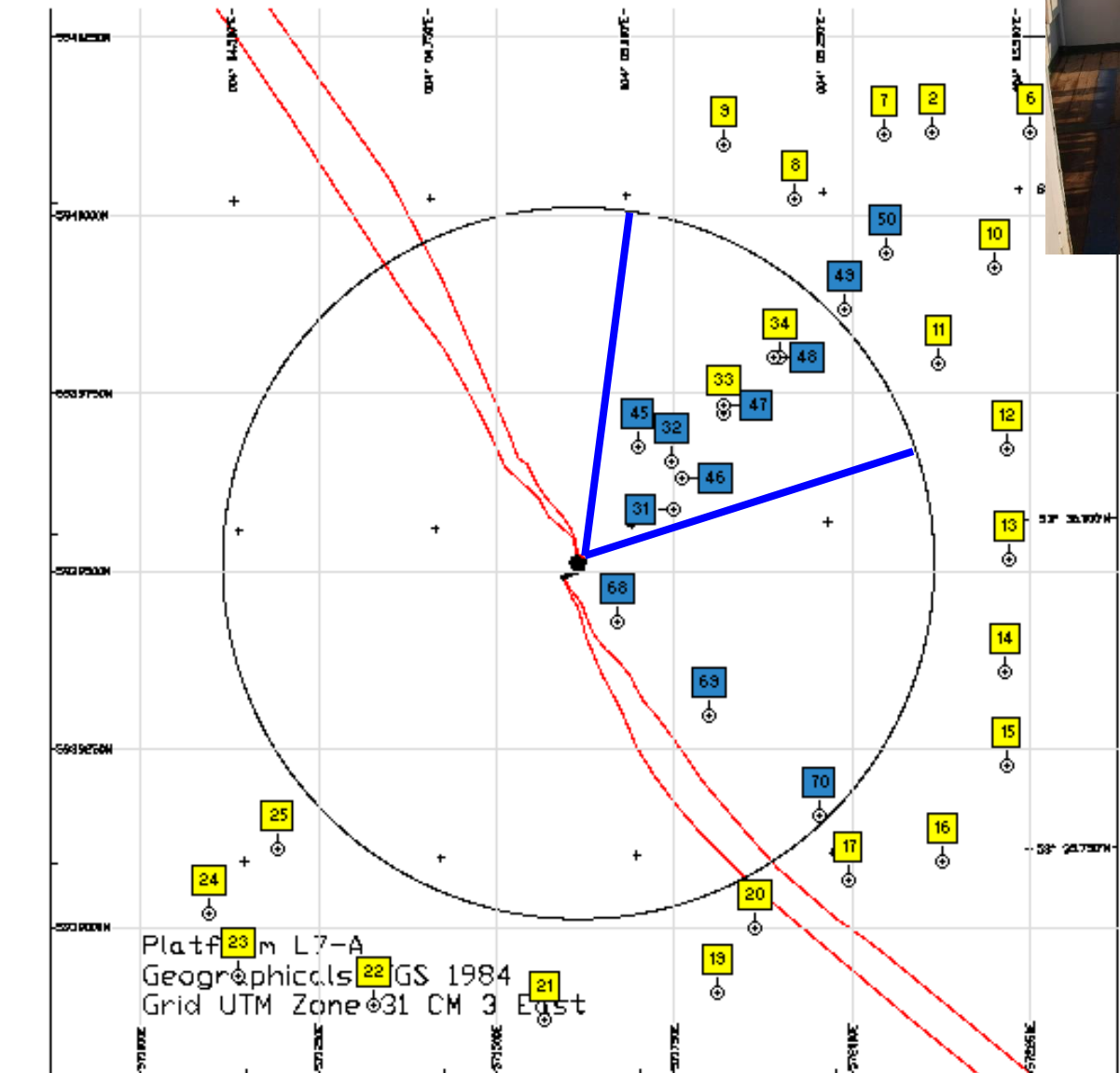
Water column profiling and sampling (POM, inorganic nutrients, DOC, DIC, DNA) with CTD/Rosette



NIOZ in-house designed benthic observatories: platforms for multitude of sensors

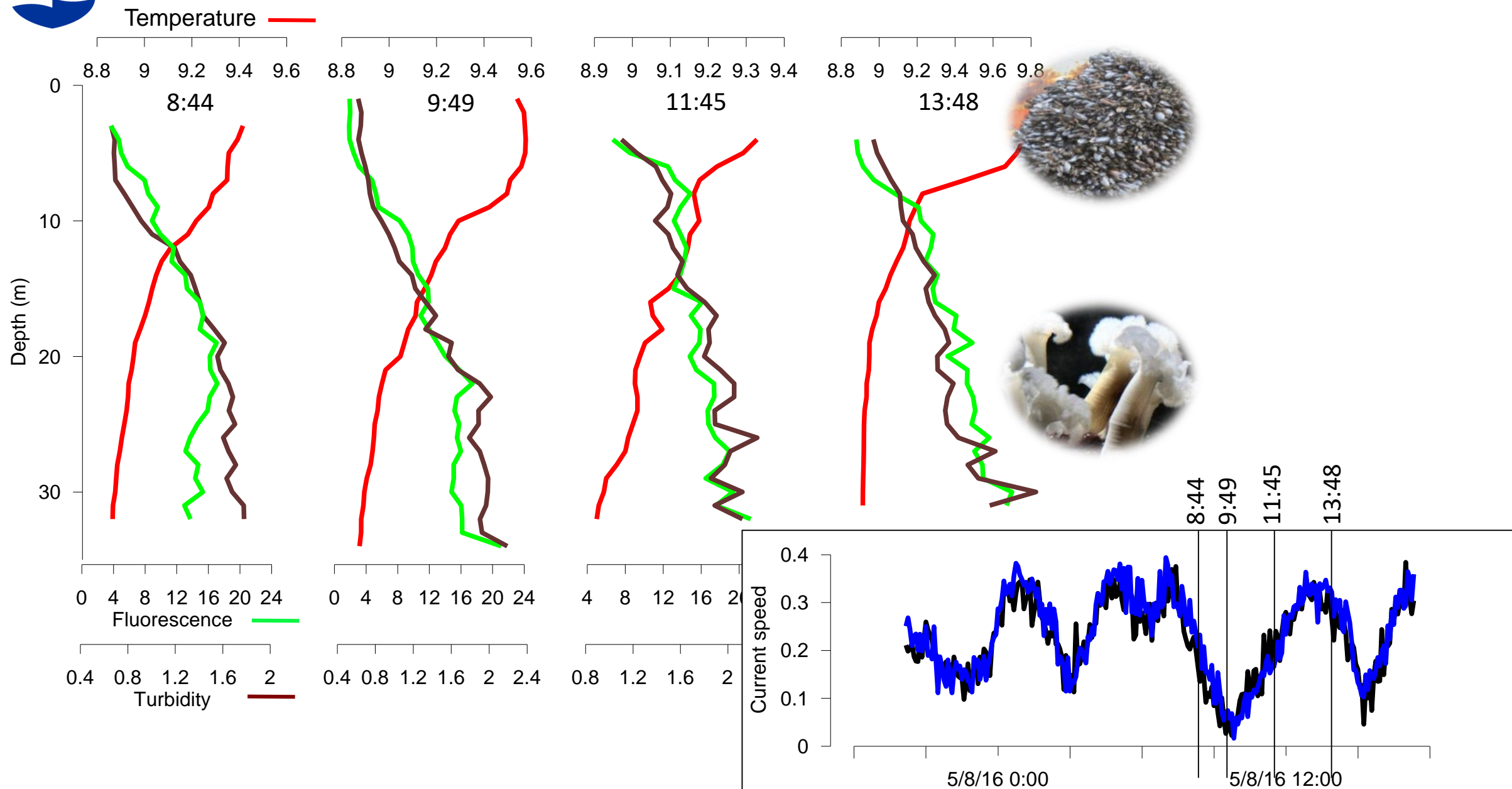


Sampling approach water column characteristics

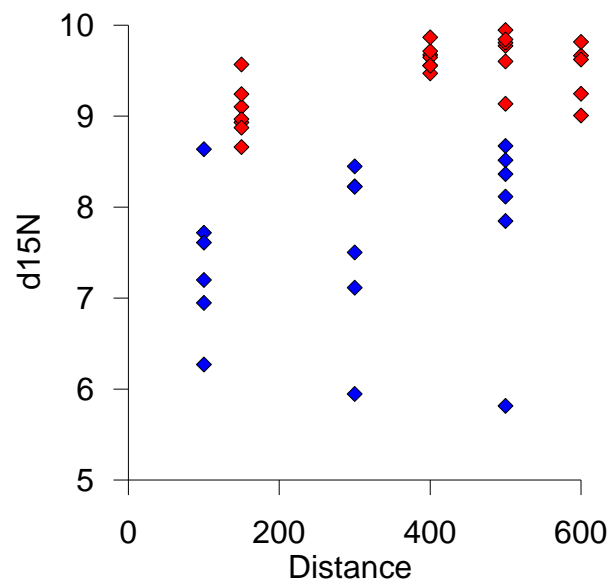
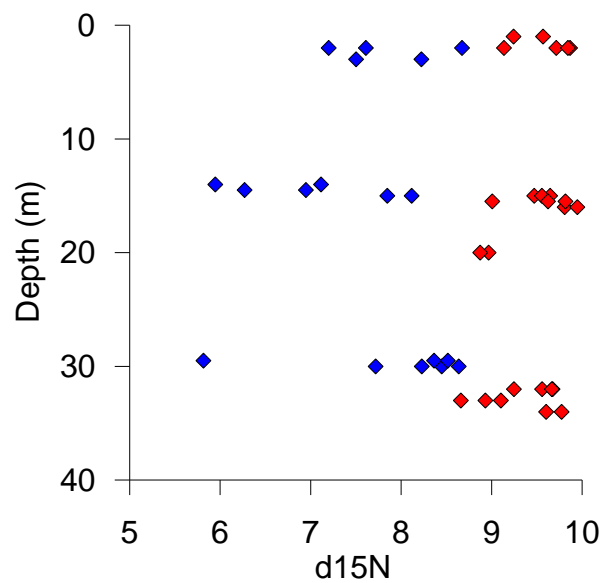
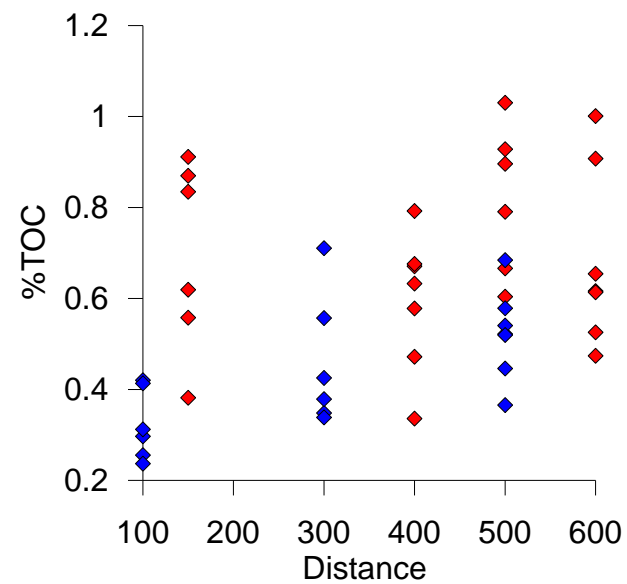
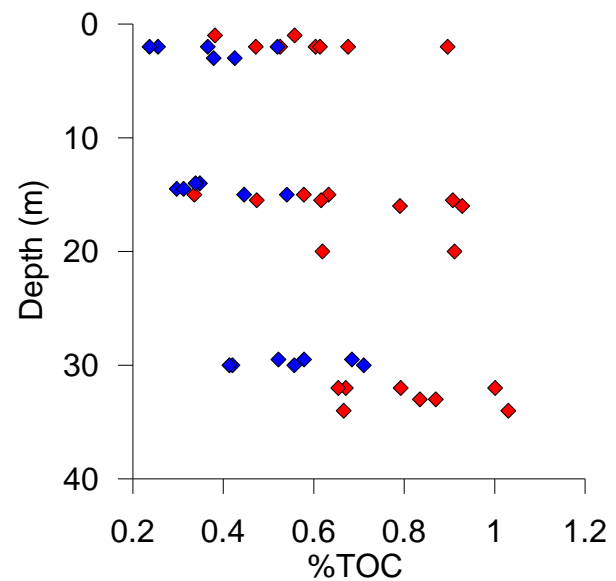


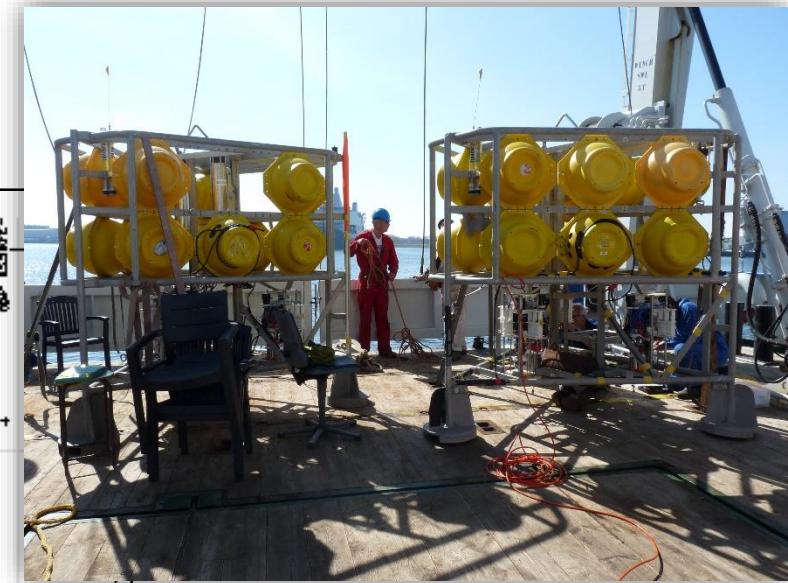
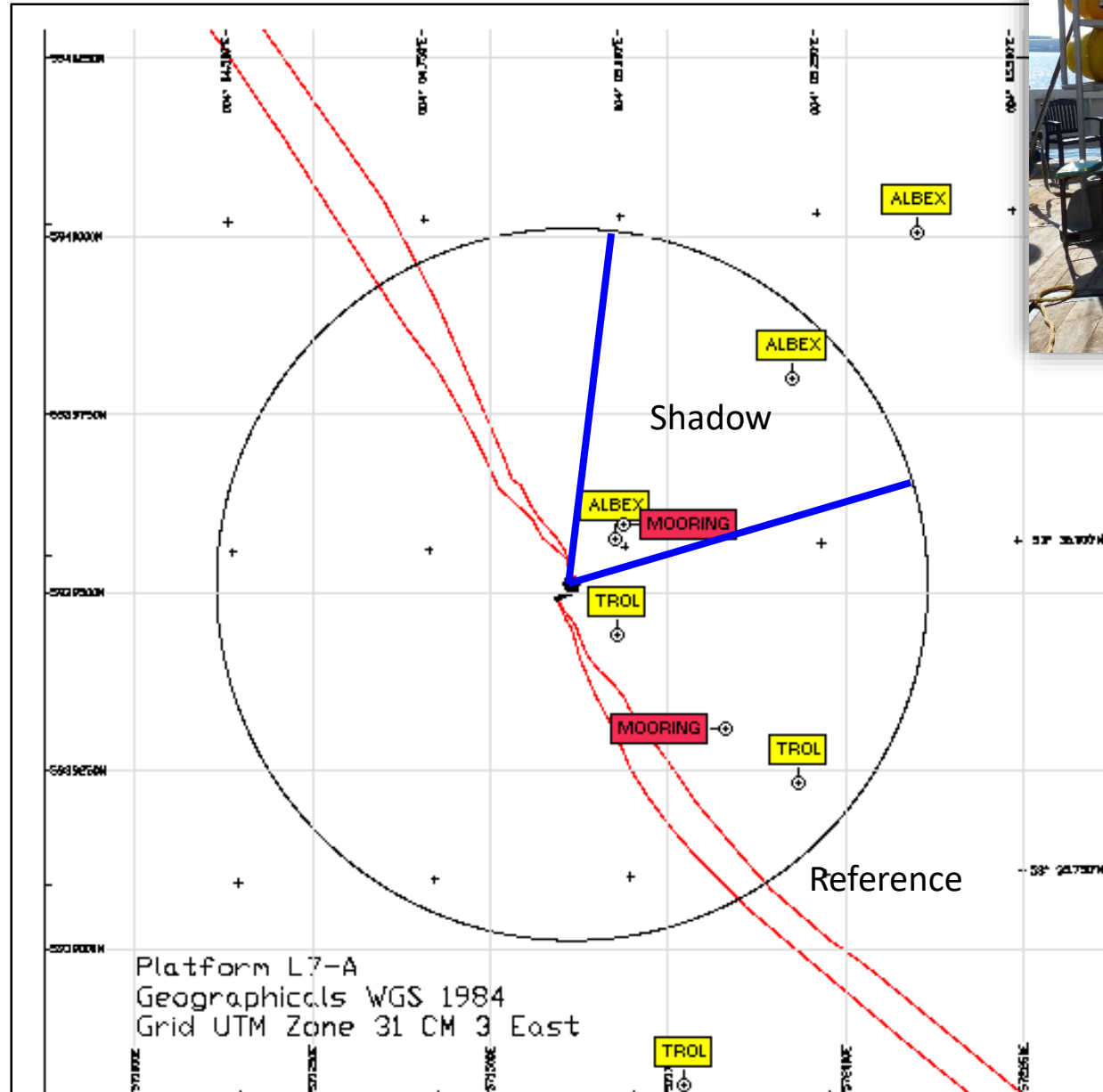


Water column characteristics



● Shadow
● Reference





Monitoring with bottom landers

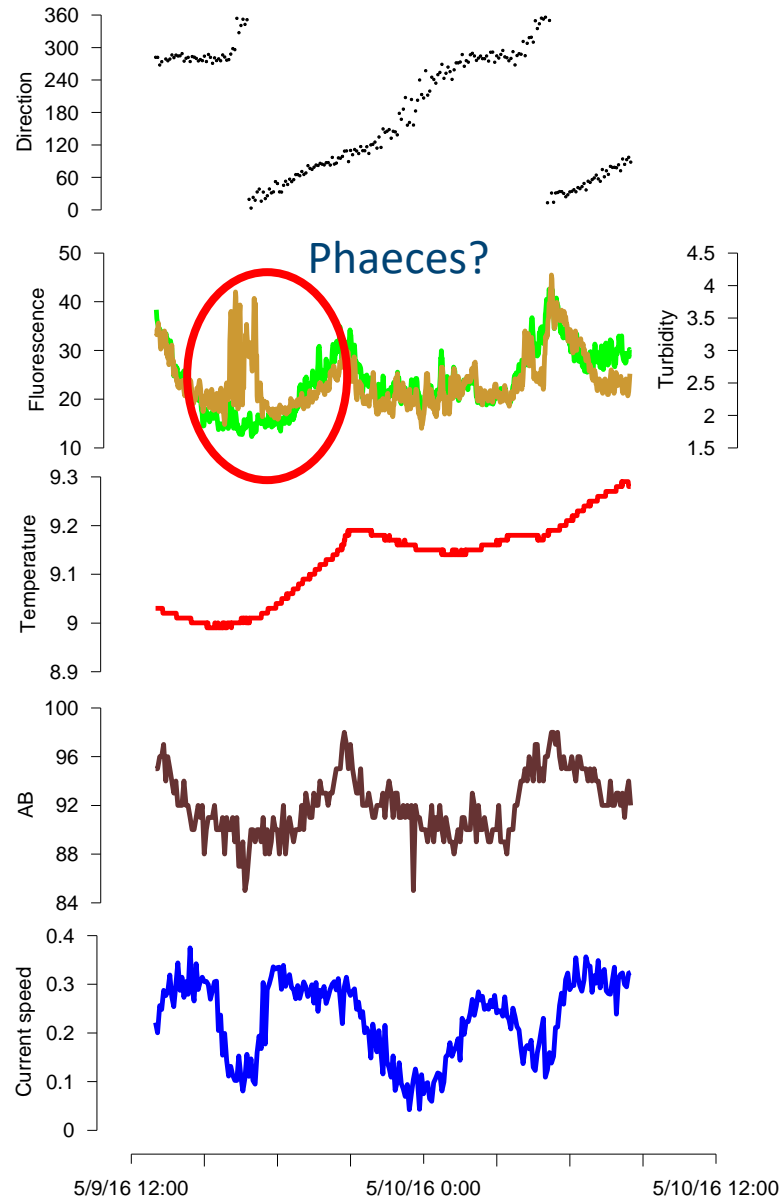
Observatories equipped with

- Benthic chambers (in situ incubations)
- Particle pump
- Current meter
- Turbidity sensor

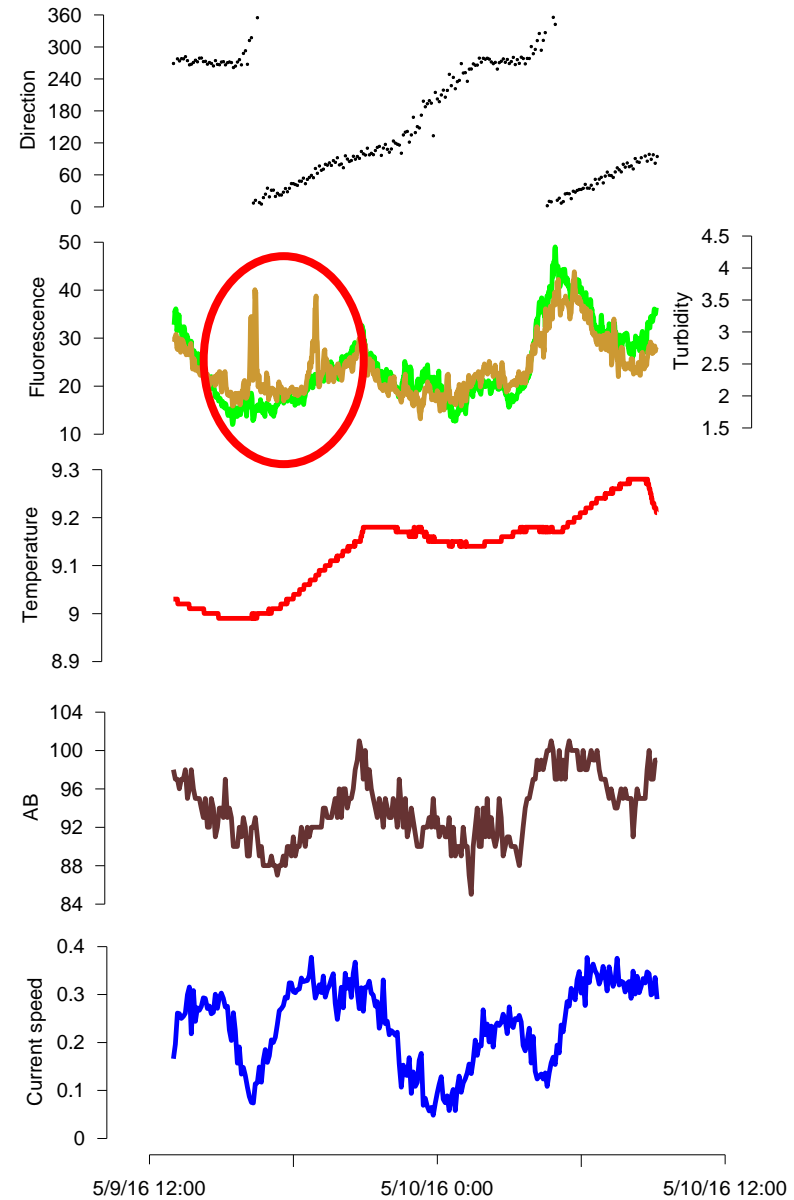


Results -> Landers at 100 m from platform

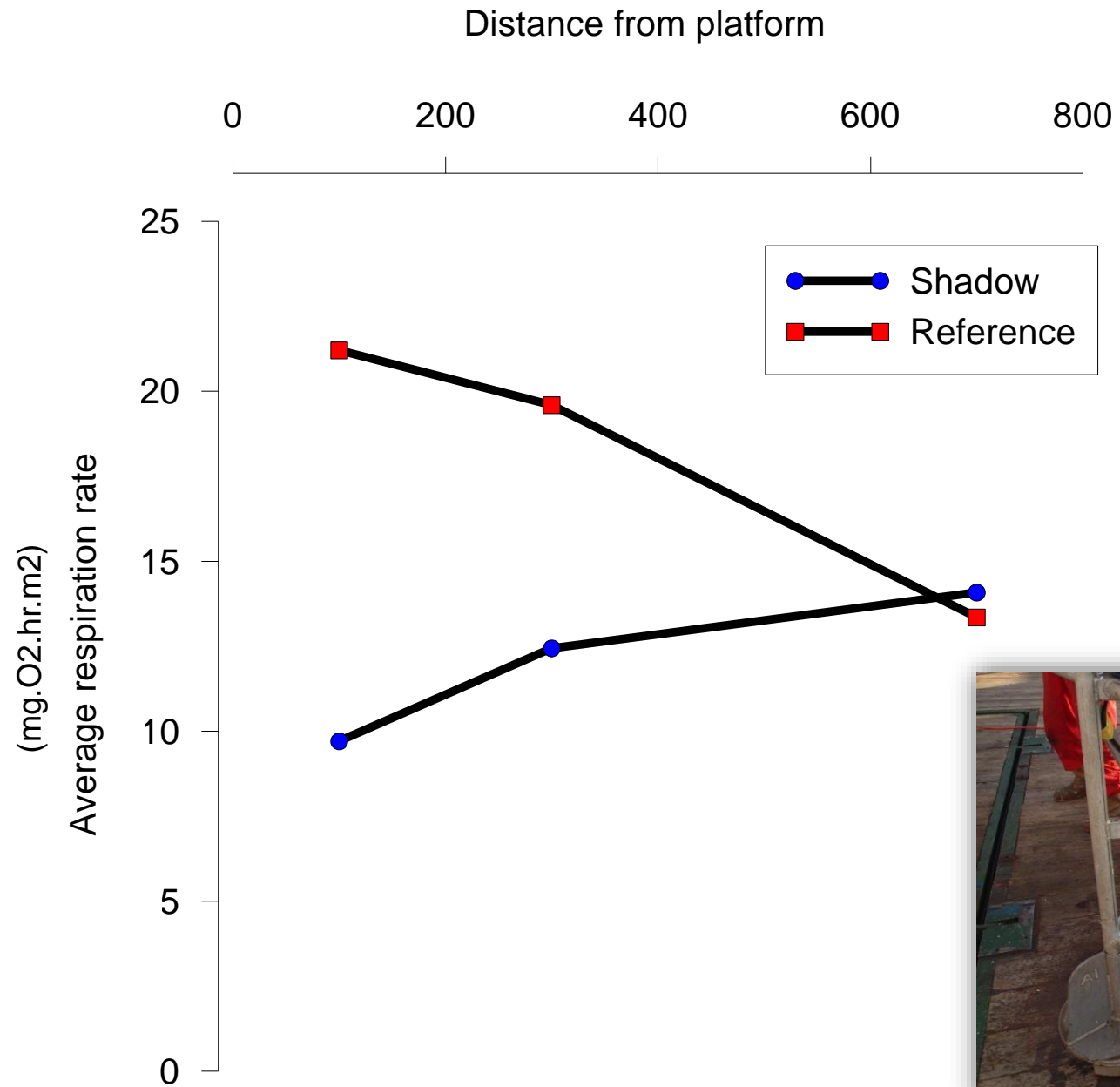
Shadow



Reference



In situ respiration experiments





Long term monitoring

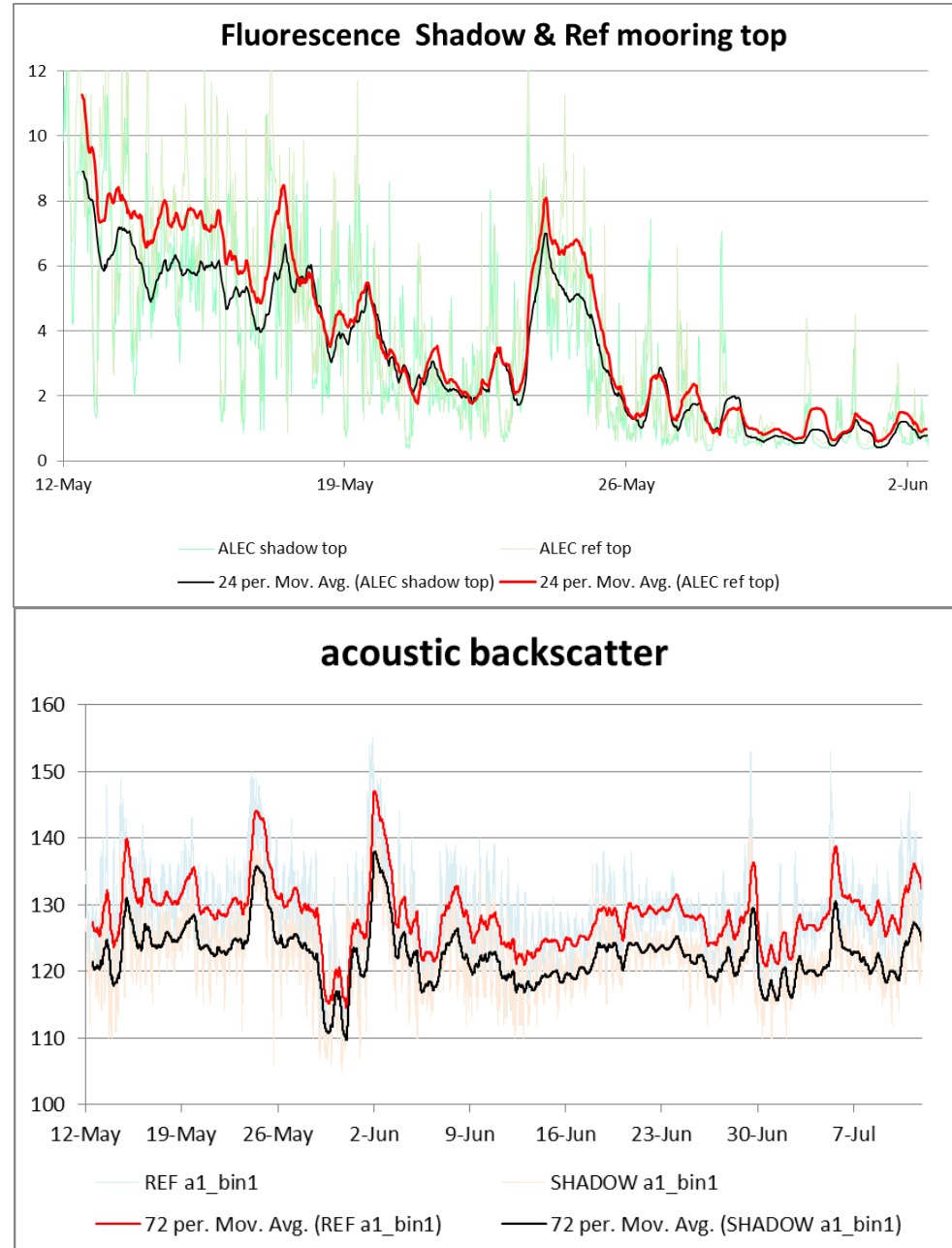
Two moorings deployed -> to capture impact of meteorological forcing, spring and neap tidal cycles and seasonal changes

Moorings were recovered 10-15 December 2016

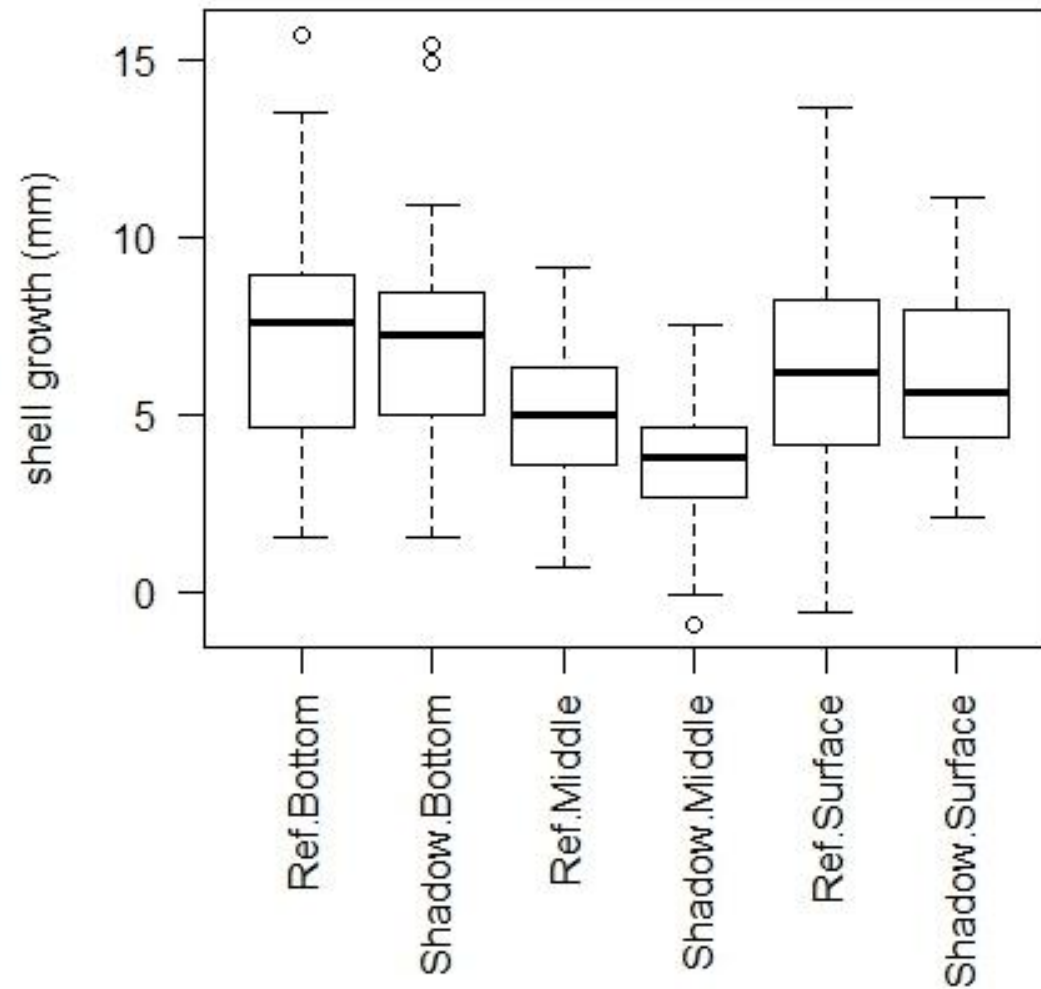


Moorings from top to bottom
overgrown with Mytilus ->
Different phases in overgrowth

Long term moorings



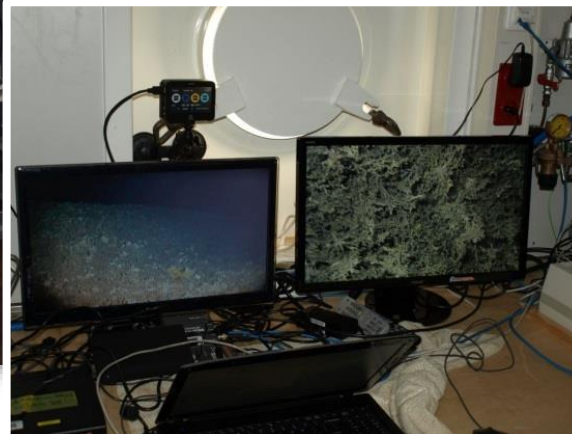
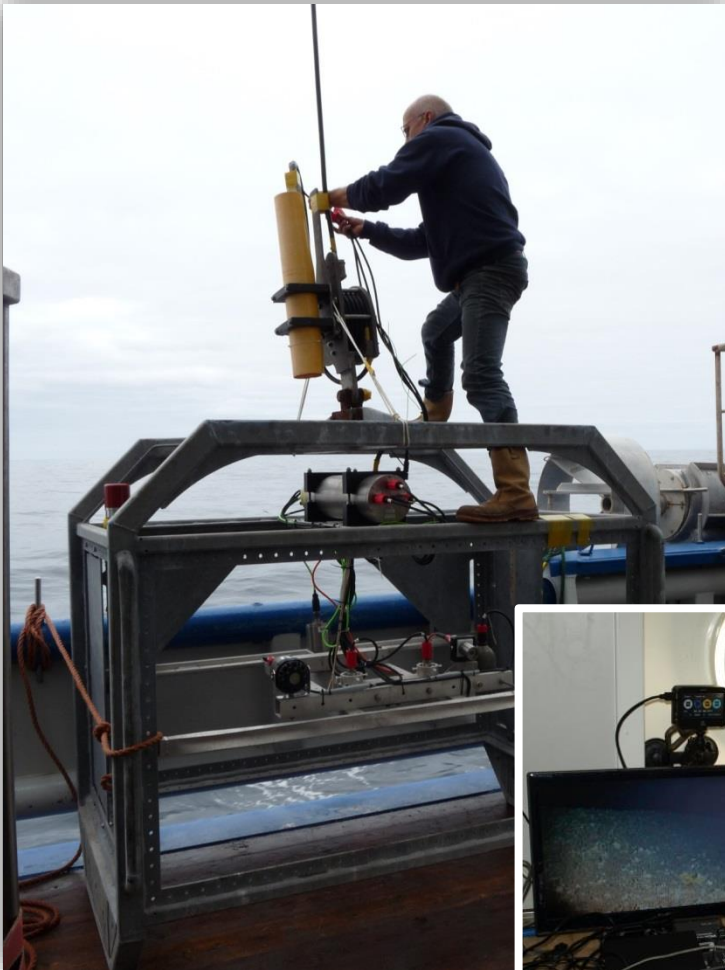
Mytilus shell growth INSITE 2016



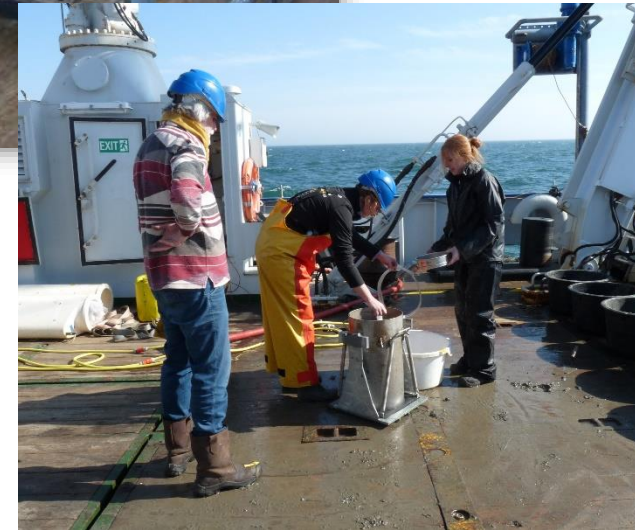


Examine whether the “SHADOW” has an impact on the surrounding benthic community

HD camera observations to define substrate and faunal abundance

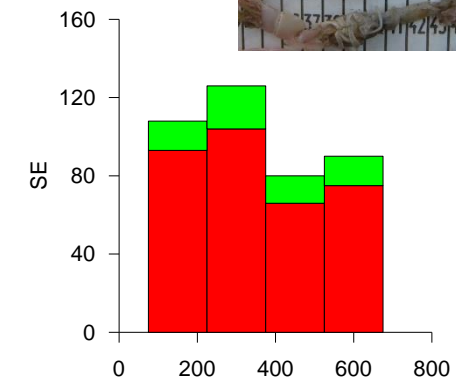
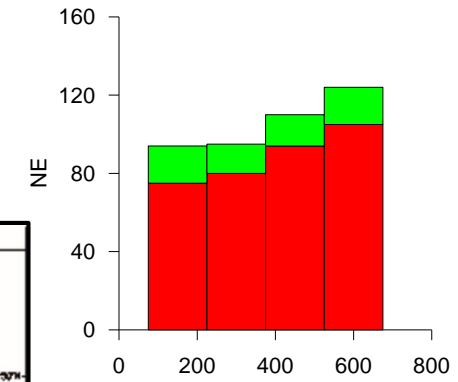
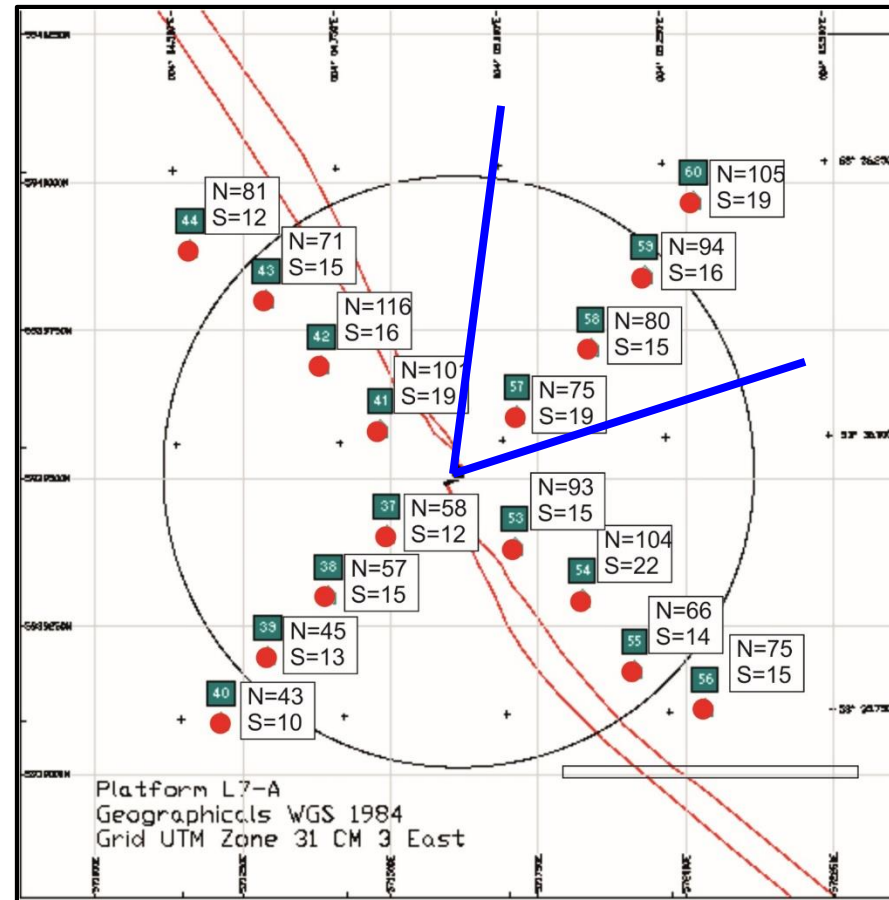
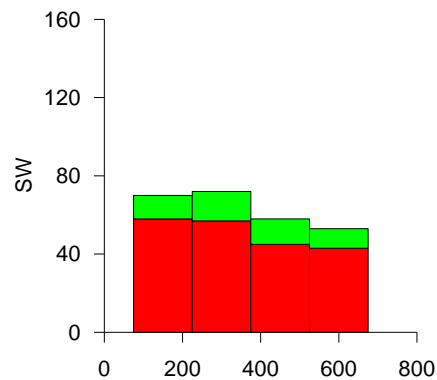
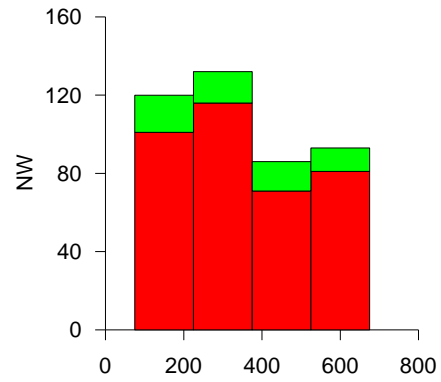


Sediment cores -> fauna and sedimentology



Benthic fauna

- Number of species
- Number of Individuals



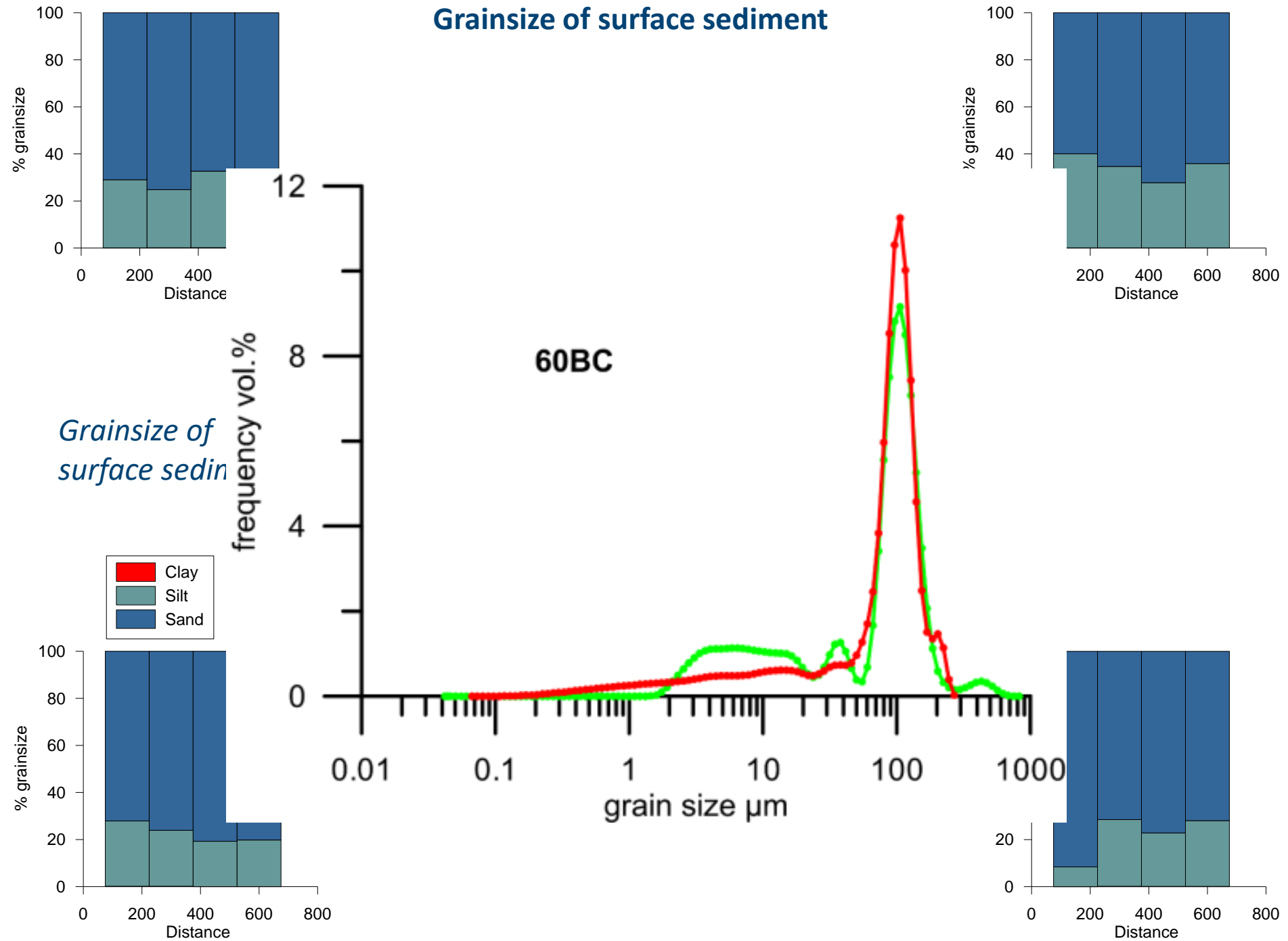
Results-> bottom sampling

*Mainly filter and
deposit feeders ->
particulate organic
matter*

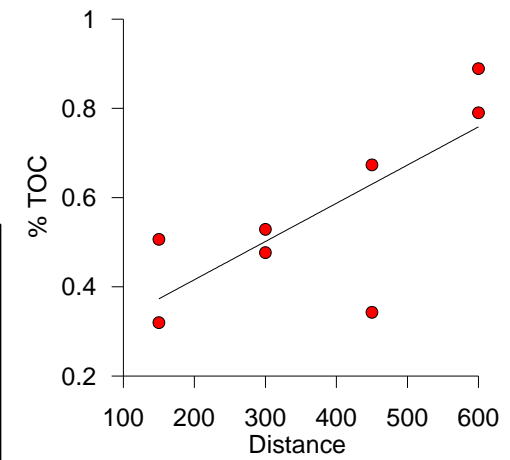
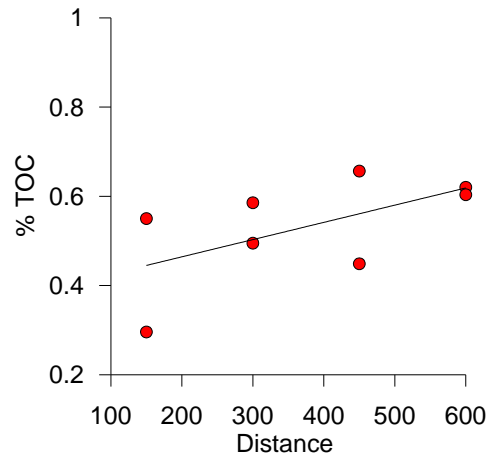
Species name	SumOfNumber		
Amphiura filiformis	641	brittle star	filterfeeder
Lumbrineris spec.	116	bristle worm	carnivore
Phoronida	101	phoronid (special phylum)	filterfeeder
Callianassa subterranea	87	burrowing shrimp	deposit feeder
Corbula gibba	42	small bivalve	filterfeeder
Ophiodromus flexuosus	35	bristle worm	carnivore
Nucula nitidosa	26	small bivalve	deposit feeder
Nereis longissima	23	bristle worm	carnivore
Upogebia deltaura	23	burrowing shrimp	deposit feeder



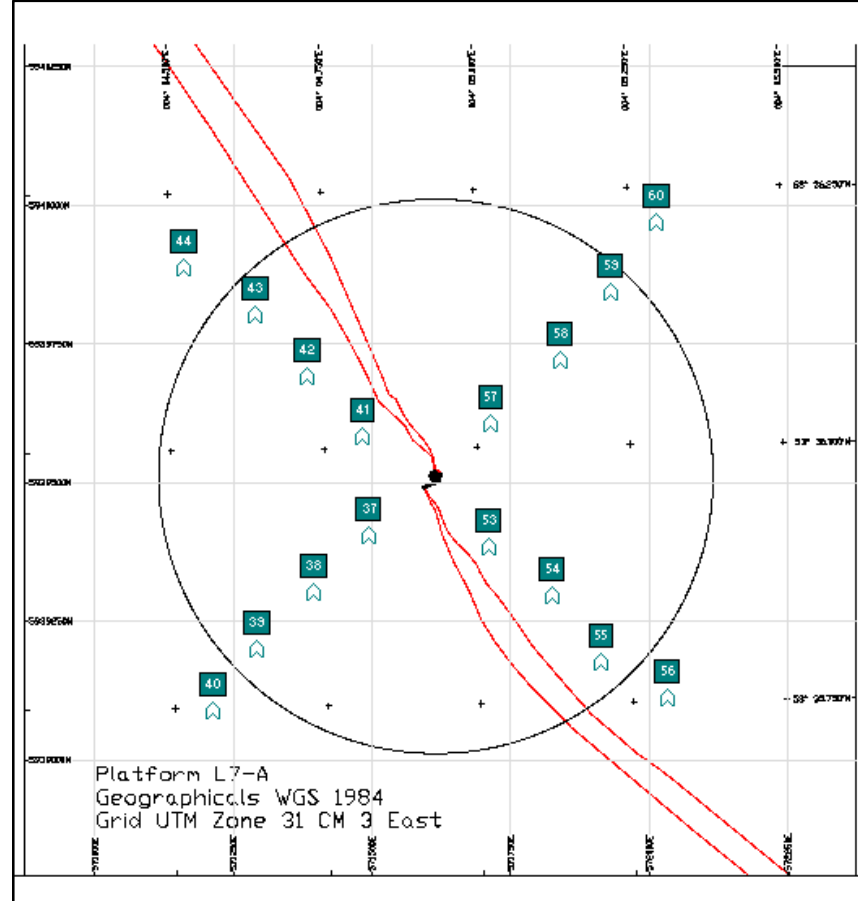
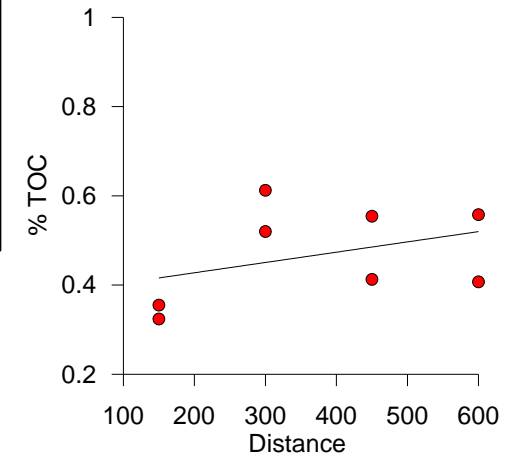
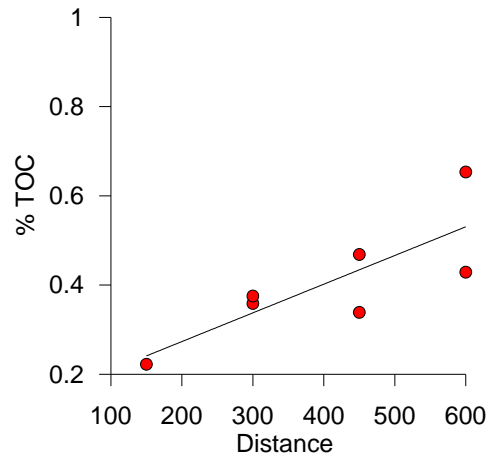
Grainsize of surface sediment



TOC of surface sediment



TOC of surface Sediment samples



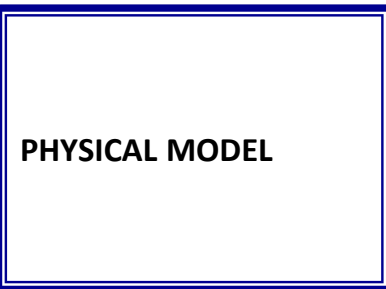


Model Three sub-models ->

to investigate extent of the SHADOW and to define if the obstacle causes an altered food supply.

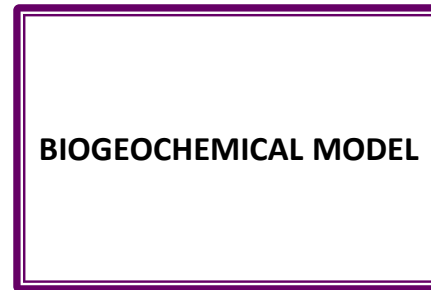
Processes affecting organic matter: Primary production, transport with currents and turbulence, passive sinking, (bio)deposition and resuspension, uptake by benthic organisms and pelagic decay

Air temperature
Air density
Wind speed and velocity
Solar radiation
Humidity
Air pressure



Temperature (T)
Turbulence (K_z)

Solar radiation



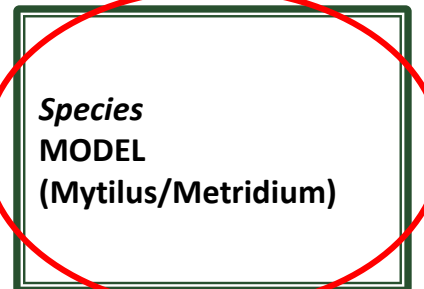
Nutrients
Food provision
Respiration
Excretion
Pseudofaeces
Faeces
Dislodgement



**Solved with ReacTran
(Soetaert and Meysman,
2009)**

Meire et al. (2009)

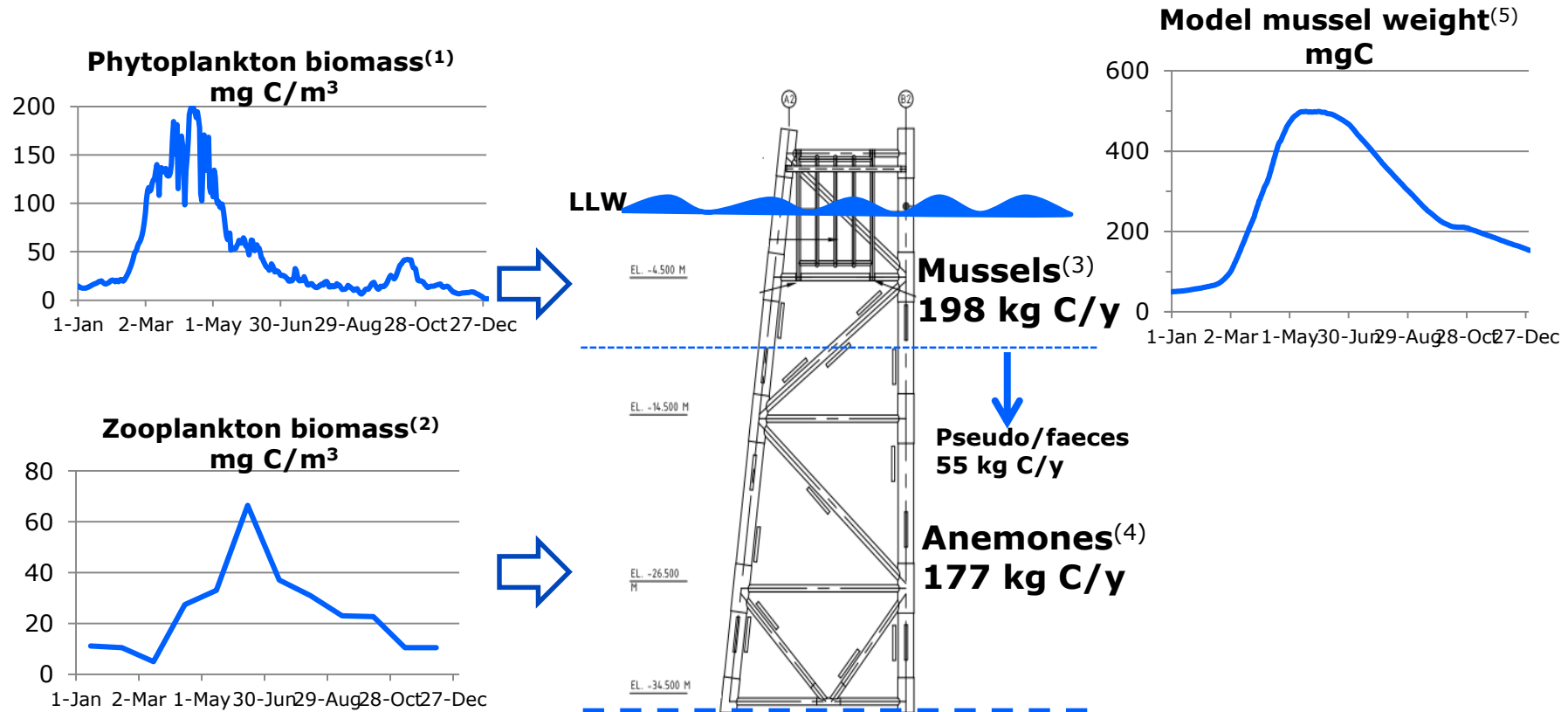
Temperature (T)



Mechanistic description of the three main sessile feeding groups: filter feeders, passive suspension feeders, and deposit feeders

Coupling pelagic and benthic processes, using the output of an existing hydrodynamic model (e.g. GETM)

Model – one dimensional



1. Data from ERSEM model run
2. Data SAHFOS – Broekhuizen et al.
3. Estimated coverage (0.4 kg DW.m⁻², 400 ind.m⁻², surface area 535 m²)
4. Estimated coverage (0.3 kg DW.m⁻², 200 ind.m⁻², surface area 1350 m²)

Carbon consumption by Mussels and Anemones estimated on the basis of available data on individual ingestion and/or respiration

“establish the magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales”

An effect of the presence of the platform is observed ->

Fauna, water column data, suspended matter, near-bed hydrodynamics

What is causing these changes?

- ❖ Epifauna
 - ❖ or just the platform itself
 - ❖ Combination of both
- } model

Did we measure at the right scale and at the right density/frequency?

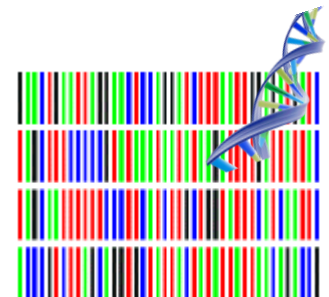
What is the extent of the “SHADOW”

- ❖ Some changes are observed at distances larger than 500 m
- ❖ Higher sampling frequency
- ❖ Epifauna in the wider North Sea

Ongoing research

- Complete the model, also for deep-water platform
- Larval studies (eDNA) to compare supply of species with those actually settling
- Analysis of samples collected at further distance from the platform

“to what extent, if any, the man-made structures in the North Sea represent a large inter-connected hard substrate system”



Outreach and awareness

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Acknowledgements: Crew and technicians of the RV Pelagia and VOS Sweet, Total, Rieneke Gieles and Ronald van Bommel