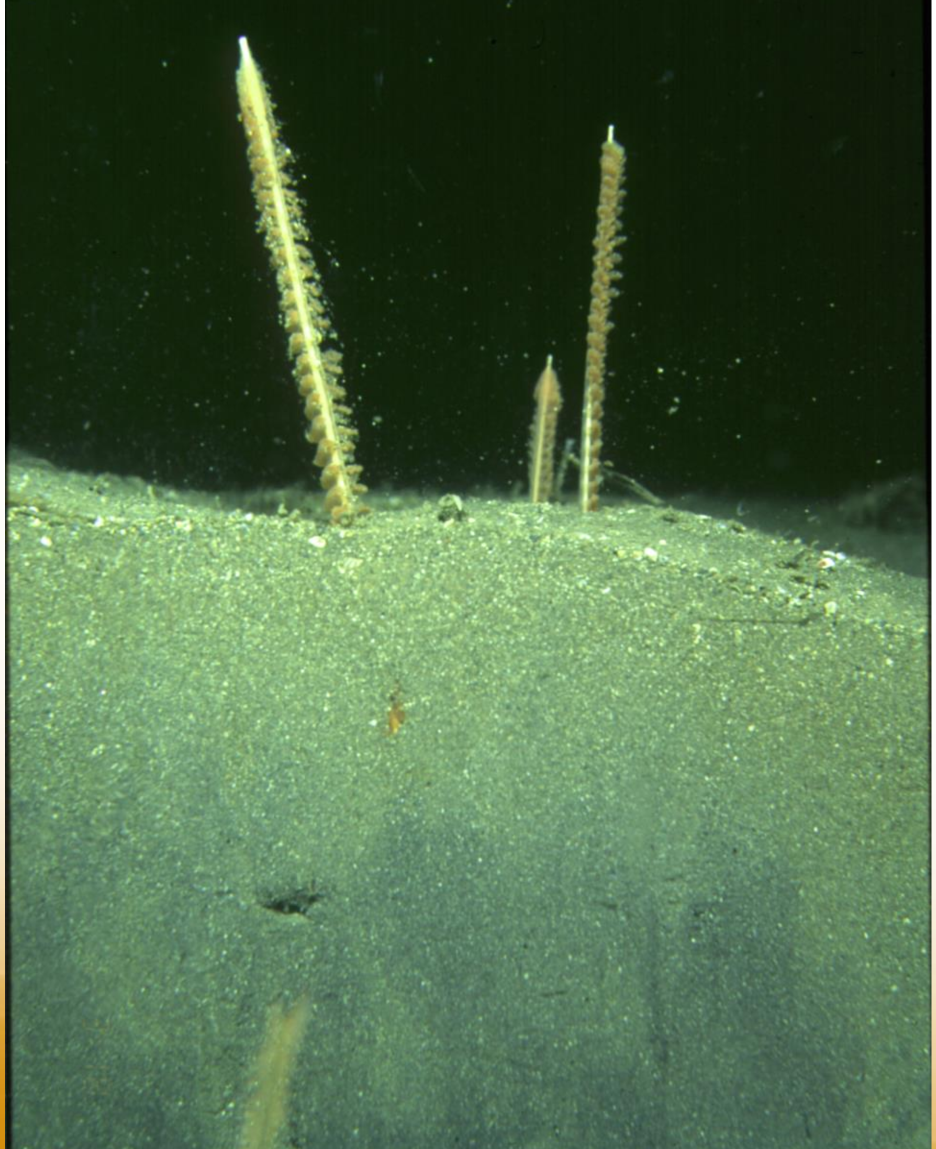
Biogeochemistry, macronutrient and carbon cycling in the benthic layer (BMCC)



SAMS

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Oxygen dynamics in shelf sediments

SAMS

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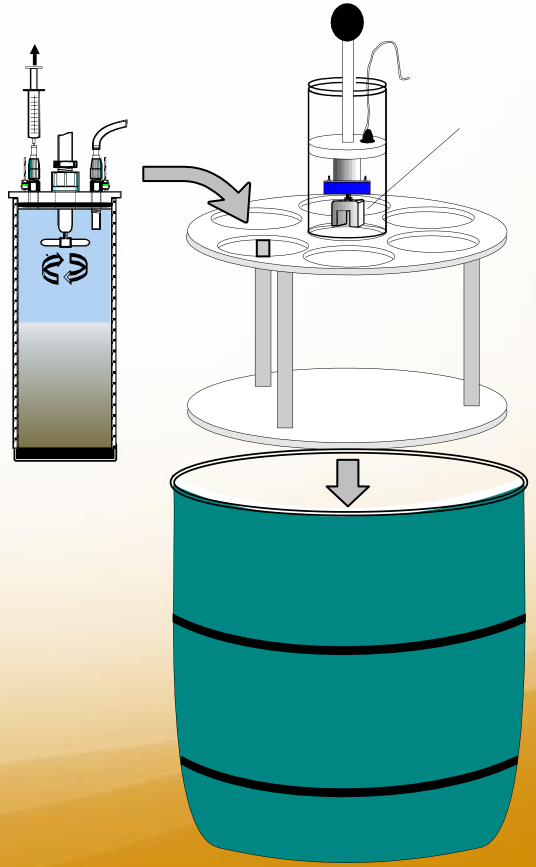
Overview of SAMS work

Sediment cores collected on each cruise at each of the four main benthic sites

Six sub-sampled NIOZ cores taken per site per cruise and incubated ~36 hours

- Oxygen consumption (total oxygen uptake rates)
- Microprofiling (OPD and diffusive oxygen uptake rates)



Sliced cores (x3)

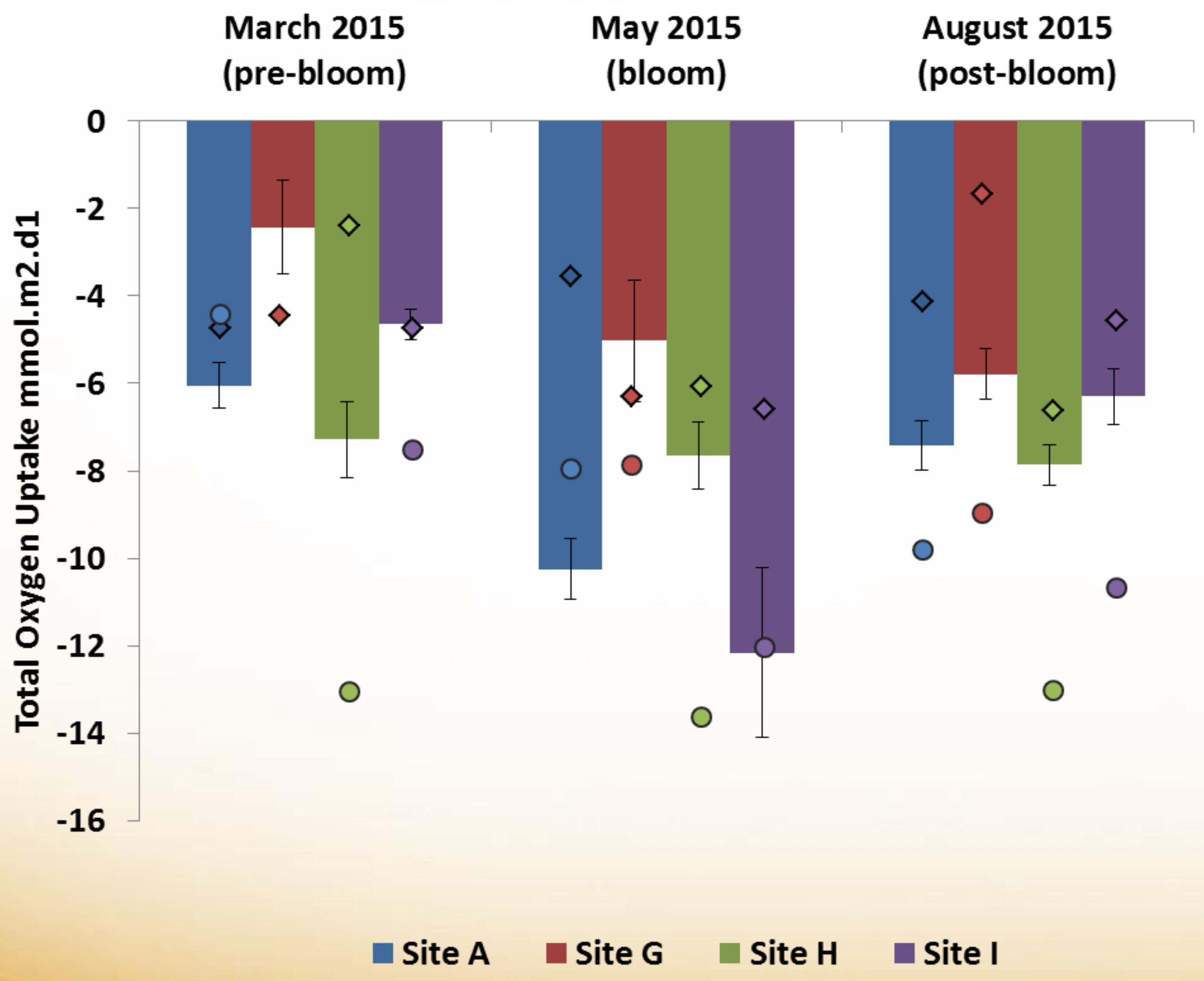
- ^{210}Pb
- POC/PON
- Porosity

Overview of SAMS work

	DY008*	DY021	DY030	DY034	*Sites sampled & analysed*
O_2 incubations	X	X	X	X	A, G, H, I
O_2 microprofiling	X	X	X	X	A, G, H, I
Total Organic Carbon profiles	**	X	X	X	A, G, H, I CaNDyFloSS
Total Inorganic Carbon profiles	**	X	X	X	A, G, H, I CaNDyFloSS
Total Nitrogen profiles	**	X	X	X	A, G, H, I CaNDyFloSS
C:N ratio profiles	**	X	X	X	A, G, H, I CaNDyFloSS
Pb^{210} (sediment accumulation)	**	X	X	X	A

CaNDyFloSS not sampled during DY008
***** samples collected, not analysed***

Benthic Oxygen dynamics - TOU



Solid bars – SAMS incubations

◊ - Data from Vas Kitidis

◯ - Data from Helen Smith / Dan Mayor

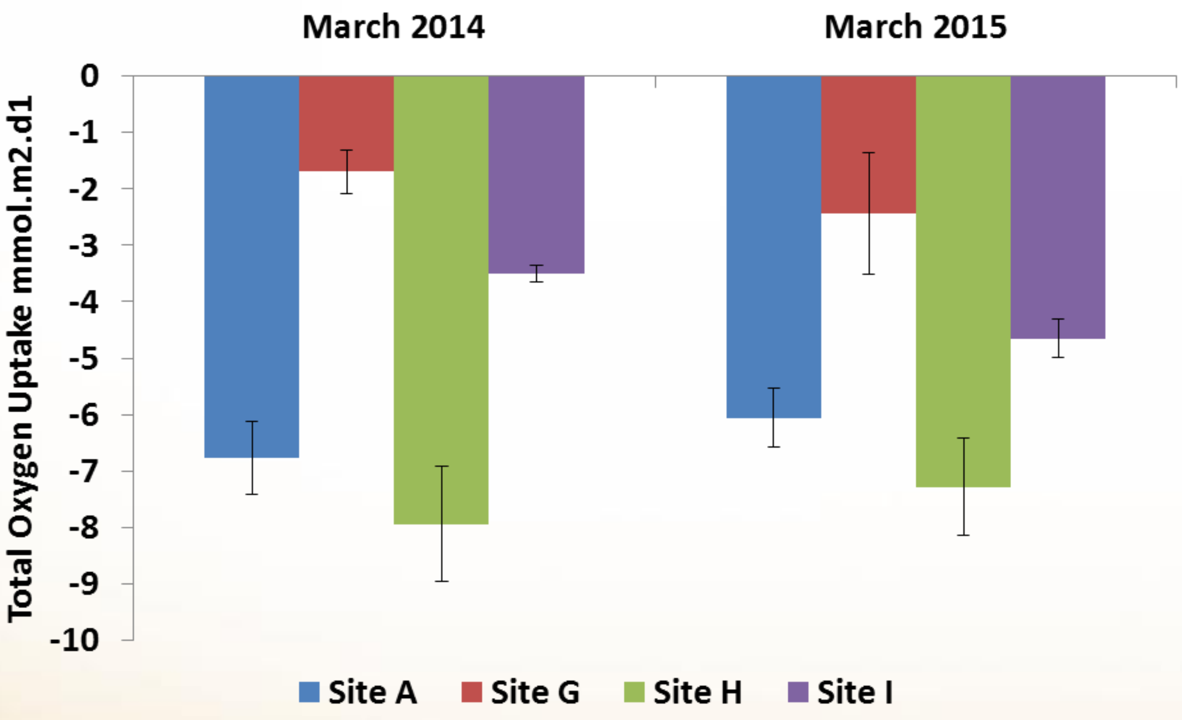
Incubations provide **total oxygen uptake (TOU)** rates

- Oxygen consumption changes with sediment type (see permeable sand (red, Site G) vs cohesive mud (blue, Site A))
- Increase in TOU with bloom – supplies organic matter to the sediment surface
  - High at bloom in mud (blue, Site A) and sandy mud (purple, Site I)

TOU = ALL oxygen consumption (faunal and microbial respiration & chemical oxygen demand)

Hicks et al, 2017, Biogeochemistry

Benthic Oxygen dynamics - TOU



Incubations provide **total oxygen uptake (TOU)** rates

- No difference between the two pre-bloom cruises (DY008, 2014 and DY021, 2015)

TOU = ALL oxygen consumption (faunal and microbial respiration & chemical oxygen demand)

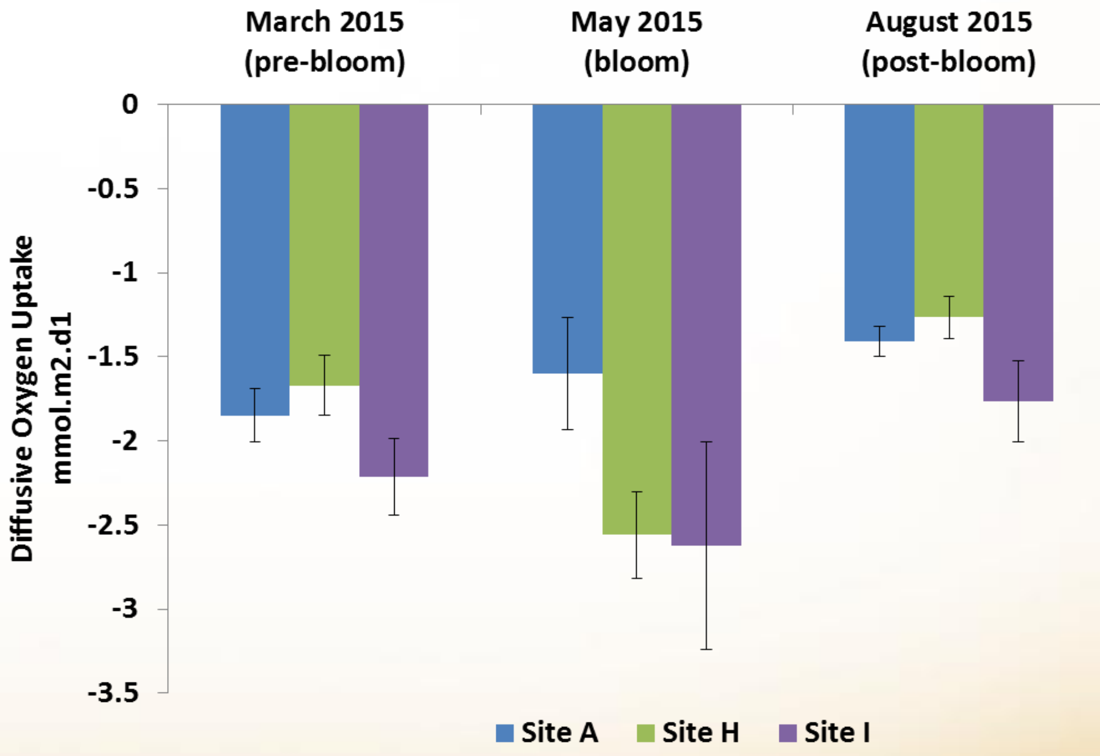
Hicks et al, 2017, Biogeochemistry

Benthic Oxygen dynamics - DOU

Oxygen microprofiles provide

- **Diffusive oxygen uptake (DOU)** rates – diffusive oxygen exchange across sediment water interface
    - microbial respiration and chemical oxidation
- Oxygen penetration depth (OPD) in sediment

- High resolution microprofiles needed (200µm increments) – capture diffusive boundary layer
    - Sites A, H, I



Hicks et al, 2017, Biogeochemistry

Benthic Oxygen dynamics - DOU

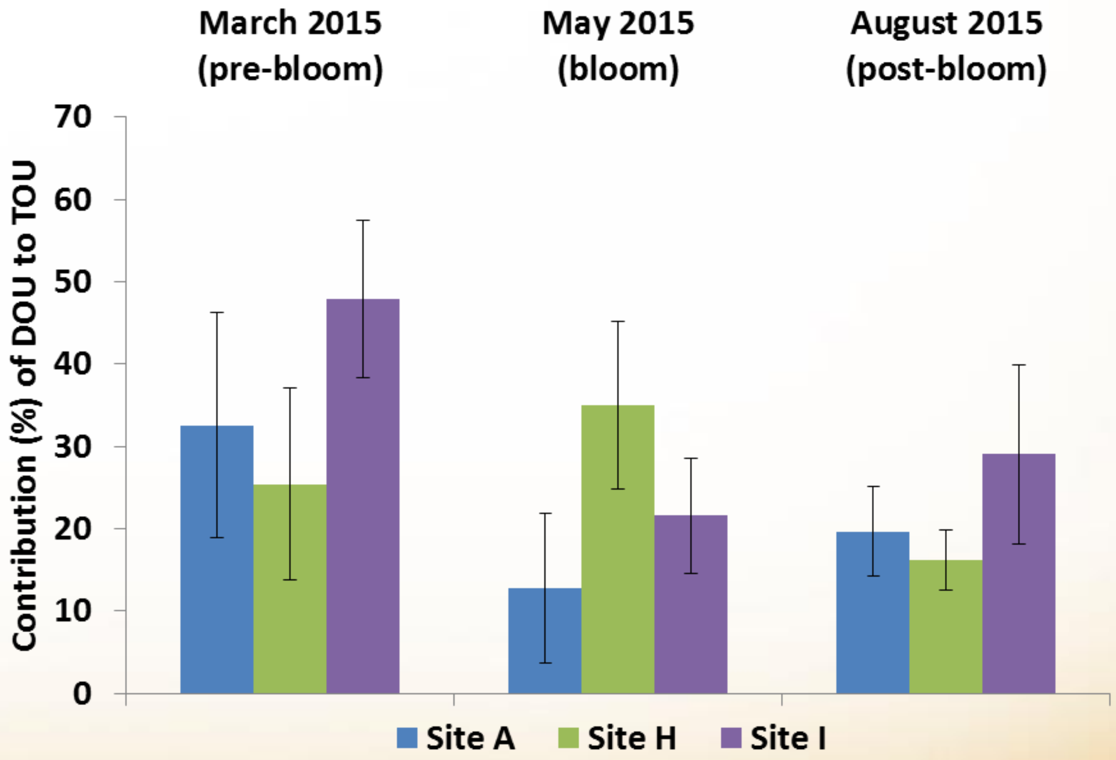
Difference between TOU and DOU = faunal contribution:

- Faunal mediated Oxygen Uptake (FOU)

Role of fauna (macro and meio) increases at all sites in response to bloom (May)

Site H (**green, muddy sand**) decrease in faunal contribution / increase in DOU during bloom

Fauna dominate oxygen consumption across all sites

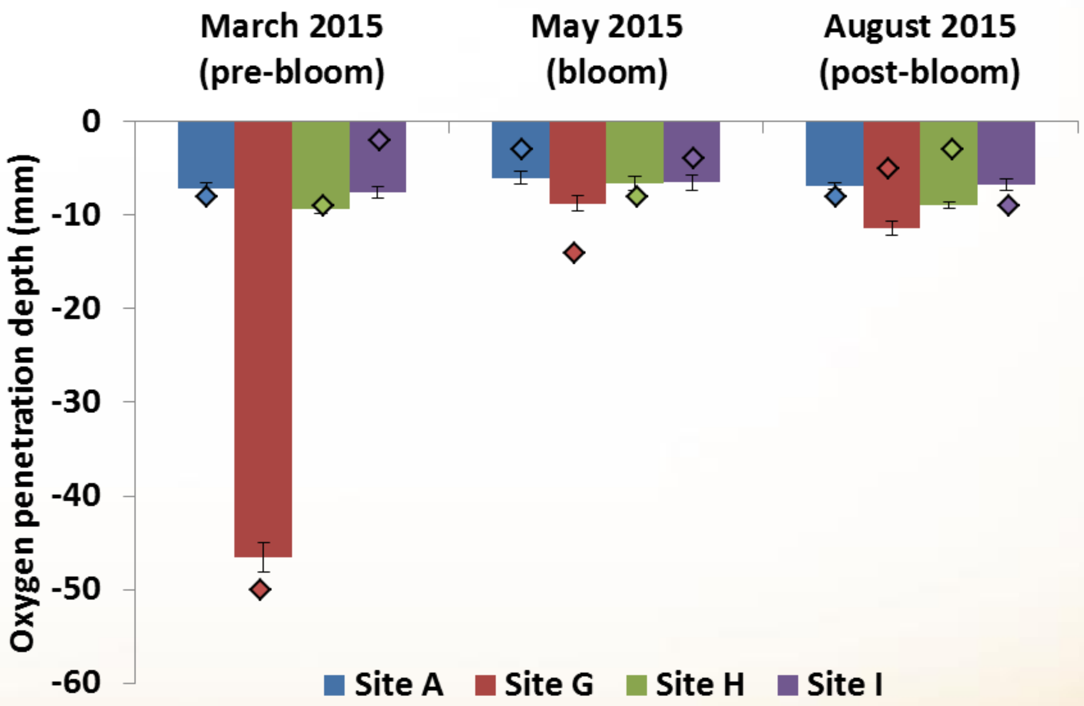


Hicks et al, 2017, Biogeochemistry

Benthic Oxygen dynamics - OPD

Oxygen penetration depth (OPD)

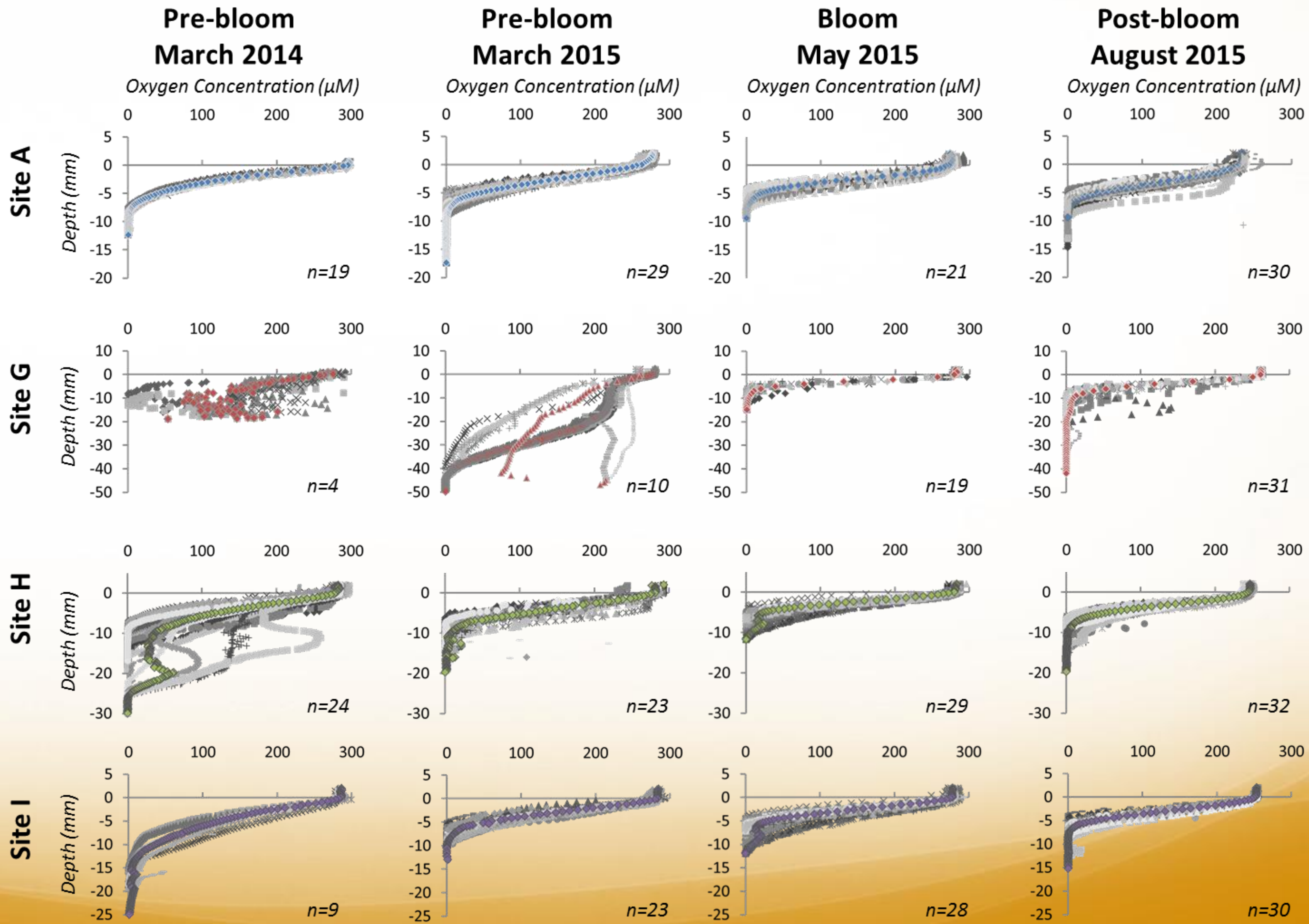
- SAMS & CEFAS microprofiles
- Changes with sediment type (deepest in permeable Site G (sand, red)
- Shoaling OPD during bloom = reduced oxic layer due to increased organic matter at sediment surface



Solid bars – SAMS profiles
◊ - CEFAS profiles

Hicks et al, 2017, Biogeochemistry

- > 300 oxygen microprofiles taken and analysed
- Variability in OPD within and between sites
- Clear evidence of faunal activity (e.g. burrows) e.g. Site H (**green, muddy sand**)



Hicks et al, 2017, Biogeochemistry

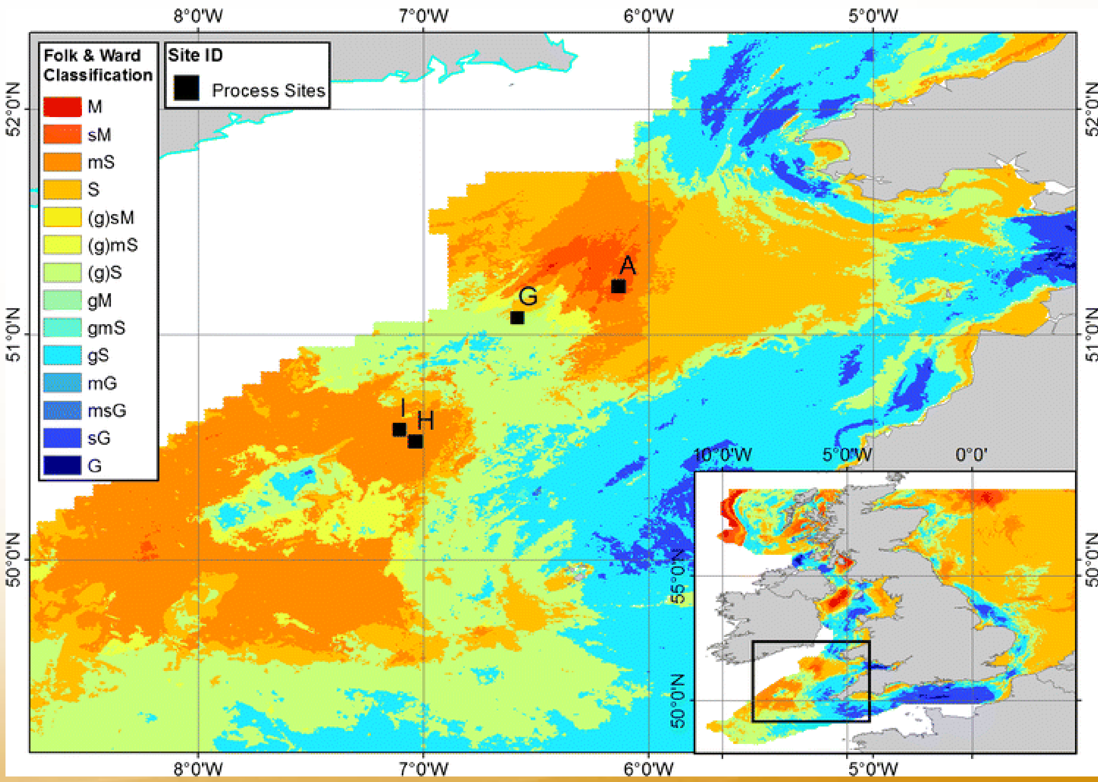
Relevance of Oxygen Dynamics

Benthic oxygen uptake an accepted proxy for carbon mineralisation

Research bias towards cohesive sediments – yet much of the shelf seas are dominated by permeable sediments

Significant difference between oxygen dynamics of **different sediments**, and **strong seasonal differences**

Benthic carbon mineralisation influenced by sediment type and season (bloom / non-bloom) – <u>should not assume same baseline for all sediment types</u>

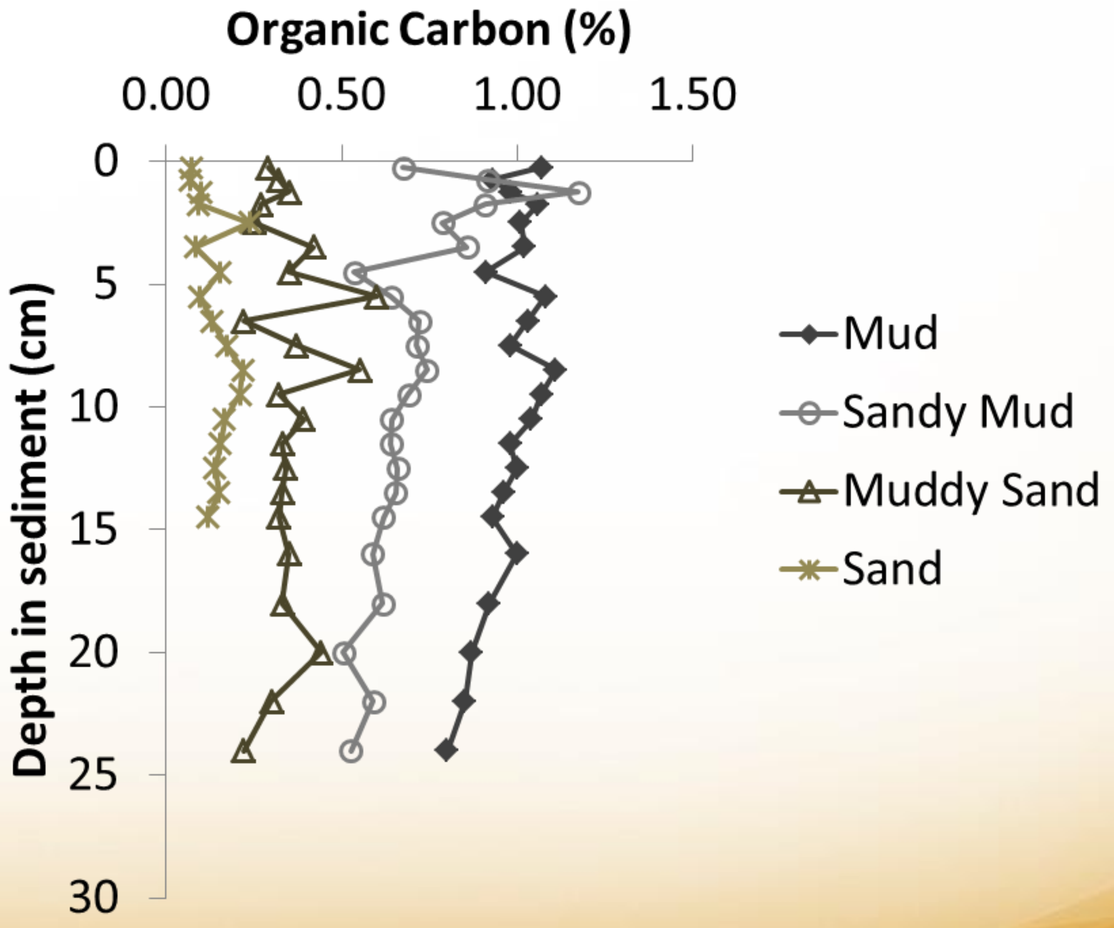


Hicks et al, 2017, Biogeochemistry (figure: B Silburn, CEFAS)

Direct carbon measurements

Total carbon content in sediment measured from sliced cores

Carbon content linked to sediment type (porosity / permeability / grain size)



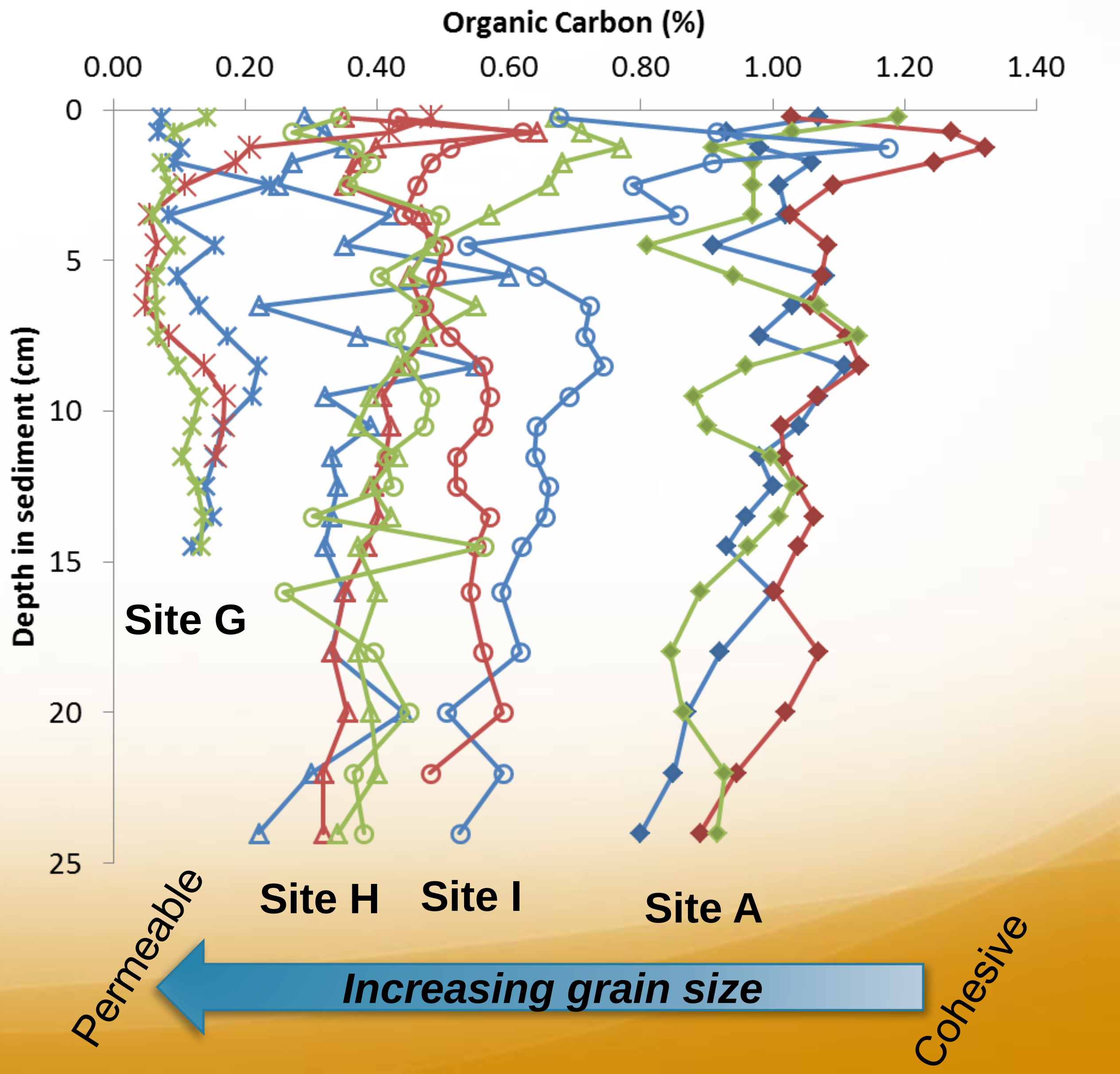
Direct carbon measurements

Total carbon content in sediment measured from sliced cores

Carbon content linked to sediment type (porosity / permeability / grain size)

Peak in surface carbon content during bloom

DY021 (pre bloom)
DY030 (bloom)
DY034 (post bloom)



Direct carbon measurements

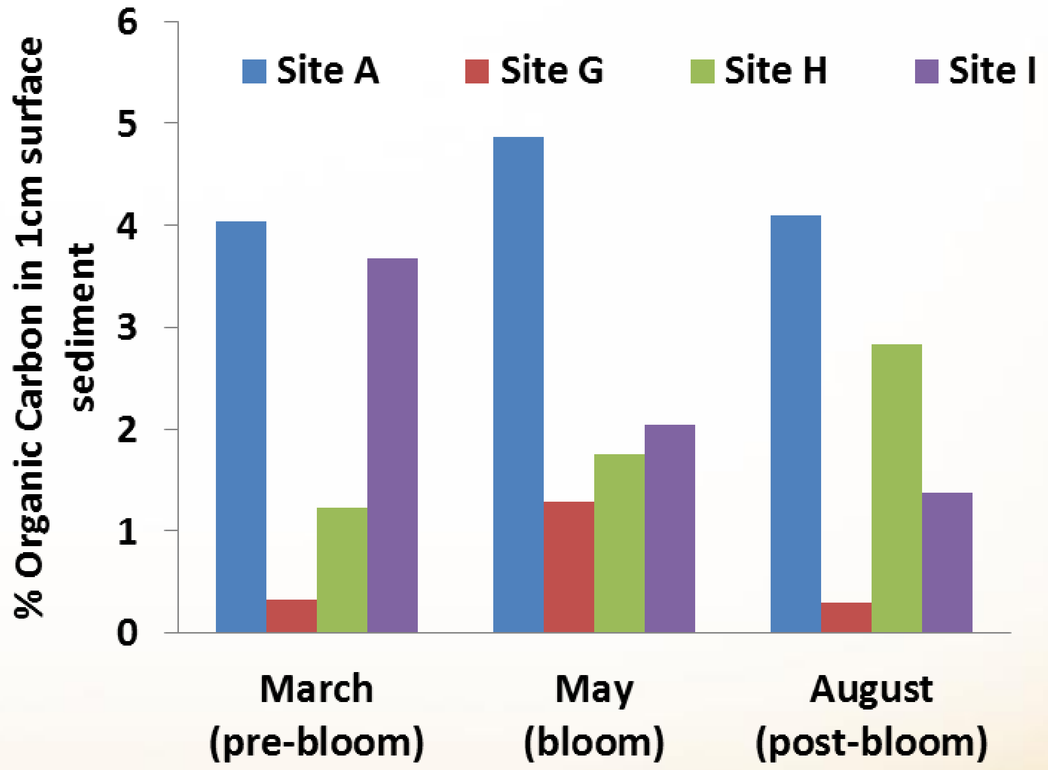
Surface content of sediments (top 1cm)

Fall of organic matter (carbon) during bloom apparent in most cohesive sediments (Site A, mud)

Differences between sediment type – effect of advective vs diffusive processes?

Pb^{210} analysed in cohesive sediment (Site A)

- no excess Pb^{210} = no sediment accumulation
- Extensive trawling at Site A (nephrops fishery)



Conclusions

Carbon dynamics **strongly influenced by sediment type**

‘Short term’ carbon dynamics (measured directly through oxygen dynamics) show a strong seasonal trend (bloom = supply of organic matter = increase in oxygen consumption)

- Biological components play a large role in this oxygen consumption (macrofauna, meiofauna, microbial) and this changes with season

‘Long term’ carbon dynamics (burial / sequestration) determined by sediment type, with more cohesive (muddy) sediment sequestering greater amounts of carbon

- Physical disturbance (e.g. trawling) disrupts this carbon storage