Preliminary tests of a saturation approach to determine grazing rates and why it might be useful.

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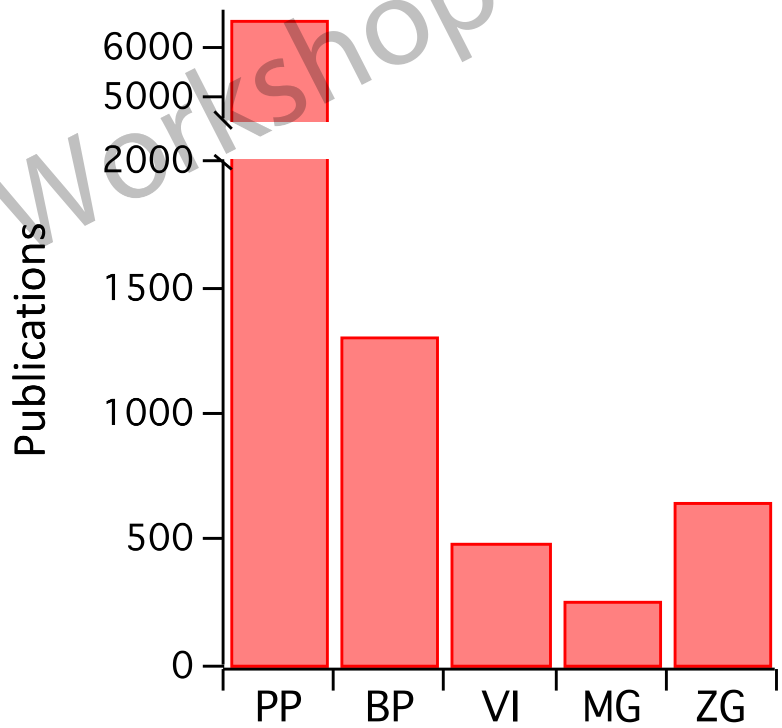
Research publications since 1980 (SCOPUS)

Title, Abstract and Keywords

Search terms:

- PP ‘ocean’
- BP ‘ocean’ and ‘bacterial production’
- VI ‘ocean’ and’ viral infection’
- MG ‘ocean’ and ‘microzooplankton’
- ZG ‘ocean’ and ‘zooplankton’



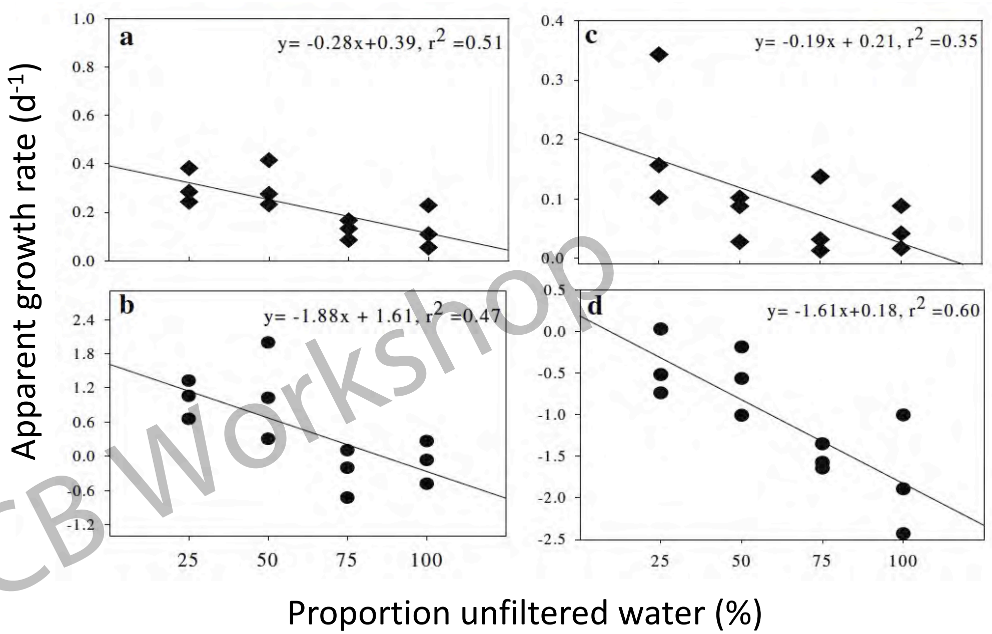
Progress in microzooplankton grazing rate determination: molecular approaches

Microzooplankton grazing on

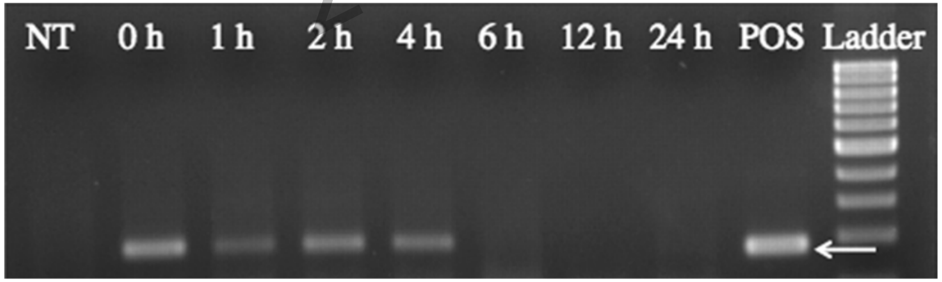
Heterosigma akashiwo:

qPCR and dilution approach

Demir et al. 2008: Microb. Ecol.



Molecular approaches to tracing prey in predators

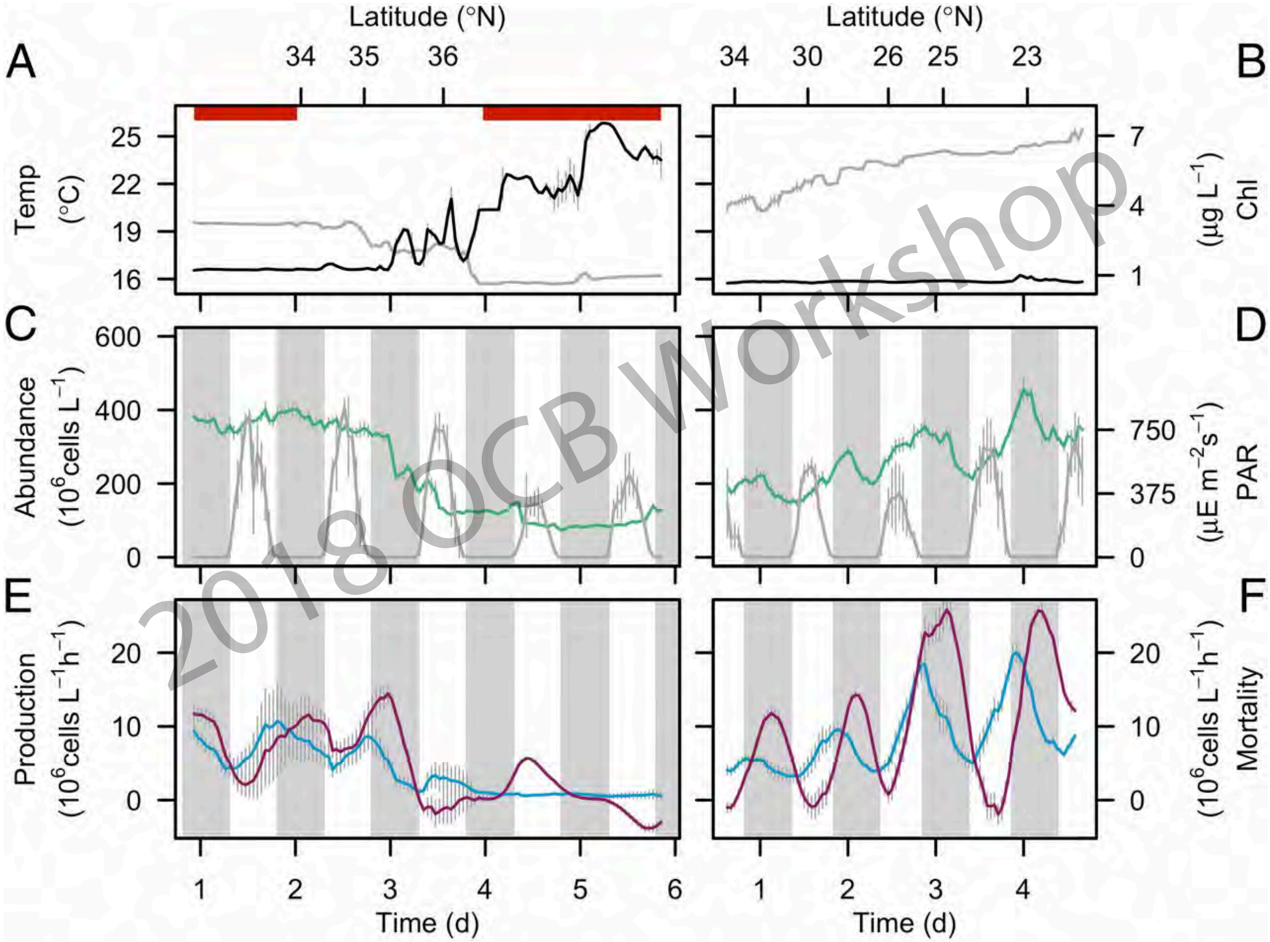


Haley et al. 2010: J. Plankton Res.

Alexandrium fundyense – specific 183bp amplicon

Progress in microzooplankton grazing rate determination: high resolution *in situ* measurements

Prochorococcus mortality synchronized with growth and light



Ribalet et al. 2015: PNAS.

The functional response

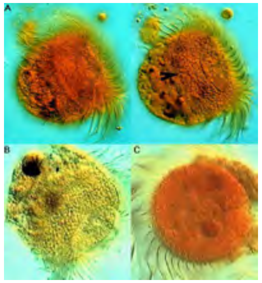
- Protistan grazers show Type II Hollings response:

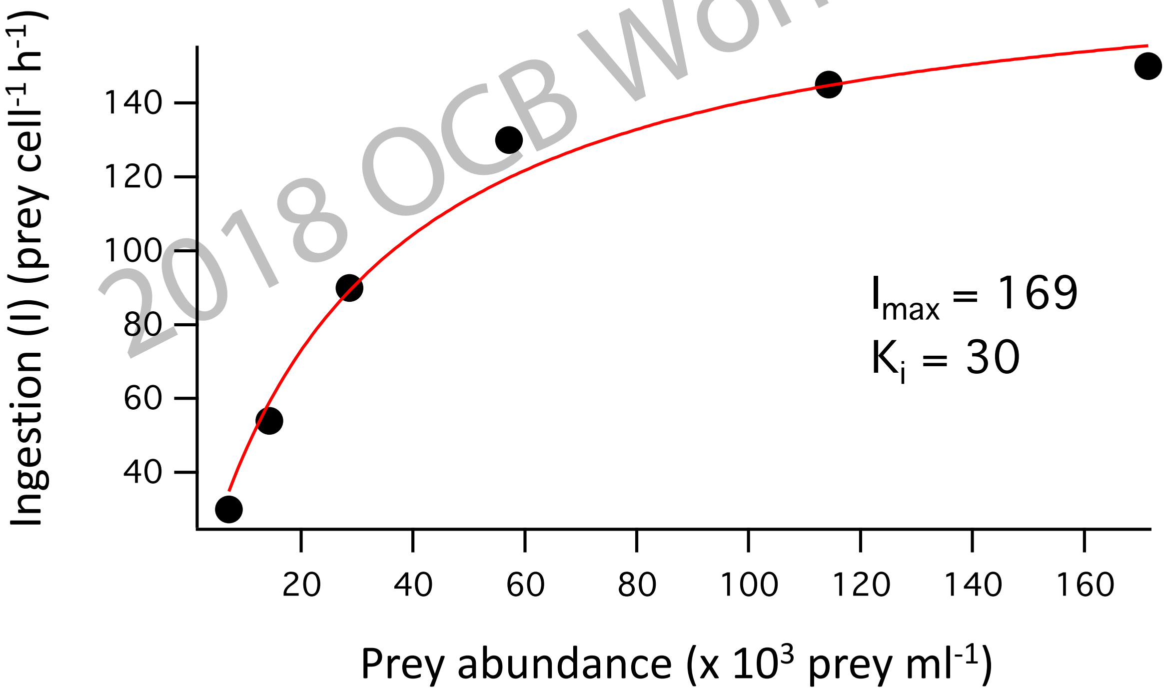
Strobilidium cf. spiralis grazing on *Isochrysis galbana*

Data modeled from Verity (1991)

Ingestion is a product of:

F = maximum clearance rate	5.7 µl $cell^{-1}$ h^{-1}
T = prey handling time	21 s



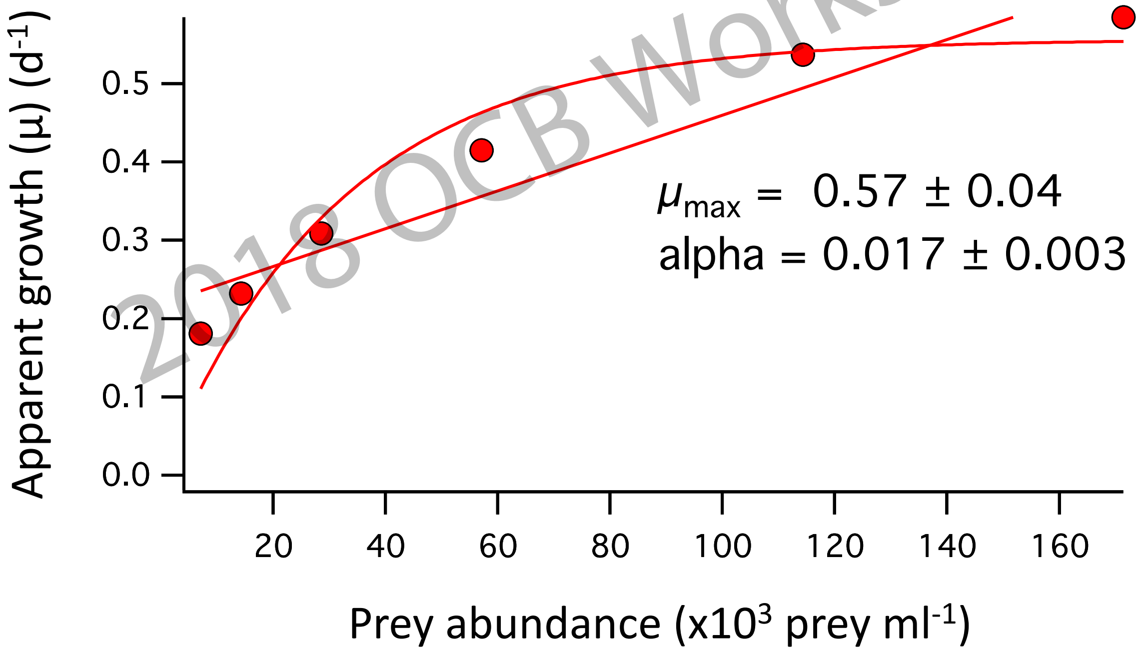


The prey response

Gross growth rate used in model = 0.60 d^{-1}

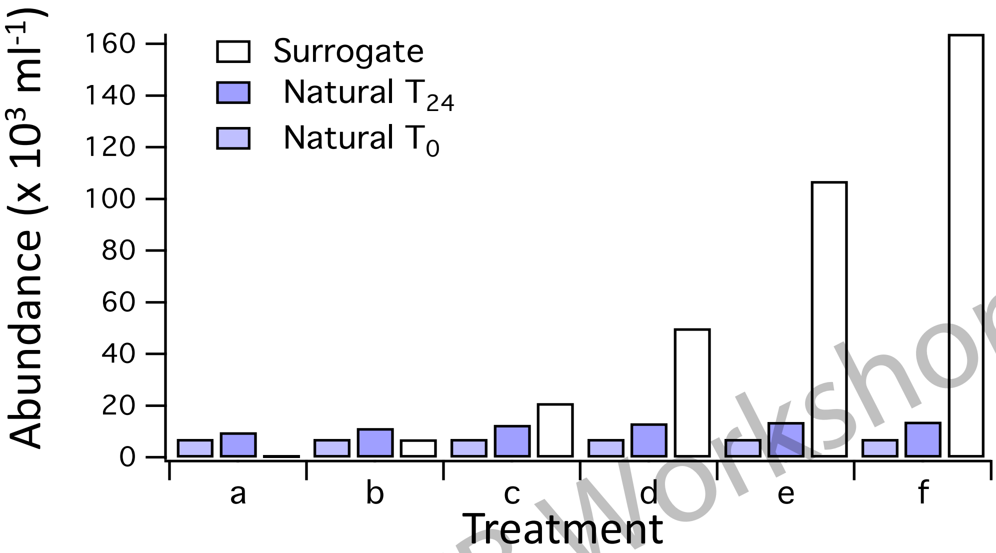
Apparent growth: $\mu = \mu max * (1 - e(-\alpha * C / \mu max))$

(e.g. Platt et al. 1975)



Data modeled from Verity (1991)

Saturation approach

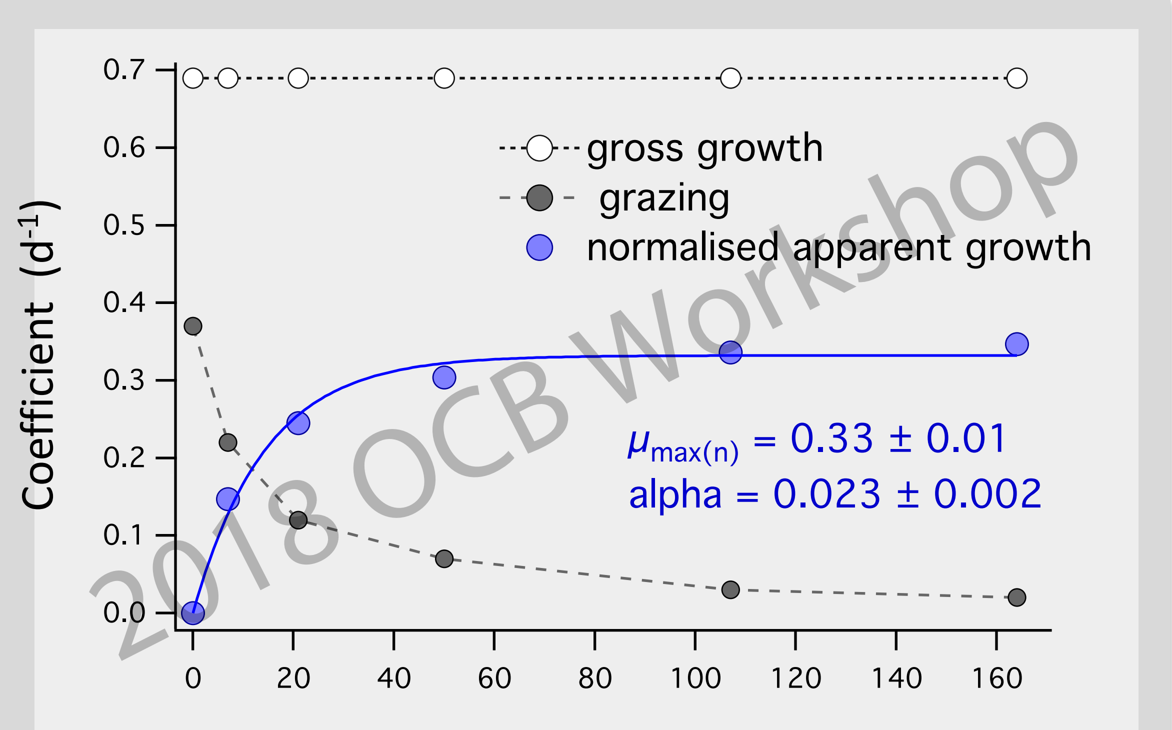


Surrogate particle requirements:

1. size similar to the phytoplankton of specific interest.
2. easily distinguished from the natural prey
3. close to being neutrally buoyant - remain suspended
4. do not influence the growth rate of the natural prey
5. are stable in seawater so abundance remains constant
6. do not clump together or stick to other particles
7. are readily available and cost effective

Saturation approach

Modeled from data of Verity (1991)

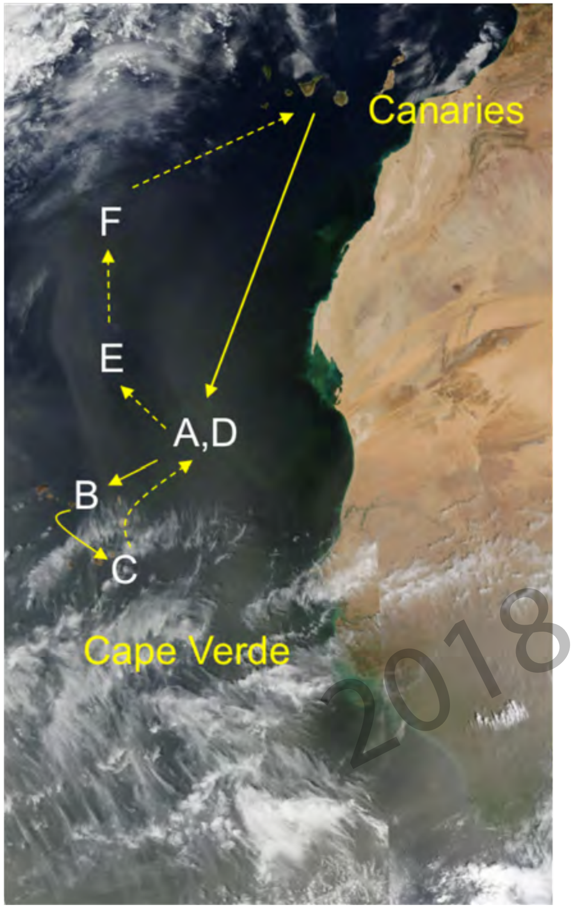


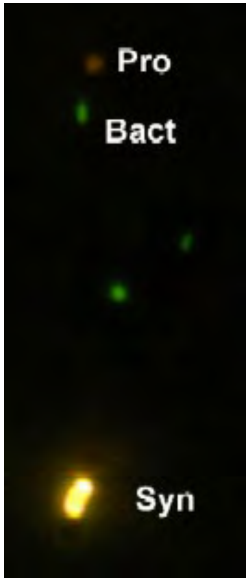
Surrogate prey abundance (x10³ prey ml⁻¹)

Model assumes surrogate and natural prey handled (T) and cleared (F) at the same rates.

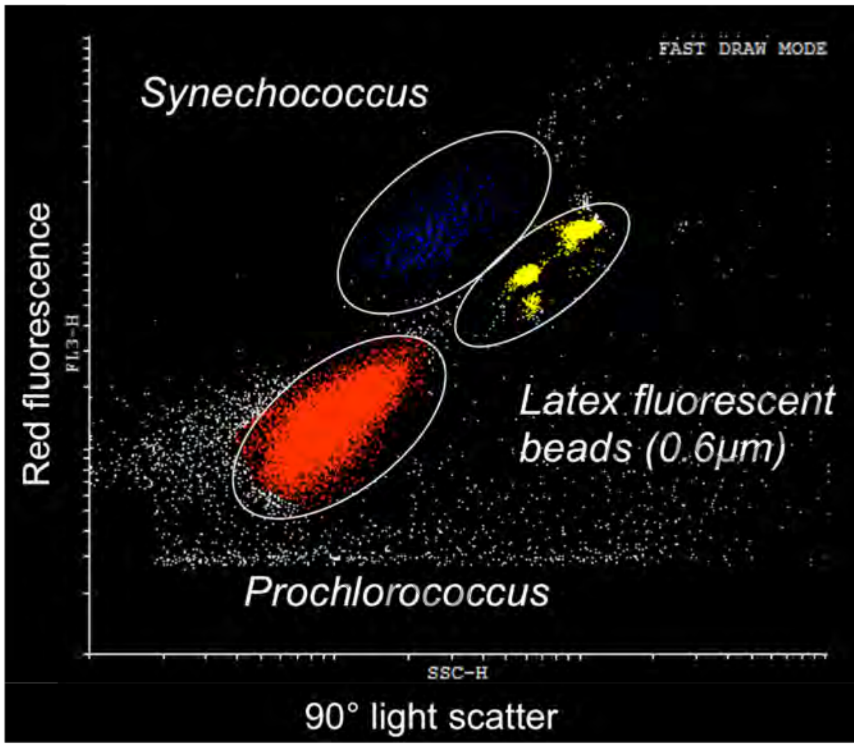
Tests in natural waters

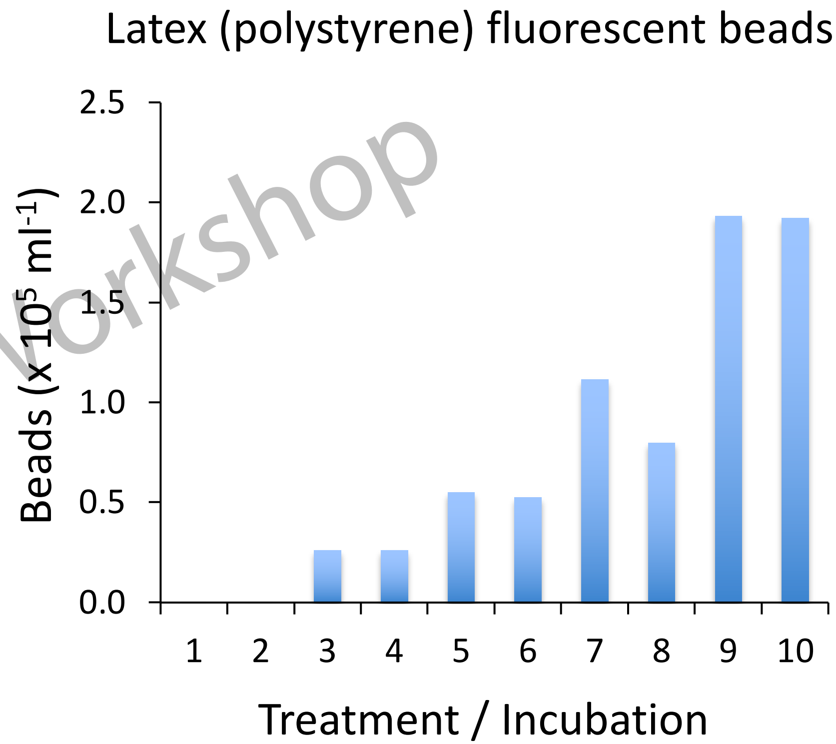
Tropical Northeast Atlantic:



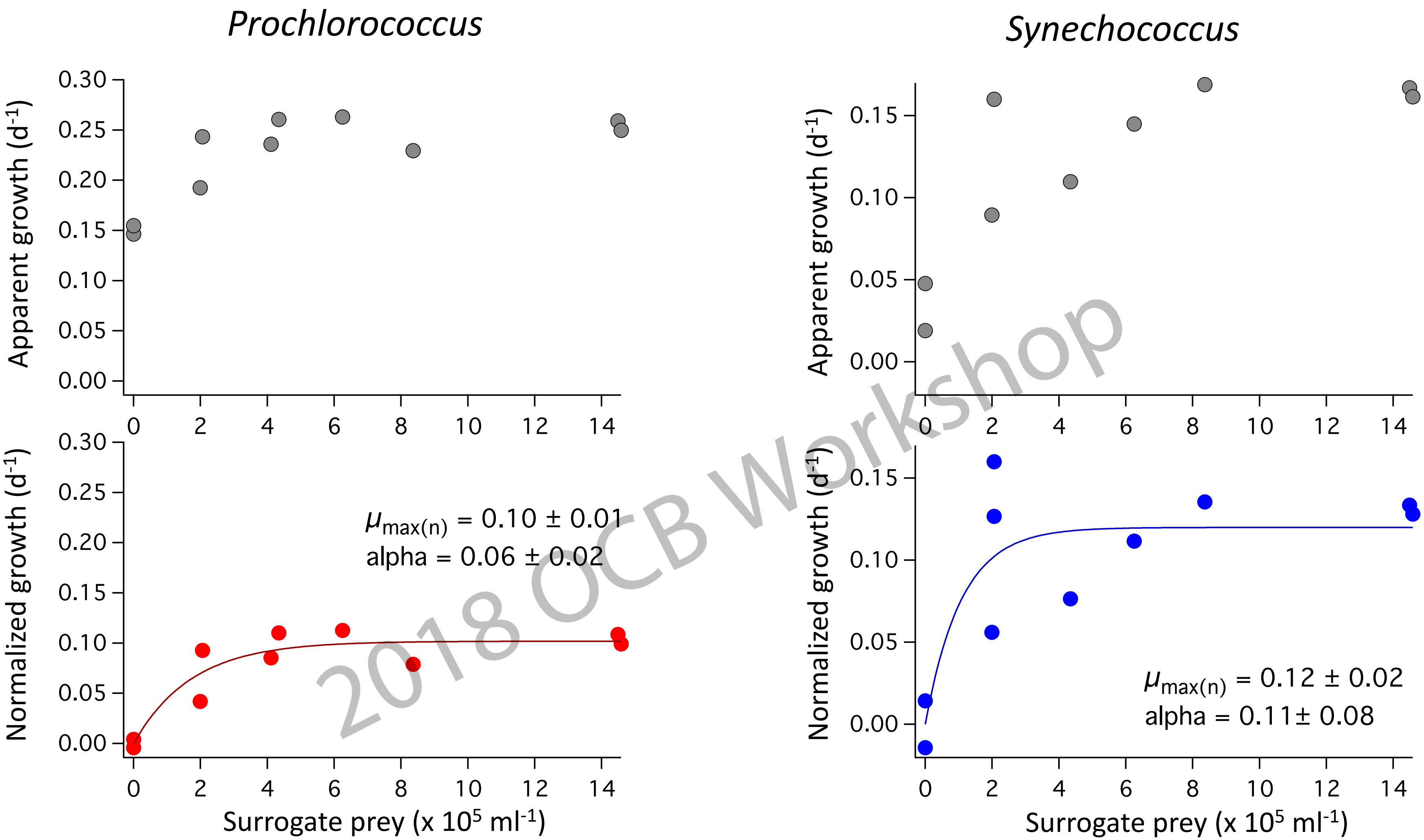


Experimental set-up



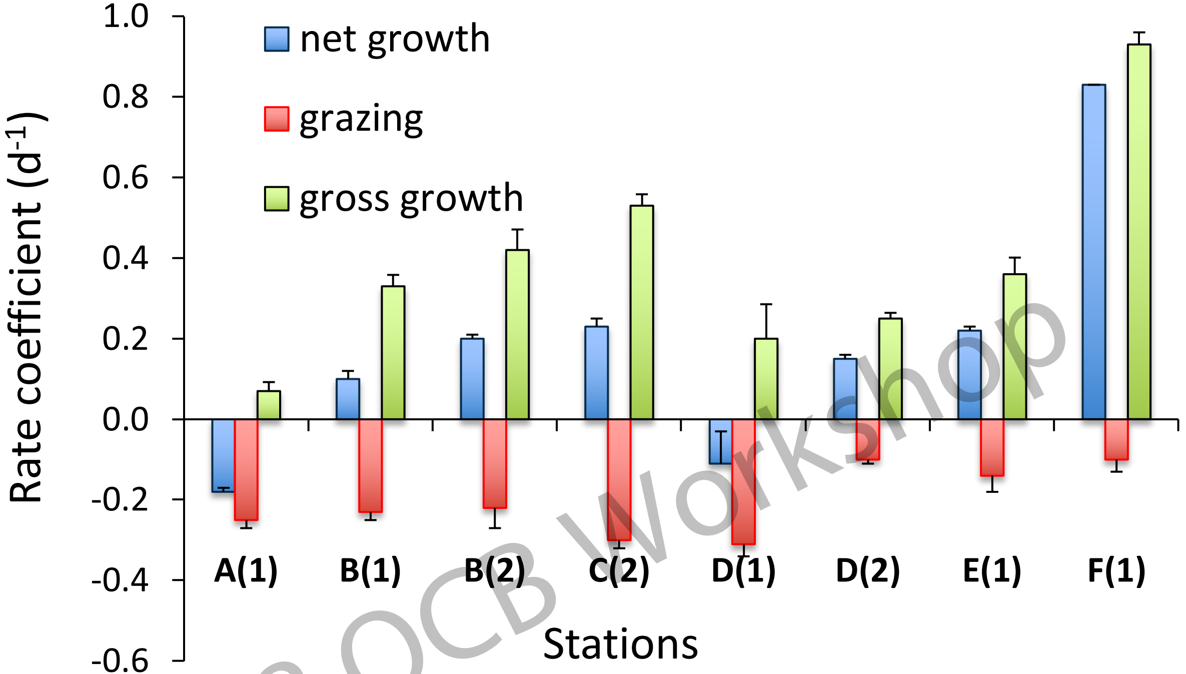


Example of results



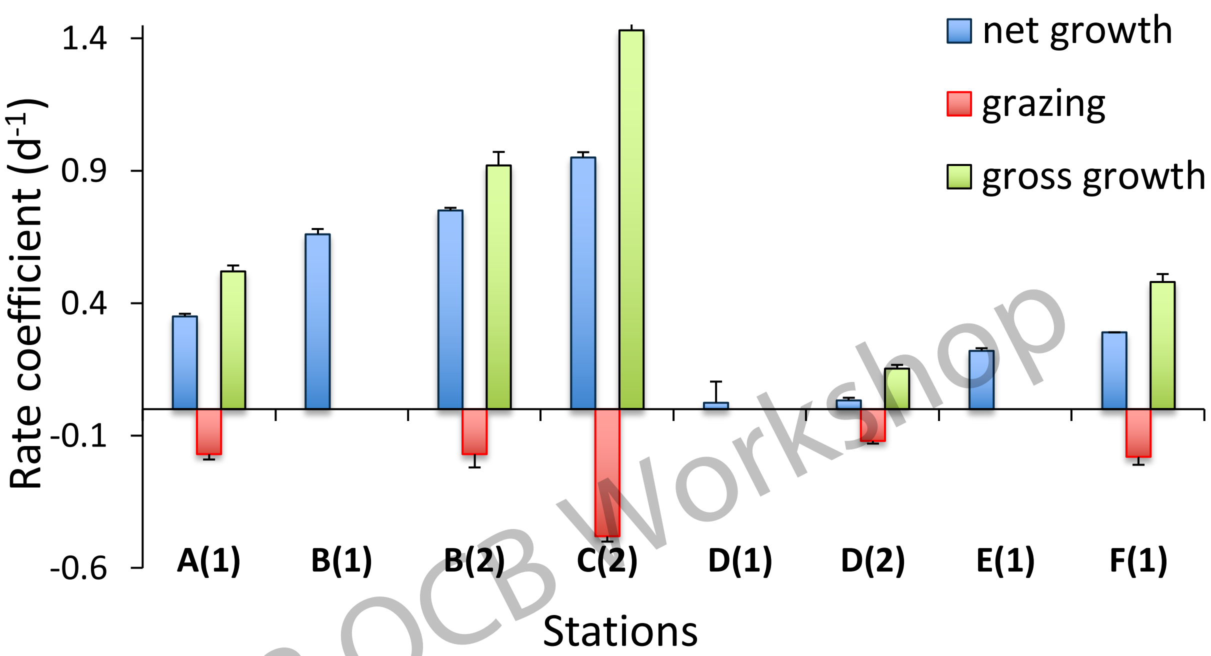
Net growth	0.15 ± 0.01	0.03 ± 0.03
Grazing mortality	-0.10 ±0.01	-0.12 ± 0.02
Growth in the absence of grazing	0.25 ± 0.01	0.15 ± 0.04

Summary of growth and grazing rates: *Prochlorococcus*



Average values:	**Saturation results**	**Dilution results**
	(n = 8)	(n = 4)
Net growth:	0.16 ± 0.34	0.35 ± 0.08
Grazing mortality	-0.21 ± 0.08	-0.25 ± 0.05
Growth in the absence of grazing	0.36 ± 0.30	0.60 ± 0.09

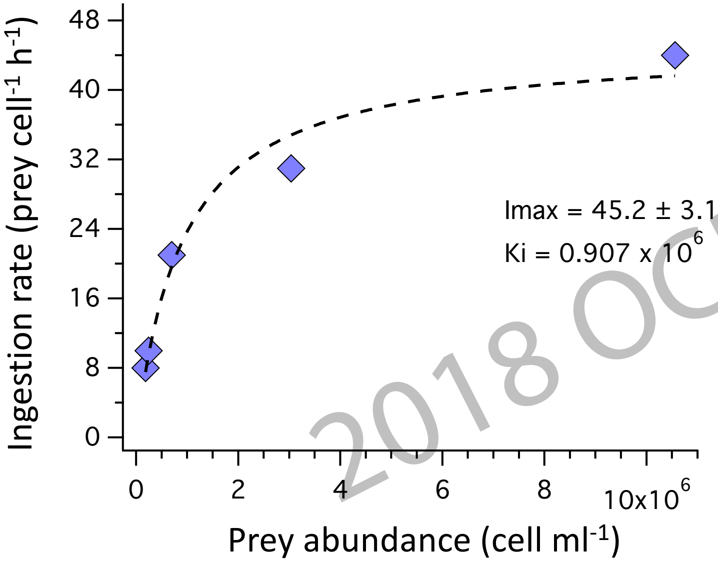
Summary of growth and grazing rates: *Synechococcus*



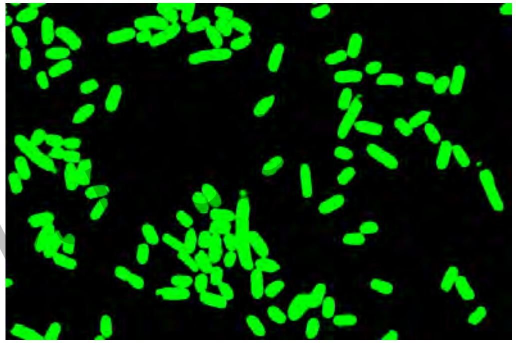
Average values:	**Saturation results**	**Dilution results**
	(n = 5)	(n = 3)
Net growth:	0.41 ± 0.34	0.12 ± 0.08
Grazing mortality	-0.22 ± 0.15	-0.18 ± 0.13
Growth in the absence of grazing	0.70 ± 0.49	0.31 ± 0.19

Testing the fundamentals: culture expts

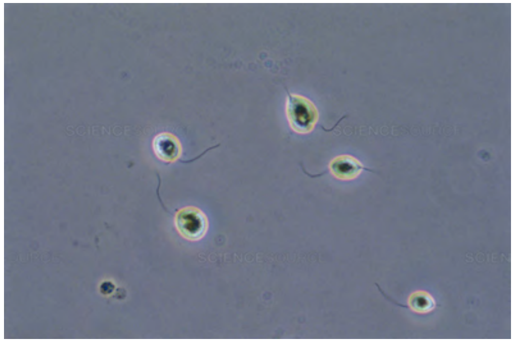
Functional response:
Oxyrrhis marina on *Micromonas pusilla*



GFP *E. coli* as surrogate prey



Alternative, more representative grazer



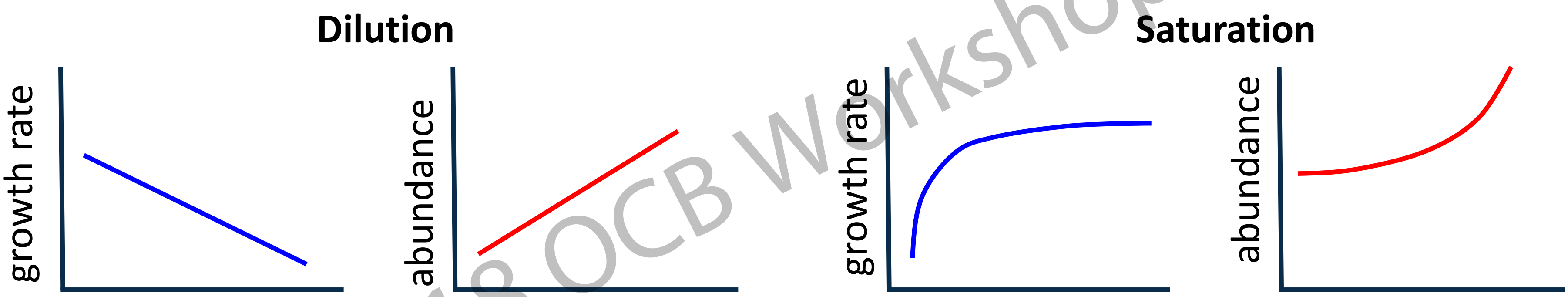
Ochromonas sp. CCP1391

Potential advantages:

1. Does not involve a filtration step: seawater chemistry and time

2. Lends itself to flow cytometry, fast sample throughput and accuracy

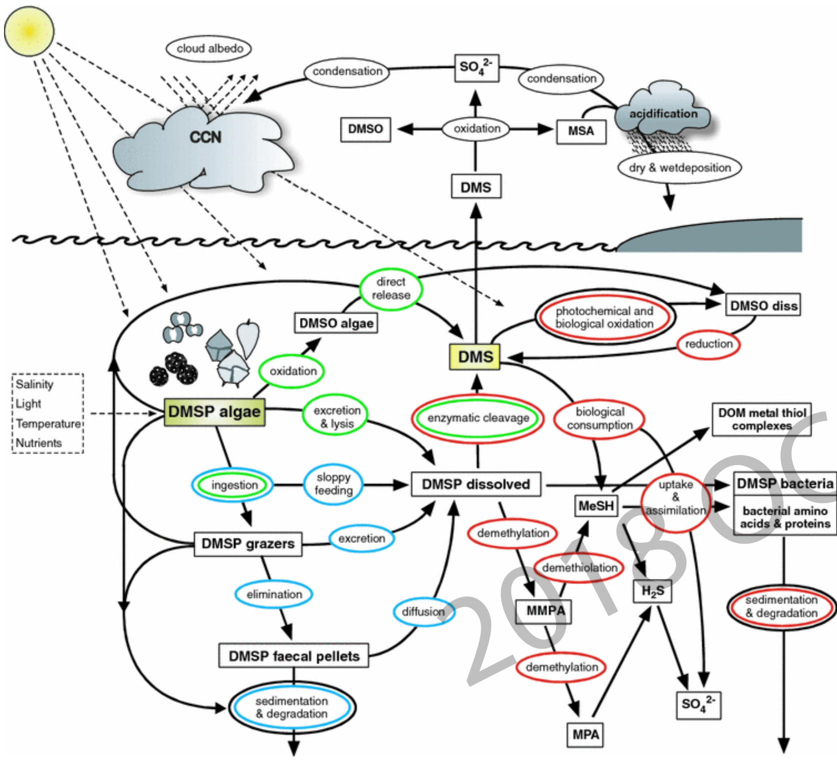
3. Does not dilute the the natural abundance: statistically more robust?



4. Potential to determine active grazers by tracing surrogate prey by microscopy.

5. The saturation approach can be applied with a minimal impact to seawater chemistry.

Trace gas production:



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A dilution approach to quantify the production of dissolved dimethylsulphoniopropionate and dimethyl sulphide due to microzooplankton herbivory

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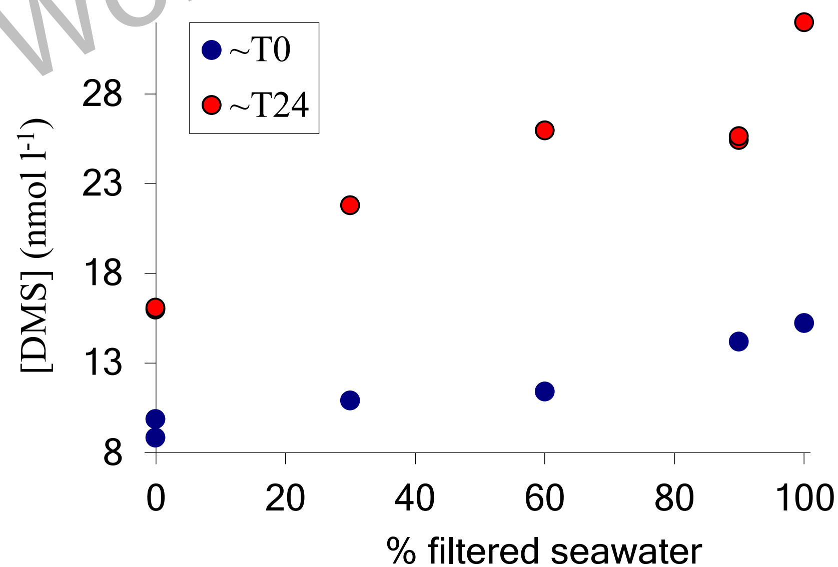
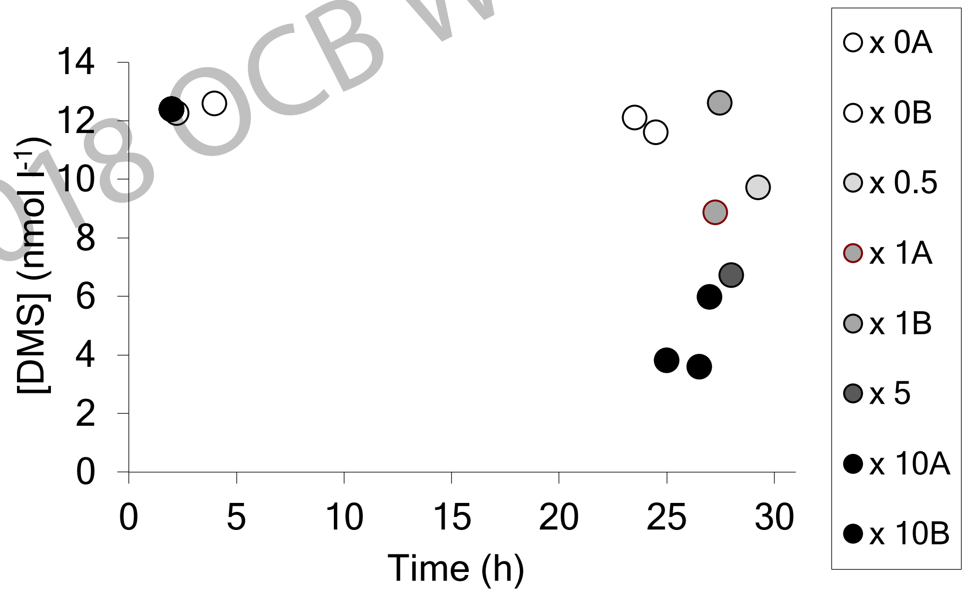


Trace gas production:

Saturation approach attempt:

- Surrogate: *Chroomonas salina (low DMSP producer)*
- Additions @ 0 to 10 x natural abundance
- 320 ml polycarbonate bottles
- simulated in situ incubations (55% light)



Summary

- Appears to provide useful information for picoplankton/grazers in oceanic waters
- Could possibly be abbreviated to fewer saturation levels
- Could be targeted at different size classes of prey/predator
- May be most useful for quantifying grazer-mediated trace gas, trace metal, macronutrient cycling