

Estuarine and catchment disturbance indicators and the response of the zooplankton biomass size frequency distribution

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THE UNIVERSITY OF
NEW SOUTH WALES



Office of
Environment
& Heritage

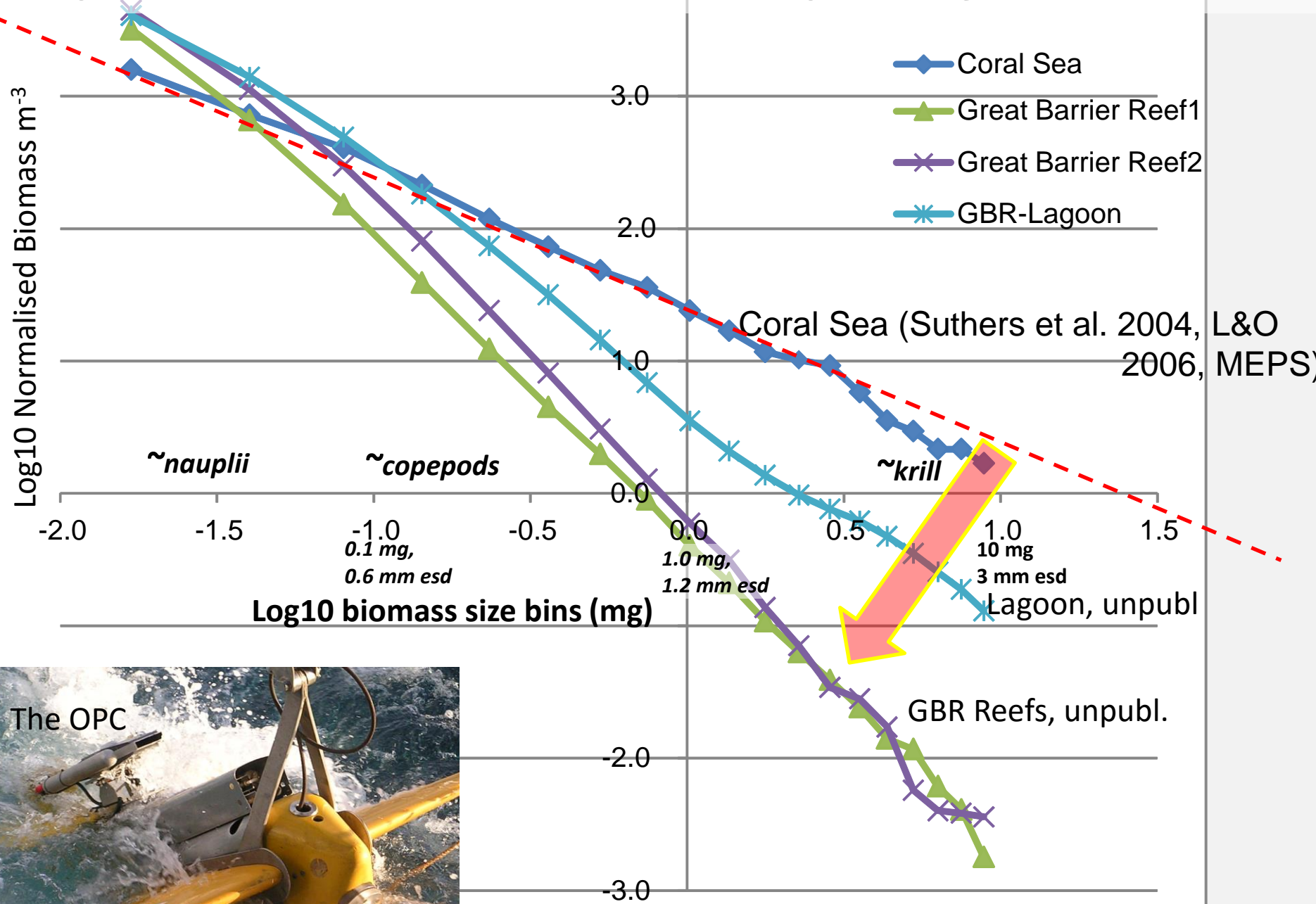
Sydney Institute of Marine Science

UNSW

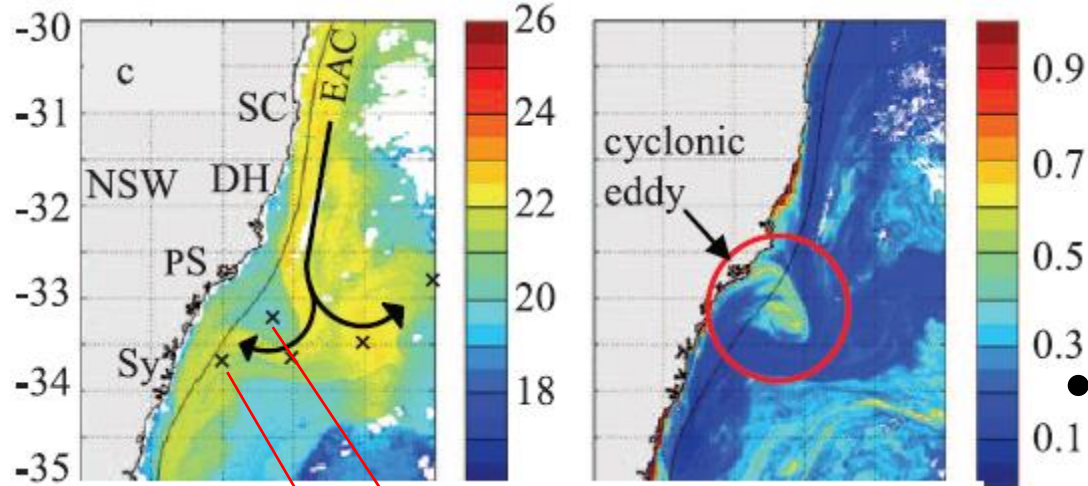


Equal partnership of 4 universities

Zooplankton biomass size frequency distribution



The OPC



Dynamic !

- Entrainment from the inner shelf;

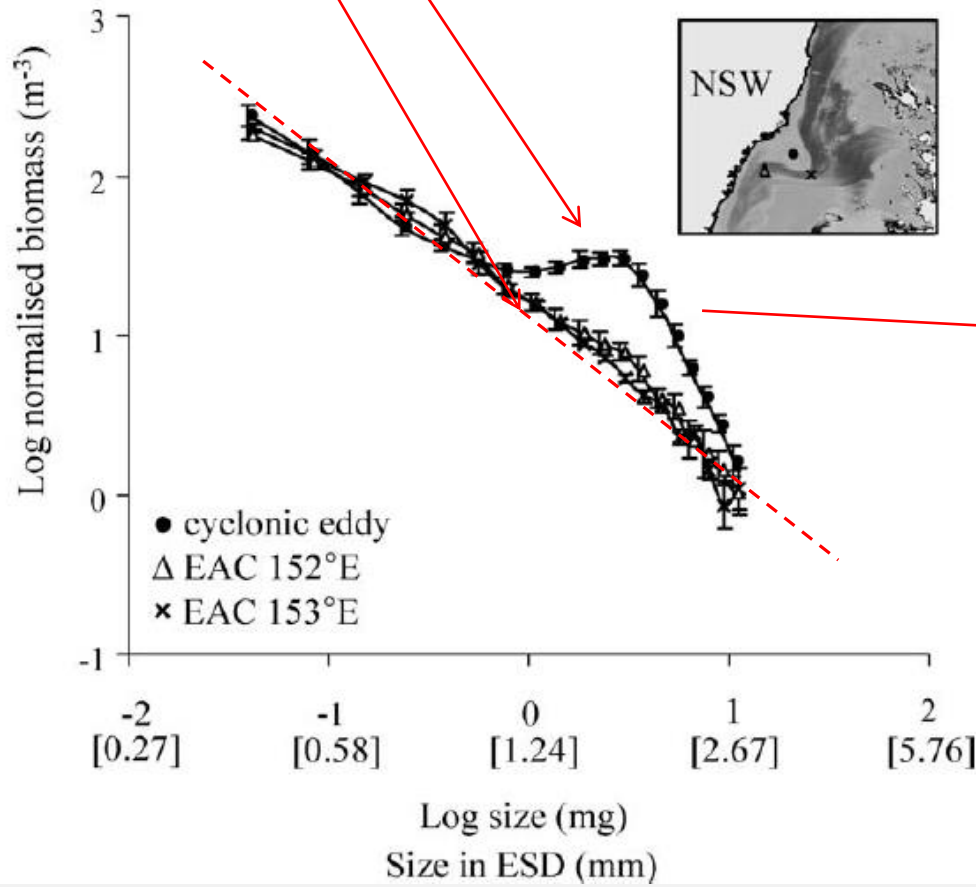
- The 'bump' composed of juvenile krill

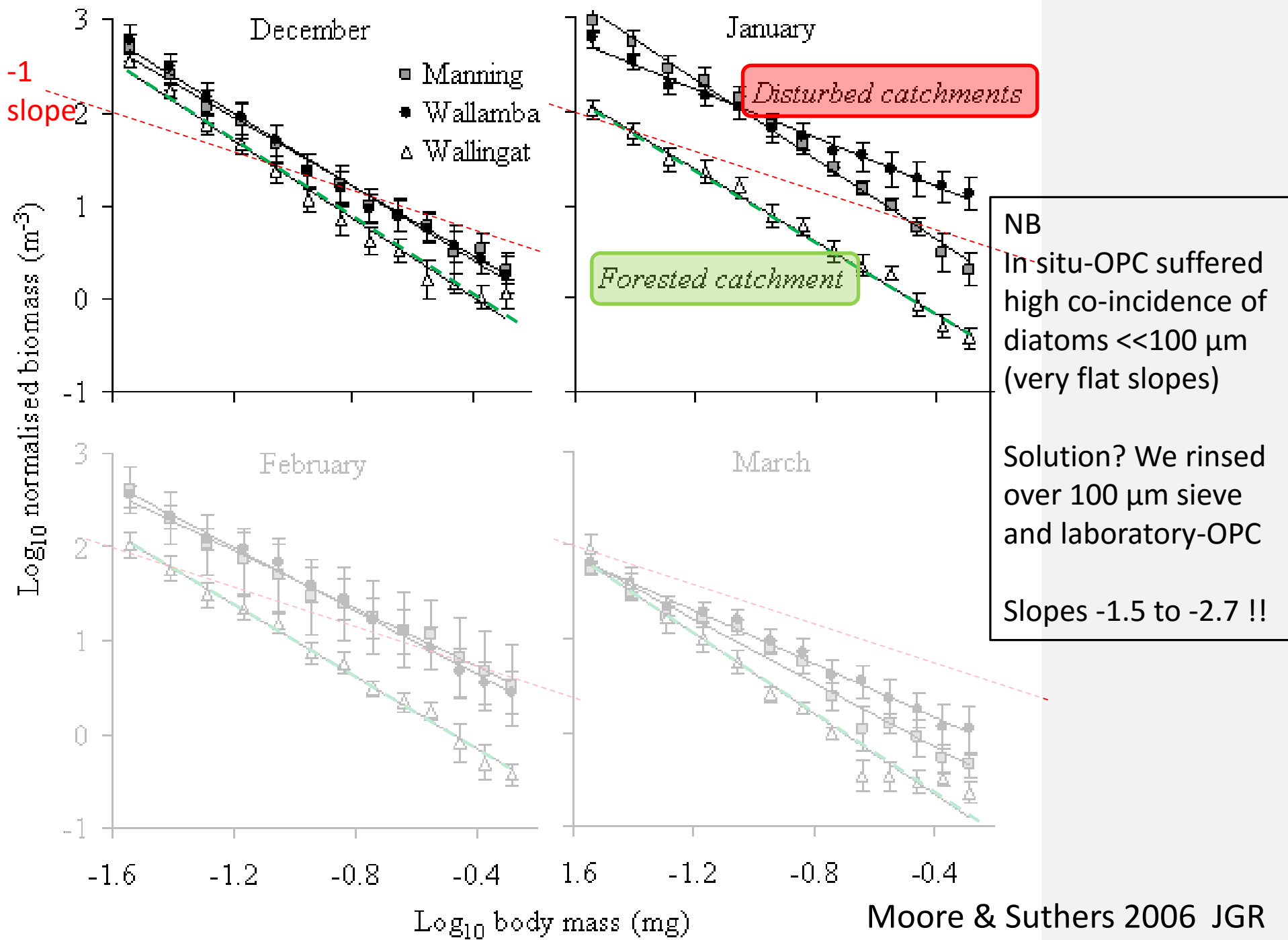
- *E. similis*

- And small salps

- *T. democratica*

- And many larval fish





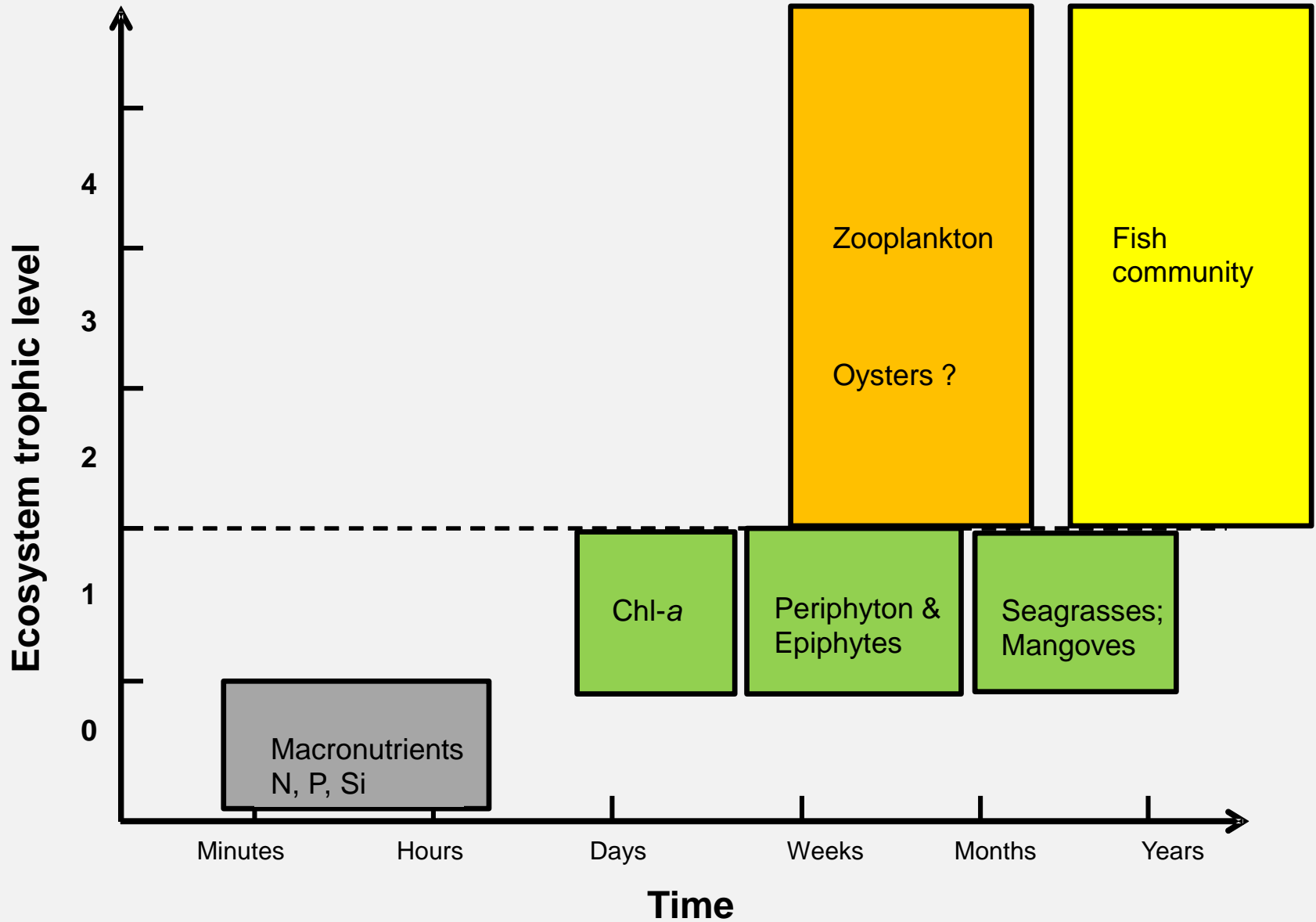
Estuary *disturbance indices* for
SE Australia ??



Estuary disturbance indices for SE Australia

- Over 50 indices!
 - Chl-a, turbidity, %change in seagrass-mangroves, fish community, % clearing, population/km², etc
 - Disturbance Index DI =
Total N flow / estimated historical TN (Roper et al. 2011)
 - i.e. 1x historical? Double? Triple? (5 is bad)
- But a DI is static!
- Estuaries are dynamic, rainfall, seasonal
- Kuprika et al. (2012)
 - Geometric Mean Size, Pareto intercept and slope,
 - Continental Shelf Res. 36: 29-40

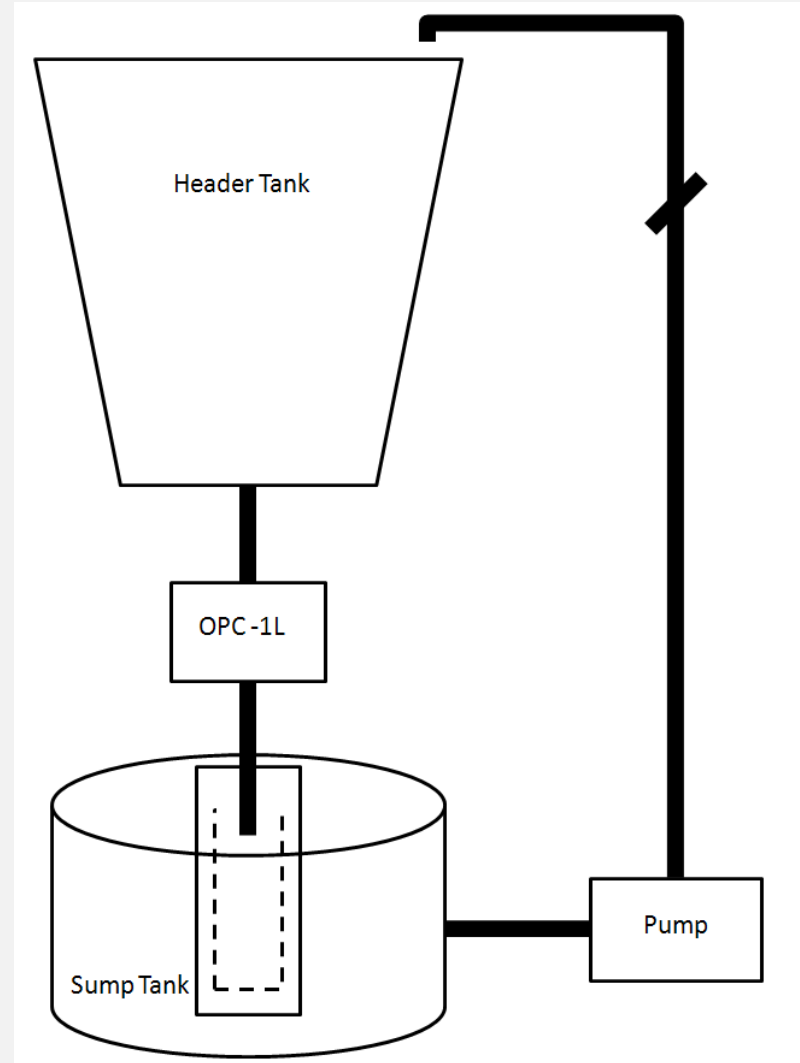
Ecosystem indicators



Aims

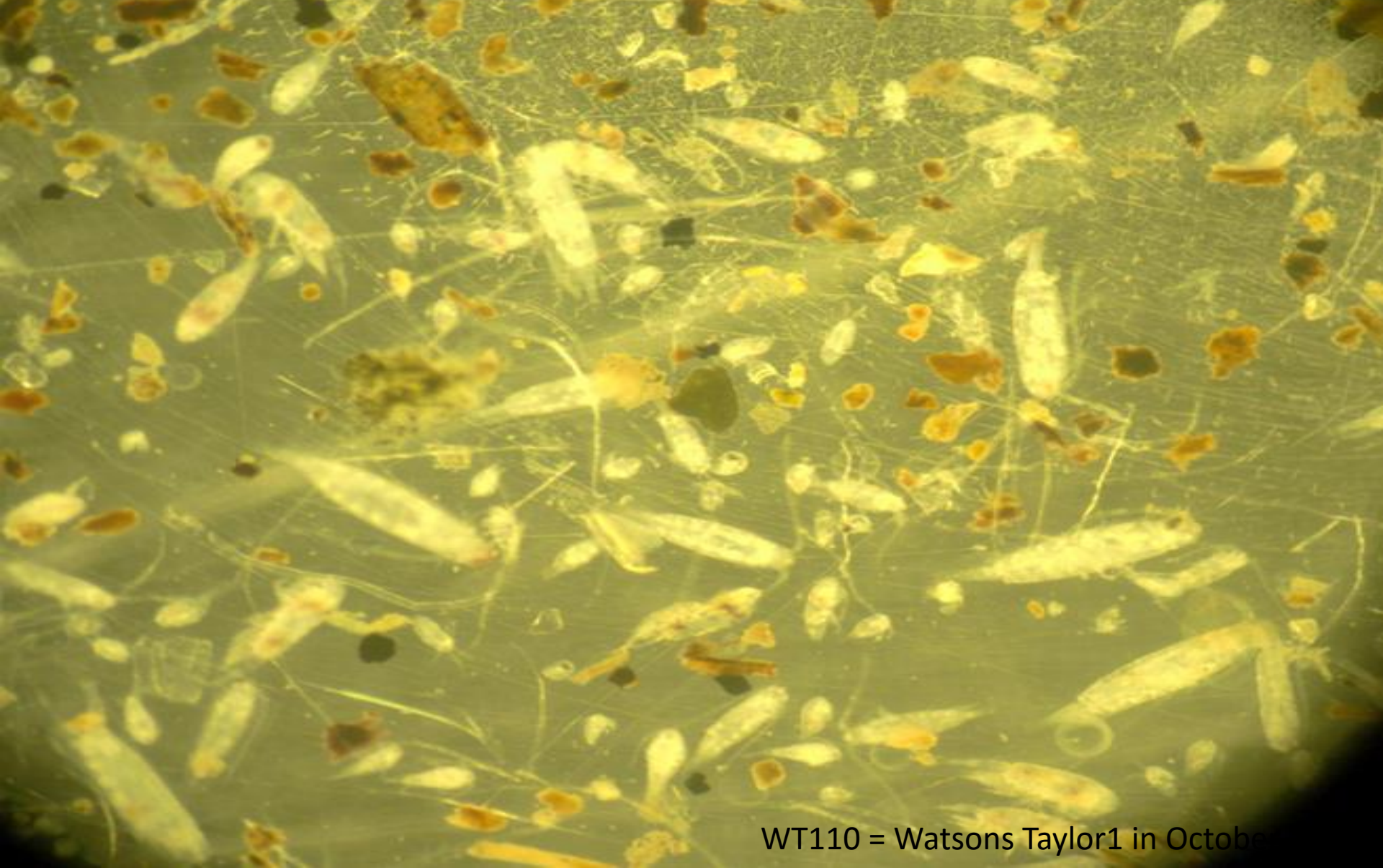
- Comparison of NBSS between 2 estuaries
 - Slope (linearity?)
 - Weighted average size?
- Quantitative indices of water quality?
- Problems in estuaries – detritus, seasonality
- Opportunities in estuaries – citizen science

Method

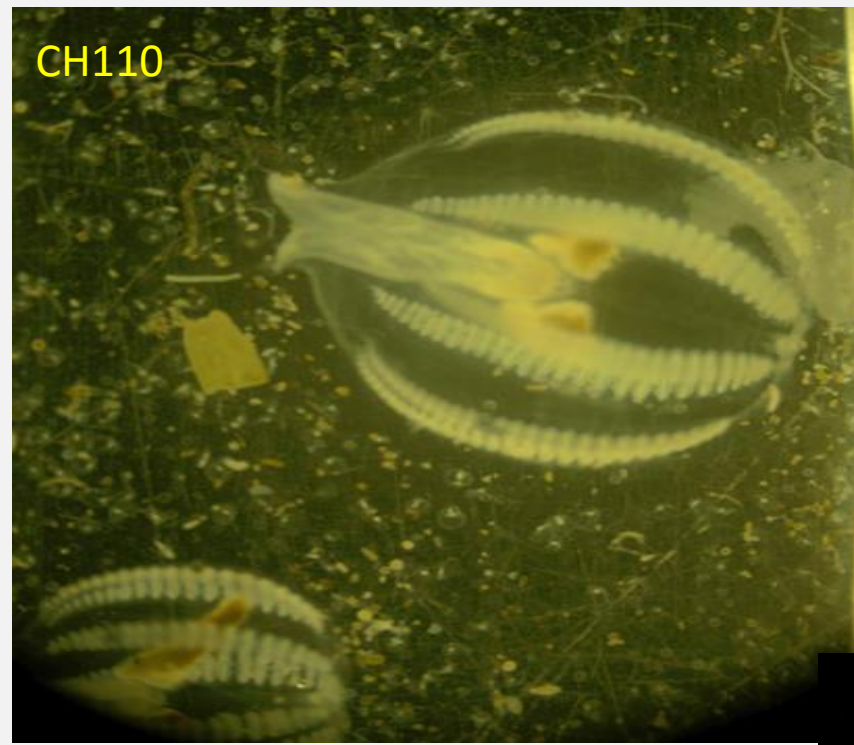


Problem - detritus, faecal pellets

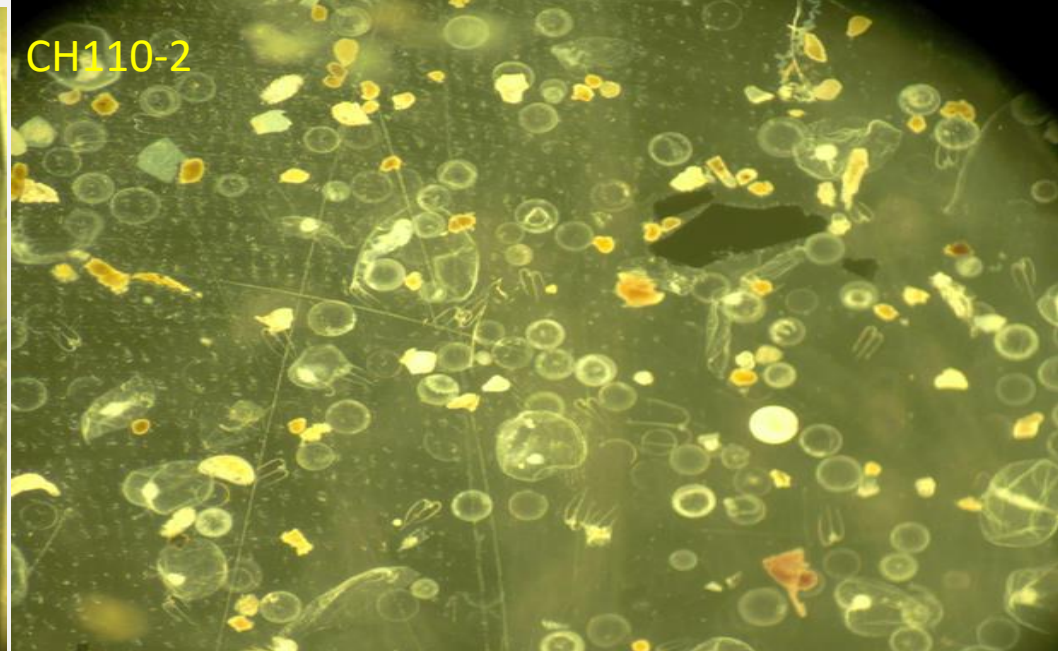
Solution? – mostly carbon; ~10% threshold



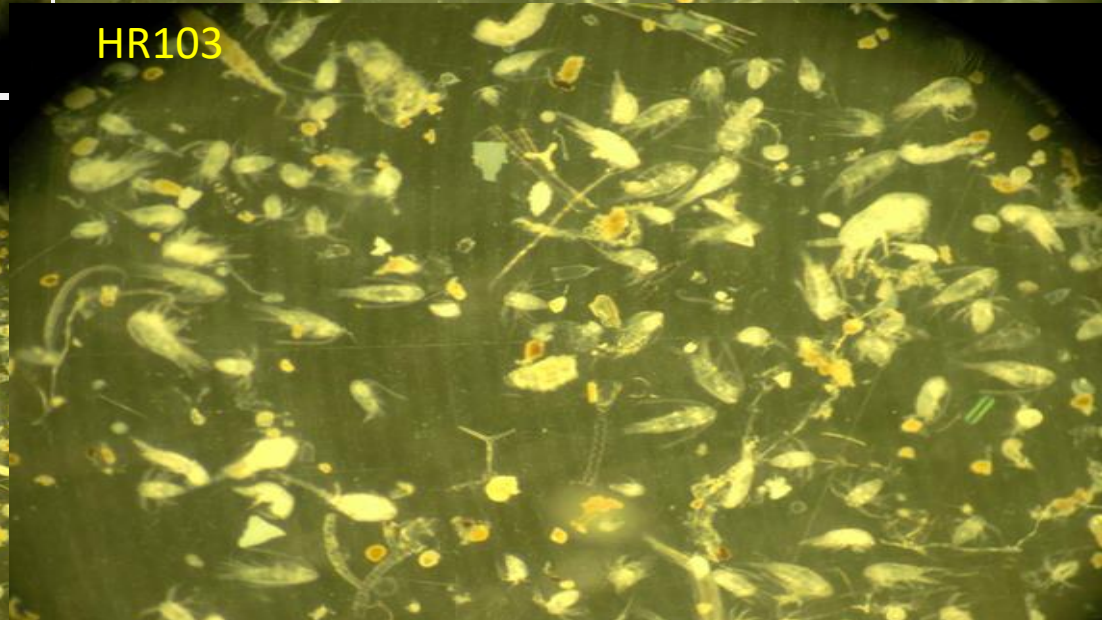
CH110



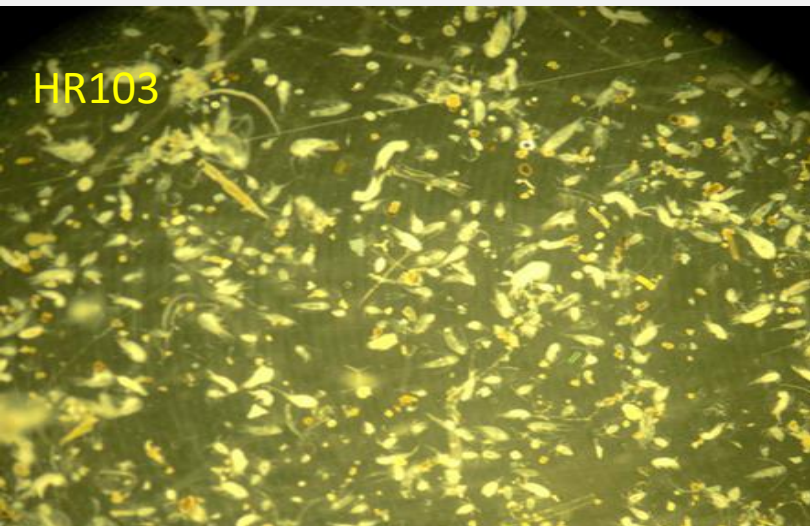
CH110-2



HR103

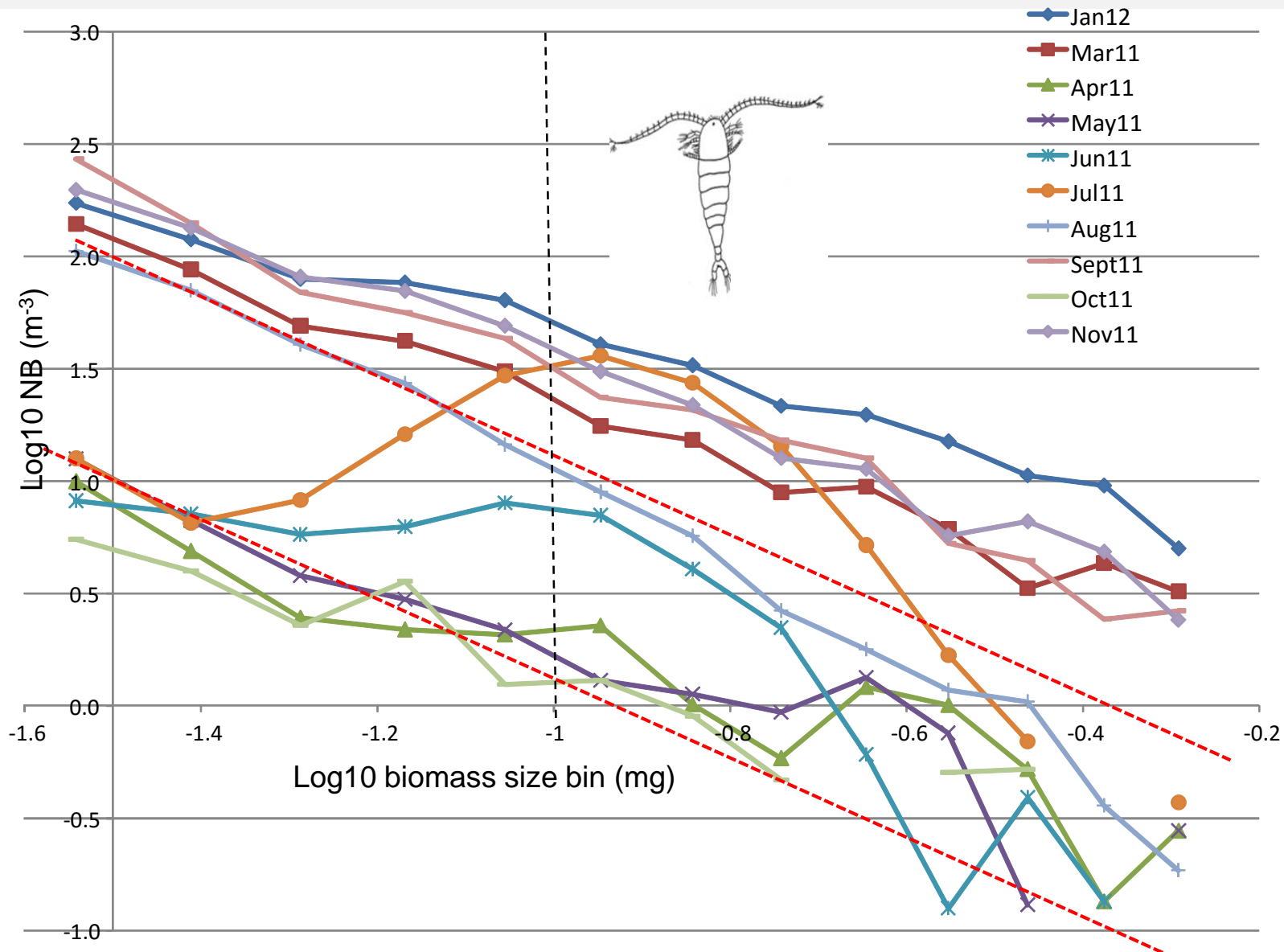


HR103

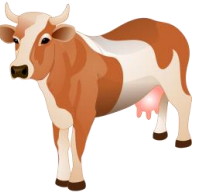


Each size category includes omnivores, but also vastly different rates

Monthly changes in the Camden Haven River



Summer, 2 sites each



Camden Haven R.

Hastings R.

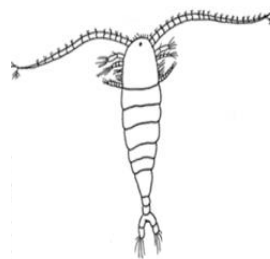
Log10 normalised biomass concentration (m^{-3})

Log10 biomass size bin (mg)

-2;
(0.01 mg
0.27 mm)



-1;
(0.1 mg
0.58 mm)

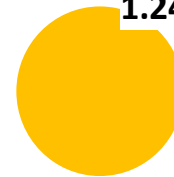
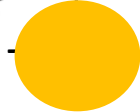


0;
(1.0 mg
1.24 mm)

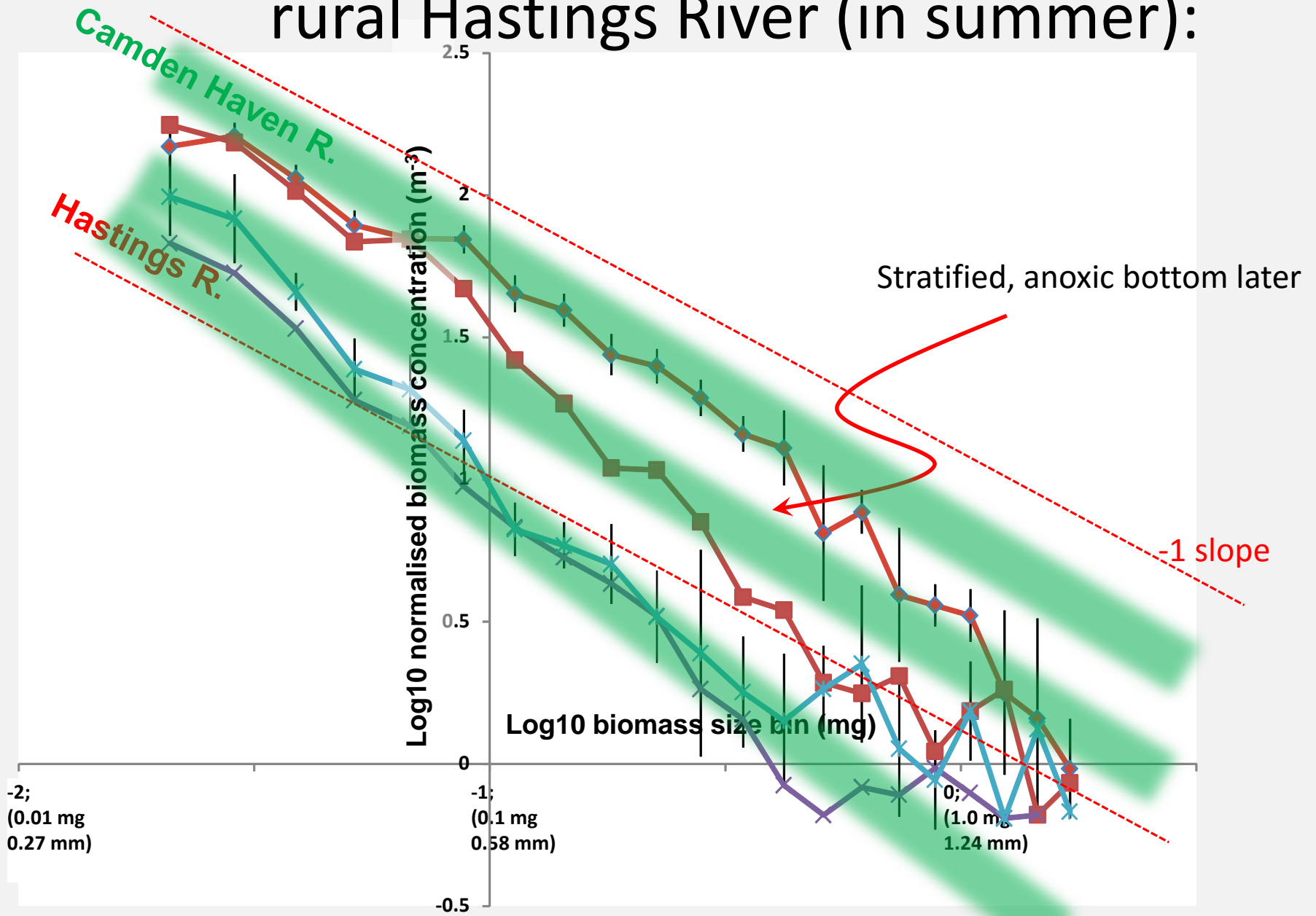
Key points:

- Normalised biomass
- Log10 biomass (mg)
- Narrow size range
 - 0.3- 2 mm ESD
 - 0.01-1 mg
- ∴ mostly linear (else Pareto)

-1 slope

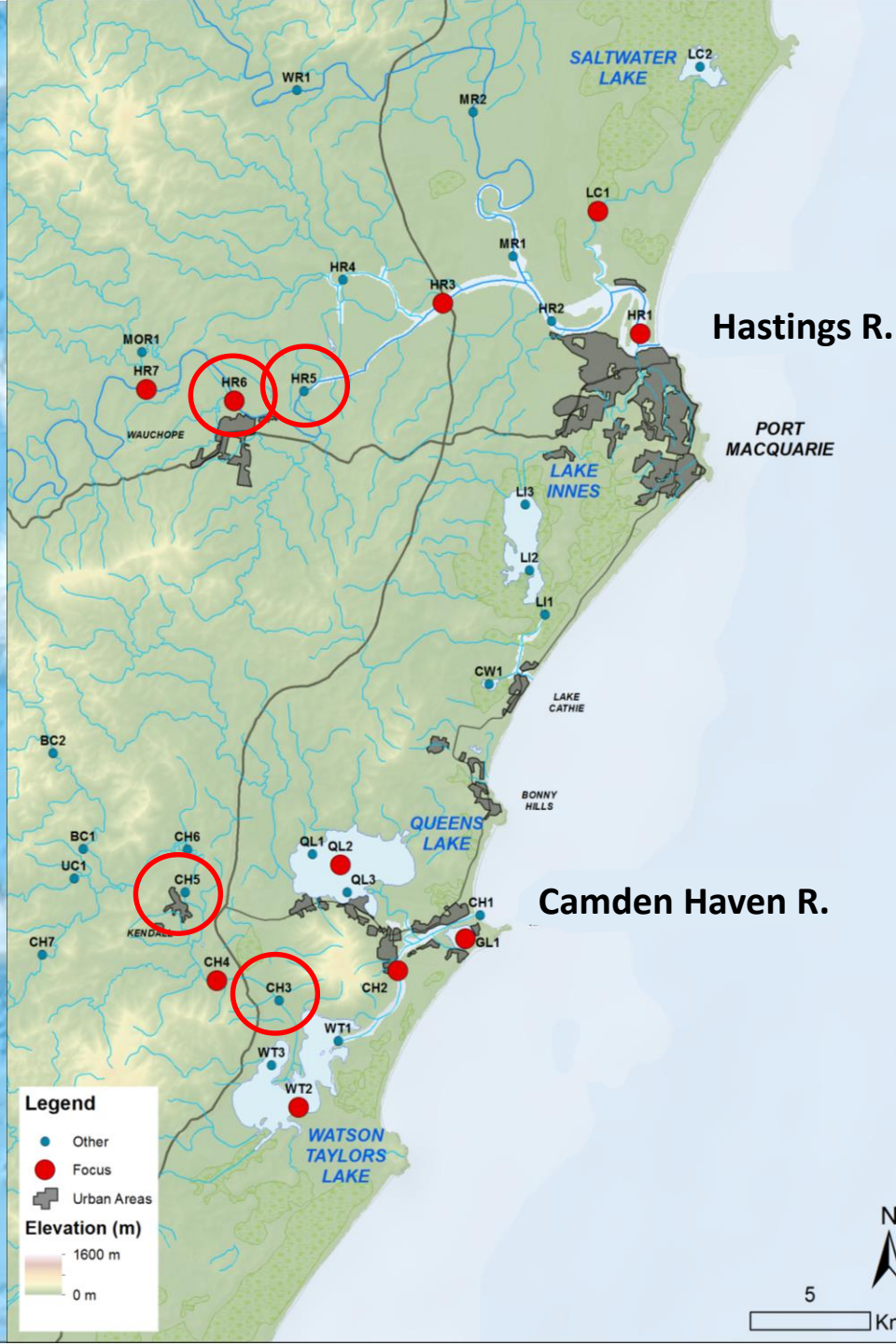


“pristine” Camden Haven ?? versus rural Hastings River (in summer):

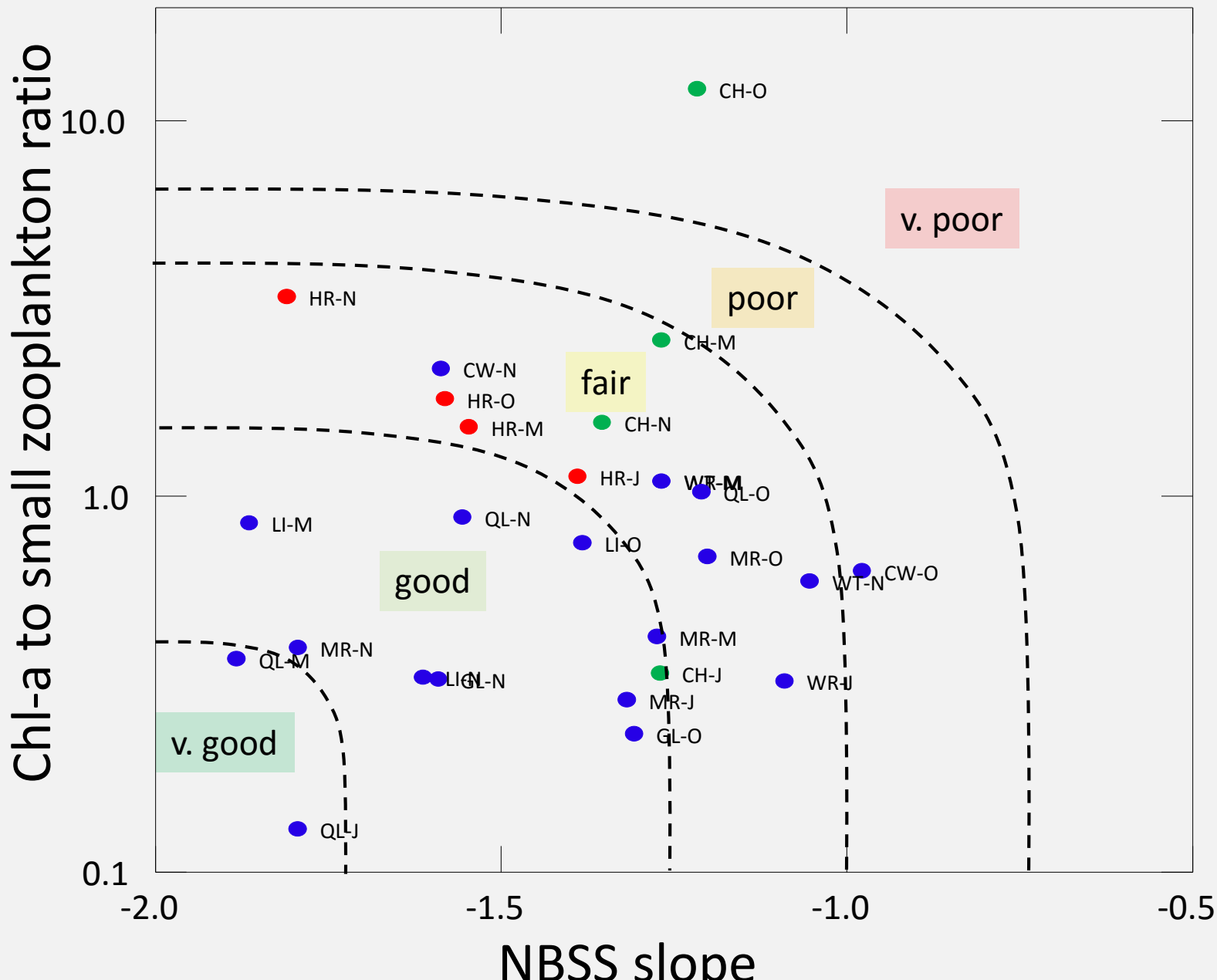


Proposed indices of size spectra

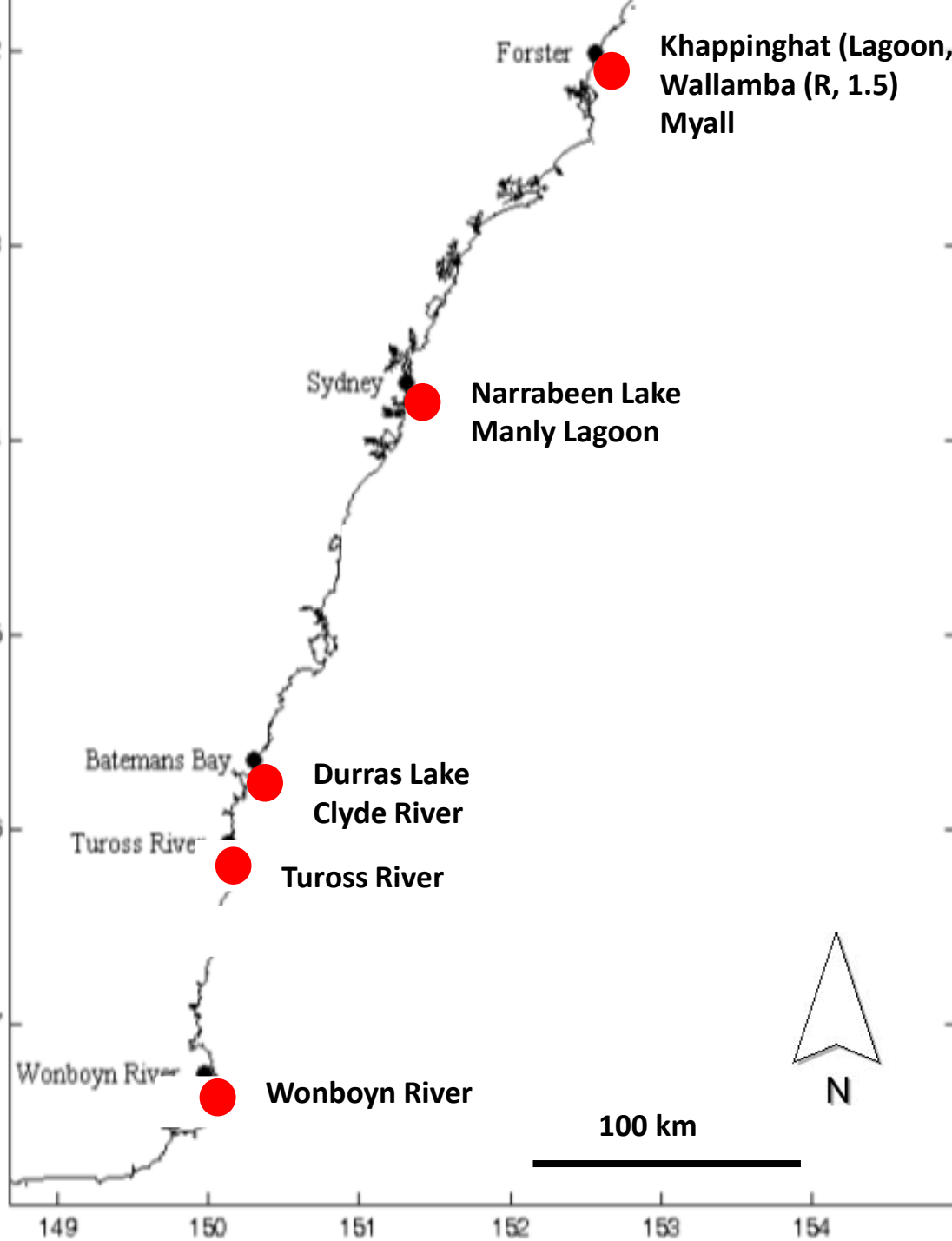
- Slope = assimilation of nutrients
 - Predation (Zhou & Huntley)
 - Steeper slope, better water quality
- [Chlorophyll-a] : small biomass ratio
 - Small ratio = good; Big ratio = eutrophic
- Or ~Geometric Mean Size ?
 - Big bugs = good; small bugs = less good

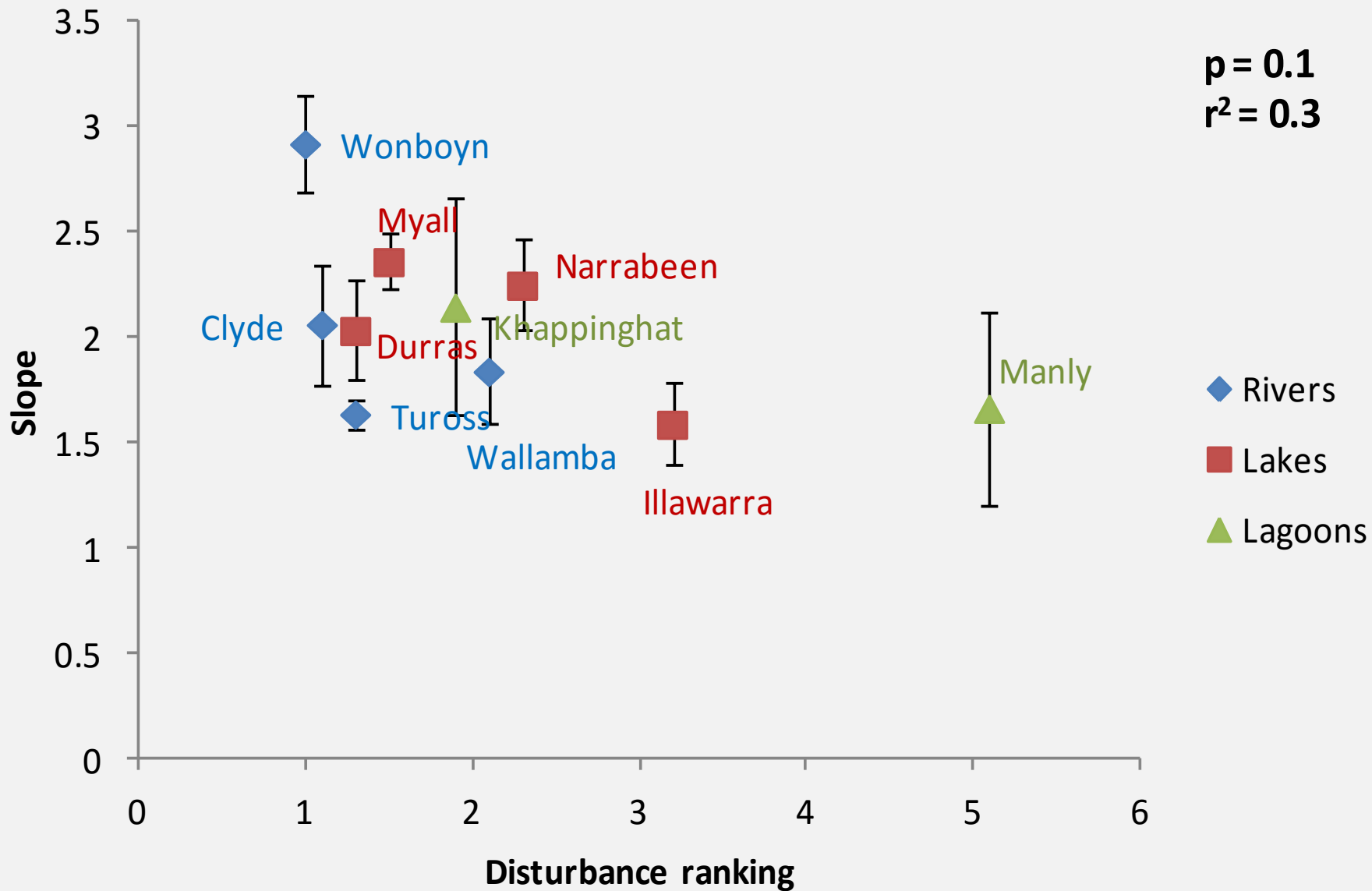


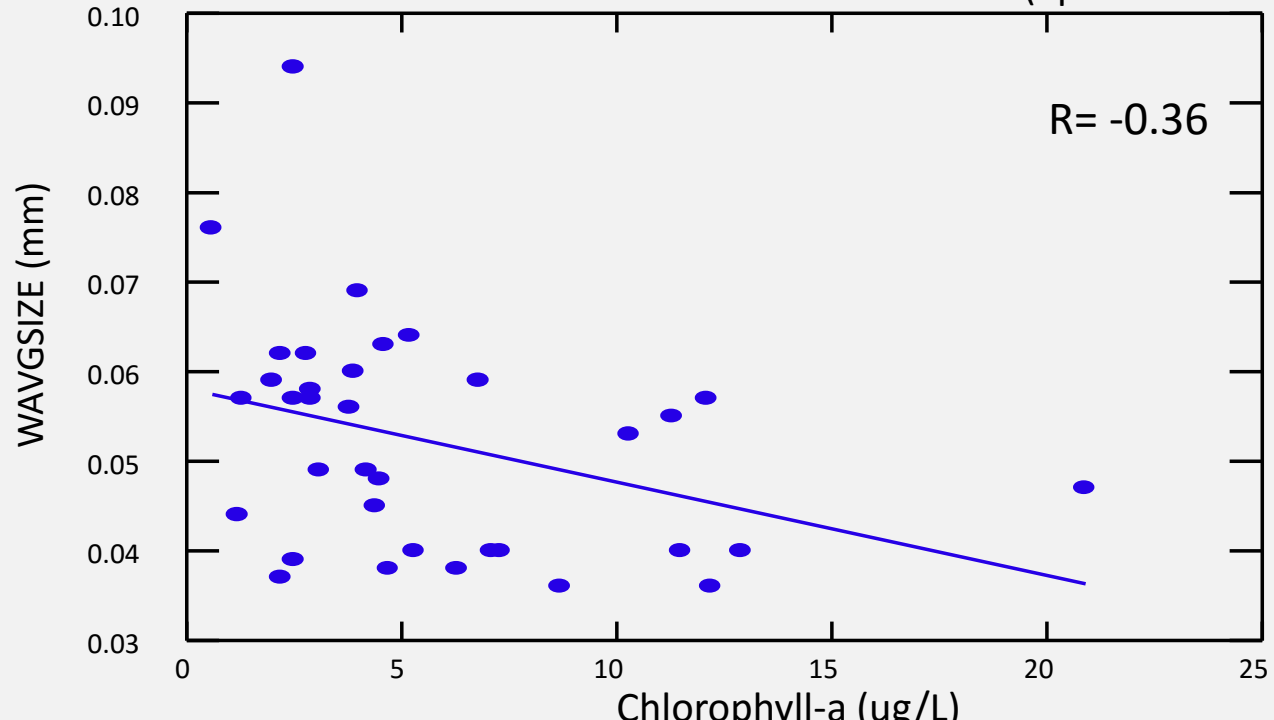
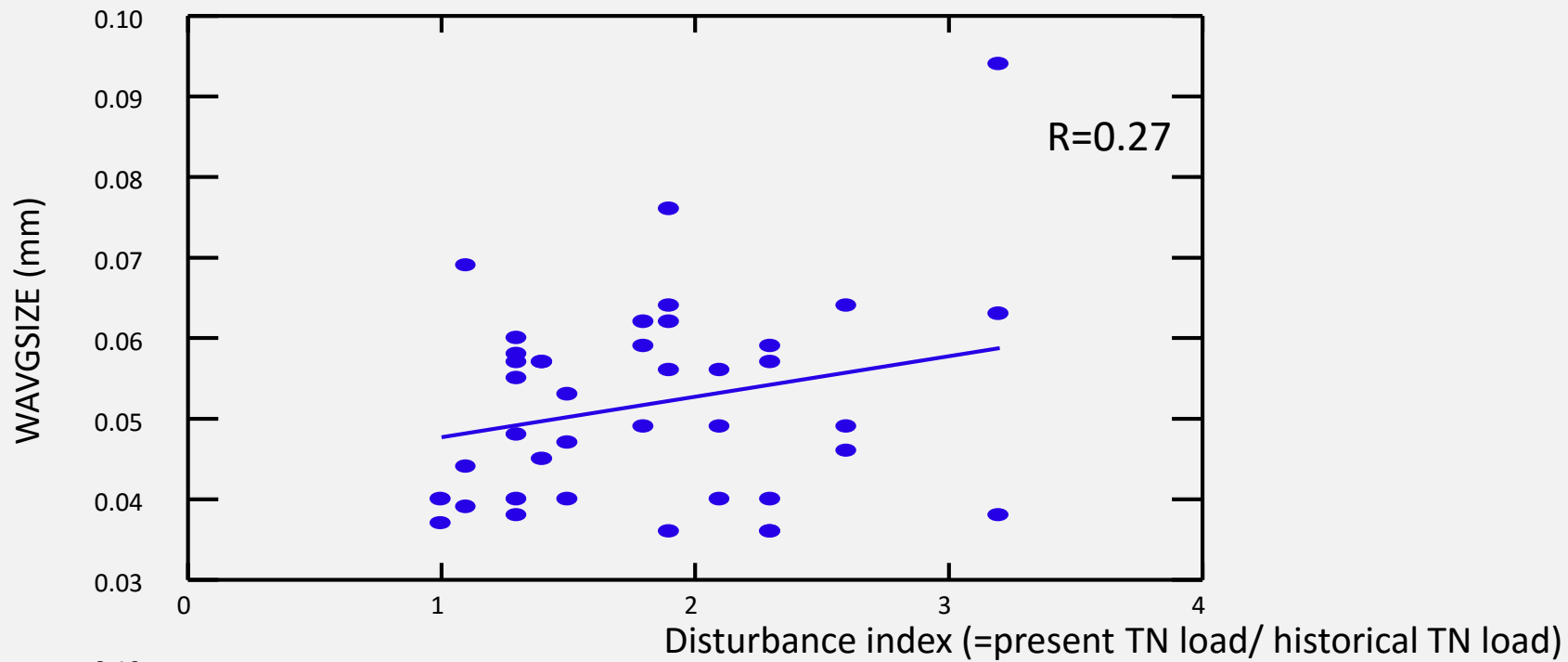
Council requested dynamic “traffic light”

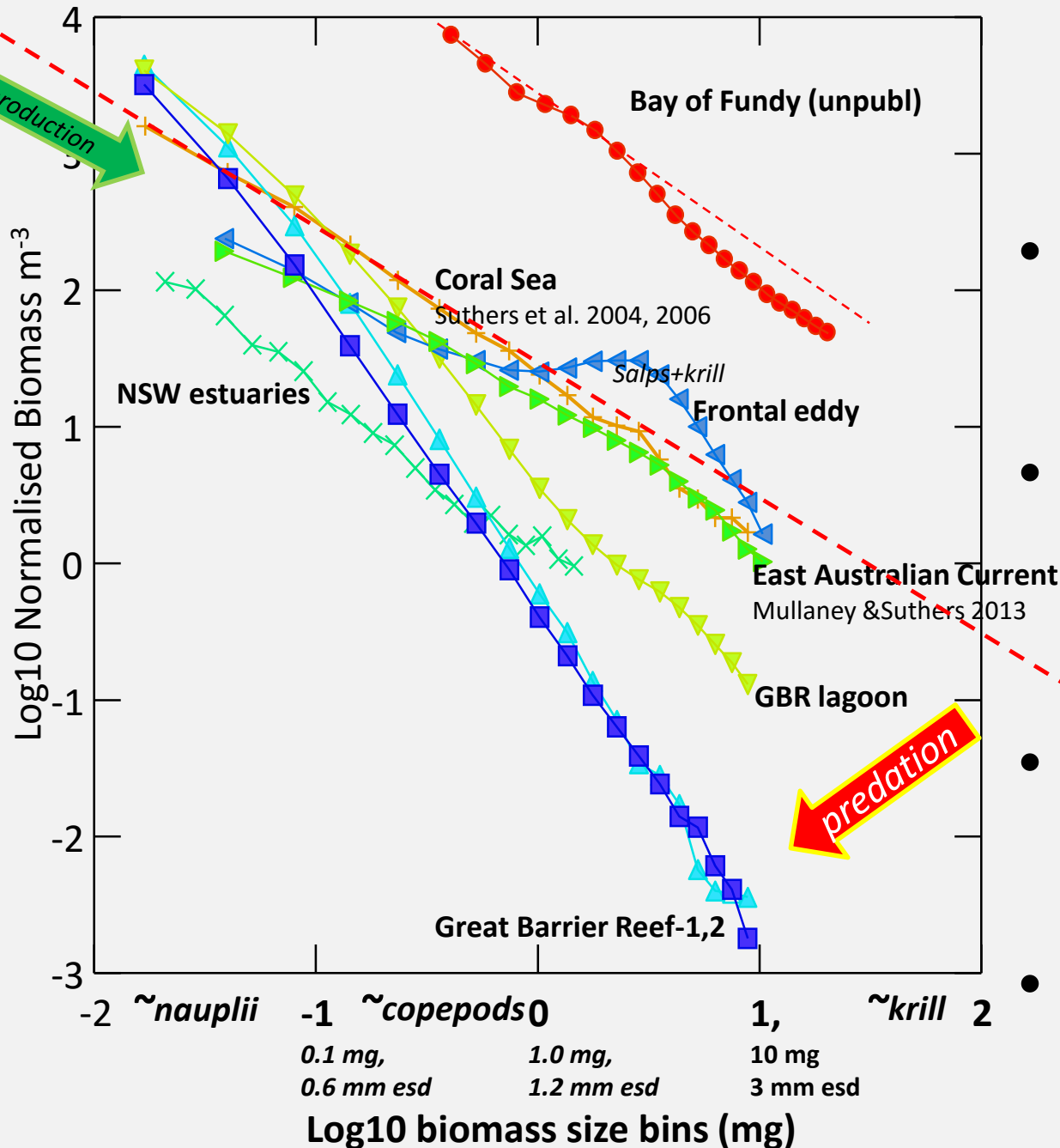


Study sites







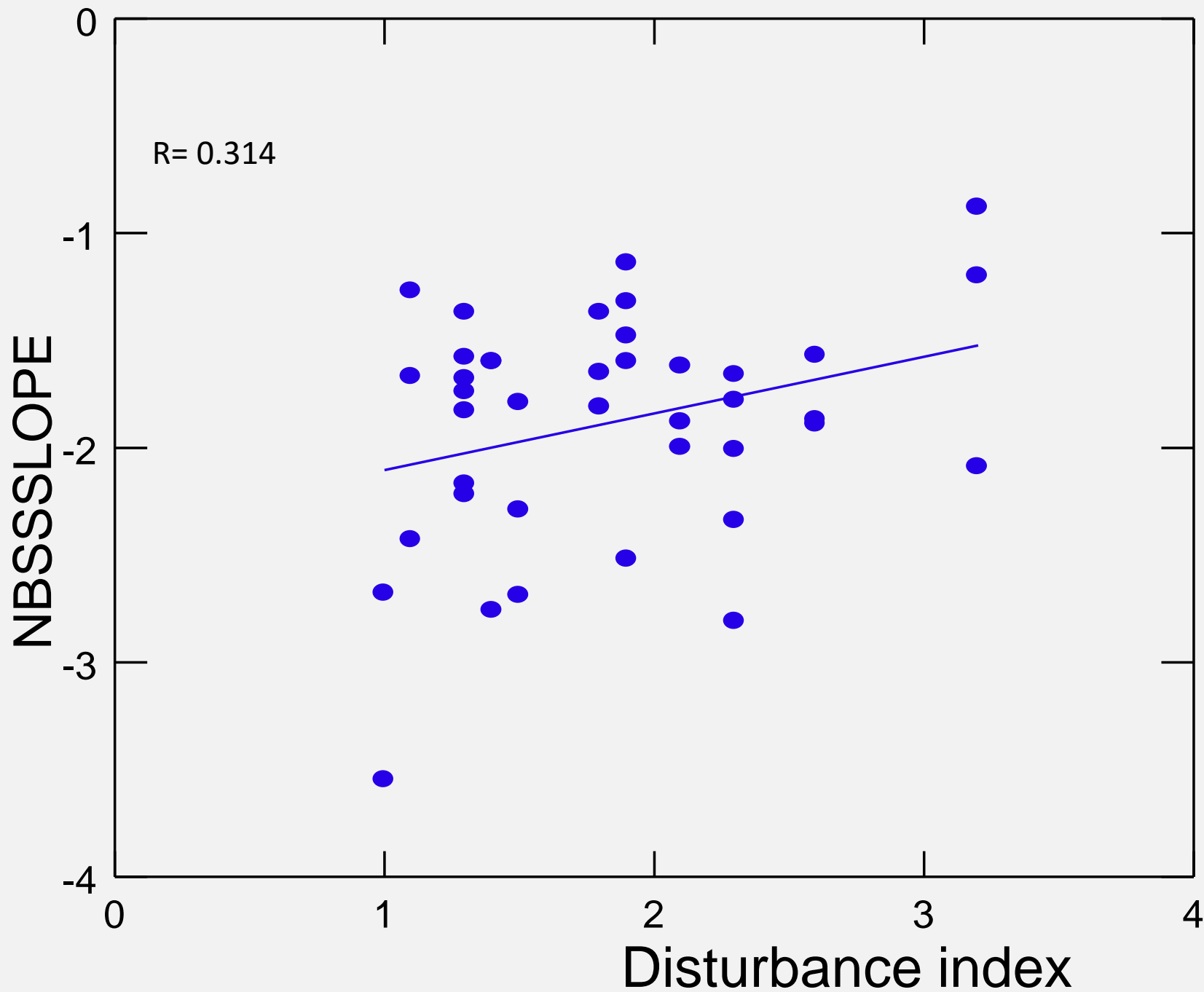


Estuaries?

- The planktonic size-based ecosystem!
- Summarised by the size frequency distribution
- speculate on production, predation
- See Jason Everett's poster

Conclusion & discussion points:

- In situ counters vs. net samples
 - Coincidence from $\ll 100$ μm particles
 - Nets are better for estuarine samples
- Detritus and arbitrary $<10\%$ threshold ?
- Difficulty of perfect flow meter data ?
 - Slope is independent of volume filtered
 - Also Geometric Mean Size (GMS)
- Slope (assimilation, predation) and GMS, (small-biomass:Chl-a ratio?) as useful indices







https://en.wikipedia.org/wiki/Camden_Haven





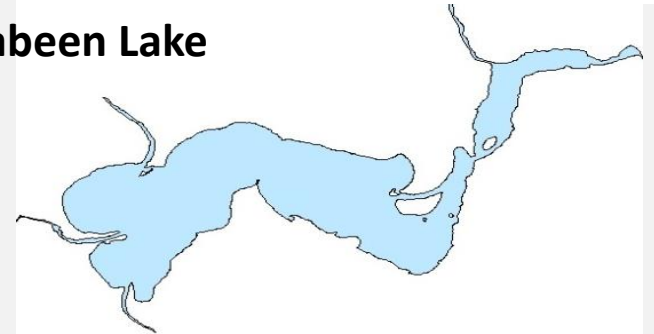
Rivers, Lakes, Lagoon

- Geomorphology of estuaries (Roy et al. 2001)
 - Rivers frequently flushed (Roper et al. 2011)
 - Lakes high dilution but less tide
 - Lagoons – smaller, shallower and lower dilution

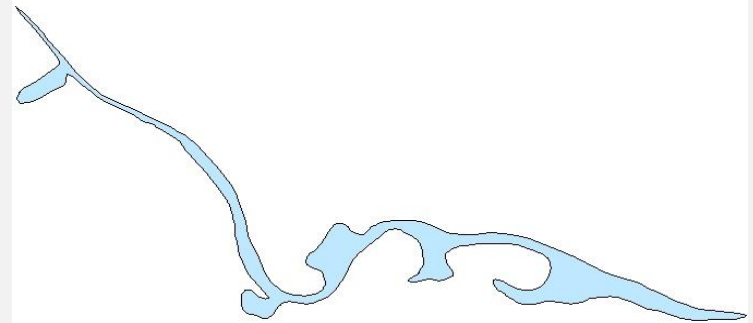
Wonboyn River

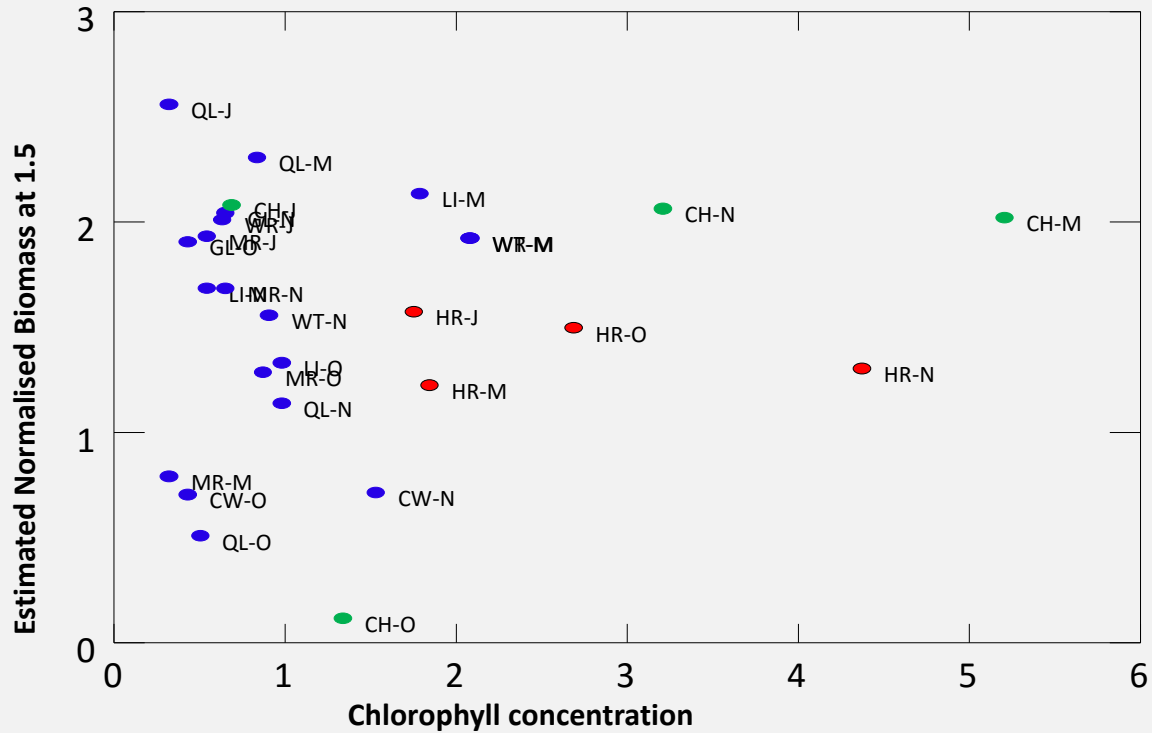
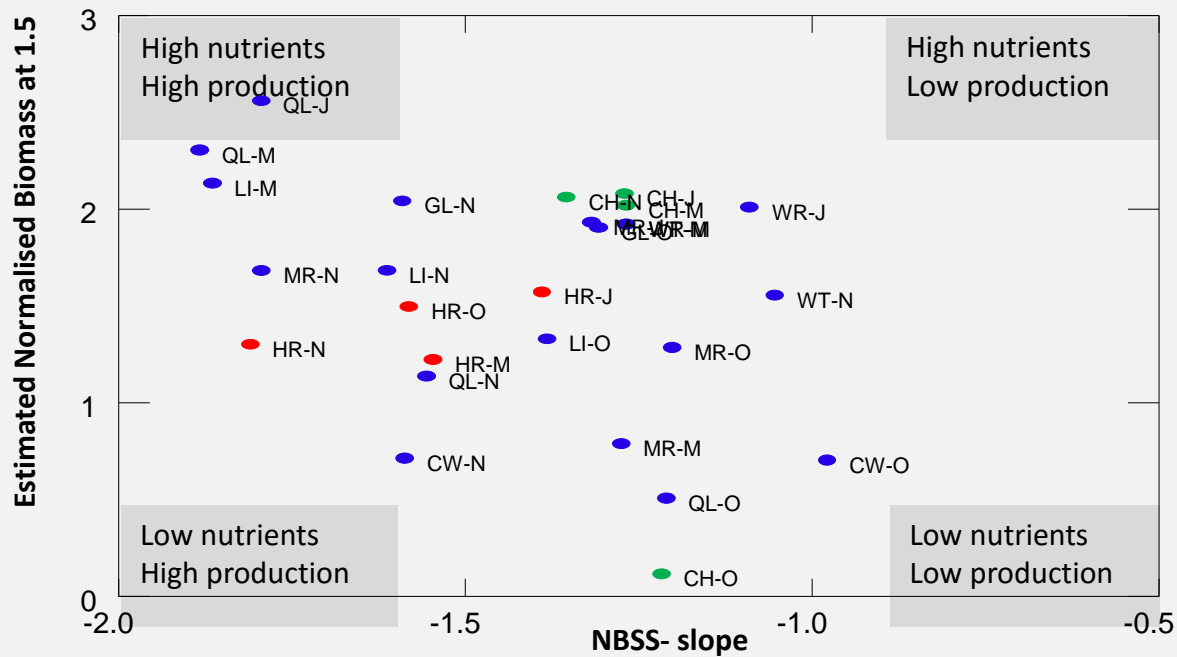


Narrabeen Lake



Manly Lagoon



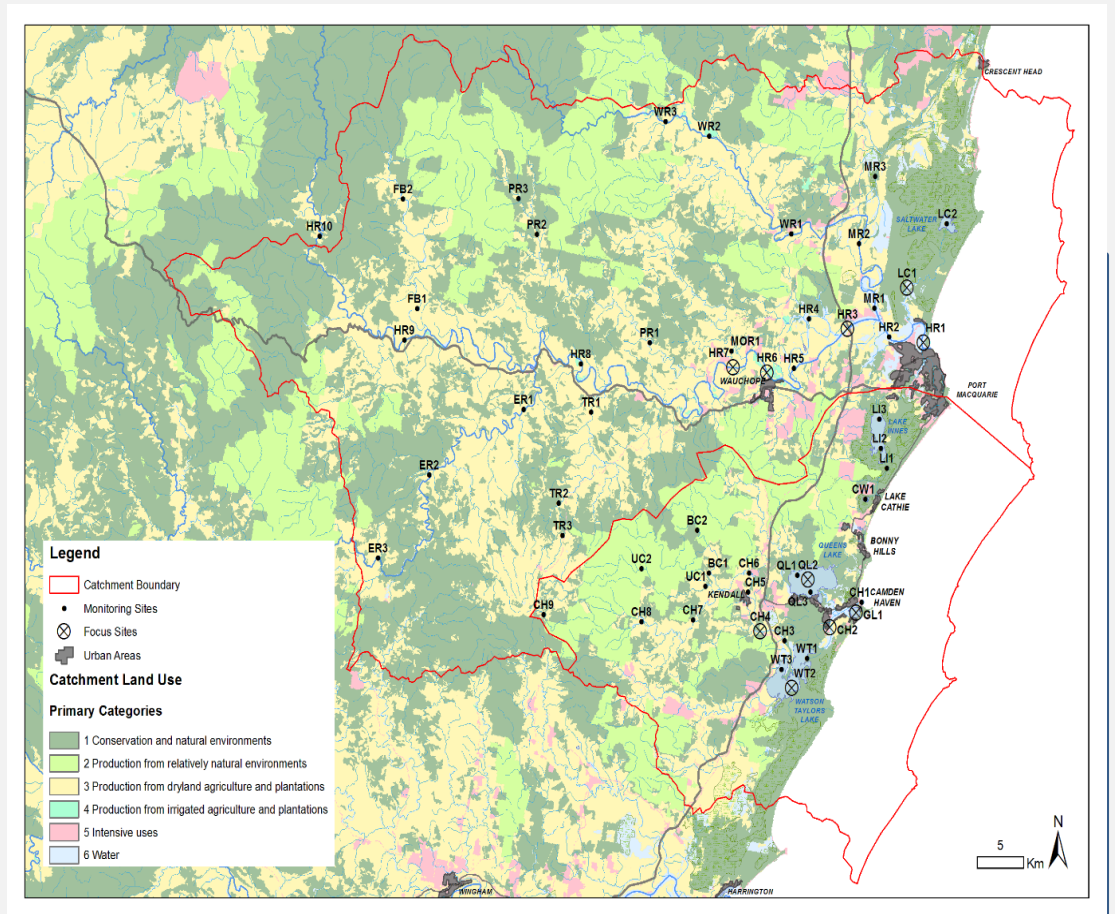
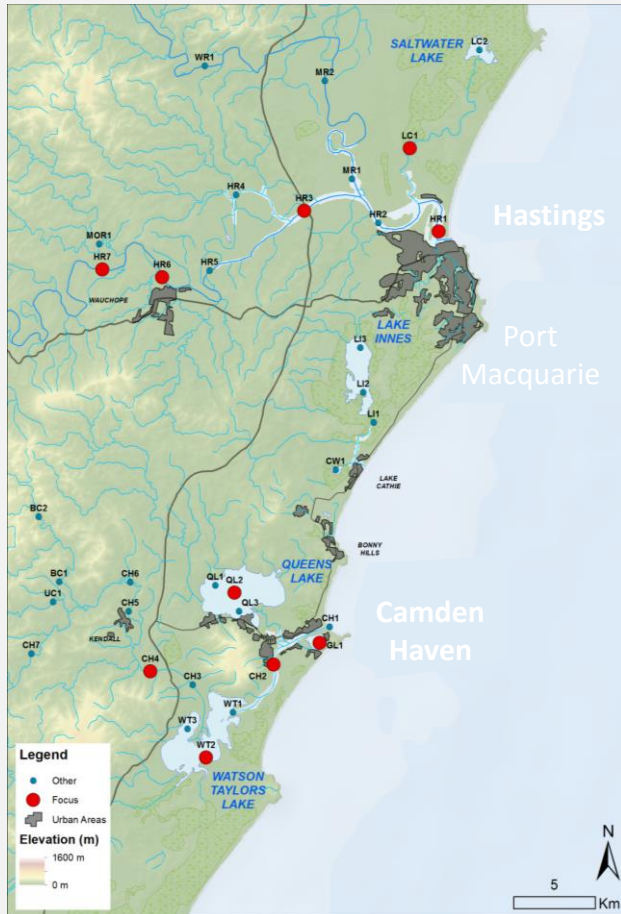


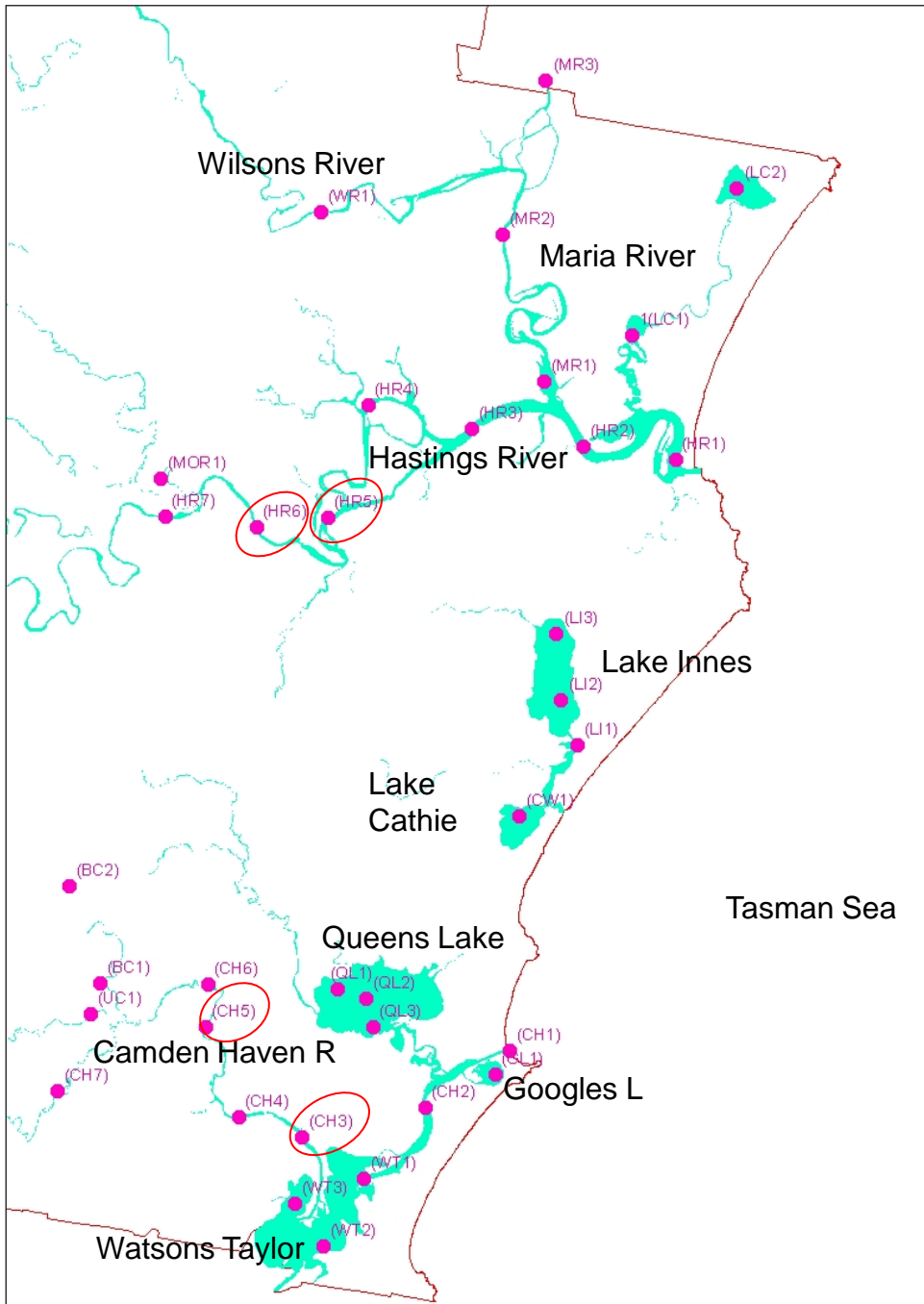
<u>rank</u>	<u>Score</u>	<u>Chl : sm</u>	<u>slope</u>
v good	5	<0.5	>1.75
good	4	0.5 to 1.5	1.25 to 1.75
fair	3	1.5 to 3	1 to 1.25
poor	2	3 to 5	0.75 to 1
v. poor	1	>5	<0.75

<u>rank</u>	<u>Range</u>
v good	>4.2 to 5
good	>3.4-4.2
fair	>2.6-3.4
poor	>1.8 to 2.6
v. poor	<=1.8

Change this to GMS and slopes

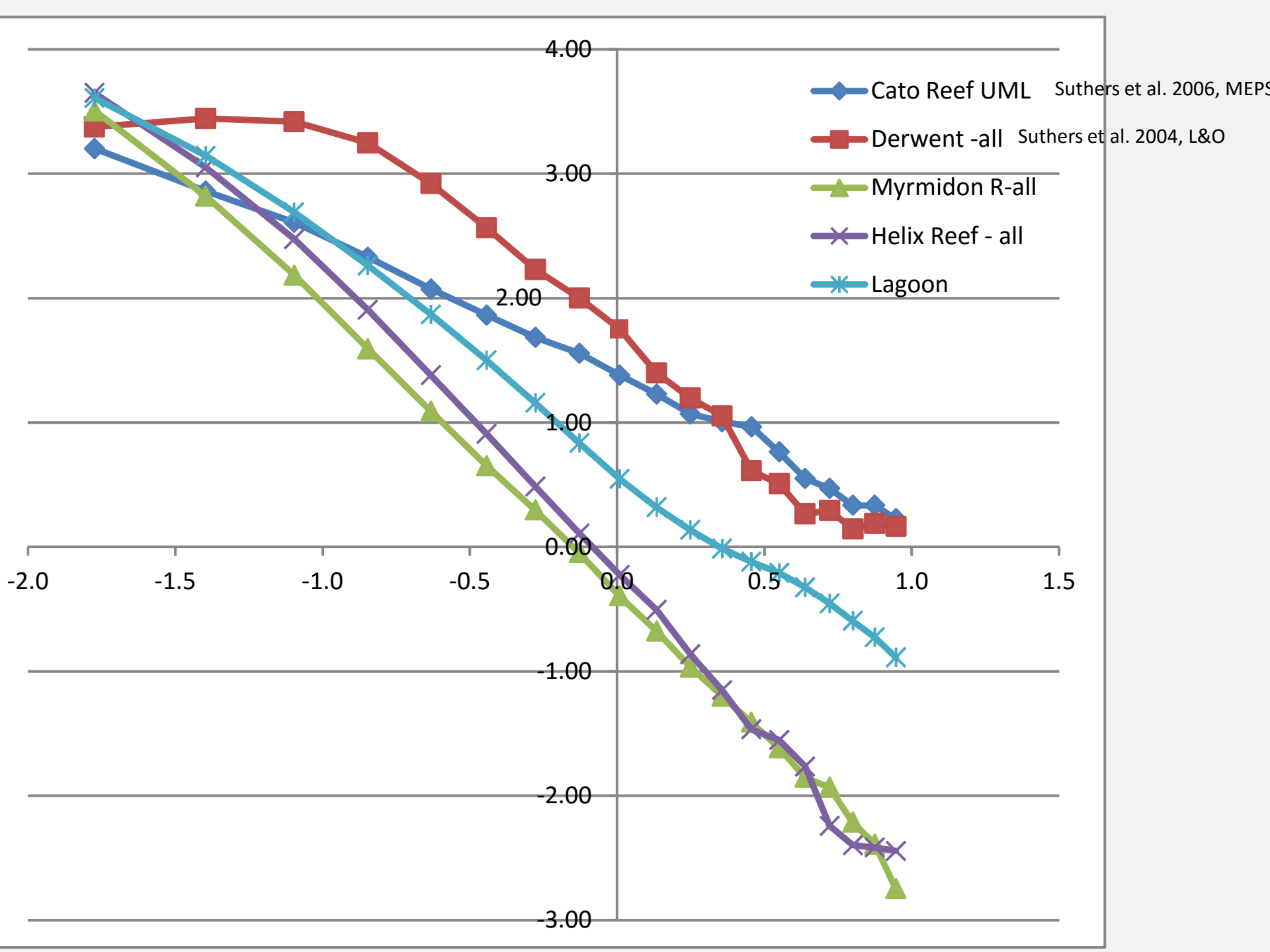
Sample Locations & Variables

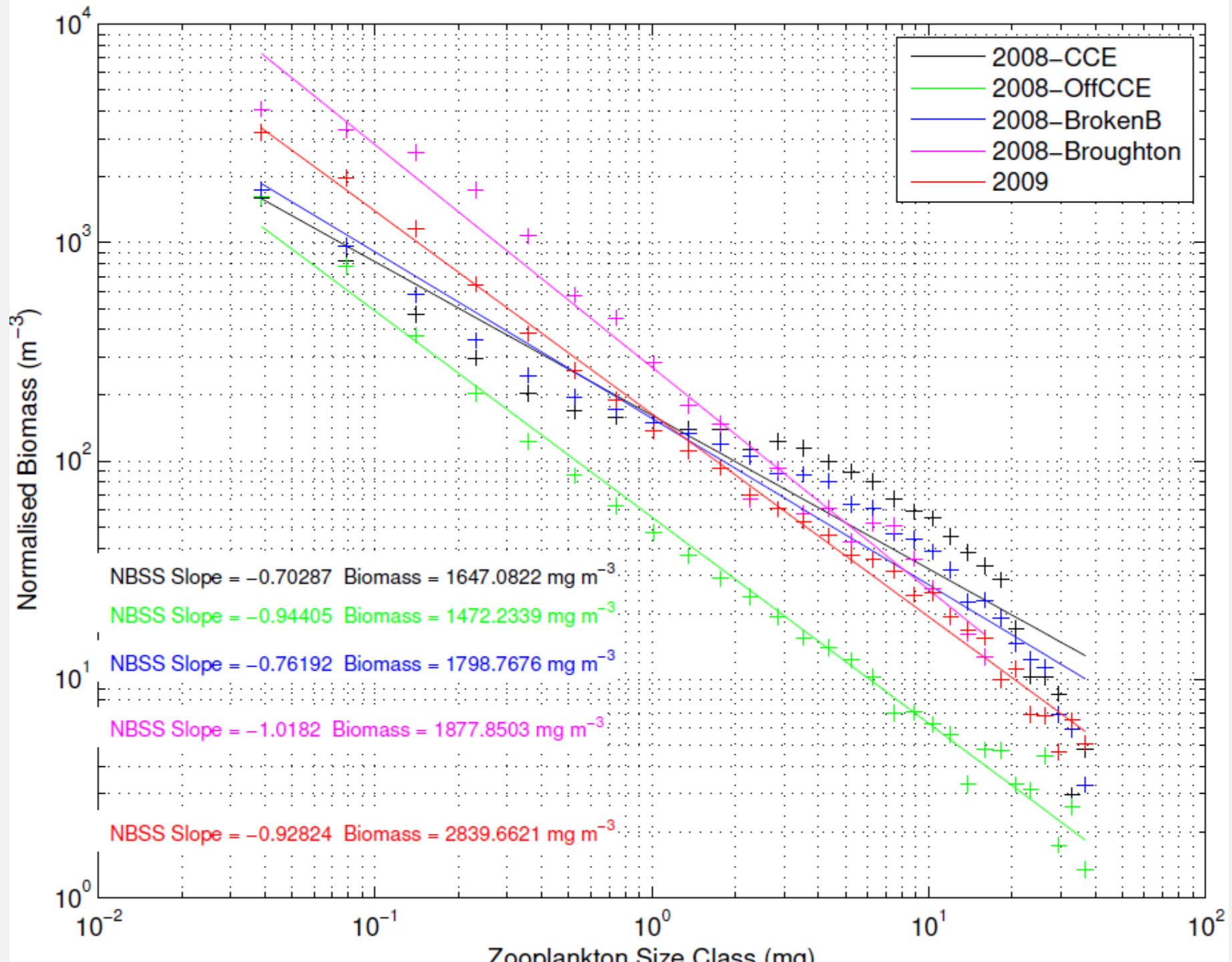




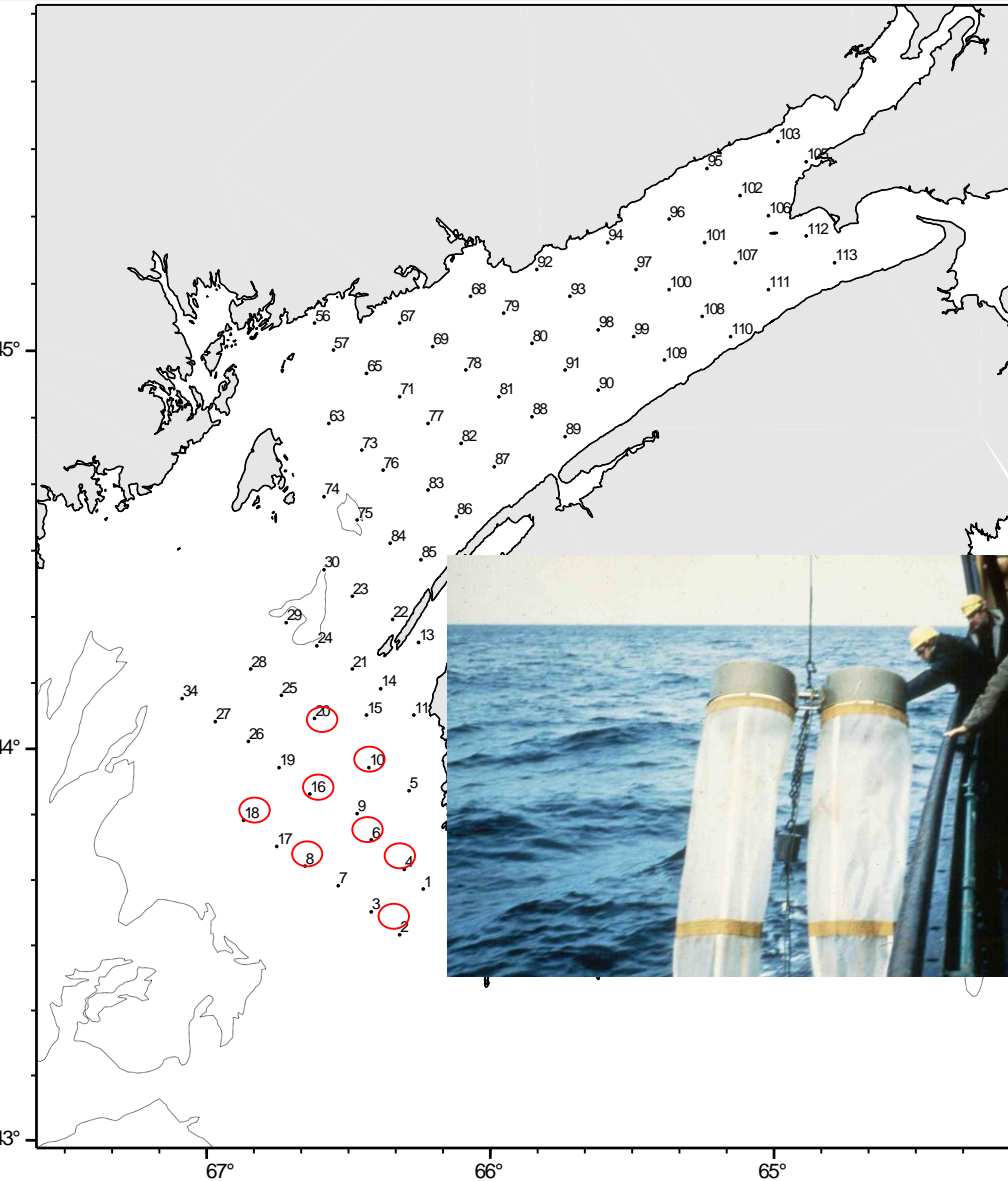
FTB1

FTB1



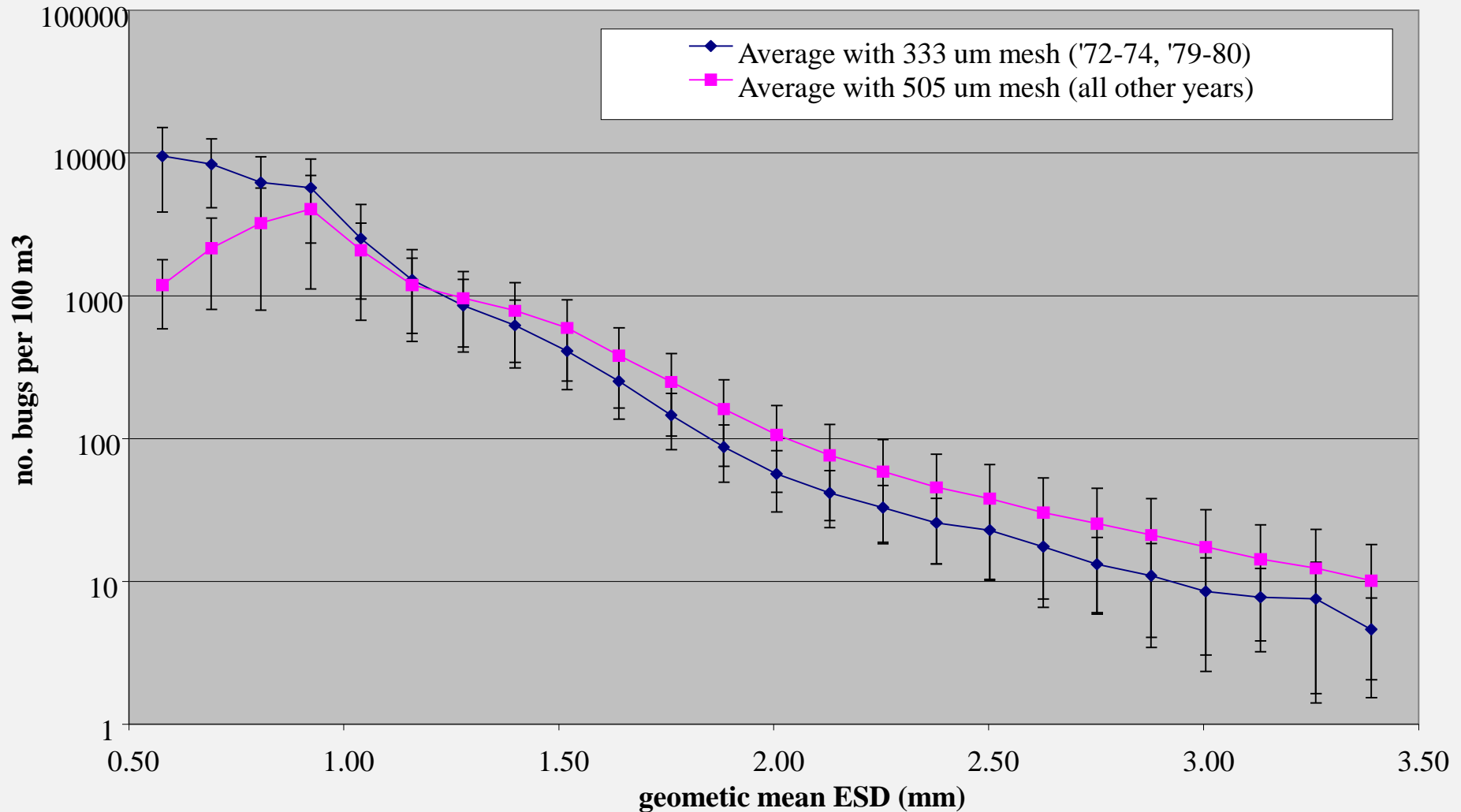


Plankton surveys Bay of Fundy:

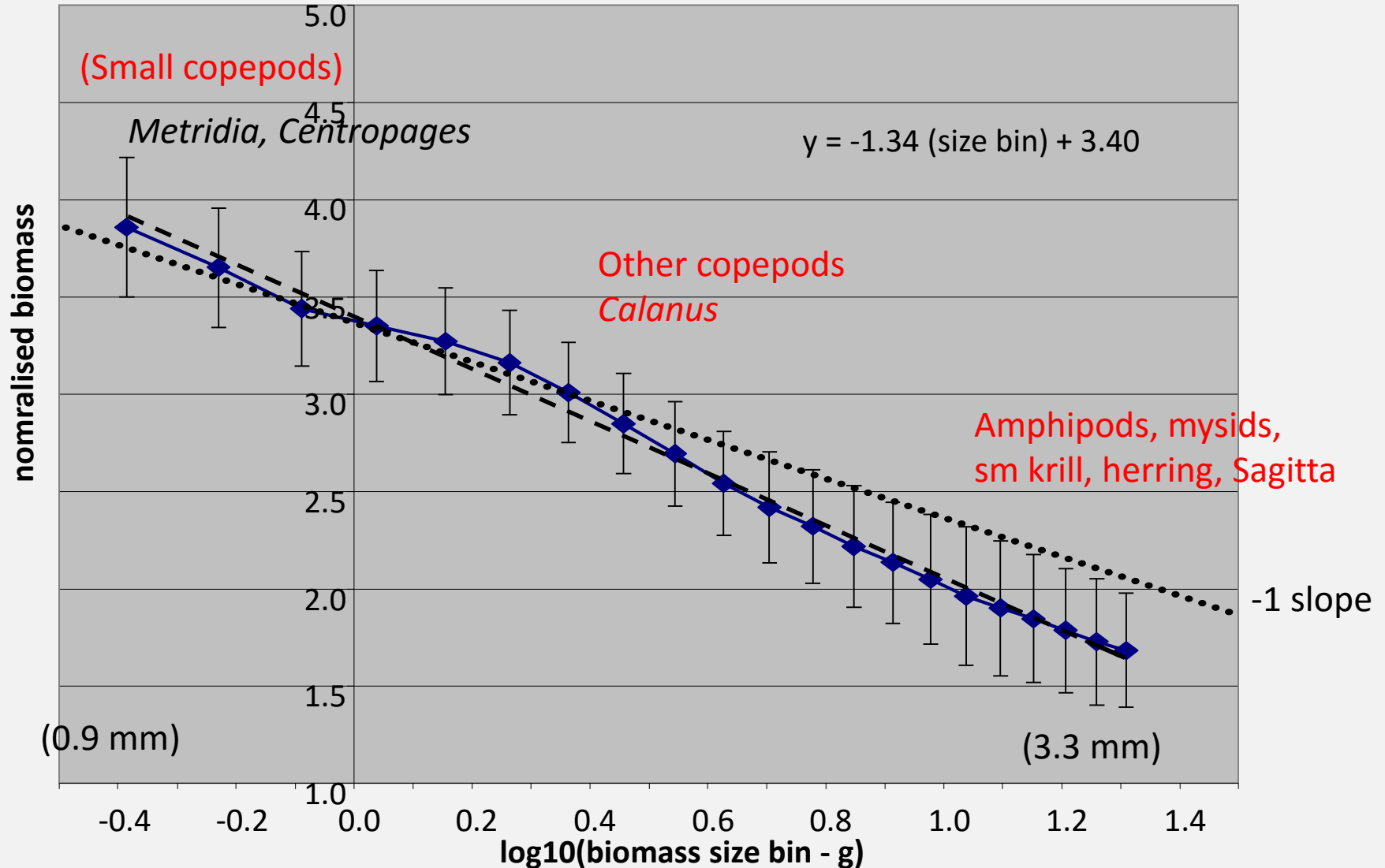


- First week of November
 - 1972-1998
- Bongo, 0.5 mm, ~500 m³
- Zooplankton
 - Atlantic Refr. Collection
 - beautifully archived + 14 taxa abund. categ. 0, <10, <100, <1000, >1000
 - OPC 8 core stations x 27 years, '72-'98

Comparison of 333 and 505 μm mesh

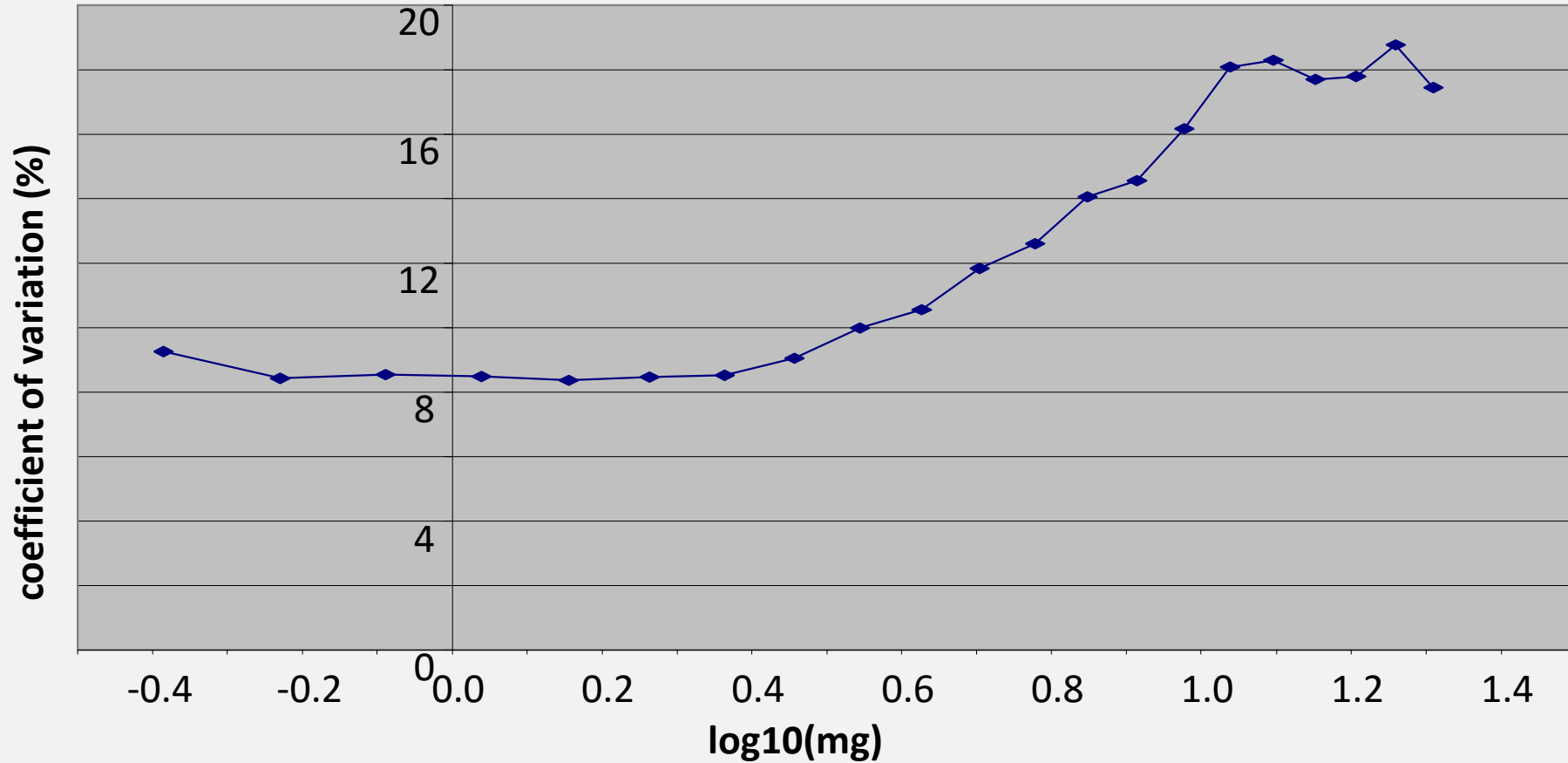


Bay of Fundy, 1972-1998 archive



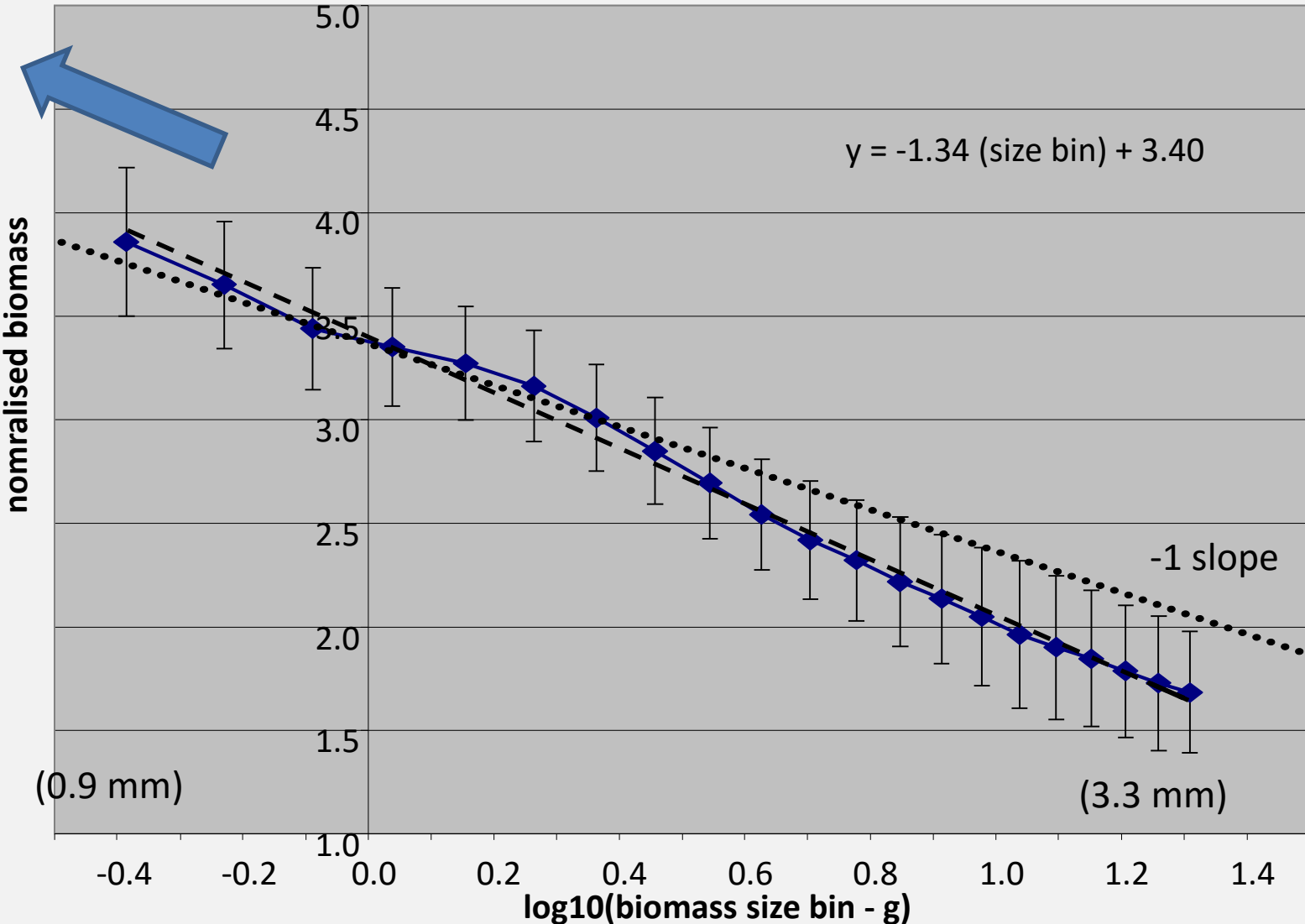
Coefficient of Variation

Effect of predation:



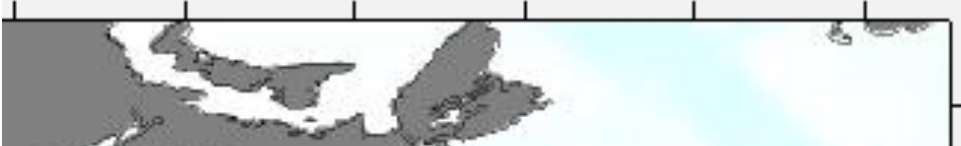
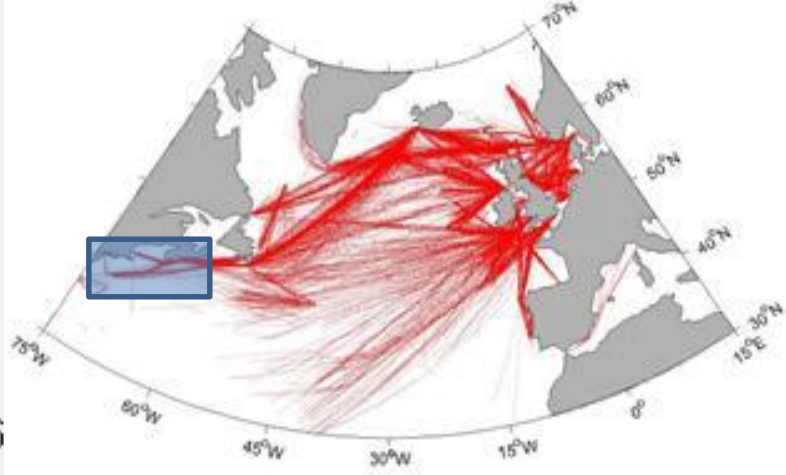
What is the expected biomass of fish? Of phytoplankton?

0.004-0.04 mm?

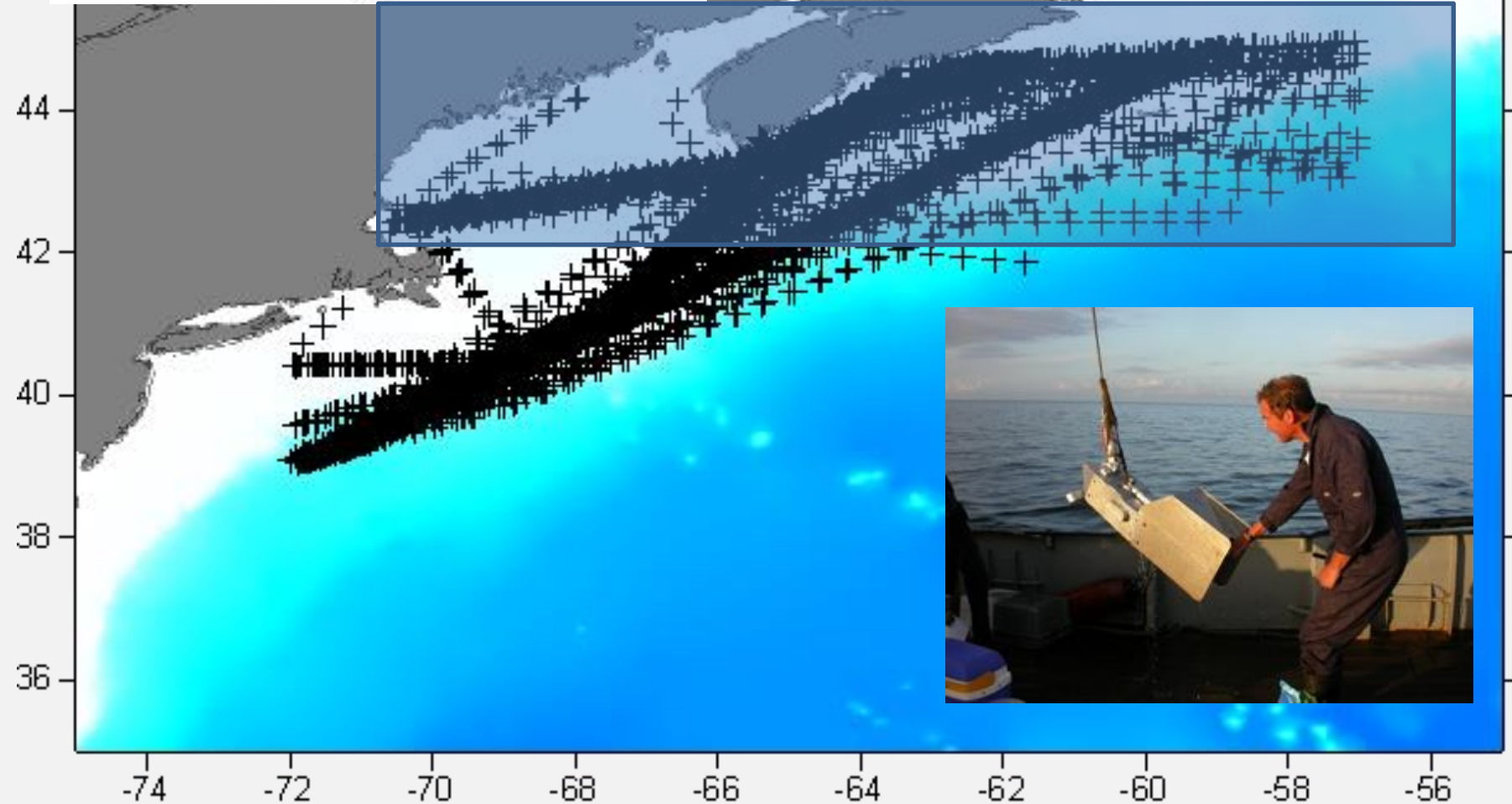


150-350 mm?

Bottom-up forcing? Continuous Plankton Recorder



46



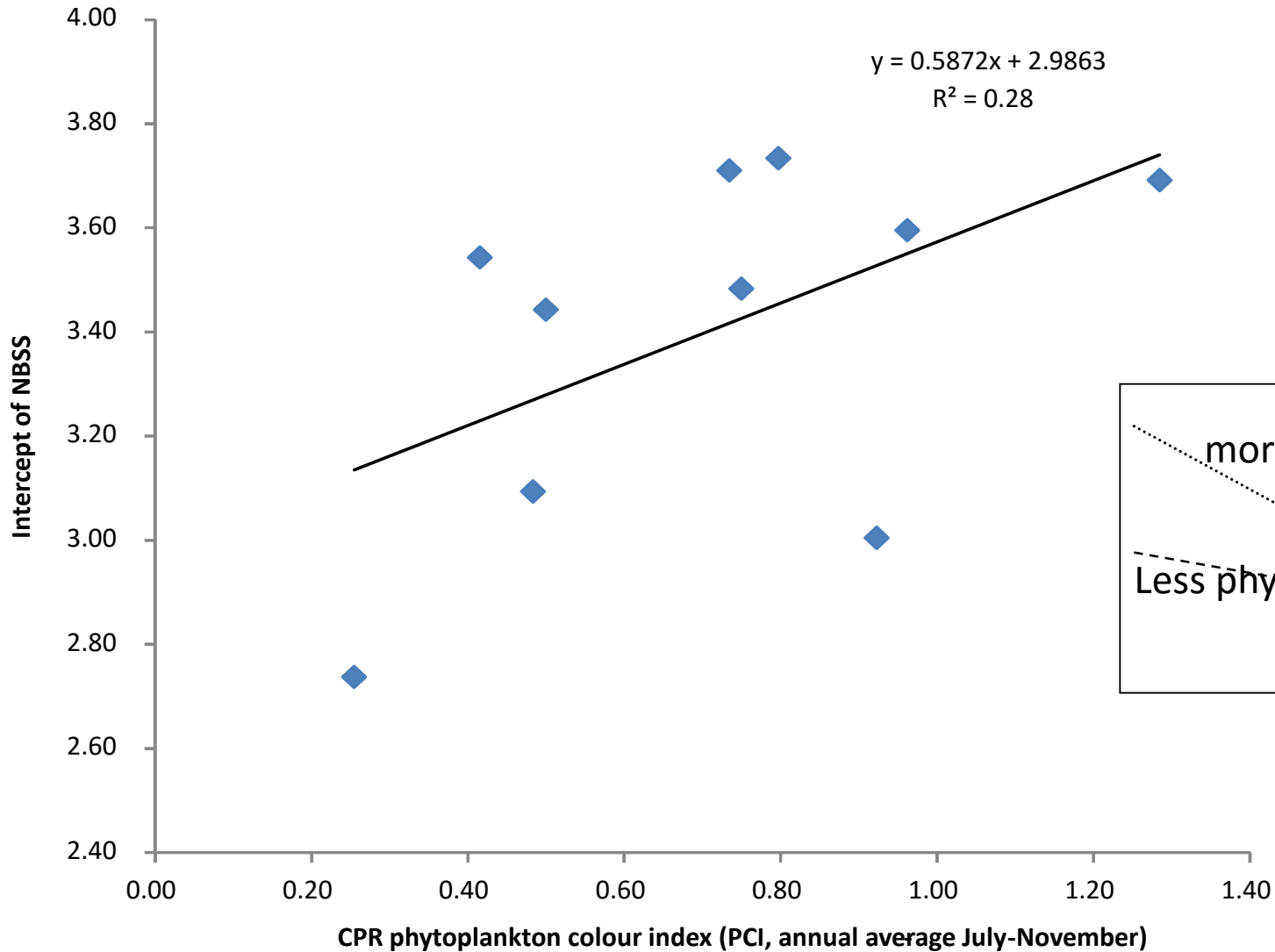
greenness index, PCI

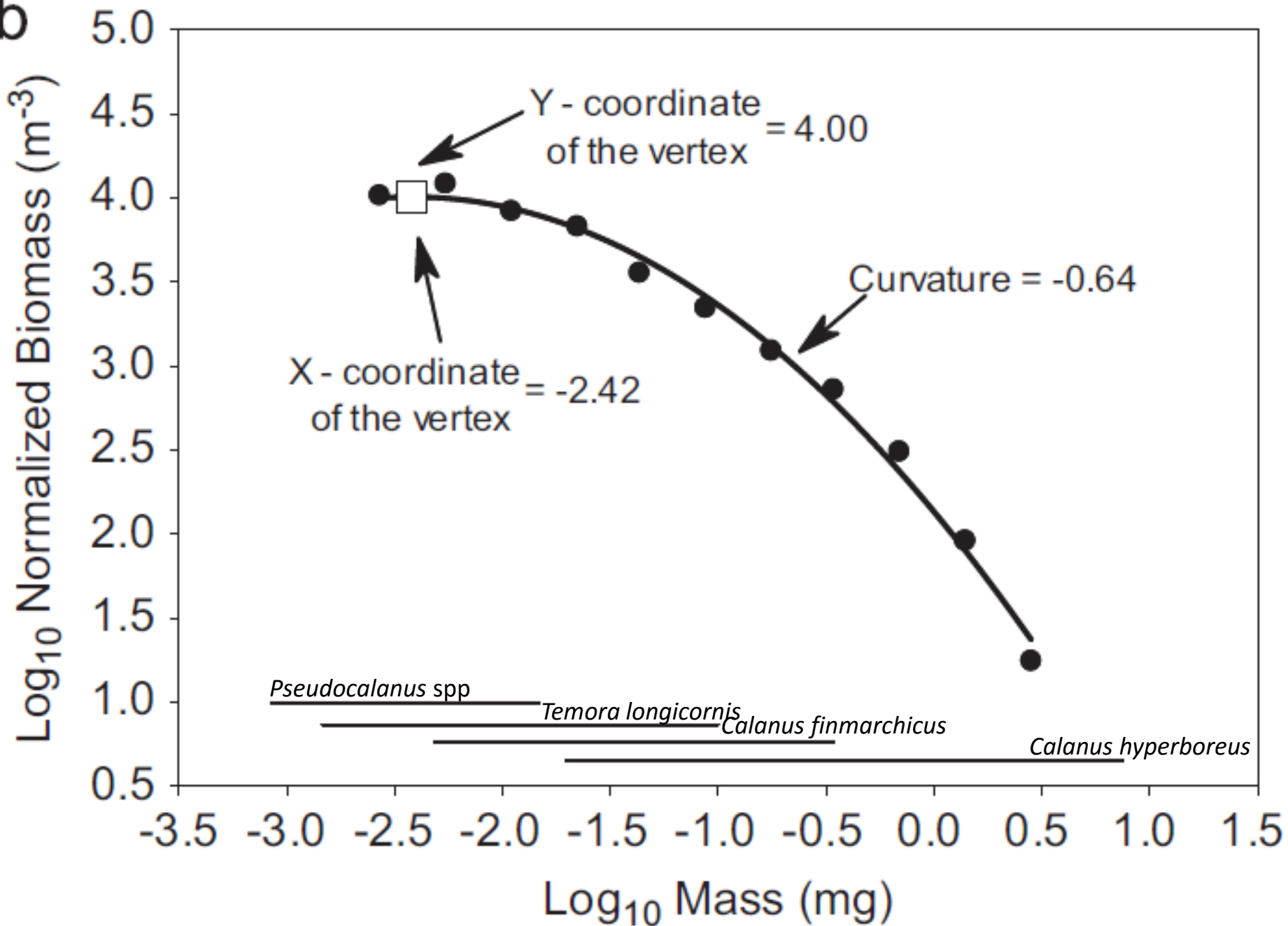
“Phytoplankton Colour Index”

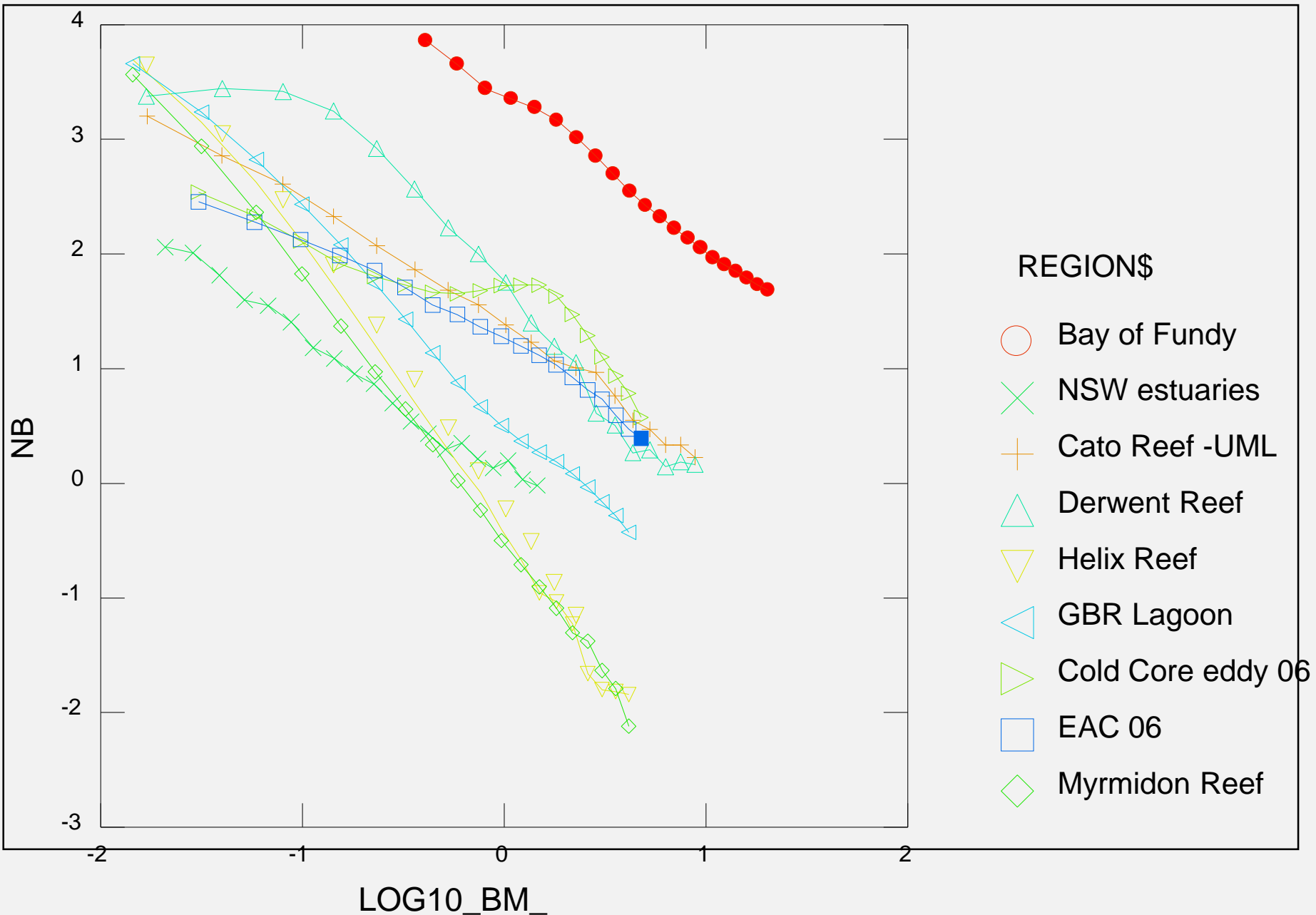
- PCI is recorded as 0,1,2 and 6.5
- Missing data from 1974 – 1990
- Is there a bottom-up effect on the biomass size distribution?
- If so, can we predict the missing years of chlorophyll from the NBSS?

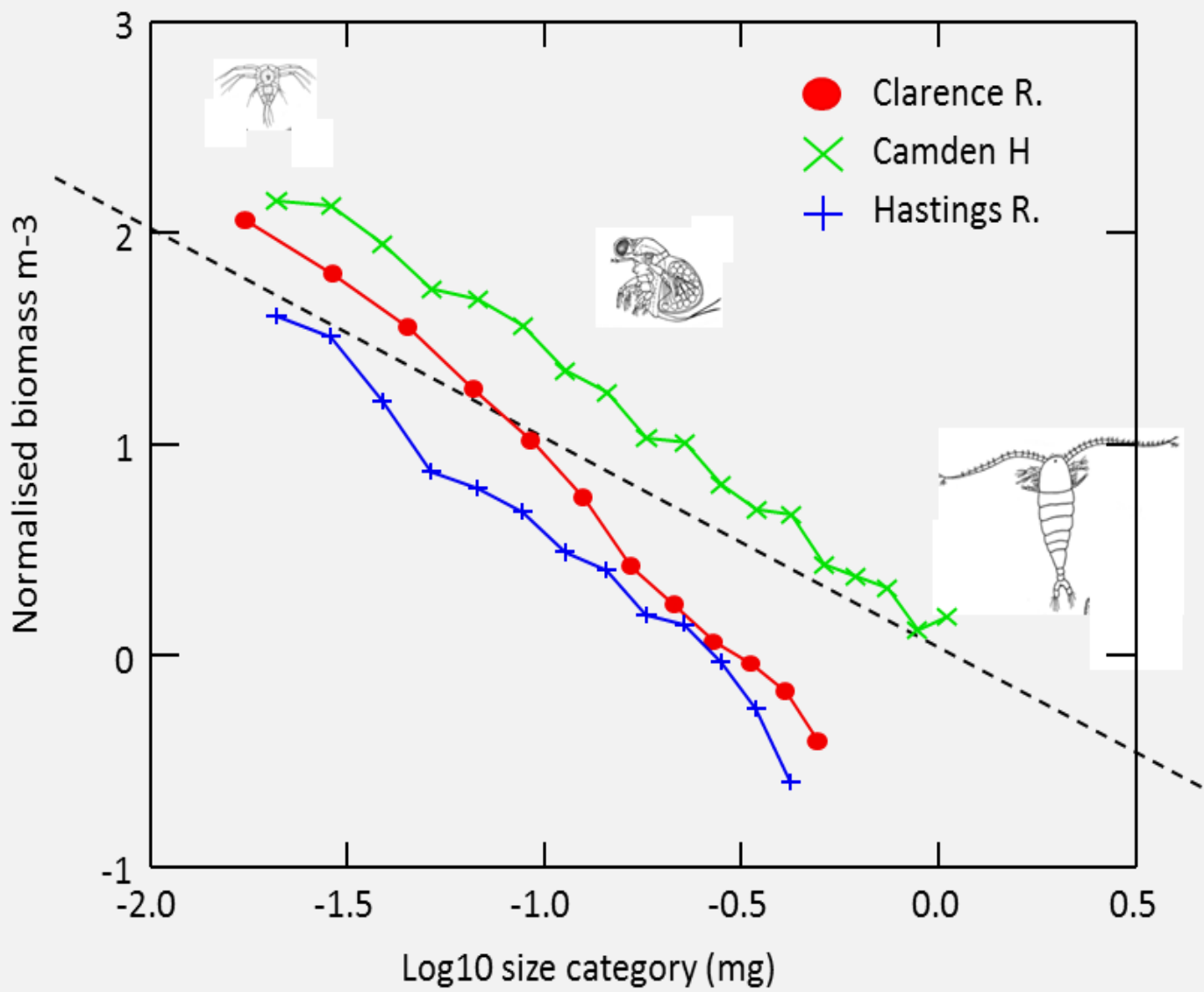
	Jul-Nov avg
1972	0.25
1973	0.50
1974	
1975	
1976	
1977	
1991	0.48
1992	0.96
1993	1.28
1994	0.75
1995	0.80
1996	0.92
1997	0.42
1998	0.73

Intercept of NBSS (1 mg)

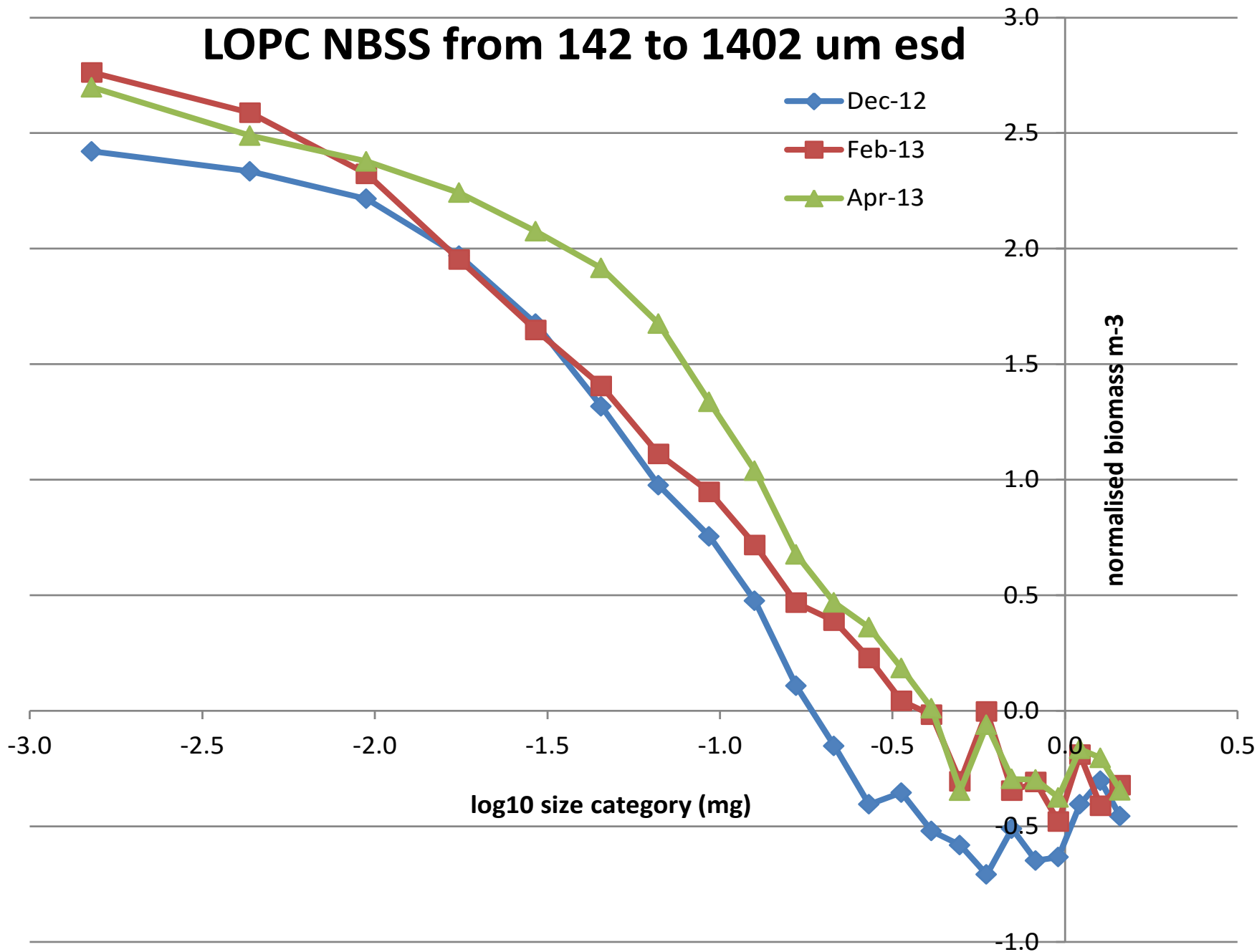


b



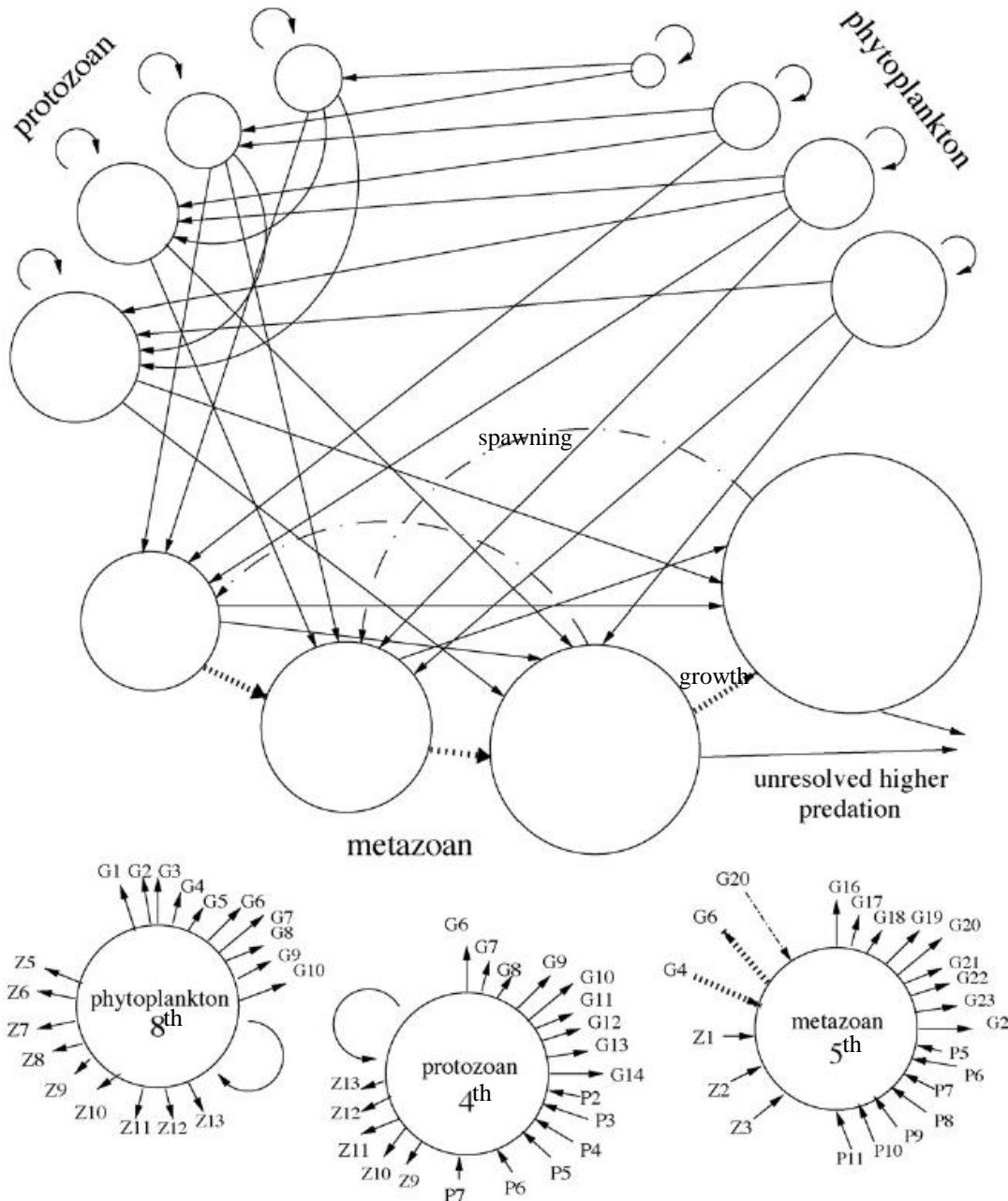


LOPC NBSS from 142 to 1402 μm esd

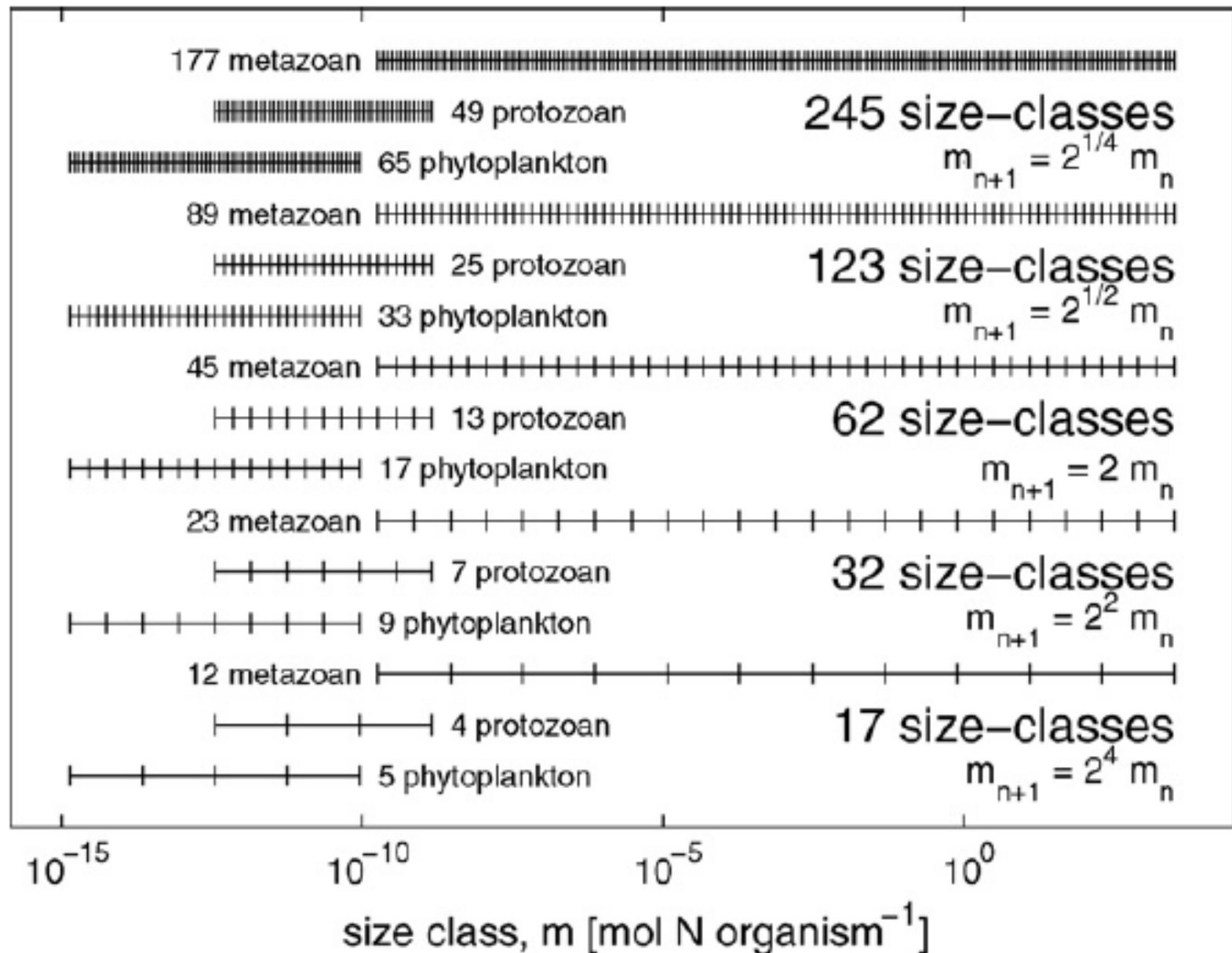




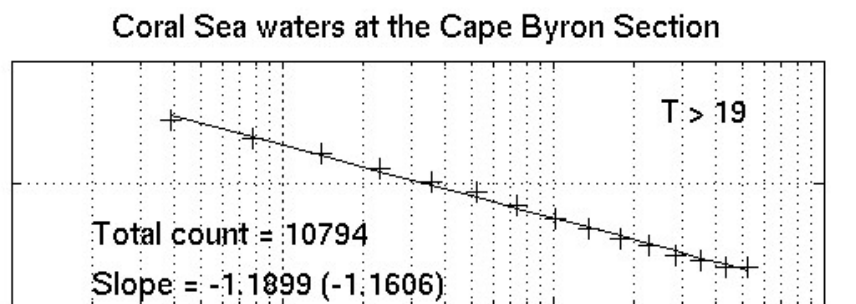
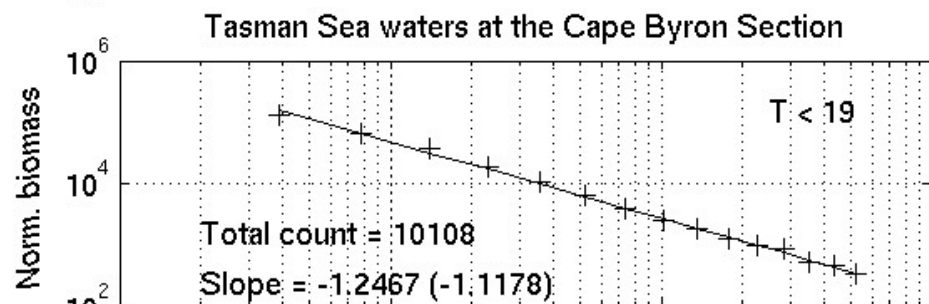
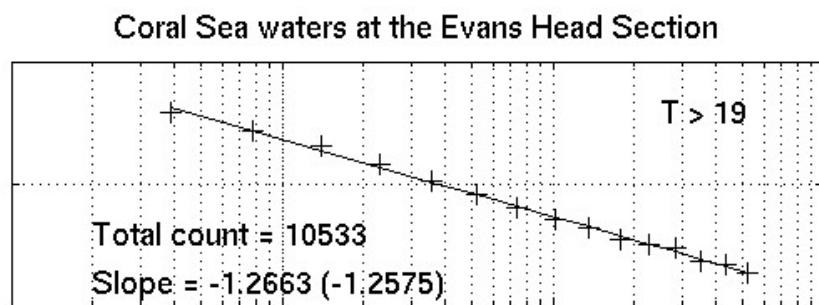
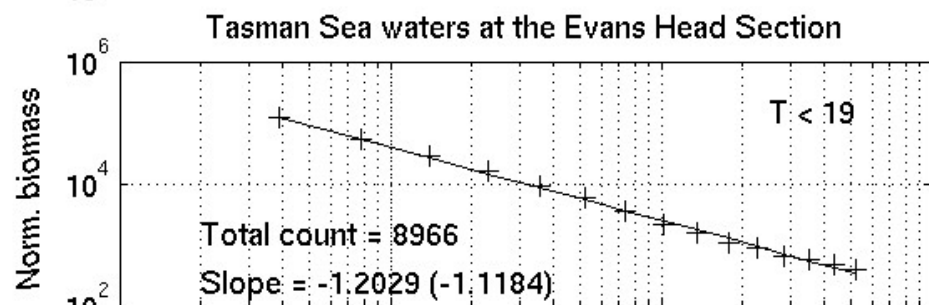
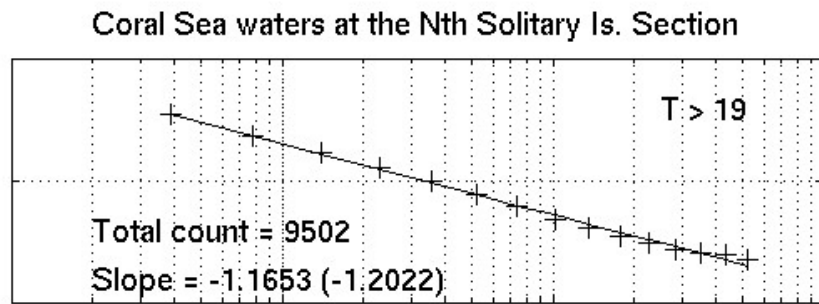
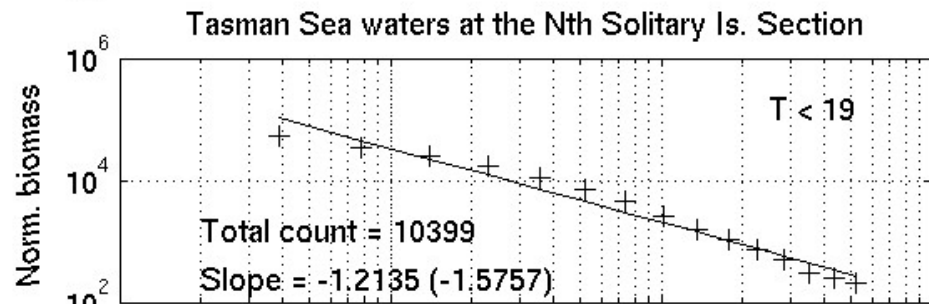
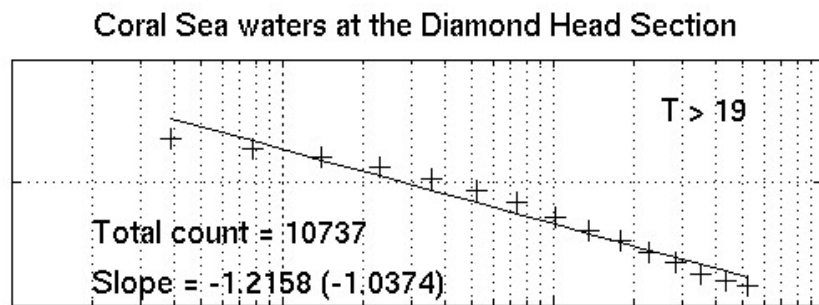
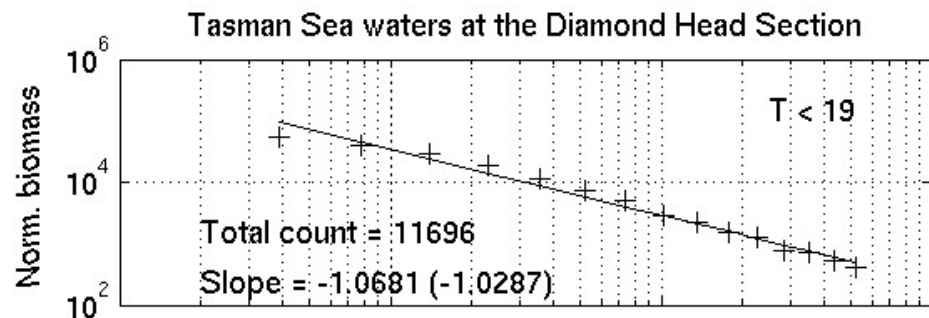
A bio-mechanical, size resolved model



- 62 size classes
- 19 orders of magn.
- Phyto 1-17
- Protozoan 9-21
- Metazoan 18-62
- Complexity stabilises model
- Initial conditions?
- Coupled hydrogr
- Sensitivity: [DIN], protozoa biomass



Increasing model structural complexity inhibits the growth of initial condition errors



Size class (m^3)

Size class (m^3)

