Predicting community gradients on commercial fishing grounds

Claire Catherall

Fisheries & Conservation Science Group

Bangor University

Michel Kaiser, Lee Murray (Bangor University), Ewen Bell (Cefas)

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Content

King scallop, *Pecten maximus*

- Background
- Sustainability
- Habitat survey design
- Results

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SCALLOP ASSOCIATION

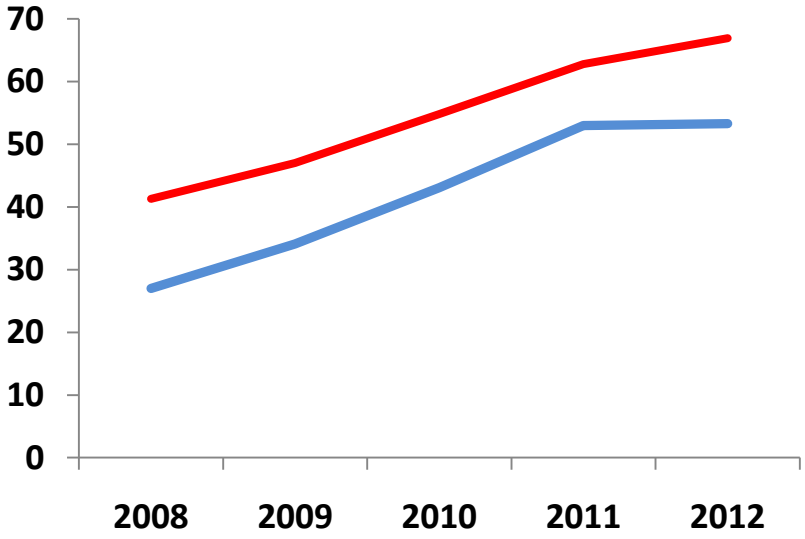
http://www.scallop-association.org.uk/

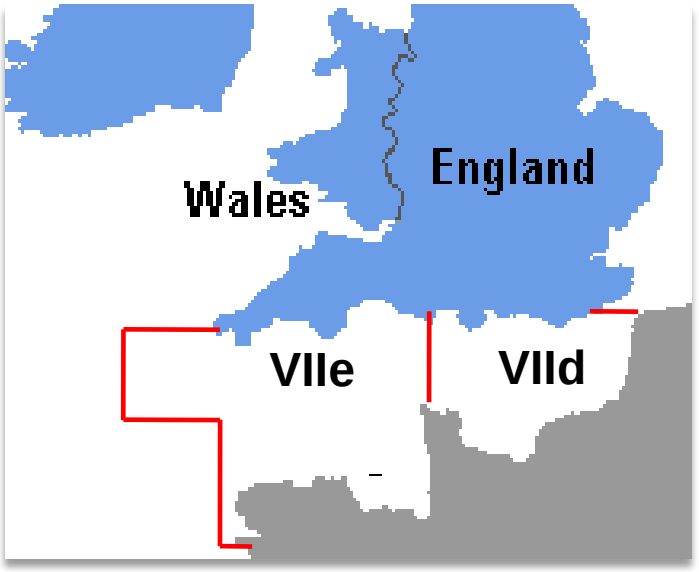
Cefas

The Fishmongers' Company

MORRISONS

Scallop fishery

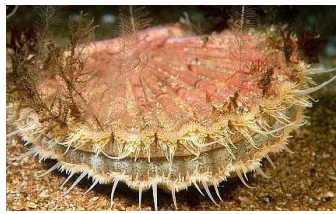




GBP 68 million
$US 114 million

Marine Management Organisation (2013)

Sustainable fisheries



Principle 1
Sustainable stocks

- Stock definition
- Stock size
- Spawning stock
- Exploitation rates

Principle 3
Effective management

- Effective, responsive
- Legislation
- Monitoring & evaluation

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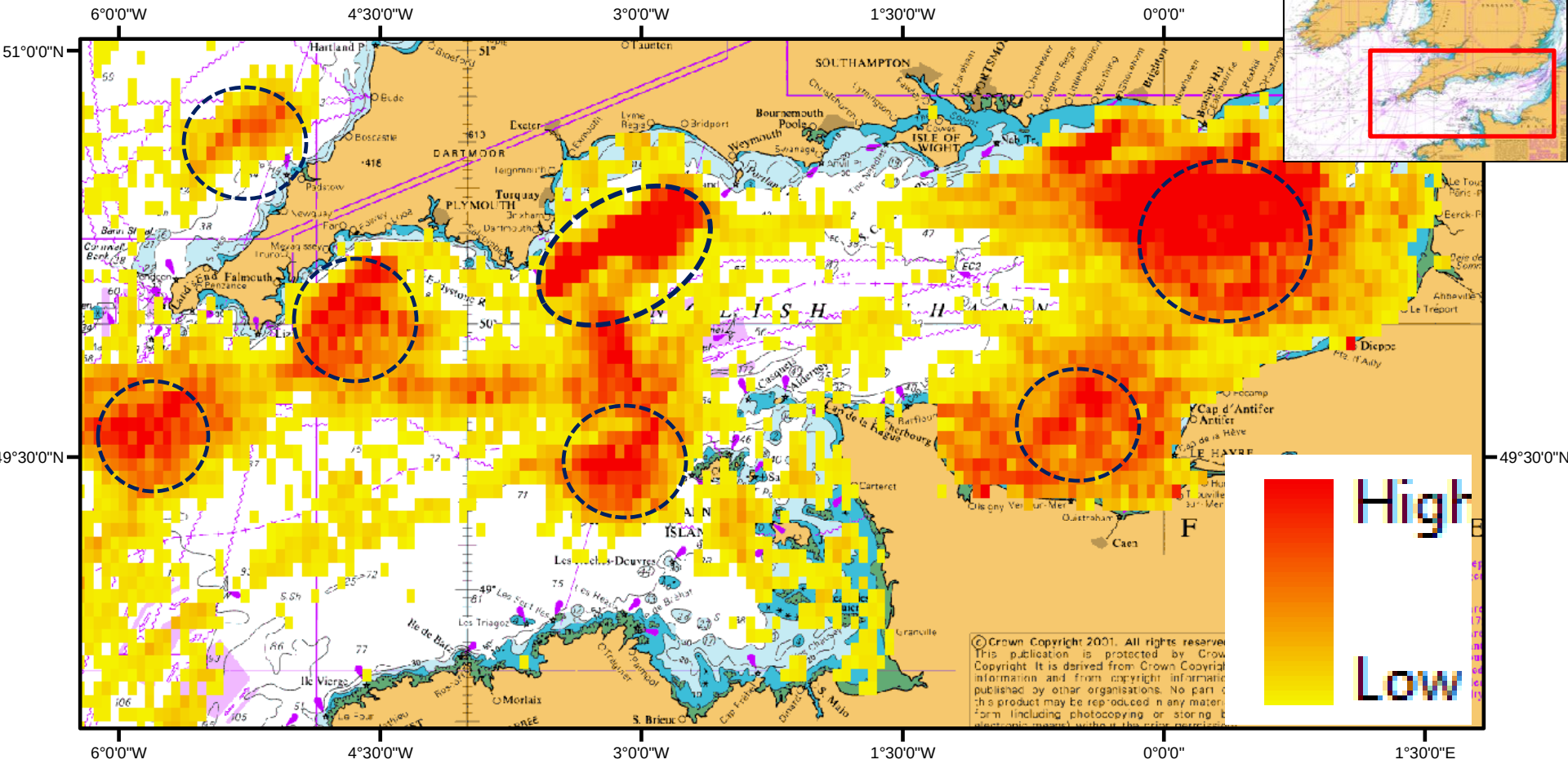
Principle 2
Environmental impact

- Bycatch
- Ecosystem impacts

Research questions

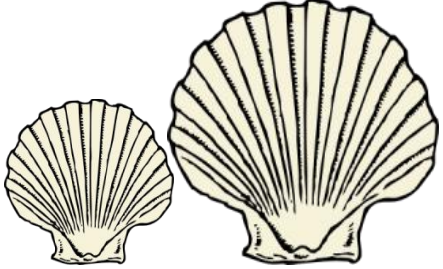
1) What is the spatial footprint of the scallop fishery?
2) What habitats and species are present?
3) What impact does the dredge fishery have on species composition & functional diversity?
4) Can diversity be predicted with environmental parameters and fishing effort data?

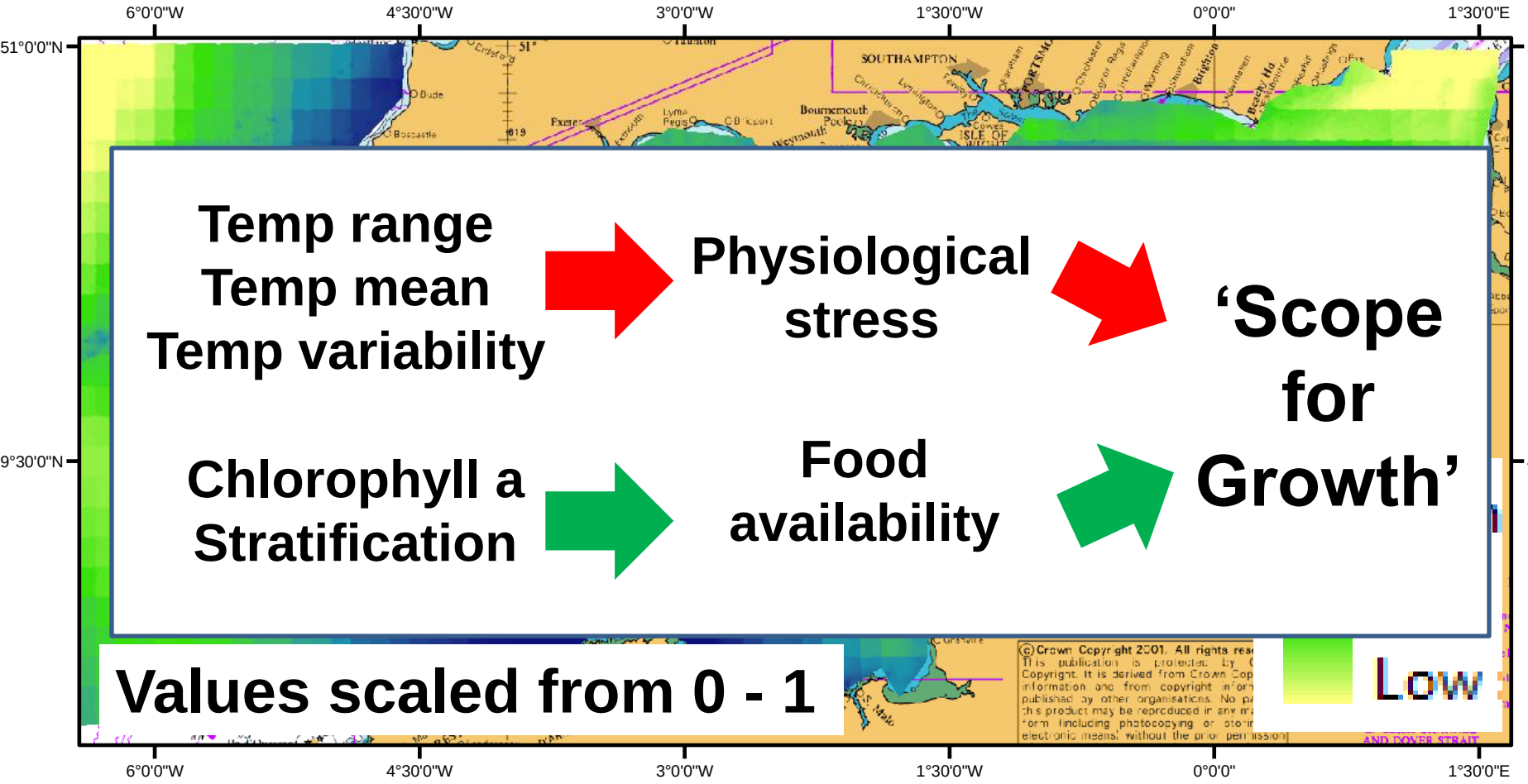
Fishing effort



Relative dredge fishing intensity (scallop vessels, speeds of 2-4 knots, 2005-2012)

‘Scope for Growth’

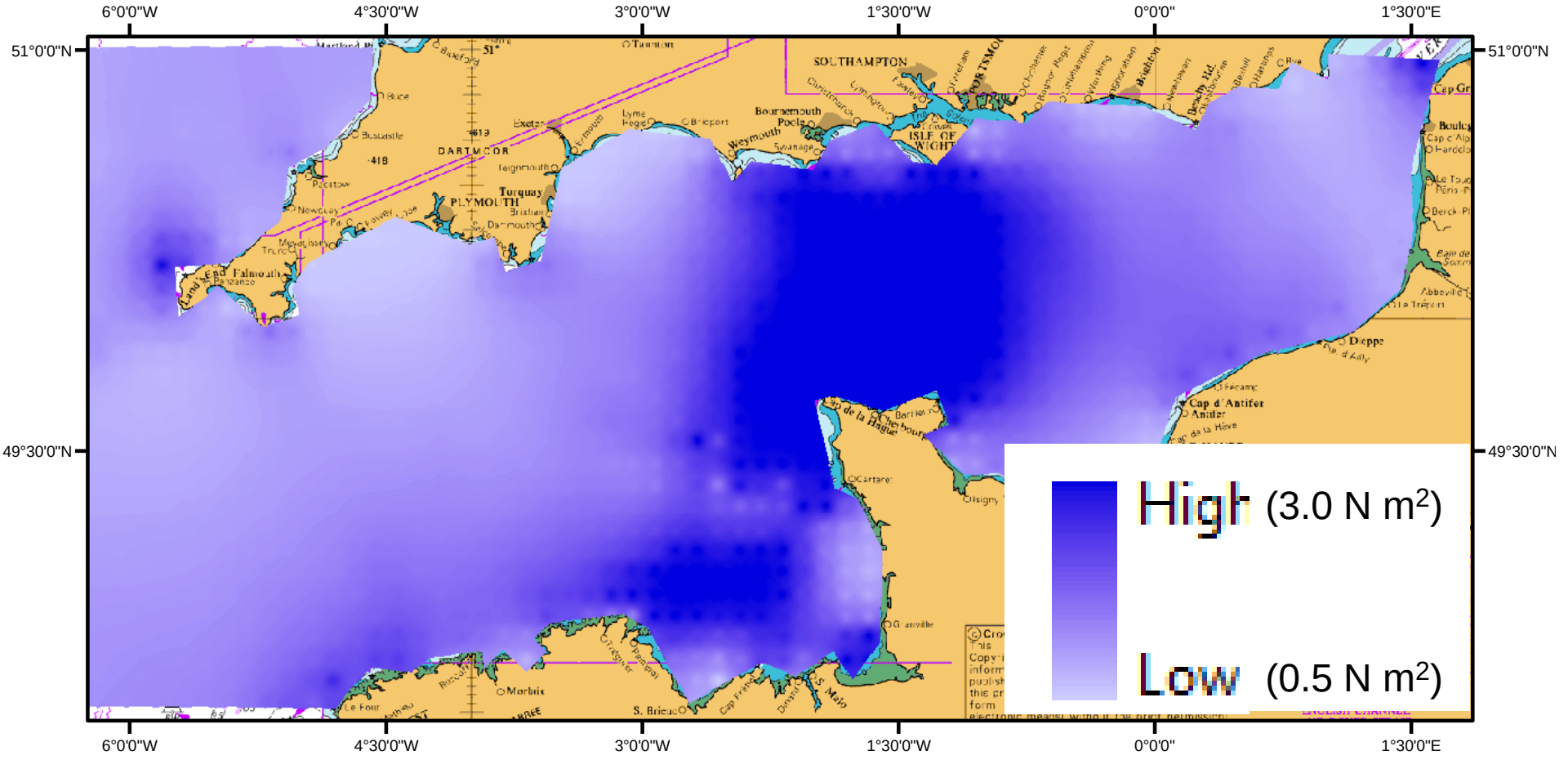




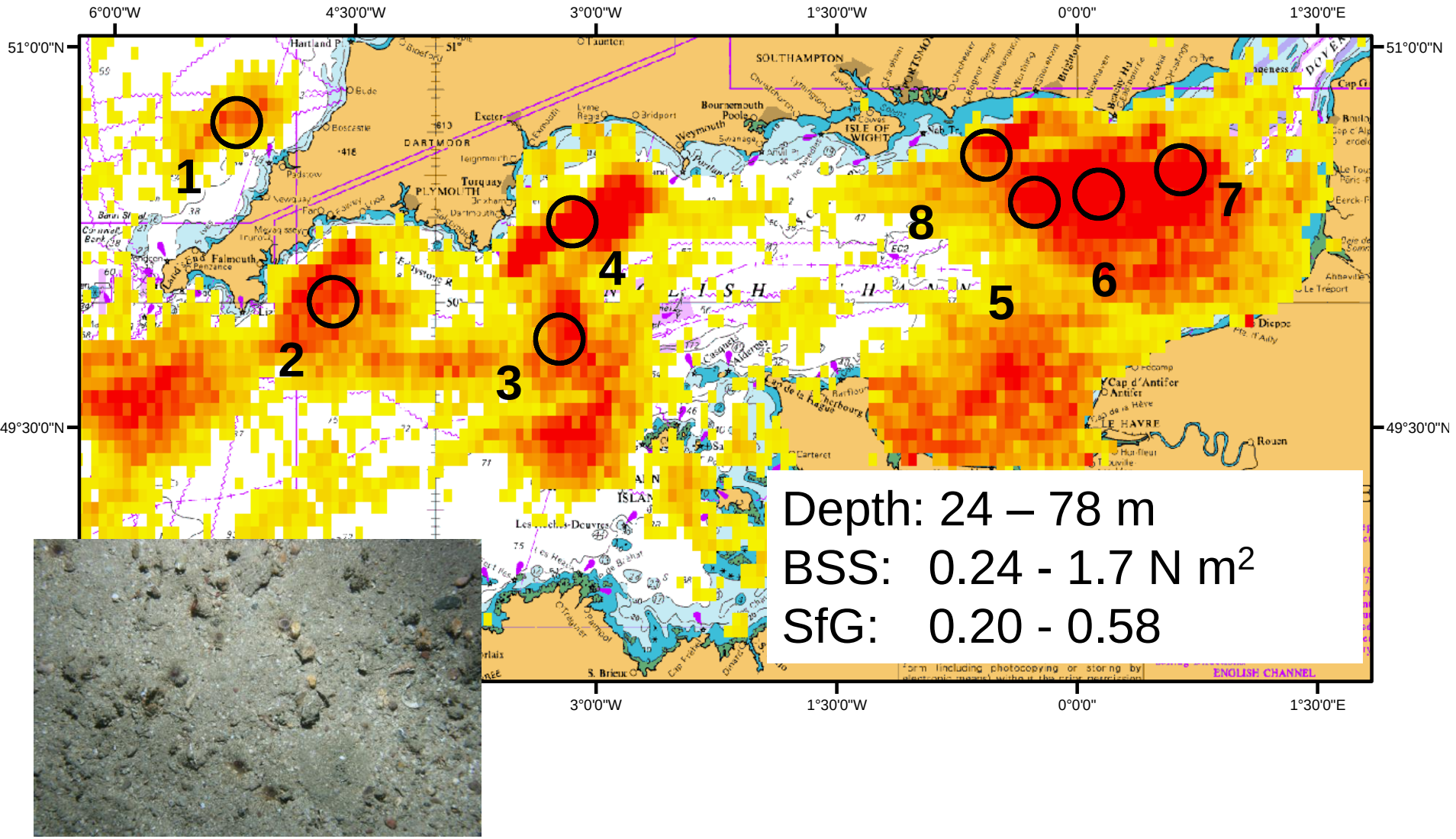
methods based on Kostylev & Hannah, 2007

Chl-a data (NEODAAS), Seabed temp data (PML), stratification data (NOC)

Bed shear stress



Sample sites

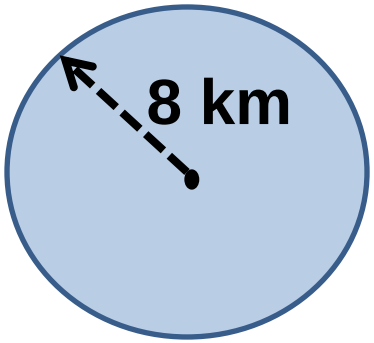


Depth: 24 – 78 m

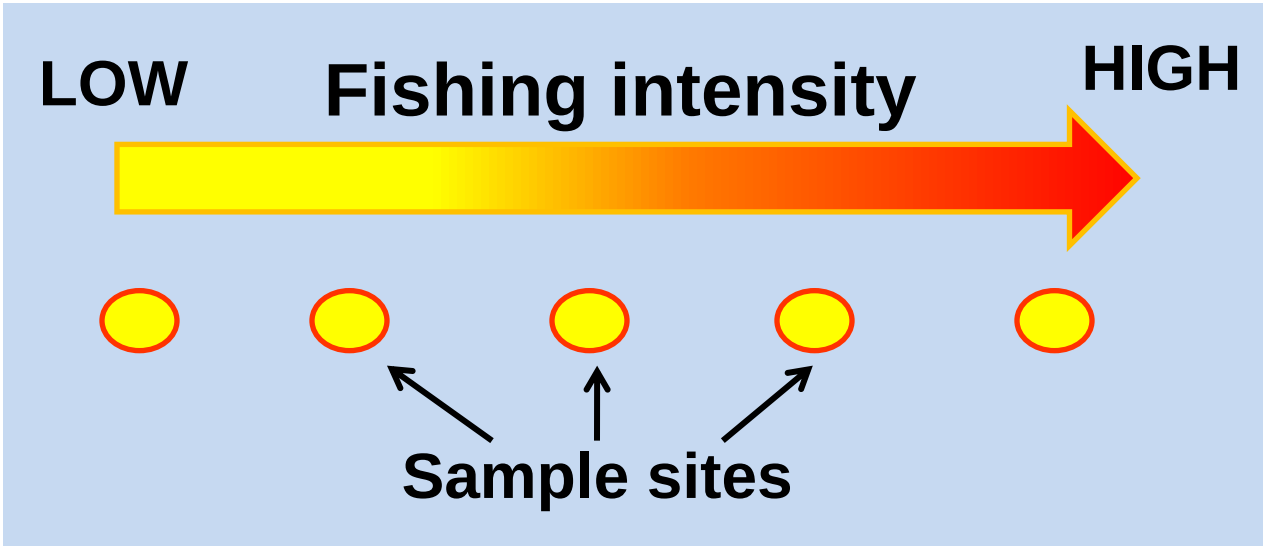
BSS: 0.24 - 1.7 N m^2

SfG: 0.20 - 0.58

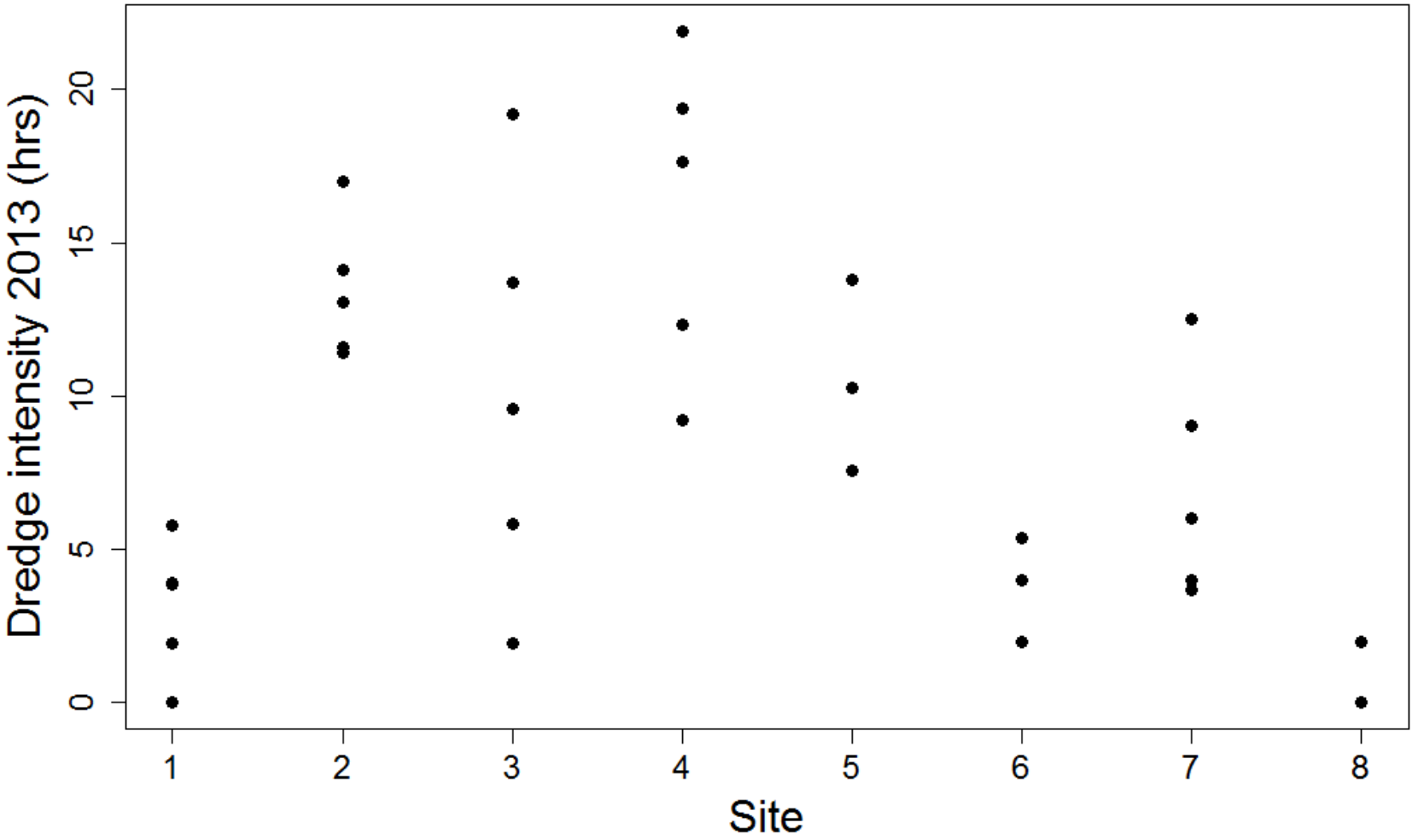
Fishing intensity



- Fishing intensity ~ VMS data (5.5 km^2 cells)
- Five stations per site - range of intensities



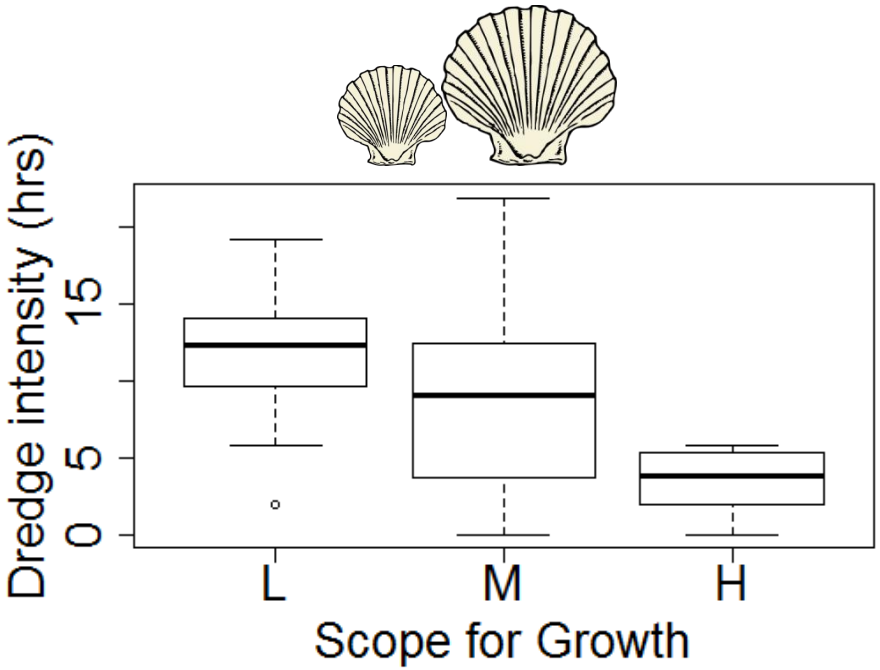
Dredge fishing intensity



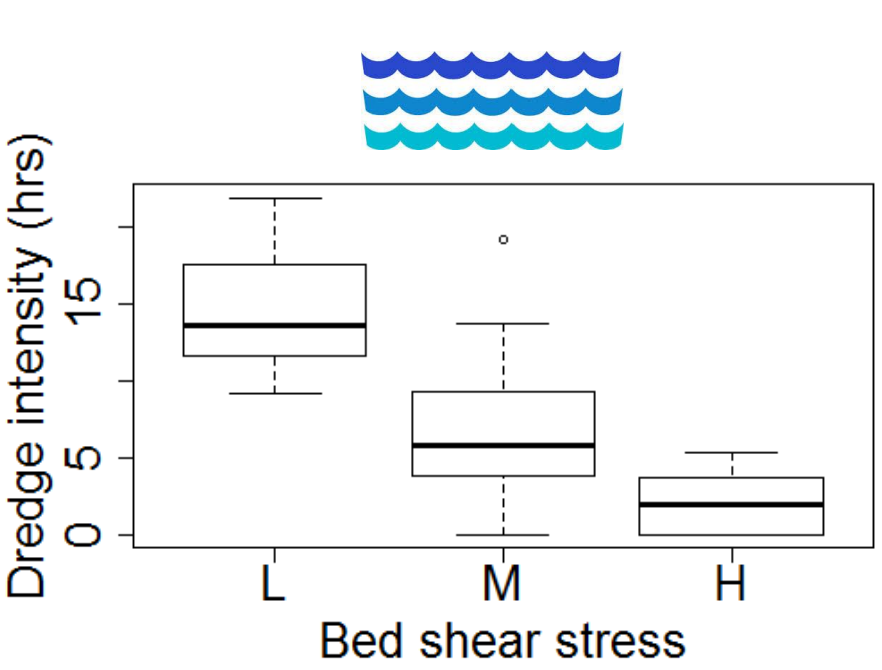
Dredge fishing intensity (total hours, Jan-Sept 2013) at each site, from aggregated VMS data.


hatch

Fishing intensity

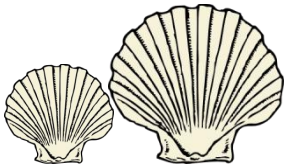


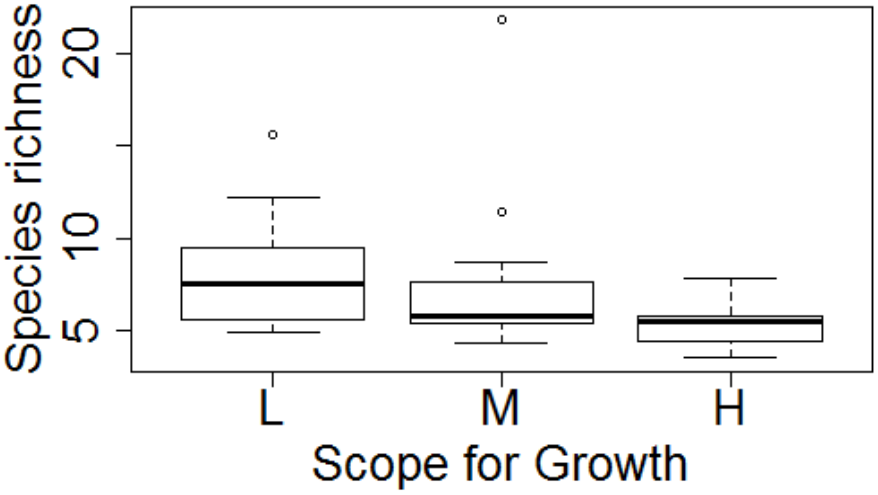
L-H : p = 0.0273

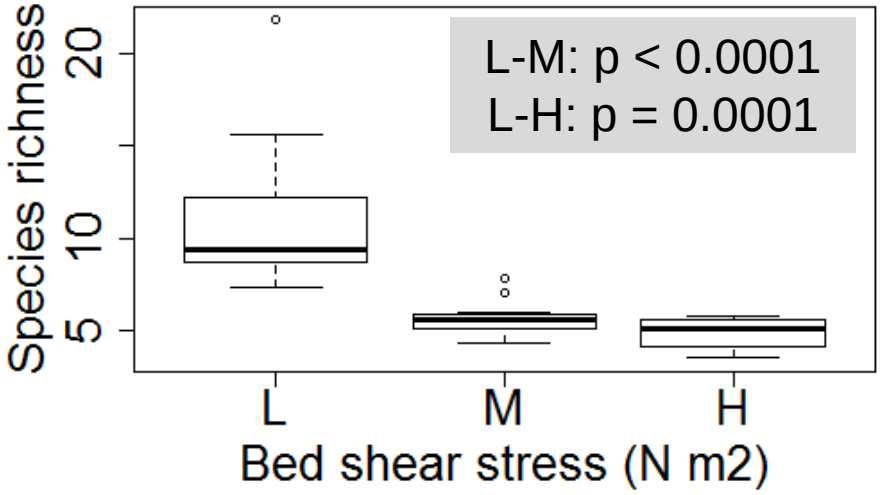


L-M : p = 0.0003
L-H : p < 0.0001

Species richness







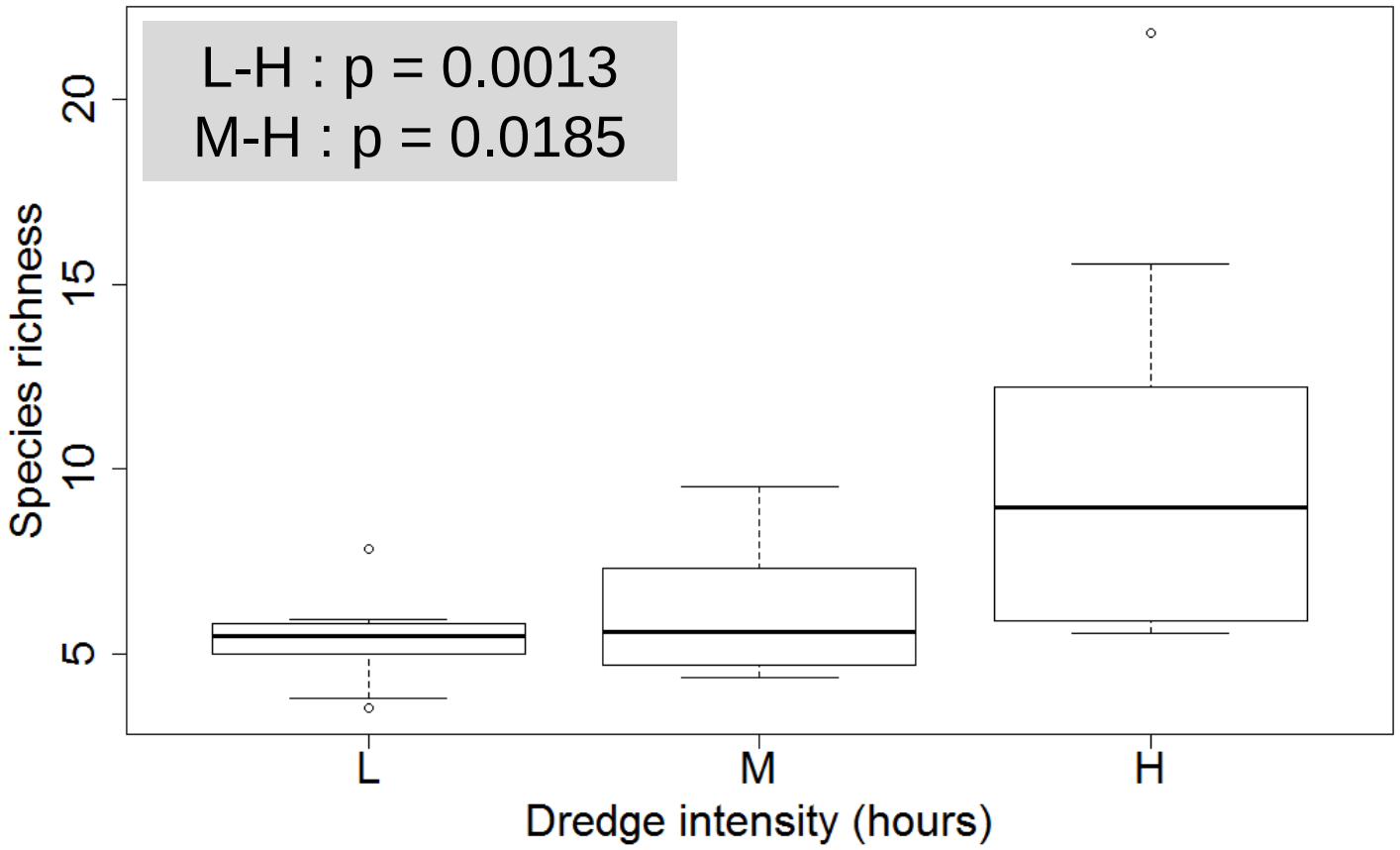
Scope for Growth (0-1)

Low: 0.20 – 0.37
Medium: 0.38 – 0.47
High: 0.48 – 0.58

BSS (Newtons per m2)

Low: 0.24 – 0.70
Medium: 0.71 – 1.04
High: 1.05 – 1.70

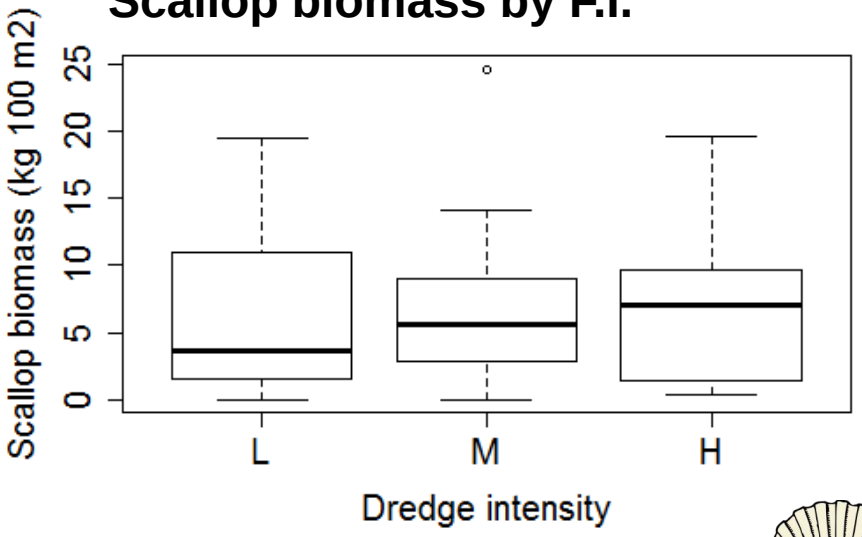
Sp. richness vs. Fishing intensity



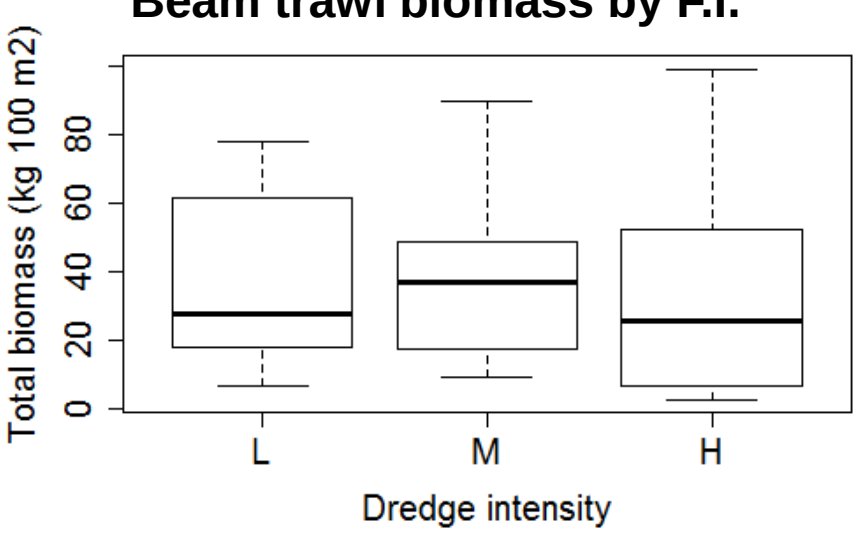
Low: 0 - 4.9
Medium: 5.0 - 11.9
High: 12.0 – 22.0

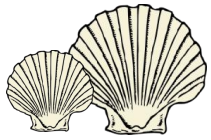
Biomass

Scallop biomass by F.I.

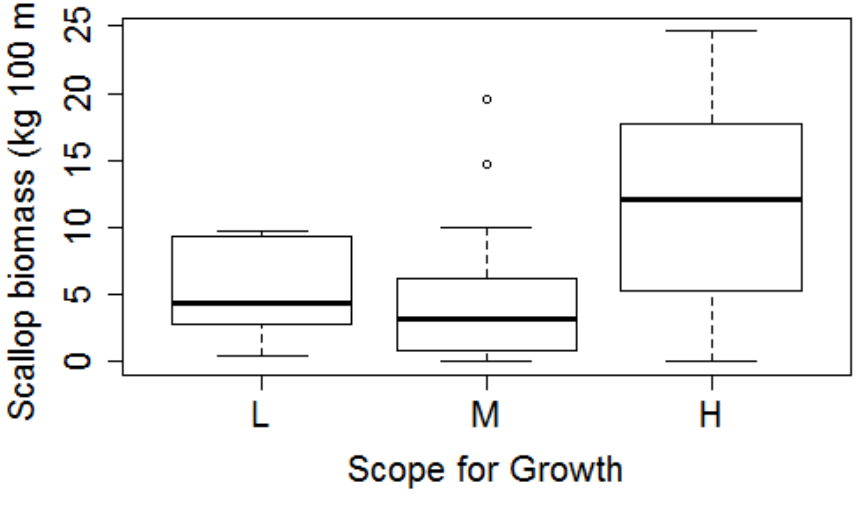


Beam trawl biomass by F.I.

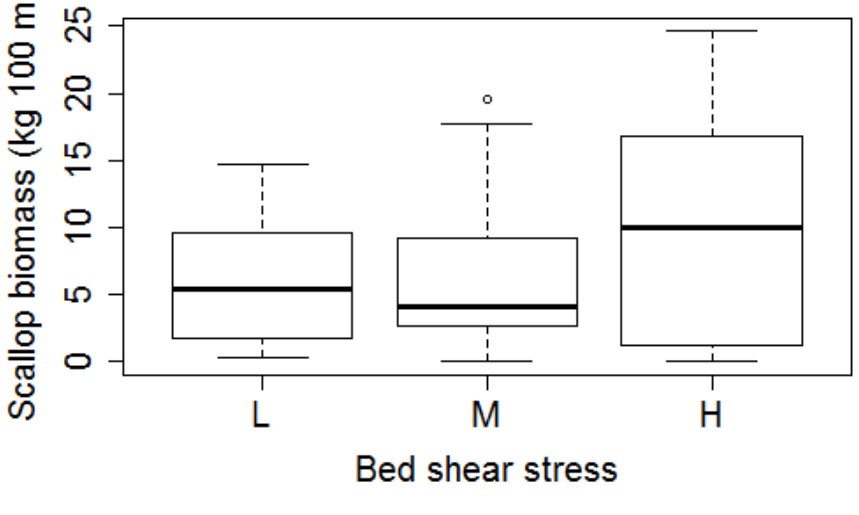




Scallop biomass by SfG



Scallop biomass by BSS



Generalised additive models

Species richness ~ (s)FI + (s)SfG + (s)BSS Δ

family = Gaussian(link = Log)

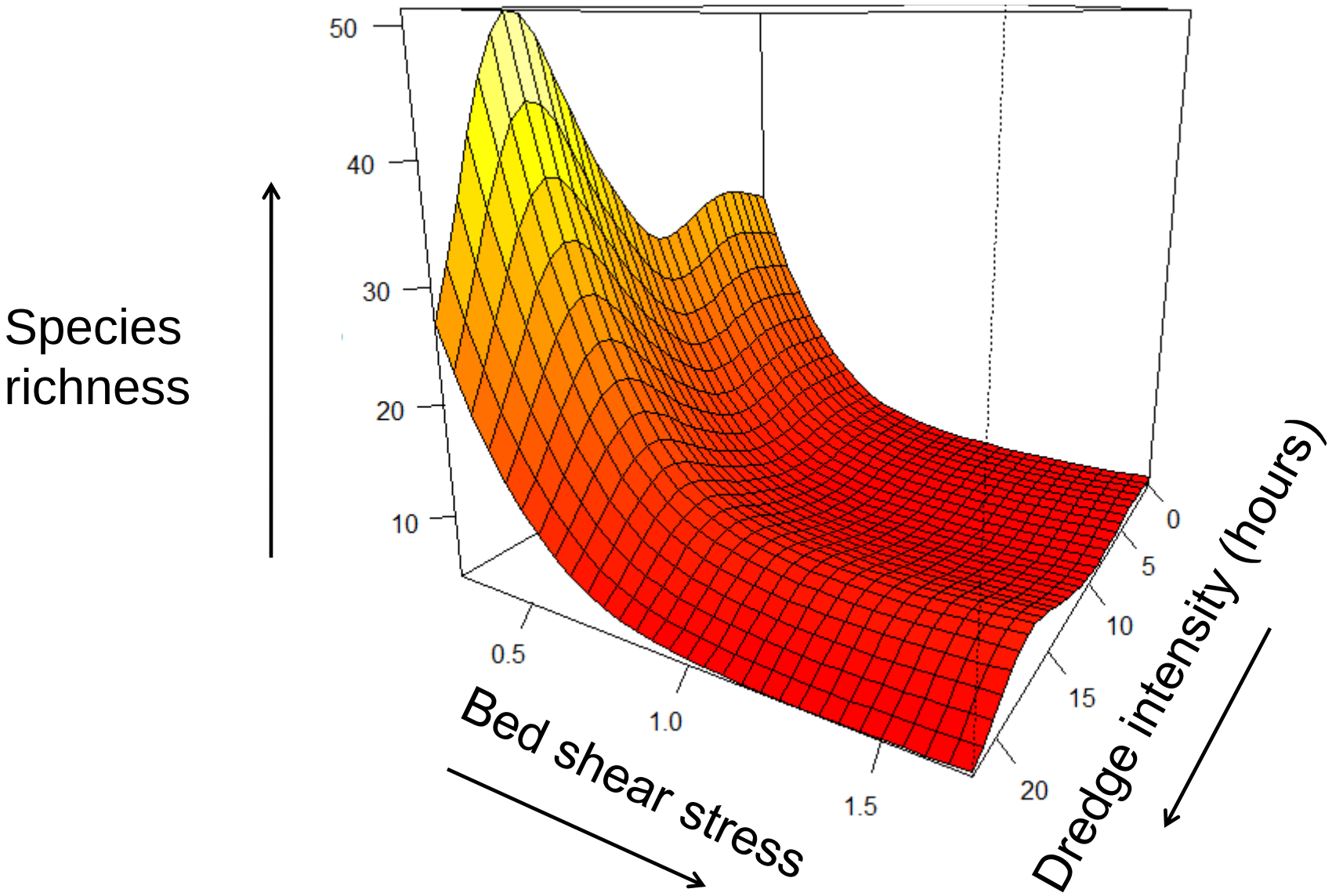
Bed shear stress	**p <0.0001*** **
Fishing intensity	**p = 0.0008** **
'Scope for Growth'	**p = 0.0027***

89% of deviance explained

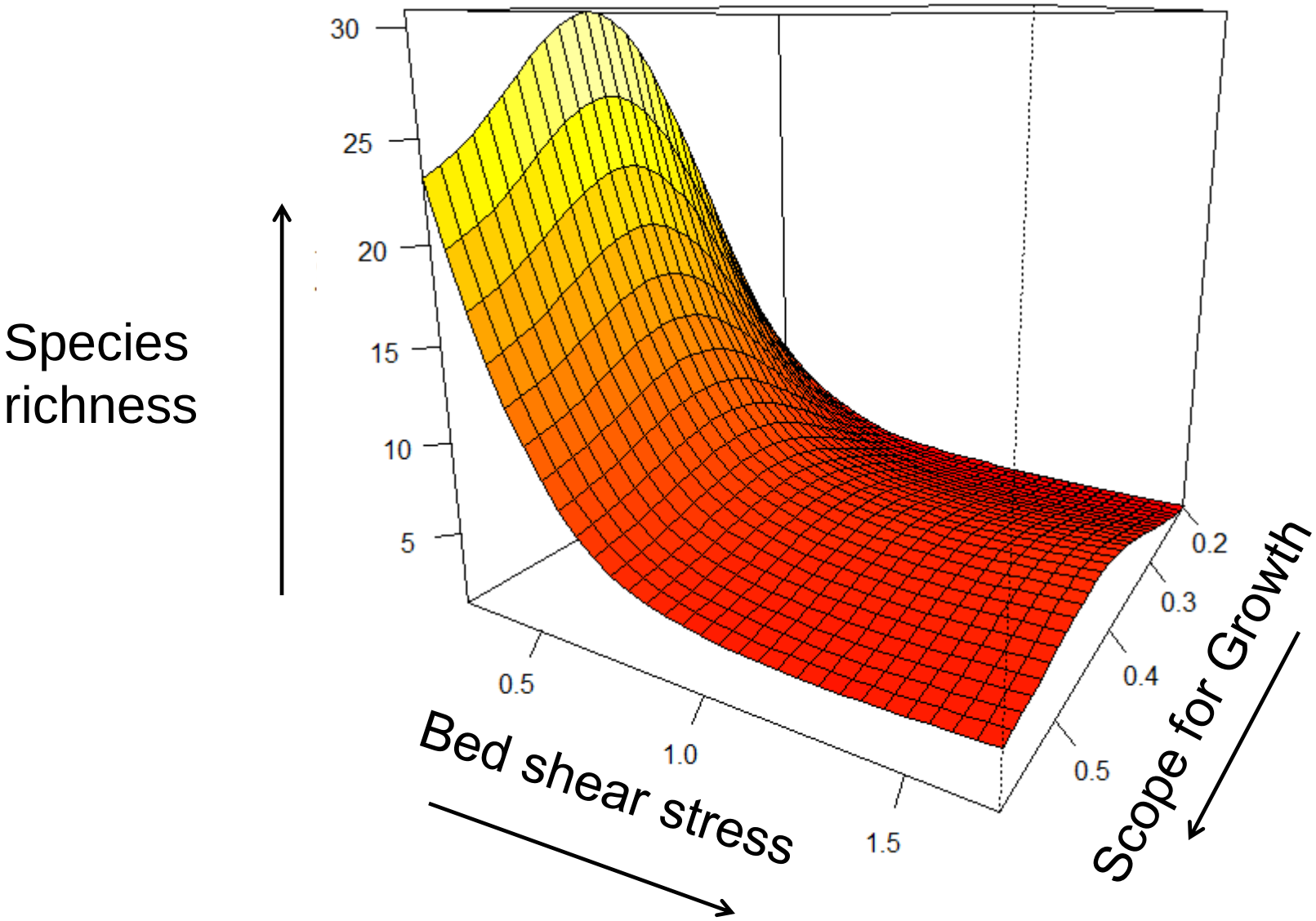
Δ Generalised additive model (GAM); 'mgcv' package, R (Wood 2011)

Sciberras et al. 2013, Cardigan Bay, Wales

Generalised additive model



Generalised additive model

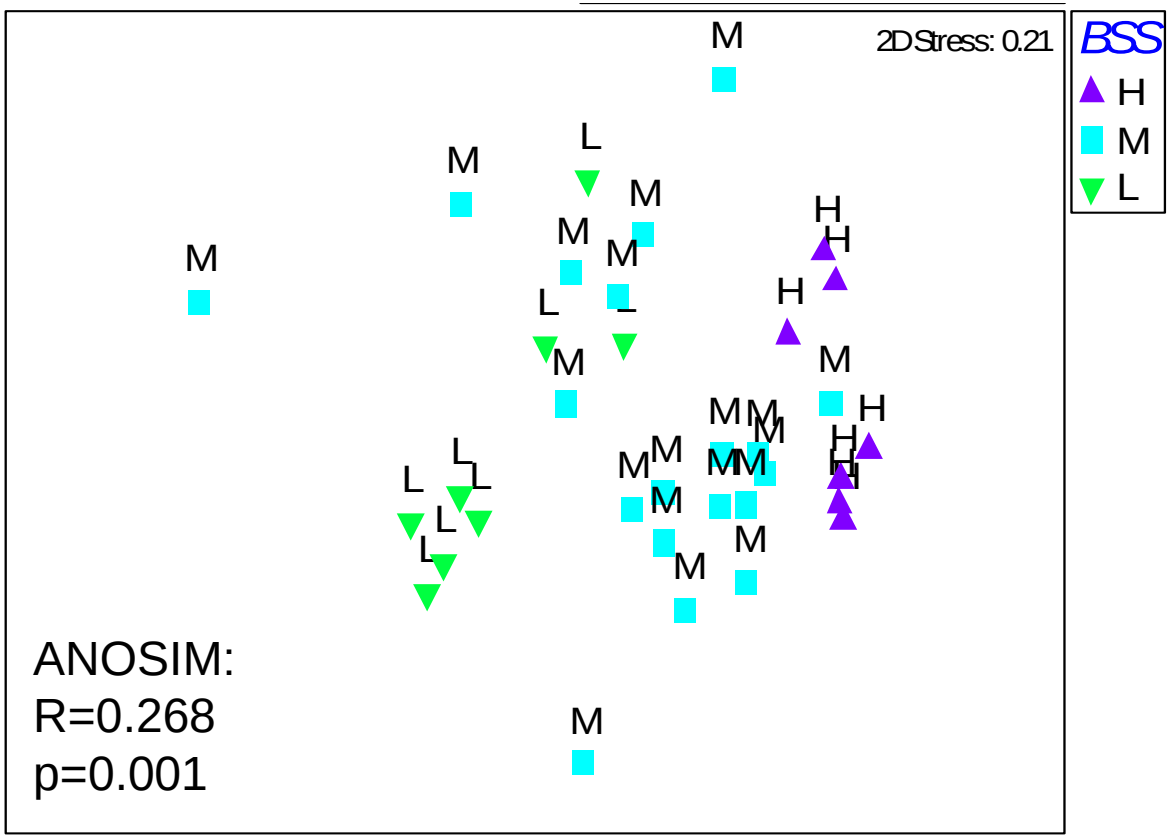


Species composition

Bed shear stress

L = 0.6 – 0.22
M = 0.23 - 0.33
H = 0.34 - 0.55

Newtons per m^2



Multi-dimensional scaling plots of relative similarity in species biomass in the beam trawl catches at each station. Symbols represent bed shear stress category (L = Low, M = Medium, H = High).

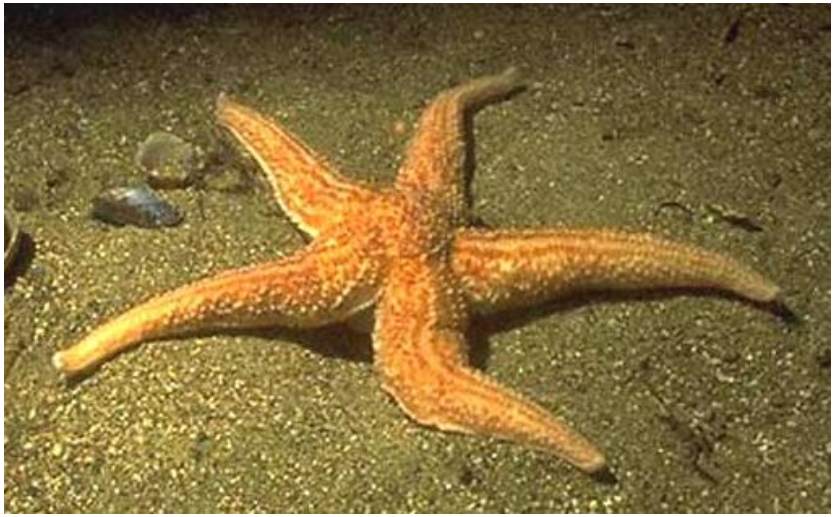
Abundant species – Beam trawl

Pagurus bernhardus

Pagurus prideaux

Aequipecten opercularis

Psammechinus miliaris



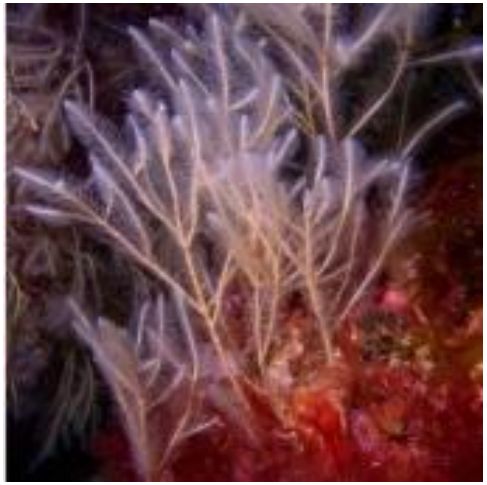
Asterias rubens

Abundant species – Beam trawl

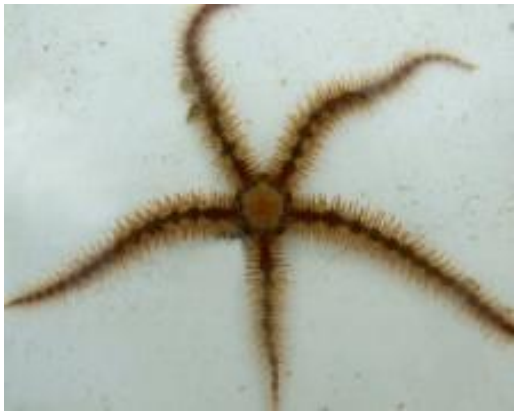
Alcyonium digitatum

Macropodia sp.

Cellaria



Nemertesia sp.

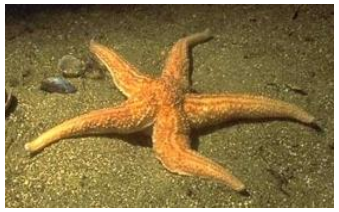


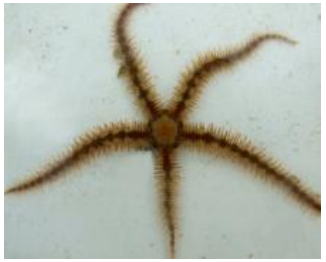
Ophiothrix / Ophuira sp.

Characteristic species

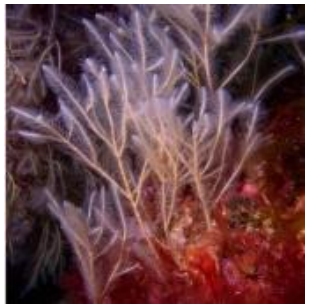
High BSS








Low BSS





Biological traits analysis

Life-history traits

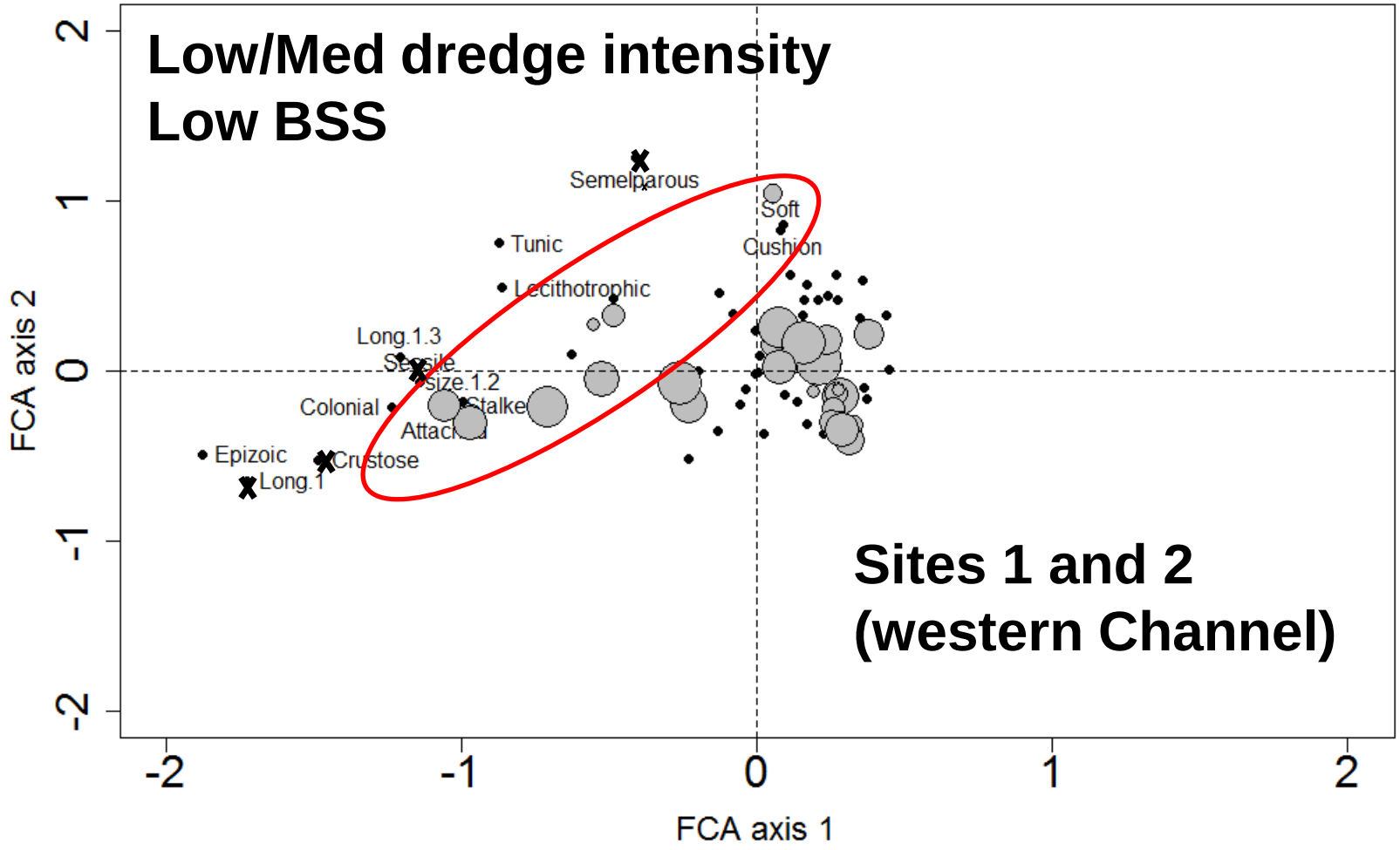
- Maximum body size
- Morphology
- Longevity
- Larval development
- Age at maturity
- Reproductive frequency

Ecological traits

- Habitat
- Living habit
- Feeding mode
- Mobility
- Food type
- Fragility
- Sociability

Fuzzy Correspondence analysis, ‘ade4’ package, R (Dray et al. 2007)

Biological traits analysis



Conclusions

- BSS has **negative** effect on species richness
- Some influence of SfG on species richness
- Positive correlation between recent dredge activity and species richness
- BSS and recent fishing intensity are negatively **correlated**
- Most abundant species **similar** across all levels of BSS = typical community
- Trait composition similar except for two western sites (~ Low-med fishing intensity, Low BSS)

Conclusions

- Scallops resilient, abundant, potentially very sustainable source of protein
- Protect areas of low BSS from increased scallop dredging
- Recovery time of specific habitat also needs to be considered

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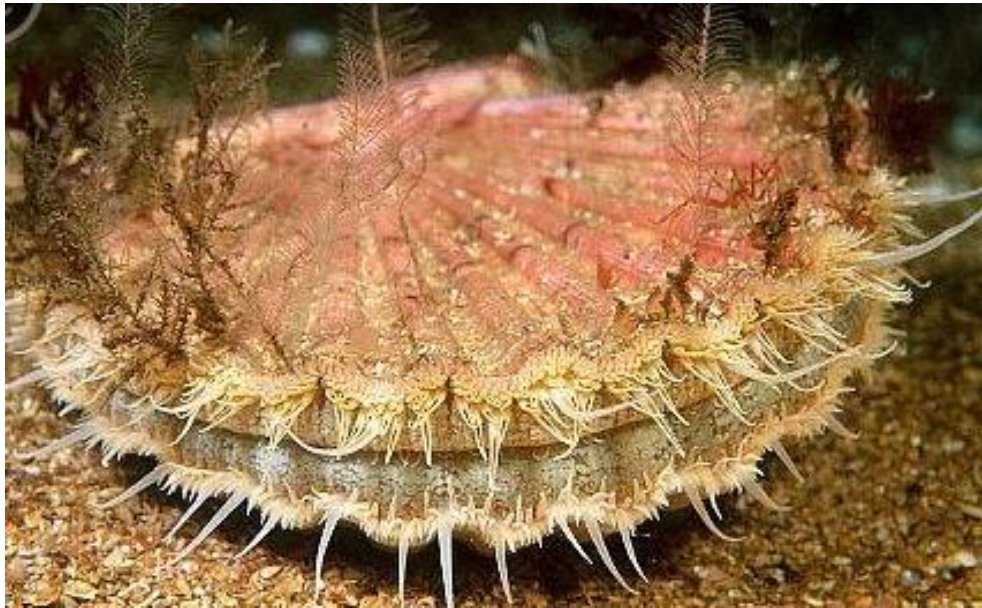
Thank you for listening!



References

Kostylev, VE & Hannah CG (2007) Process-driven characterisation and mapping of seabed habitats. in Todd, B.J. and Greene, H.G., eds., Mapping the Seafloor for Habitat Characterization: Geological Association of Canada, Special Paper 47, p. 171-184.

Marine Management Organisation (MMO) (2013). UK Sea Fisheries Statistics 2012. http://www.marinemanagement.org.uk/fisheries/statistics/documents/ukseafish/2010/final.pdf

Sciberras, M., Hinz, H., Bennell, J.D., Jenkins, S.R., Hawkins S.J., Kaiser, M.J. (2013). Benthic community response to a scallop dredging closure within a dynamic seabed habitat. Marine Ecology Progress Series 480: 83-98.