



Fish habitat interactions under anthropogenic and climatic forcing

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Fish habitat considerations

Fish habitat has a number of functions

- Provision of refugia or breeding/spawning habitat
- Provision of food

Both functions are affected by fishingand climate forcing



Key model parameters

Spatially resolved data for:

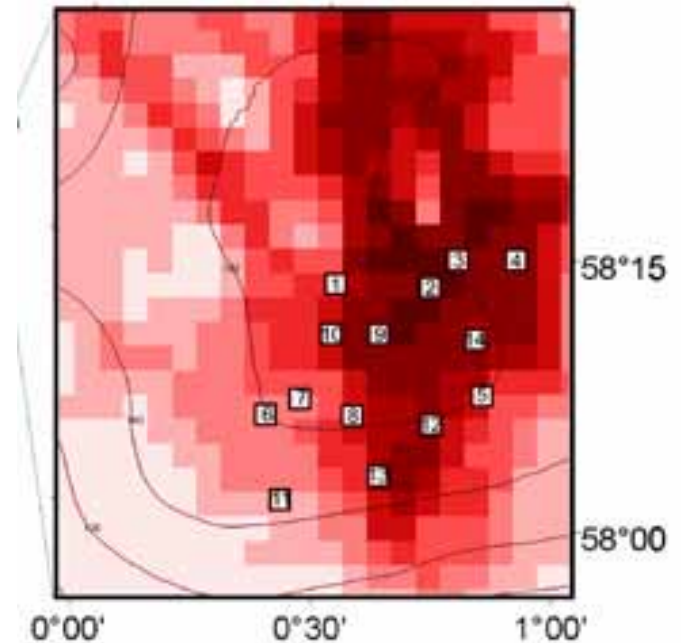
Chla = food for benthos = carrying capacity

Shear stress = supply of food for benthos

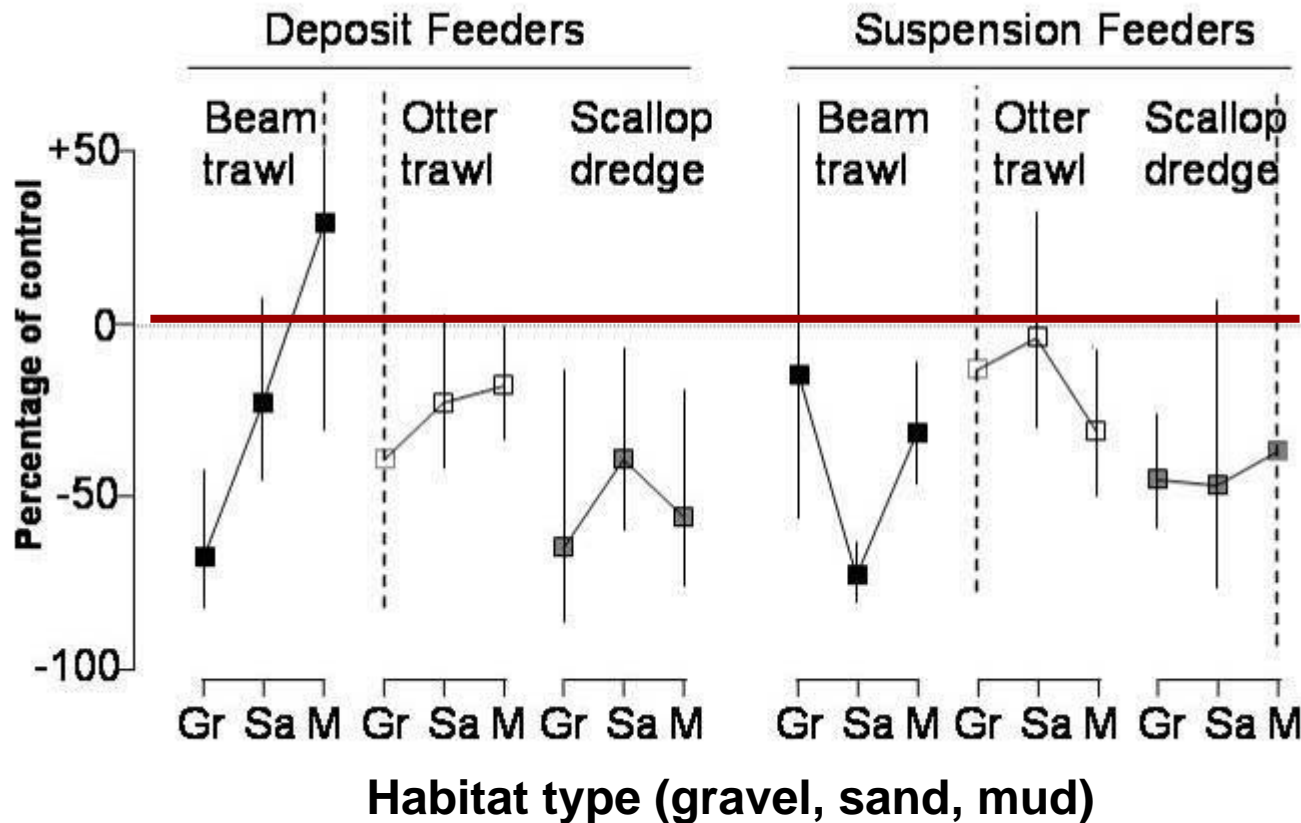
Wave erosion = key limiting factor (mortality)

Bottom fishing = mortality/competitive release

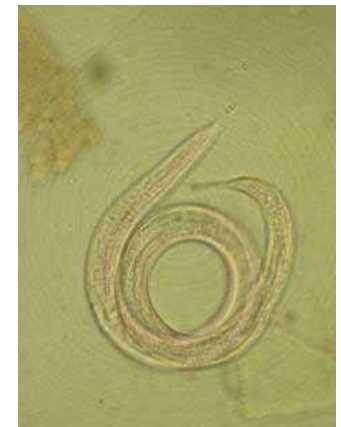
Habitat type



Fishing mortality - reduces carrying capacity for fish



No change



The direct effects of different types of fishing gear were strongly habitat-specific.



Fishing can radically depress production in some habitats but not others

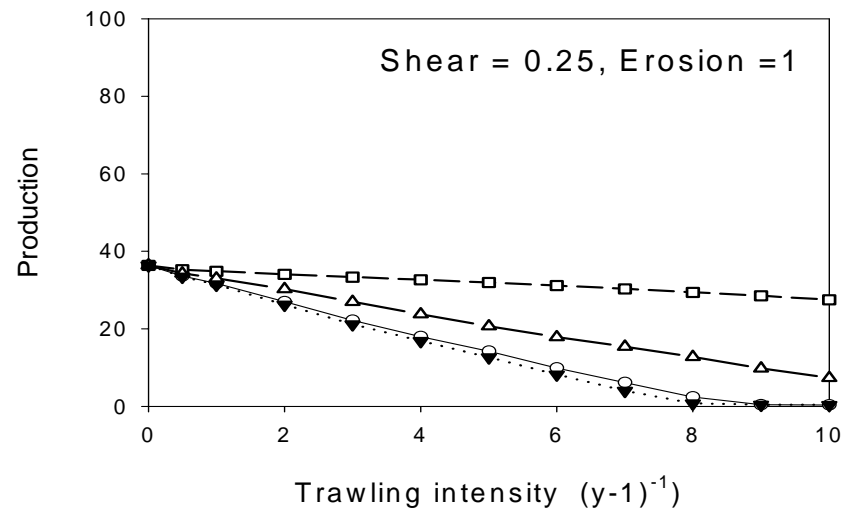
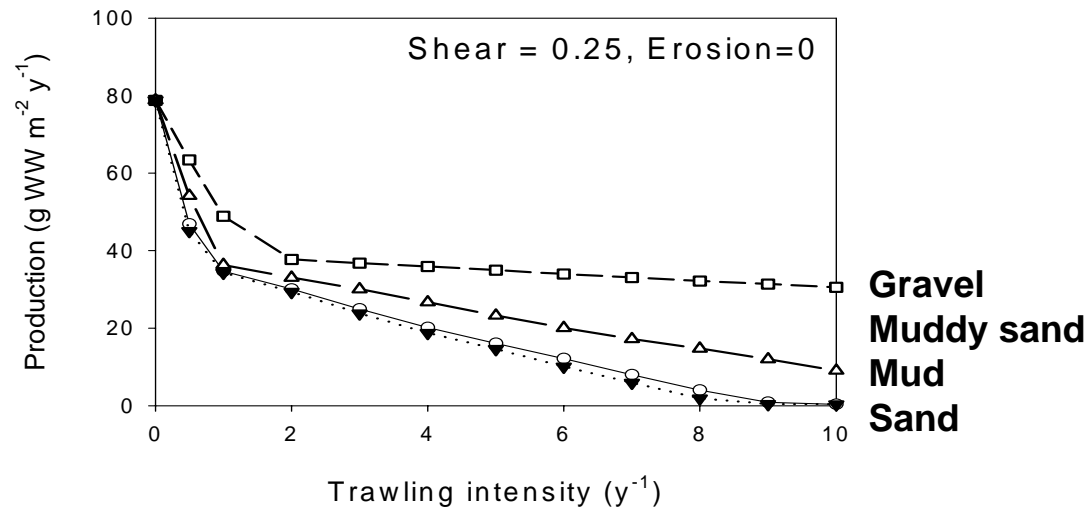
Shear from currents = food supply
Erosion from waves = mortality

Two scenarios shown for 4
different habitat types

Trawling intensity derived from
Vessel Monitoring System data.

Hiddink et al. 2006 *Can. J. Fish. Aquat. Sci.*

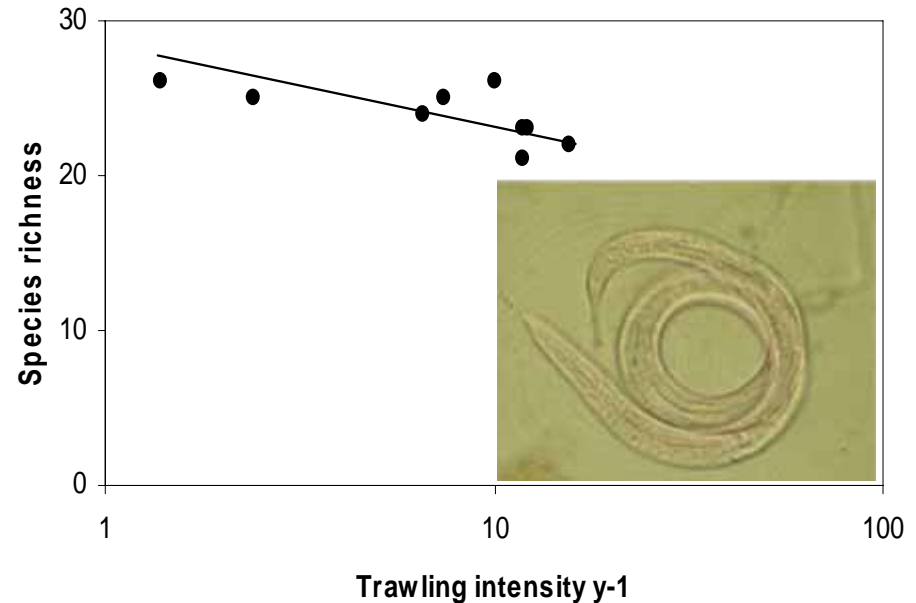
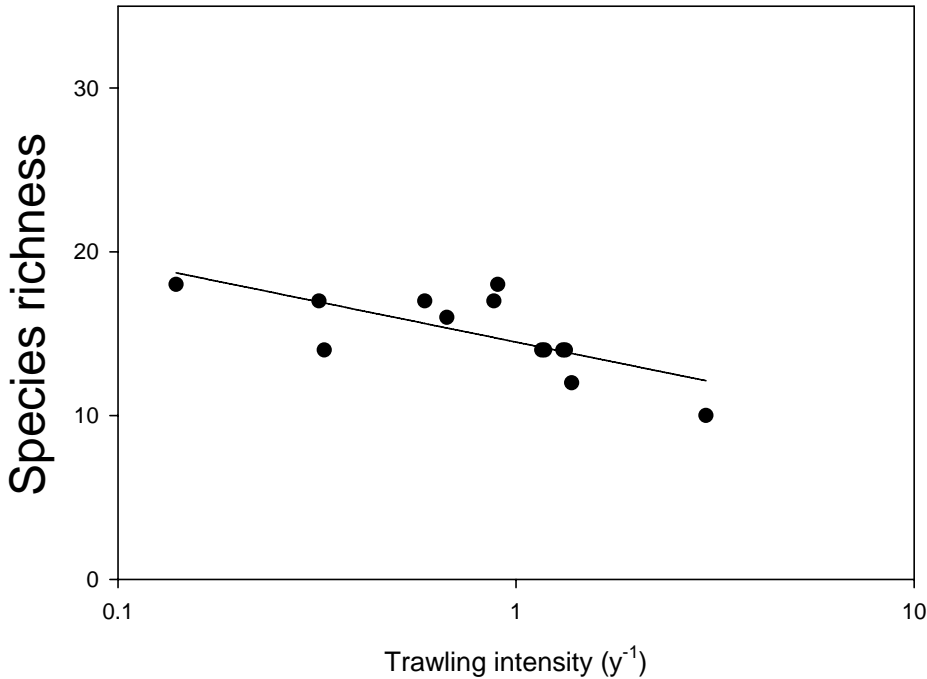
(A) P Production



Trawling impact on nematodes

Fladen Ground

Irish Sea



Sabatieria

Aponema

Calomicrolaimus

Halalaimus

Fladen Ground

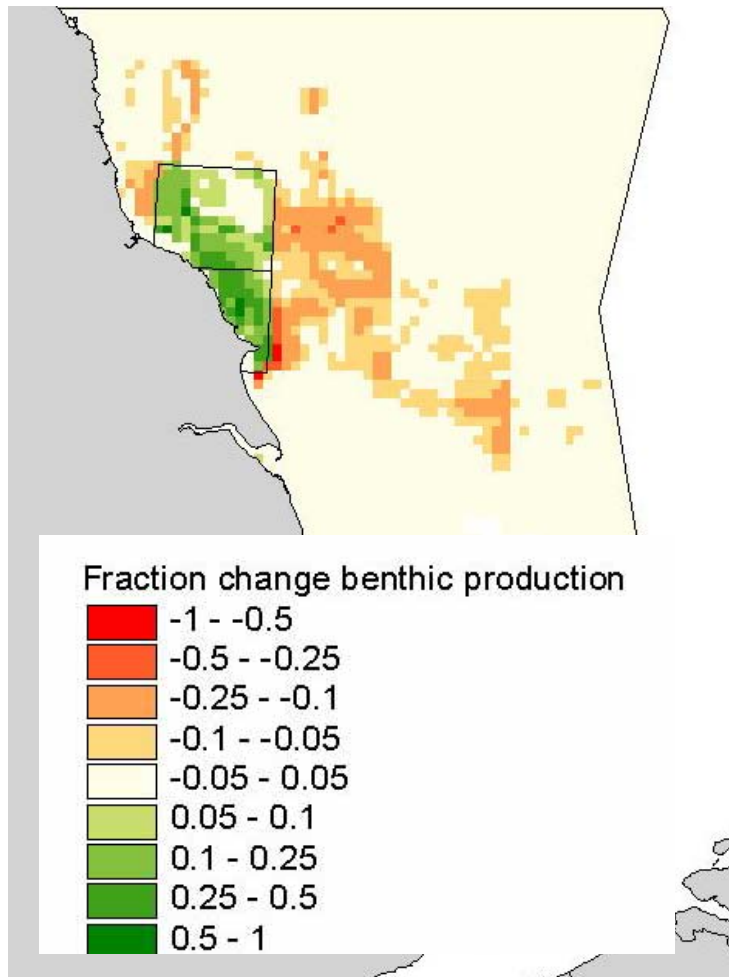
positive, $R^2 = 0.42$

positive, $R^2 = 0.33$

negative, $R^2 = 0.52$

negative, $R^2 = 0.46$

Hinz, Hiddink, Forde & Kaiser (in press)
Can. J. Fish. Aquat. Sci.

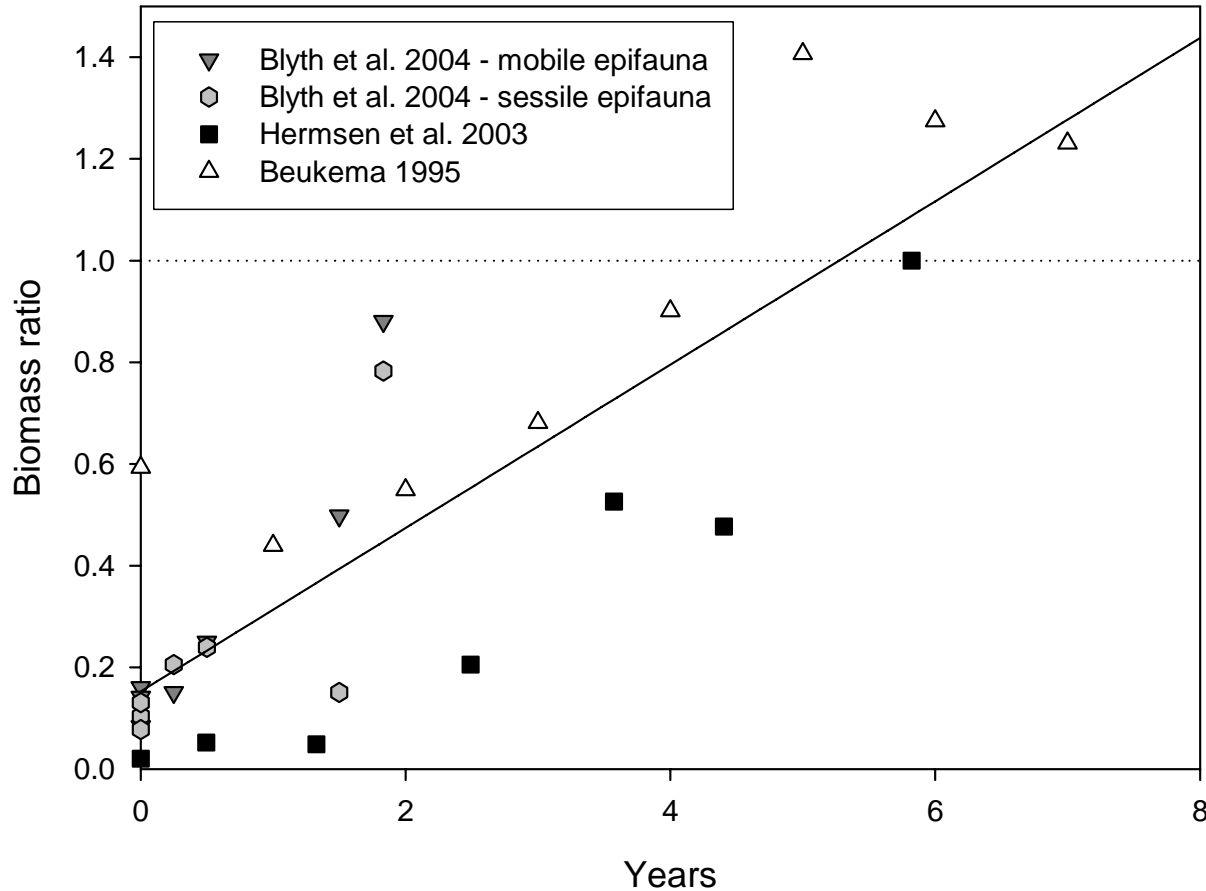


Removal of effort: slow recovery

Relocation of effort: negative effect on benthic biomass and production – resulting in net loss of fish habitat in the short-term

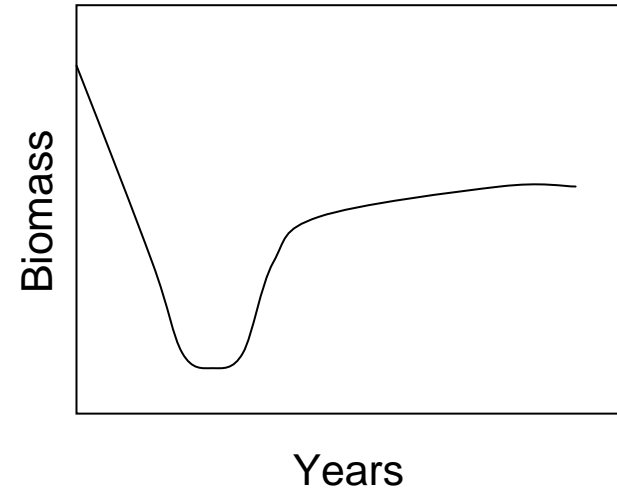
Without effort reduction, spatial closures only have a minor (positive or negative) impact on overall benthic ecosystems.

Observed recovery rates



Gross loss of biomass and production for several or more years

Steele & Beet 2003



Data from large-scale observational studies of recovery after the removal of fishing activity. Hiddink et al. 2006 Ecosystems

Ecological impact of the plaice box

Gear restriction area (MPA) :
Only small trawlers, effort in box reduced
>90%. Effort outside box increased

Aim: to reduce the bycatch of undersized
plaice in a nursery ground.



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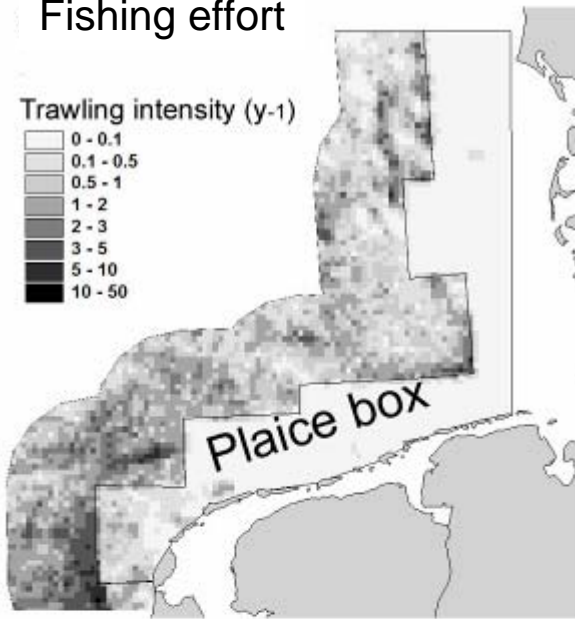
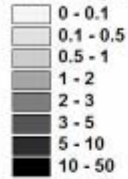
Aim: to reduce the bycatch of undersized
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Ineffective:
Juvenile plaice have
moved out of plaice box
after implementation

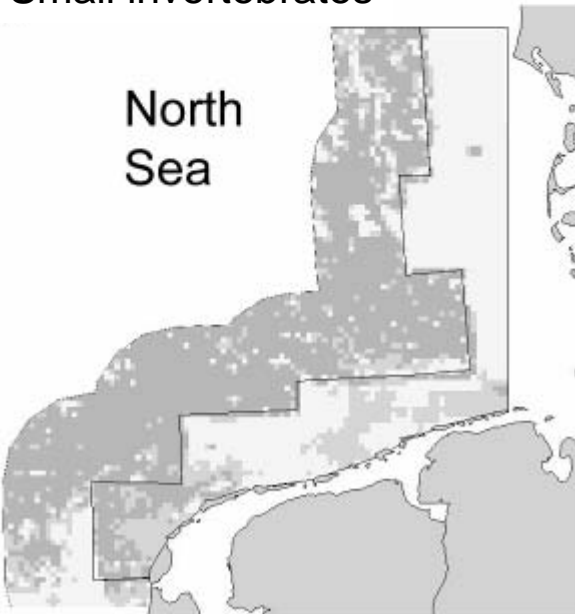


Fishing effort

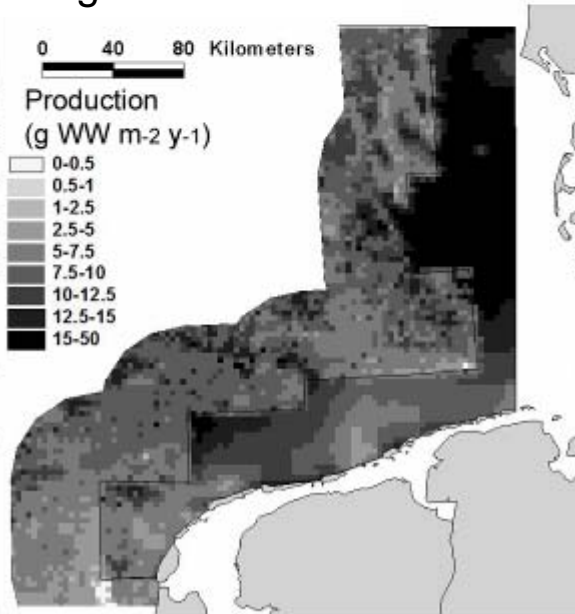
Trawling intensity (y-1)



Small invertebrates



Large invertebrates



Plaice eat small worms

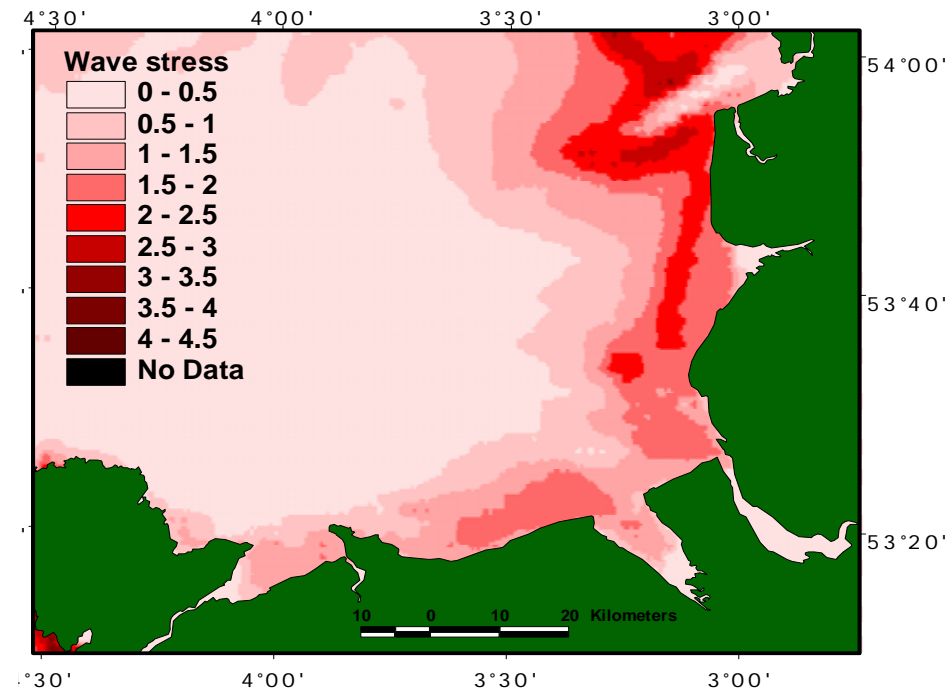
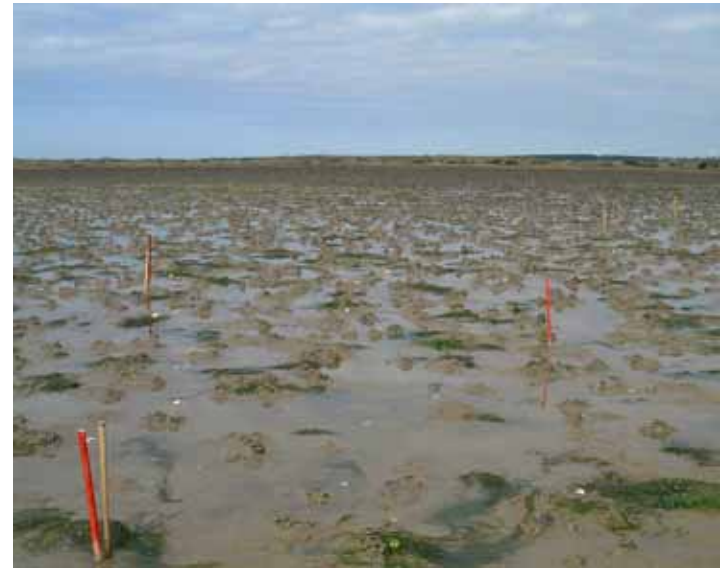
Effect of trawling

Total benthic production: **down**

Small worm production: **up**

Implications of understanding physics for site selection

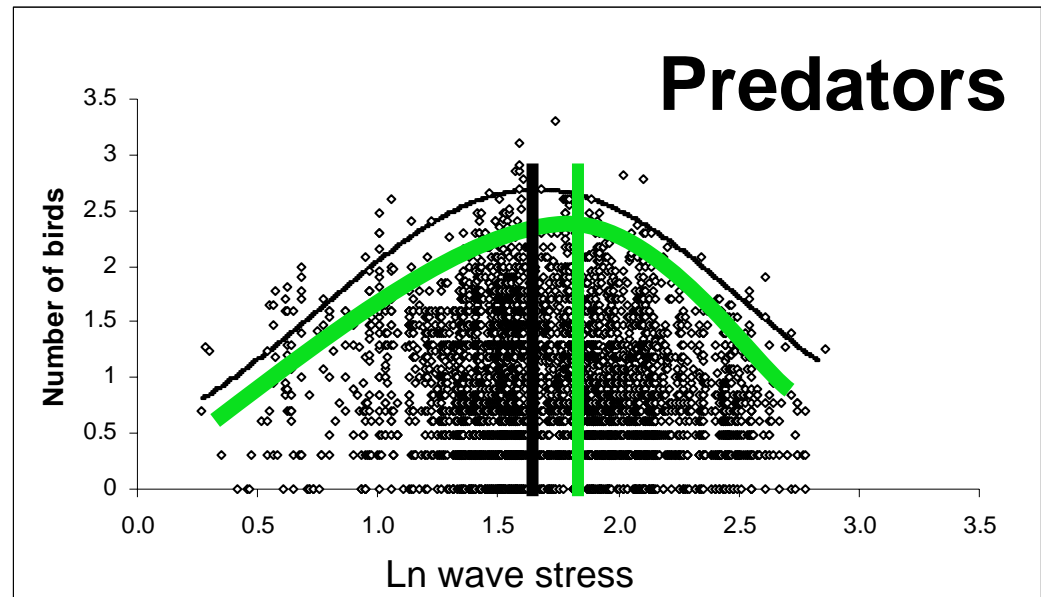
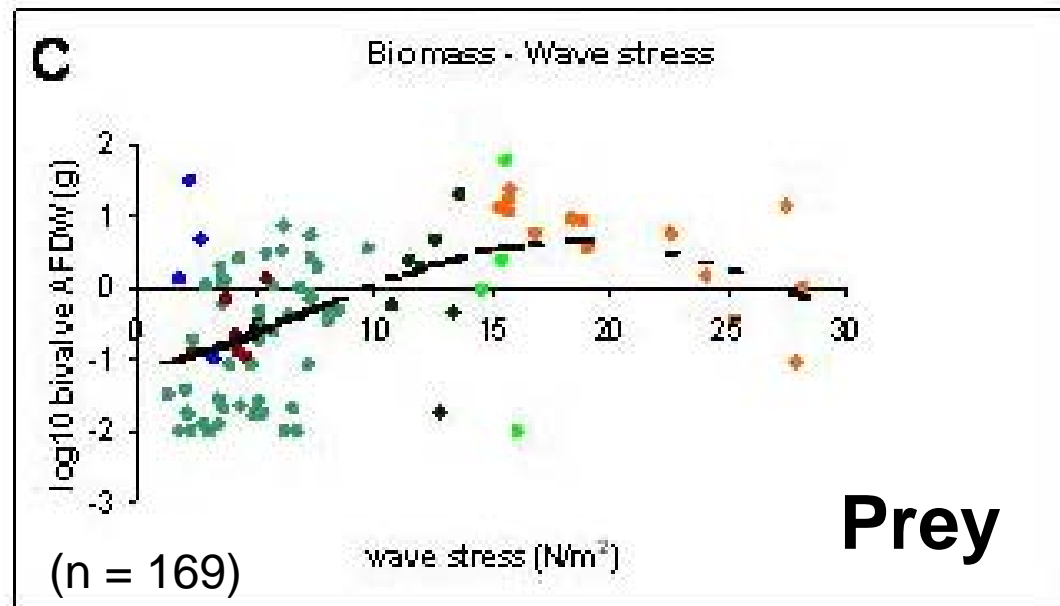
- Apparently similar habitats differ in their carrying capacity due to limiting factors (stressors and food supply)
- These limiting factors are particularly prone to change in the coastal zone



Wave stress in Liverpool Bay

The power of prediction for management

- Our improved understanding of the interaction between physics and biology enables us to identify gradients of production based on empirical observations
- This can be applied to calculate likely changes in habitat quality



Kaiser et al. 2006 Ibis

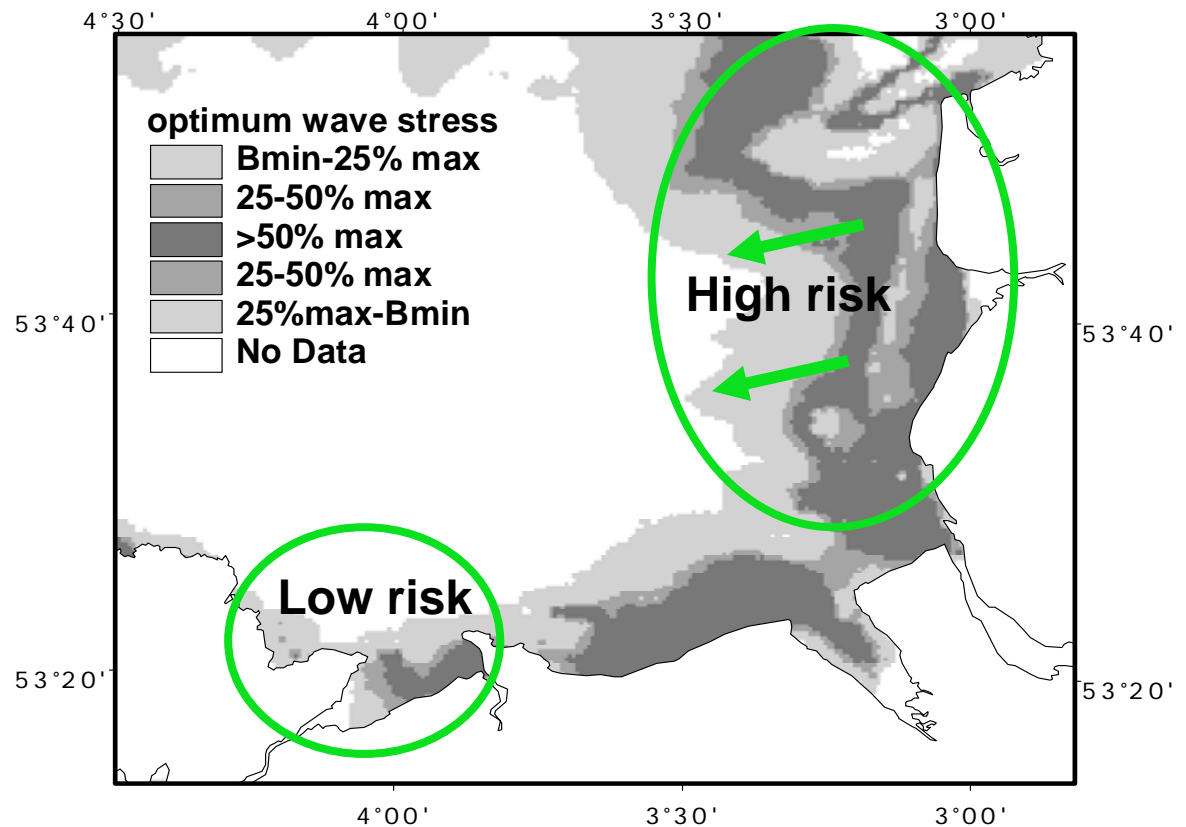
Note different scales

A platform for scenario predictions

We can now predict the spatial extent of areas that yield different levels of production and hence carrying capacity.

As wave erosion is a key driver it is possible to highlight those areas most prone to change

This has implications for future-proofing of MPAs



Implications of research

- In a context of spatial management our findings underline the following points:
- It is imperative to understand the implications of spatial management and how this will affect fishers' behaviour
- Climatic forcing has the potential to radically alter the productivity of shallow inshore areas
- Any spatial management measures should be viewed as adaptive and not permanent to permit future adjustment