

# Trawling impact and Productivity

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Best Trawling Practice Workshop, 17-19 June 2013, Seattle



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# Overview

- History of the issue
- Changes in growth of flatfish
- Empirical studies of growth & condition in relation to trawling gradients
- Modelling studies
- What can learn from fishers behaviour (trawling patterns)

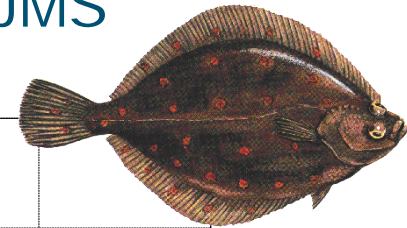
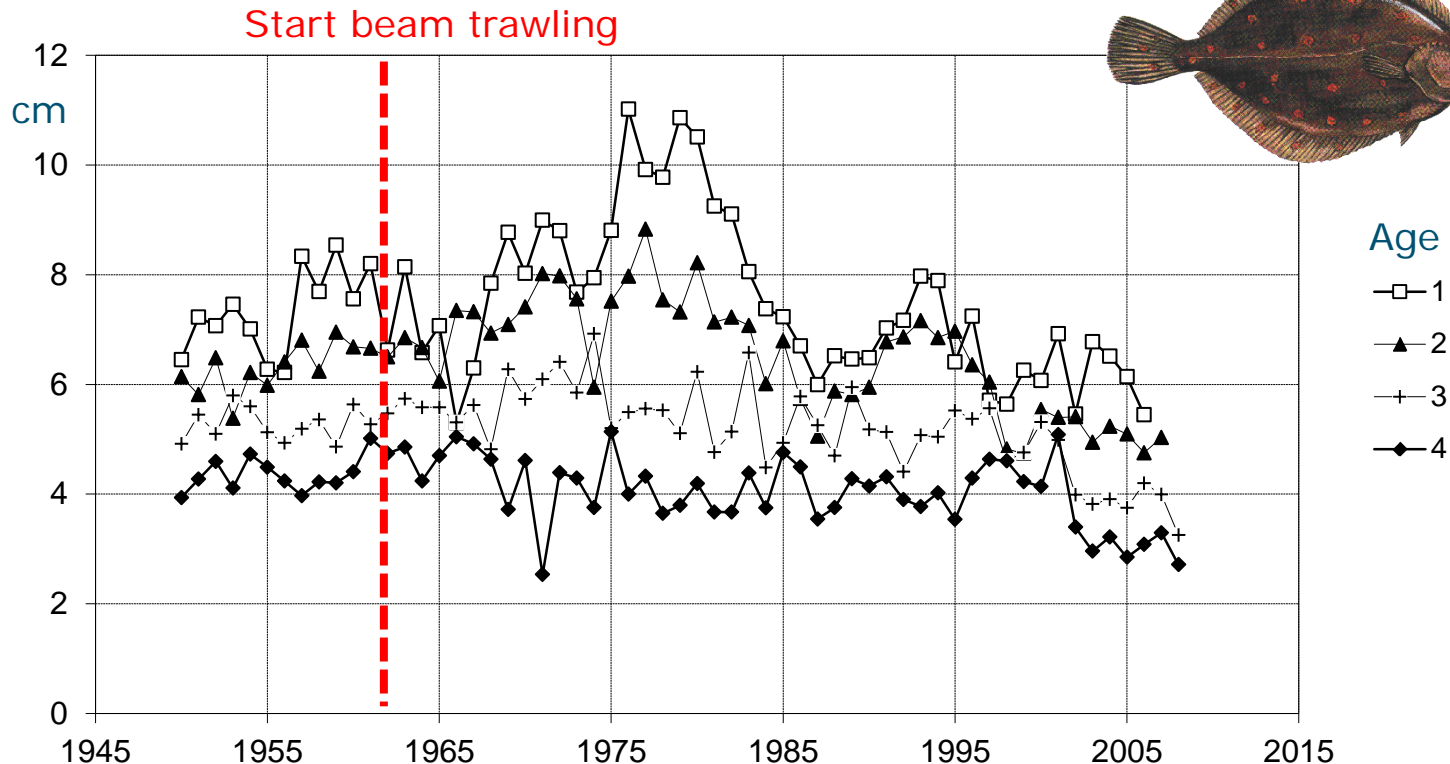
# History

- De Veen (1976) suggested positive effect of trawling on growth rate of North Sea flatfish (sole)
- Interpretation of the causal mechanism
  - Food subsidies (damaged benthos, discards)
  - Changes in species composition (increase in opportunistic species) Rijnsdorp & van Beek (1991)
- Complications
  - Changes in Length at age integrates cumulative effects of environment during life time
  - Co-linearity several environmental factors (eutrophication, trawling, pollution)

# Otolith back-calculation

change in growth rate by age/length class & area

- Plaice – Rijnsdorp & van Leeuwen (1996) ICES JMS
- Sole – Millner & Whiting (1996) ICES JMS

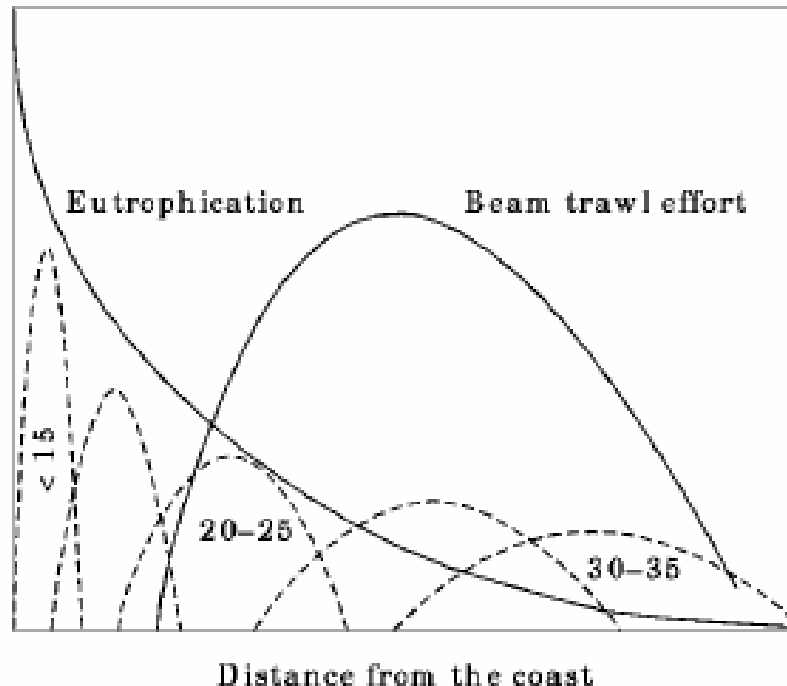


# Test of effect of eutrophication, density, temperature and beam-trawl effort of different size classes

ICES Journal of Marine Science, 53: 1199–1213. 1996

## Changes in growth of North Sea plaice since 1950 in relation to density, eutrophication, beam-trawl effort, and temperature

A. D. Rijnsdorp and P. I. van Leeuwen



Small size

– eutrophication

Medium size

– eutrophication  
& trawling

Large size

– no effect

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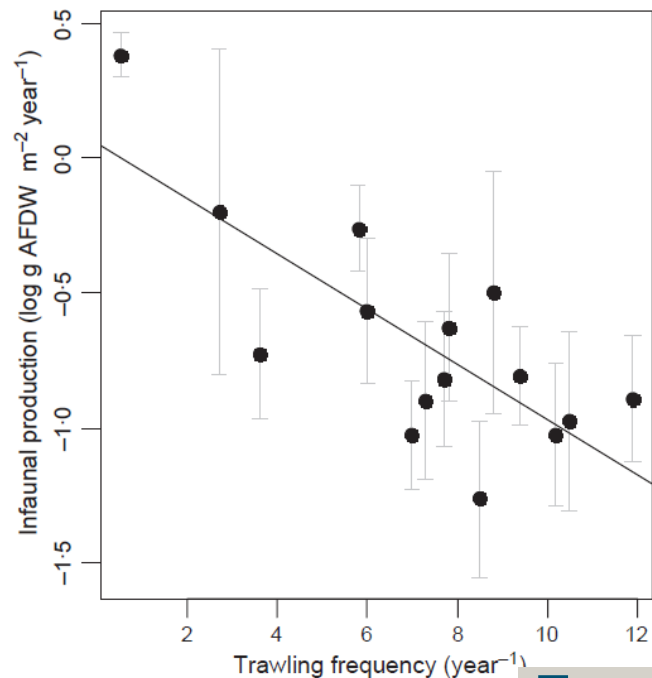
# Other observations

- Shepherd et al (2010) → plaice LAA correlated with trawling frequency in Irish Sea
  - Positive on sand habitat
  - Negative on gravel habitat

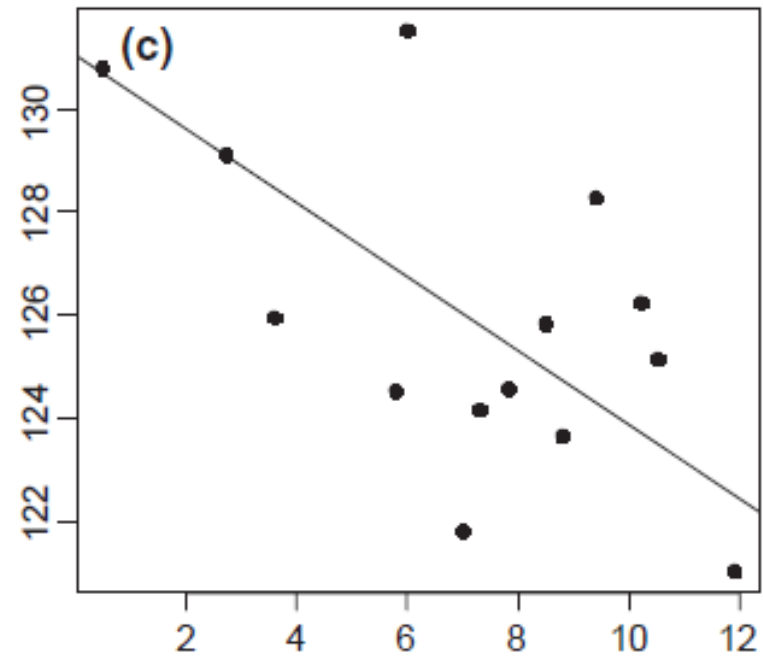
# Other observations

Hiddink et al (2011) → plaice condition negatively correlated with trawling frequency (muddy habitat – Nephrops fishing ground). No correlation found for dab and whiting.

Infaunal production



Plaice Plaice condition



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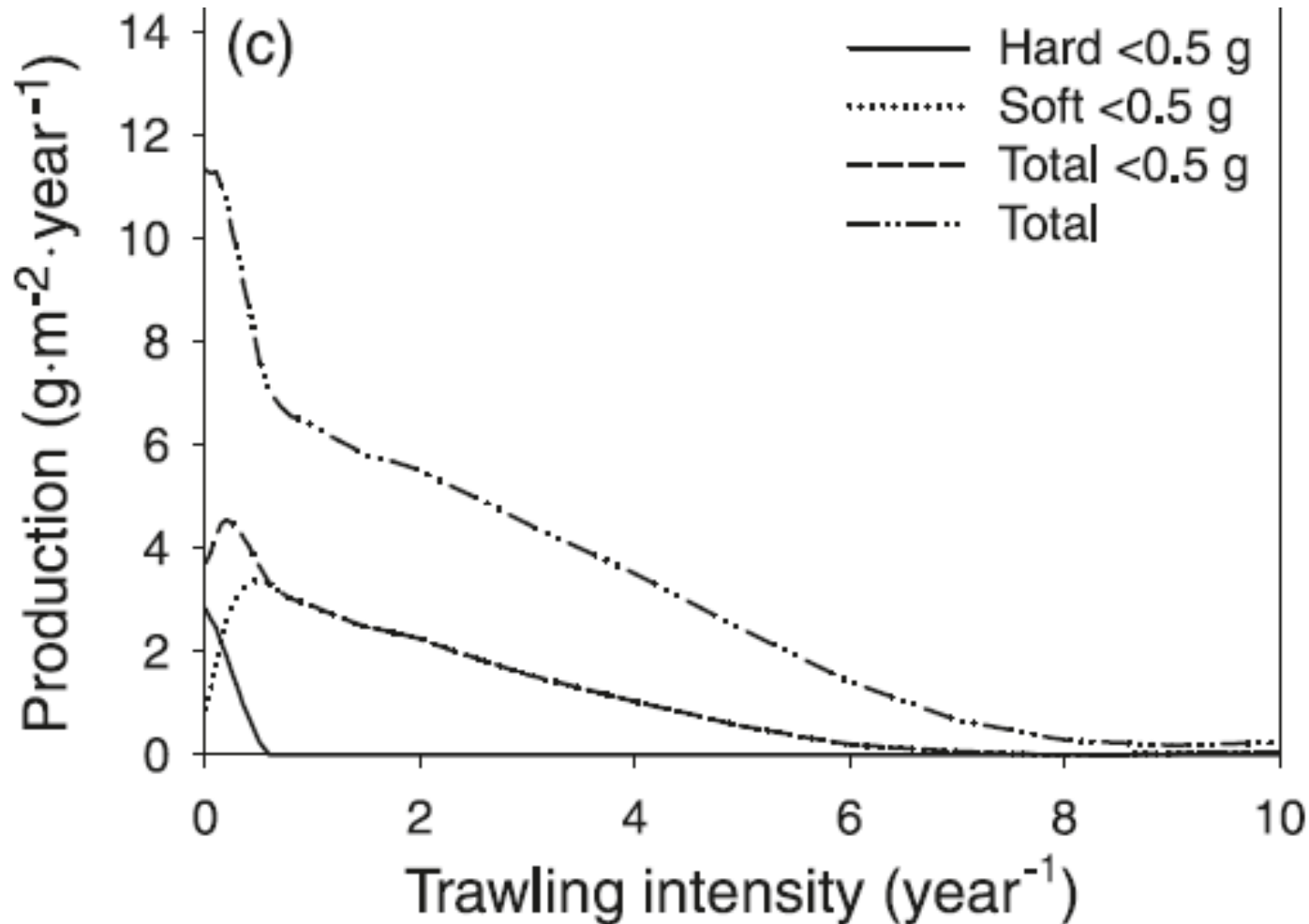
# Problems

- Correlations may break down if more data become available
  - Plaice growth
    - Effect of sea bed disturbance no longer significant (Beare et al 2010 Plaice Box Evaluation)
  - Shepherd et al (2011) Condition – trawling intensity relationships ProcRSoc paper (withdrawn)
  
- What are the underlying mechanisms?



# Modelling studies

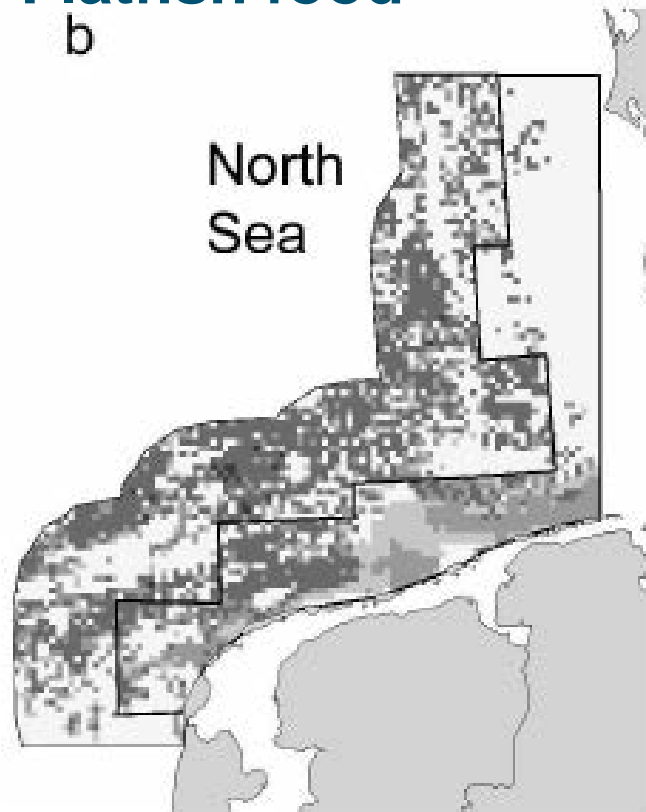
Duplisea et al: size based model (hard, soft benthos)



# Effect reduction beam trawling in Plaice Box on food of plaice

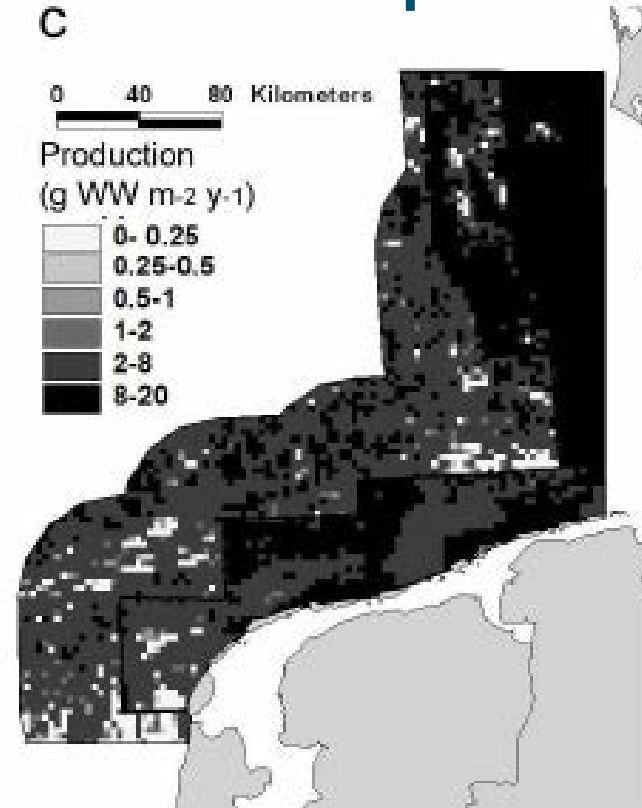
## Flatfish food

b



## Total benthic production

c



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- Previous work has ignored the effect of
    - feeding by fish on the abundance and productivity of benthic invertebrates
    - fishing on the abundance of fish

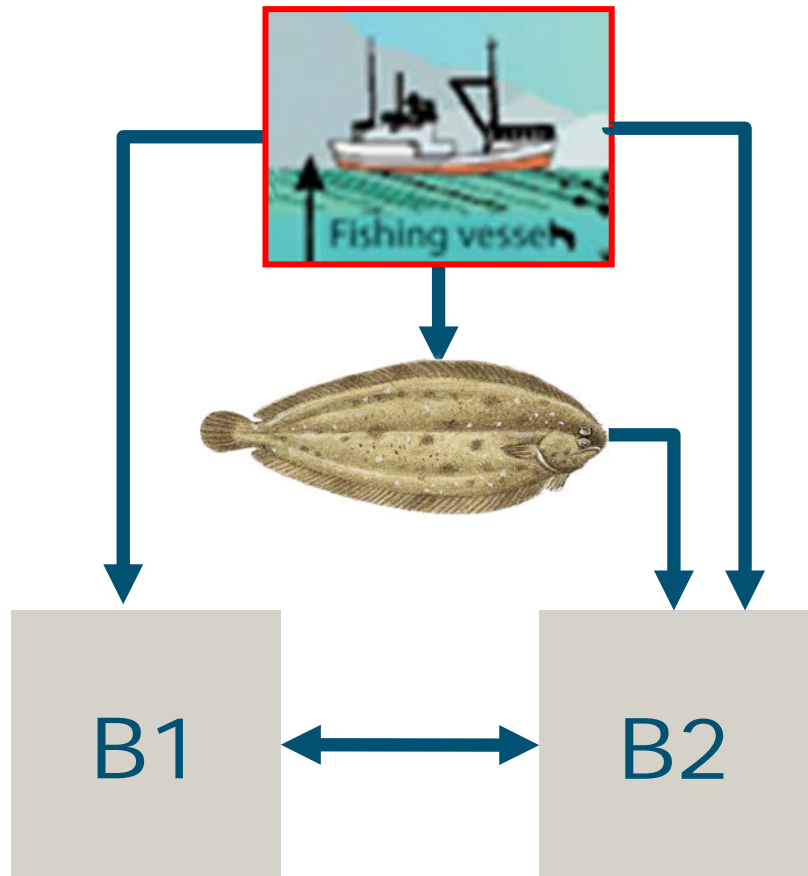
# Including fish predation

- Daniel van Denderen (PhD at IMARES)

Van Denderen, van Kooten, Rijnsdorp. When does fishing lead to more fish?  
Community consequences of bottom trawl fisheries in demersal food webs. Proc  
Royal Soc B (submitted)

B1 and B2 differ in:  
Susceptibility for trawling  
Suitability as food for fish

Compare  
top-down & bottom-up  
regulated systems

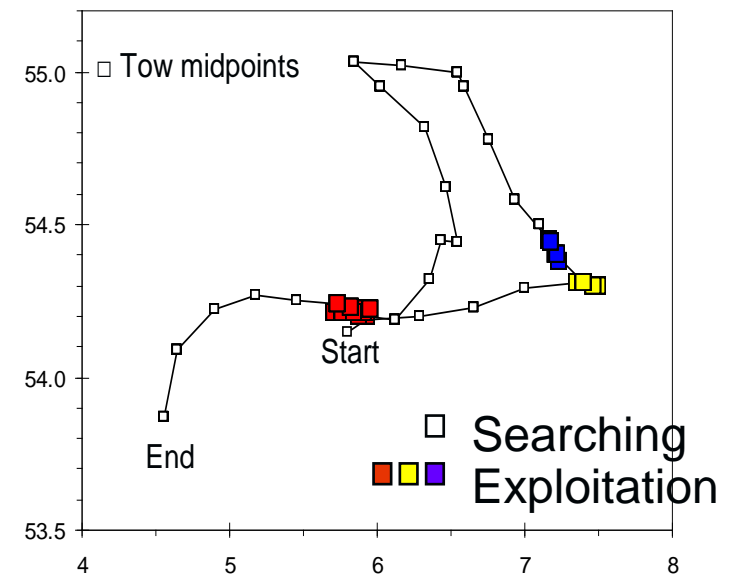
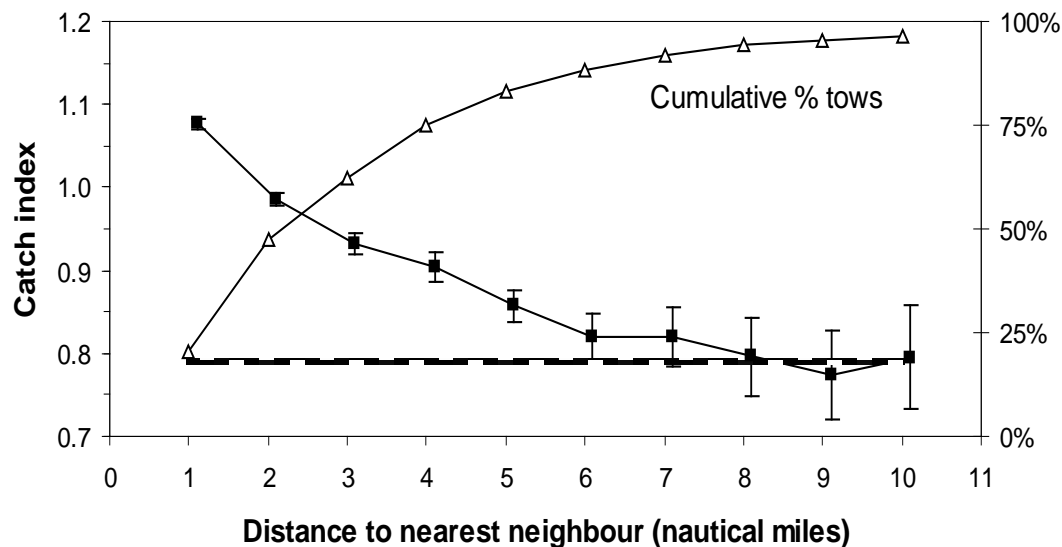


# Conclusions

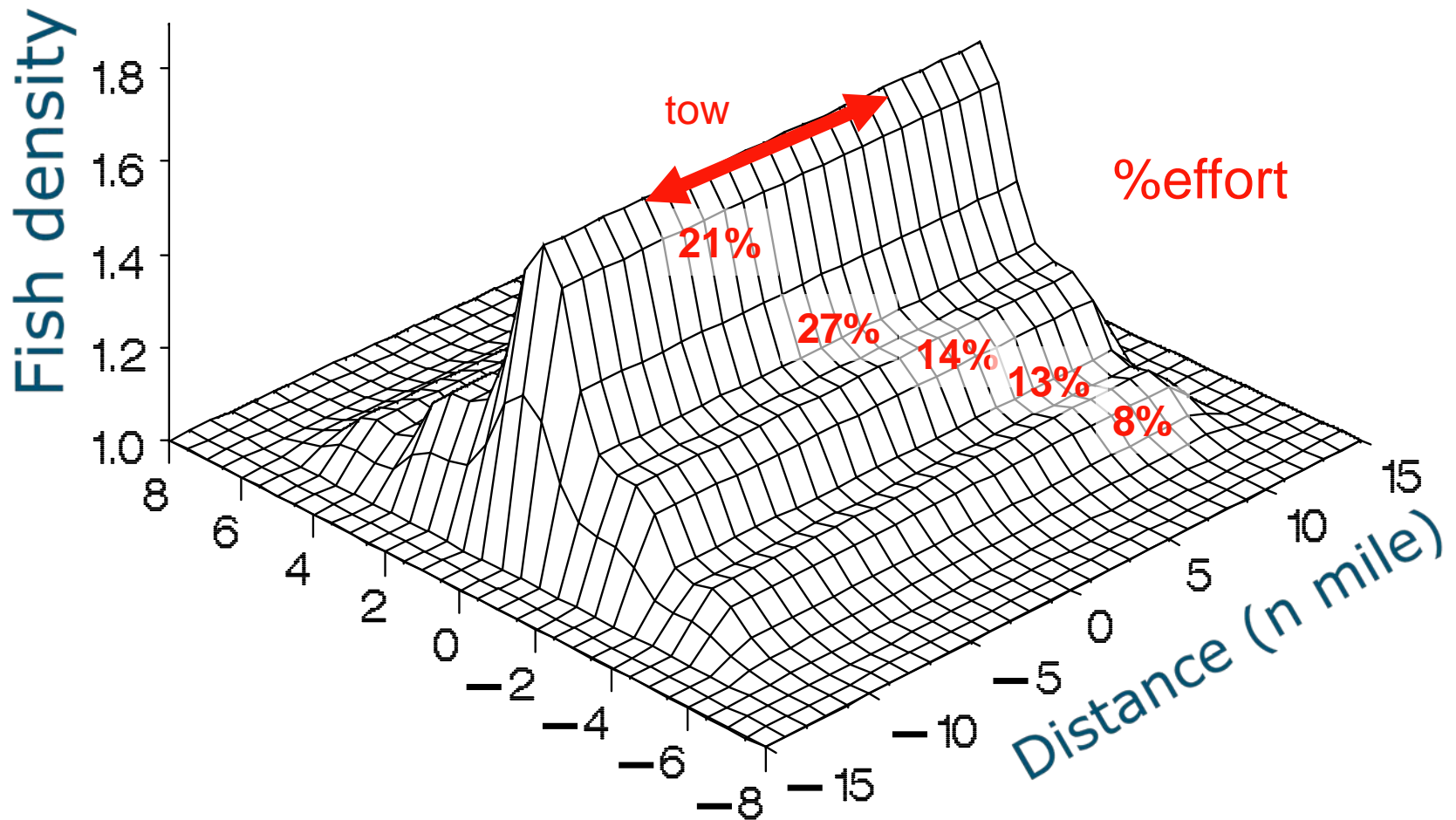
- Response to trawling depends on whether the abundance of benthos is top-down or bottom-up controlled.
- Fishing may result in higher fish abundance, higher (maximum sustainable) yield and increased persistence of fish when the benthos which is the best quality fish food is also more resistant to trawling.
- These positive effects occur in bottom-up controlled systems and systems with limited impact of fish feeding on benthos that resemble bottom-up control.
- Fishing leads to lower yields and fish persistence in all configurations where susceptible benthos are more profitable prey.

# What can we learn from fishing patterns?

- Consistency in trawling patterns over time
- Factors determining trawling patterns:
  - Fisheries aggregate at local hotspots of fish
  - Fish aggregate at hot spots of their food



# Dimensions of a fishing ground



**Spatial dimension and exploitation dynamics of local fishing grounds by fishers targeting several flatfish species**

# Persistence of a fishing ground

- Spatial covariance within a week & with previous week (lag -1, lag -2)

