Long term changes in the North Sea ecosystem:

Disentangling fisheries, climate and eutrophication

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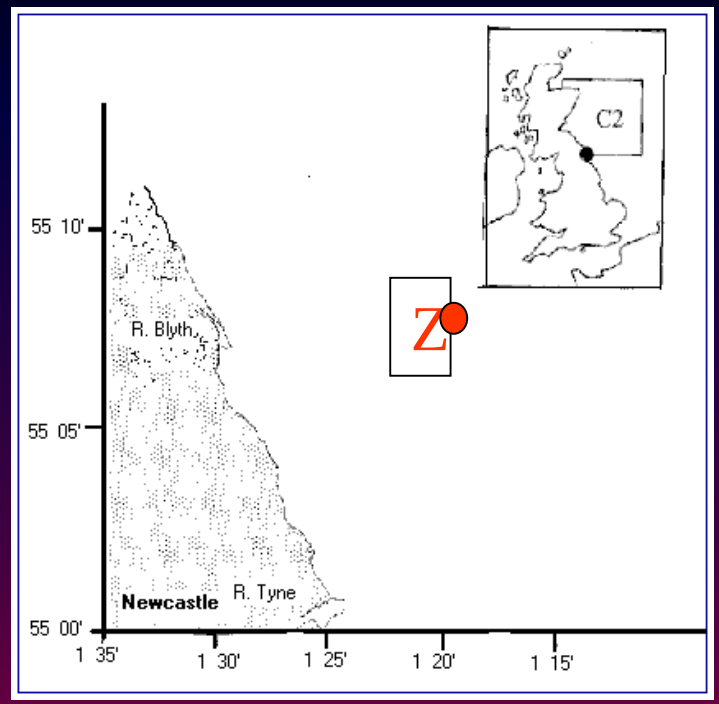
The Dove Time Series

The Dove Time Series

- One of the best multi-decadal, coastal, ecological datasets for the North Sea
- 3 concurrent and adjacent sampling programmes, 1 for zooplankton and 2 for benthos
- Data examined for:
  - Extrinsic control
  - Multi-decadal signals
  - Possible existence of phase shifts

Zooplankton 1969-2001

- Fixed station
  - 6 miles offshore,
  - 53 m deep
  - Monthly net sampling



- This study:
  - 1969-1995 (not 1989)
  - Annual means of species abundance (numbers/m^3)
  - Data log(x+1) transformed

Benthos - Station M1 1972-2001

- *Amphiura filiformis-Echinocardium cordatum* variant

(community type sensu *Peterson & Boysen-Jensen, 1911*)

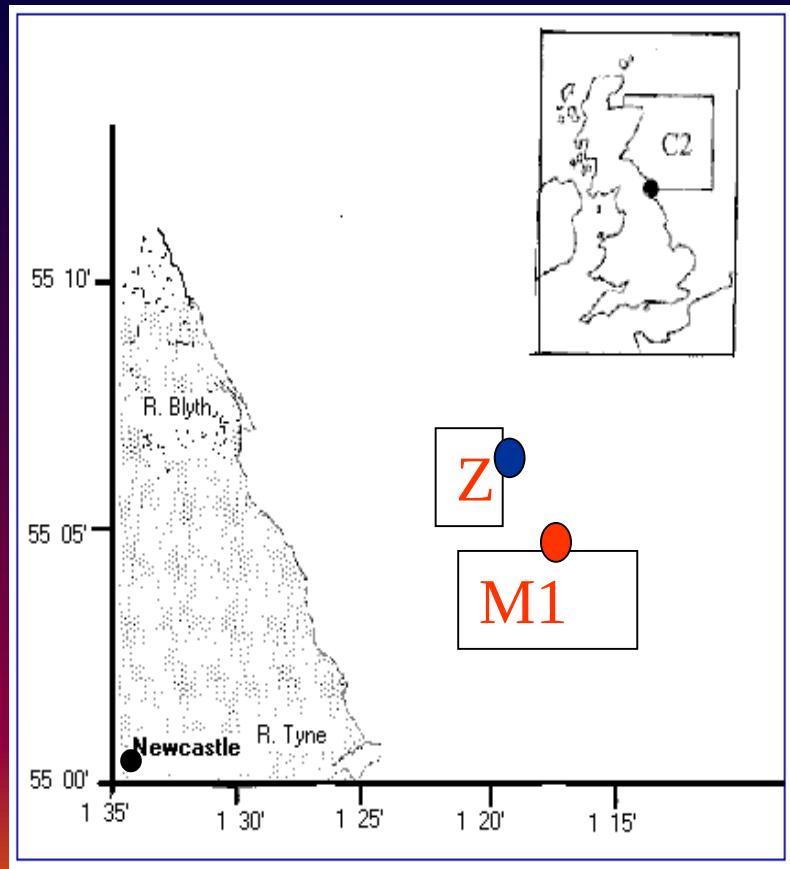
-Station 6.5 miles offshore, 55m deep

-Twice yearly sampling

- This study: 1973-2001 (not 1998)

-Annual means of genera abundance (no/m^2)

-Database reduced - Total 65 genera

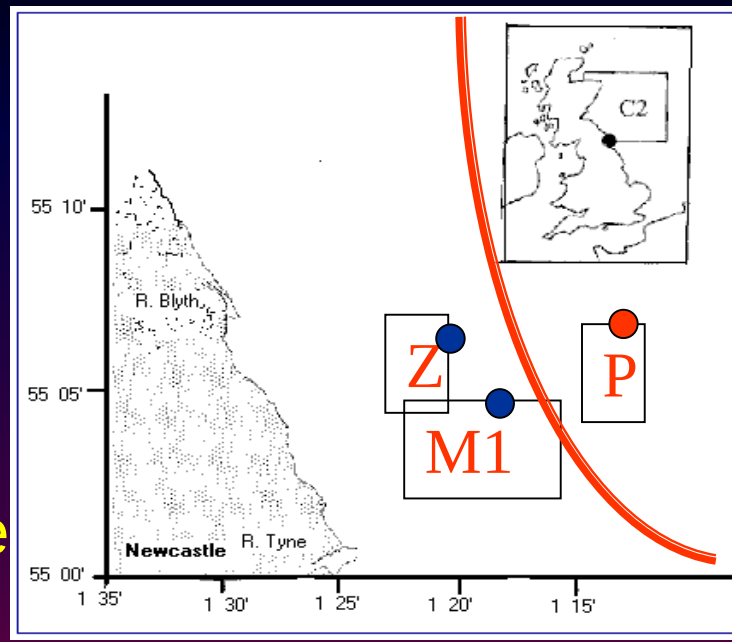


Benthos - Station P 1971-2001

- *Brissopsis lyrifera-Amphiura chiajei* variant (**community type sensu *Peterson & Boysen-Jensen*, *1911***)

-Station 11.5 miles offshore 80m deep - within a ***Nephrops* fishing ground**

-Once yearly sampling



- This study: 1971-2001 (not 1977 or 1998)

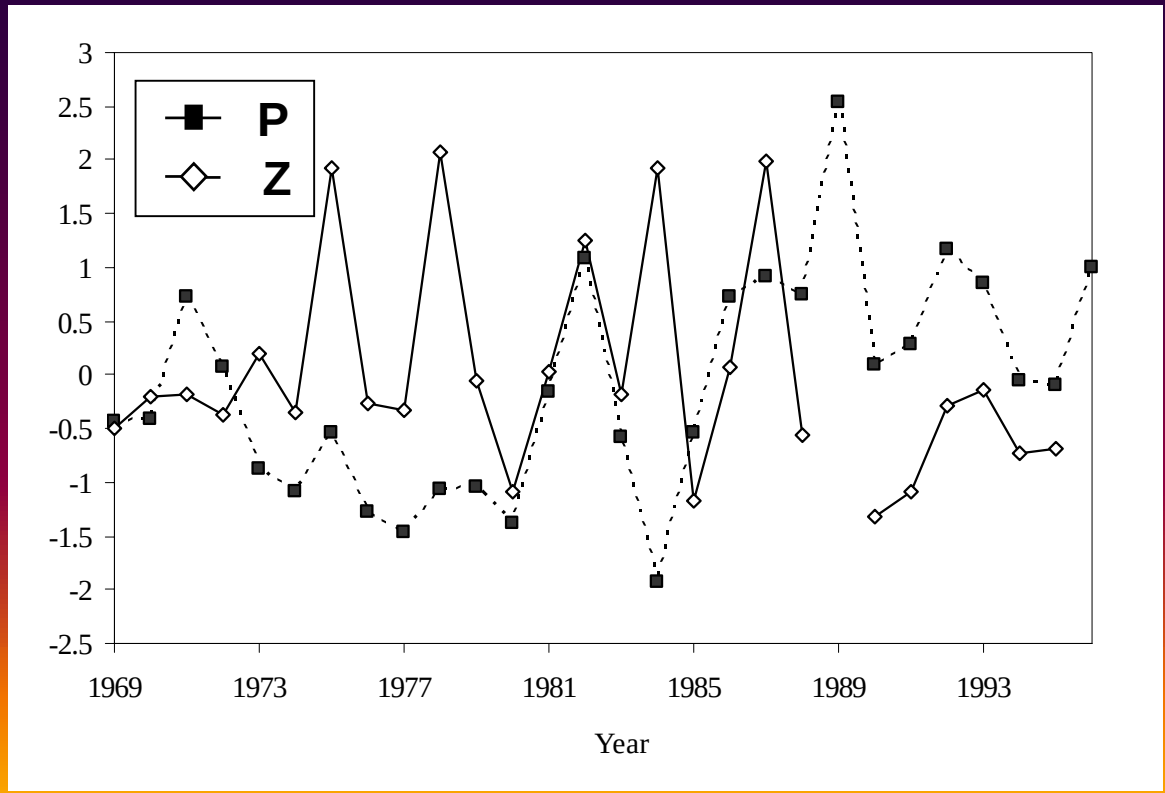
Annual means of genera abundance (no/m^2)

Database reduced to 50 genera

Productivity and eutrophication

- Phytoplankton abundance (at 10m) is scored by the CPR
- Does not trend (i.e. no evidence of a eutrophication effect)

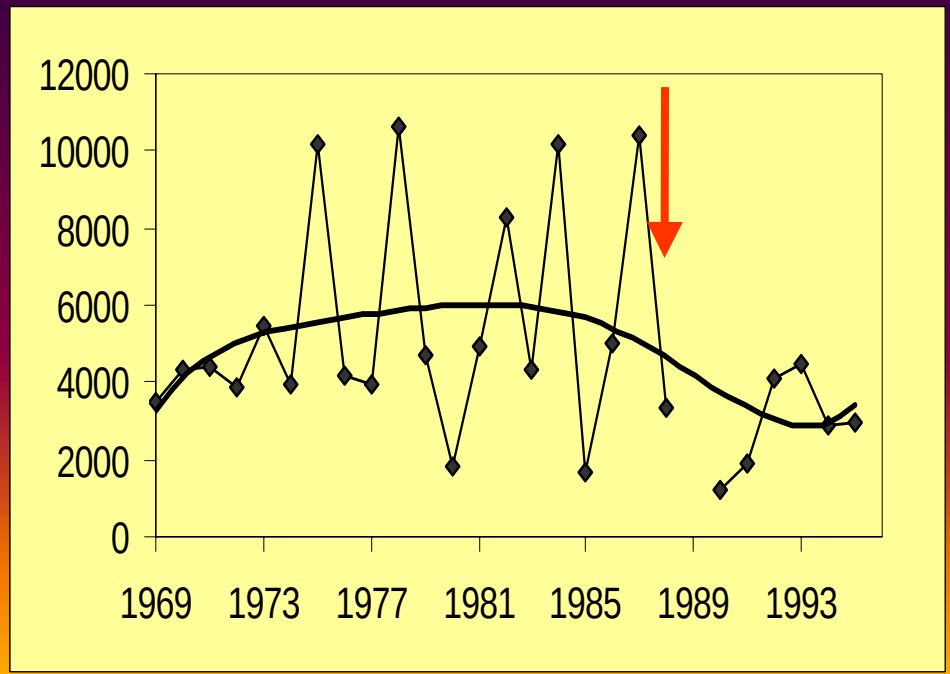
- Phyto vs zooplankton
r^2=0.07%
p=0.733



Findings: Zooplankton 1969-1995

- Total productivity and community composition highly variable between 1974-1990
- Productivity of a small number of DOMINANT TAXA has strong influence on variability of total community

- No major phase shifts (in total abundance or composition of the genera)



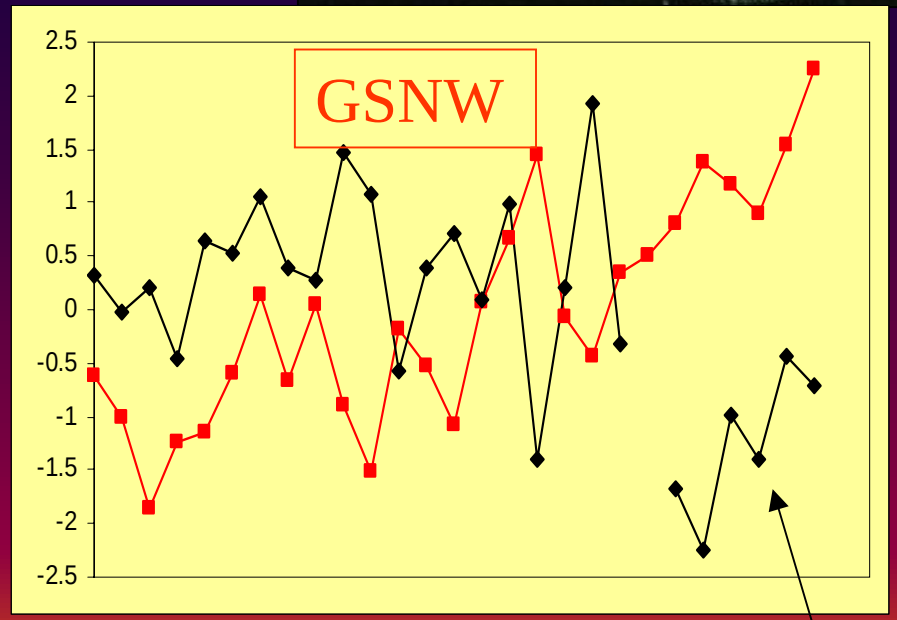
Zooplankton and extrinsic control

- Phytoplankton productivity
  - NO LINK to total zooplankton

  BUT,

  +ve correlation with *Acartia clausi*

  -ve correlation with jellyfish juveniles



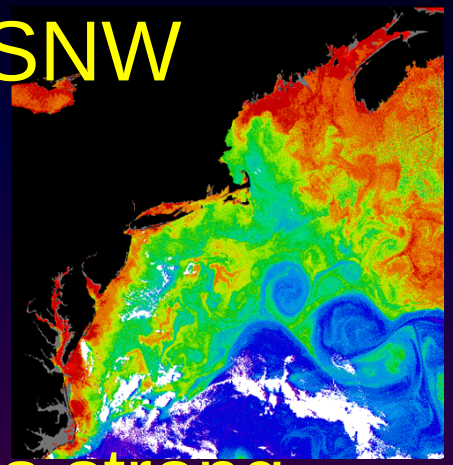
- GSNW position
  - NO LINK to total zooplankton

  BUT, strong negative relationships with several dominant taxa

Pseudo/Para/Micro-calanus juveniles, r^2=38.4%, p=0.005

Summary - Dove Zooplankton

Northerly positions of GSNW



- Decreased productivity of dominant small taxa & juveniles
- Variation in dominant taxa has strong influence on total productivity and composition of the whole community

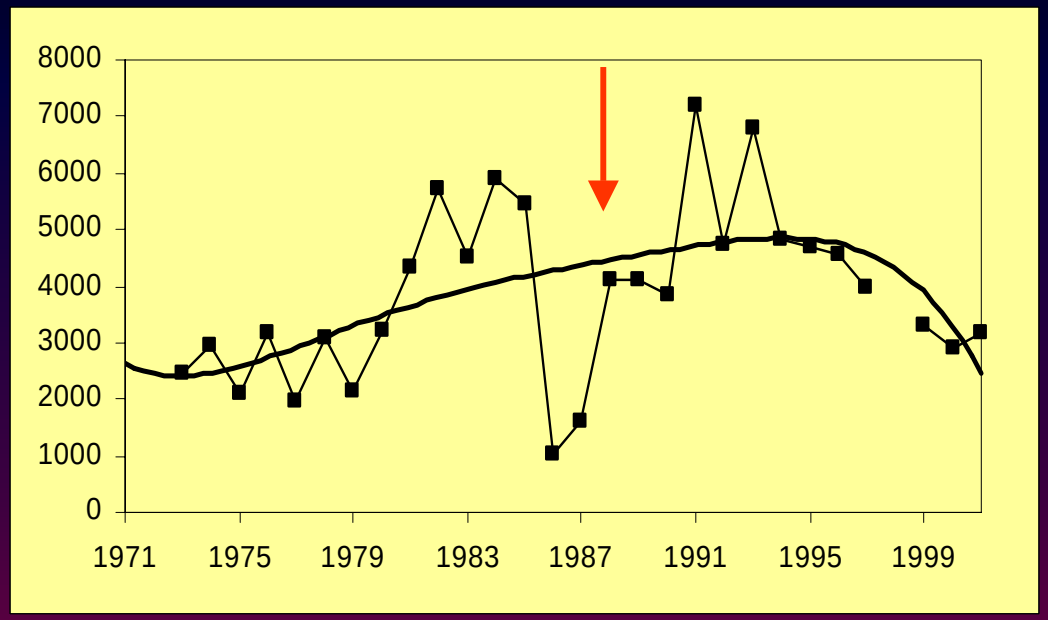
Negative relationship contradicts findings for other areas of North Sea.

Due to internal predatory feedback mechanism?

Findings: M1 Benthos 1973-2001

High variability in productivity and taxa composition (1981 -1994)

No major phase shifts or regime changes



Link to organic input?

1st decade - stable biennial cycle. Evidence of density dependence? (Buchanan, 1993)

No link to zooplankton.
Signal from the phytoplankton?

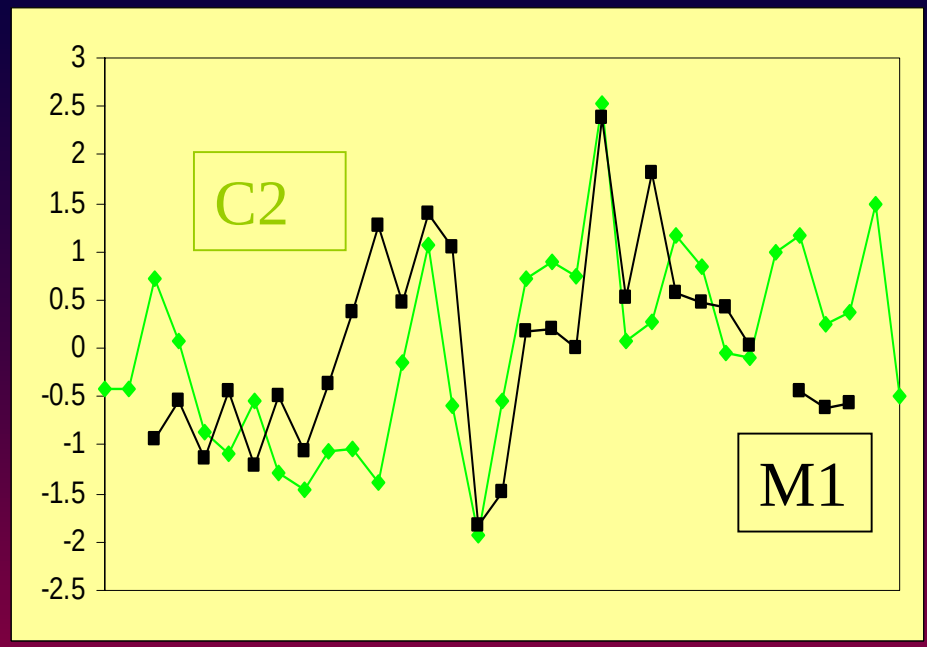
M1 Benthos and extrinsic control

CPR area C2 Phytoplankton

Significant association with M1 benthos at a 2-year lag

(r^2=28%,p=0.006)

Association strongest 1981-1991 (r^2=55%)

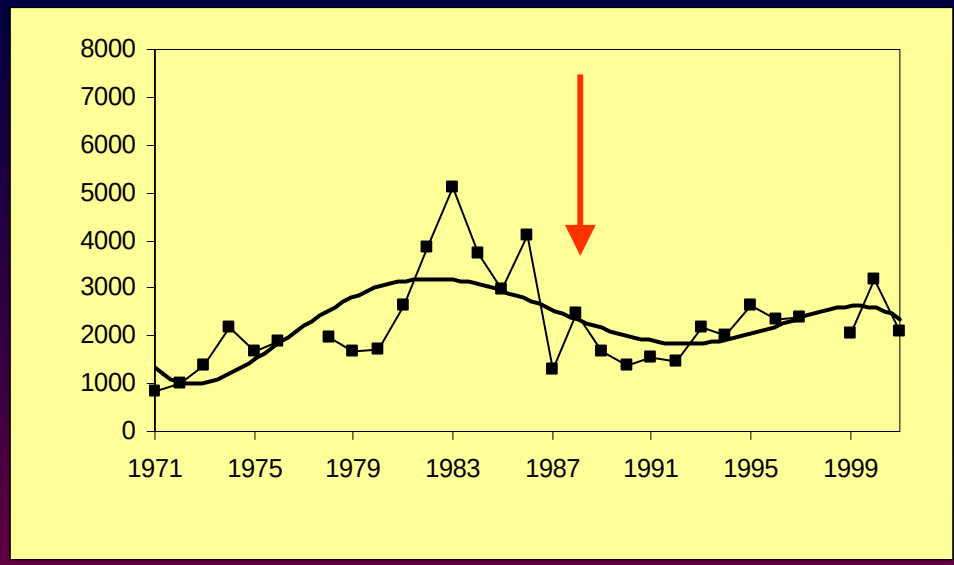


Also correlates with the GSNW position (r^2=22.5%,p=0.037)

And, winter NAO Index at a 1-year lag (r^2=17.3%,p=0.033)

Findings: P Benthos 1971-2001

- Lower productivity and variability than M1
- Taxa composition
  -highly variable (1987-1993)
- No phase shifts

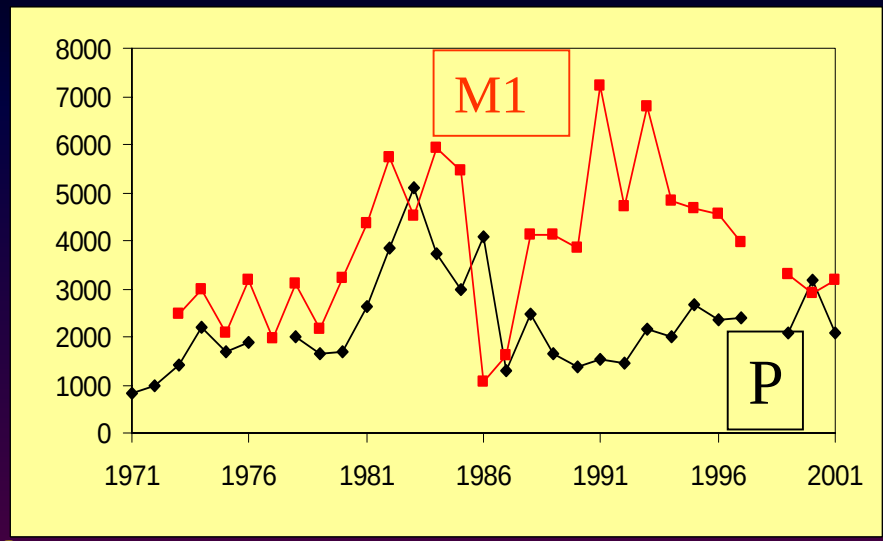


Would expect Stations P and M1 to respond to the same extrinsic drivers

No association however, between P benthos and phytoplankton productivity, or either climate proxy

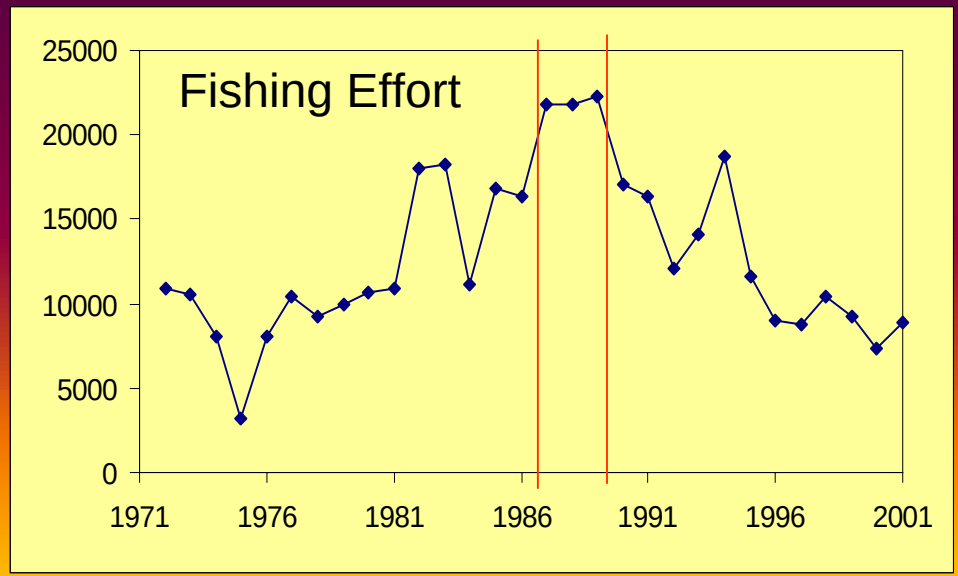
Fisheries and P Benthos

Station P tracks M1 and phytoplankton until the mid 1980s



Loss of signal coincides with increase to highest fishing effort in *Nephrops* ground, within which P is located

Genera composition highly variable and production
low at this time



Summary - Dove Benthos

M1 benthos → influenced by both phytoplankton productivity & the climate proxies (GSNW position & winter NAO Index)

Associations between the extrinsic drivers and benthic production vary as the 30-year time series extends

P benthos

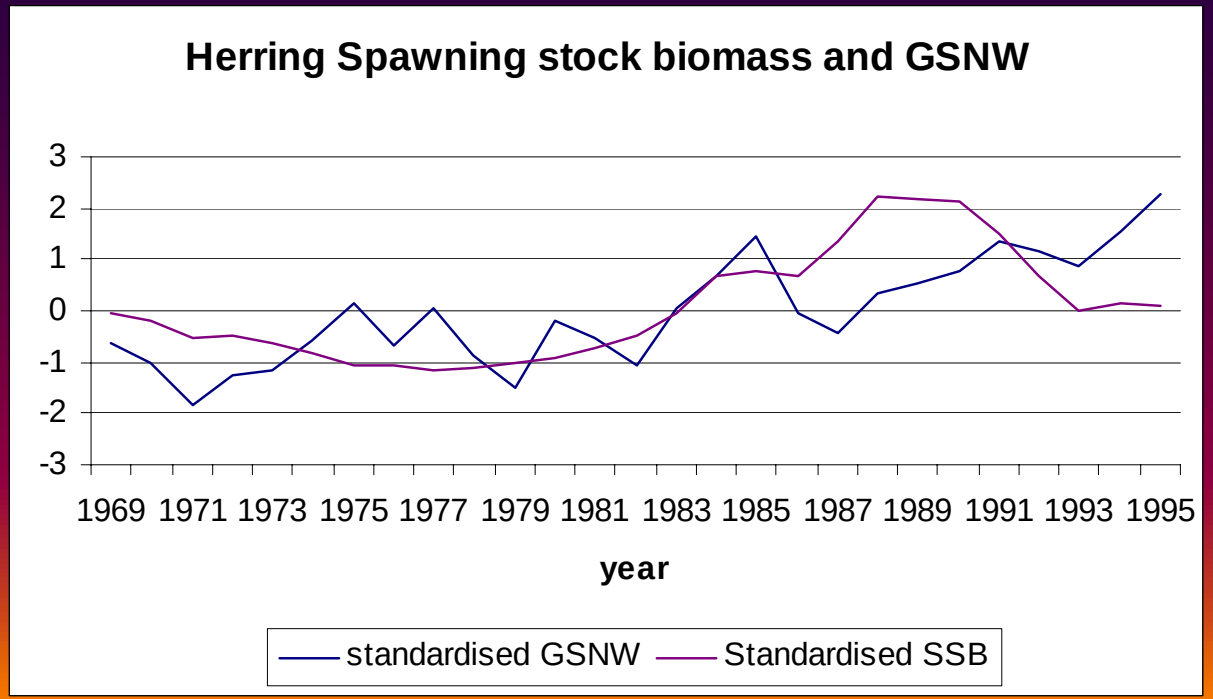
Effects of high trawling effort for *Nephrops* overrides extrinsic drivers

Fish and climate

- Fish stocks are highly mobile and no data exist on local abundance
- Weak link for herring to climatic drivers

R^2= 27%

p=0.005



CONCLUSIONS - Multi-decadal changes

- No evidence of major phase shifts in any of the multi-decadal Dove Time Series
- Both zooplankton and benthos at Station M1 showed control by extrinsic drivers - different mechanisms
- Control of Station P benthos was dominated by the effects of the N*ephrops* trawl fishery

Importance of Integration

Individual components of a shelf sea ecosystem react differently to the same extrinsic drivers

To provide level of ecological understanding necessary to underpin ecosystem-based approaches, concurrent multi-decadal time series are essential.

We continue to collect these time series data and wish to thank all those involved in sample collection and analysis, particularly the research vessel crews.

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