Long-term changes in the distribution and abundance of selected fish larvae from the CPR (1950-2005) over the UK shelf, in relation to biological and environmental factors

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Outline

1. CPR survey and fish larvae
   - The CPR survey
   - Analysis of fish larvae and area of work
   - Species caught by the CPR

2. Biogeographical changes for main taxonomic groups and relationship with environment
   - Clupeids, Sandeels and Atlantic mackerel
   - Distribution, changes through time and space
   - Long-term trends and links with temperature, NAO, zooplankton, phytoplankton, salinity

3. Clupeids and fishing effects
   - Relationship between CPR fish larvae and stock assessment data (fisheries)
Continuous Plankton Recorder study

- CPR has been running for more than 80 years
- Unique source of long-term information of zooplankton in the North Atlantic
fish larvae samples and area of work

- Sampling locations from CPR survey covering 1950-2005
- Over 106500 data points
fish larvae caught by the CPR

Total fish larvae mean abundance caught by CPR, 1950-2005
Clupeids, Sandeels and Atlantic mackerel larvae in relation to their environment

Environmental Data:

- Monthly average SST and Surface salinity (1°x1° grid) obtained from the International Comprehensive Ocean–Atmosphere Data Set (ICOADS) 1960-2005
- Winter NAO Index obtained from US National Center for Atmospheric Research
- Phytoplankton Chlorophyll Index (PCI) obtained from CPR
- Dinoflagellates abundance obtained from CPR
- Diatoms abundance obtained from CPR
- Zooplankton (copepods and cladocerans) abundance from CPR

Fisheries data:

- Stock and recruitment indices for herring, obtained from the International Council for the Exploration of the Sea
A changing environment...

Principal Component Analysis on 7 standardized environmental variables

3 distinct periods of time:

1. 1960-1969
   - high salinity, diatoms, dinoflagellates and Zooplankton
   - low SST and PCI

2. 1970-1995
   - Low diatoms, dinoflagellates, PCI, SST, salinity

3. 1996-2004
   - High SST, PCI, diatoms
Sandeel larvae

Abundance distribution in 8-years groups

Mean monthly abundance (1950-2005)
Correlations with sandeel larvae abundances (1960-2005)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>zooplankton Abundance</td>
<td>0.077</td>
<td>0.575</td>
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<td>diatoms</td>
<td>0.076</td>
<td>0.607</td>
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<td>Dinoflagellates</td>
<td>0.036</td>
<td>0.806</td>
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<td>PCI</td>
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<td>Surface salinity</td>
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<td>SST</td>
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<td>Winter NAO</td>
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Atlantic Mackerel larvae

Mean monthly abundance (1950-2005)

Abundance distribution in 8-years groups
Atlantic Mackerel larvae

Correlations with Atlantic mackerel larvae abundances (1960-2005)

<table>
<thead>
<tr>
<th>Variable</th>
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<tr>
<td>Zooplankton Abundance</td>
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<td>Diatoms</td>
<td>0.461</td>
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<td>Dinoflagellates</td>
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<td>PCI</td>
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<td>Surface salinity</td>
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<td>SST</td>
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<tr>
<td>Winter NAO</td>
<td>-0.014</td>
<td>0.921</td>
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</tbody>
</table>

Long-term trends

1. High Sal, diatom, dinoflag, Zoo.
   Low SST, PCI

2. Low diatom, dinoflag, PCI, SST, Sal

3. High SST, PCI, diatom

Mean Yearly Abundance / m³
Clupeid larvae

Mean monthly abundance (1950-2005)

Abundance distribution in 8-years groups
Correlations with clupeid larvae abundances (1960-2005)

<table>
<thead>
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<tbody>
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<td>zooplankton Abundance</td>
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<td>diatoms</td>
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<td>Dinoflagellates</td>
<td>0.142</td>
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<td>PCI</td>
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<td>Surface salinity</td>
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<td>SST</td>
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<td>0.829</td>
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<td>Winter NAO</td>
<td>-0.154</td>
<td>0.257</td>
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Results environmental impacts on fish larvae

Our results suggest that different type of fish larvae respond differently to changing environment:

- Sandeels: SST seems the most critical driver?
- Atlantic mackerel: Temperature and prey?
- Clupeids: prey and salinity?

However relationships between fish larvae and individual variables are weak, highlighting the complexity of the mechanisms involved.

- variables may have a direct or indirect effect (or both)
- several variables acting at the same time not always in the same direction

Possibility to develop species specific indices of survival with selected environmental variable? And on specifically delimited areas?
CPR clupeid larvae and herring stock assessment data

2 areas selected:
- North Sea & eastern channel
- West of Scotland
Clupeid larvae from CPR vs Herring recruits and total biomass

North Sea

R=0.42 (p=0.003)

R=0.34 (p=0.016)

West Scotland

R=0.44 (p=0.002)

R=0.44 (p=0.001)
Clupeid larvae from CPR vs Herring Spawning Stock Biomass (SSB)

- Differences in the two areas with much closer relationship between SSB and fish larvae abundance in the North Sea.
- SSB dropped dramatically in the 70s as a result of fishing.
- F variations roughly in line with SSB in North Sea also in line with larvae. **Top down control?**
- In West of Scotland Since late 80s, although number of larvae has increased and fishing decreased, this hasn’t been followed by a recovery in SSB. **Other component of the clupeids or Environmental effect?**
Difficult to separate all the individual environmental effects on fish larvae as these are species specific, act directly and/or indirectly, with and/or against other environmental variable. But potential to develop species specific indices.

Fishing mortality impacts directly on the adult population but the impact on fish larvae is difficult to disentangle from environmental effects, so a lot more work needed before we can separate the two effects.

Great potential for Continuous Plankton Recorder Data to be used in fisheries science.
Acknowledgements

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