

Spreading anchovy in the North Sea

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Project Aims

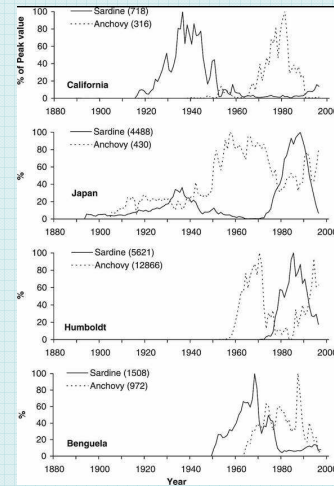
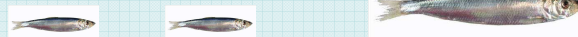
- Simulate the spread of a hypothesized anchovy regime shift in the North Sea.
- Determine which properties allow a local shift to spread into a shift of the whole system.
- Eventually assess how these properties change with pressures like climate change or harvesting.

Regime shifts are more or less rapid shifts to another more or less stable state. Here, I consider a regime to be a state of high or low abundance of anchovy (distinguished by an arbitrary cut-off).

Background

1. Small pelagic fish - e.g. anchovy, herring, sprat, sardine

- Notorious for their large population fluctuations
- Often, one species dominates at any one time. Changes of dominant species were termed "regime shift".
- Exact mechanism unknown but such shifts usually go along with climatic changes.



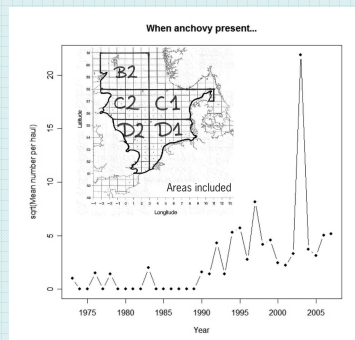
2. The North Sea system

The increased anchovy population is my focus, but other changes occurred too:

- | | |
|-------------|--|
| Food | - Major changes in the plankton: species composition, abundance and phenology. |
| Competitors | - Low herring recruitment since 2000 |
| Predators | - Generally low predatory fish populations (e.g. cod) |

A model in which changed conditions (one or more of the above) allow the overcoming of depensation may be able to explain the mechanism behind the anchovy increase.

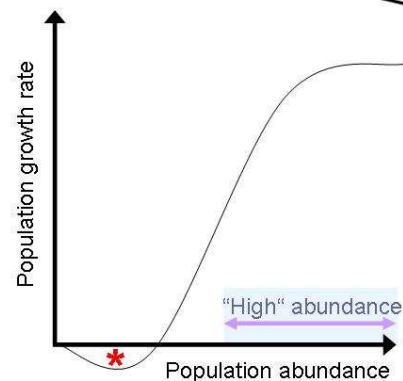
*Depensation is the reduction of population growth rate at low abundances.



Model overview

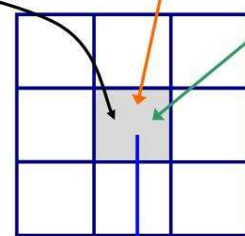
POPULATION DYNAMICS

IN EACH CELL:



ENVIRONMENT by grid cell
Influencing population growth

Movement between adjacent cells



Overcome depensation* & shift (or not)

Movement allows for spread to where environmental conditions alone would not allow overcoming of depensation.

Assumptions

- **spatial heterogeneity** in environmental conditions (competitors, food, temperature)
- **depensation** in the system. This can result from e.g. predation on the competitors' young; schooling with the "wrong" species at low abundances of your own species
- **localised source** of a population that spreads to adjacent cells.

Progress

So far, the model is built using Grind for Matlab (van Nes, 2009).

Next steps are:

- parameterisation, sensitivity analysis
- use different patterns of environmental heterogeneity

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