



Edinburgh,  
7–11 May 2012

Theme A. Science to underpin sustainable fisheries  
A.1. Climate change impact on fisheries

# Climatic variability and decline of Atlantic Iberian *Nephrops* fisheries

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# INTRODUCTION

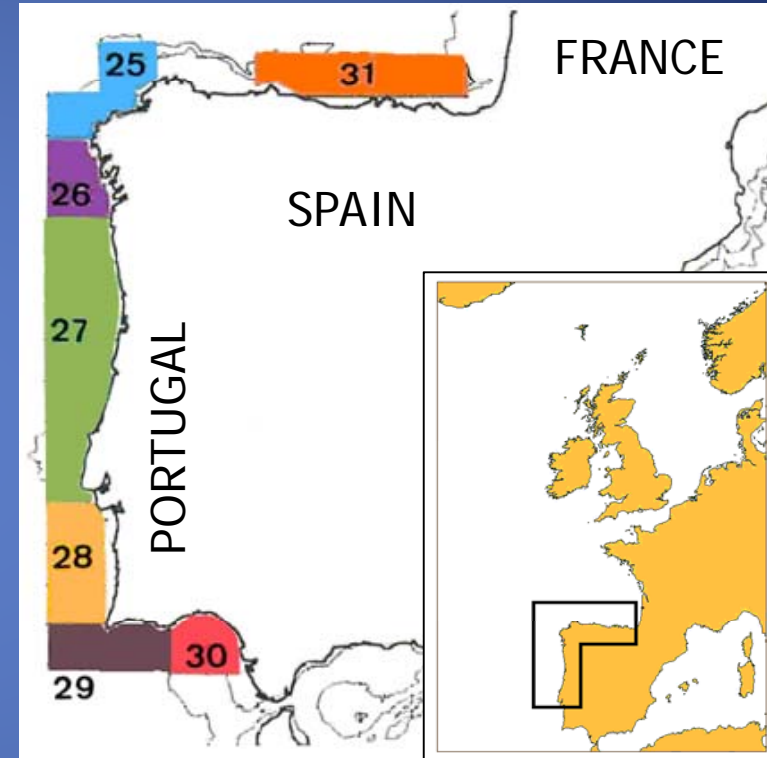
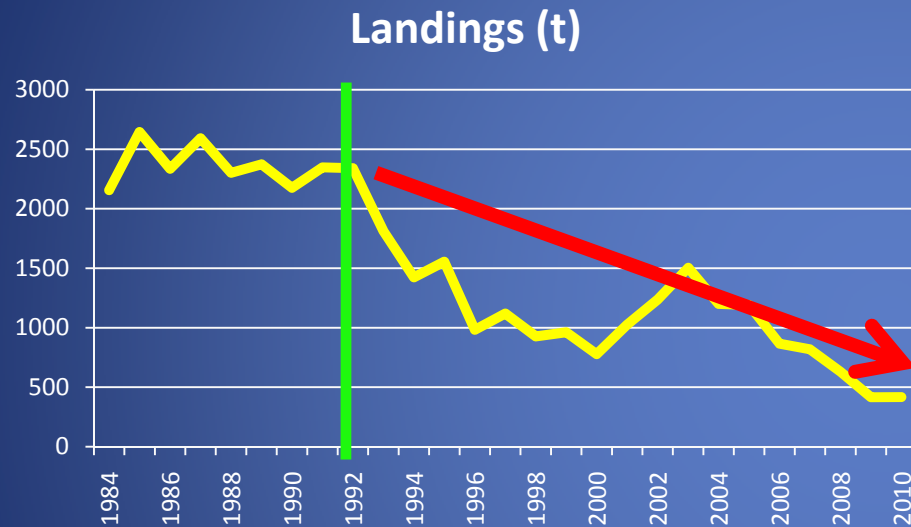


# Norway lobster (*Nephrops norvegicus*)

- Burrowing decapod
- Fishing pressure (and F) higher in males
- 6-8 weeks pelagic larval phase (January/February)
- Negligible discard (CPUE=LPUE)



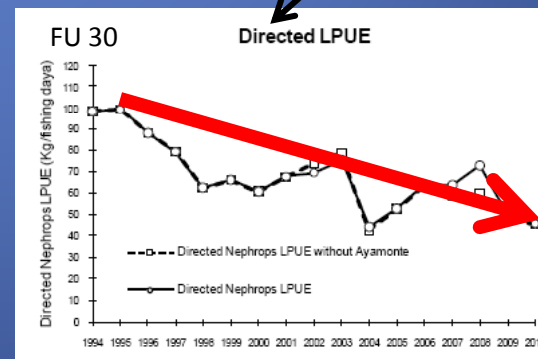
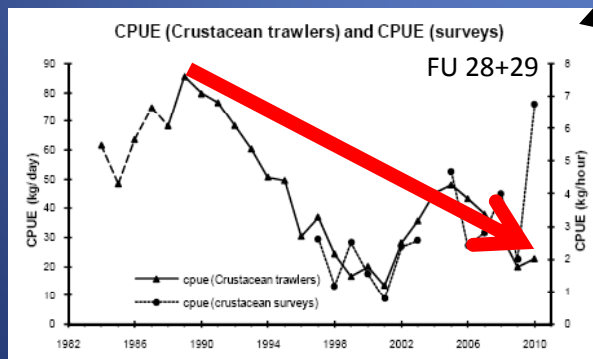
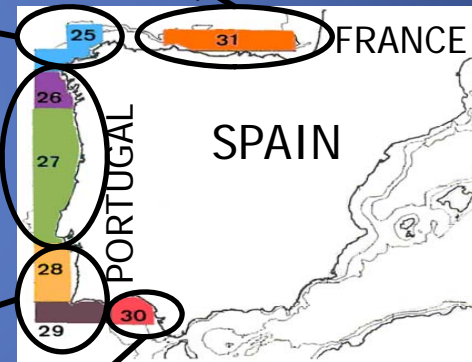
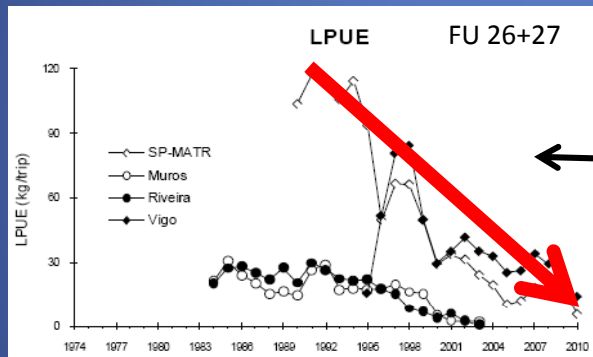
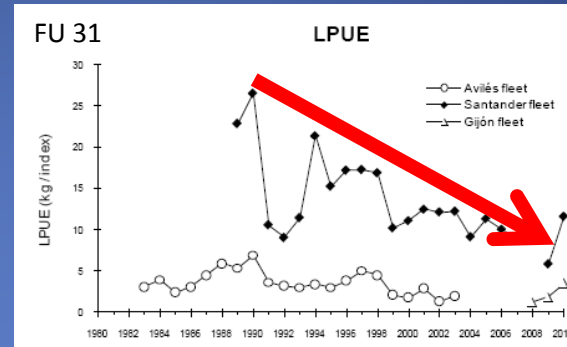
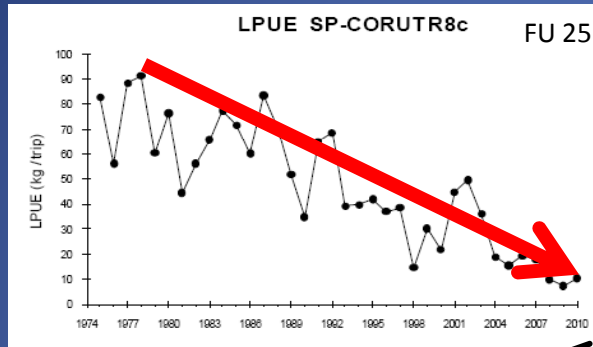
# Atlantic Iberian *Nephrops* stocks



Landings have declined by 84% over the last 25 years!  
A Recovery Plan has been implemented since 2006

# Climatic variability and decline of Atlantic Iberian *Nephrops* fisheries

## LPUE



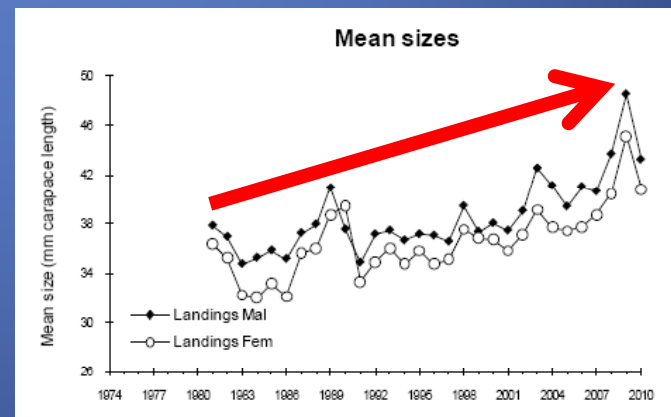
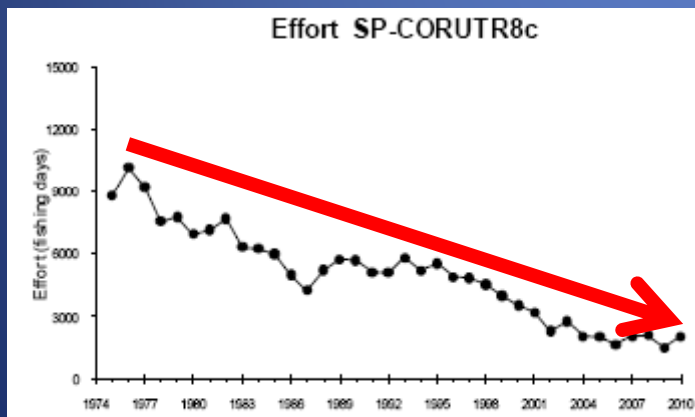
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A.1. Climate change impact on fisheries

## Why environmental factors could be involved?

Because different stocks from different areas have:

- Similar decreasing trends (landings, CPUE)
- With **decreasing F** (fishing mortality)
- **Mean sizes increasing** (recruitment failure?)



# OBJECTIVES



- Analyse and model the **catch-per-unit-effort (CPUE)** from a stock representative of the Atlantic Iberian *Nephrops* stocks under time series approach
- To identify **environmental and population variables** that show similar temporal patterns to *Nephrops* CPUE's

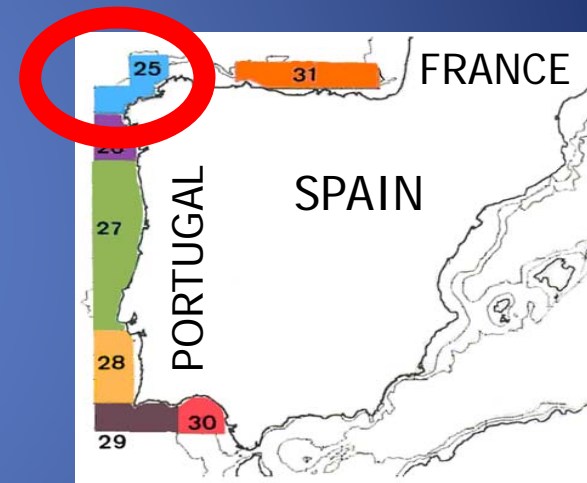
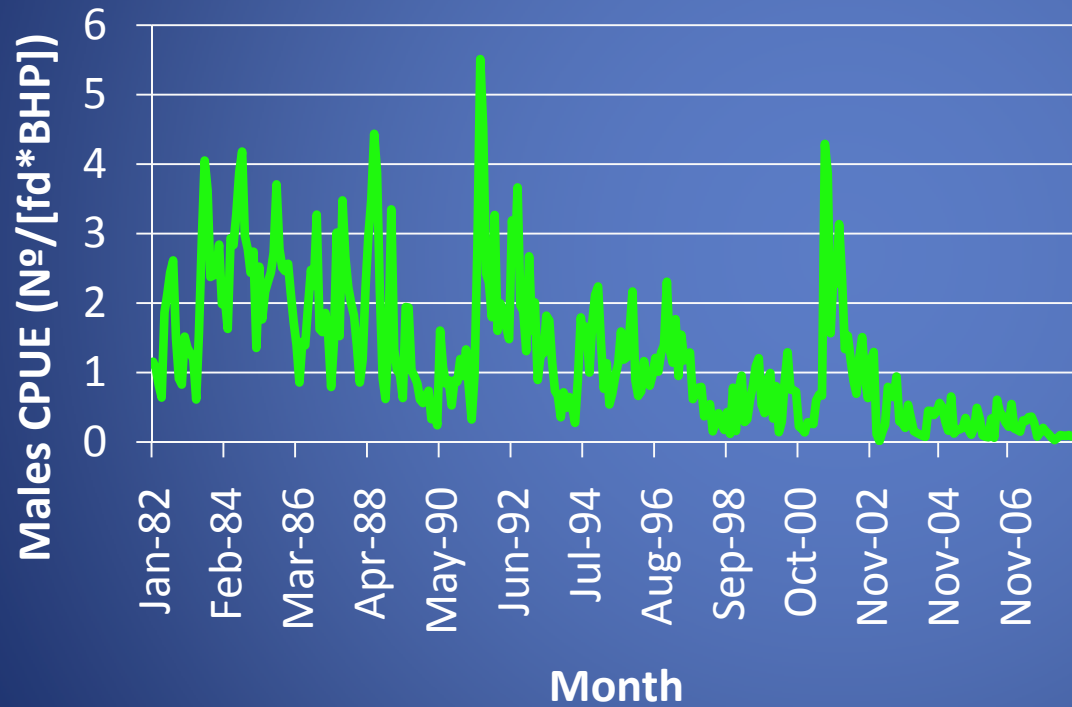


# MATERIAL AND METHODS



## Data used (monthly basis):

- FU 25 *Nephrops* males CPUE (n°/[fd\*BHP]) (1982-2008)



## Environmental variables:

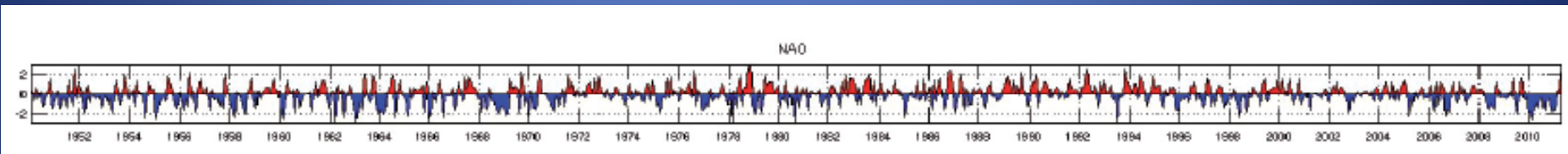
- Previous works:
  - upwelling index/Ekman transport
  - temperature (SST & 70 m depth)
  - chlorophyll
  - nitrates
  - salinity

- Now:
  - Teleconnexion patterns:
    - NAO
    - EA-WR
    - POL
    - EA
    - SCA
  - AMO

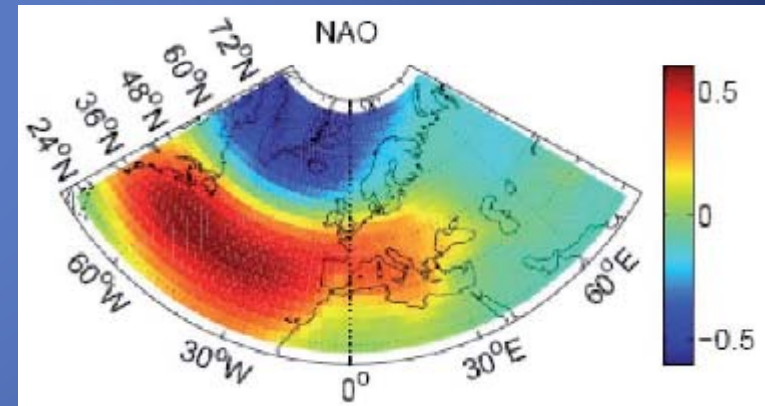


## Environmental variables:

### *North Atlantic Oscillation index (NAO)*

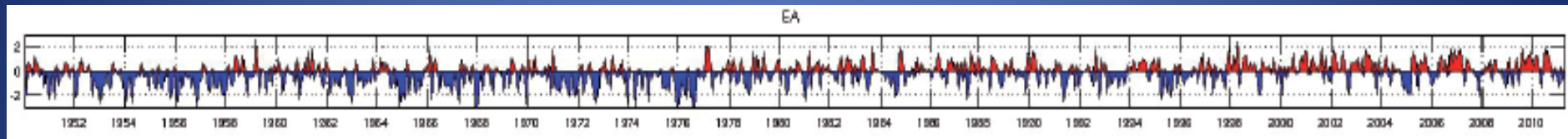


- Pressure difference between Iceland (low pressures) and Azores (high pressures)
- Negative correlation with precipitation in the NW Spain, positive with up-welling

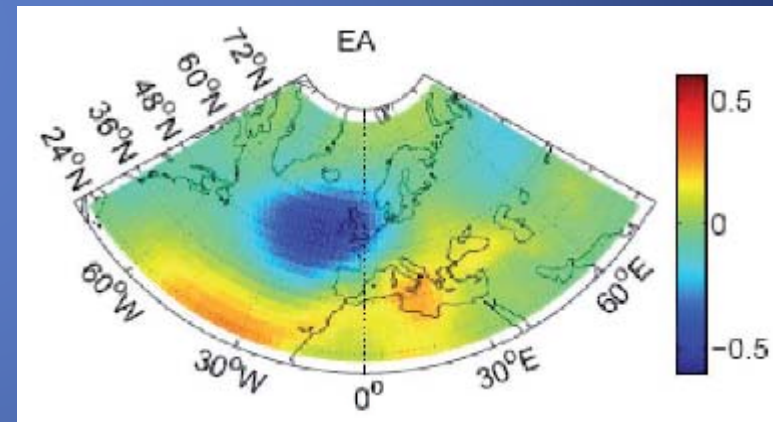


## Environmental variables:

### *Eastern Atlantic index (EA)*

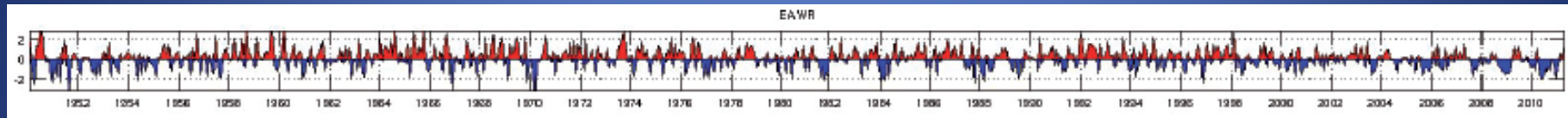


- Relation between the pressure in West of British Isles (low p.) and in NW Africa (high p.)
- Positive correlation with precipitation, temperature and negative with up-welling in the NW of Spain

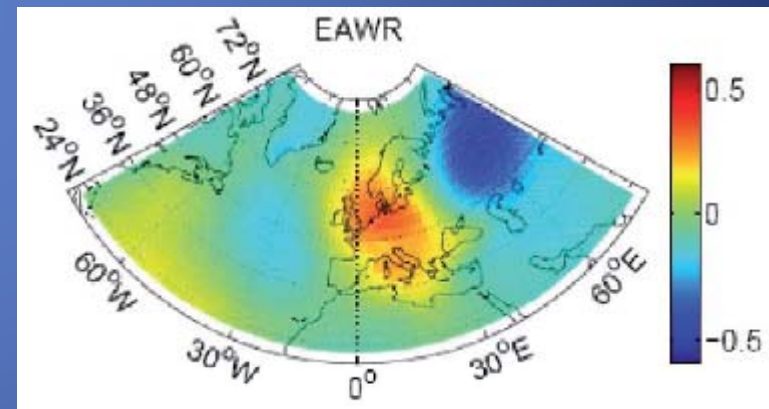


## Environmental variables:

### *Eastern Atlantic / Western Russia index (EA/WR)*

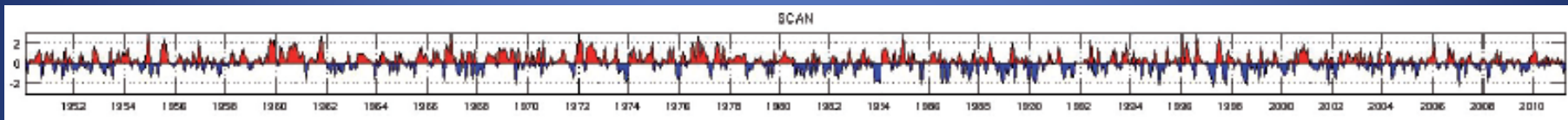


- Describes the system of high pressures in Central Europe and low pressures in West of Russia and NE Atlantic
- Related to winter anticyclones in Central Europe

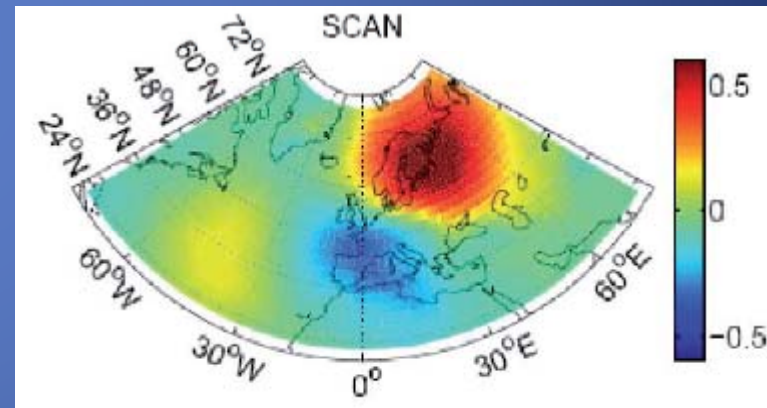


## Environmental variables:

### *Scandinavia index (SCA)*

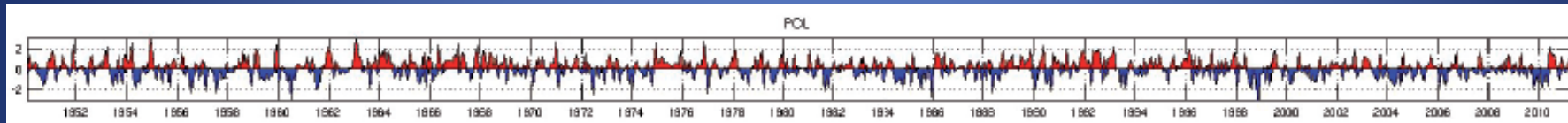


- Measures the anomaly of very high pressures in Scandinavia and low pressures in Western Europe and Eastern Russia
- Positive correlation with precipitation in NW Spain, negative with temperature

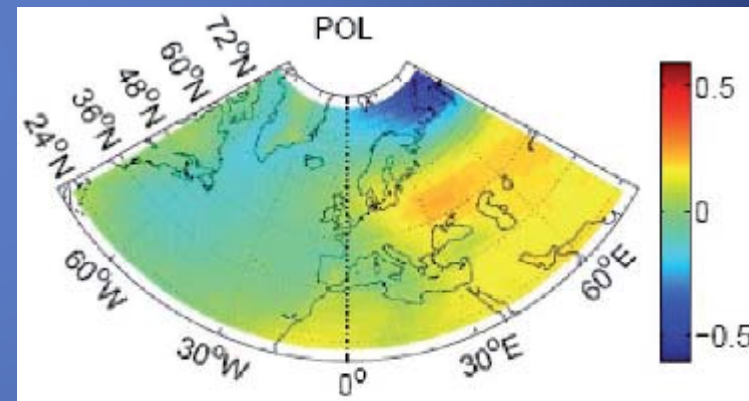


## Environmental variables:

### *Polar index (SCA)*



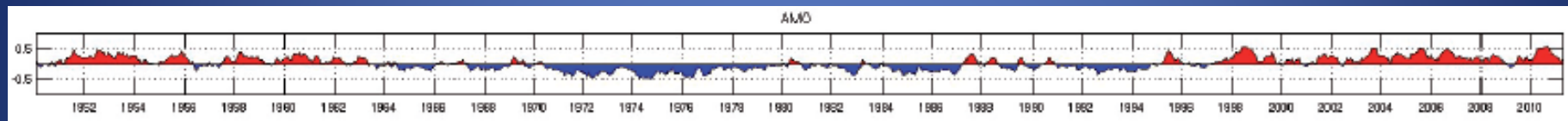
- Quantifies the system of low pressures in polar region and high pressures in Eurasia
- Related to circumpolar circulation





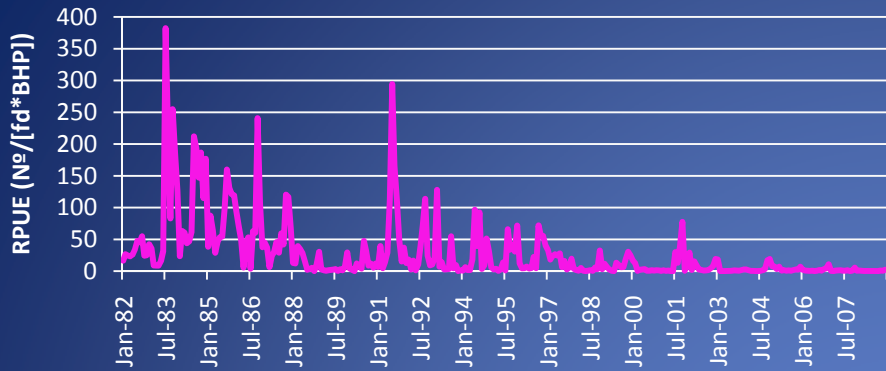
## Environmental variables:

### *Atlantic Multidecadal Oscillation index (AMO)*



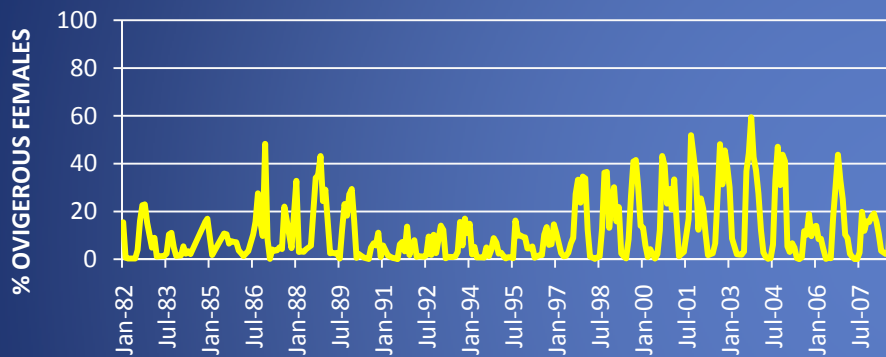
- AMO = SST anomalies
- In North Atlantic is the main multidecadal oceanographic variability pattern
- Related to precipitation (Enfield et al., 2001)

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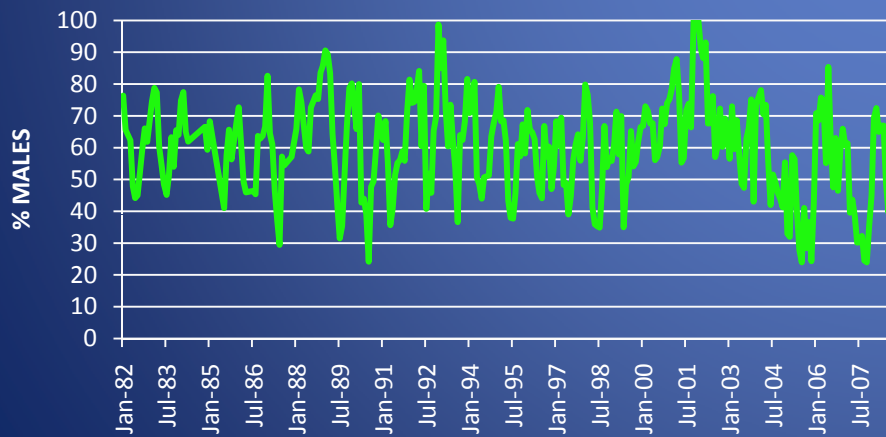


Population variables:

RPUE



% OVIGEROUS FEMALES



% MALES



## Time series analysis:

- Seasonal decomposition of CPUE series
- Modelling CPUE time series

Identification, estimation and diagnosis

- Introduction of different factors in the model, with different lags

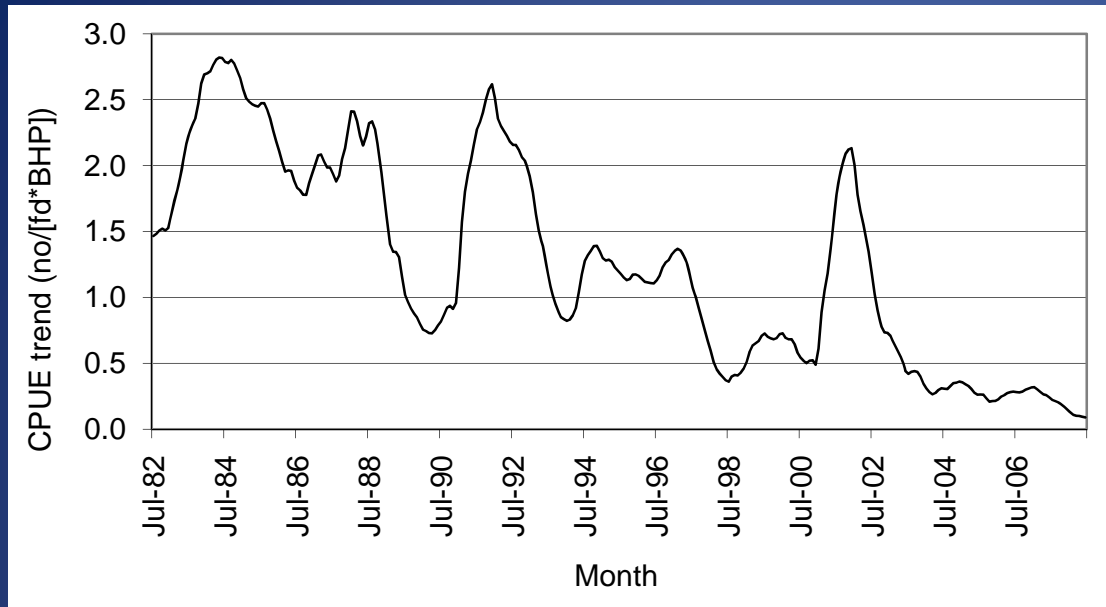
(various trials i.e.  $t = 0$  months, 12 months, 24 months, etc.)



# RESULTS

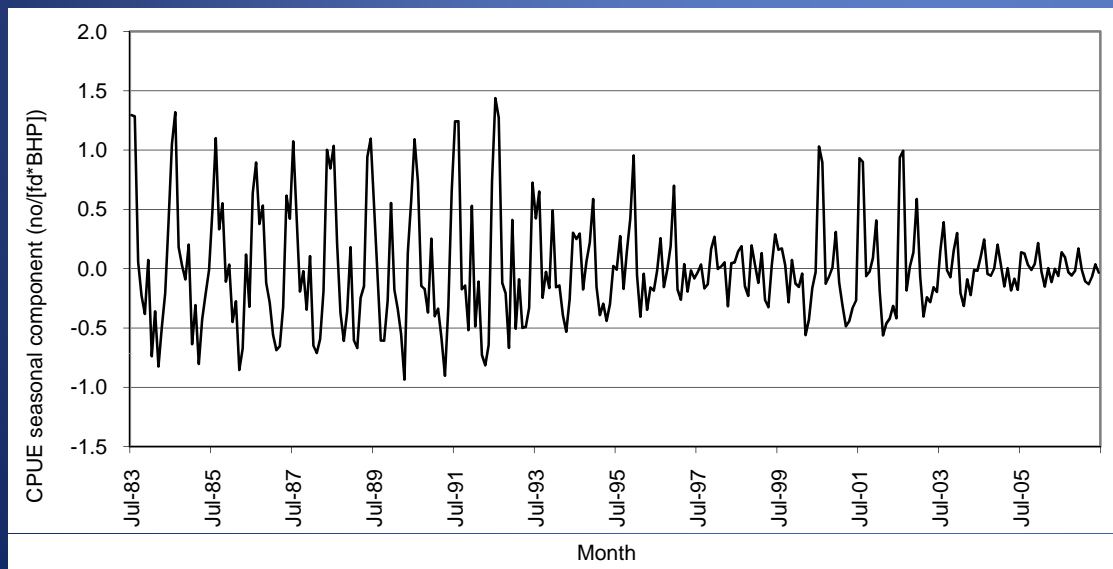


# Climatic variability and decline of Atlantic Iberian *Nephrops* fisheries



Seasonal decomposition of the CPUE

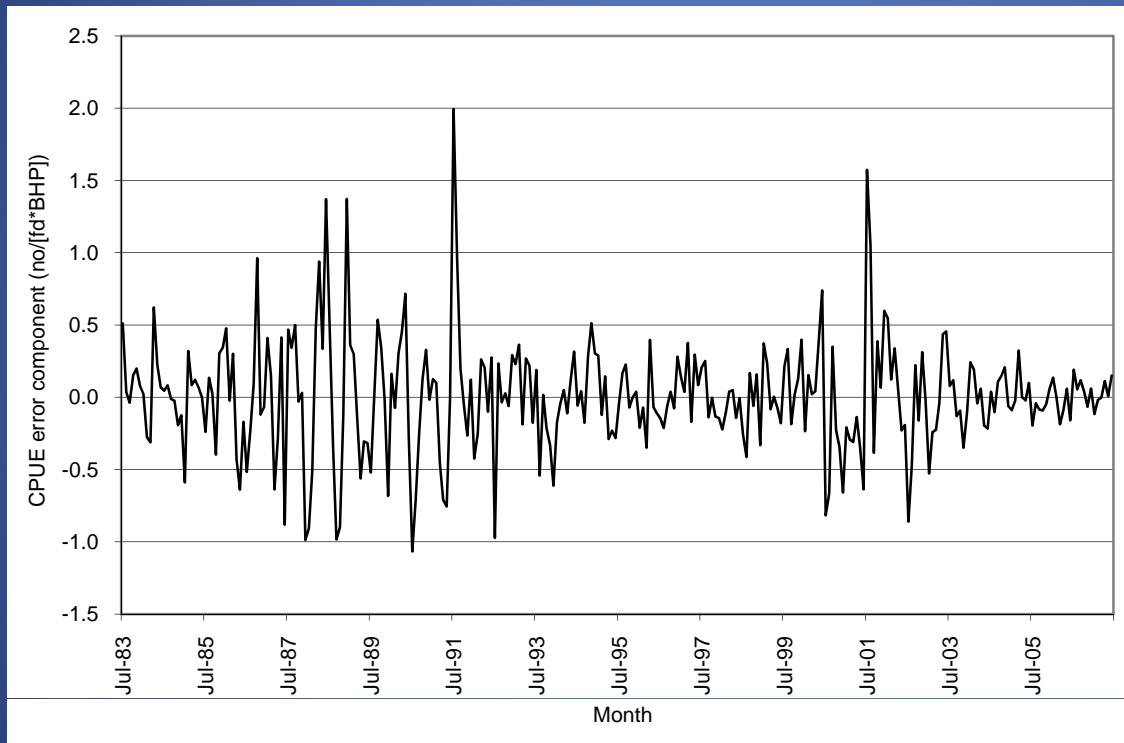
Trend-cycle component



Seasonal component



## Seasonal decomposition of the CPUE



Irregular  
component

FU 25 males *Nephrops* CPUE  
ARIMA model

$$Y_t = \phi Y_{t-1} + a_t + \Theta a_{t-12} + b$$

$$Y_t = 0.76 Y_{t-1} + a_t - 0.26 a_{t-12} + 1.2$$

(Model standard error = 0.60; P[b] < 0.001)

FU 25 *Nephrops* males density today = 0.76 \* Density 1 month ago + Error today - 0.26 \* Error 1 year ago + 1.2



## Environmental variables that individually outperform ARIMA model of FU 25 males *Nephrops* CPUE (SINGLE INPUT REGRESSIONS)

Variable	Lag	Coefficient	p value	Confidence level (%)
POL	1.9 years	-0.08	0.002	99.8
EA-WR	0 months	0.08	0.003	99.7
EA-WR	7 years	0.07	0.011	98.9
AMO	10 years	-0.97	0.013	98.7
POL	2 years	0.06	0.024	97.6
NAO	3 years	0.06	0.026	97.4
SCA	10 years	0.06	0.03	97.0
SCA	5.9 years	-0.05	0.05	95.0

i.e.  $Y_t = 0.77 Y_{t-1} + a_t - 0.26 a_{t-12} - 0.08 POL_{t-23} + 1.2$

(Model standard error = 0.59;  $P[\phi, \theta, b, \text{POL coefficient}] \leq 0.002$ )





## Population variables that individually outperform ARIMA model of FU 25 males *Nephrops* CPUE (SINGLE INPUT REGRESSIONS)

Variable	Lag	Coefficient	p value	Confidence level (%)
RPUE	0 months	0.007	0.000	100.0
RPUE	8 years	0.005	0.000	100.0
RPUE	10 years	0.002	0.002	99.8
RPUE	4 years	0.003	0.003	99.7
%MALES	6 years	-0.01	0.008	99.2
%MALES	1 year	-0.008	0.013	98.7
%OVIGE	6 years	-0.01	0.025	97.5
%OVIGE	6 months	-0.008	0.043	95.7

i.e.  $Y_t = 0.71 Y_{t-1} + a_t - 0.21 a_{t-12} + 0.005 RPUE_{t-96} + 0.7$

(Model standard error = 0.51;  $P[\phi, \theta, b, RPUE \text{ coefficient}] \leq 0.000$ )



## FU 25 males *Nephrops* CPUE Multivariate ARIMA model

$$Y_t = 0.70 Y_{t-1m} + a_t - 0.18 a_{t-1y} + 0.003 \text{ RPUE}_{t-10y} \\ - 0.08 \text{ POL}_{t-1.9y} \\ + 0.003 \text{ RPUE}_{t-8y} \\ + 0.07 \text{ EAWR} \\ - 0.8 \text{ AMO}_{t-10y} \\ - 0.007 \% \text{ MALES}_{t-6y} \\ + 1$$

(Model standard error = 0.44;  $P[\phi, \theta, b, \text{variables coefficients}] < 0.028$ )



# CONCLUSIONS



- Both population related factors and environmental factors (specially Polar index) could have influence in the decrease of Atlantic Iberian *Nephrops* stocks
- Time series approach is a useful tool to study these relationships

THANK YOU

