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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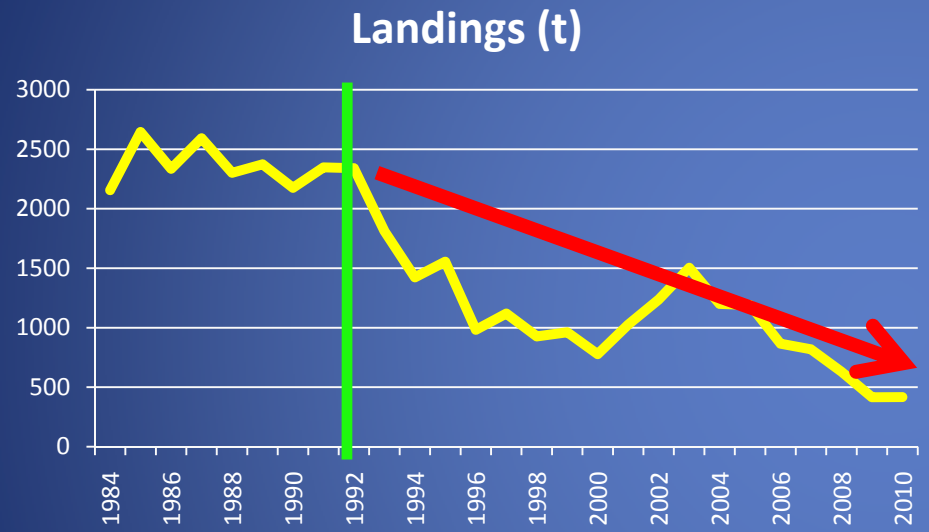
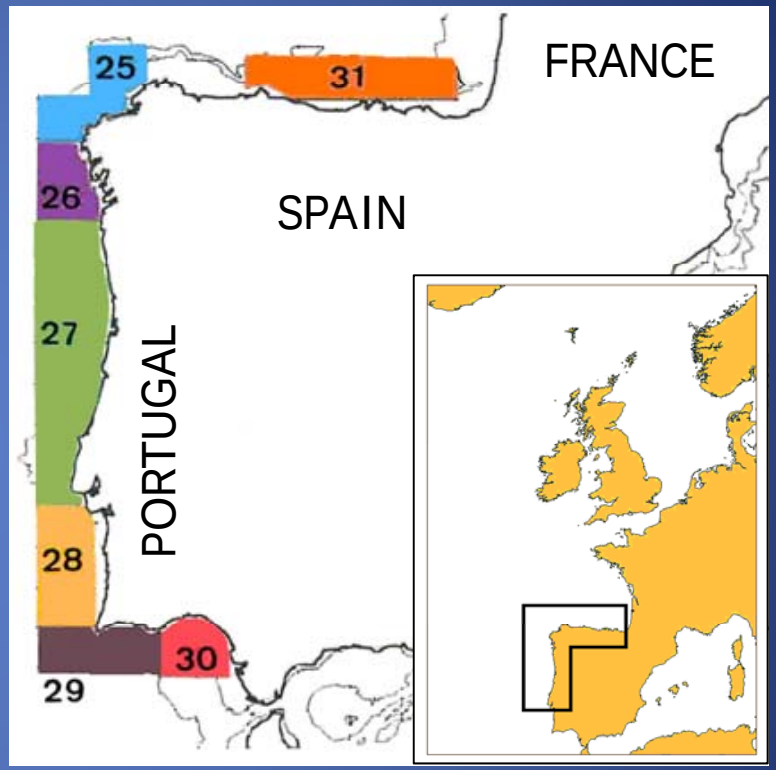
INTRODUCTION

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)

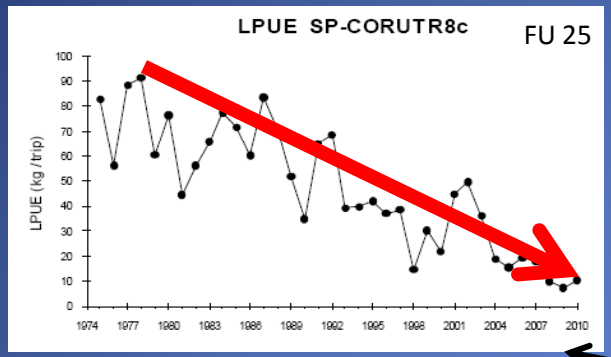
Atlantic Iberian *Nephrops* stocks

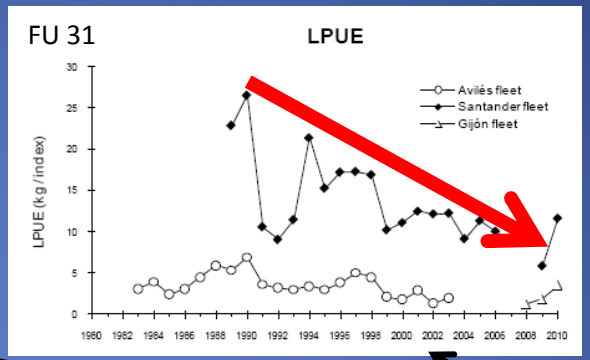


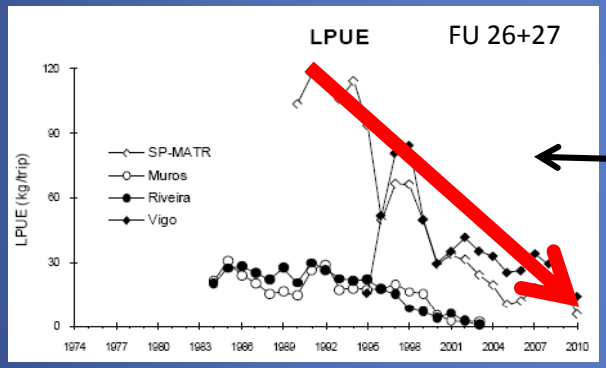


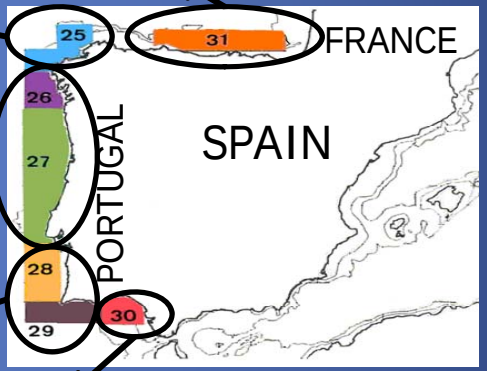
Landings have declined by 84% over the last 25 years!
A Recovery Plan has been implemented since 2006

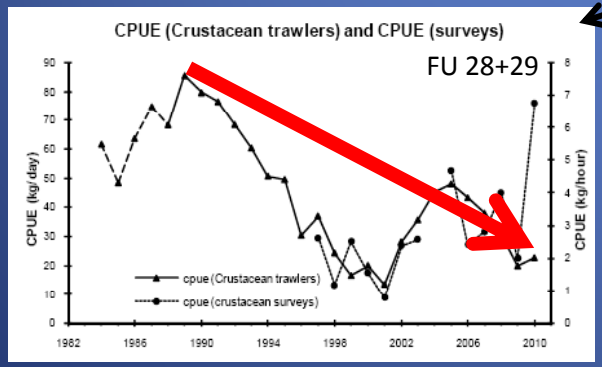
LPUE

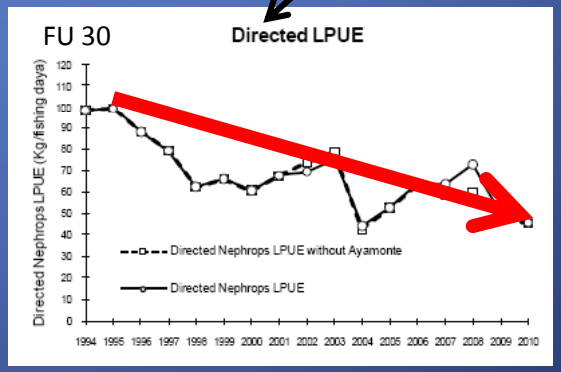

LPUE SP-CORUTR8c
FU 25
LPUE (kg/trip)


FU 31
LPUE
Avilés fleet
Santander fleet
Gijón fleet
LPUE (kg/index)


LPUE
FU 26+27
SP-MATR
Muros
Riveira
Vigo
LPUE (kg/trip)


25
31
FRANCE
26
27
PORTUGAL
SPAIN
28
29
30

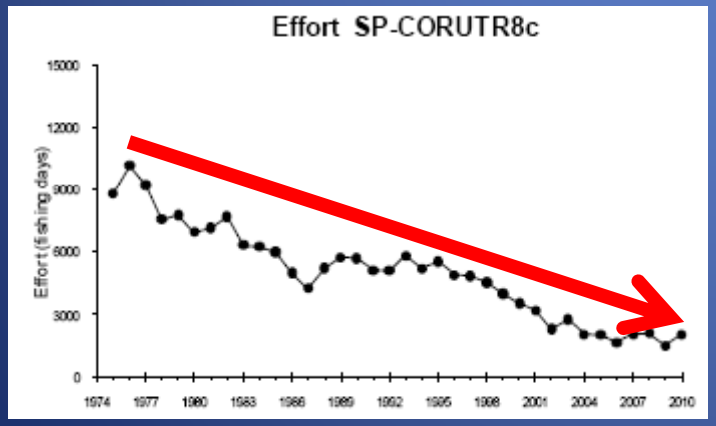

CPUE (Crustacean trawlers) and CPUE (surveys)
FU 28+29
CPUE (kg/day)
CPUE (kg/hour)
cpue (Crustacean trawlers)
cpue (crustacean surveys)

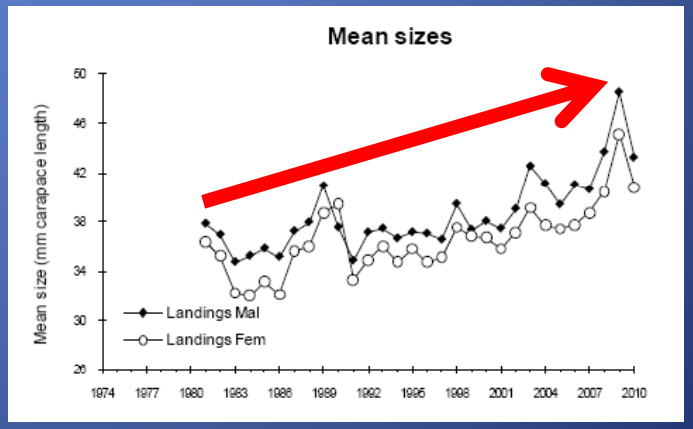

FU 30
Directed LPUE
Directed Nephrops LPUE (Kg/fishing days)
Directed Nephrops LPUE without Ayamonte
Directed Nephrops LPUE

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

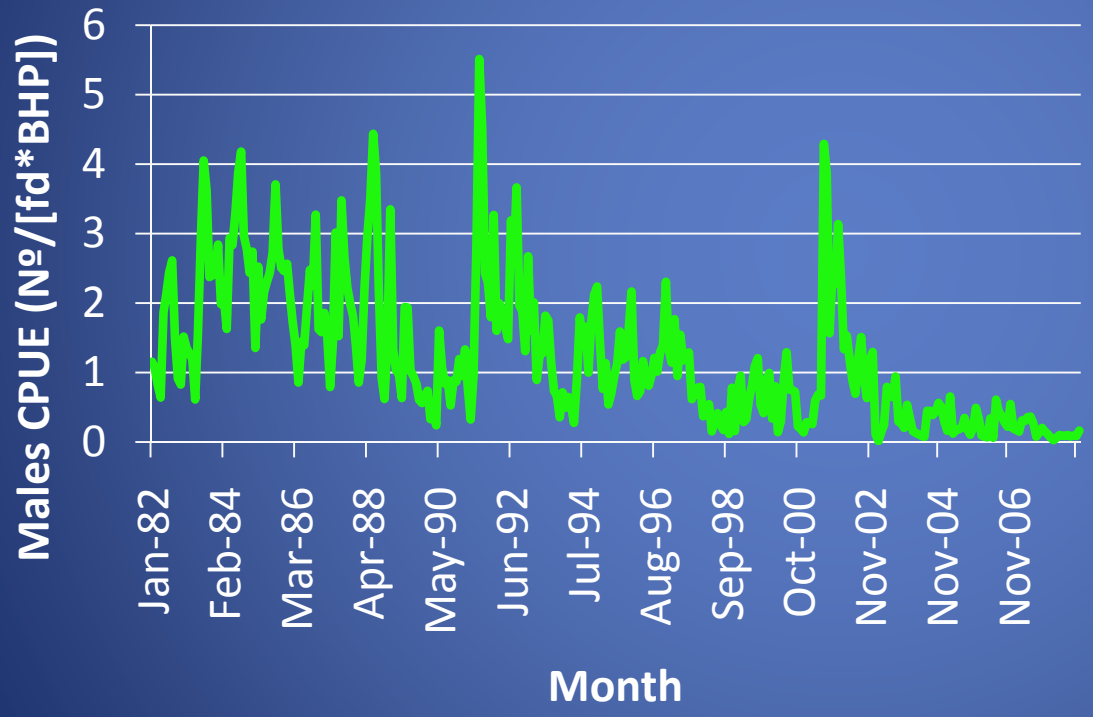
- Analyse and model the catch-per-unit-effort (CPUE) from a stock representative of the Atlantic Iberian *Nephrops* stocks under time series approach

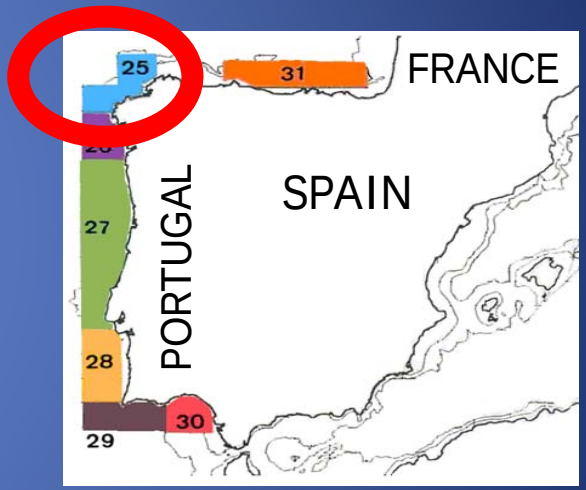
- To identify environmental and population variables that show similar temporal patterns to *Nephrops* CPUE's

MATERIAL AND METHODS

Data used (monthly basis):

- FU 25 *Nephrops* males CPUE (nº/[fd*BHP]) (1982-2008)





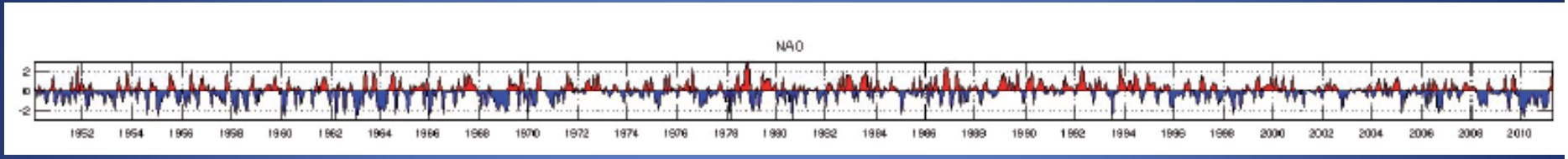
Environmental variables:

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

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

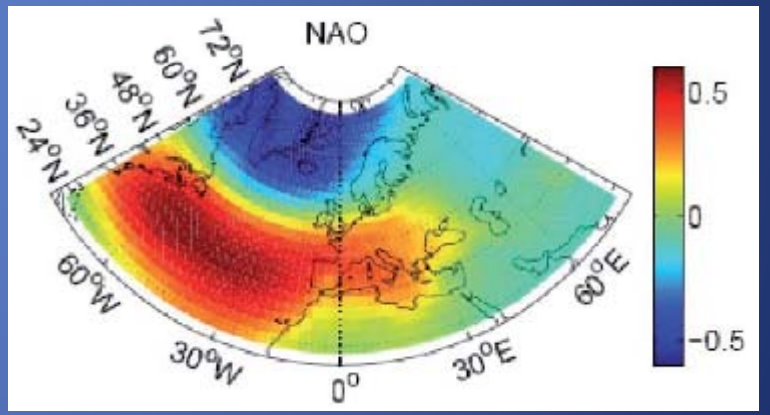
Environmental variables:

North Atlantic Oscillation index (NAO)



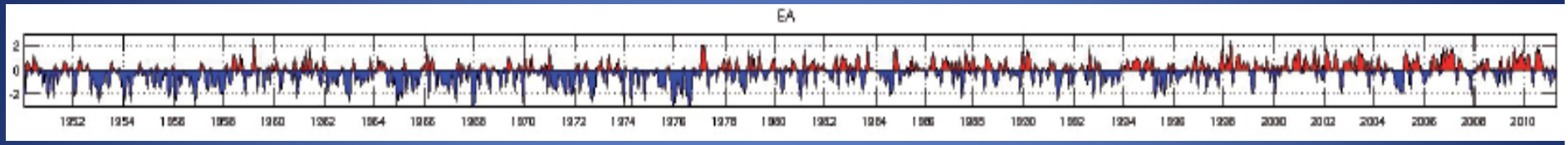
- Pressure difference between Iceland (low pressures) and Azores (high pressures)

- Negative correlation with precipitation in the NW Spain, positive with up-welling



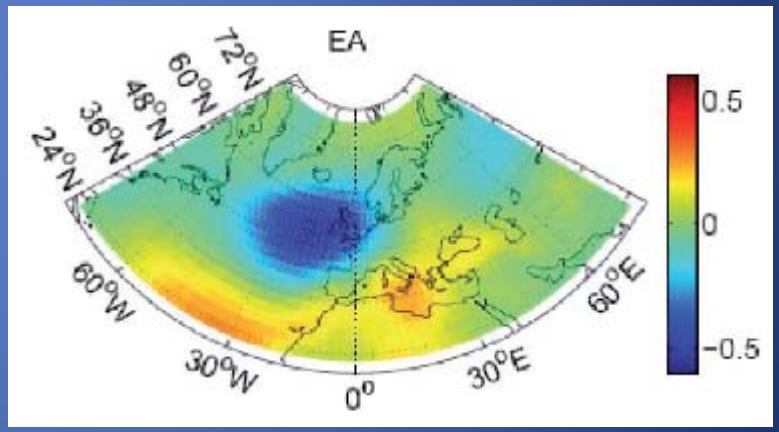
Environmental variables:

Eastern Atlantic index (EA)



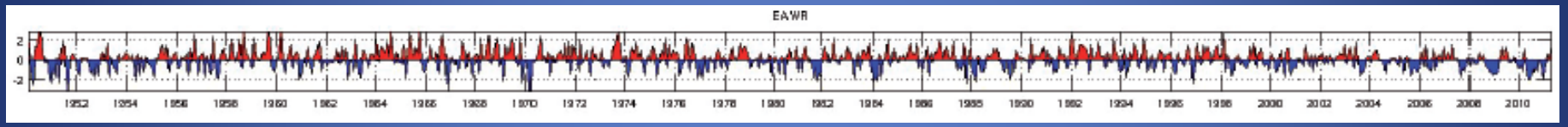
- Relation between the pressure in West of British Isles (low p.) and in NW Africa (high p.)

- Positive correlation with precipitation, temperature and negative with up-welling in the NW of Spain



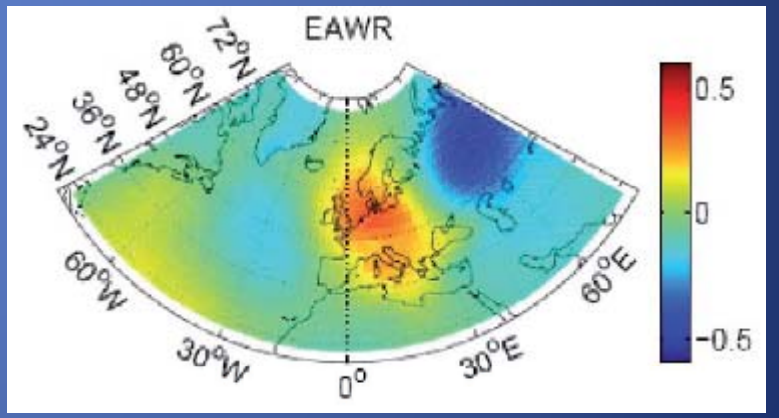
Environmental variables:

Eastern Atlantic / Western Russia index (EA/WR)



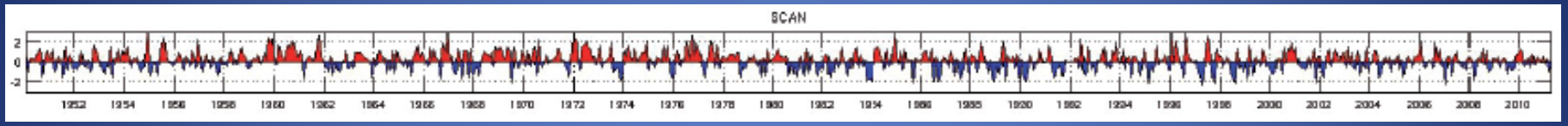
- Describes the system of high pressures in Central Europe and low pressures in West of Russia and NE Atlantic

- Related to winter anticyclones in Central Europe



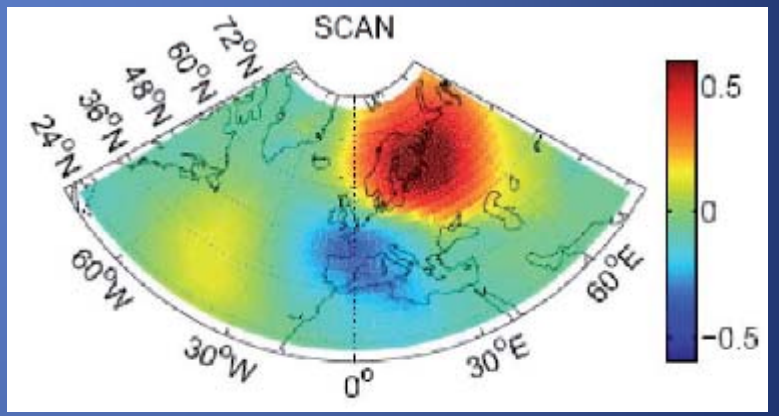
Environmental variables:

Scandinavia index (SCA)



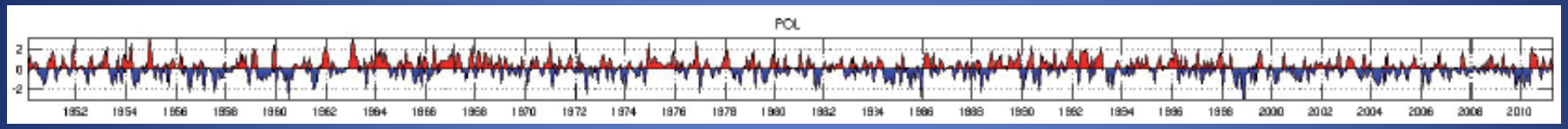
- Measures the anomaly of very high pressures in Scandinavia and low pressures in Western Europe and Eastern Russia

- Positive correlation with precipitation in NW Spain, negative with temperature



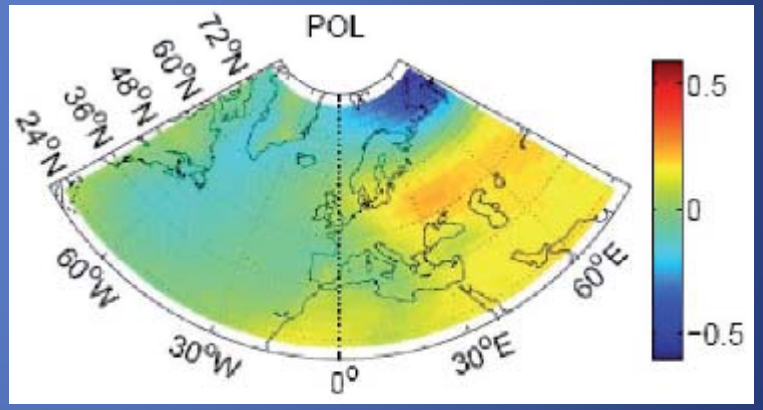
Environmental variables:

Polar index (SCA)



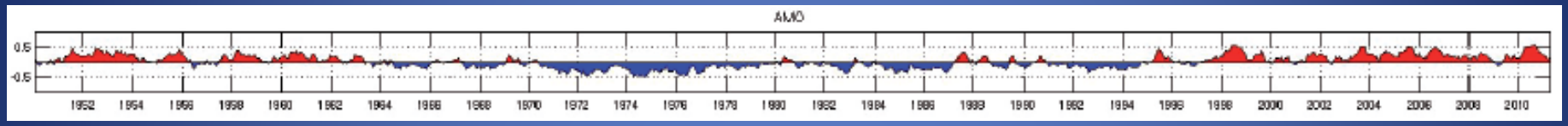
- Quantifies the system of low pressures in polar region and high pressures in Eurasia

- Related to circumpolar circulation



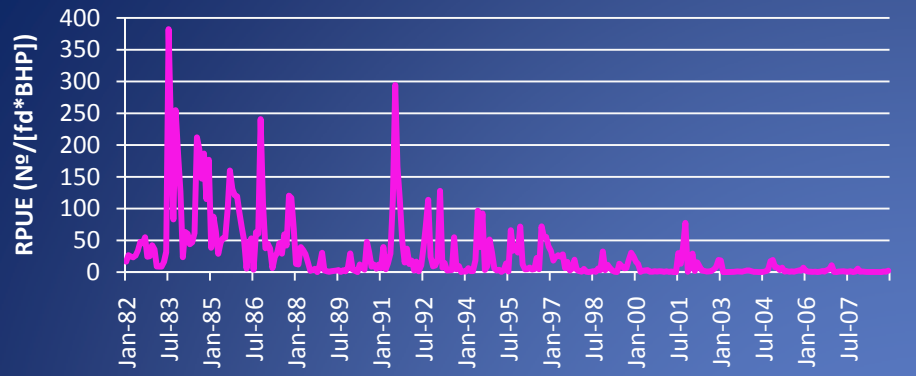
Environmental variables:

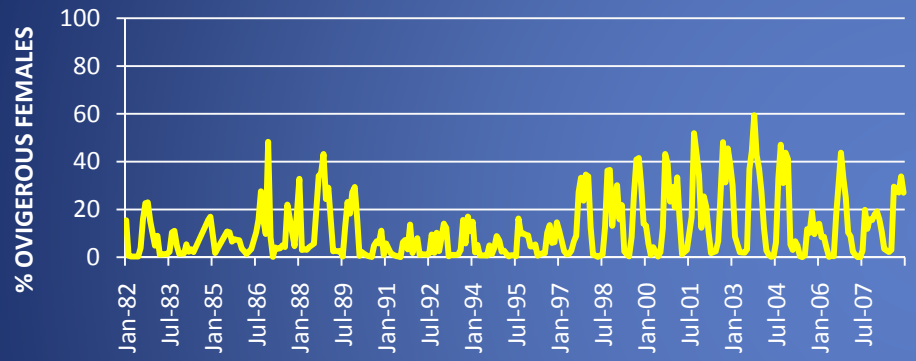
Atlantic Multidecadal Oscillation index (AMO)

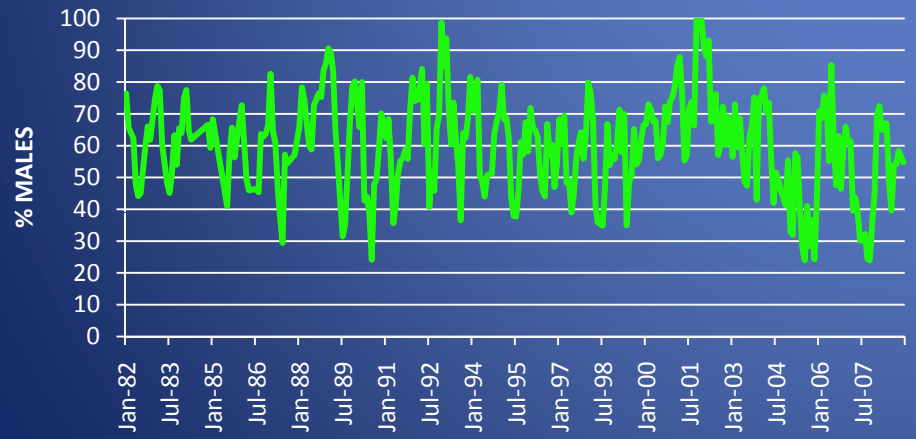


- AMO = SST anomalies
- In North Atlantic is the main multidecadal oceanographic variability pattern
- Related to precipitation (Enfield et al., 2001)

Climatic variability and decline of Atlantic Iberian *Nephrops* fisheries







Population variables:

RPUE

% OVIGEROUS FEMALES

% MALES

Time series analysis:

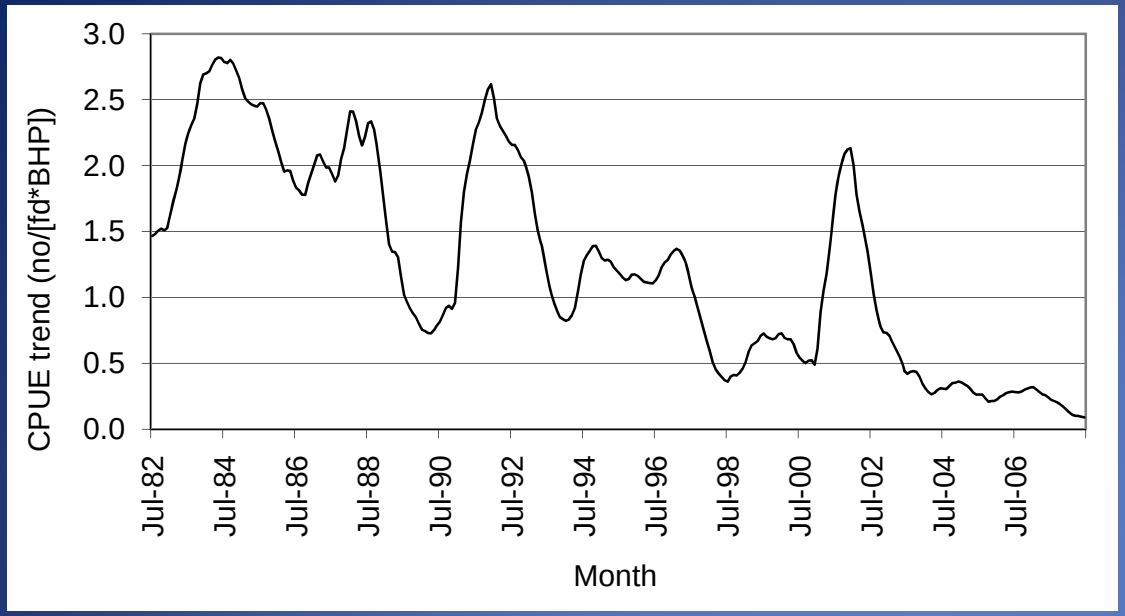
- Seasonal decomposition of CPUE series
- Modelling CPUE time series

  Identification, estimation and diagnosis

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

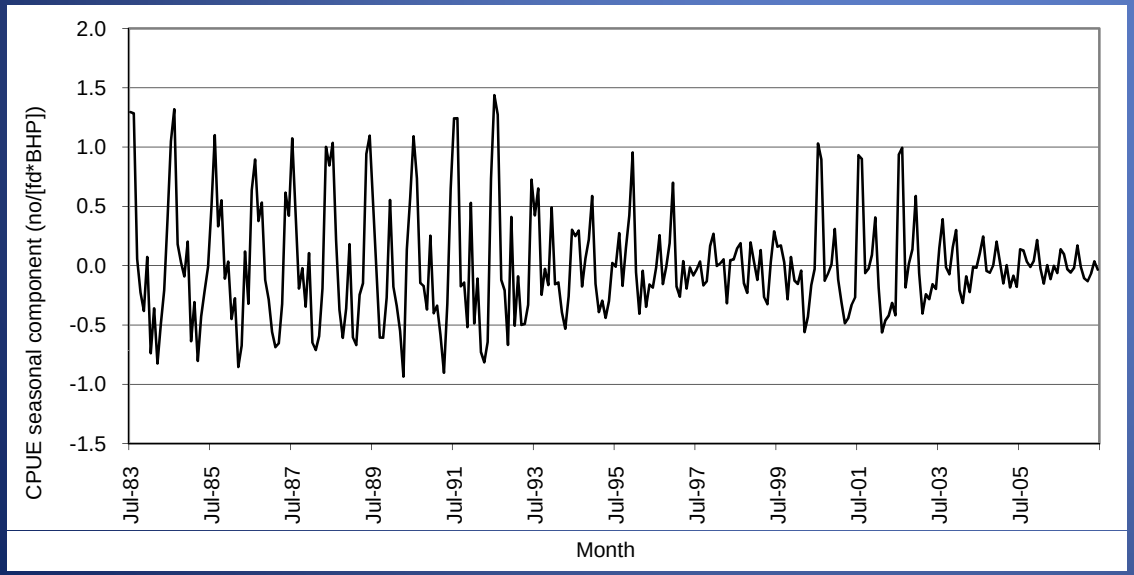
  (various trials i.e. t = 0 months, 12 months, 24 months, etc.)

RESULTS



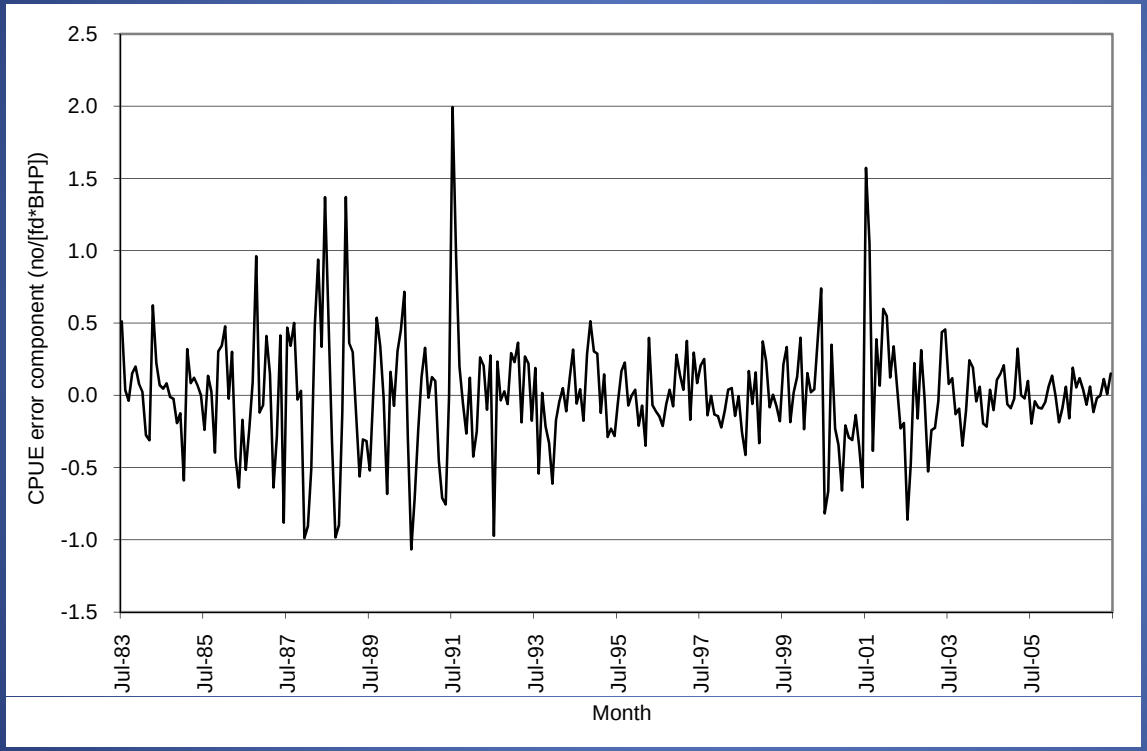
Seasonal decomposition of the CPUE

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[ϕ, Θ, b, POL coefficient] ≤ 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[ϕ, Θ, b, RPUE coefficient] ≤ 0.000)

FU 25 males *Nephrops* CPUE
Multivariate ARIMA model

$$Y_t = 0.70\, Y_{t-1\,m} + a_t - 0.18\, a_{t-1\,y} + 0.003\, RPUE_{t-10\,y} - 0.08\, POL_{t-1.9\,y} + 0.003\, RPUE_{t-8\,y} + 0.07\, EAWR - 0.8\, AMO_{t-10\,y} - 0.007\, \%MALES_{t-6\,y} + 1$$

(Model standard error = 0.44; P[ϕ, Θ, b, 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