



INSTITUT SENEGALAIS DE RECHERCHES AGRICOLES
CENTRE DE RECHERCHES OCEANOGRAPHIQUES DE DAKAR – THIAROYE



FISHING EFFECTS ON SENEGALESE OCTOPUS STOCK IN THE CONTEXT OF CLIMATE VARIABILITY

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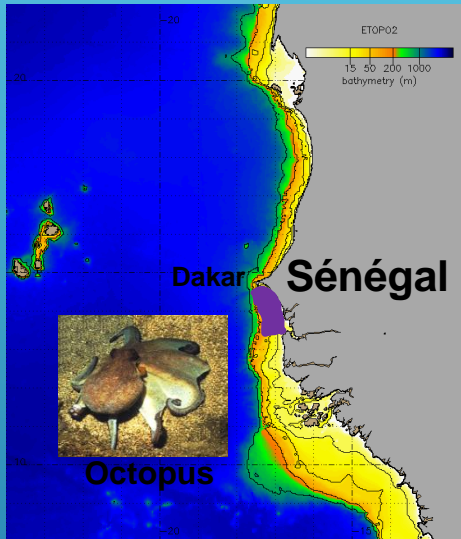
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PRESENTATION OUTLINE

- Scientific context and objectives
 - Impact of marine environment and fishing on the dynamics of octopus stock
 - Fisheries Management Perspective
 - Conclusion
- 

SCIENTIFIC CONTEXT AND OBJECTIVES

- Octopus stock location: **South of Dakar (Petite Côte)**

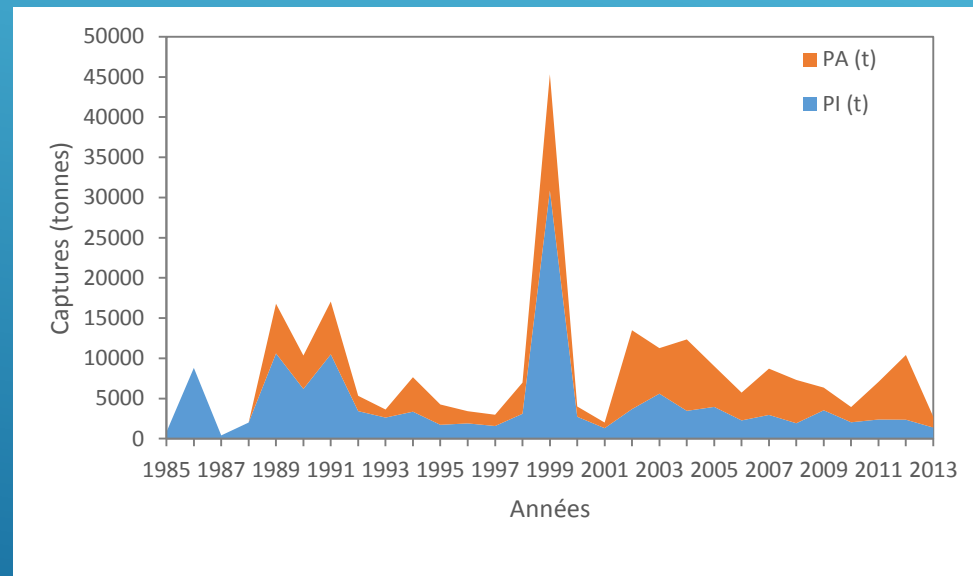


A single annual cohort

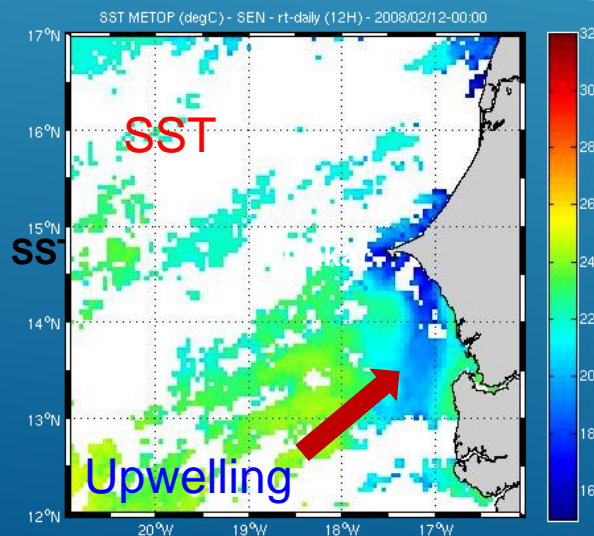
Craftsman gear: **Jiggs**



Catches: high interannual variability



Potential impact of upwelling?



SST picture reproduced
from METEOSAT
satellite data : 5 km, 15
days:
Source: Thiaw 2010

MODELS FOR SHORT-LIFE SPECIES

- **Biological characteristics**

- Very short life cycle (about 1 year),
- Very fast growth,
- High natural mortality rate of larvae and juvenile octopus
- Females generally die after spawning

- **The stock closely depends on environmental variability and exhibit fast and unstable dynamics**

- Their production potential greatly varies from year to year
- Recruitment success strongly depends on hydroclimatic conditions

Application of specific models to analyze the stock dynamics
and assess its exploitation level

MAIN OBJECTIVE

Understanding the dynamics of octopus stock in order to consolidate scientific bases for a suitable fisheries management plan



KEY POINTS

1. Stock dynamics – Octopus/environment/fishing

- What is the recruitment and biomass variability for the octopus?
- What part of abundance variability is related to the environment?
- In the context of climate variability, what is the state of the octopus stock?

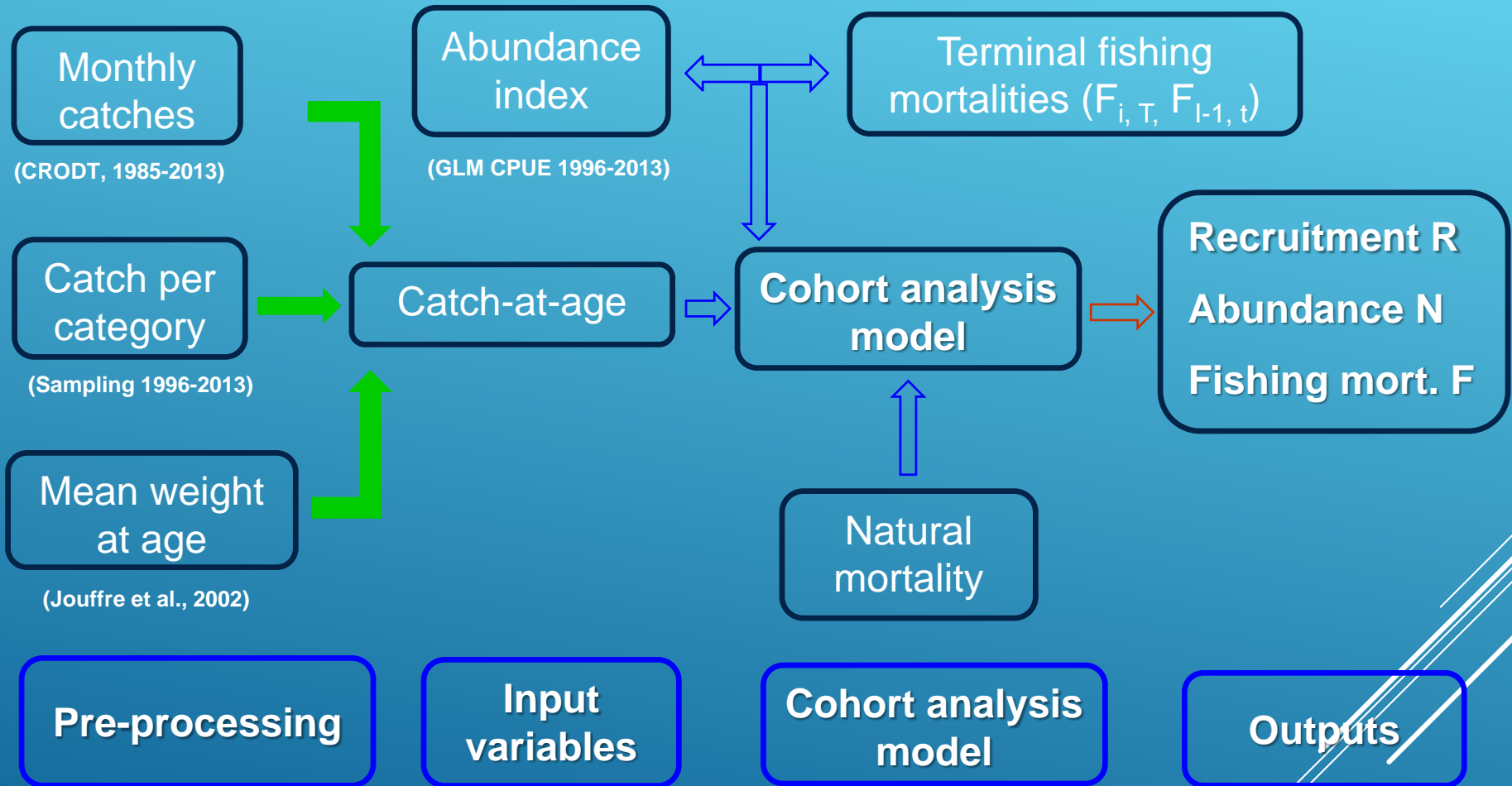
2. Fisheries management perspectives

- Octopus management plan proposal in Senegal

OCTOPUS STOCK DYNAMICS IN SENEGAL

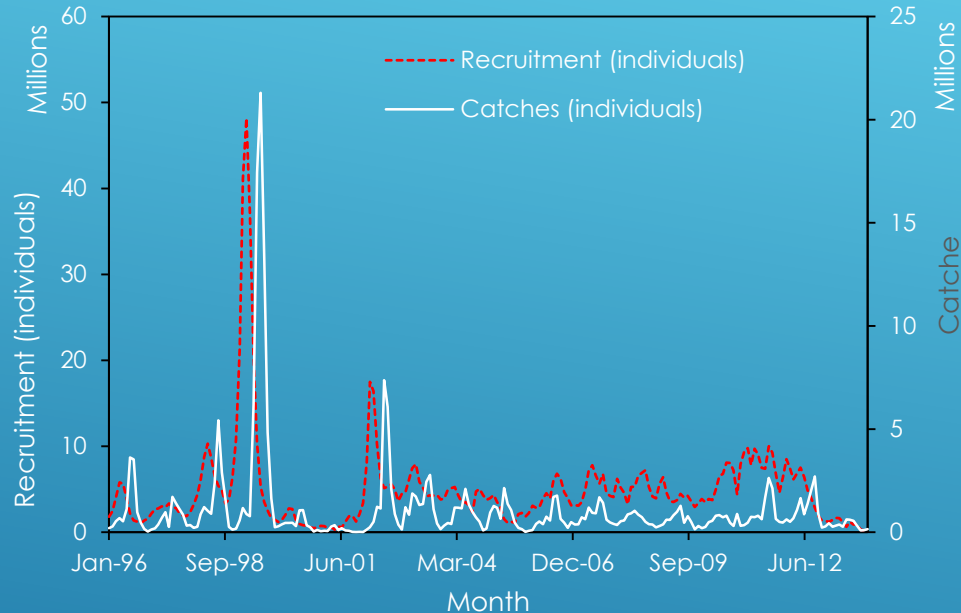
- What is the recruitment and biomass variability for the octopus?

COHORT ANALYSIS MODEL

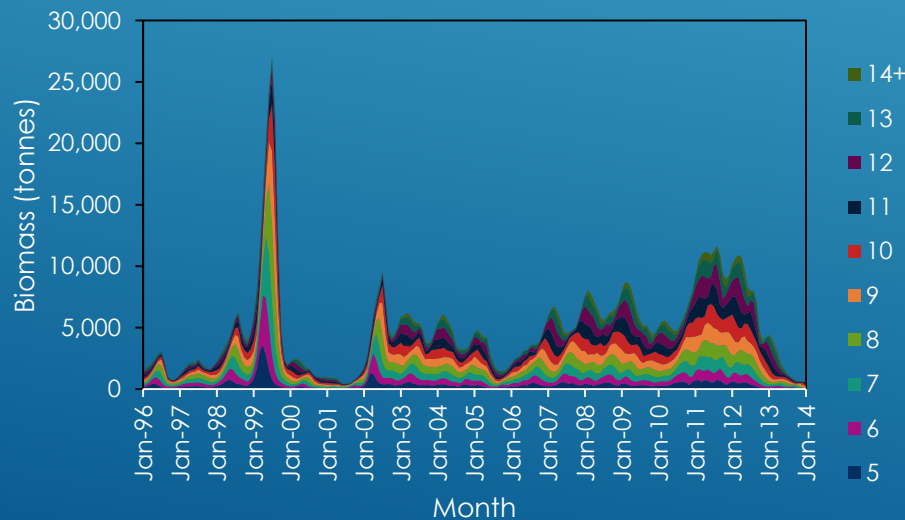
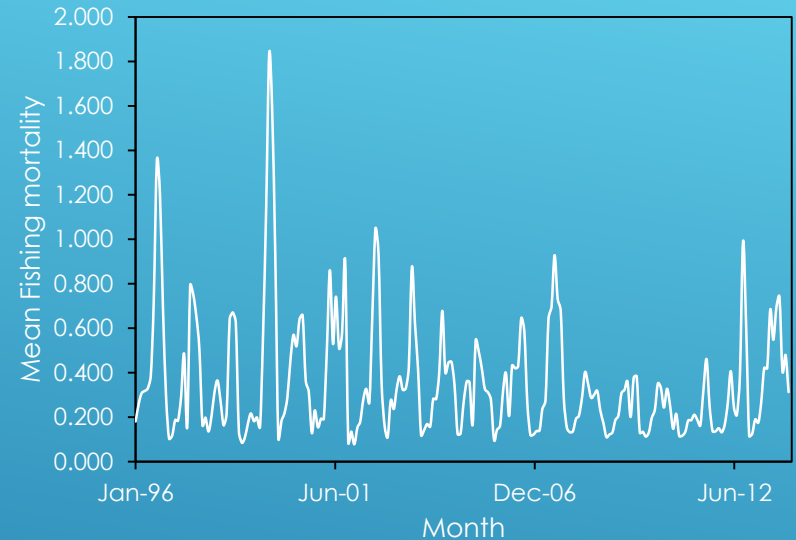


OCTOPUS STOCK DYNAMICS

Recruitment



Fishing mortality



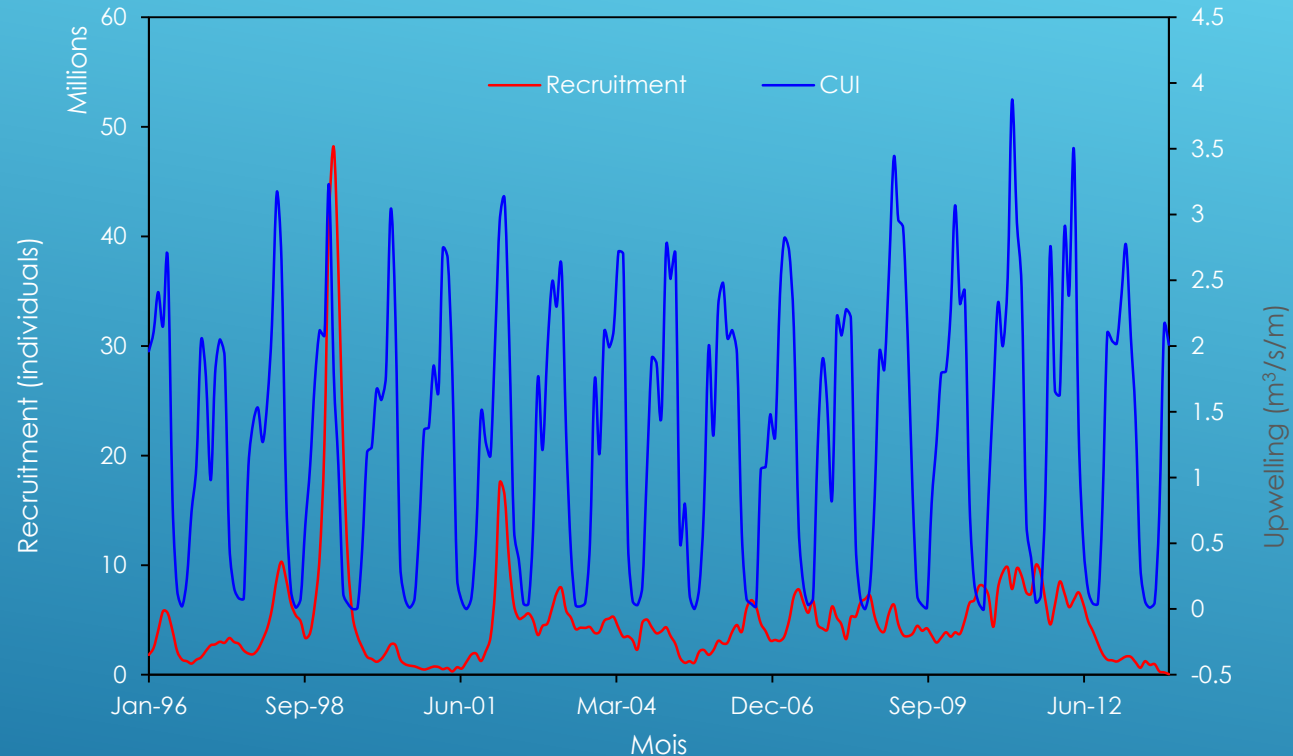
High seasonal and interannual variability in recruitment, biomasses, fishing mortality and catches

ANALYSING OF ENVIRONMENTAL EFFECTS

Impact of upwelling on octopus stock dynamics?

Several white lines of varying lengths and slopes are positioned in the bottom right corner of the slide, creating a modern, abstract graphic element.

IMPACT OF ENVIRONMENT ON RECRUITMENT



Interannual variability of recruitment and upwelling intensity

ANALYSING OF ENVIRONMENTAL EFFECTS

■ Biological data

- **Monthly recruitment:** estimated using cohort analysis (1996-2013)

■ Environmental data

- **Monthly coastal upwelling index** (CUI, m³/s/m) from NOAA website (1985-2013)

■ Time series decomposition

$$R_t = p_t + s_t + u_t$$

P_t : smoothed mean: **trend component**

s_t : Mean by month: **seasonal component**

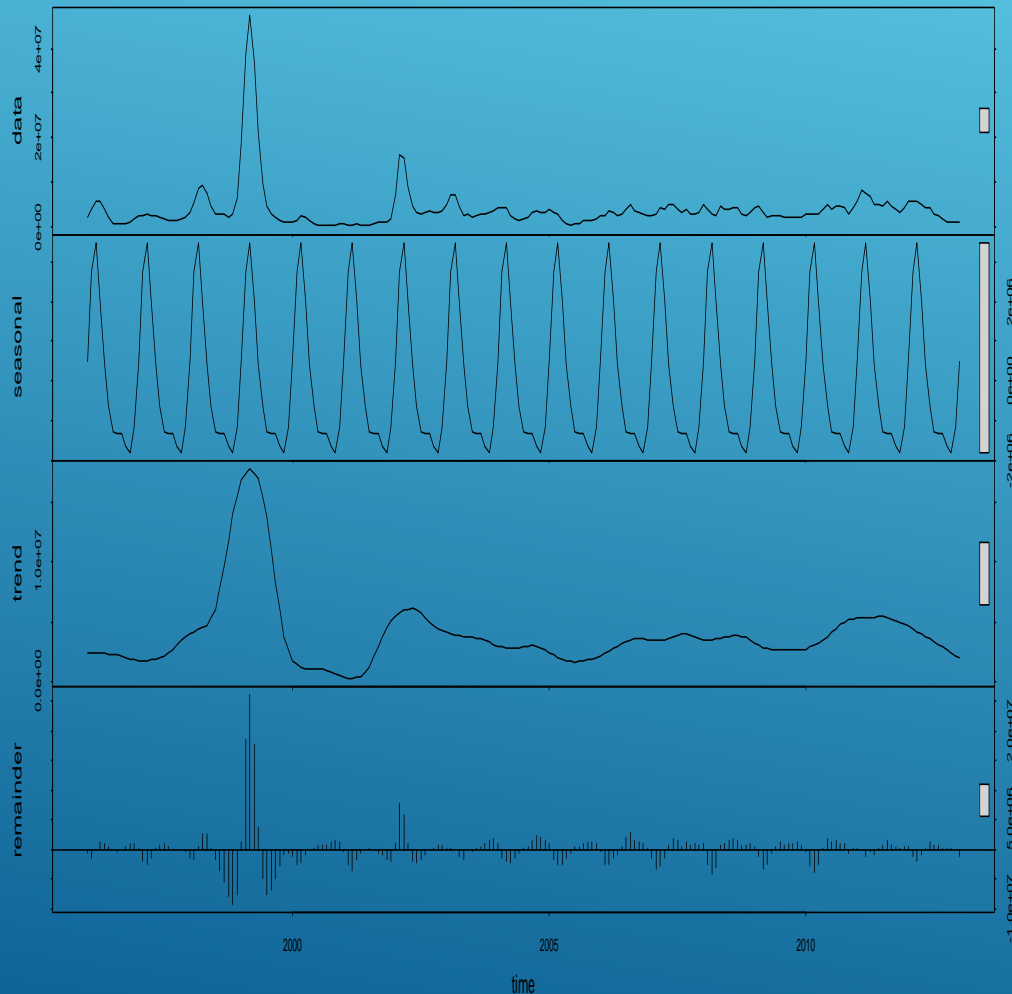
U_t : Residuals: **residuals/errors**

Application

1. Monthly recruitment
2. Coastal upwelling Index

SEASONAL DECOMPOSITION OF RECRUITMENT

Octopus recruitment



Input variable: **recruitment from VPA**

Seasonal componente:

Seasonal variability of recruitment

- **Main peak : March**
- **Secondary peak : September**

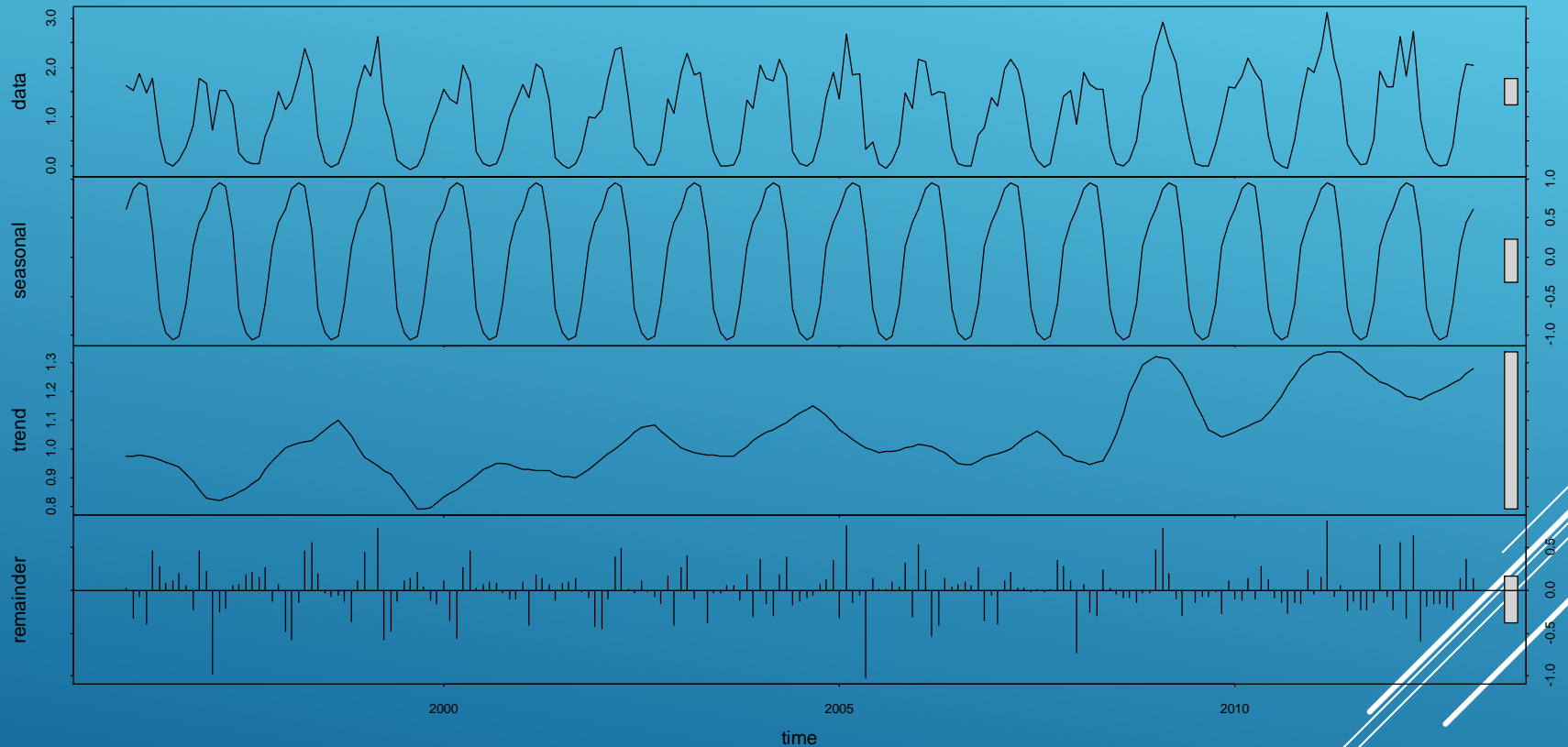
Trend (1996-2013)

- **Maxima: 1999, 2002 and 2011**
- **Minimum: 2001**

Residuals

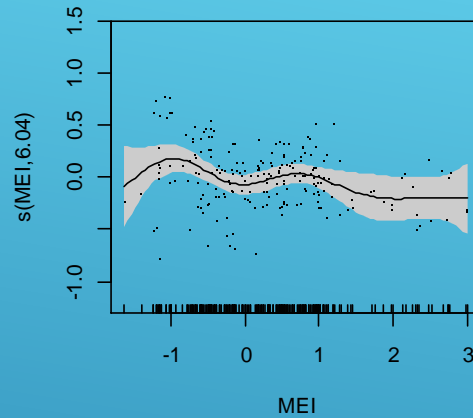
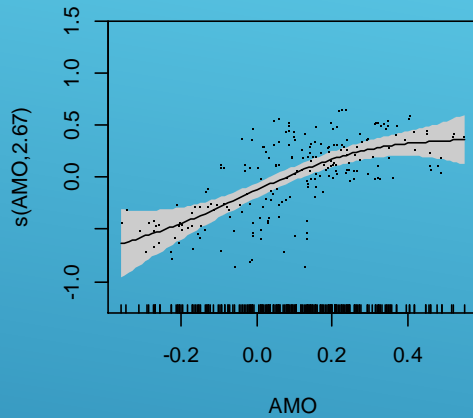
SEASONAL DECOMPOSITION OF ENVIRONMENT

Coastal upwelling index (CUI)



High seasonal variability of upwelling and recruitment

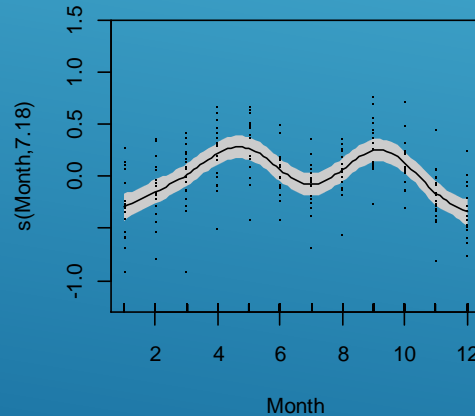
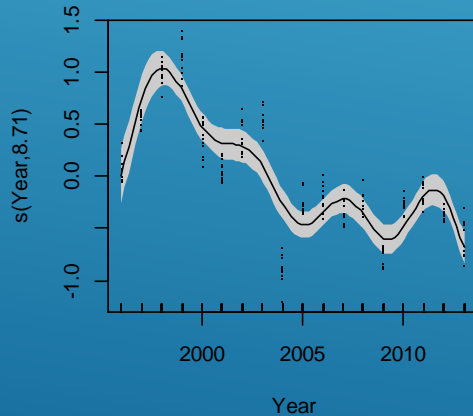
GAM FOR ARTISANAL ABUNDANCE INDEX



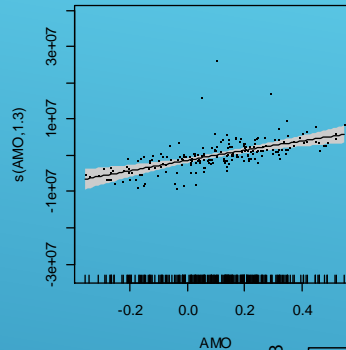
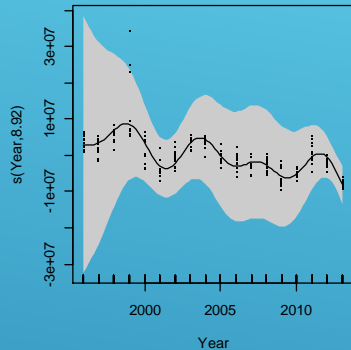
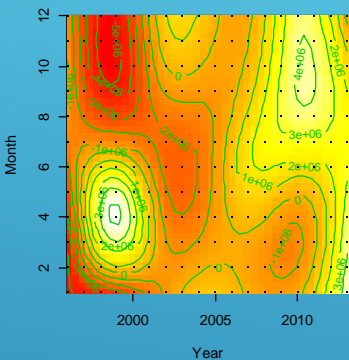
	edf	Ref.df	F	p-value	
AMO	2.674	3.445	15.922	5.52E-10	***
MEI	6.039	7.226	2.417	0.0197	*
Year	8.714	8.964	55.862	< 2e-16	***
Month	7.183	8.221	12.172	6.09E-15	***

$R^2(\text{adj}) = 0.751$

Deviance explained = 78%

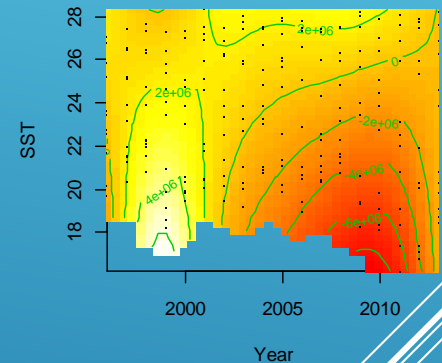
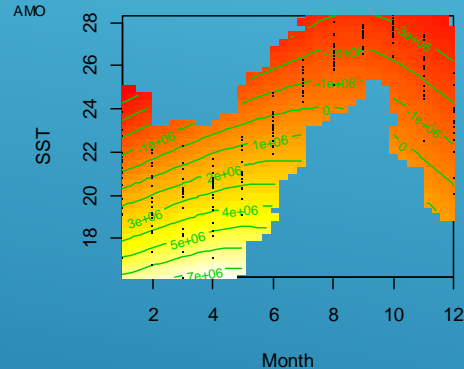
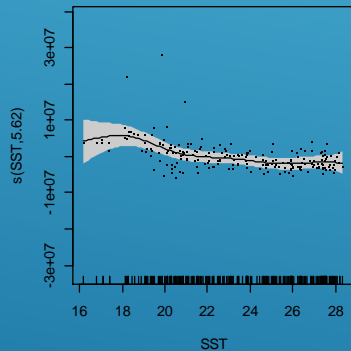
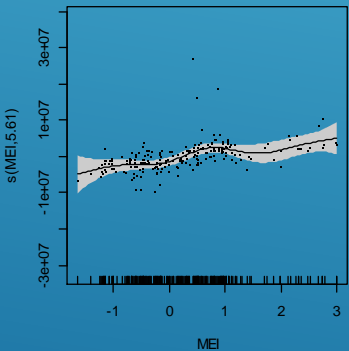


GAM APPLIED TO RECRUITMENT



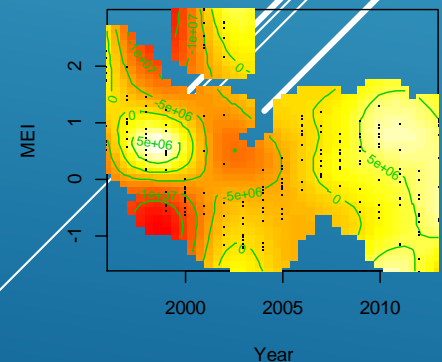
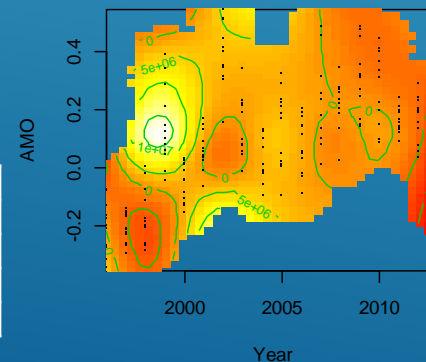
Effects	edf	Ref.df	F	p-value	
Interaction (Year,Month)	19.096	24.36	2.283	0.00105	**
Year	8.923	8.965	7.66	1.16E-09	***
AMO	1.299	1.53	25.456	6.07E-07	***
MEI	5.605	6.762	6.266	1.70E-06	***
SST	5.62	6.777	2.94	0.00677	**

R^2 (adj) = 0.567, Deviance explained = 64.8%



R^2 (adj) = 0.818, Deviance explained = 87%

Effects	edf	Ref.df	F	p-value	
interaction (Month,SST)	5.608	6.518	6.542	1.79E-06	***
interaction (Year,SST)	4.333	42	1.235	2.37E-11	***
interaction (Year,AMO)	26.762	30.827	9.149	< 2e-16	***
interaction (Year,MEI)	24.345	42	6.527	< 2e-16	***



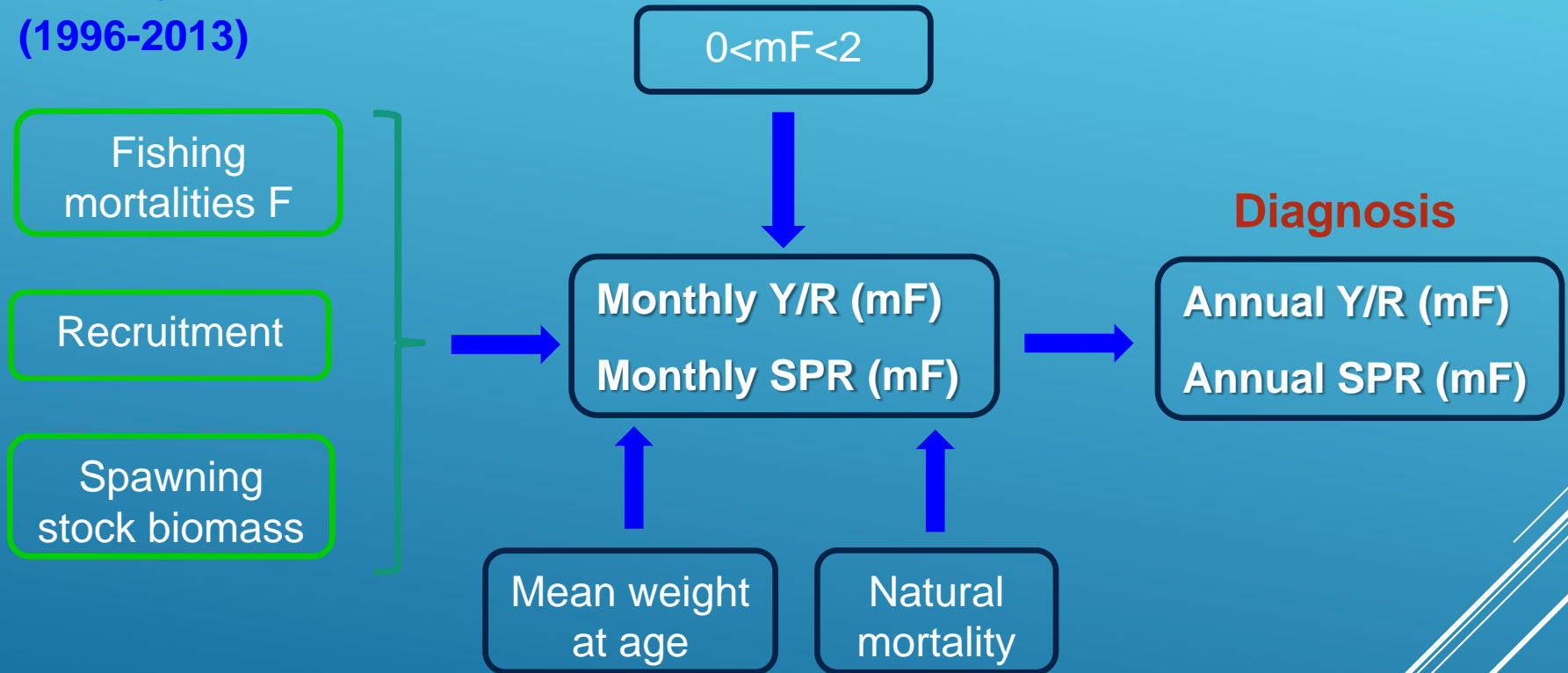
DIAGNOSIS DE L'ETAT DU STOCK POULPE

- In this context of variability, what is the diagnosis of the state of the octopus stock?



DIAGNOSIS: TOOLS **Y/R** and **SPR**

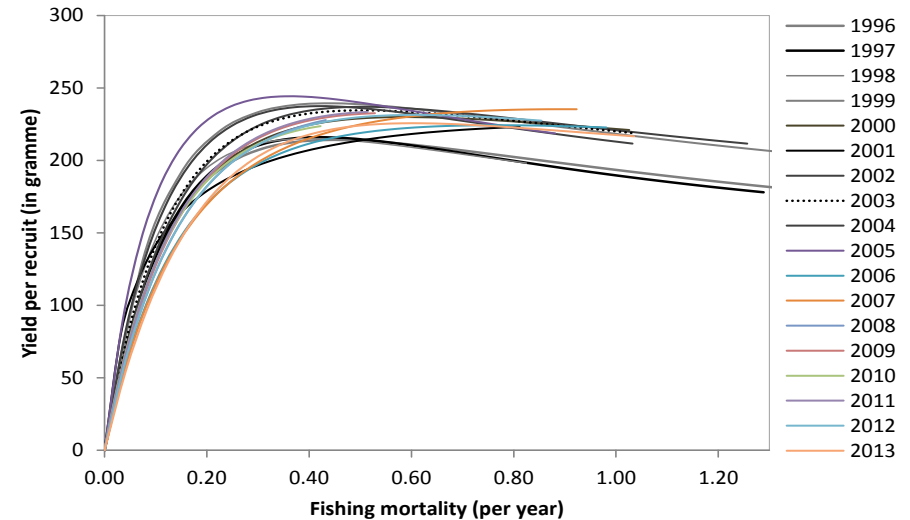
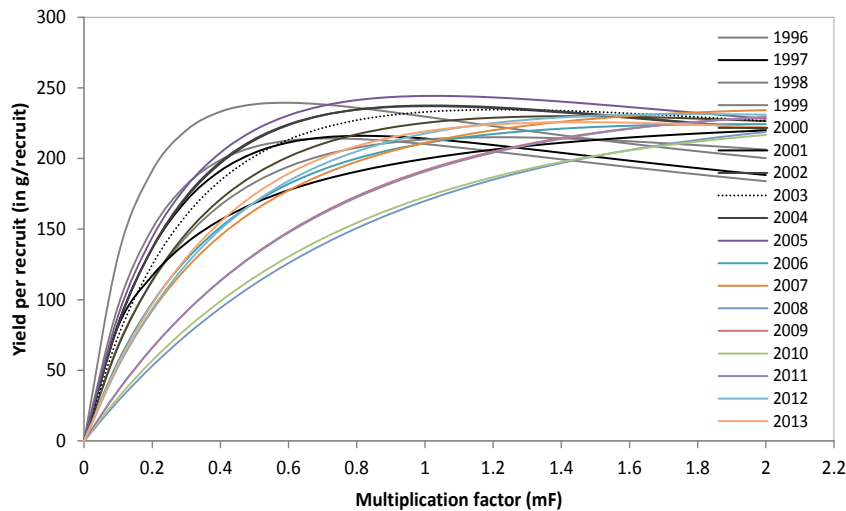
Monthly VPA outputs
(1996-2013)



Thompson and Bell model (1934)

DIAGNOSIS OF THE STOCK STATE

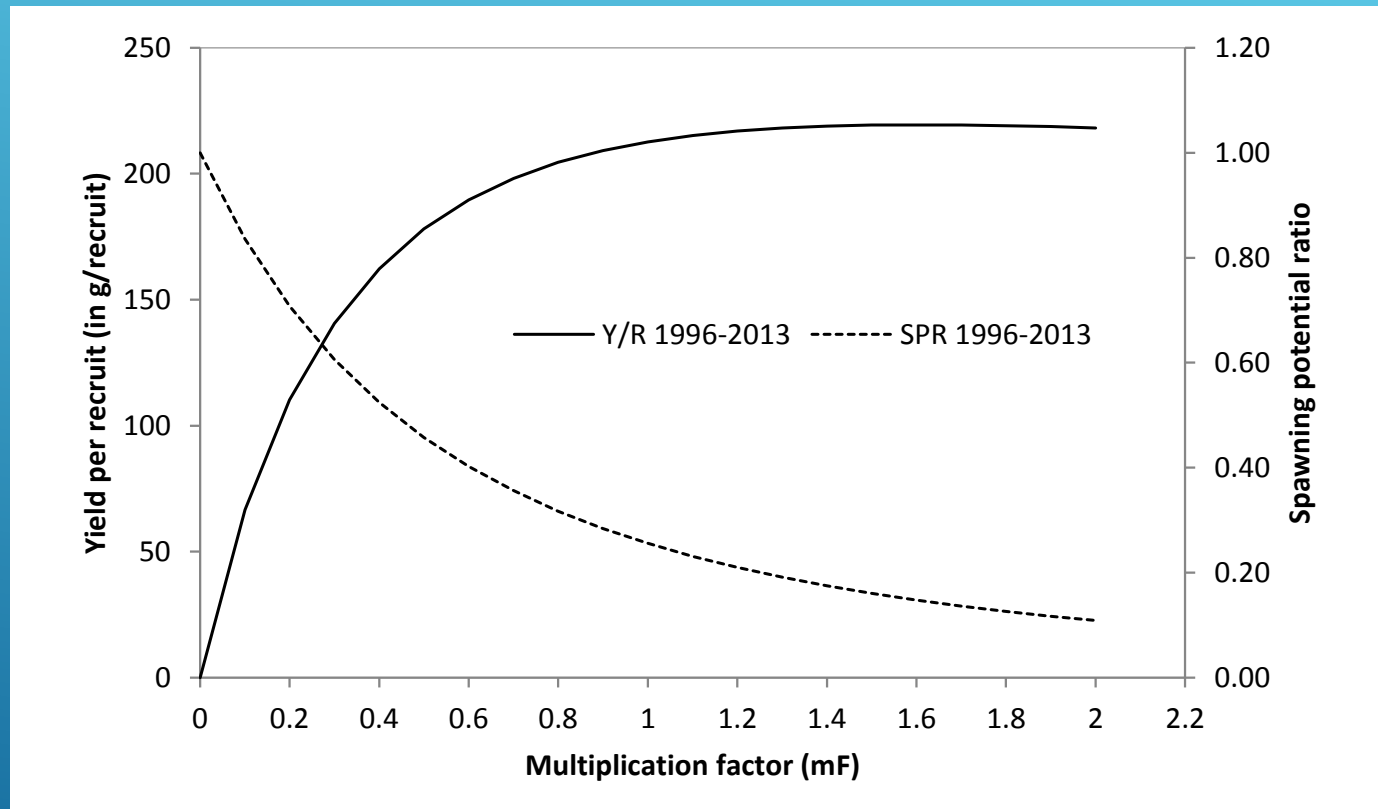
Current fishing effort



Y/R vary from year to year, despite the large difference in annual production levels.

DIAGNOSIS OF THE STOCK STATE

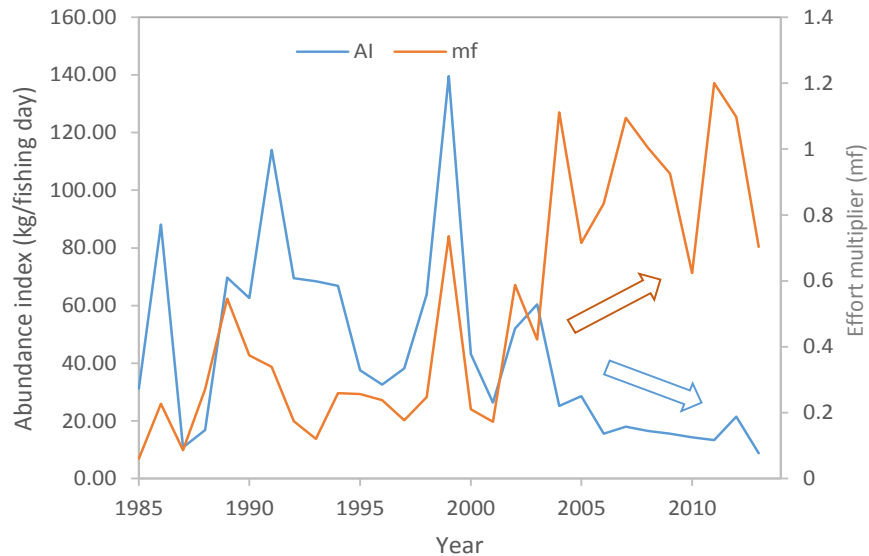
Mean diagnosis 1996-2013



Relative spawning stock biomass per recruit is **26%**
compared to the virgin stock.

Surplus production models

Abundance\Fishing effort

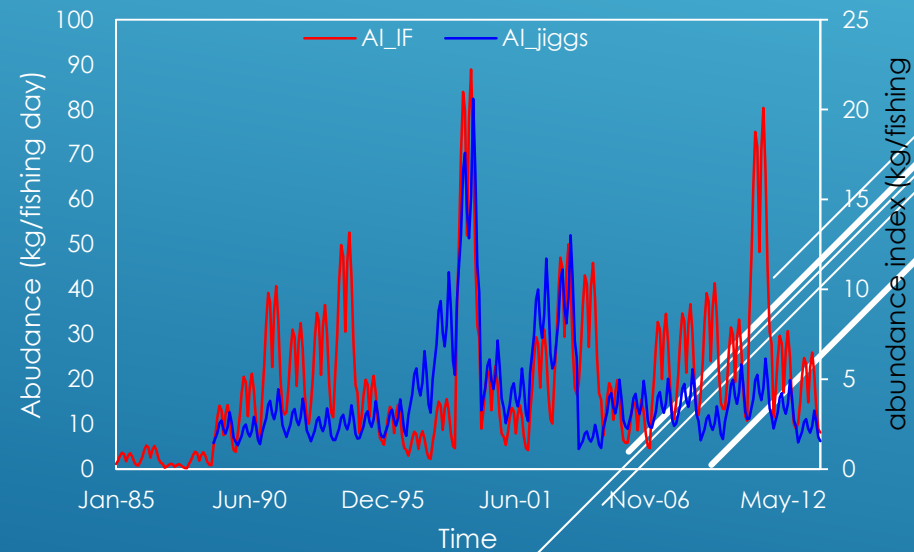
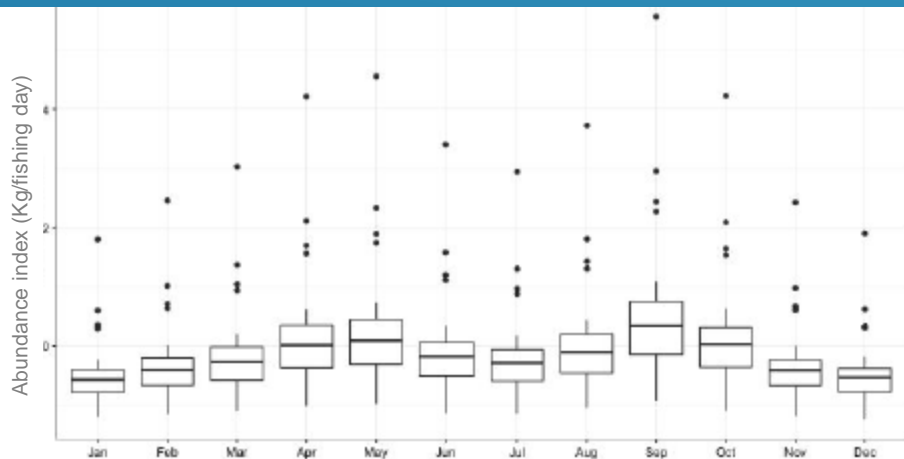


Octopus stock abundance:

- **High interannual variability: no clear trend**
- **Maxima: 1986, 1989, 1991 et 1999**

Fishing effort

- **Strong increase**



Dynamic production model with SST and CUI effects

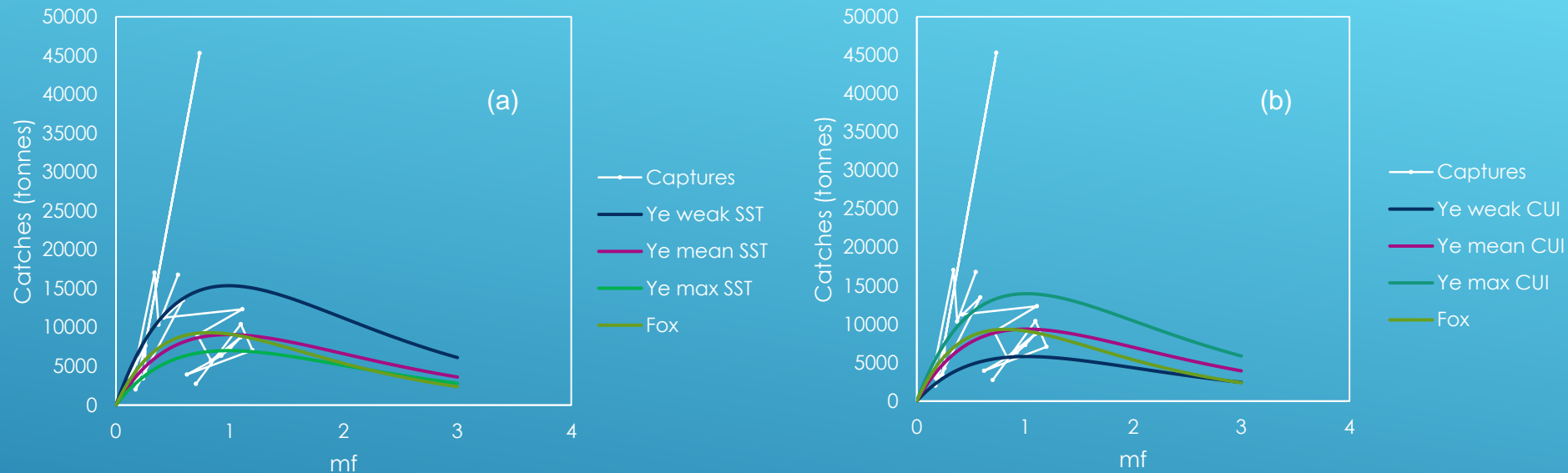
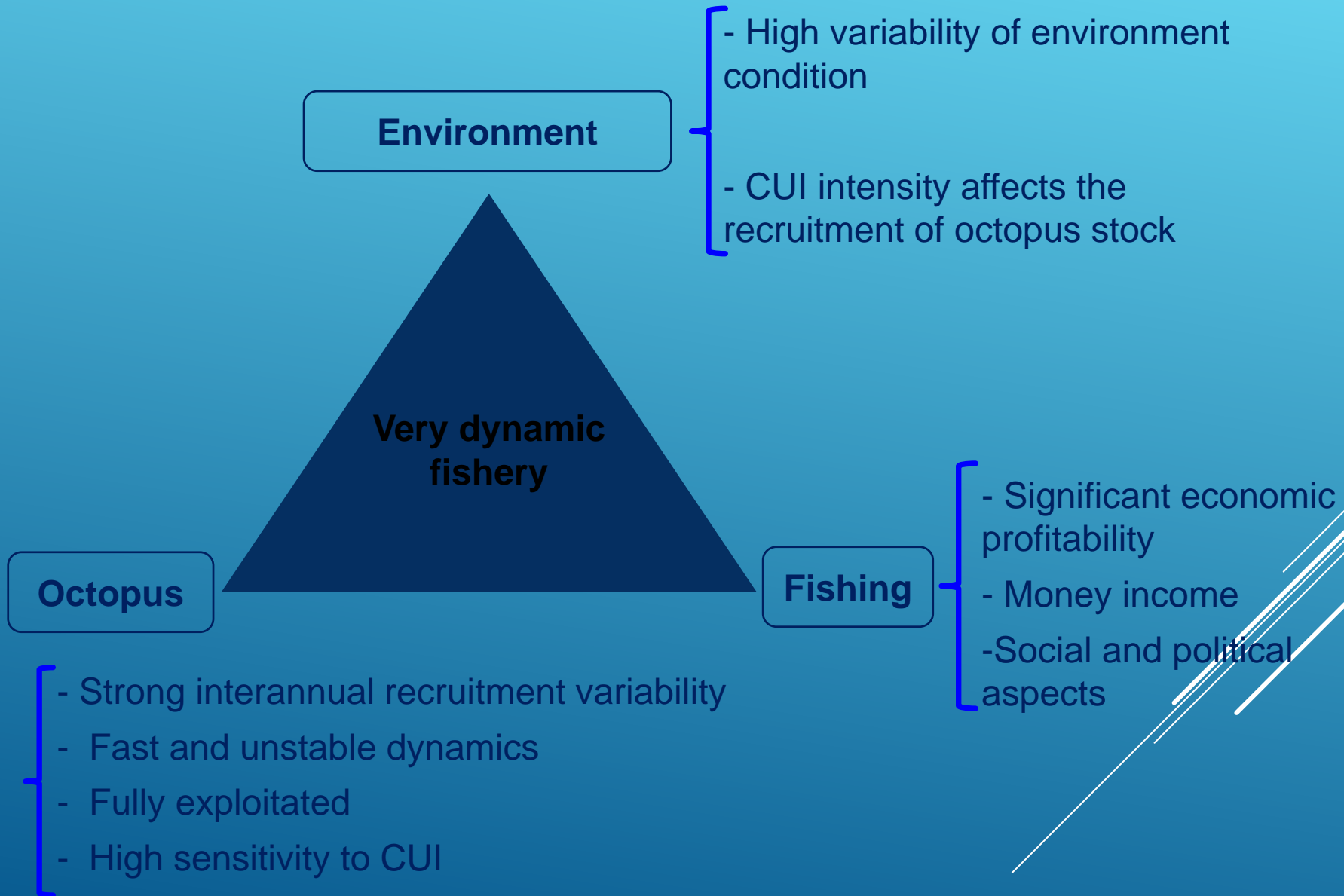


Figure 3.1 – Diagnosis of the exploitation status of the octopus stock using surplus production models with environment effects (a) for SST and (b) for CUI

Stock diagnosis

- Near full exploitation
- Annual Catches depend on upwelling intensity
- MSY varies according to upwelling intensity and sea surface temperature

FISHERIES MANAGEMENT PERSPECTIVE





Thank you!