

**Modelling Fish Habitat Characteristics**

**Predicting habitat changes under climate change scenarios**

**RECLAIM work plan**

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**RECLAIM / MARFISH joint meeting, 10 April 2008**

## Processes relating fish distributions to environment

+ different scales in relationship (history, movements) :

fish are not necessarily at a given time where they ' should ' be

-> point - point correlations (GLM) often explain low percent variance

-> pattern - pattern correlation useful (EOFs)

+ energetic processes of individual fish : suitability & density-dependence

fish integrate their environment

-> habitat quality (density-dependence) : Ideal free distribution (Basin model: McCall, 1990)

-> non-immediate environment : Energy budgets (DEB: Kooijman, 2000)

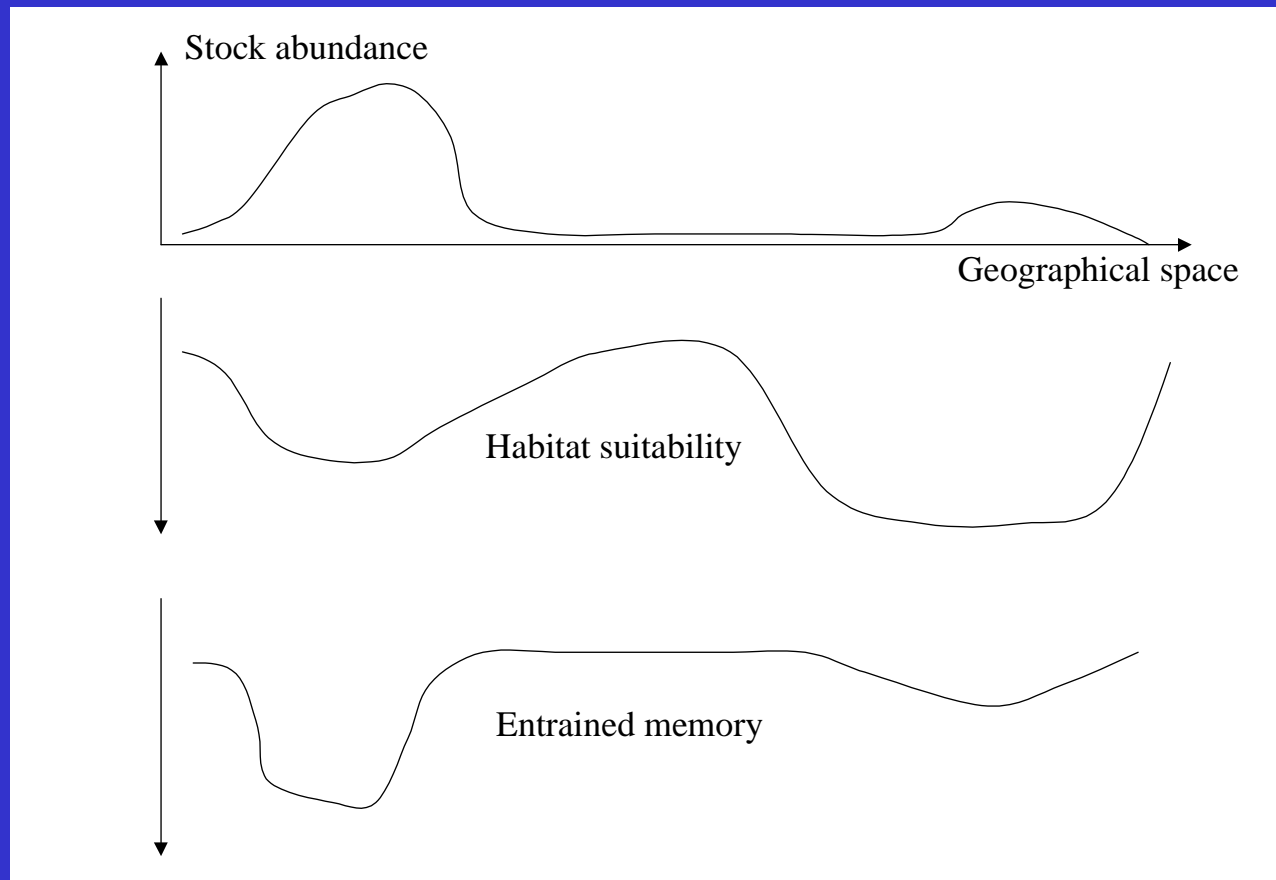
+ spatial processes of population life cycle pattern : behaviour

life cycles spatially organised to match oceanographic features (Sinclair, 1988)

-> spatial memory in the stock: habitat selection (ICES SGRESP)

# Integration of (physiological) suitability with spatial memory

(effect of F ?)

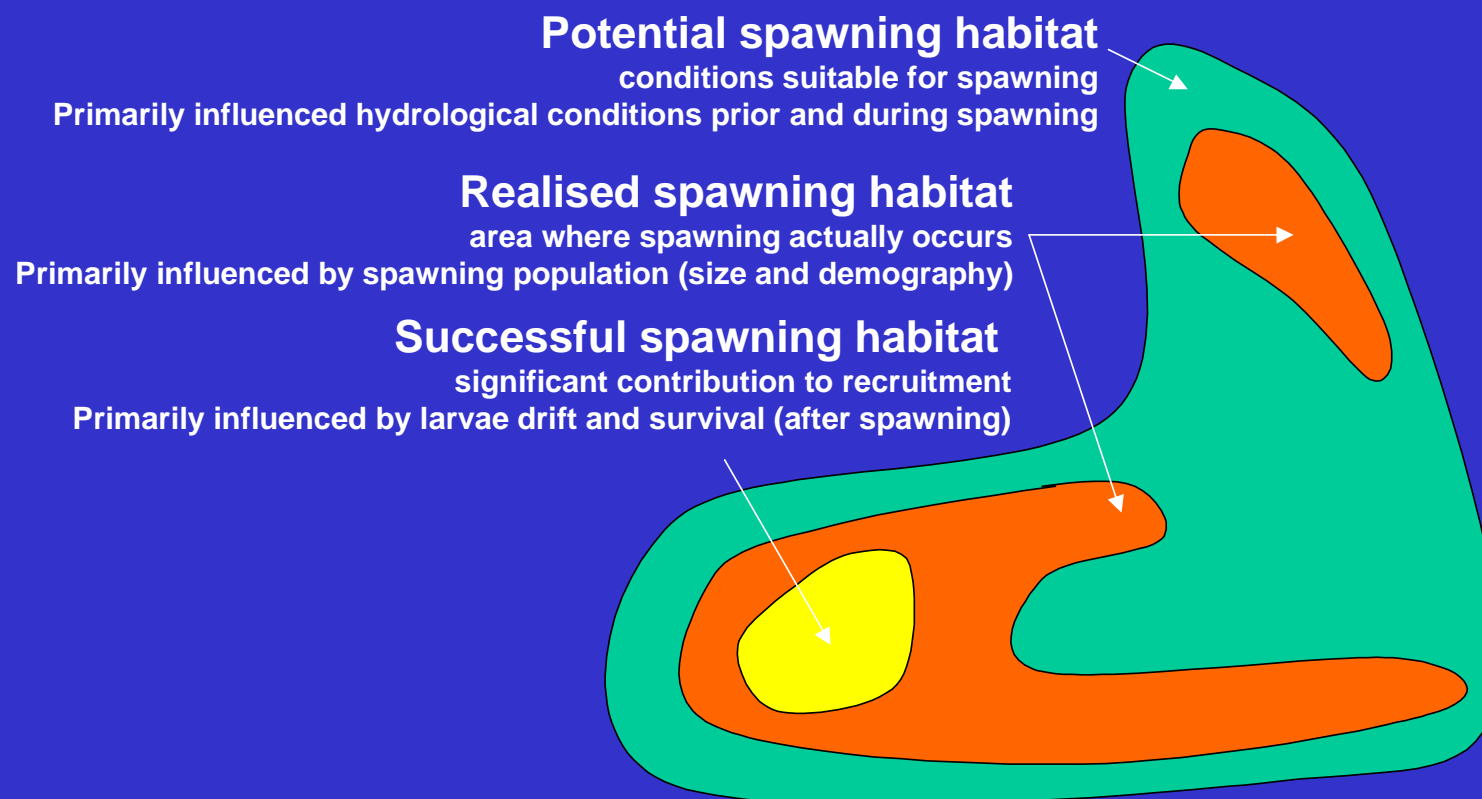


South African sardine ICES WKTEST

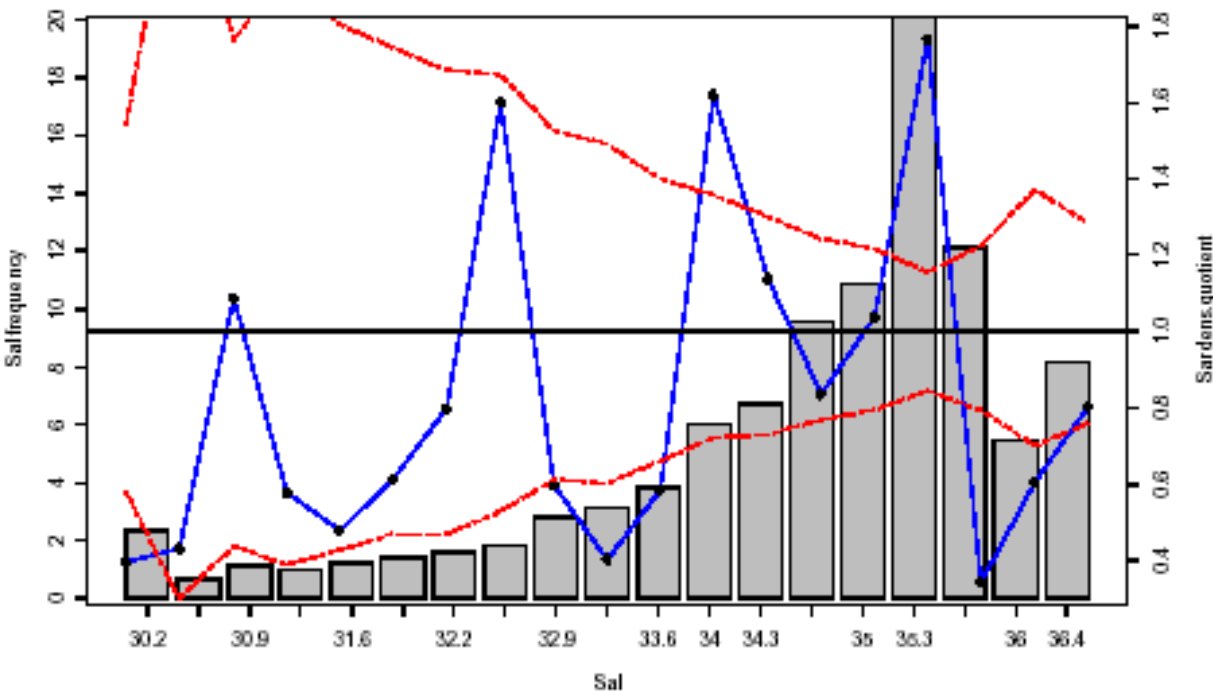
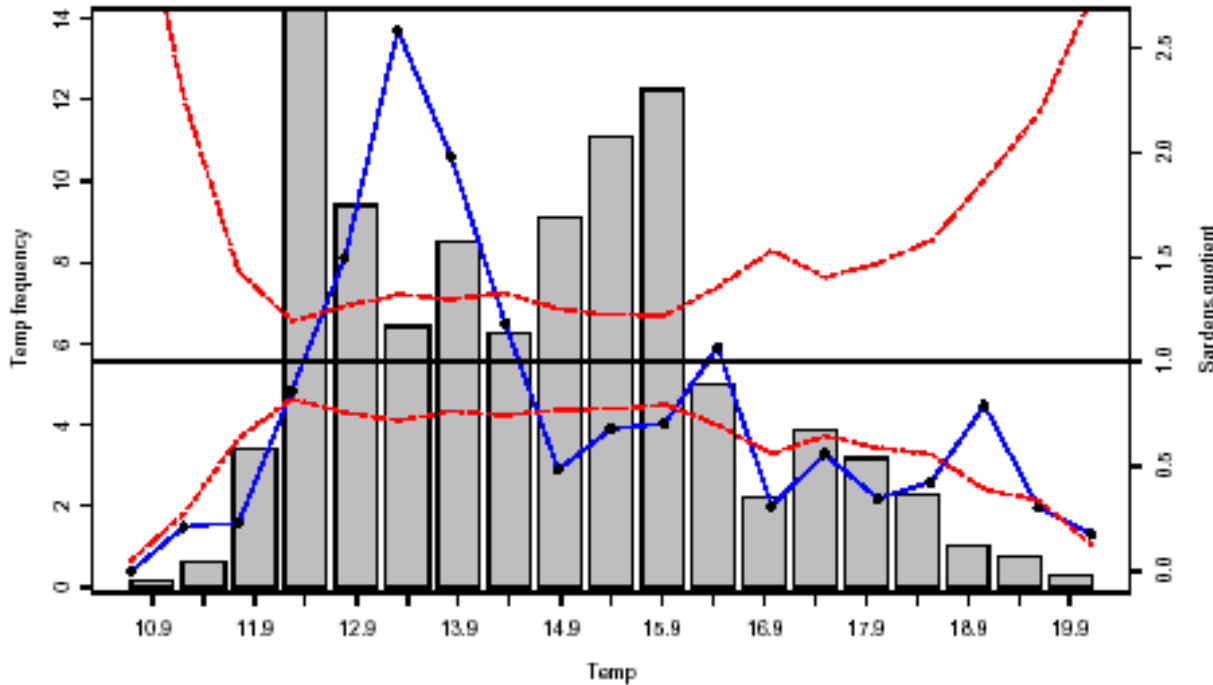
## Advection - Diffusion Framework to predict fish distributions

Bertignac et al. 1998 FOG 7: 326-334

Characteristics of habitats : methods to estimate & predict them



Terminology	Method
<p><b>Potential Habitat</b></p> <p>Necessary Conditions (physical)</p>	<p>GAM applied to Pres./Abs. data</p> <p>Physiological tolerance</p>
<p><b>Preferred Habitat</b></p> <p>Necessary conditions for high concentrations</p>	<p>Quotient Plots (or Cum.Dist.Func)</p> <p>GAM (0/1) * GAM (z&gt;1)</p> <p>Regress. Quantile</p>
<p><b>Realised Habitat</b></p> <p>Part of Pot.Hab. effectively occupied</p>	<p>Empirical Orthogonal Func. (EOF)</p>
<p><b>Suitable Habitat</b></p> <p>Conditions supporting biol.func.</p>	<p>IBM bioenergetic</p> <p>--&gt; potential for growth / repro</p>
<p><b>Essential Habitat</b></p> <p>Area of importance to Pop. maintenance</p>	<p>Spatialised Pop Matrix Model</p>



Quotient Plots :

Temperature & salinity

Preferenda for sardine eggs

Eggs surveys Iberia & Biscay

2000 - 2005

bars: available habitat

blue: preferred habitat

red : significance limits

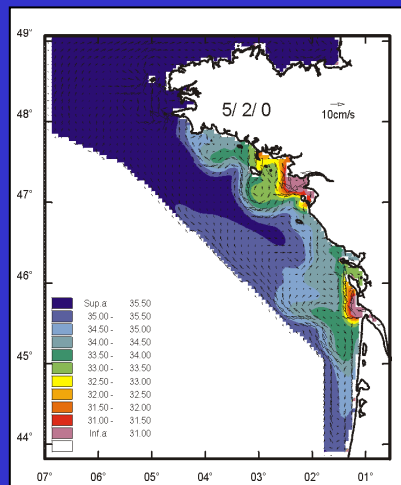
Prob. Pres = GAM (hydrological data)

## Potential spawning habitat for anchovy in Biscay

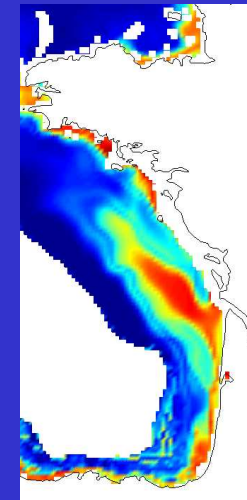
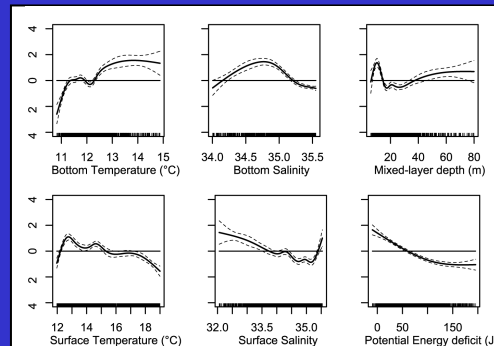
all available egg surveys pooled: all possible observed conditions --> 'potentiality'

Hydrological conditions : CTD or model  
Realistic 3D hydrodynamical simulations

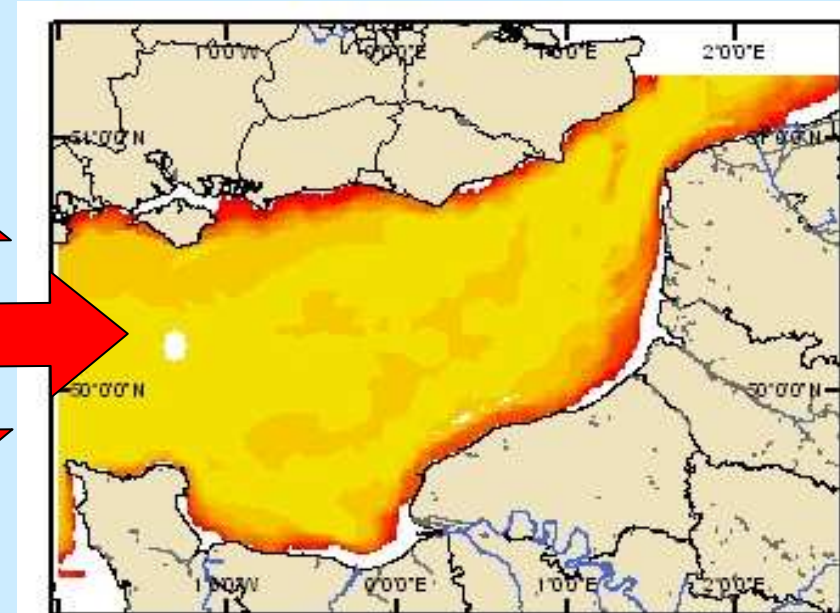
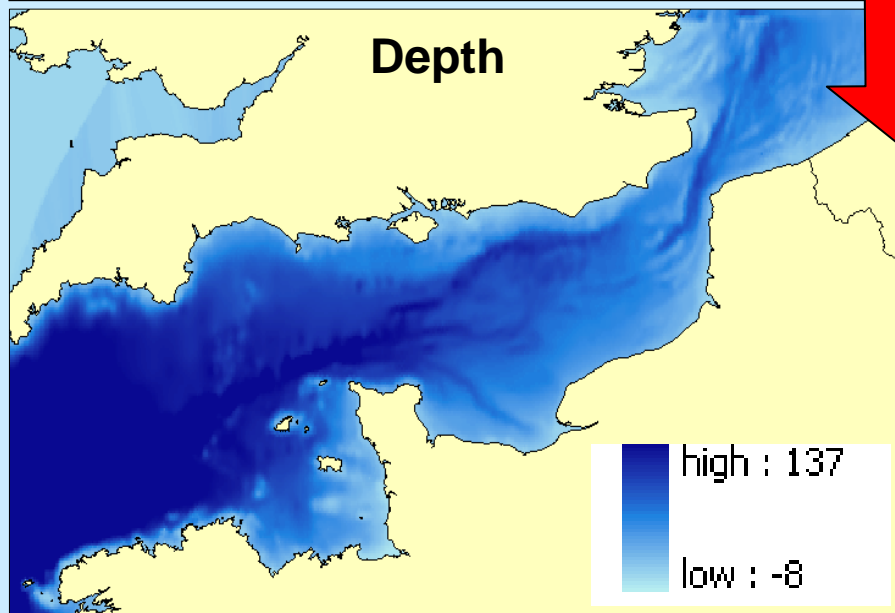
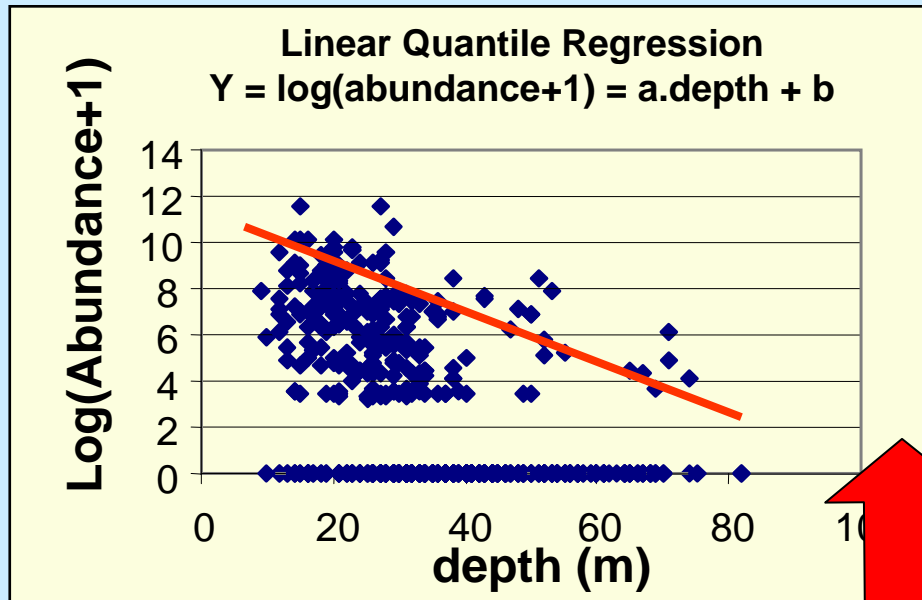
Potential Spawning Habitat



Regression model : GAMs



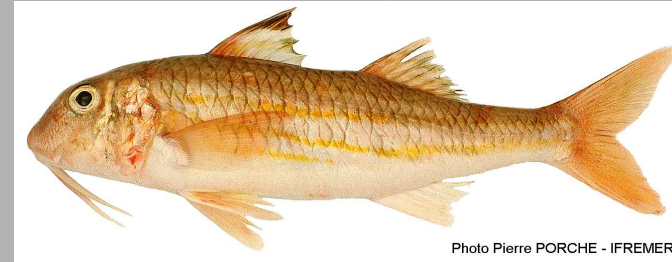
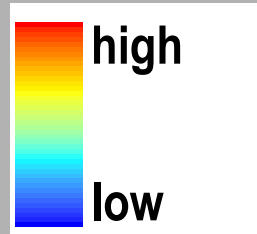
# Modelling preferential habitats using Regr. Quantiles : Principle



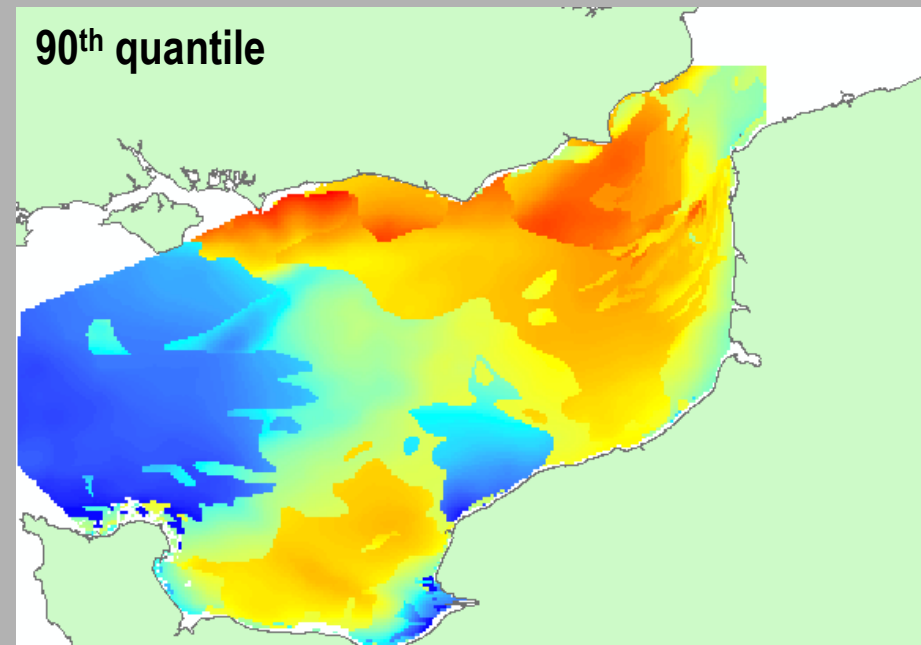
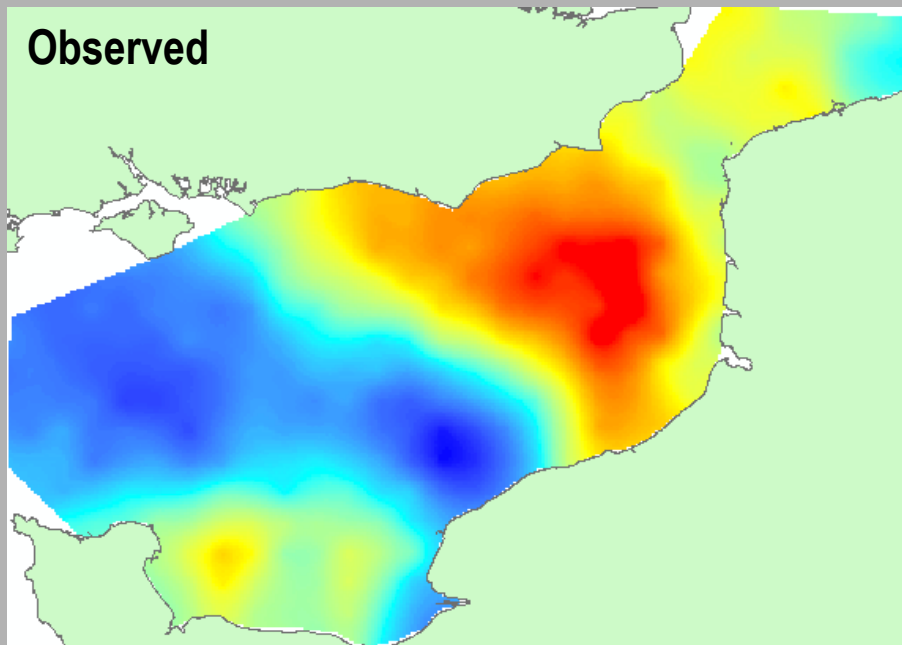
**Prediction of the preferential habitat as a function of depth**

# Red mullet (*Mullus surmuletus*)

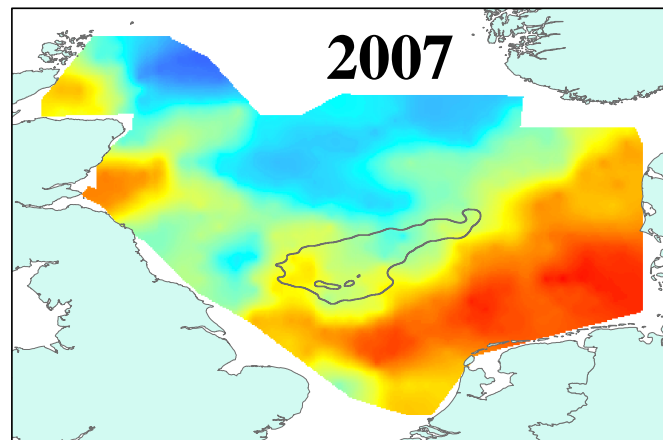
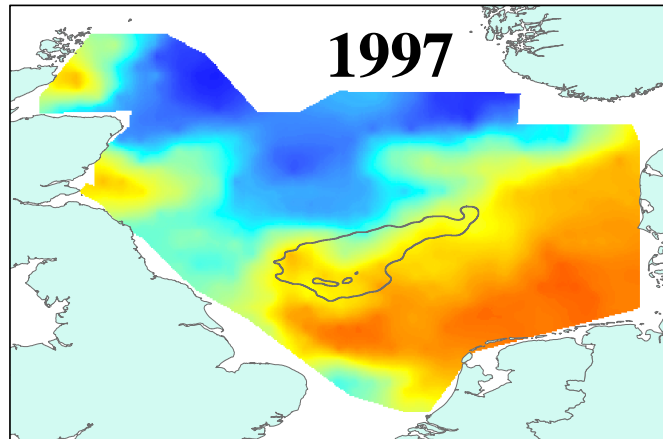
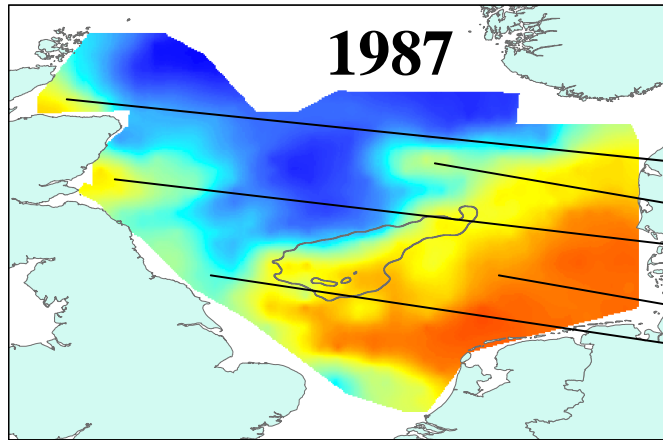
EU Charm



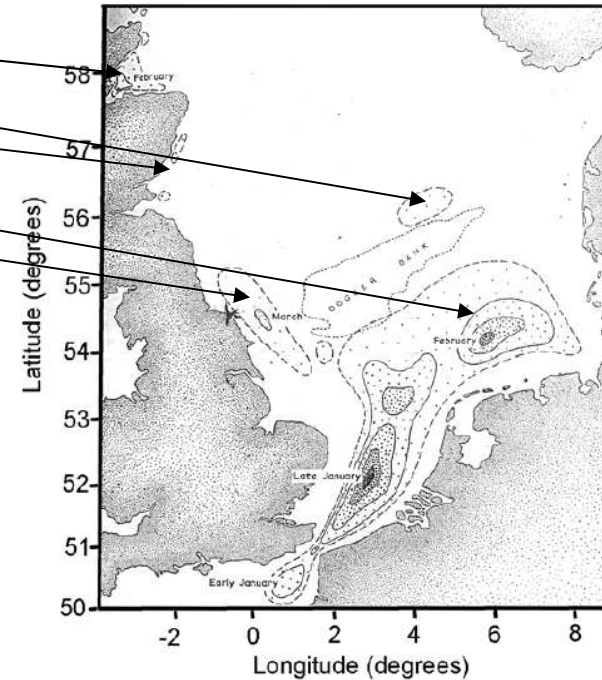
Autumn



# Modelling Preferential habitat with GAM : Spawning North Sea Plaice

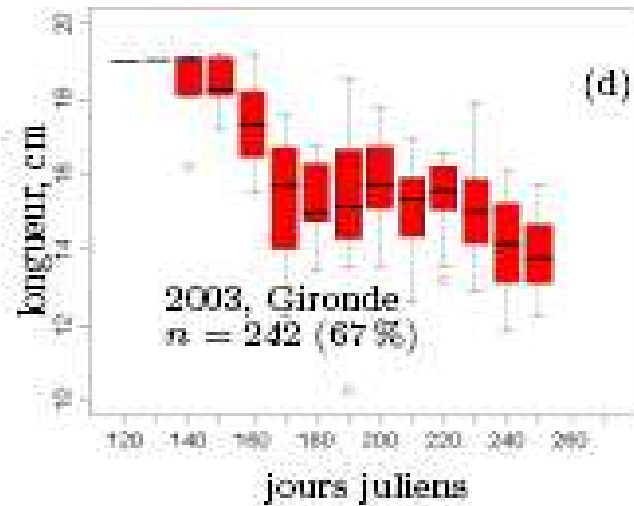
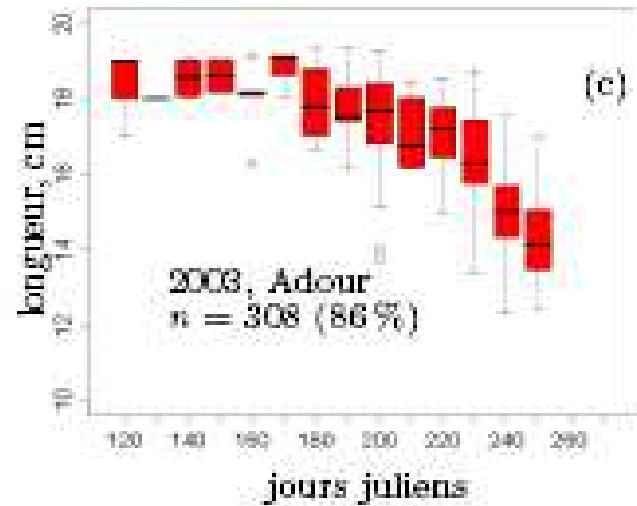
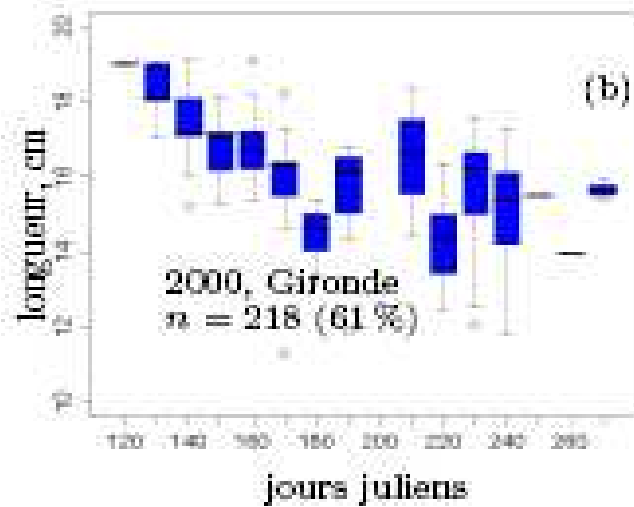
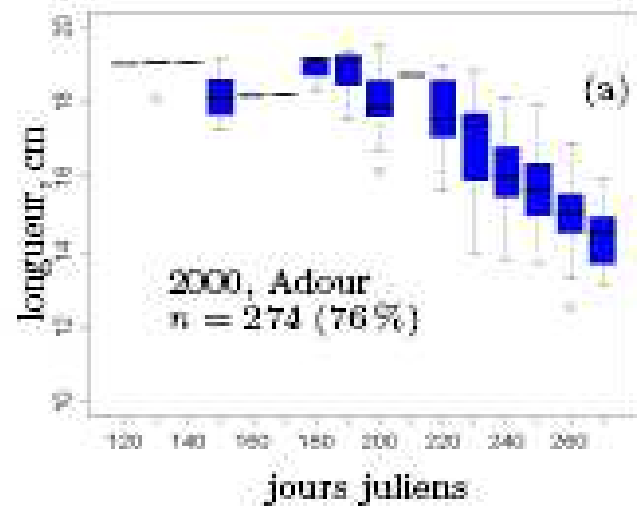


Spawning grounds (Harding, 1978)



- method : GAM with IBTS Data
- response : spawning adults
- environment : depth, bottom and surface salinity, bedstress, sediment

## Habitat suitability estimated using DEB : adult anchovy in Biscay



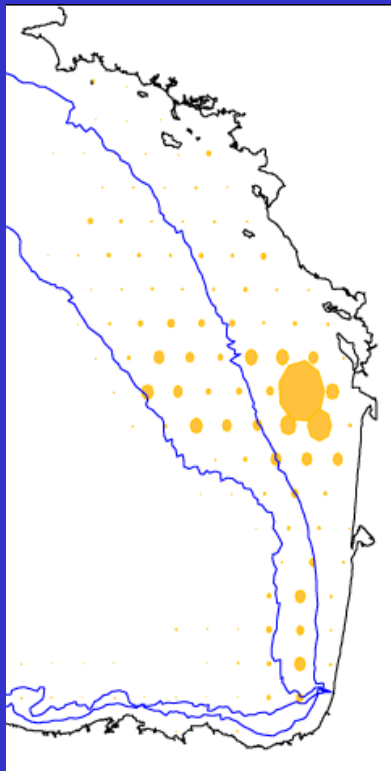
Length at which individuals are physiologically limited as the season progresses

# Successful spawning habitats estimated using a larval IBM : anchovy in Biscay

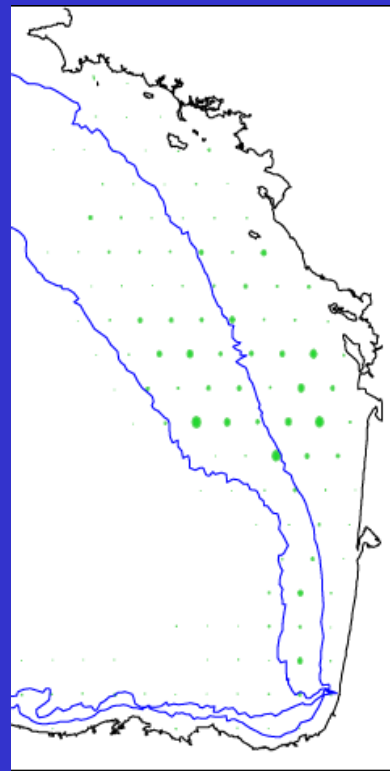
Allain et al. 2007, FOG 16: 506-514

## Origin of survivors after 100 days

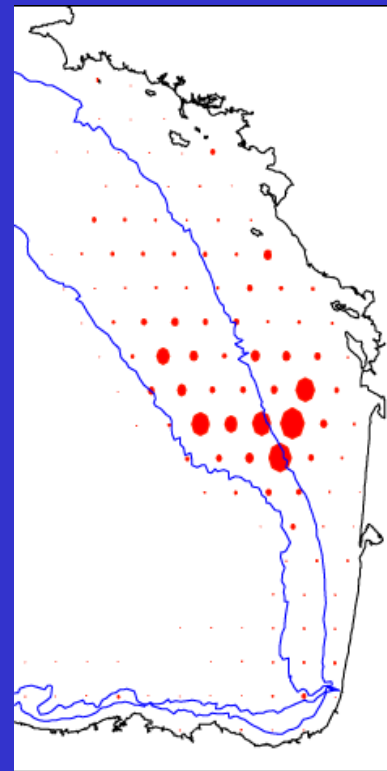
spatial



1997

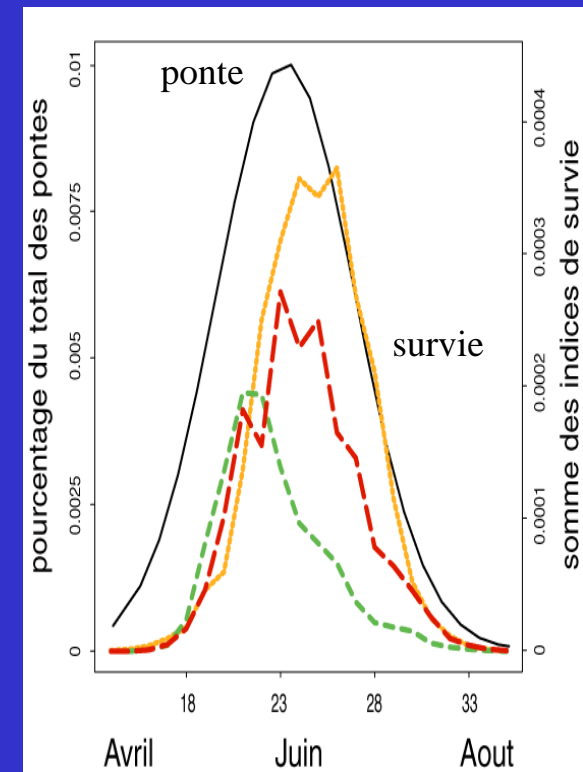


1998



1999

temporal



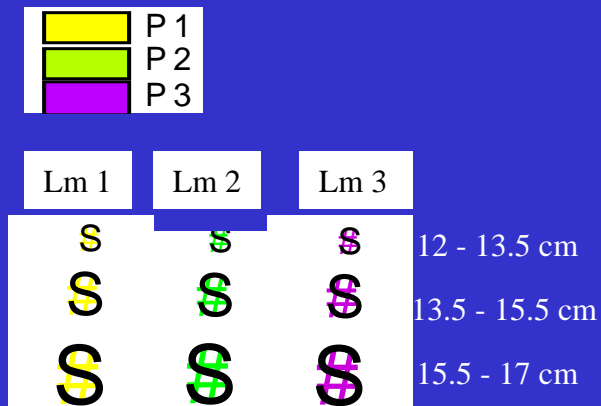
97 98 99

# Essential Habitat : Matrix Population Modelling

Zonation based on biological parameters

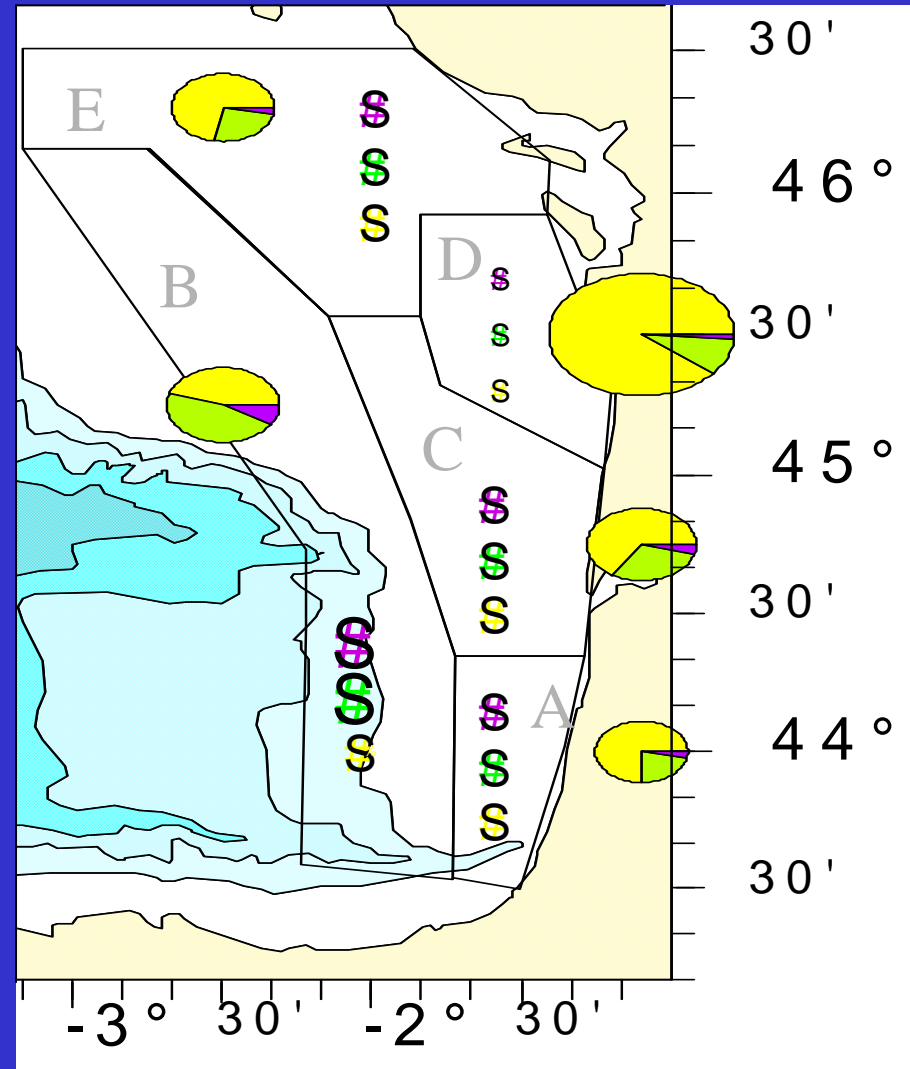
Anchovy 1983-2002

Trawl hauls from acoustic surveys pooled



Elasticity analysis :

Fertility in zone D determines  
population long-term growth rate



Task 3.1: Testing Impacts of Climate Change on Spatio-temporal Habitat Utilization

Area	EnvData	FishData Species	Stage	Method
Biscay	river plume extent temperature upwelling index stratification fronts	anchovy	spawning adults (PelGas) eggs (PelGas) larvae	GAM, EOF QP, GAM, EOF IBM, CO
North Sea + EEC		plaice & sole	spawning adults (IBTS Q1) eggs feeding adults (BTS Q3)	GAM
		herring	spawning adults (HERAS) larvae (MIK Q1) juveniles (IBTS Q1)	
		sprat	larvae	IBM, CO
	temperature river plume extent fronts	anchovy	wintering adults (IBTS Q1) spawning adults (IBTS Q3)	EOF EOF

Construct habitat models on different life stages

Use habitat models conditioned by climate change scenarios

Conclude on changes in life cycle patterns

QP: quotient plots: preferendum  
 GAM: potential habitat  
 RQ: regression quantiles: preferred potential habitat  
 CO: comparison of Potential for growth model habitat estimates with observed spatial patterns  
 EOF: pattern in the variation of habitat occupation  
 IBM: larvae IBM-derived potential habitat of potential for growth