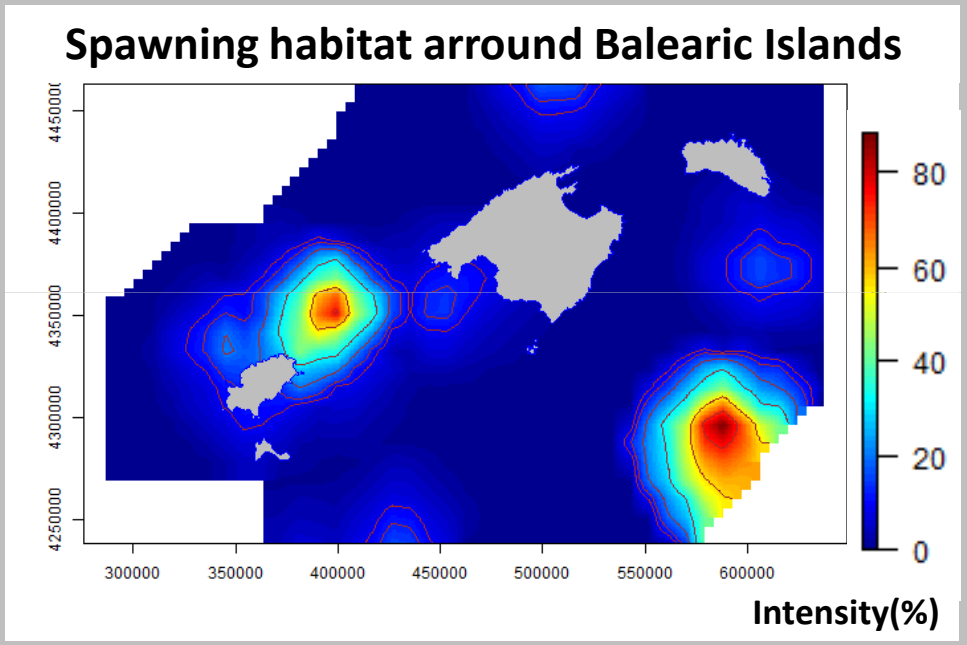
Towards an operational oceanography tool for fisheries: predicting spawning habitat of Bluefin tuna in Western Mediterranean



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IMEDEA CSIC Universitat de les Illes Balears

College of Oceanic & Atmospheric Sciences

OSU Oregon State University

BLUEFIN TUNA PROJECT

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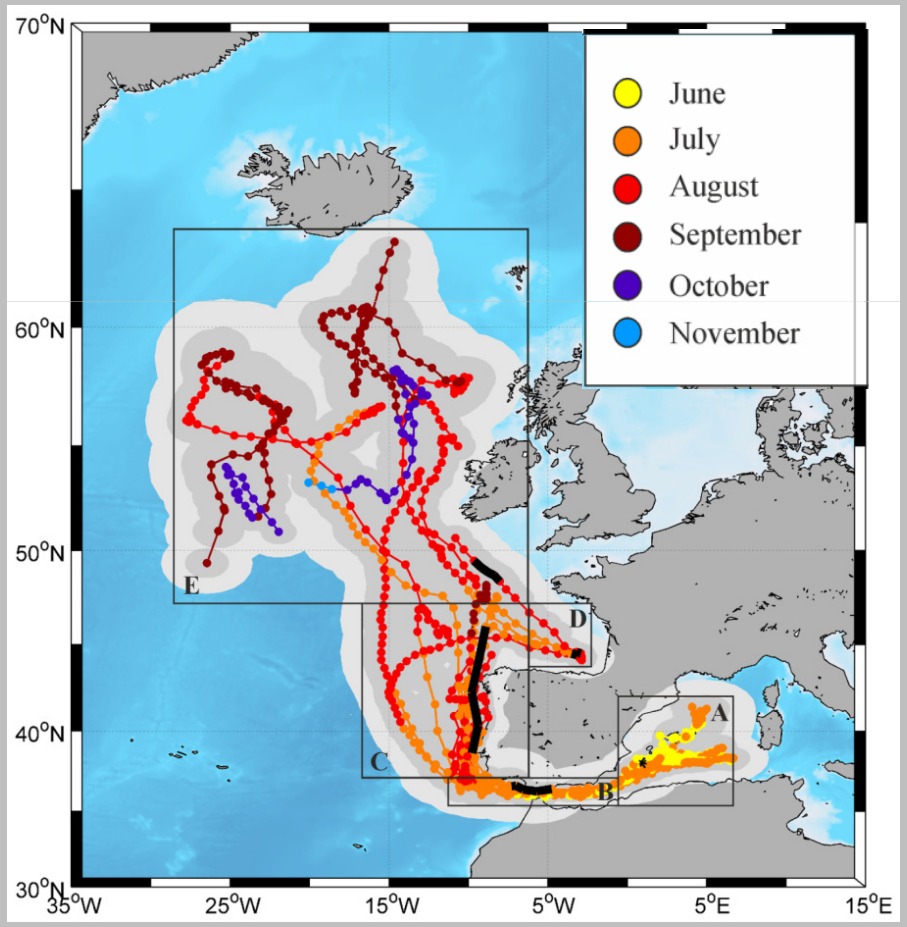
INTRODUCTION

Migration patterns along the year (Eastern Stock)

Winter in feeding areas
Summer in spawning areas



Aranda et al, PONE 2013

1- Within the Mediterranean, the **Balearic Sea is one of the most relevant spawning area.**

2- After reproductive season **adult Bluefin tuna return** to Atlantic feeding areas

INTRODUCTION

In the Balearic Sea, fisheries target aggregations of adult Bluefin tuna during reproduction

-Bluefin tuna support a relevant economic activity

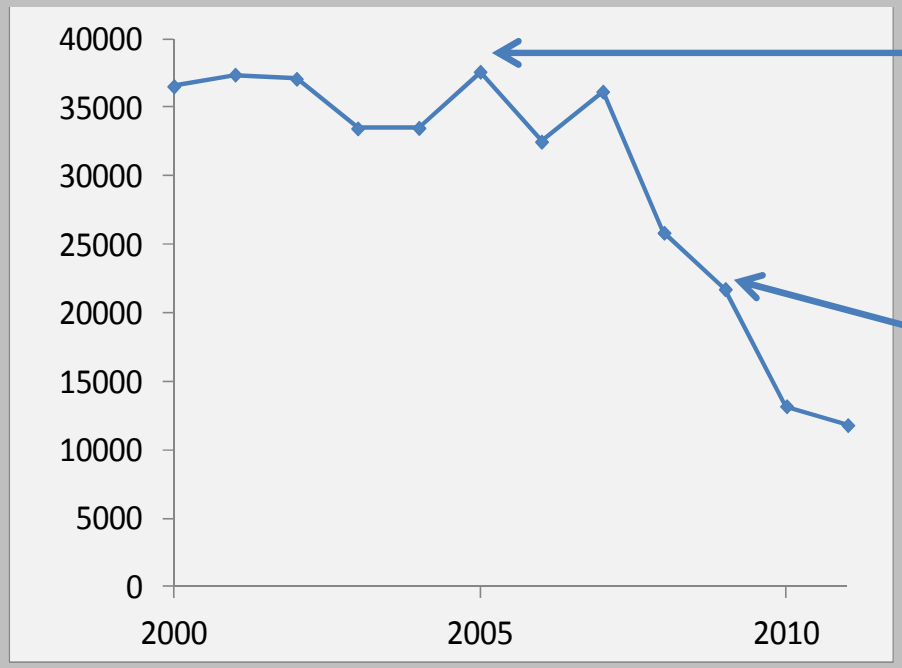
- Mediterranean catches have a value over 226 million dollars

-More than 3.500 direct jobs

(Sumaila and Huang, 2010)

INTRODUCTION

Overfishing: Temporal evolution of the catch (2000-2011)



Fishing quota limitations

Stock assessment warned of fisheries collapse

Actual management of Bluefin tuna:

1- Fishing quota (after abundance indices calculated from adult catches)

2- Minimum fish length regulations

ACTUAL MEASUREMENTS TO CONTROL TUNA POPULATIONS DO NOT INCLUDE ENVIRONMENTAL VARIABILITY

GOAL

Take advantage of new Operational Oceanography tools to introduce environmental variability on Bluefin tuna management and conservation

Objectives:

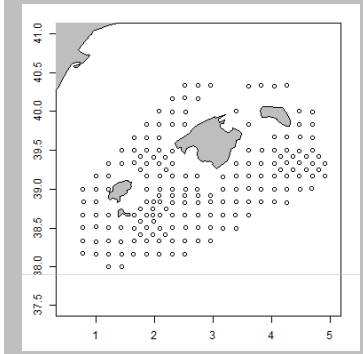
1- Identify the relations between **Bluefin tuna reproductive ecology** and **regional mesoscale oceanography,** and identifying **key environmental variables**

2- Selected operational oceanography products and predict spawning areas to propose **alternative management approaches** (applications)

METHODS

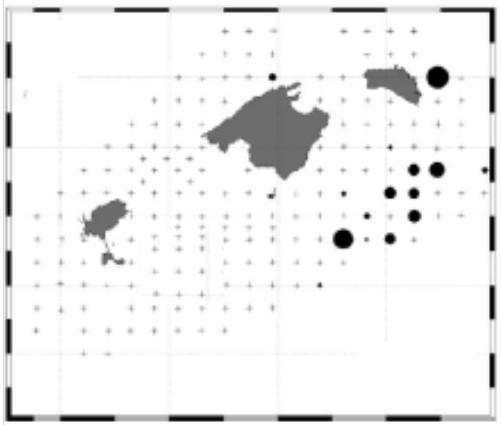
1- How spawning of bluefin tuna depends on regional mesoscale oceanography + identify **key environmental variables**

5 years of data
2001 to 2005



Identification of spawning
Habitat from larval abundance

Oceanography from CTD



Spawning habitat = f (environmental variables ,CTD)

GAM

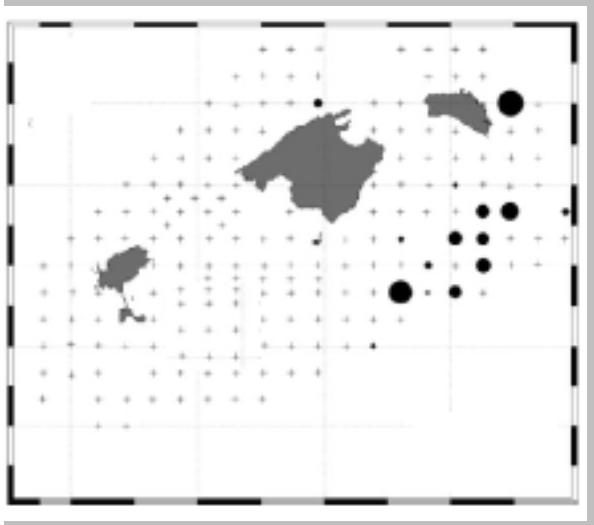
KEY ENVIRONMENTAL VARIABLES

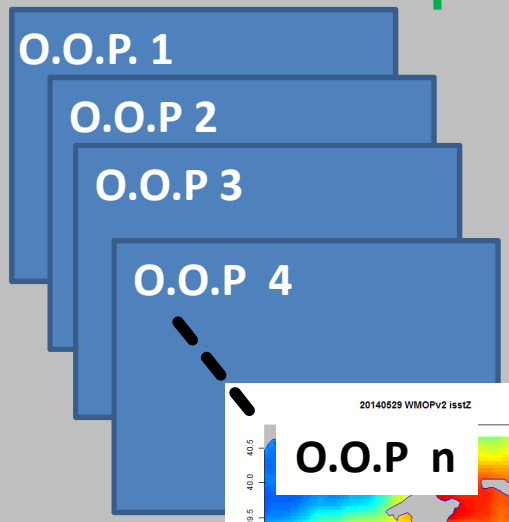
METHODS

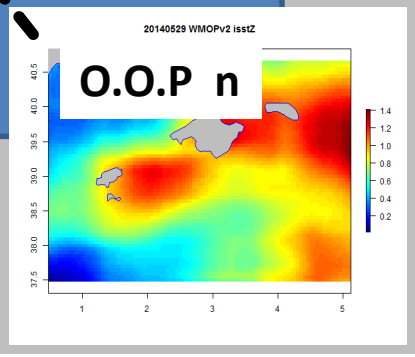
2- Selected operational oceanography products and predict spawning areas

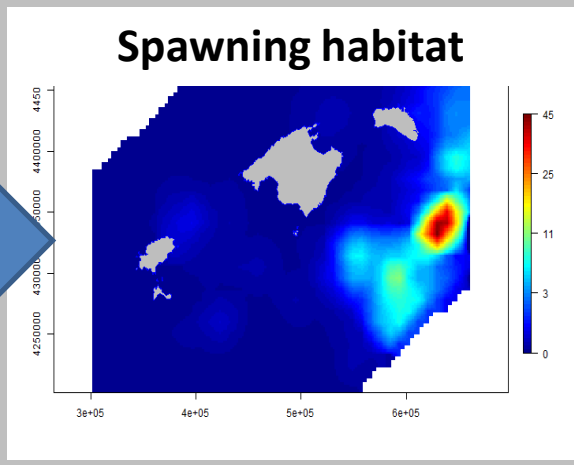
General aditive models are fitted agains environmental data from Operational Oceanography to obtain **predictive spawning habitat maps**

GAM







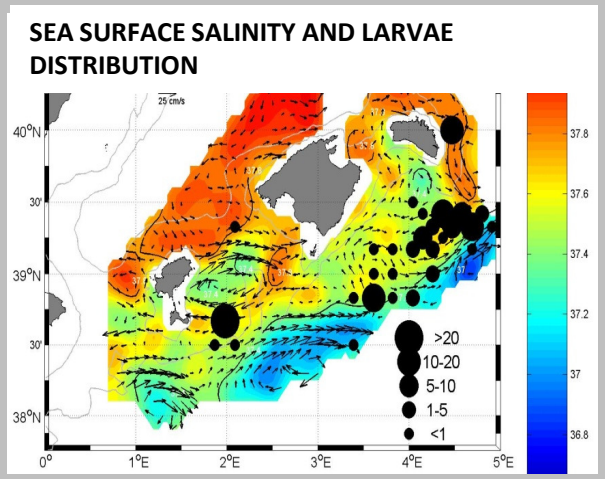


RESULTS

1- How spawning of bluefin tuna depends on regional mesoscale oceanography + identify **key environmental variables**

Key Environmental Variables

- -Chlorophyll-a
- -Sea surface temperature
- -Sea Surface salinity
- -Sea Surface geostrophic velocities
- -Spatial gradients geostrophic velocities



GAM; decision trees; NNS

-Bluefin tuna reproductive ecology is highly dependent on regional mesoscale oceanography

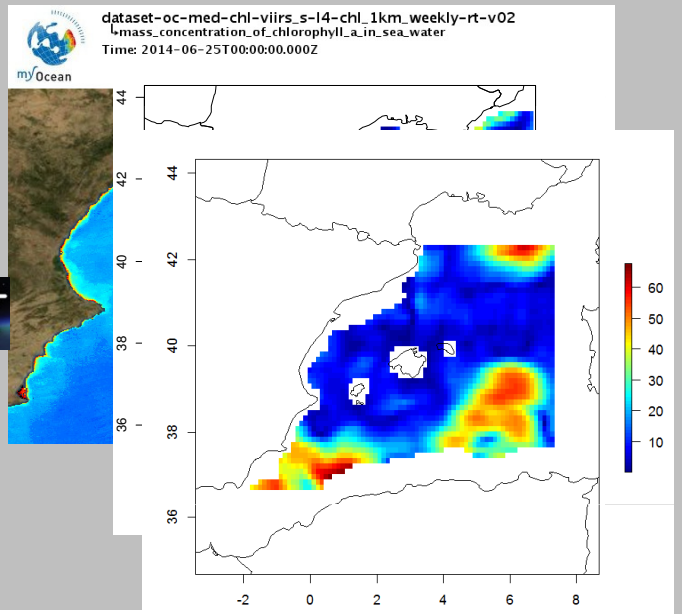
Alemany et al 2010, Mulhing et al 2013, Reglero et al 2012, Alvarez-Berastegui 2014

RESULTS

2- Identify operational data sources giving information about identified variables

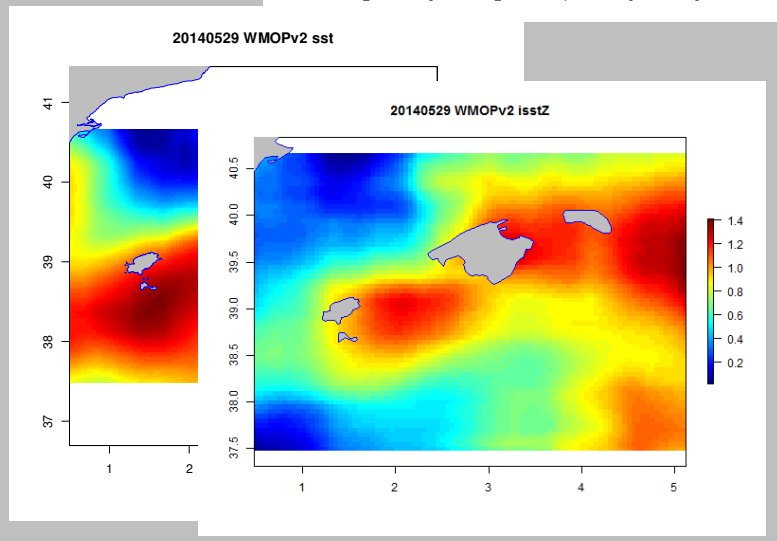
From remote sensing

- Chlorophyll-a
- Sea Surface geostrophic velocities
- Spatial gradients of geostrophic velocities at specific scales (Alvarez-Berastegui et al 2014)



From hydrodinamic models

- Zonal sea surface temperature
- Zonal sea surface temperature increment



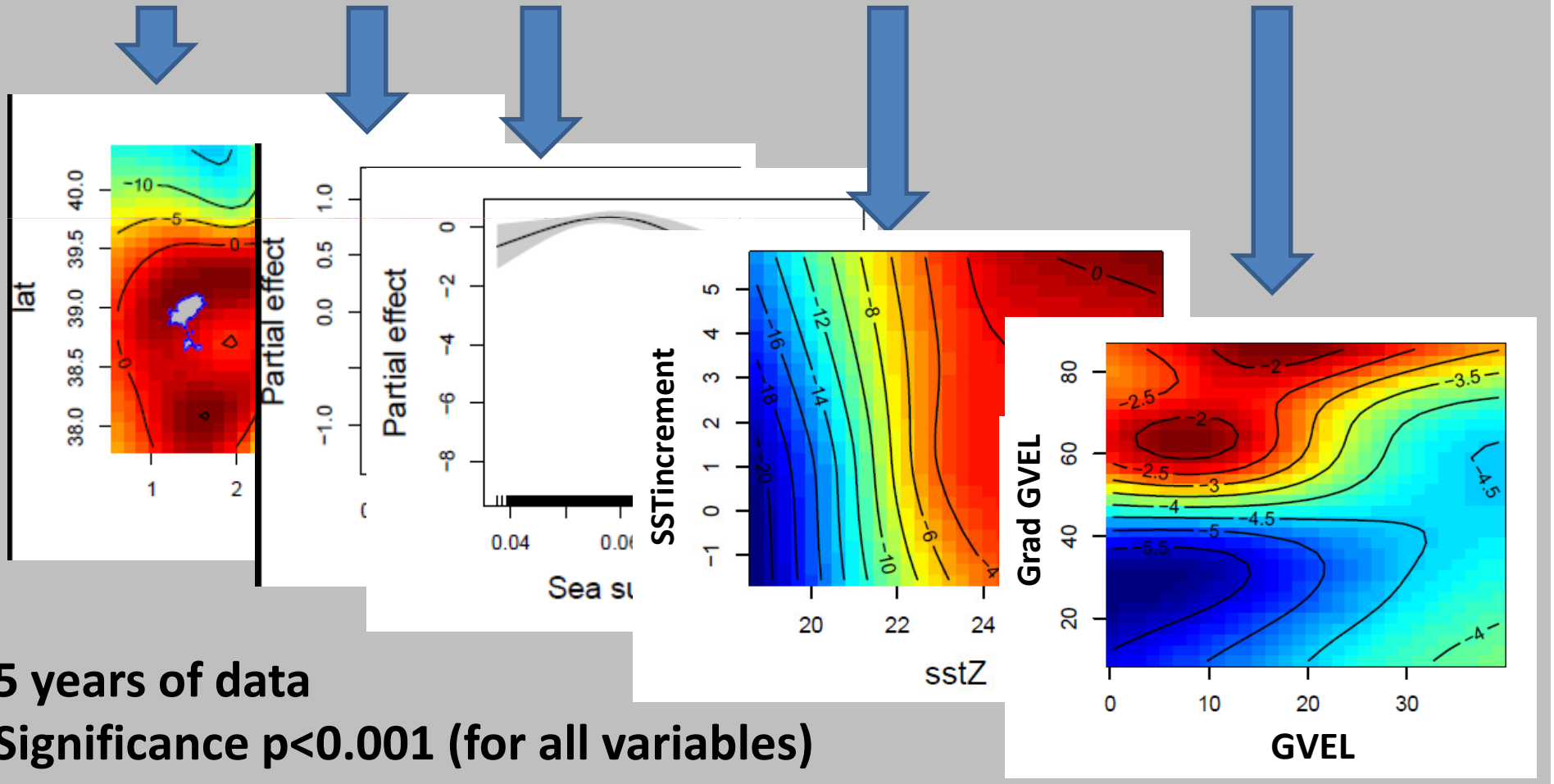
Sea Surface salinity NOT SELECTED

RESULTS

2- Modeling SPAWNING HABITAT from operational oceanography data sources

(GAM) Spawning habitat =

S_1(long, lat) +S_2(hour)+ S_3(chla) + S_4(SSTZ, SSTincrement) + S_5 (GVEL, gradGVEL)

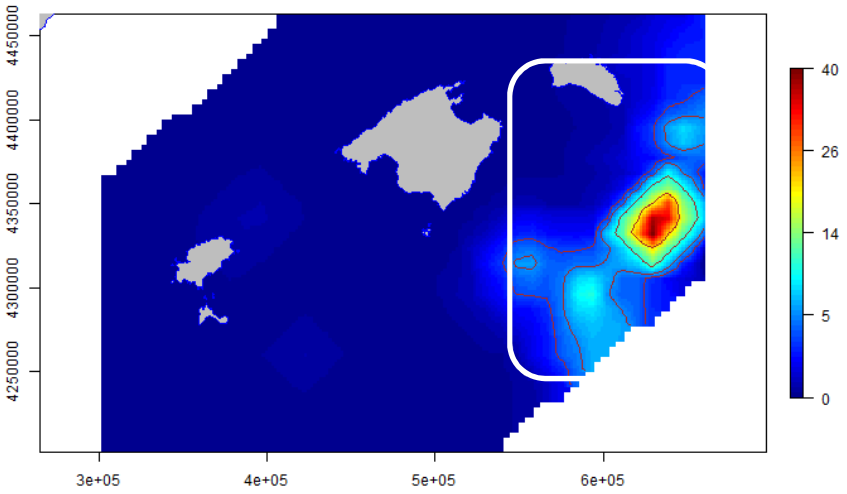


5 years of data

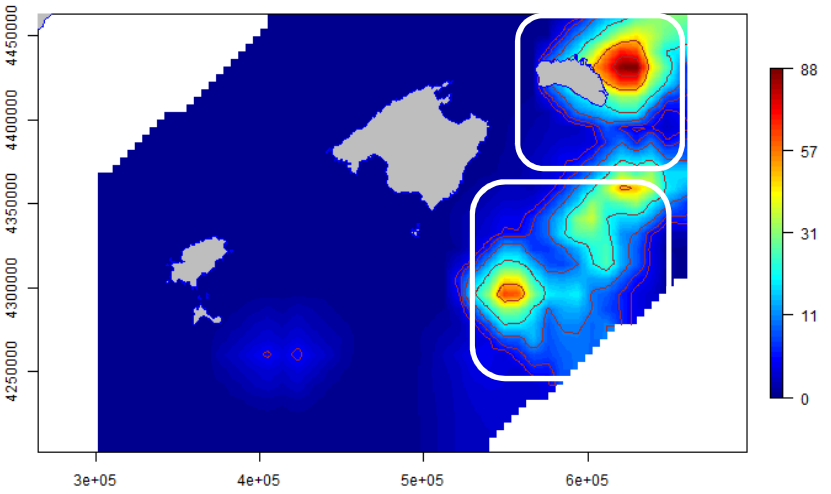
Significance p<0.001 (for all variables)

RESULTS: CROSS-VALIDATION

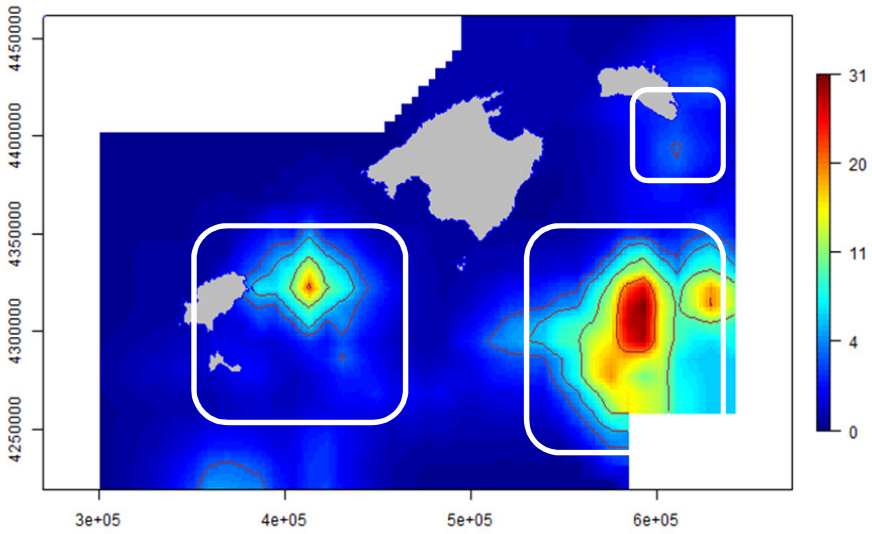
Predicted spawning habitat (2002)



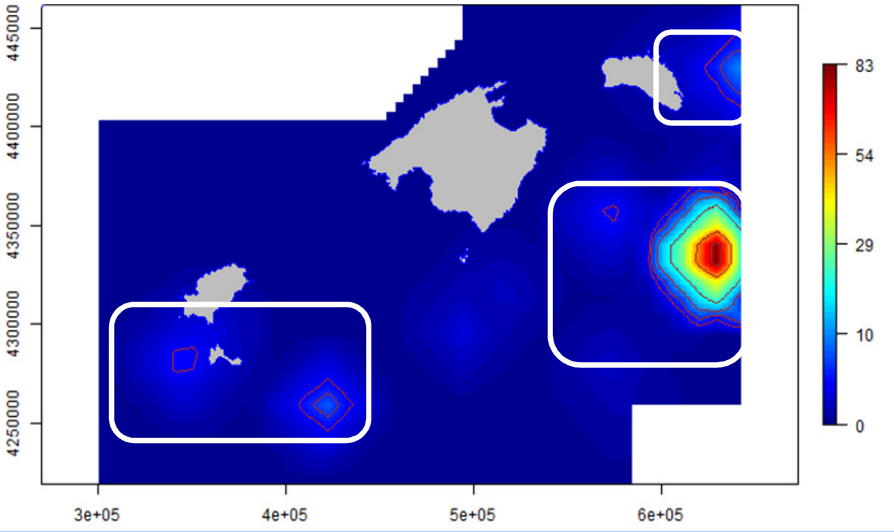
Observed spawning habitat (2002)



Predicted spawning habitat (2004)



Observed spawning habitat (2004)

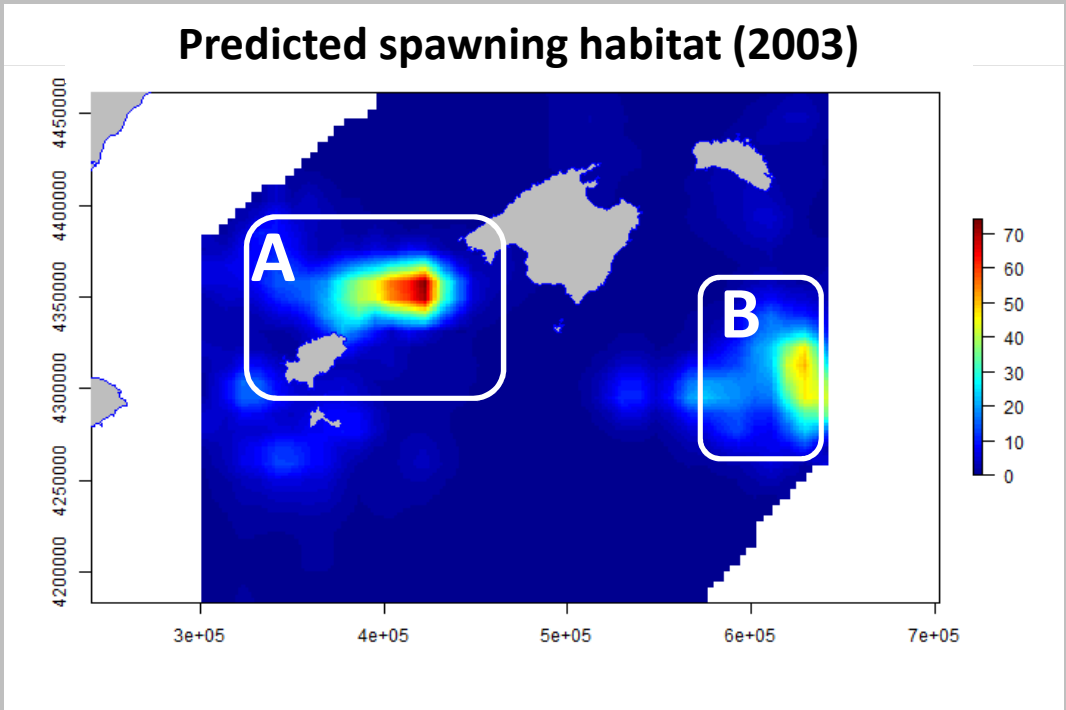


Applications to management

1-Propose spatial planning management approaches

Spawning habitat mapping

Selection of closure areas To reduce accidental catch



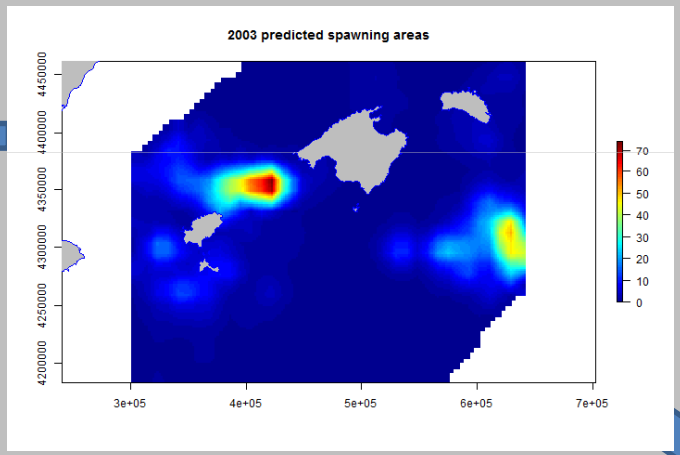
http://www.theg.ca/hooking-a-big-one/

Applications to management

2- Improve indices of adult abundance <u>from larval data</u>

+ Adult abundances->+Larval abundances

Larvae abundance in a year



Habitat quality

Habitat standardized LARVAE abundance indices

IMPROVING 15% C.V.
(Ingram et al. ICCAT 2013)

Closing remarks

1- Spawning ecology of bluefin tuna highly **dependent** on regional **mesoscale oceanography**

2- Quality of input **Operational Oceanography products** (As sea surface salinity) determine applicability to fisheries management

3- Operational Oceanography products:

-Improve actual techniques for evaluation of adult stock abundance

-Open new ways for approaching Bluefin tuna management (spatial management)

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