**TWAM 2013**
International Conference & Workshops
16 - 20th March 2013 Aveiro - Portugal

Transboundary water management
across borders and interfaces
present and future challenges



COEXIST
Interaction in coastal waters

COOPERATION

FORWARD
Framework for Ria Formosa water quality, aquaculture, & resource development

# Integrated modelling of goods and services provided by aquaculture to coastal systems

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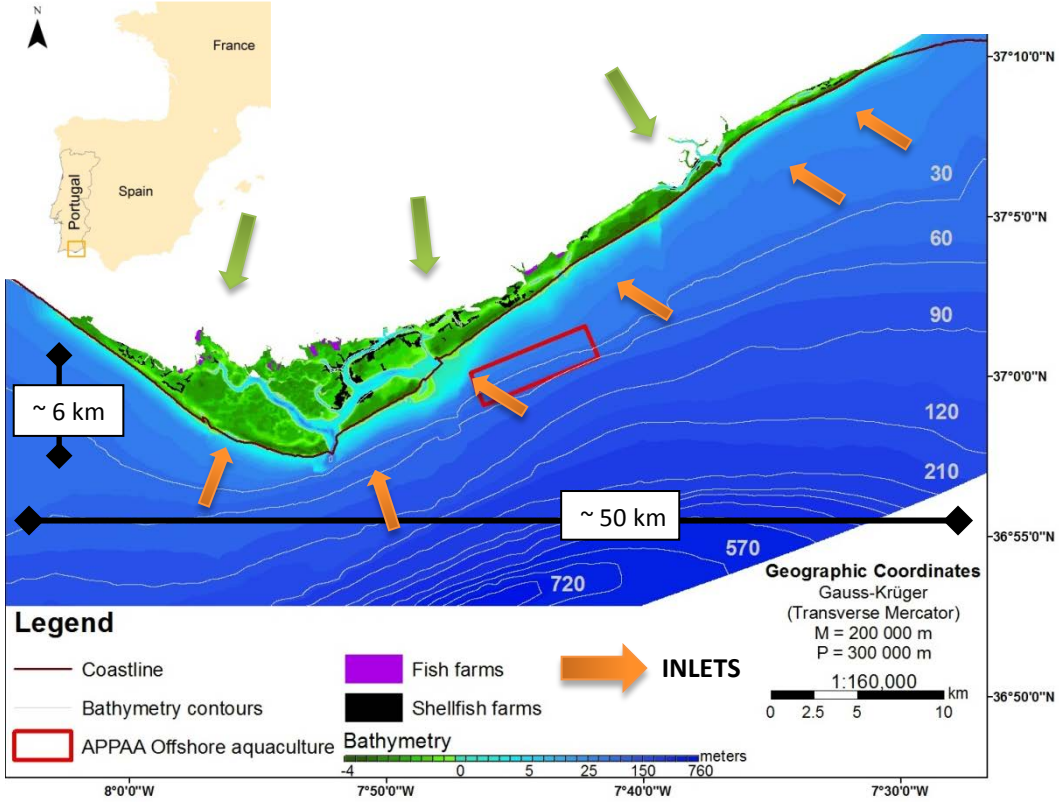
# Ria Formosa – Portugal (Europe)

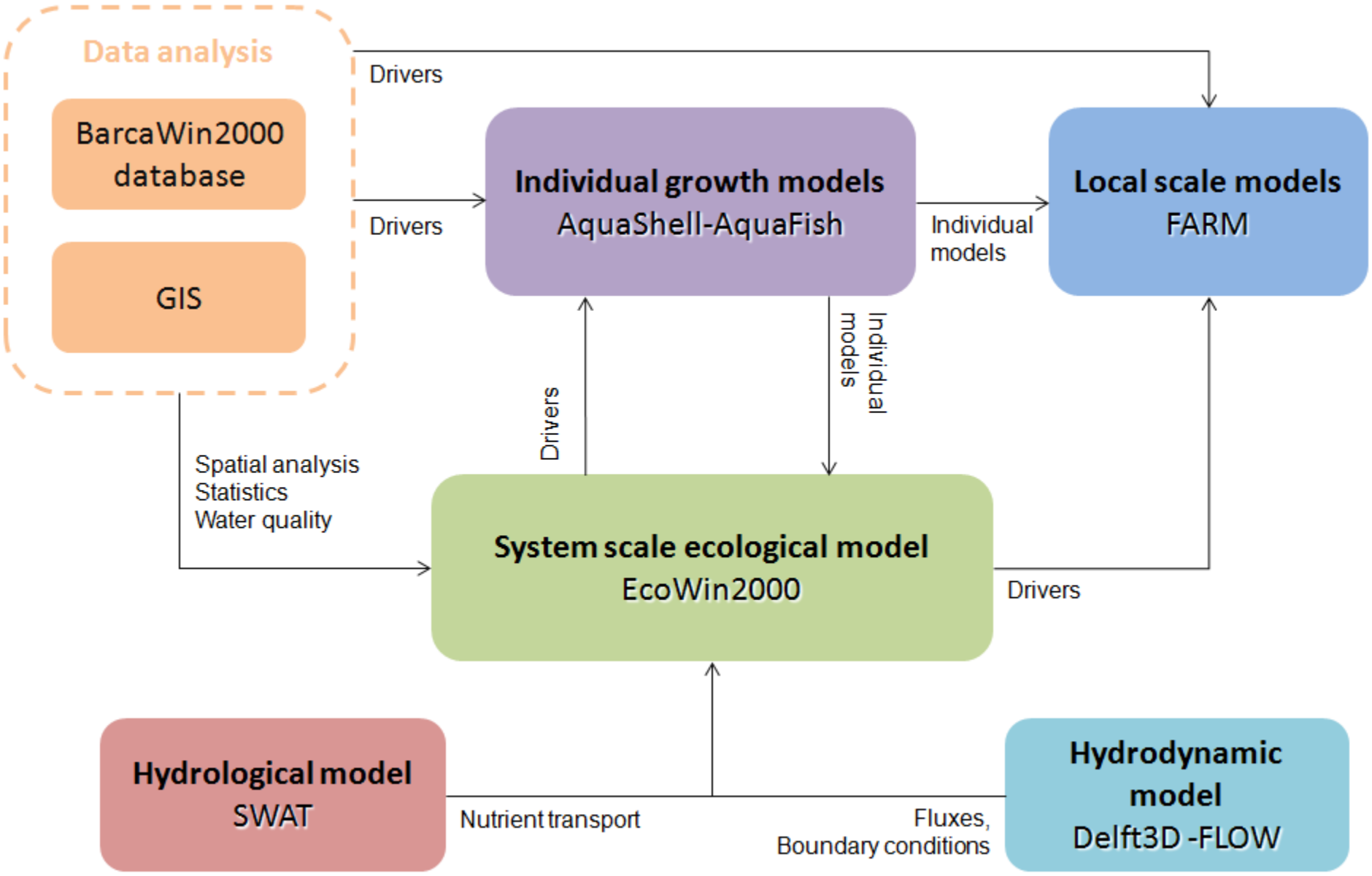



- 184 km$^2$, 1-3 m tidal range, 13-23 ºC, 36 psu
- Lagoon: high socio-economic & natural value. Native clams (*Ruditapes decussatus*)
- 40% of aquaculture products in Portugal (8 kton/y, 44.3 M€/y) originate from Ria Formosa
- 90% of the national production of clams, 26% of oysters.
- Total bivalve production 2750 ton/y for 26 M€/y (36 M$/y)

**Bivalve and finfish aquaculture, salt extraction, wild fisheries, Marine Protected Area**

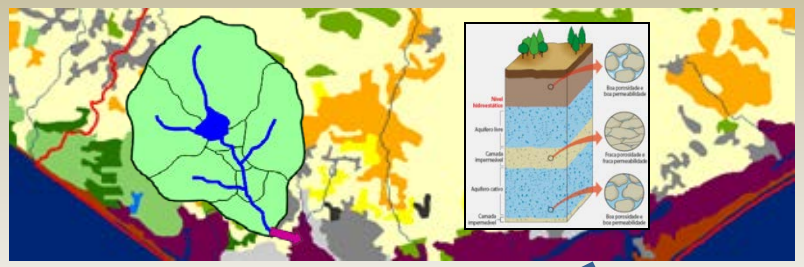
**Clam culture is an important activity, involving over 10 000 people in the Ria Formosa**

# FORWARD/COEXIST modelling framework




**Different models for different questions. Scales are from minutes to decades.**

# Model framework: different scales



**Hydrological model:** SWAT

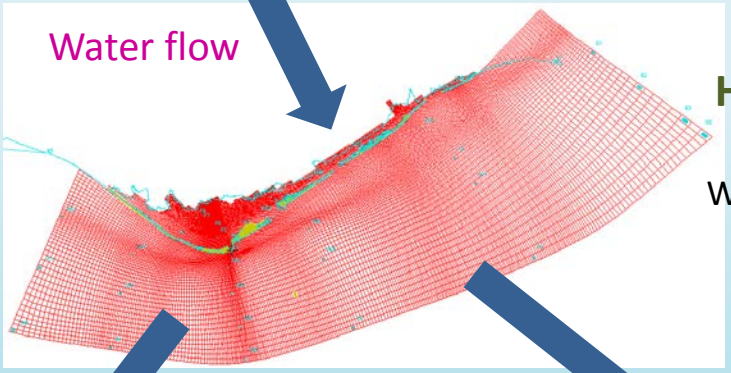
Wastewater discharges + Non-point sources

637 km$^2$, 50 sub-basins

**COASTAL BASIN**

**COASTAL WATERS**

Water flow



**Hydrodynamic model**

Delft3D – Flow

Water flux from tide & waves

1600 km$^2$, 30 000 cells

Nutrient loading

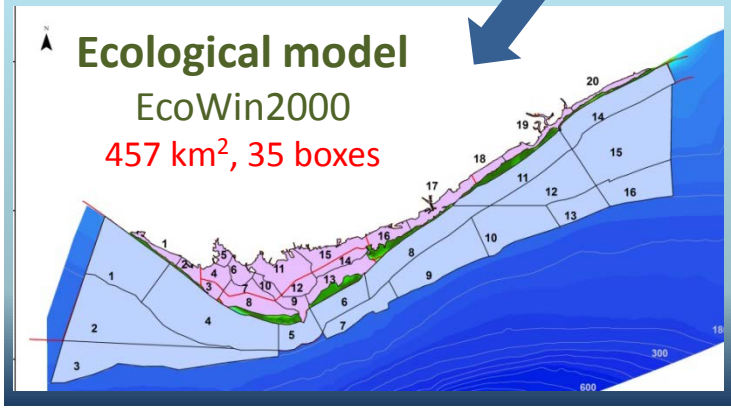
Water flow

Water flow

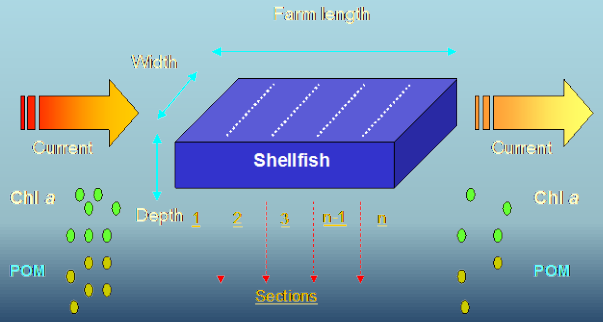
**Local scale models**

FARM

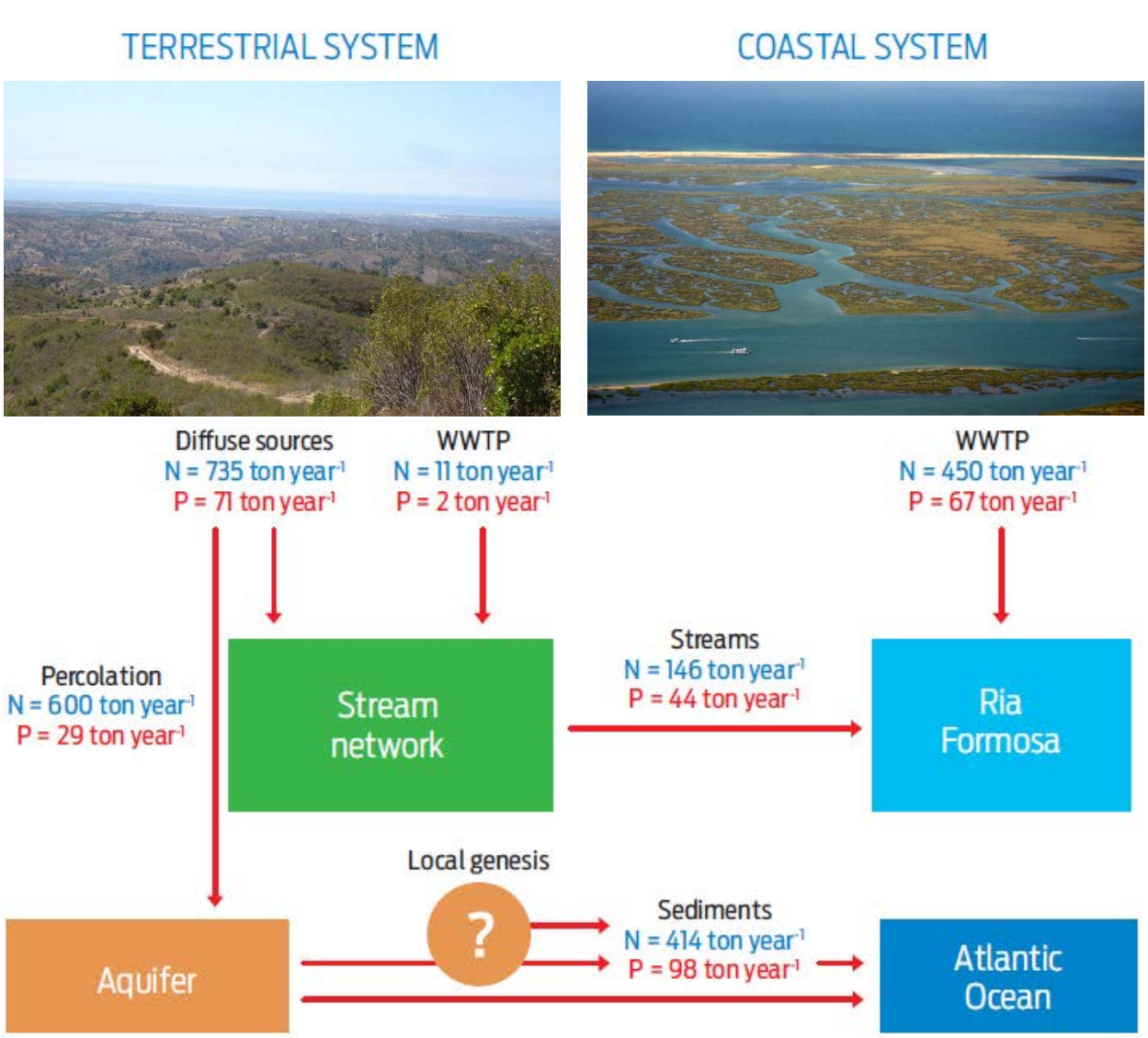
<5 ha, 5-10 sections

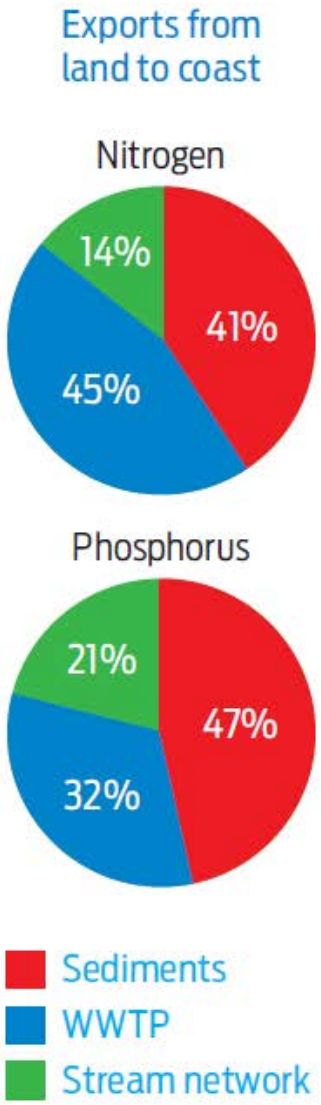



Drivers



# Nutrient discharge: 2007-2008

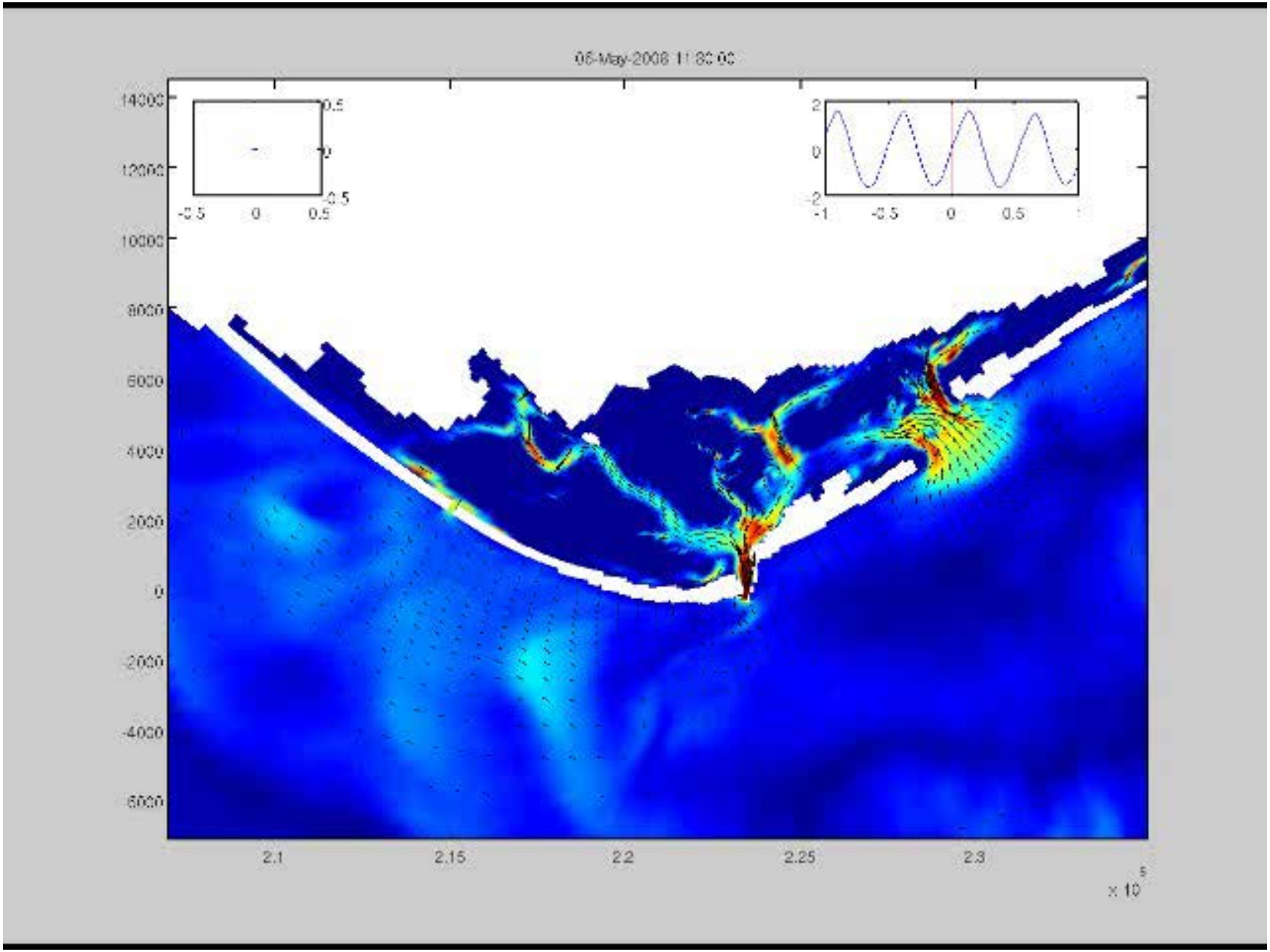



**A significant part of the nitrogen and phosphorus load is from non-point sources.**

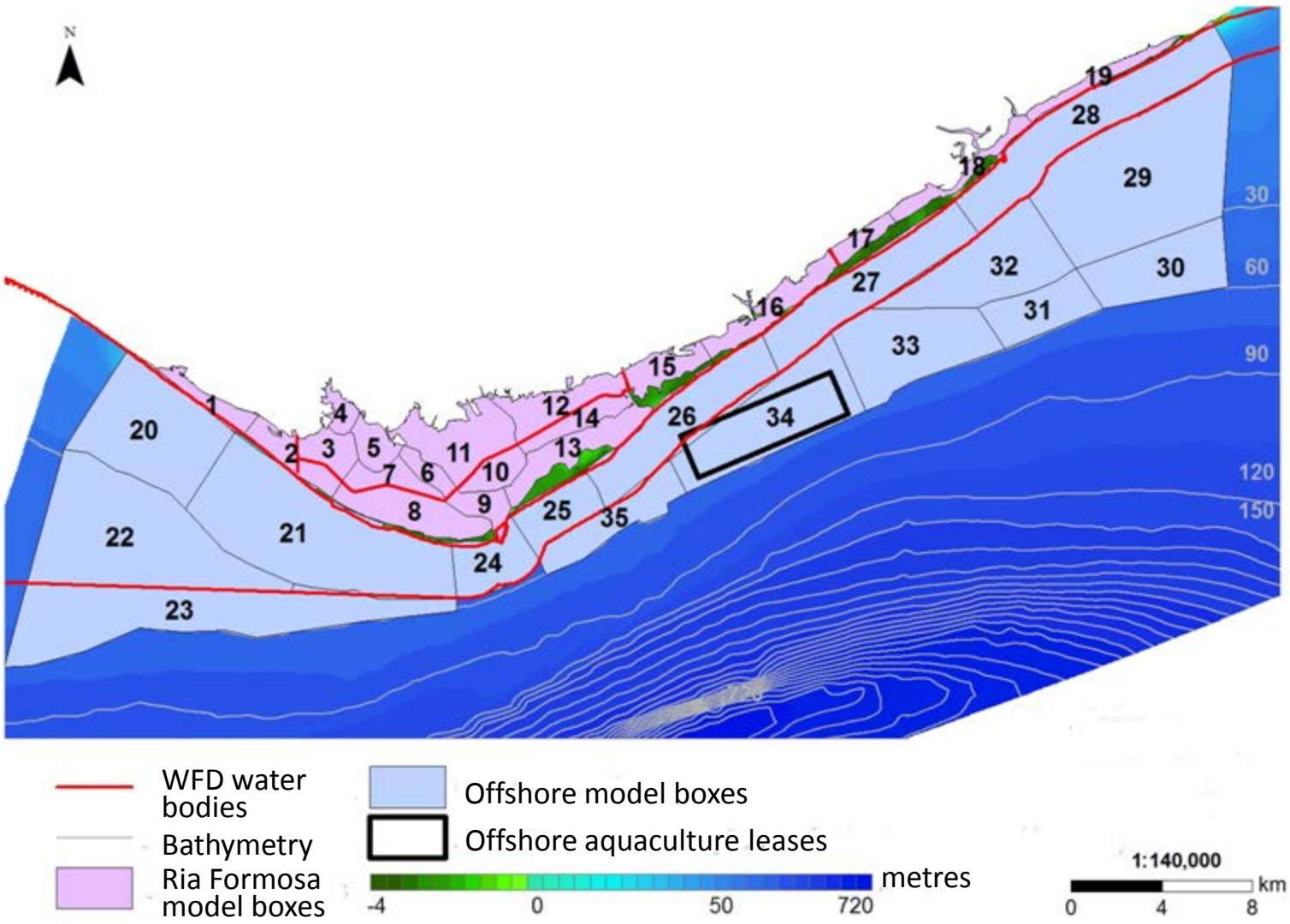
# Connectivity: Offshore-lagoon






**Tidal circulation in the Ria Formosa, Algarve. Residence time of 1-2 days.**

# EcoWin2000 system-scale model

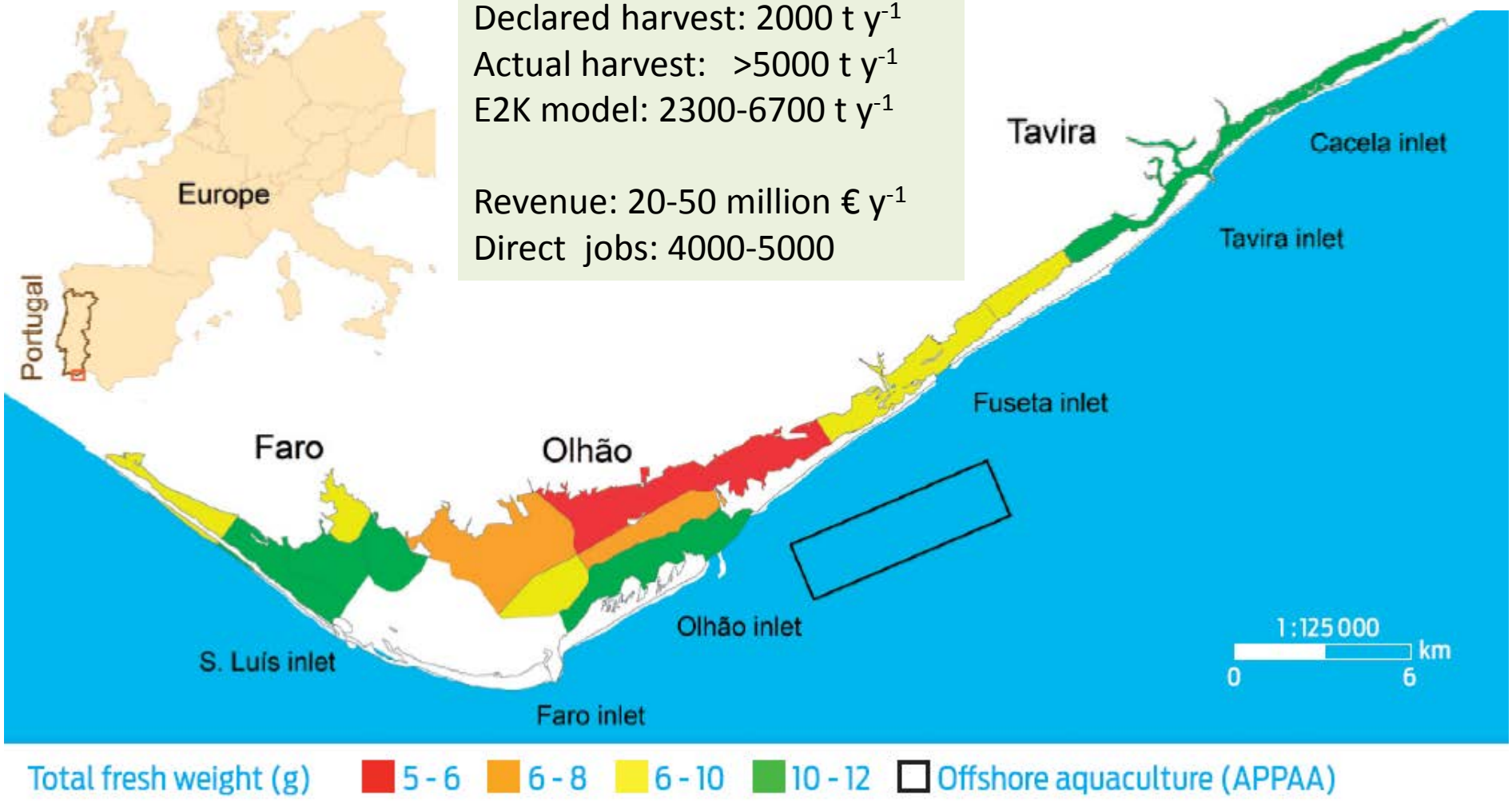



**The system is divided into 35 boxes. Boxes were defined using GIS based on uses, legislation, water quality, and hydrodynamics**

# EcoWin2000 model – system-scale clam production

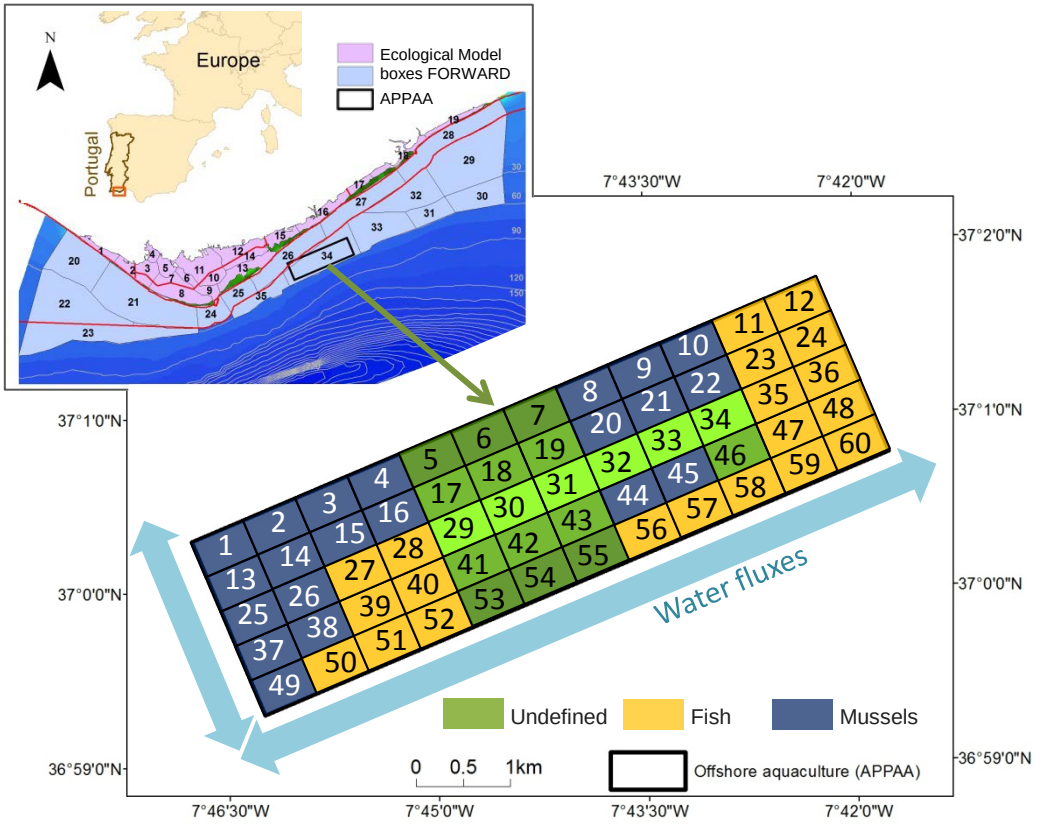
Declared harvest: 2000 t $y^{-1}$
Actual harvest: >5000 t $y^{-1}$
E2K model: 2300-6700 t $y^{-1}$

Revenue: 20-50 million € $y^{-1}$
Direct jobs: 4000-5000




**System-scale carrying capacity is spatially variable, depends on ocean connections.**

# Goods and services from bivalves

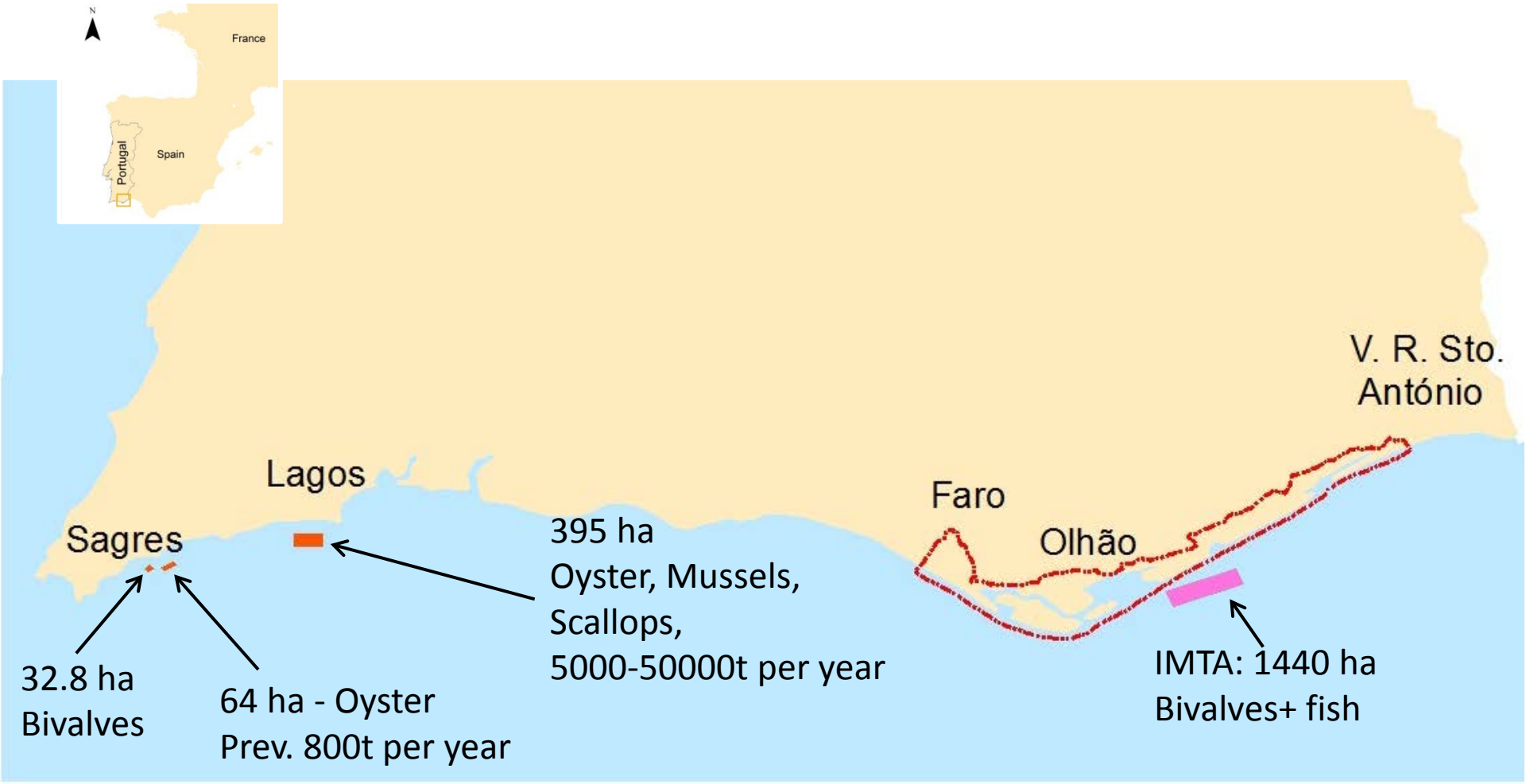



- Removal of organic waste from finfish aquaculture
- Detrital organic material enhance shellfish growth
- Bivalves may act as firewall to prevent virus spreading?

Up to 70% finfish
At least 30% bivalves

**Several large areas in the Algarve are currently designated for offshore aquaculture**

# Offshore aquaculture in the Algarve




Natural park of the Ria Formosa

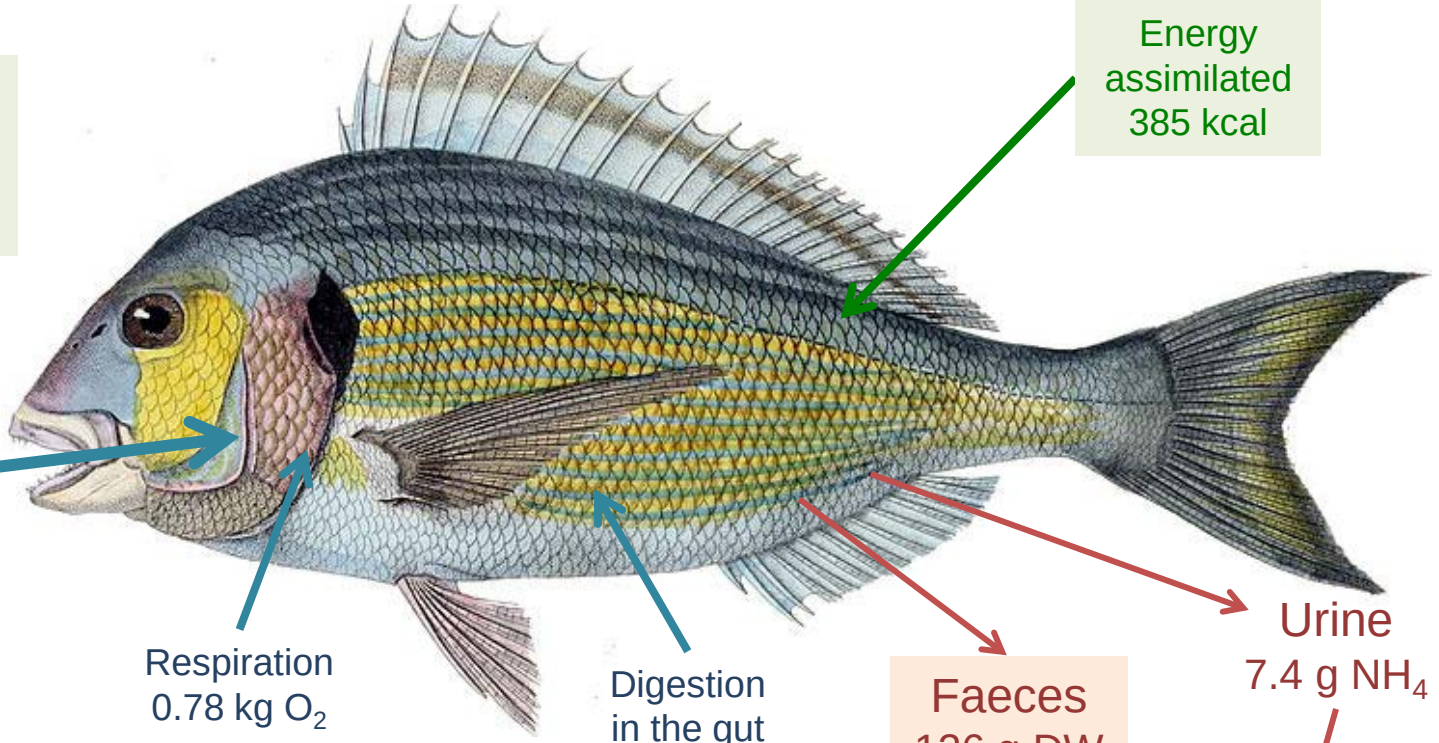
Área Piloto de Produção Aquícola de Armona

Offshore aquaculture

# Individual: Mass balance for gilthead cultivation

## Weight: 350 g, AquaFish model

Anabolism: 1471 kcal
BMR: 277 kcal
SDA: 809 kcal
Swimming: 0.2 kcal



Energy assimilated 385 kcal

Food ingestion
449 g DW

Feed supplied
463 g DW

Respiration
0.78 kg $O_2$

Digestion in the gut

Faeces
126 g DW

Urine
7.4 g $NH_4$

Feed loss
14 g DW

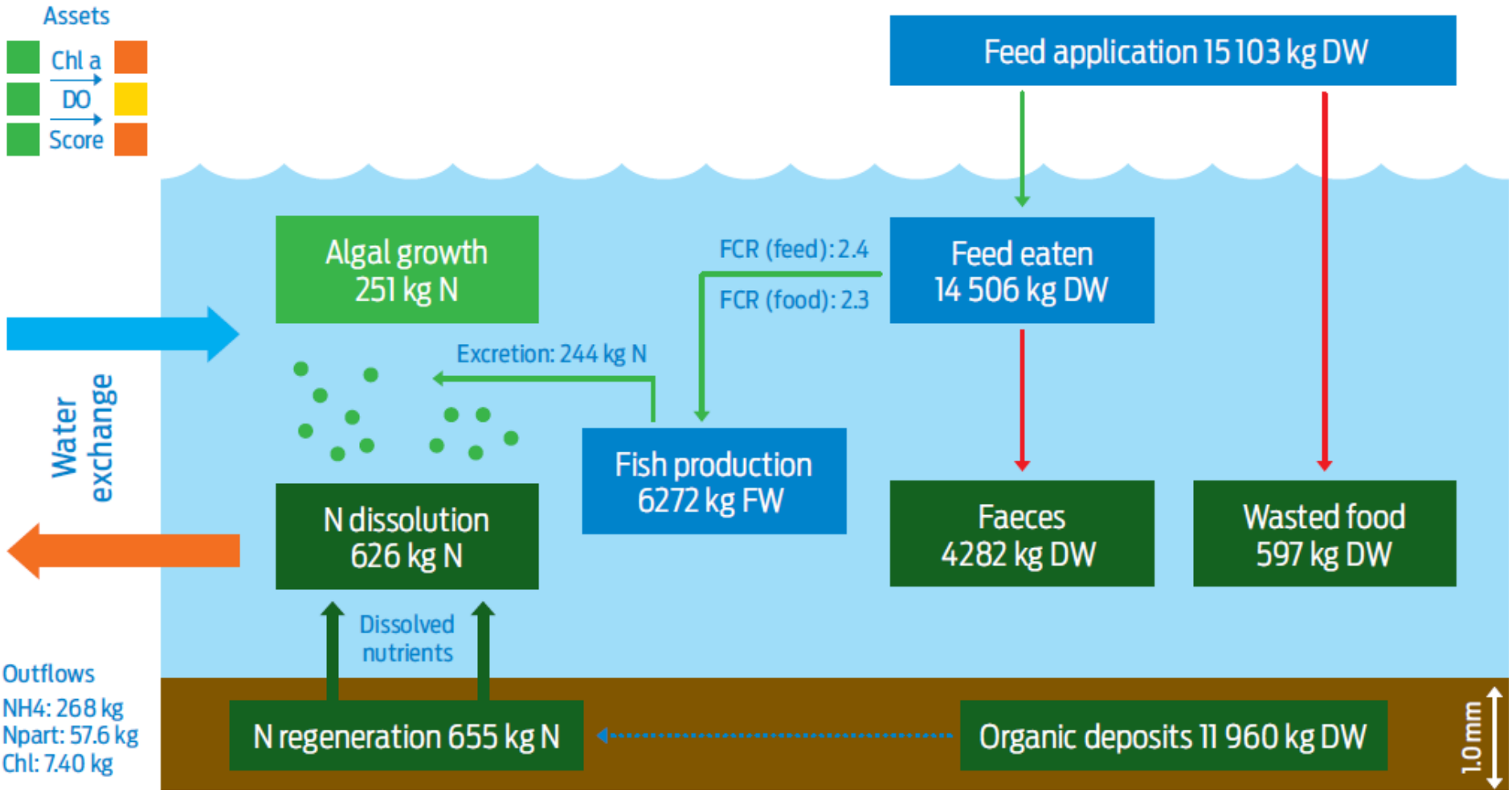
Organic pollution
140 g DW

Inorganic pollution
7.4 g $NH_4$

Cultivation:414 days
Current: 10 cm $s^{-1}$
Biomass: 350 g FW
Length: 29 cm
FCR: 1.3
ADC (N): 82%

# Population: FARM model for culture of finfish

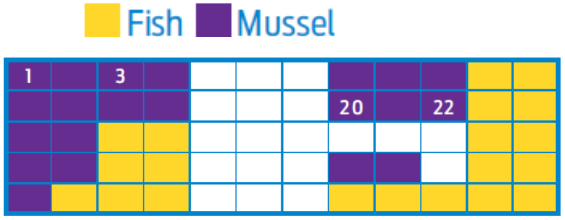
AquaFish model – gilthead bream (*Sparus aurata*)

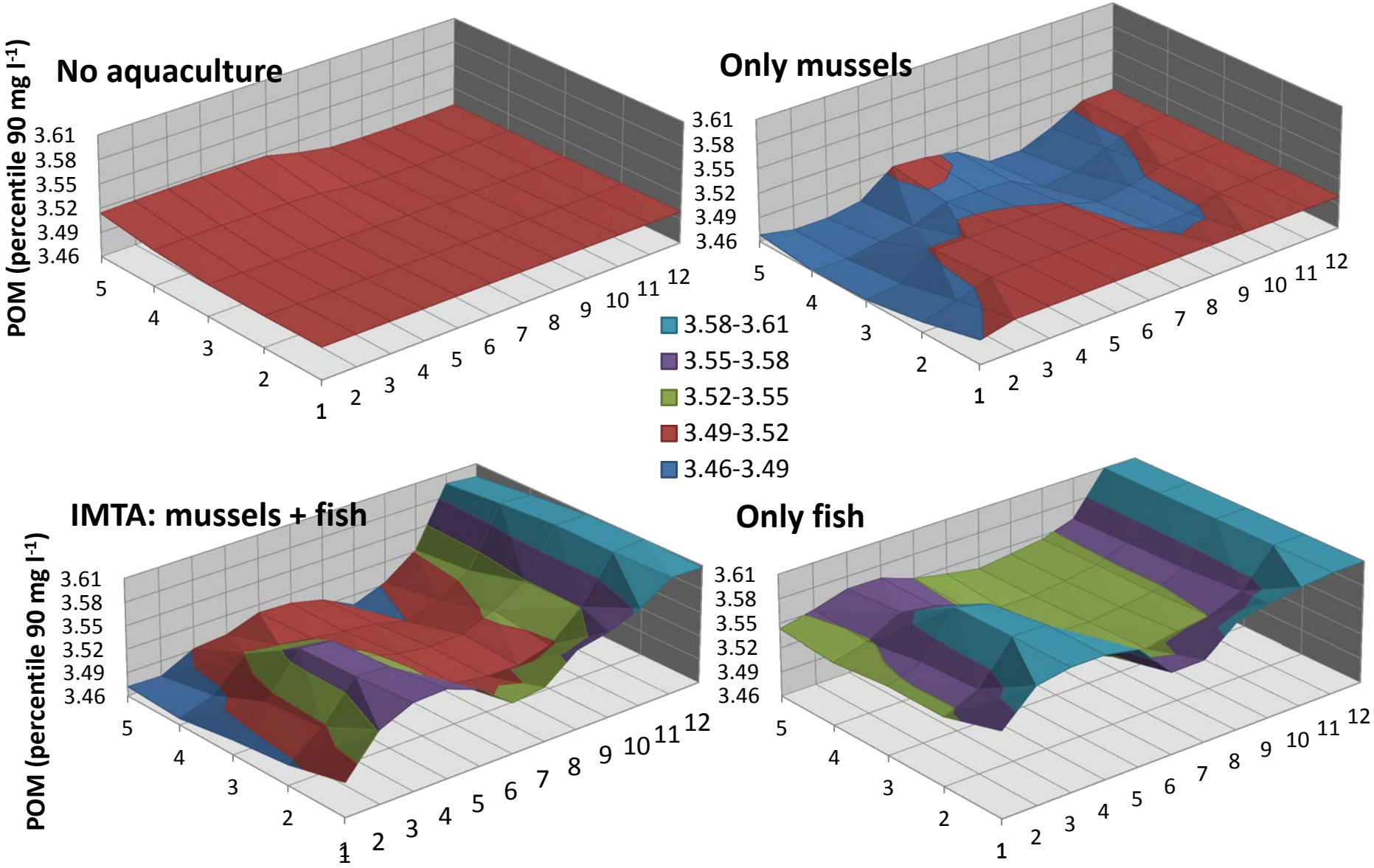



**Mass balance for gilthead pond culture – models are important for optimization**

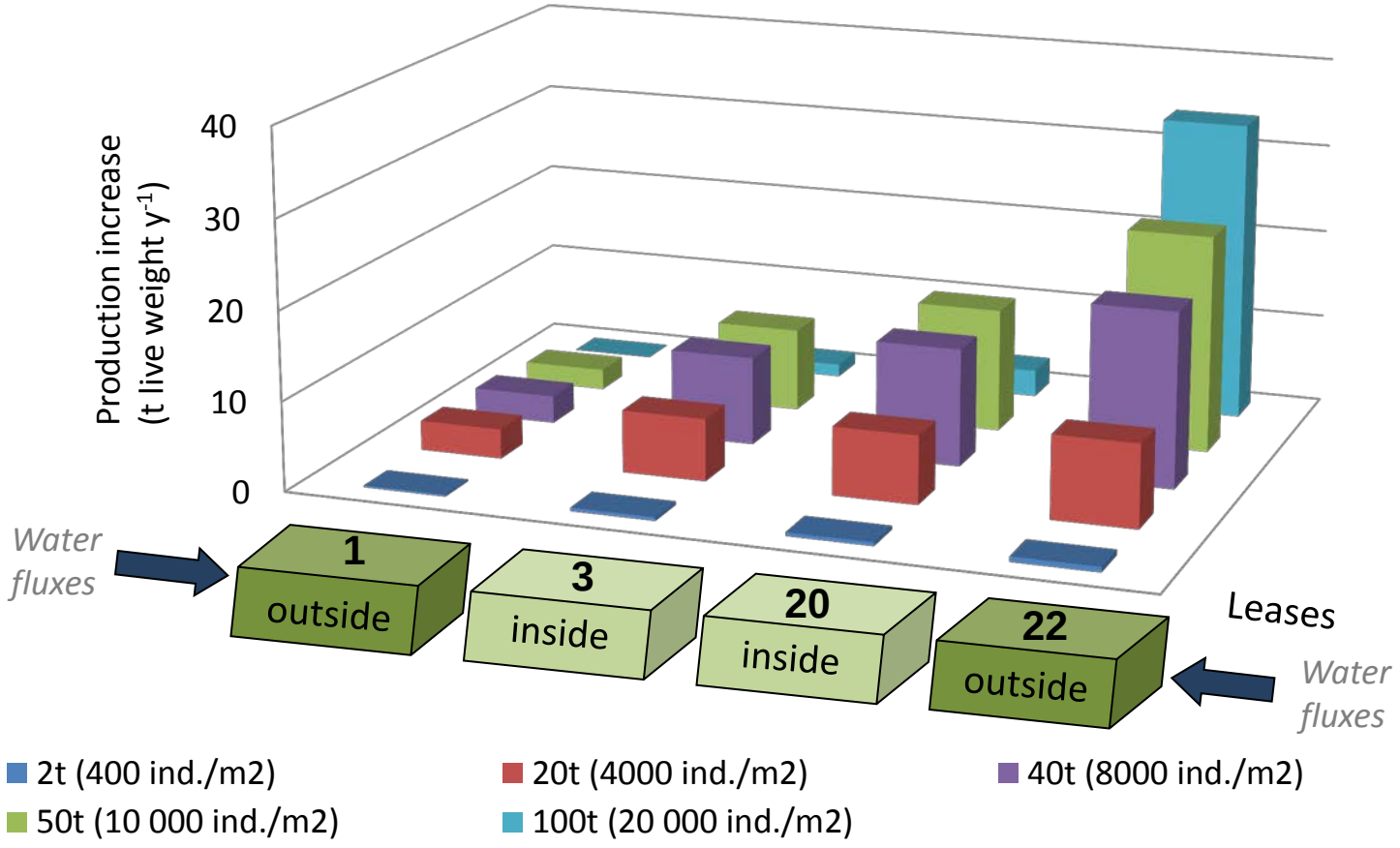
Ferreira et al, 2012. Aquaculture 358–359: 23–34.

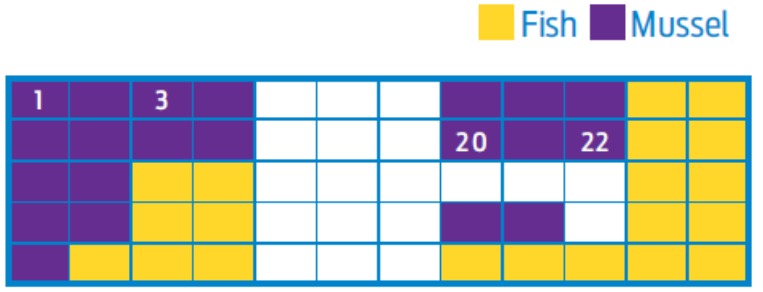
# IMTA: Positive externalities of shellfish culture



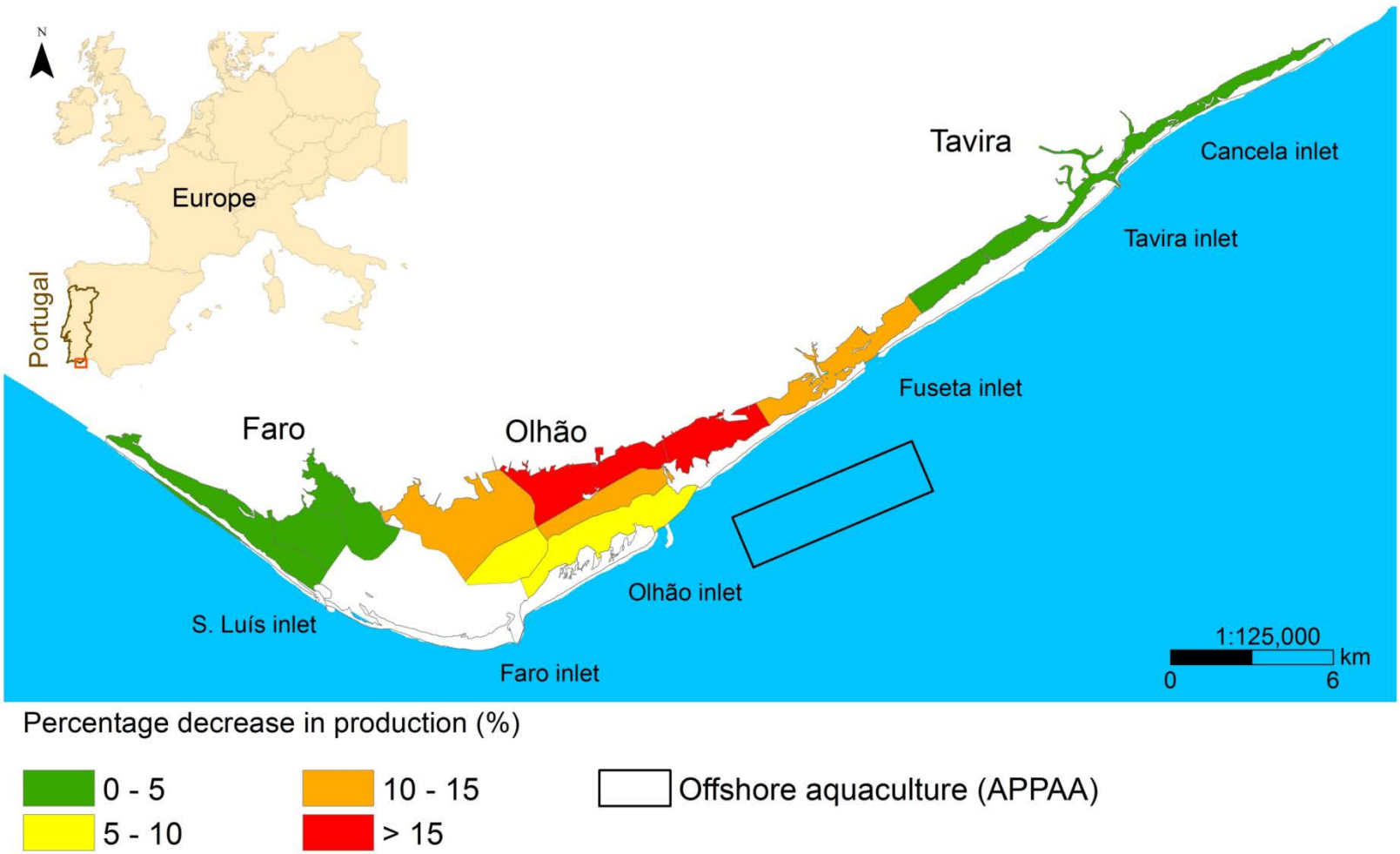
# Simulation of enhanced mussel production with IMTA




**Mussel (blue) lease 22 performs best due to the adjacent finfish culture (yellow), even at high mussel stocking densities.**

# EcoWin2000 - Simulated change in clam harvest due to offshore aquaculture of mussels




**An annual loss of 120 t of clams (1.2 million €) is offset by 13,000 t of mussels**

# Synthesis

- A set of models that address different issues, at different time and space scales, can be very valuable for coastal management;
- Ecological models, governance models – solving the 50% of the problem you like best does not solve the problem
- Many coastal systems show similar problems – social conflict is often more of a management challenge than ecological understanding
- Sound governance, and stakeholder-driven participation, are key factors in making the public understand that IMTA can and should be a positive sum game.

Read the book! http://goodclam.org

# FORWARD products - website

FORWARD Framework for Ria Formosa water quality, aquaculture, & resource development

Home | Project | Results | Team | Meetings | Documents | Links | Gallery | Contact us

## Welcome to the FORWARD project

In 2010 the Institute of Marine Research - IMAR (Portugal) was awarded a 2 year contract by the "Polis Litoral Ria Formosa", under the Plan 6 (Plan for recovery and sustainable management of activities related to resources Ria) for the FORWARD project (Framework for Ria Formosa Water quality, Aquaculture, Resource & Development).

The aim was to develop and test an integrated framework for interpreting coastal zone structure and dynamics, for the recovery and sustainability of aquaculture activities in the present and future.

This public website and the book are the main sources for obtaining information about the project. Here you can find a description of the main objectives, activities and results.


**FORWARD book** – click here

To get a printed copy of this book you ju
your postal address


**Location**

Press to find out the FORWARD location

**Geographic Information Systems**

See the project development activities in GIS maps

**FARM model**

Determine your aquaculture production for optimal carrying capacity

**Management**

For a better understanding of the certification process

http://goodclam.org

# Thanks for your attention…

## Thanks to all people involved in FORWARD/COEXIST

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