COCKLES

Co-Operation for Restoring CocKle SheLlfisheries and its Ecosystem-Services in the Atlantic Area

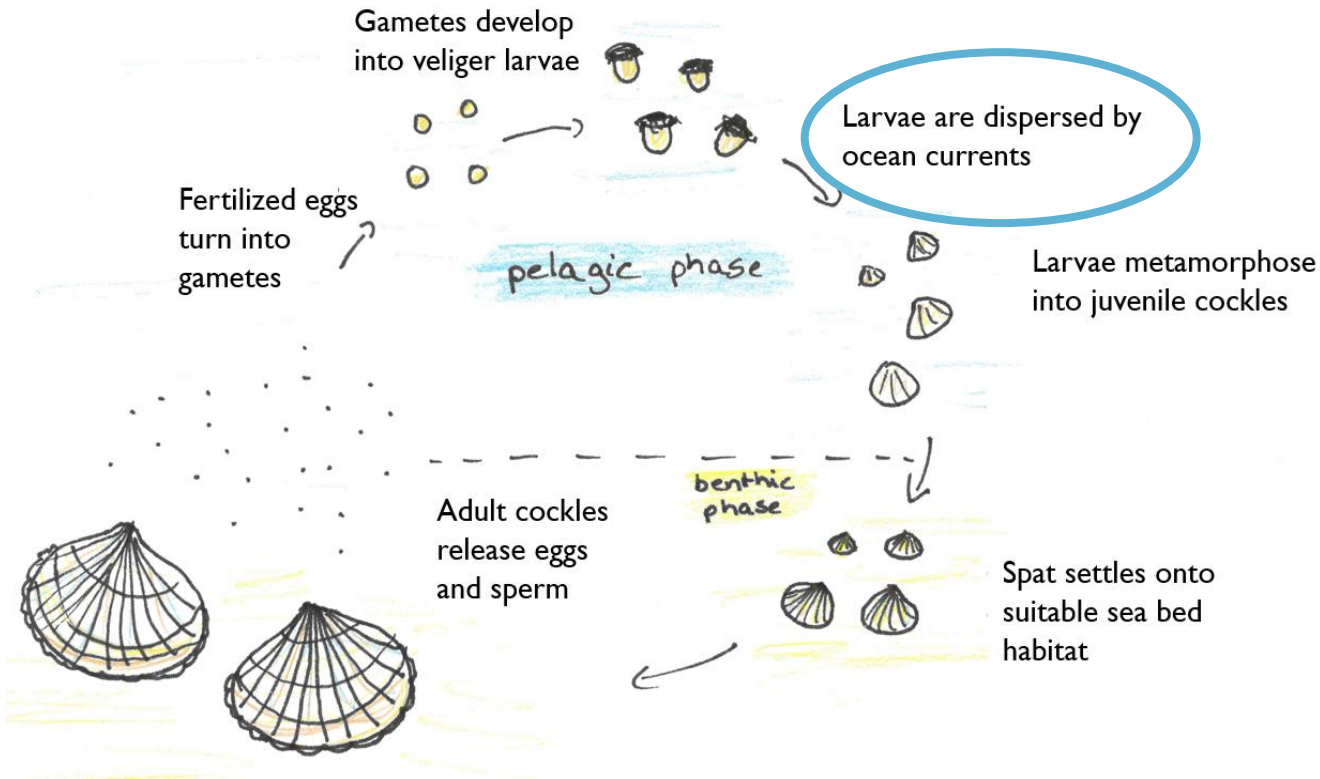# Modelling Larval Dispersal across the Atlantic Area

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FINAL VIRTUAL CONFERENCE

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www.cockles-project.eu

Why are we interested in larval dispersal?

Gametes develop into veliger larvae

Fertilized eggs turn into gametes

Larvae are dispersed by ocean currents

pelagic phase

Larvae metamorphose into juvenile cockles

Adult cockles release eggs and sperm

benthic phase

Spat settles onto suitable sea bed habitat

Connectivity is a measure of the rate of exchange of larvae between subpopulations

Important for:

- Determining which populations are more vulnerable

- Understanding oceanographic 'barriers'

- Management (MPA, commercial beds…)

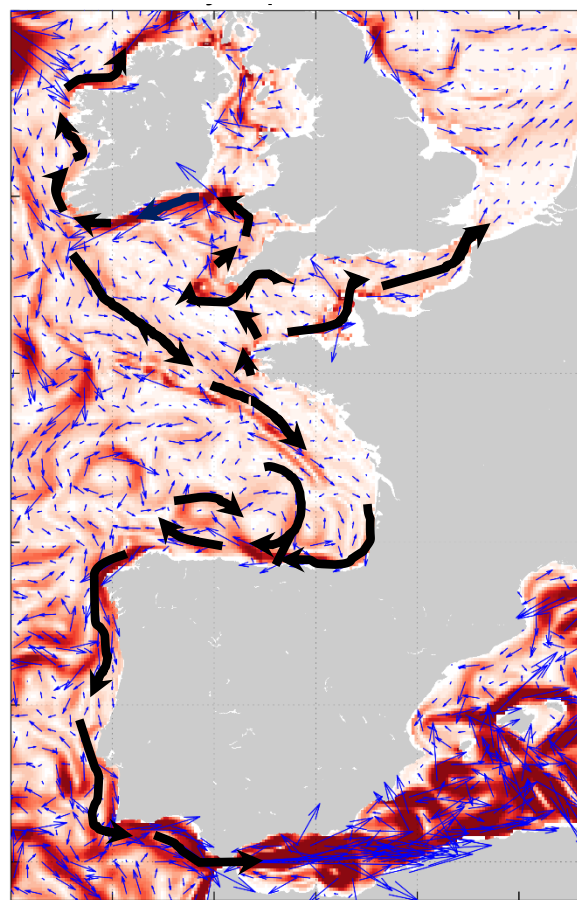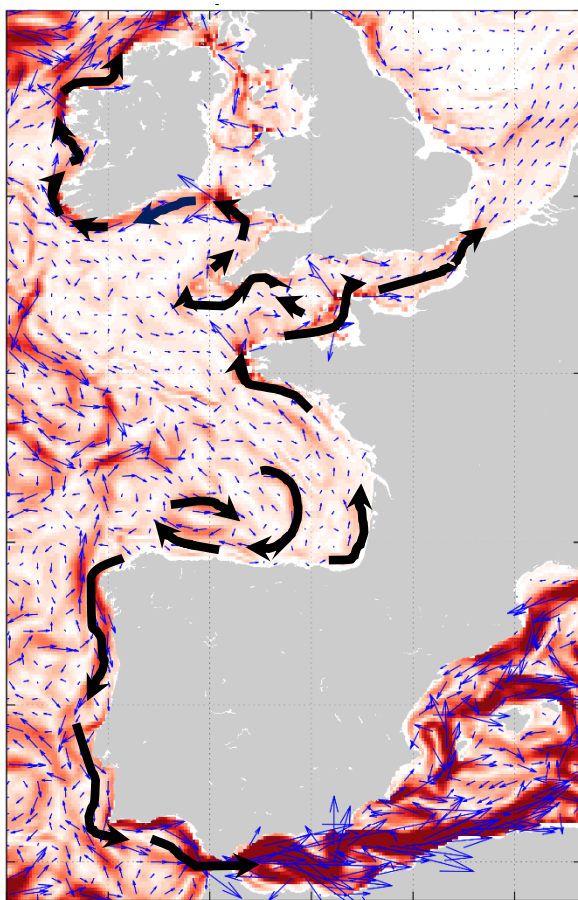# Oceanography of the Atlantic Area

Monthly mean sea surface temperatures

Wide range of oceanographic features:

Fronts

Tidal mixing

Upwelling

Eddies

Wind mixing
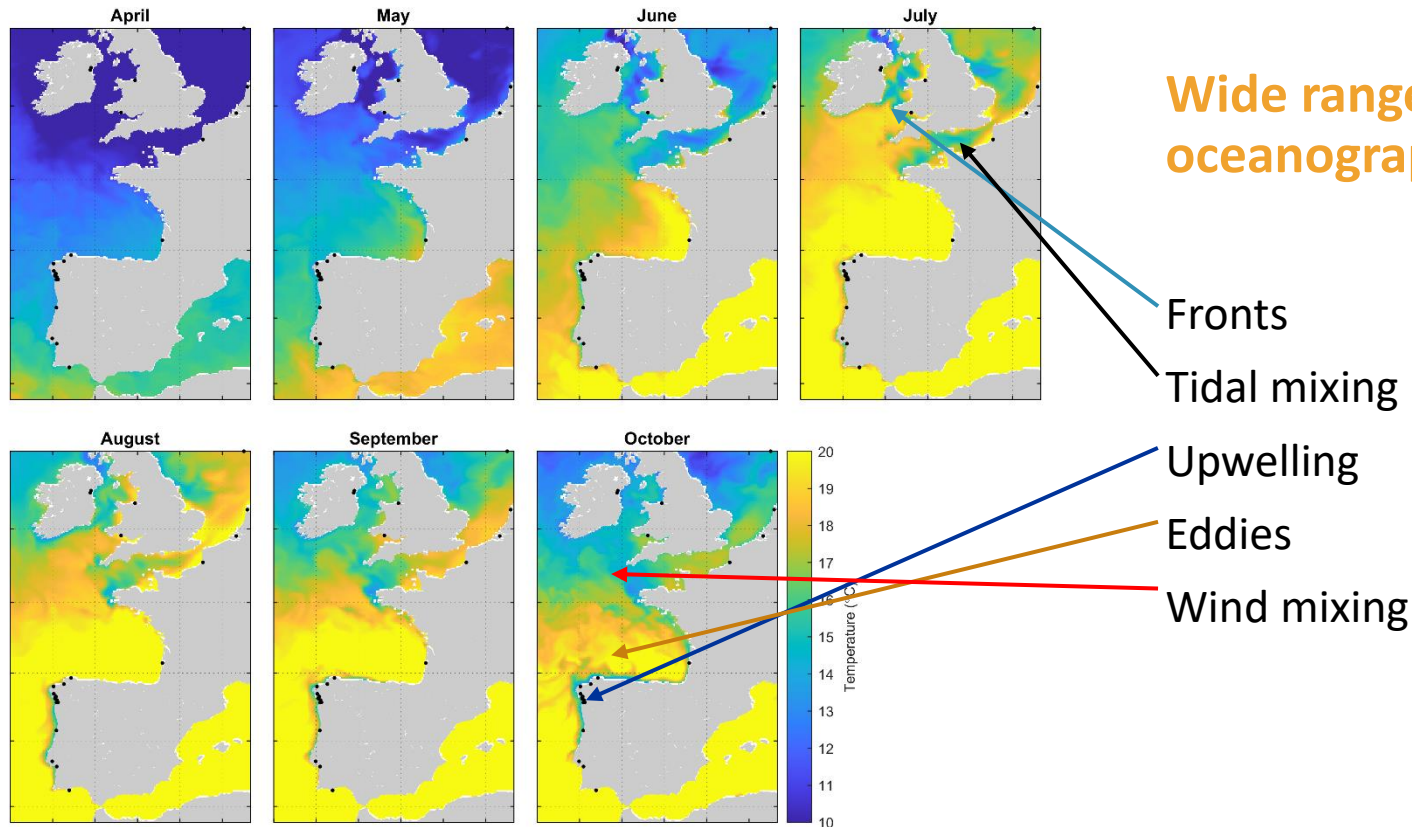
IBI model PHYS_005_001 year 2018; 1/35° horiz. resolution

Ocean currents in the Atlantic Area

April -June

July - September

Current velocity (m/s)

0.15

0.1

0.05

0

IBI model PHYS_005_001 year 2018; 15 m depth
1/35° horiz. resolution

Larval dispersal modelling

Focus on three areas:

- **Full Atlantic Area**
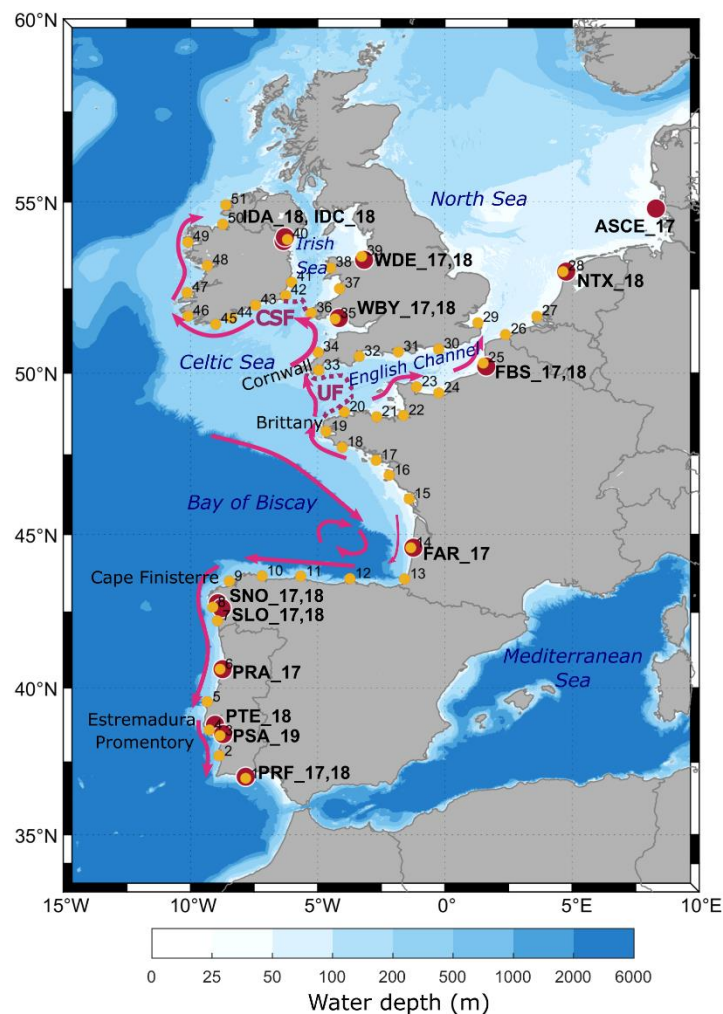- **Irish and Celtic Sea**
- **Galician Rias**

Larval dispersal model:

- Virtual larvae released from cockle bed locations and advected for 35 days by ocean currents

- Last 10 days used for connectivity analysis

- Larval dispersal evaluated with releases from April to September

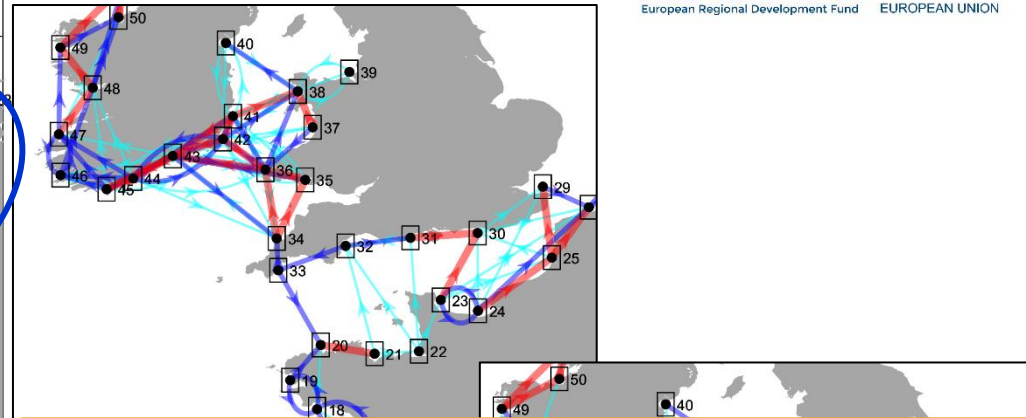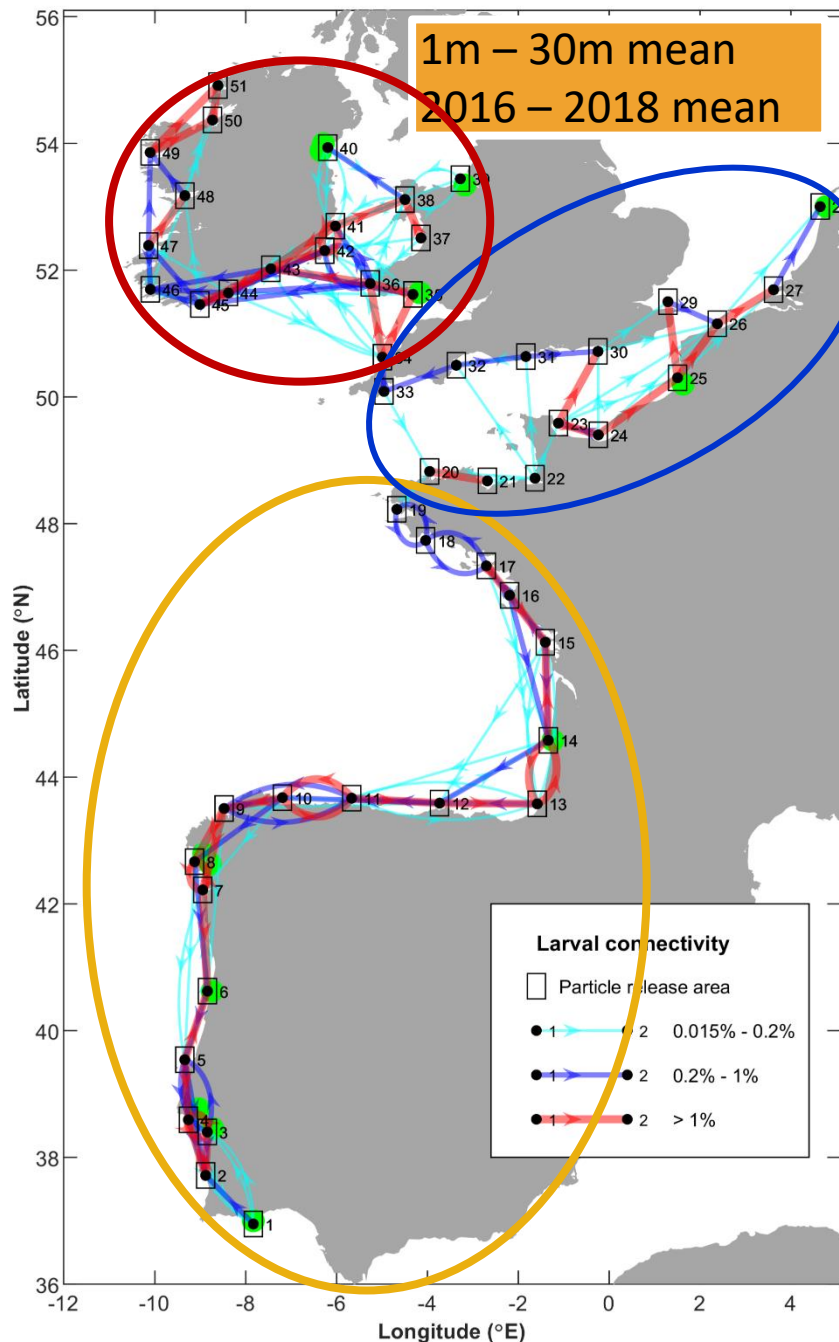- Interannual variability considered where possible
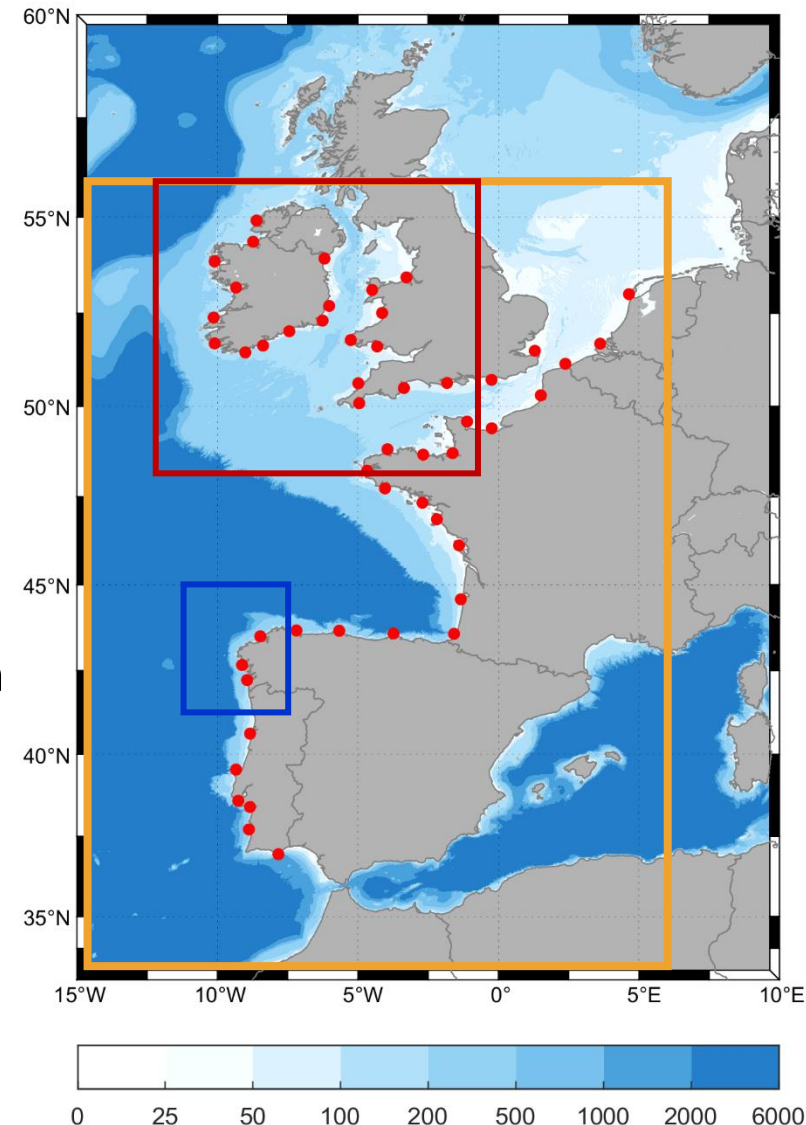
Atlantic Area Connectivities

- Virtual larvae released from 51 sites
- April to September simulated
- 400 particles advected from each site per release day for 40 days
- Connectivity analysis based on 17,625,600 trajectories
- Last 10 days used for analysis

Atlantic Area connectivity

- Three distinct oceanographic units:
1. Portugal, Spain, France up to Brittany
2. English Channel
3. Irish and Celtic Sea

- Divides more pronounced the deeper the larvae in the water column (more realistic?)

- Divides similar to patterns identified in the genetics analysis

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Modelling larval dispersal in the Rias Baixas

**Rias Baixas
MOHID model**
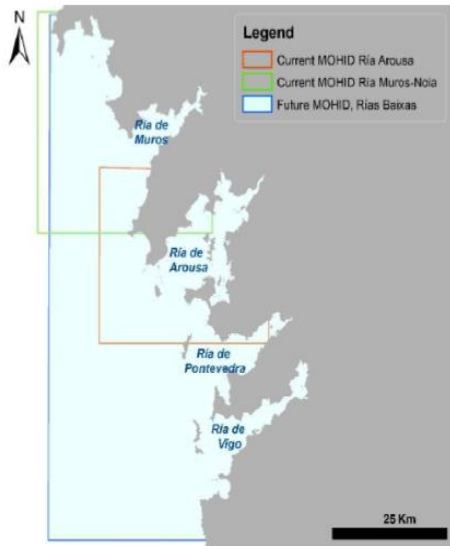
**ROMS model NW
Spain & Portugal**
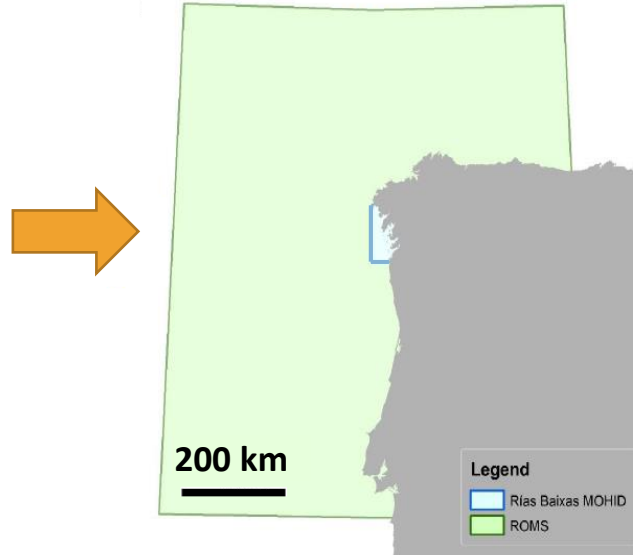
Merging of high and low resolution hydrodynamic models to achieve high resolution rias but also large enough domain
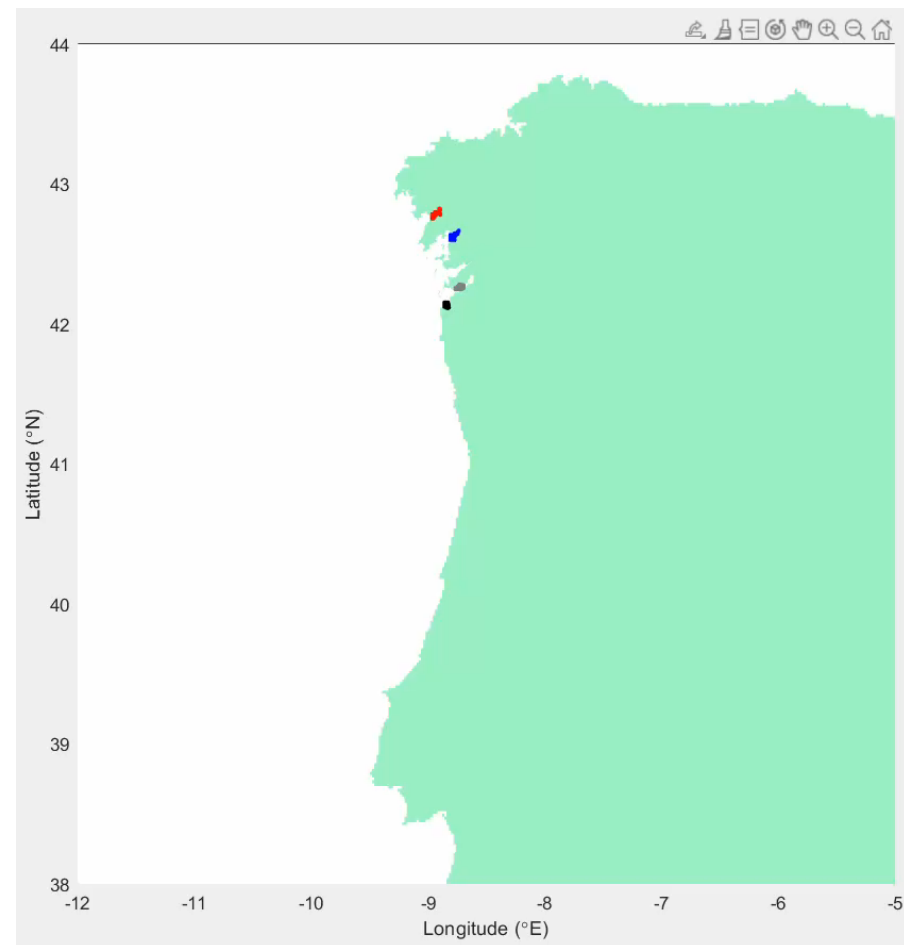
Particle tracking model setup:

- 200 virtual particles released each day
- April to September for the year 2018
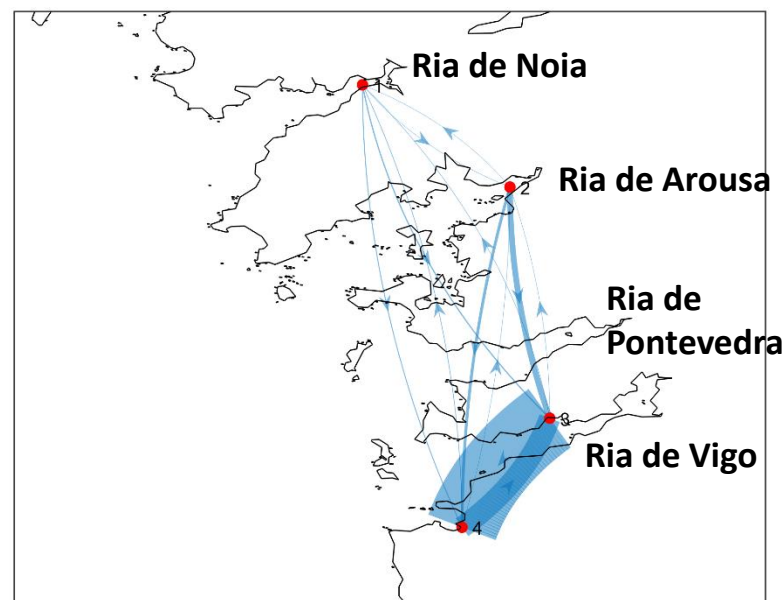- Advected for 35 days, with last 3 days used for connectivity analysis

Connectivity patterns Rias Baixas

April – September mean

01/06/2018 release

All Rias connected, but:

- Southern 3 sites show much stronger connectivities
- Fairly consistent pattern between months; weakest connectivities in August
- Weaker connectivity with Ria de Noia
- Implications for spread of Martilliosis?

Irish and Celtic Sea seascape genetics

Aims:

- Investigate population structure at finer scale resolution
- Understand drivers of genetic differentiation – environmental variables

Methods:

- Cockles sampled from 7 locations in 2010 and 2011
- Filtered dataset has 138 individuals and 1725 SNPs
- Larval dispersal modelling carried out using AMM NEMO model (1.5 km horizontal resolution)
- Link genetic and environmental data
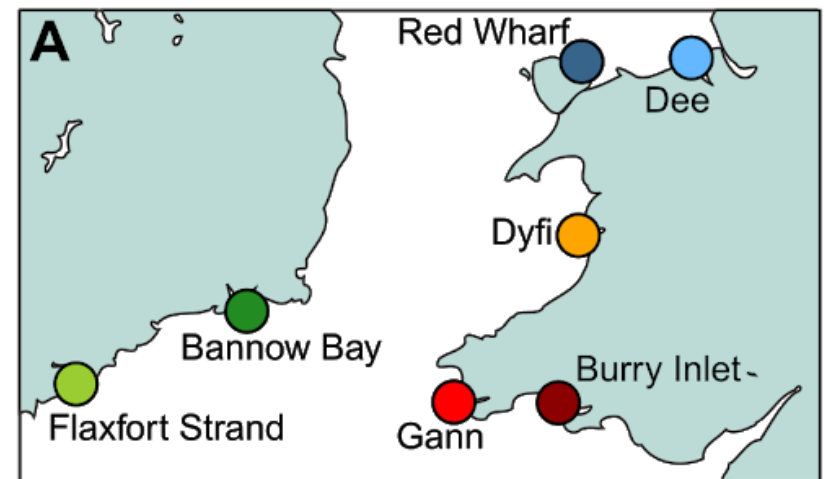
Coscia et al., Fine-scale seascape genomics of an exploited marine species, the common cockle *Cerastoderma edule*, using a multimodelling approach, *Evolutionary Applications*, 2020.

Genetic substructure in the Irish and Celtic Seas

neutral

outlier

Geographic distance & currents

SSTs
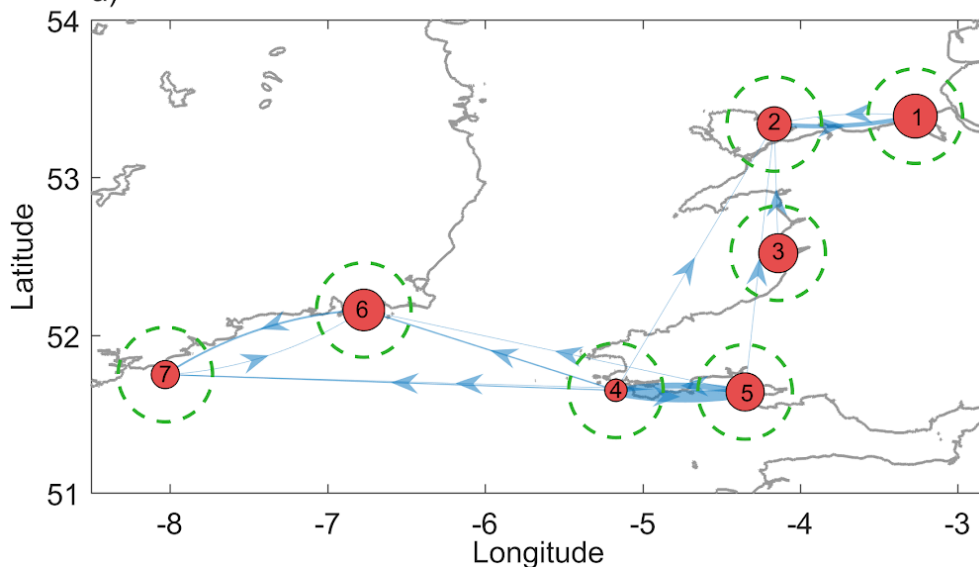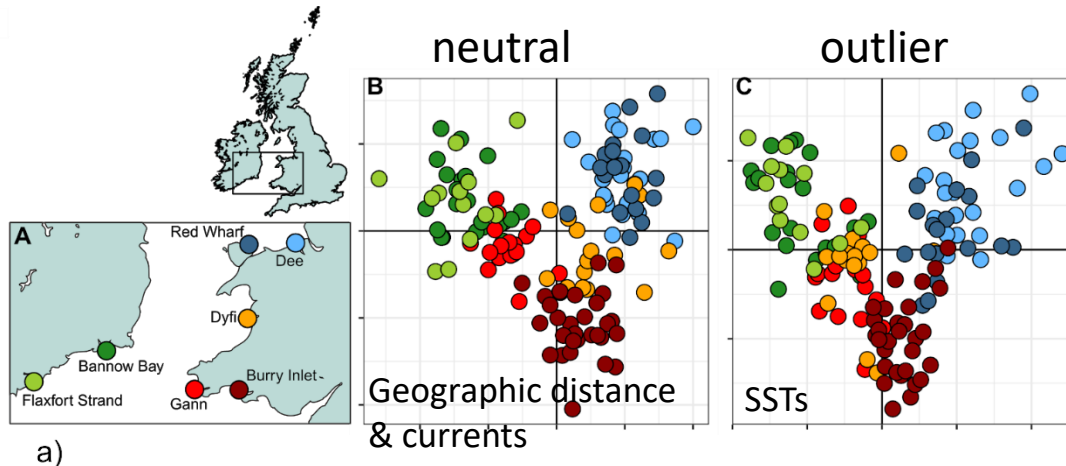
Distinct genetic substructure seen in neutral and outlier markers related to larval connectivity & environmental variabiles:

All sites connected, but distinct sub-units:

1. North Wales sites
2. Burry Inlet, Dyfi estuary & Gann
3. Irish sites and Gann

Mirrored in the genetics (neutral markers); outlier makers related to SSTs

Importance of larval dispersal for C. edule in the Atlantic Area

- Larval dispersal is an important part of the cockle's lifecycle during which subpopulations are able to connect with each other

- Understanding of larval dispersal important to determine vulnerable beds & thus inform management decisions

- Larval dispersal was investigated in 3 different areas:
    - Whole Atlantic Area: 3 distinct subgroups were demonstrated
    - Rias Biaxas: All rias connected by larval dispersal but Ria de Noia less so
    - Irish Sea: 3 subgroups identified in the genetics related to larval dispersal
    - → Work highlighted potential oceanographic barriers: headlands of Brittany and Cornwall, and Celtic Sea and Ushant Fronts

- Where is more work needed?
    - More knowledge on larval behaviour is required (ongoing experiments)
    - Links between estuaries and large-scale oceanography

Thanks for all of the fruitful discussions and enjoyable collaborations on the COCKLES project!