

COCKLES

Co-Operation for Restoring Cockle SheLLfisheries and its Ecosystem-Services in the Atlantic Area

Historical *versus* current status of cockle distribution, abundance, population dynamics and reproductive health.

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WP4 General objective

Comprehensive baseline study of cockle population distribution, abundance, dynamics and site influences in the Atlantic Area (AA) past and present



- Lead Partner UCC
- All partners involved



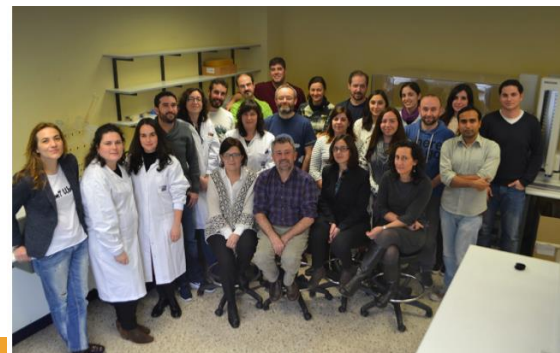
WP: 4 Baseline assessment: Characterising populations, reproductive health and genetics

Action 4.1: Historical survey of cockle distribution, abundance & population dynamics (*January 2018 – March 2019*) (*UCC- contribution from all partners*)

Action 4.2: Field survey of cockle distribution, abundance & population dynamics currently (*April 2018 – October 2019, All partners*)

Action 4.3: Cockle reproductive health (*April 2018 - October 2019, All partners*)

Action 4.4: Cockles population genetics (*October 2017 –September 2019, CIMA- all partners*)



- 10,878 records of quantitative & qualitative data
- 1859 to the present day

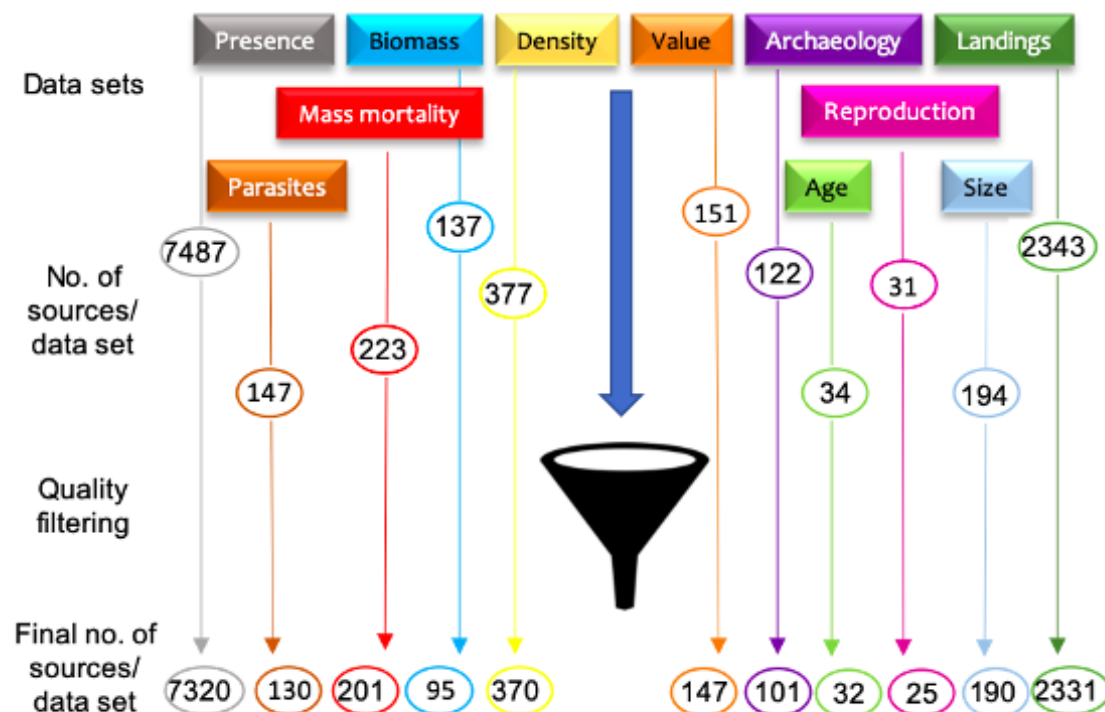




Figure 1. A late Mesolithic shell midden, containing cockles located in Co. Down, Ireland (Murray, 2011).

Distribution

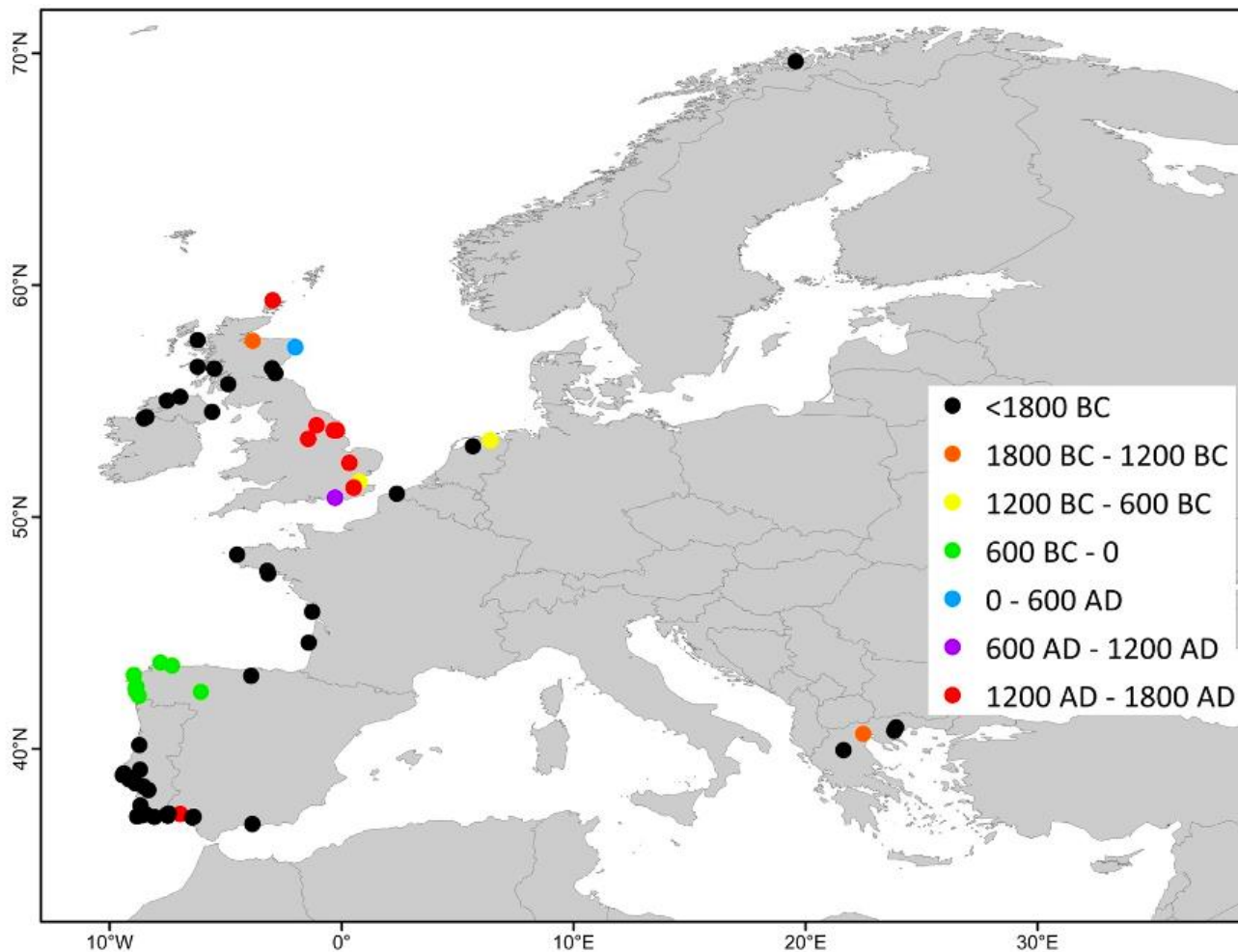


Figure 2. Locations of archaeological records of cockles

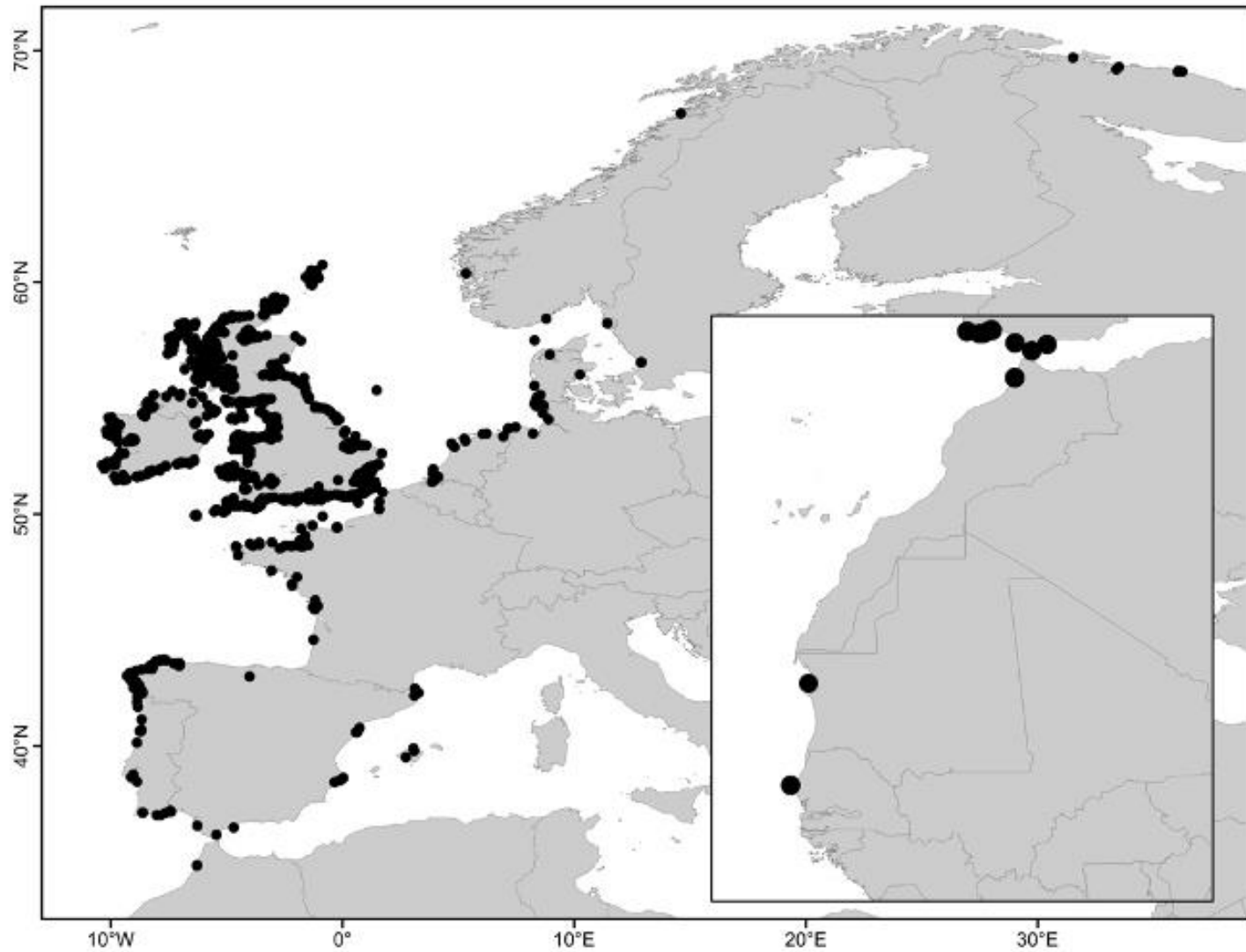


Figure 3. Distribution of cockles, with records ranging from 1893 to 2017.

Density

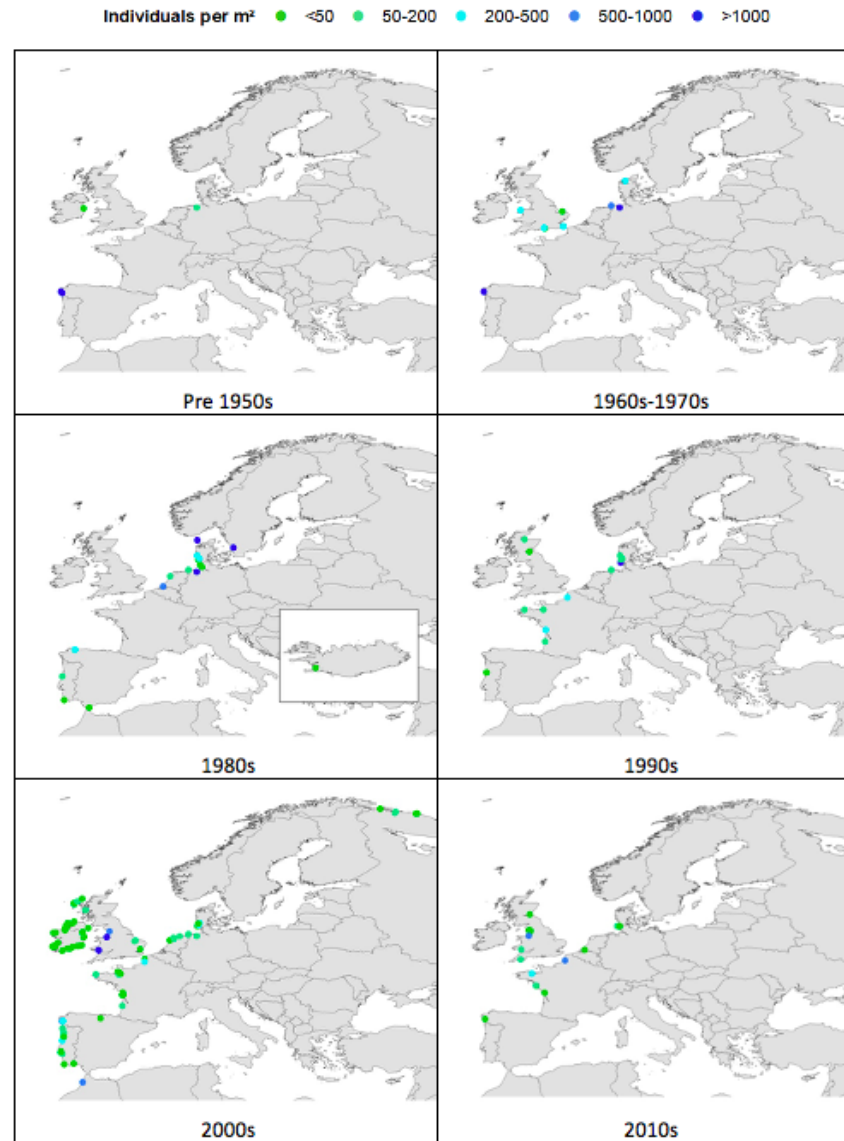


Figure 4. Density (individuals/m²) of cockles reported across Europe between the 1940s and 2010s, where dot coloration indicates the number of individuals/m².

Capture & Production

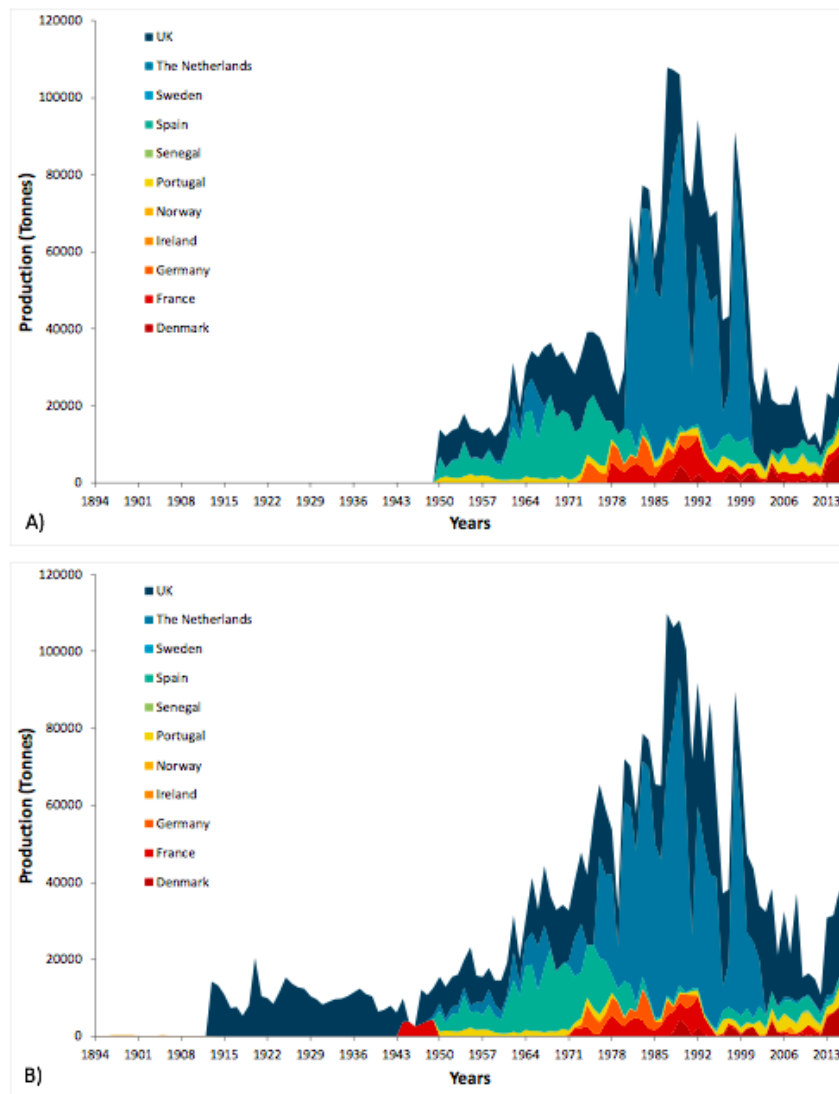


Figure 5. Cumulative capture and aquaculture production of *C. edule*. A) Using FAO data and B) Using data from multiple sources.



Parasite & Pathogen Species Richness

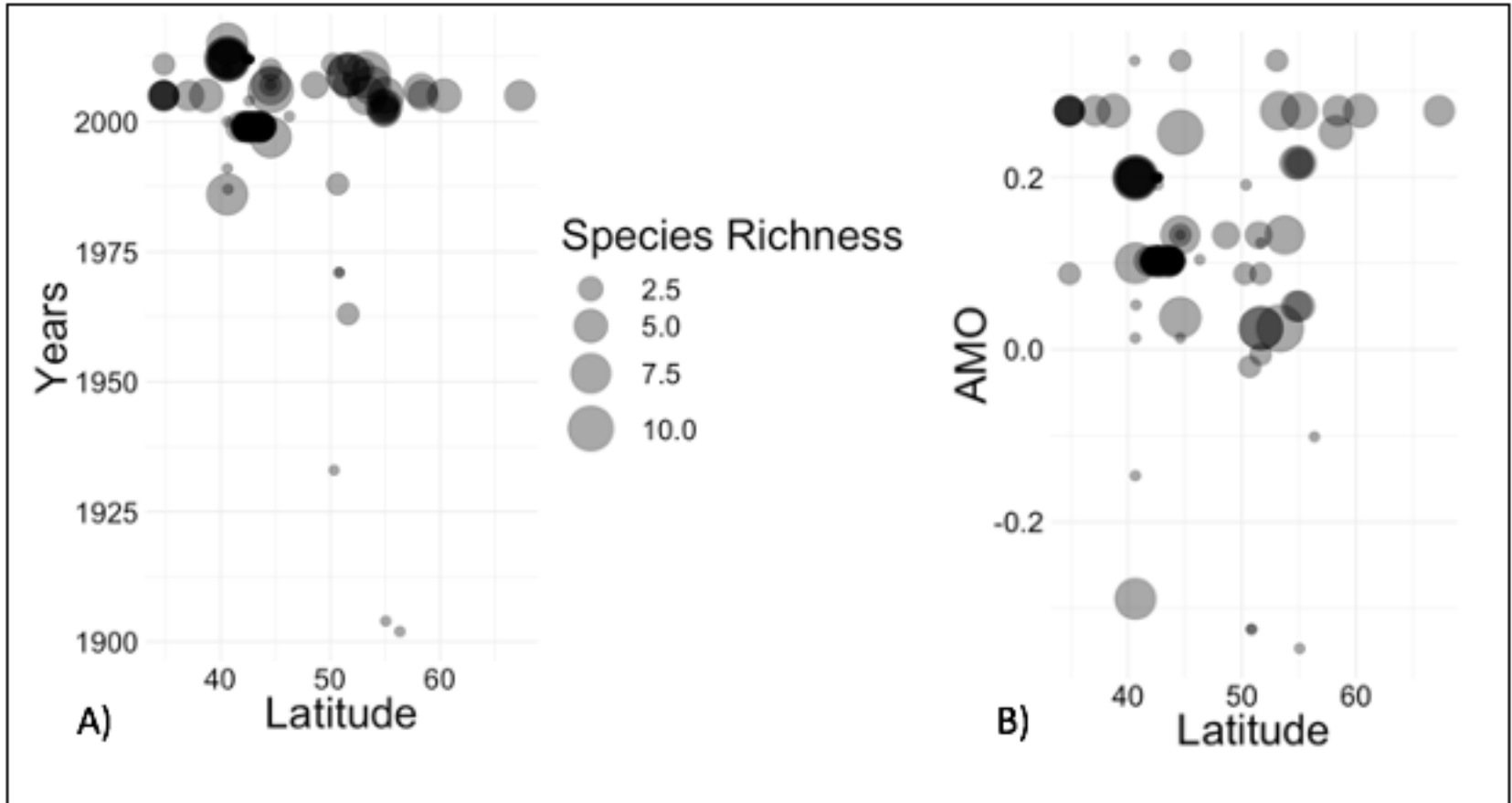


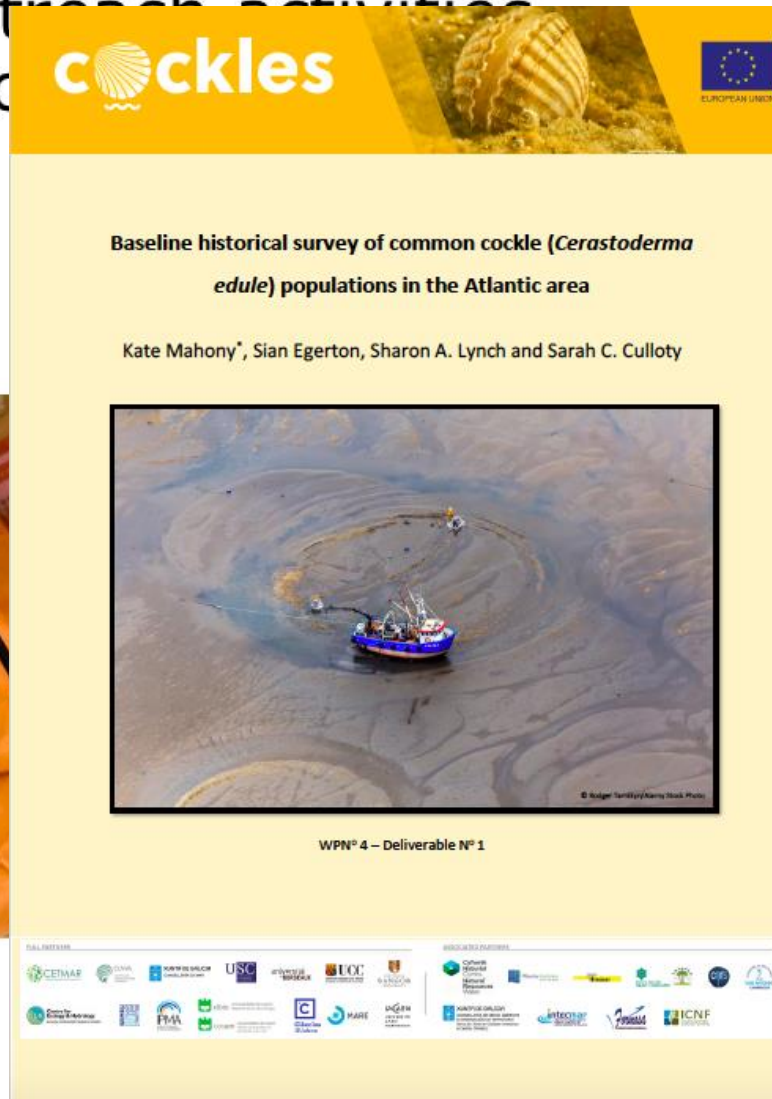
Figure 6. Species richness at certain latitudes by A) Year and B) AMO index.

Key Findings:

- Cockle density and mortality are site dependent
- Many mortality events have occurred due to a combination of causes (disease, extreme weather, pollution)
- More mass mortalities have been recorded in recent years
- Reports of mass mortalities higher in years with a + AMO index
- Lower density in cooler years (- AMO index)
- At a local scale variation evident (management regimes, parasites, water quality, fisheries etc)

Recommendations: Standardised, regular monitoring shared between all countries. Knowledge exchange platform for all stakeholder communities. Local management rather than regional.

(3) Infographic for Educational Kit, School outreach activities & Public



4.2 Current Cockle Population Dynamics in the AA



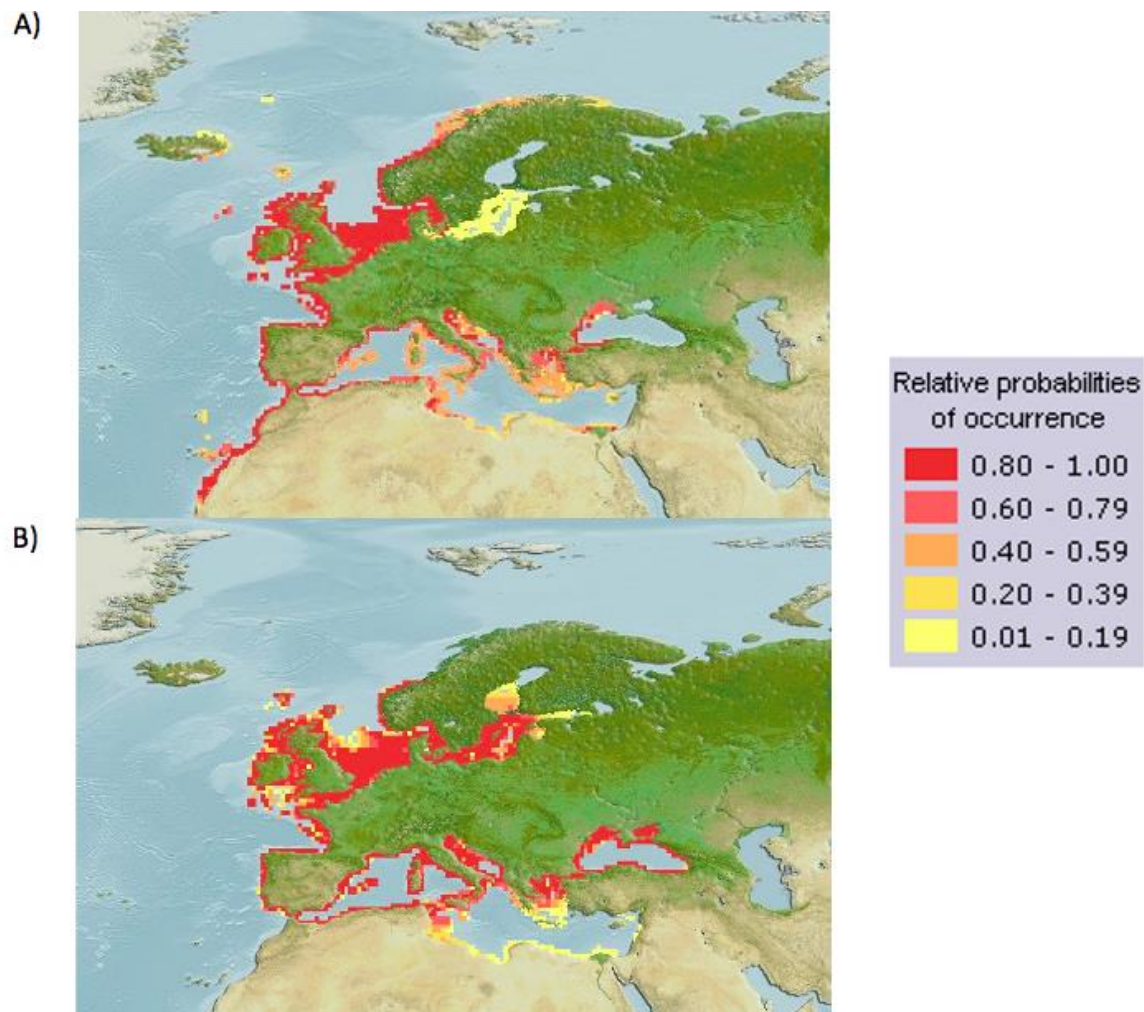
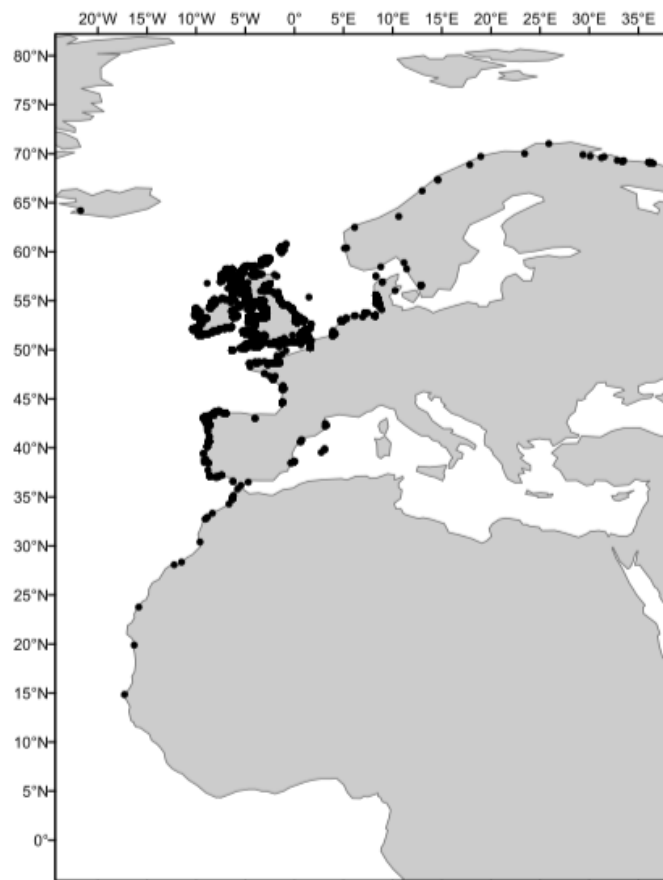


Figure 1. Computer generated probable distribution maps of A) *Cerastoderma edule* and B) *Cerastoderma glaucum*. The colour range indicates the areas containing suitable habitat for the species and therefore likely areas of occurrence (www.aquamaps.org).

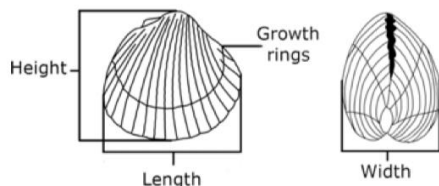


Current Cockle Distribution

Figure 7 Distribution of *Cerastoderma edule* according to records from COCKLES Deliverable 4.1, 4.2 and studies published in the interim between these reports (1893 to 2020).

Country	Ecosystem	Dates	Coordinates	Study Leader
Wales	Dee Estuary	February 2019	53°20'N 3°10'W	UBx
Ireland	Cork Harbour	February 2019	51°51'N 8°15'W	UBx
Ireland	Dundalk Bay	July 2019	53°56'N 6°19'W	UCC (MI & BIM)
Wales	Burry Inlet	February 2019	51°40'N 4°12'W	UBx
France	Bay of Somme	Apr 2019	50°14'N 1°33'W	UBx
France	Seine Estuary	2017-2018	49°28'N 0°04'W	UnCaen
France	Baie des Veys	2017	49°21'N 1°07'W	UnCaen
France	Roscoff Bay	May 2019	48°43'N 3°59'W	UBx
France	Arcachon Bay	Nov 2018	44°39'N 1°08'W	UBx
Spain	Baiona Inlet	Jan 2019	42°07'N 8°49'W	UBx
Spain	Ria de Arousa	Apr & Sep 2017 -2019	42°30'N, 8°50'W	CIMA
Portugal	Óbidos Lagoon	Jul 2019	39°24'N 9°12'W	MARE
Portugal	Tagus Estuary	Apr 2018 & May 2019	38°49'N 9°03'W	MARE
Portugal	Sado Estuary	May 2018	38°24'N 8°37'W	MARE
Portugal	Ria de Aveiro	Jan 2019	40°38'N 8°44'W	UBx
Portugal	Tagus Estuary	Jan 2019	38°38'N 9°06'W	UBx
Portugal	Sado Estuary	Jan 2019	38°27'N 8°43'W	UBx
Portugal	Ria Formosa	Jan 2019	37°01'N 7°48'W	UBx
Portugal	Ria Formosa	Jan 2018, Nov, Dec 2019	37°01'N 7°48'W	IPMA



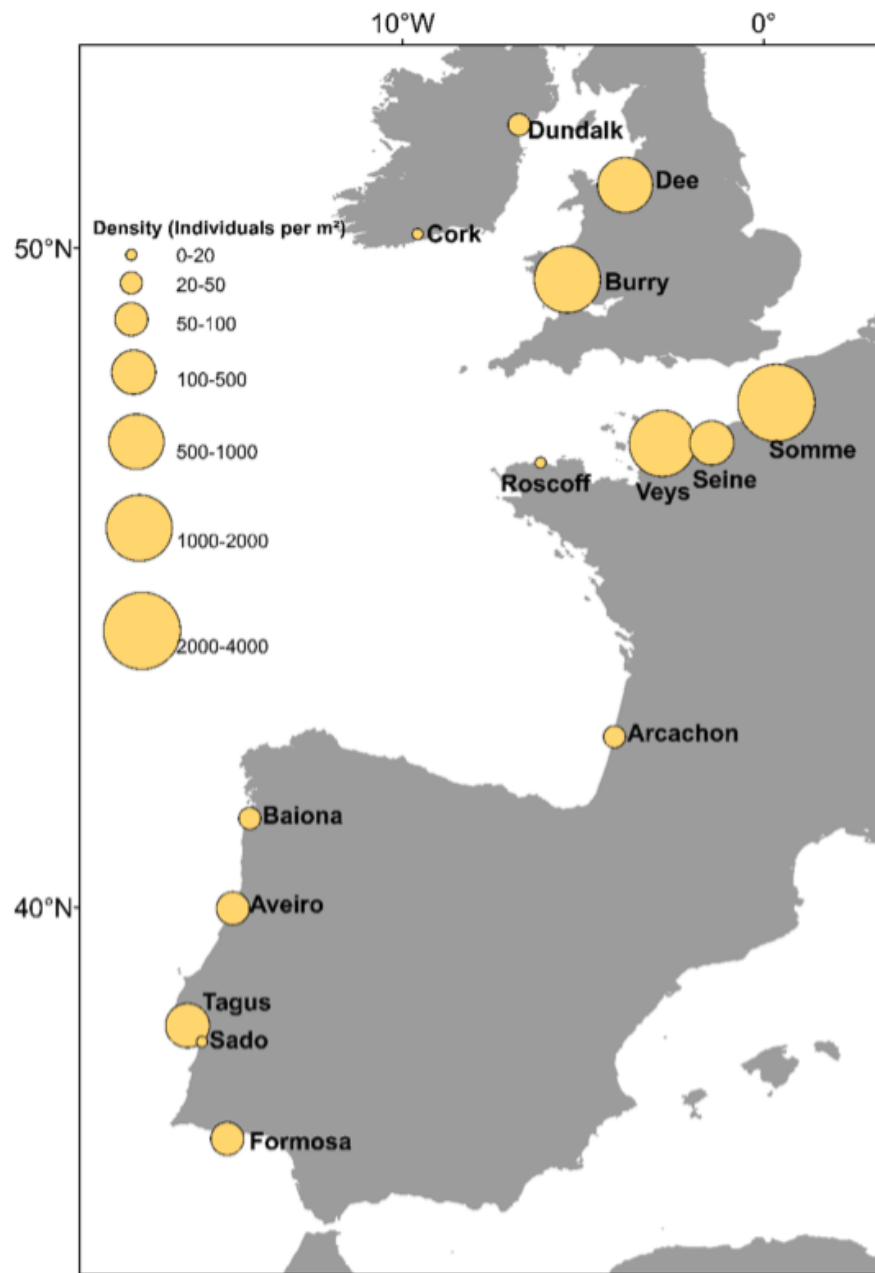


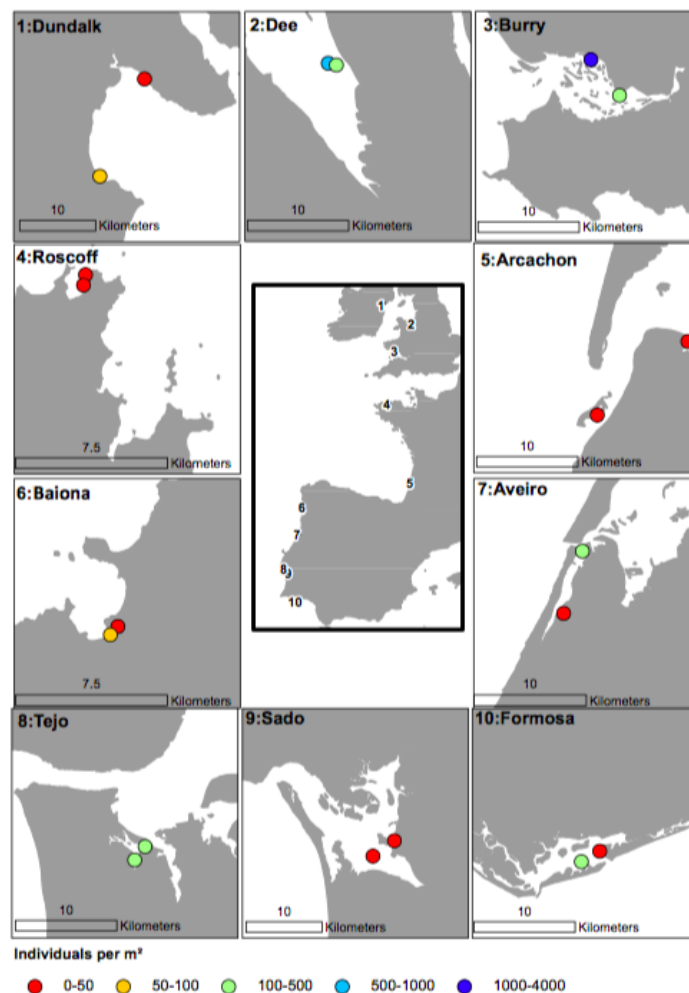
Description of the sites and beds examined for morphometrics (**Investigation 3**), across the Atlantic Area. MCS = Minimum capture size.

Area	Bed	Sampling frequency	Sampling duration	n	Coordinates	Fishery	MCS	Activities	Conservation designation
Carlingford	Oyster Farm	Bimonthly	April 2018-October 2019	229	54°01'N, 6°09'W	Occasional light hand-harvesting	17mm	Shipping, aquaculture, farming	SAC, SPA, Ramsar Site
Dundalk	Annagassan	Bimonthly	July 2018-October 2019	269	53°52'N, 6°20'W	Suction dredge	22mm	Razor clam fishery	SAC
	Cooley			269	54°00'N, 6°17'W				
Dee	-	Seasonal	July 2018-September 2019	360	53°20'N 3°10'W	Hand raking and sieving	20mm	Agriculture, industry	SPA, SAC
Burry	-	Seasonal	July 2018-	360	51°40'N	Hand raking and	Variable	Agriculture, industry	SAC, SPA, Ramsar Site

Area	Bed	Sampling frequency	Sampling duration	n	Coordinates	Fishery	MCS	Activities	Conservation designation	Industry, shipping	SPA
Ria de Arousa	Sarrido	Once	February 2018	60	42°30'N, 8°50'W	Hand operated hoes and rakes	25 mm	Shellfishery, mollusk aquaculture, fishing, agriculture	SAC, SPA, RAMSAR site		
Aveiro	Aveiro Lagoon	Bimonthly	April 2018-October 2019	300	40°38'N, 8°44'W	Hand rake	25 mm	Aquaculture, agriculture, fishing, industry	Marine Reserve, SPA	Recreational boating	National Reserve
Óbidos	-	Once	July 2019	129	39°24'N, 9°13'W	Hand operated hoes, rakes, dredges, harvesting knife and freediving	25 mm	Agriculture, industry	CORINE Biotope	Shellfishery, mollusk aquaculture	SAC
Tagus	-	Annual	April 2018-May 2019	4542	38°49'N, 9°01'W	Hand operated hoes, rakes, dredges, harvesting knife and freediving*	25 mm	Urban Centre, industry, fishing, agriculture	SPA, SCI, Natural Reserve, RAMSAR site		
Sado	-	Annual	May 2018-May 2019	215	38°24'N, 8°37'W	Hand operated hoes, rakes, dredges, harvesting knife and freediving	25mm	Urban Centre, industry, fishing, aquaculture	SPA, SCI, Natural Reserve, RAMSAR site, CORINE biotope		

Current Cockle Average Density





Current Cockle Density

Figure 7. Density (Individuals/ m²) measured at 18 sites in 9 AA ecosystems by UBx, and externally gathered data from Dundalk Bay (The Marine Institute and Bord Iascaigh Mhara, 2019) between 2018 and 2019. Note: ecosystems were excluded from this map if only one site was measured.

Cockle densities measured in the Ria Formosa in 2018.

Area	Bed	Density (kg/ m ²)
Olhão	Cabeço do Zé Bruto	3.3
	Cabeço do Berbigão	0.7
	Areais	0.8
	Fortaleza	1.0
Faro	Esteiro do Ramalhete	0.1
	Cabeço do Arnaldo	1.1
	Ilhote das Cobras	1.5
Fuseta	Cidade sem Lei (sul)	0.04
	Cidade sem Lei (norte)	0.03

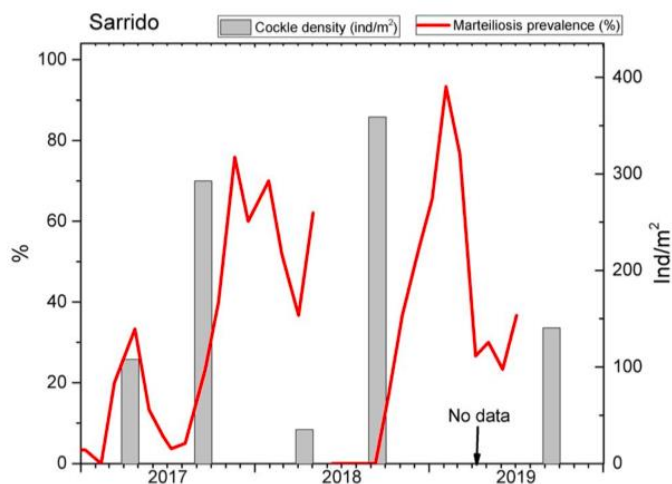


Figure 8. Cockle density (Individuals/ m²) and prevalence of *Marteilia cochillia* infections at Sarrido, Galicia between 2017 and 2019.

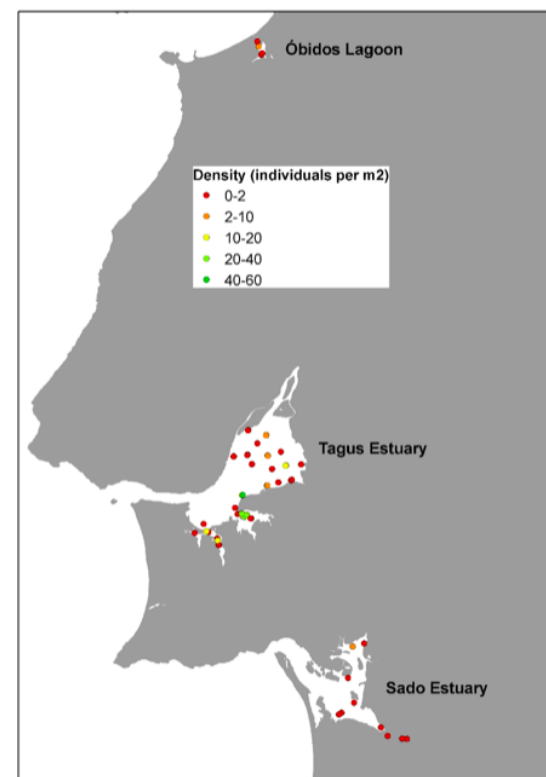


Figure 9. Density (Individuals/ m²) measured by MARE at the Tagus and Sado Estuaries, and Óbidos Lagoon. Sampling was conducted between 2018 and 2019 using a vessel-operated clam dredge.

- Salinity differed significantly across sites
 - Lowest at Carlingford (Ire)
- Large seawater temperature range
 - Highest at Sado (Pt) & Arcachon (Fr)
 - Lowest at Irish sites
- Large variations in primary productivity
 - Lowest at Carlingford
 - Highest at the Welsh sites
- Mean primary productivity of all sites was relatively high, it varied largely over the sampling period

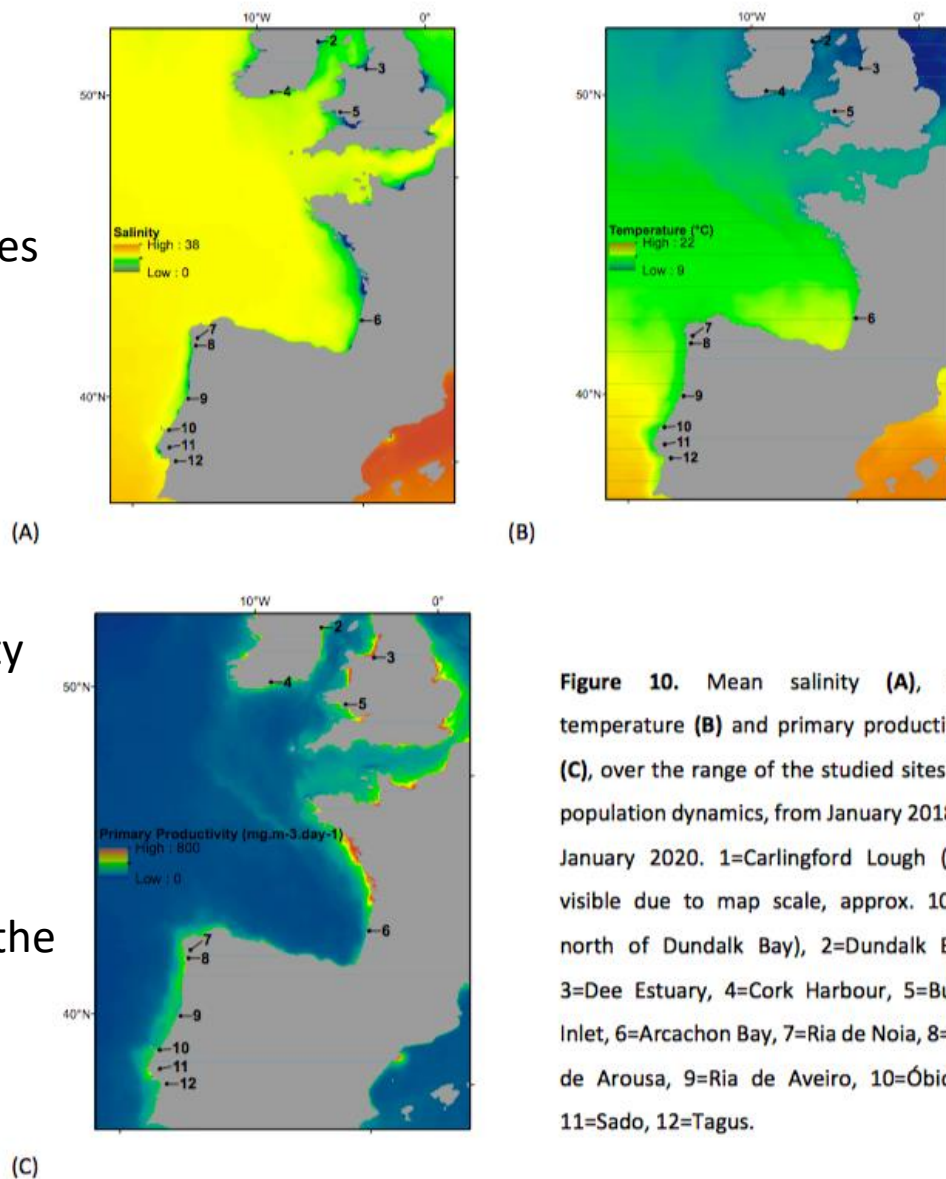


Figure 10. Mean salinity (A), sea temperature (B) and primary productivity (C), over the range of the studied sites for population dynamics, from January 2018 to January 2020. 1=Carlingford Lough (not visible due to map scale, approx. 10km north of Dundalk Bay), 2=Dundalk Bay, 3=Dee Estuary, 4=Cork Harbour, 5=Burry Inlet, 6=Arcachon Bay, 7=Ria de Noia, 8=Ría de Arousa, 9=Ria de Aveiro, 10=Óbidos, 11=Sado, 12=Tagus.

Summary statistics (Mean (Median) \pm SD) of key environmental variables (salinity, sea water temperature ($^{\circ}\text{C}$) and productivity ($\text{mg C/ m}^3/\text{ day}$)) at all sites (in descending order latitudinally) from **Investigation 3** (Population dynamics), from January 2018 to January 2019. Data was obtained from Copernicus, 2020. The minimum value for each parameter is in *italics* and the maximum is in **bold**.

Country	Location	Bed	Salinity	Seawater temperature	Productivity
Ireland	Carlingford	Oyster Farm	20.5 (12.4) \pm 10.6	10.8 (10.4) \pm 2.5	24.0 (15.0) \pm 28.1
Ireland	Dundalk	Annagassan	30.3 (30.3) \pm 1.0	10.9 (10.1) \pm 3.9	80.4 (70.0) \pm 6.40
		Cooley	30.3 (30.3) \pm 0.9	10.8 (10.6) \pm 3.5	56.1 (45.0) \pm 42.9
Ireland	Cork Harbour	Cuskinny	33.9 (34.0) \pm 0.7	11.6 (10.9) \pm 2.6	68.6 (53.0) \pm 48.8
		Ringaskiddy	33.9 (33.9) \pm 0.7	11.6 (11.3) \pm 2.6	68.9 (60.0) \pm 49.6
Wales	Dee Estuary	Dee	26.7 (26.3) \pm 2.5	11.2 (10.2) \pm 6.3	247.8 (164.0) \pm 224.1
Wales	Burry Inlet	Burry	27.0 (27.2) \pm 1.5	12.0 (10.2) \pm 5.0	258.1 (150.0) \pm 236.4
France	Arcachon	Banc d'Arguin	33.3 (33.3) \pm 0.5	15.5 (14.2) \pm 5.3	27.2 (18.0) \pm 21.2
Spain	Ría de Muros y Noia	Noia	34.3 (34.6) \pm 1.0	14.3 (13.9) \pm 1.8	63.2 (52.0) \pm 38.1
Spain	Ría de Arousa	Sarrido	34.3 (34.5) \pm 1.0	14.8 (14.4) \pm 2.3	86.4 (91.0) \pm 41.2
Portugal	Ria de Aveiro	Aveiro Lagoon	34.2 (34.4) \pm 1.0	14.8 (14.8) \pm 1.7	38.6 (25.0) \pm 34.2
Portugal	Óbidos	Óbidos	35.0 (35.1) \pm 0.3	15.1 (14.7) \pm 1.6	44.6 (28.0) \pm 30.0
Portugal	Tagus	Tagus	28.2 (29.3) \pm 2.6	15.2 (15.1) \pm 1.5	71.8 (47.0) \pm 53.8
Portugal	Sado	Sado	35.6 (35.6) \pm 0.2	15.6 (15.2) \pm 1.8	40.9 (31.0) \pm 31.0

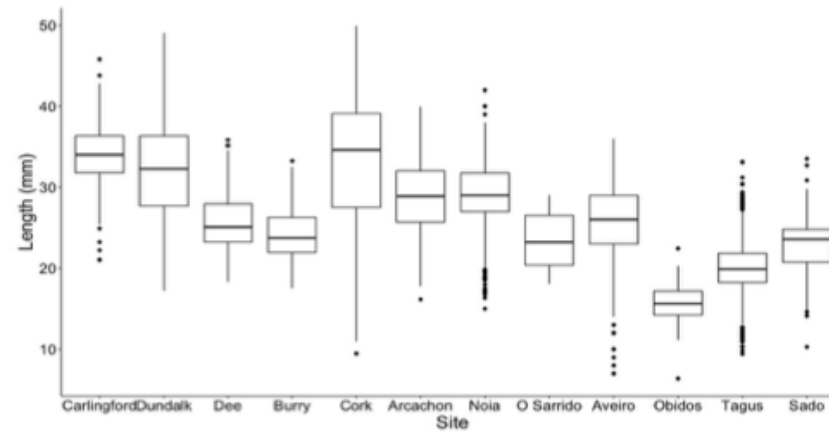
Morphometrics

(A) Mean Length

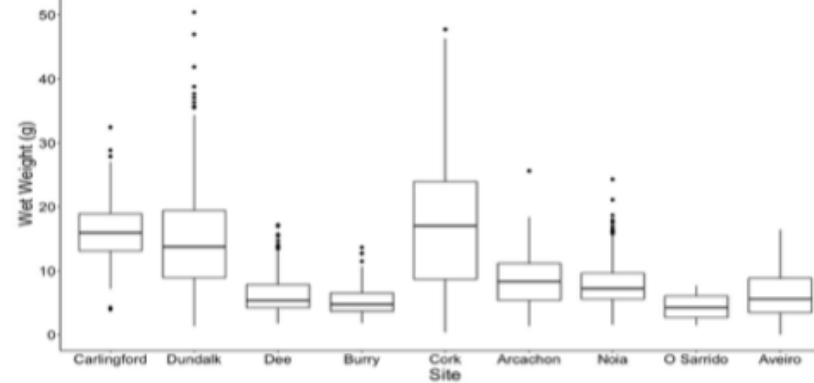
(B) Mean Weight

(C) Mean Age

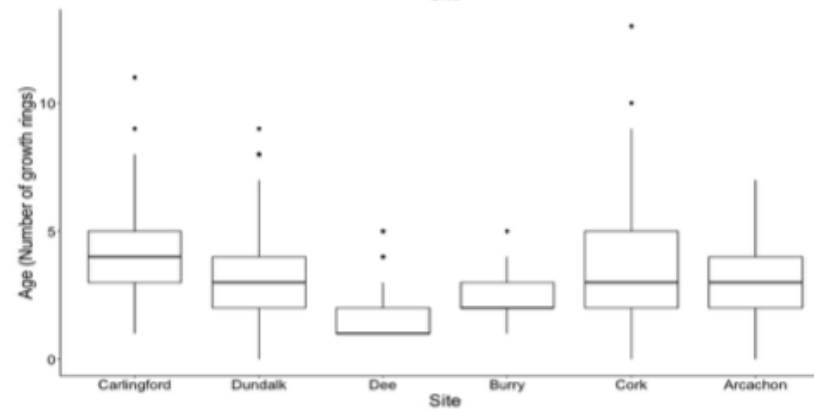
(A)



(B)



(C)



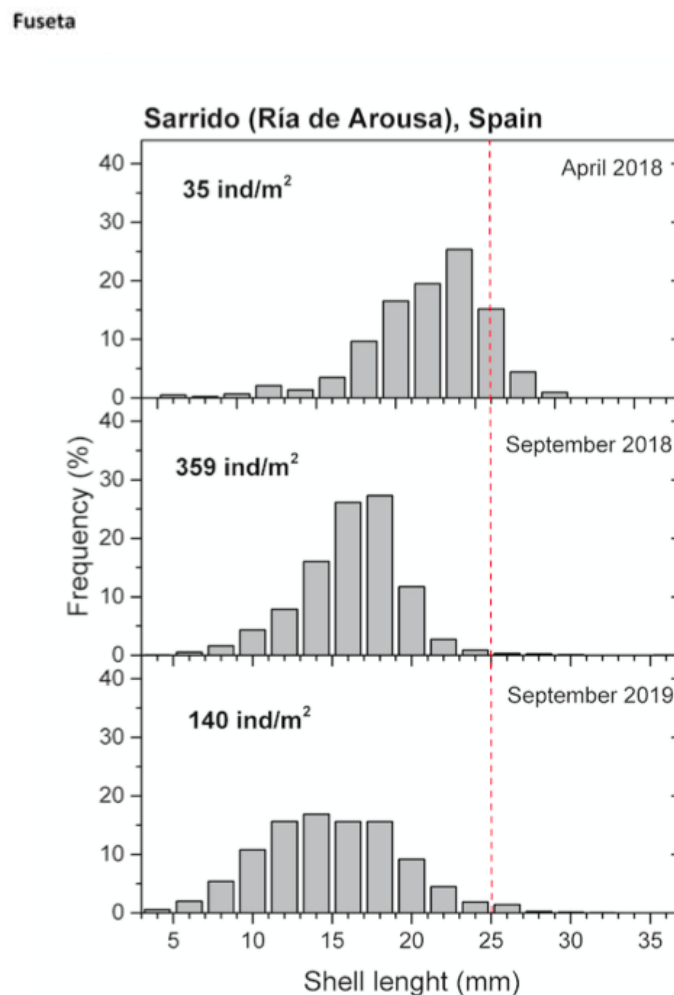
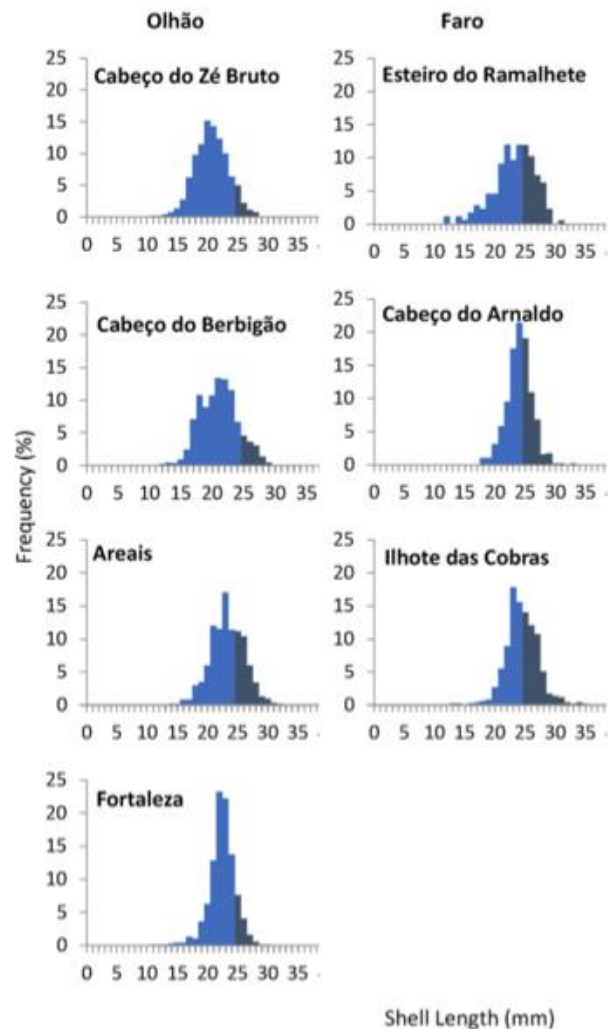


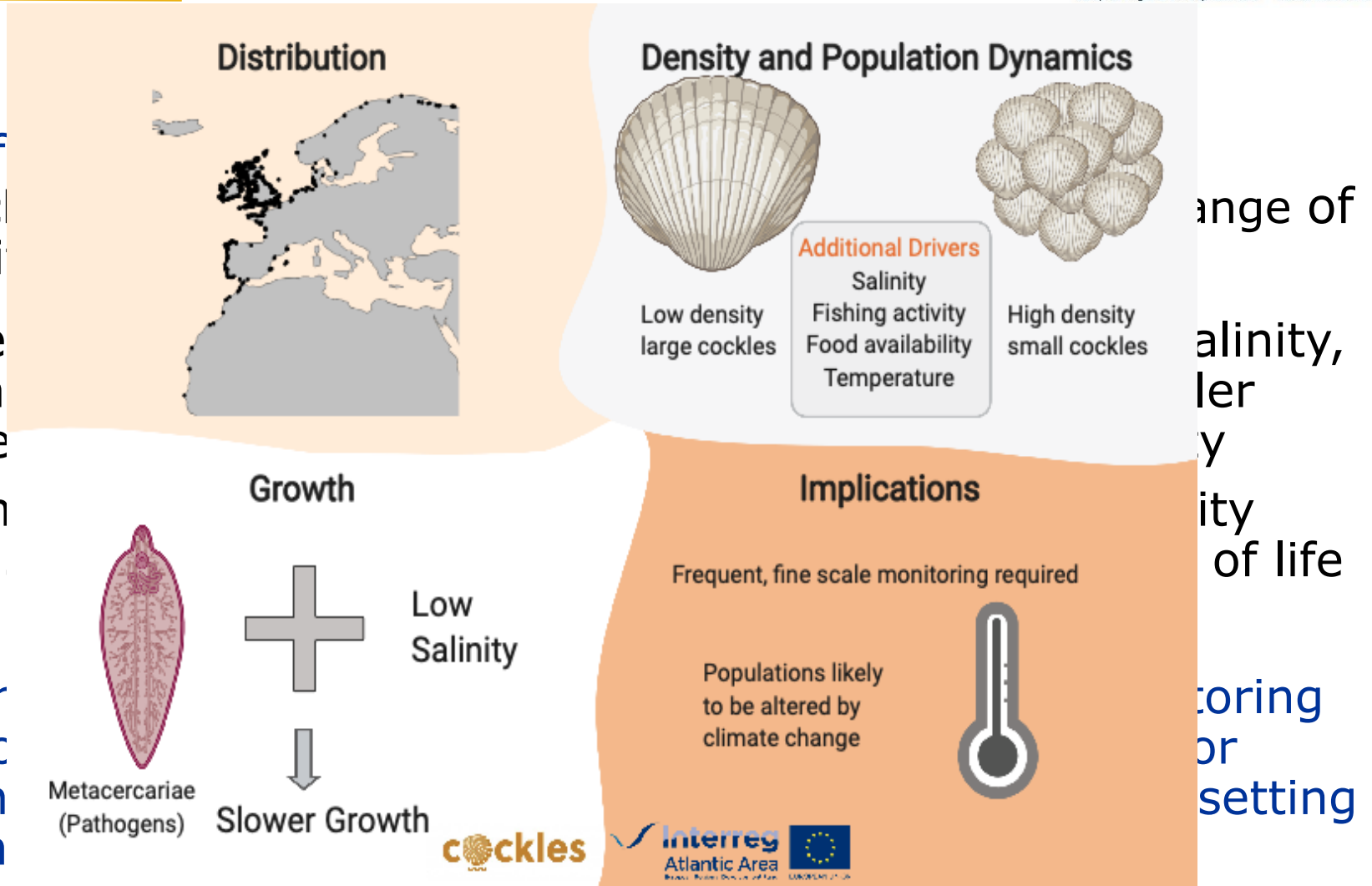
Figure 10. Shell length frequency distributions in cockles at Ria Formosa, Portugal (Light blue below MCS, dark blue >MCS)

Figure 14. Shell length frequency distributions of cockles sampled in Sarrido. Cockles were sampled over varying time periods, indicated on the graph. Vertical red dashed line indicates the minimum legal size of cockles in Spain (25 mm).

Key factors

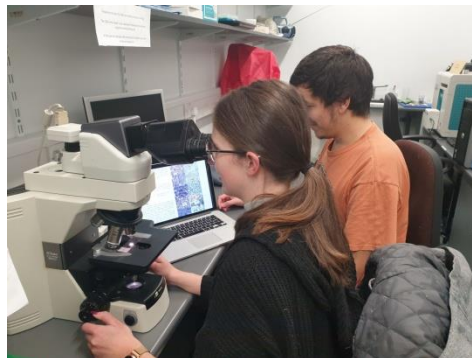
- Cockle distribution
- Growth rate
- Condition
- Fish size
- Concentration

Recreation is recommended to be minimized



Key Findings:

- *C. edule* exhibits an extensive range at least 15°N to 71°N
- Environmental parameters (salinity, sea temperature and primary productivity) varied significantly between AA sites
- *C. edule* populations proliferate across wide environmental ranges
- Densest populations are located in Wales and northern France
- Marteilirosis in Spain
- Average length and weight tended to decrease with latitude



FULL PARTNERS



ASSOCIATED PARTNERS



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Cockles

4 November at 06:09 ·

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Cockles are an important specie



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Acronym: COCKLES

Title: Co-Operation for Restoring Cockle Shellfisheries and its Ecosystem Services in the Atlantic Area

Contract: EAPA_458/2016

Deliverable 4.2

Field survey of cockle distribution, abundance & population dynamics currently



Lead Partner for Output

University College Cork [UCC]

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Dissemination level

☐

PU Public

☐

PP Restricted to other programme participants

☐

RE Restricted to a group specified by the Consortium

☐

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Acknowledgement

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TREMATODE AND CAN
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