Towards improving biofouling knowledge within MRE environments

Quillien Nolwenn*, Ameryoun H., Barillier A., Berhault C., Boukerma K., Bressy C., Briand J.-F., Cayocca K., Compère C., Damblans G., Debout V., Dreanno C., Dubois F., Félix-Henry A., Grenier A., Gueuné H., Jacob D., Leblanc V., Lejart M., Pagot J.-P., Reynaud M., Schoefs F.

***nolwenn.quillien@ite-fem.org**

France Energies Marines (FEM) – a brief overview

- **French national research institute of reference on MRE**
- **Supported by the National Research Agency (ANR)**

A roadmap based on MRE sector objectives
4 Research programs

Mission:
Technology & Scientific environment coordination and valorization to overpass MRE locks

Key facts:
32 members
23 employees *(permanent, PhD, post-doc & research engineer)*

Budget: 2M€/year
21 actual R&D projects

Members: Research labs, industrial groups, SME, Coastal regions

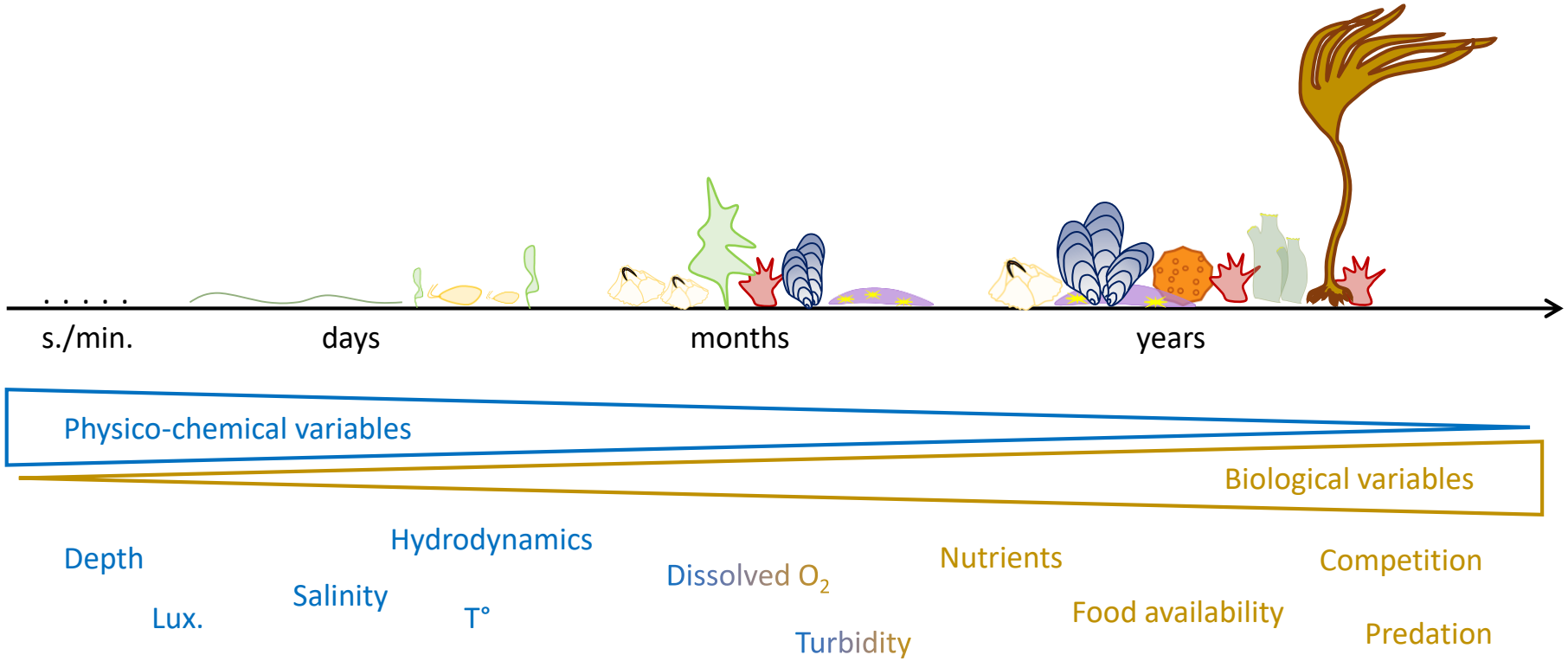
Biofouling – a major concern for MRE projects

- Colonisation by living organisms of surfaces settled in aquatic ecosystems (biology)
- Accumulation of undesirable biological attachment to man-made structures (engineering)

Dürr & Thomason, 2010

Biofouling – a major concern for MRE projects

- Colonisation by living organisms of surfaces settled in aquatic ecosystems (biology)
- Accumulation of undesirable biological attachment to man-made structures (engineering)



Connell and Slayter 1977; Andersson & underwood, 1994; Want et al., 2017

Biofouling – a major concern for MRE projects

Tidal turbine removal after 3 years in canadian shallow waters (www.racerocks.ca)

Biofouling – a major concern for MRE projects

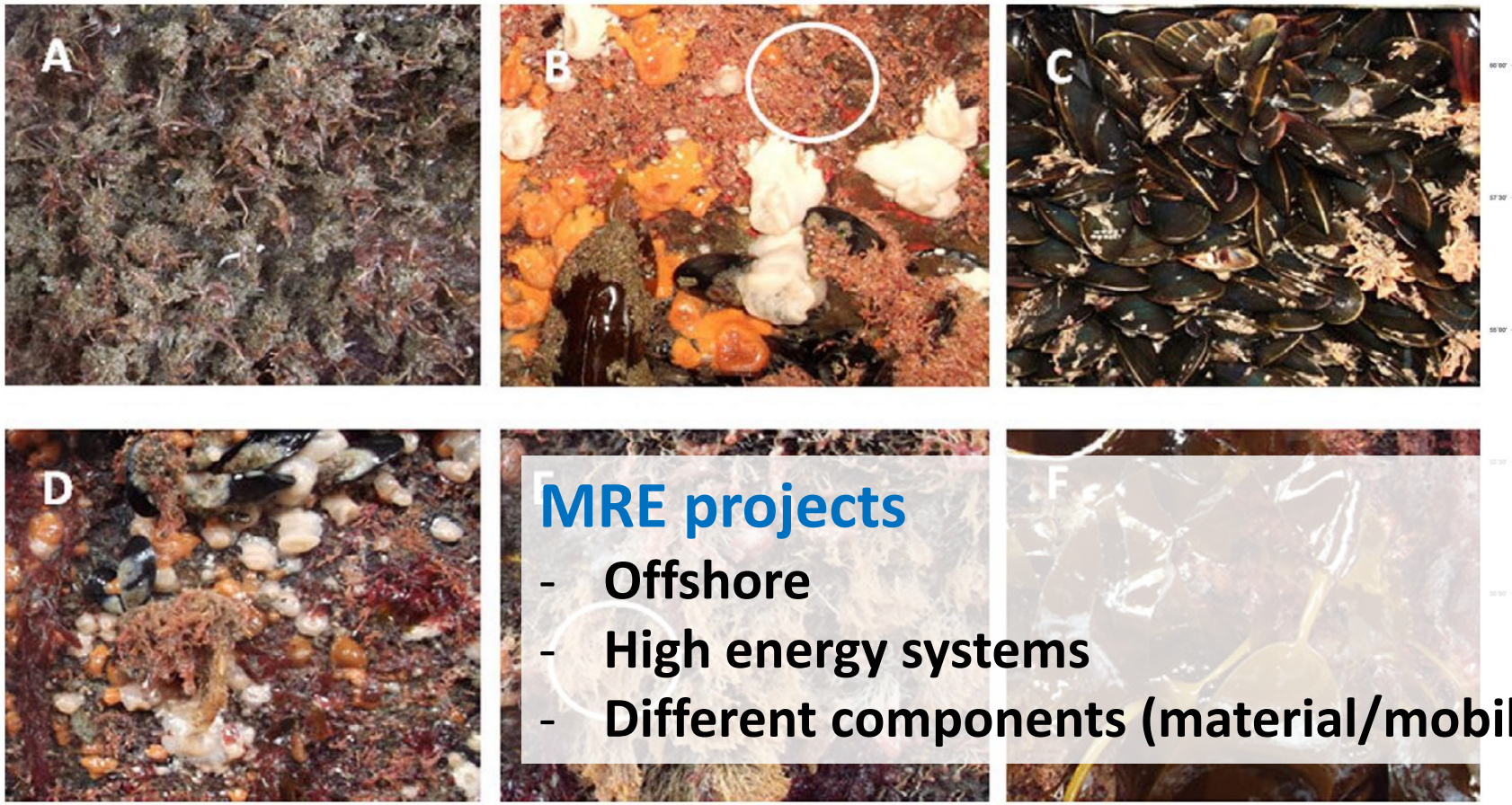
- **Direct** and **indirect** effects of biofouling on MRE structures/at MRE sites
  - ↗ hydrodynamics loadings *(structure, mooring)*
  - ↘ overall device production performance *(tidal turbine, wave-energy, OTEC)*
  - Reef effect *(production)*
  - Facilitation of invasive species expansion
  - Changes in ecosystem functioning *(nutrient cycling, new trophic links, $C_{fixation}$)*

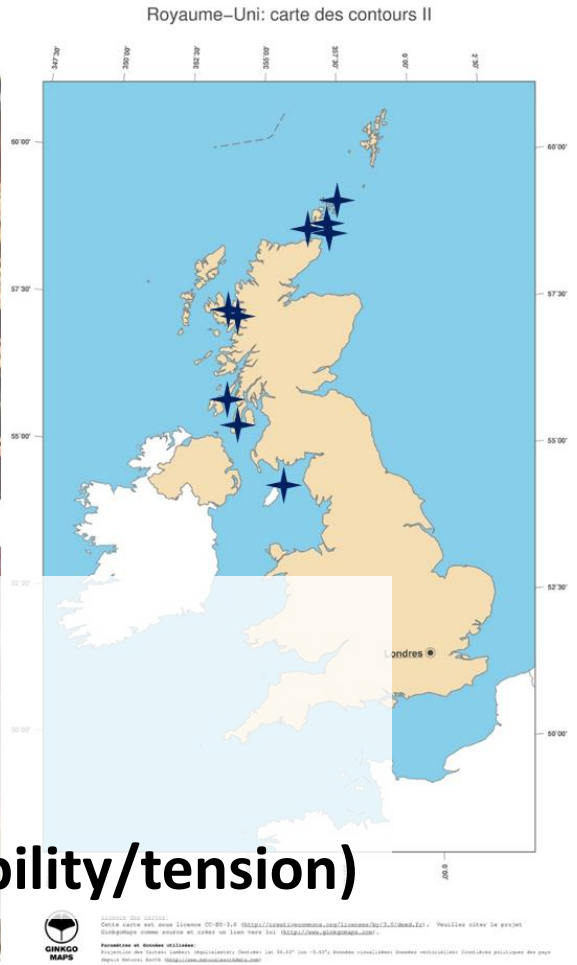
Depending on the type of structure and components / type of fouling
(community composition, biomass, geometry, flexibility, diversity, …)

Nall et al., 2015; Langhamer et al. 2009; Langhamer 2012; Krone et al., 2013

Biofouling – a major concern for MRE projects

- Highly variable in **space** and **time**





MRE projects

- Offshore
- High energy systems
- Different components (material/mobility/tension)

MacLeod et al., 2016

Biofouling – a major concern for MRE projects

- **Strong need for:**
  - *In-situ* **knowledge** to better apprehend the process
  - **Quantification** of biofouling with data useful for **biology** as well as **engineering**
  - New **approaches** to measure biofouling in challenging systems/context *(offshore, low cost, dynamics)*
  - **Modelling** the process of biocolonisation

Thickness

Species richness

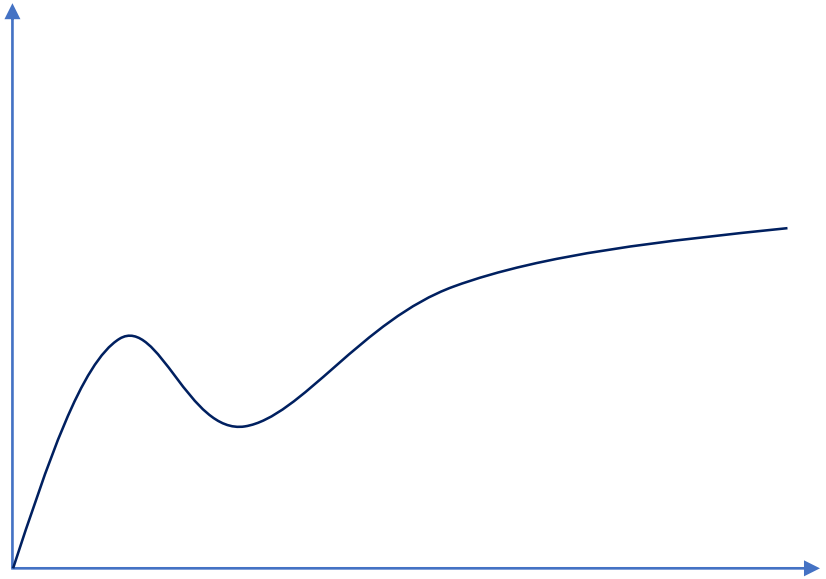
Roughness

Volume

Biomass

Life history traits

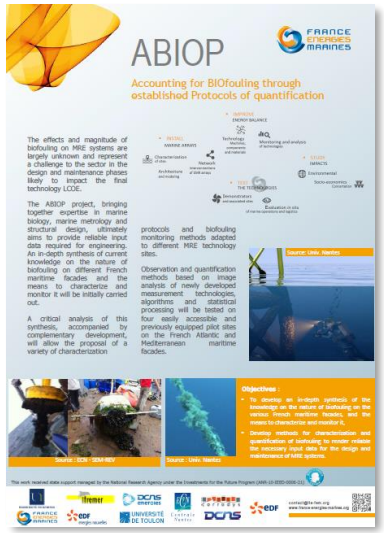
Abundance



ABIOP – as a first step to achieve these objectives

ABIOP
(AAP EMR-ITE-2016)

Accounting for **BIO**fouling through established **P**rotocols of quantification



→ Develop in depth **syntheses** on biofouling & monitoring methods

→ Develop **adapted methods** to characterize fouling in MRE context

→ **Testing** the developed methods & gathering data ***in situ***

↓

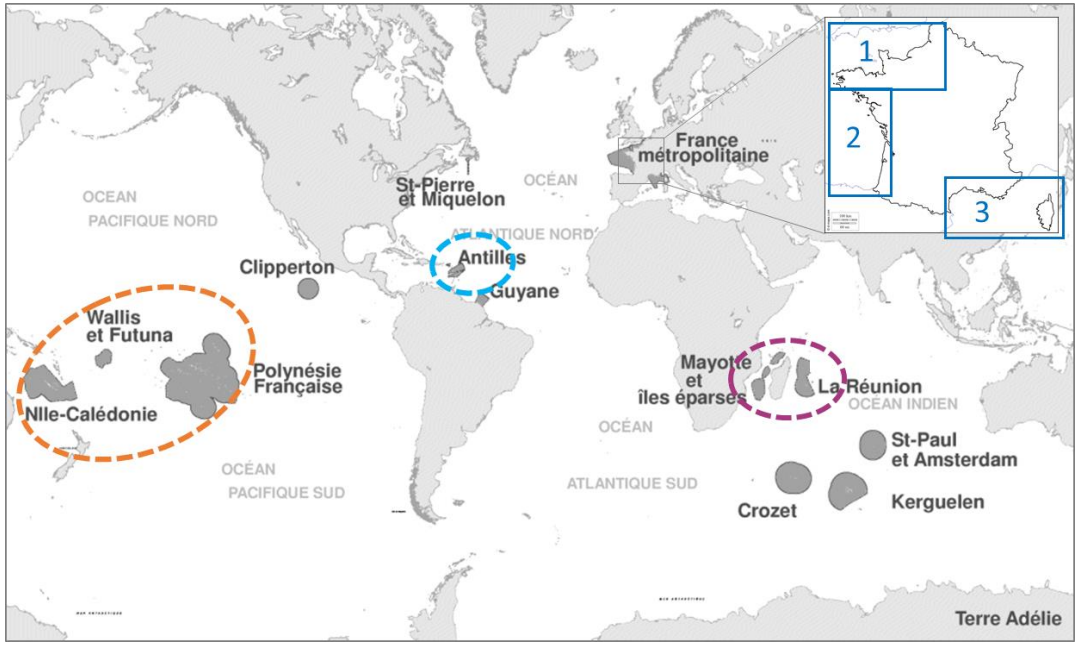
Talk by **Marine Reynaud *et al.***
Environmental monitoring on the SEM-REV sea test site
Tomorrow, 14:10

Main objectives

ABIOP – accounting for biofouling in MRE context

- **Literature review** (n=71)
  - Published articles
  - Investigative reports
  - Information from developers

  → *Methods*
  → *Biological variables*
  → *Environmental variables*

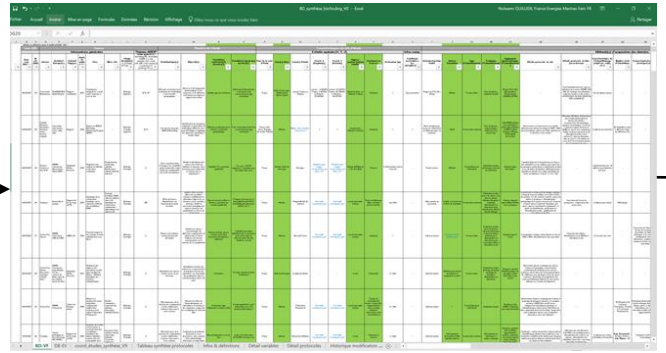


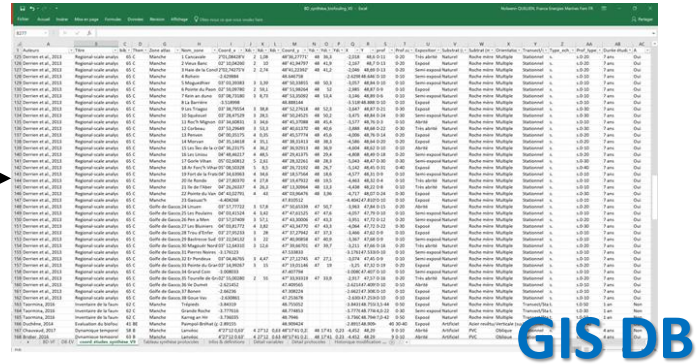
- **Construction of GIS**
- **Bibliometrics**
- Recommendations for future protocols

WEB OF SCIENCE™

ABIOP – accounting for biofouling in MRE context

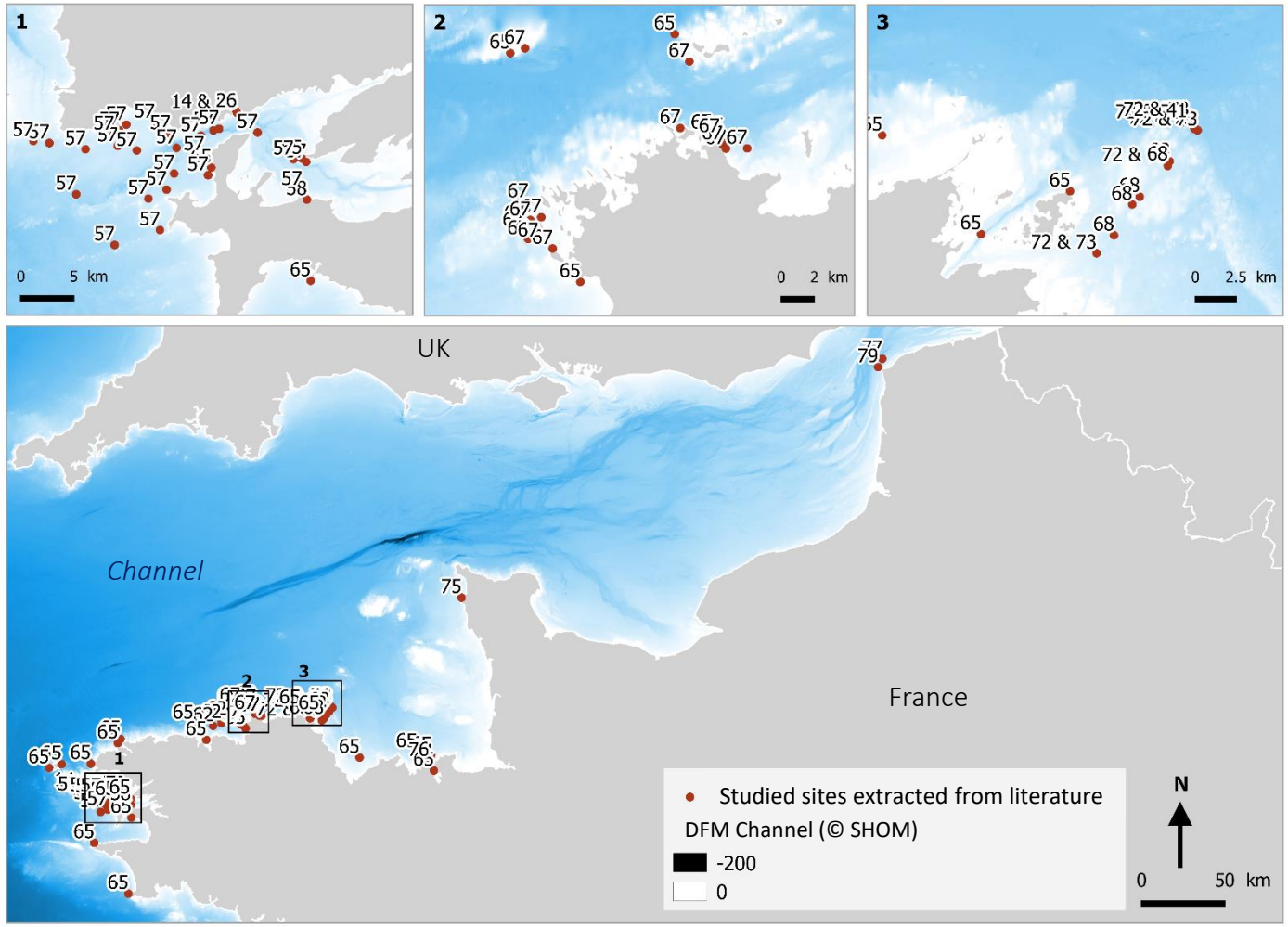
- **Database**
  - **Temporal** *(duration, data acquisition frequency)* and **spatial** *(X, Y)* scales
  - Precise indications about **protocols** *(sampling type, sample area, equipment, $N_{samples}$, numerical analyses, etc.)*
  - Investigated substratum *(type of structure, material, positioning, complexity, history)*
  - Explanatory **physico-chemical** variables *(waves, T°, salinity, …)*
  - Explanatory **biogeochemical** variables *(Si, P, etc.)*
  - Explanatory **biological** variables *(Chl-a, competition, predation, …)*
  - **Response biological variables** *(coverage, abundance, species richness, roughness, biomass, …)*





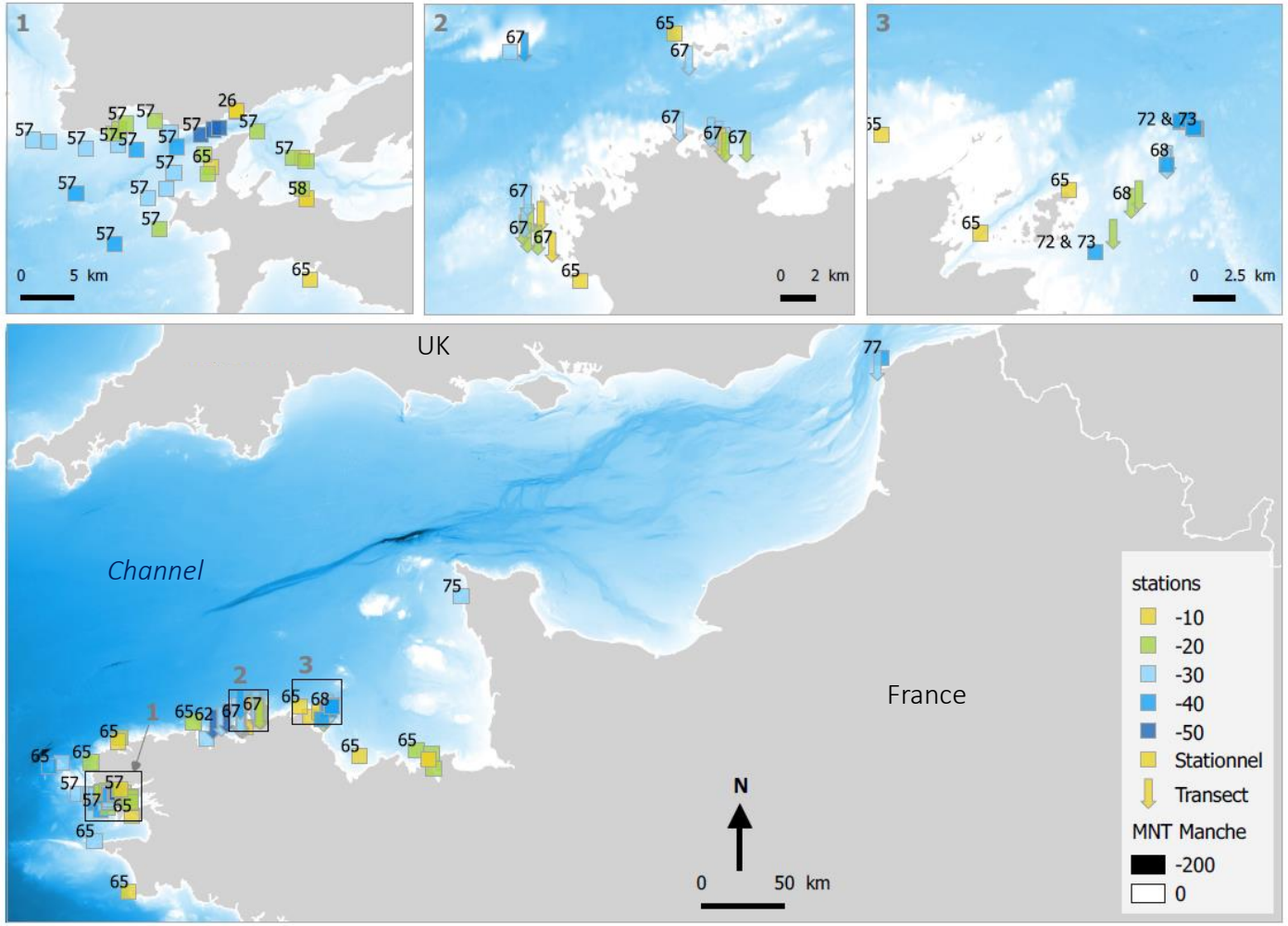
GIS DB

ABIOP – accounting for biofouling in MRE context



- Maps showing studied sites

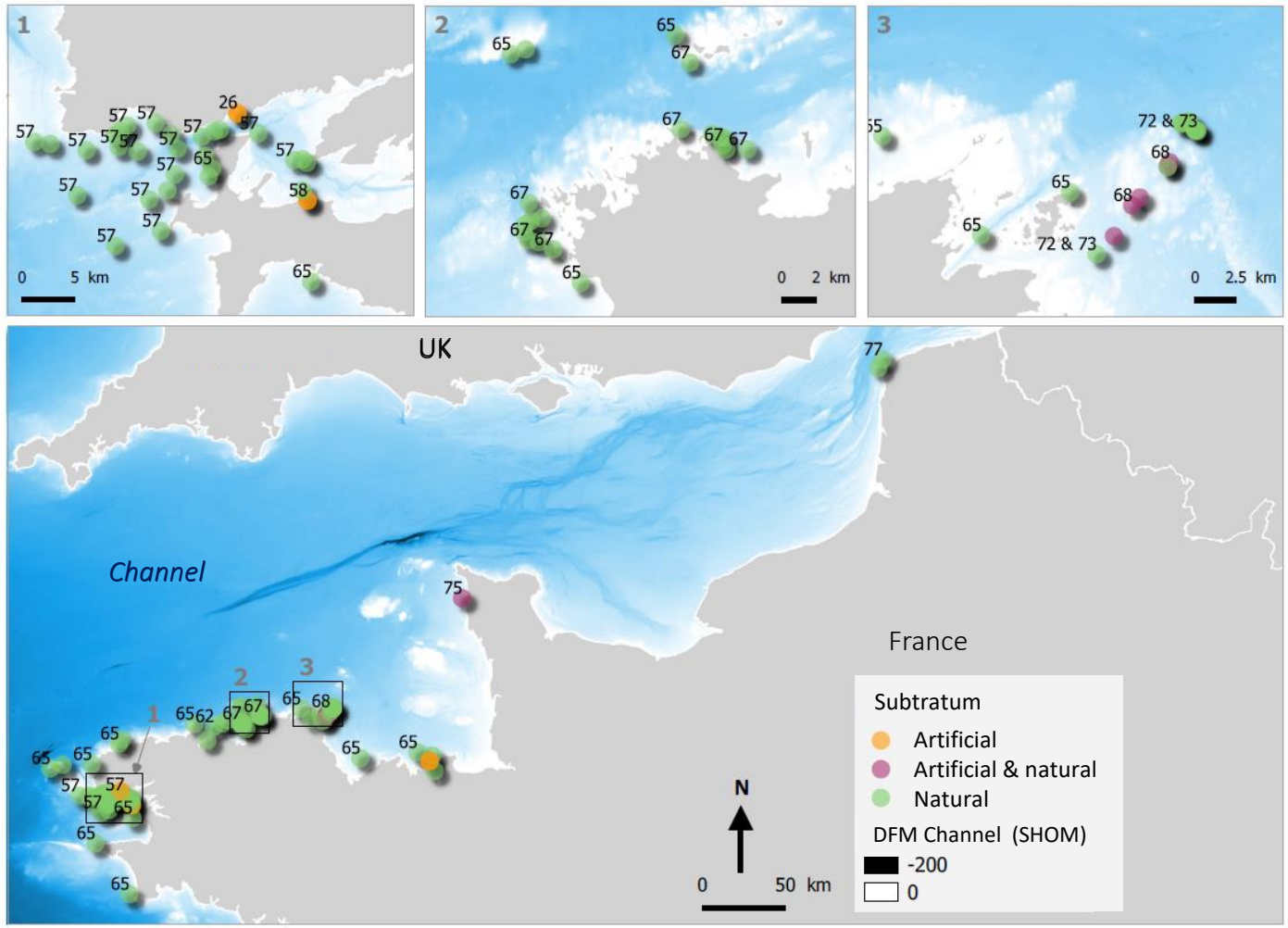
ABIOP – accounting for biofouling in MRE context



- Maps showing studied sites
- Depth & type of sampling

Main results

ABIOP – accounting for biofouling in MRE context

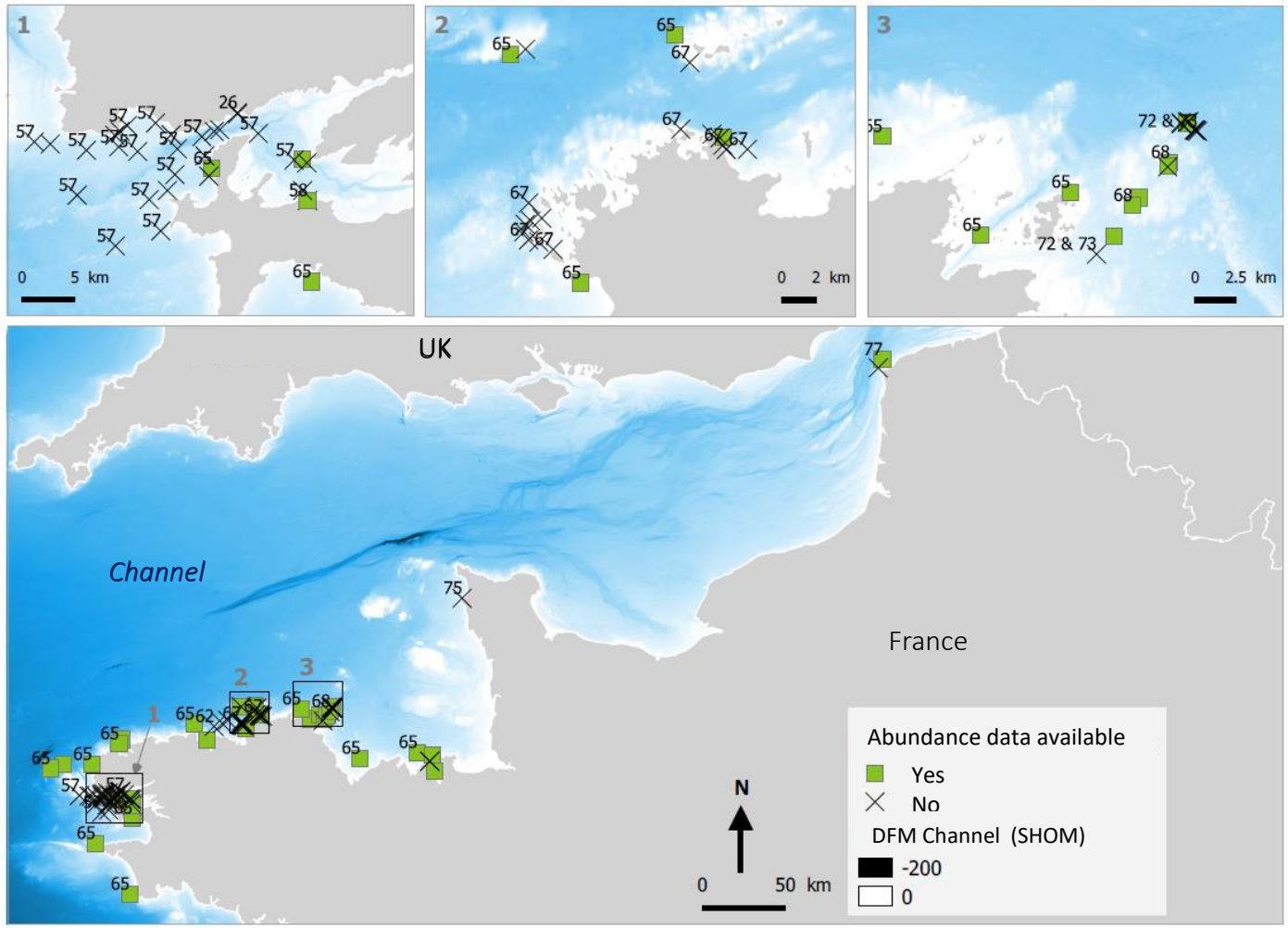


- Maps showing studied sites
- Depth & type of sampling
- Type of substratum

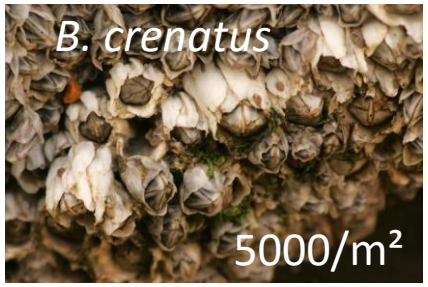
Slate
Concrete
PVC
Rocks
Plexiglass
Glass
Metal

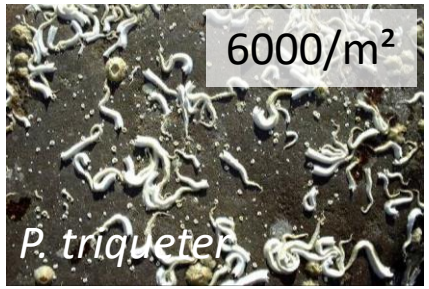
Main results

ABIOP – accounting for biofouling in MRE context



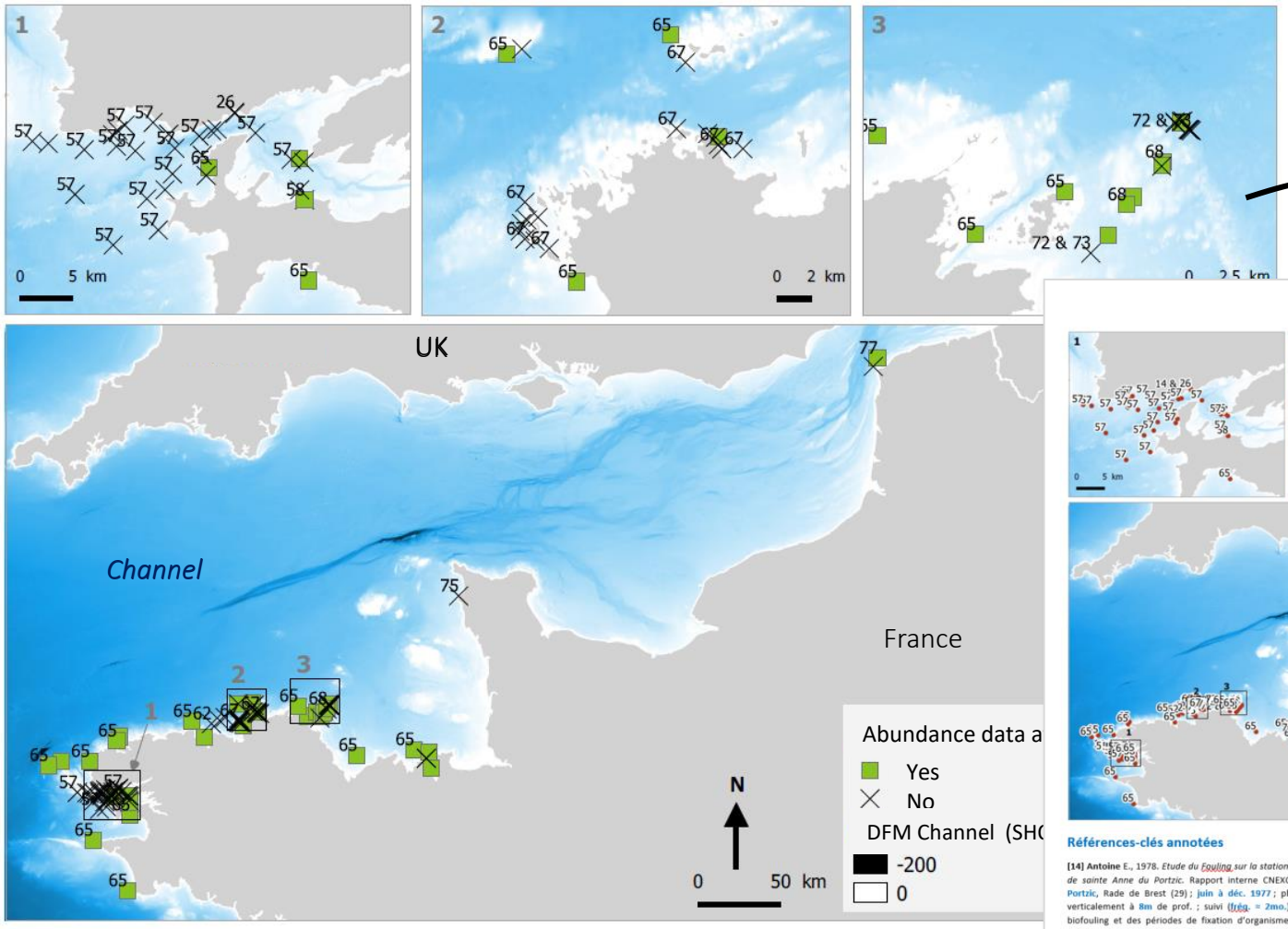
- Maps showing studied sites
- Depth & type of sampling
- Type of substratum
- Availiability of response Δ



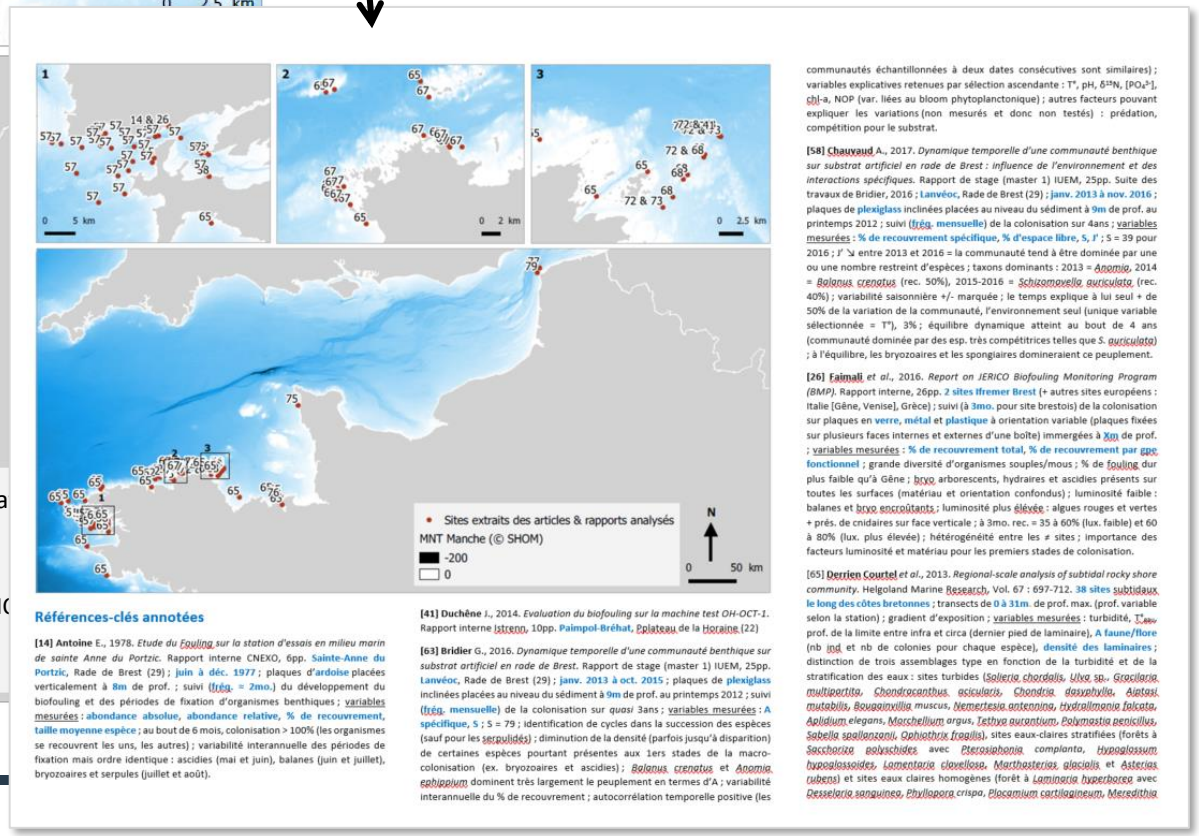


Main results

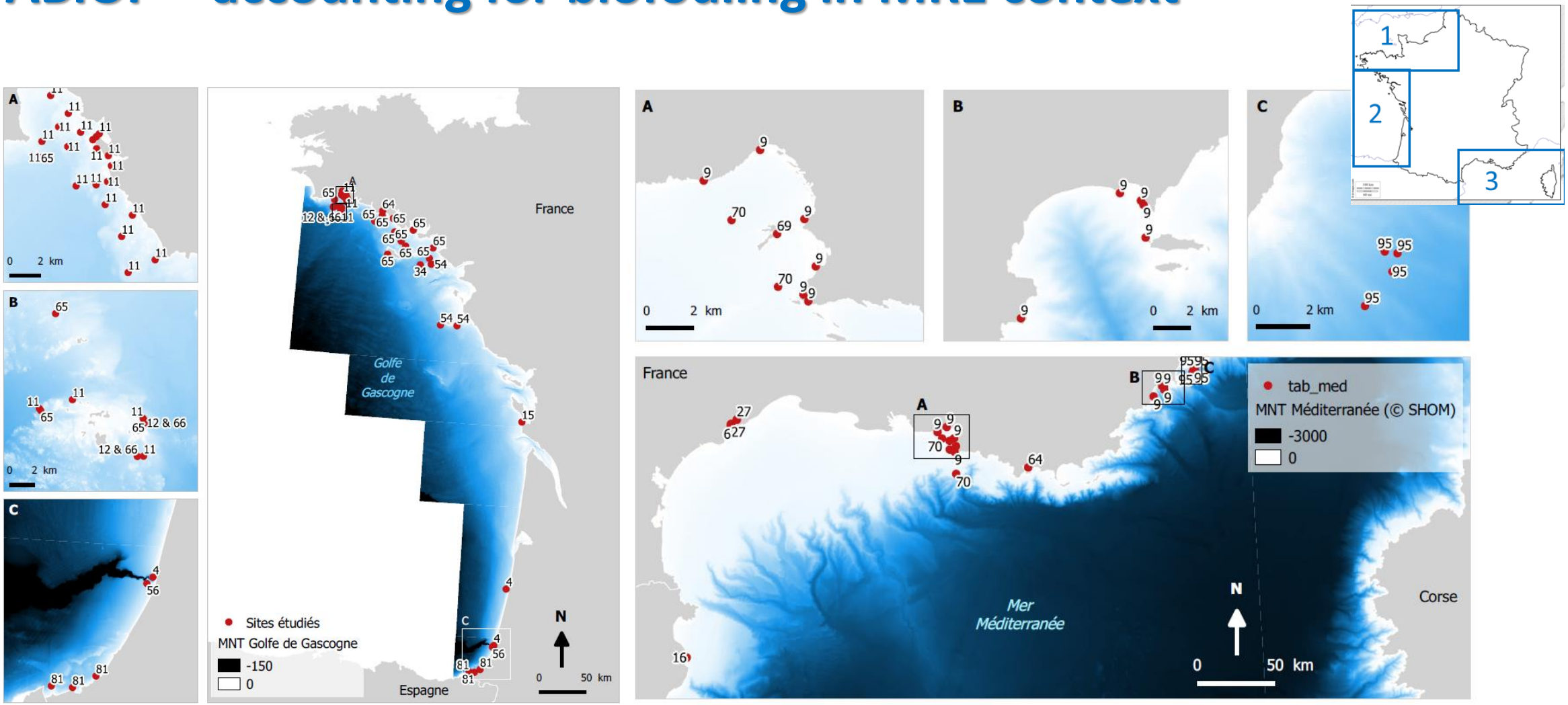
ABIOP – accounting for biofouling in MRE context



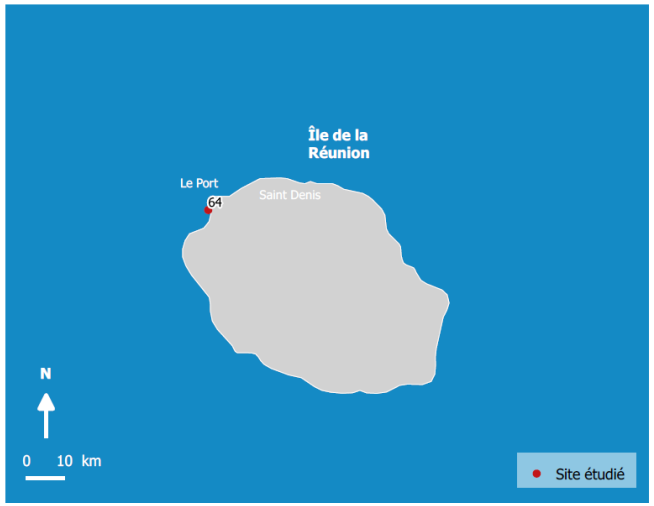
- Maps (GIS) and key information from literature feeding an atlas

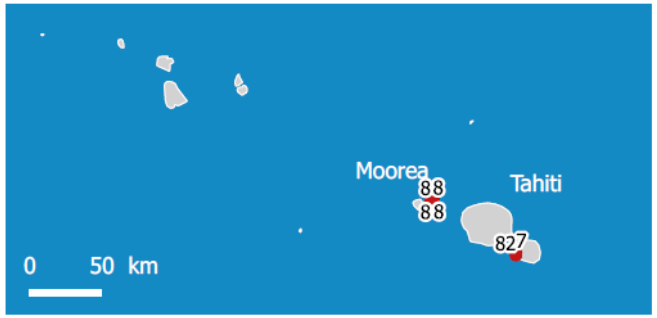


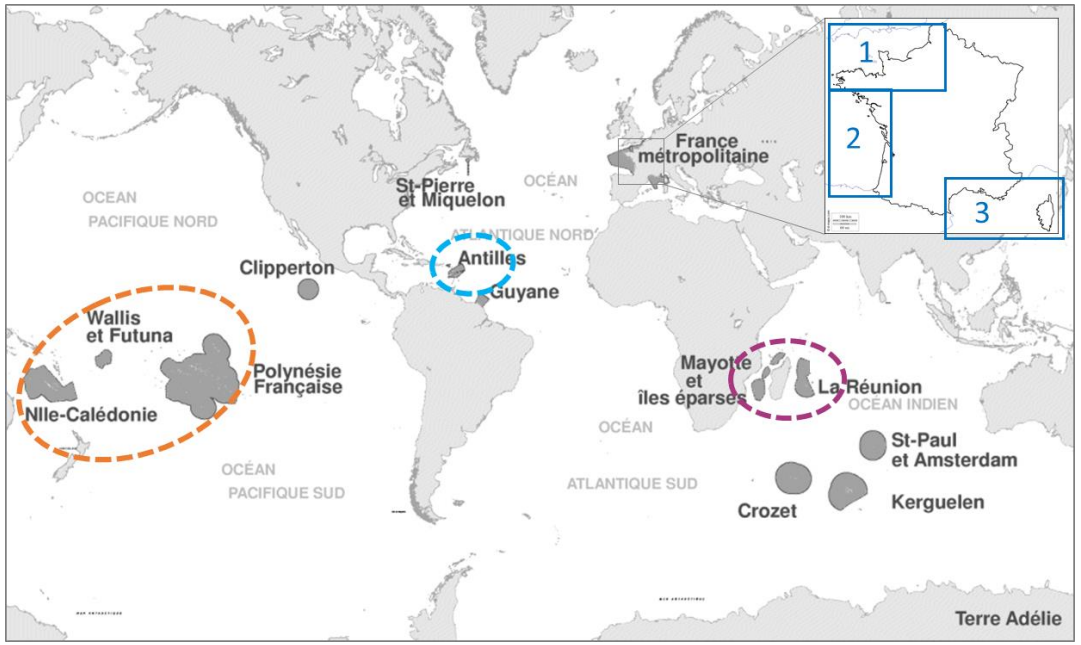
ABIOP – accounting for biofouling in MRE context



ABIOP – accounting for biofouling in MRE context





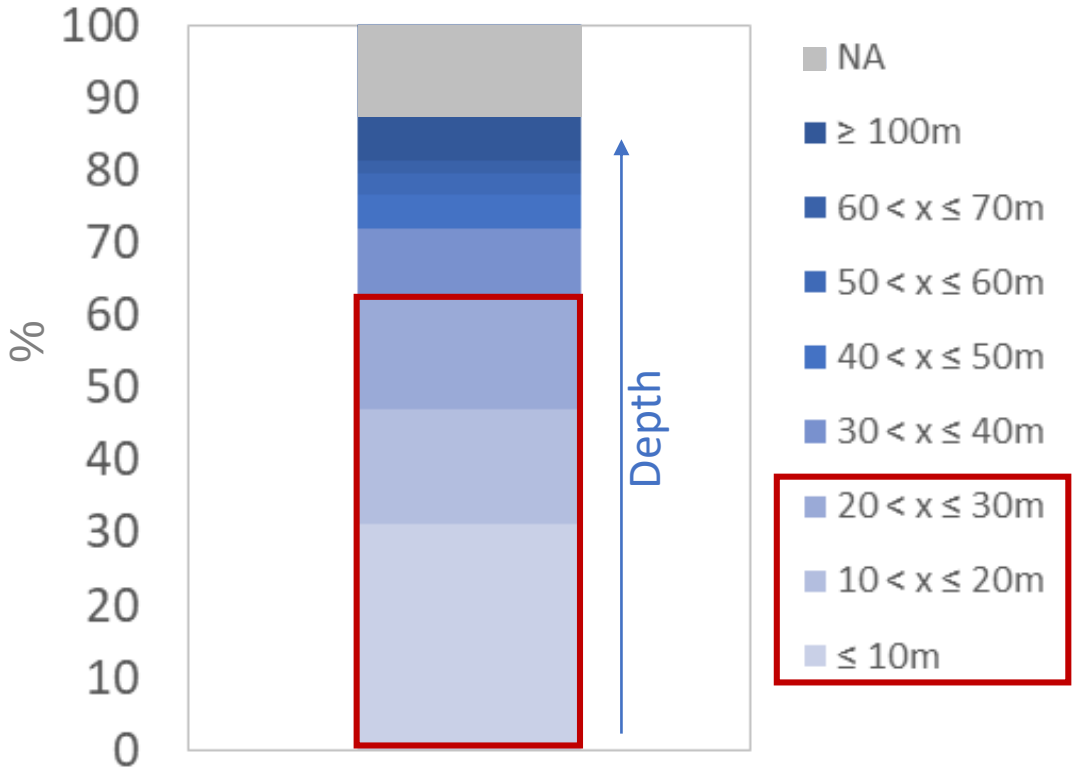


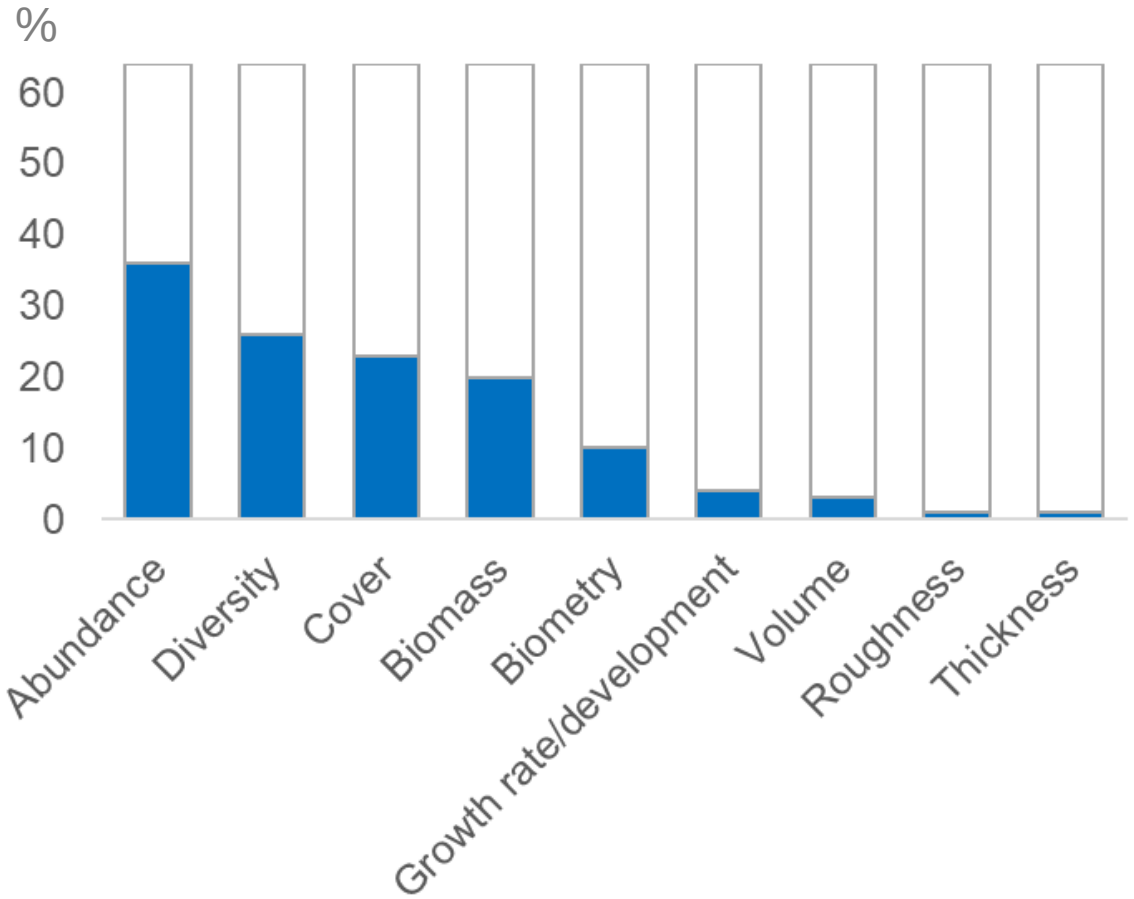
→ Very few data over-seas

Main results

ABIOP – accounting for biofouling in MRE context

- **Bibliometrics**





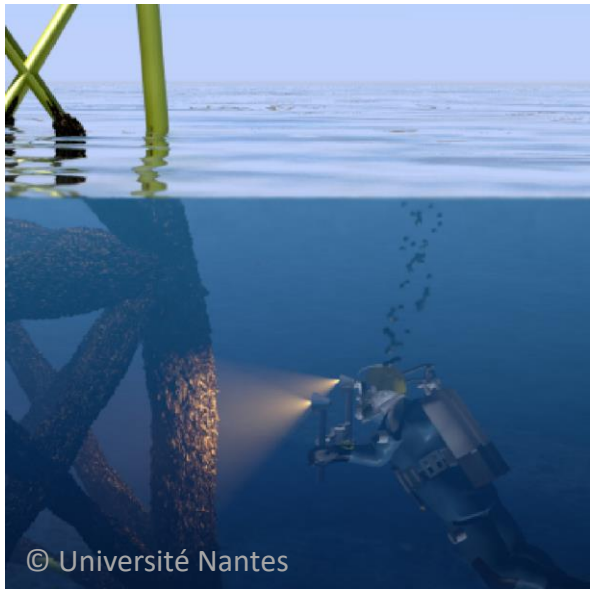
ABIOP – accounting for biofouling in MRE context

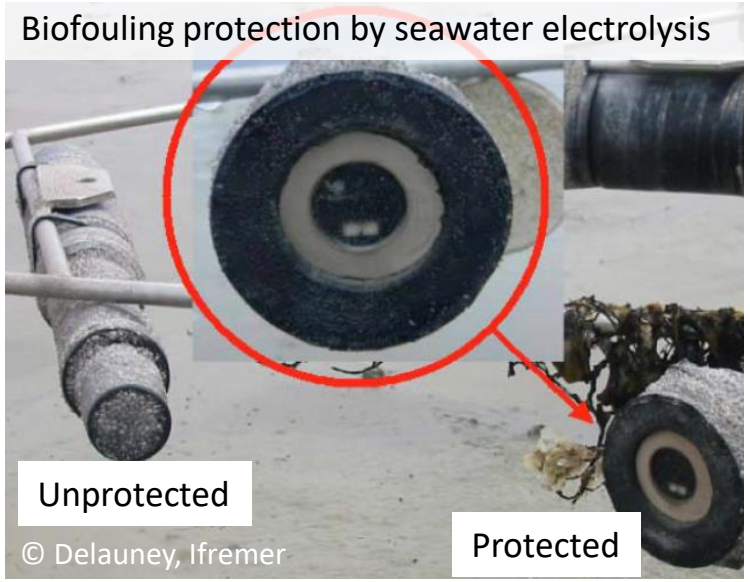
→Data extracted mainly relevant for **biological analyses** in the frame of EIA

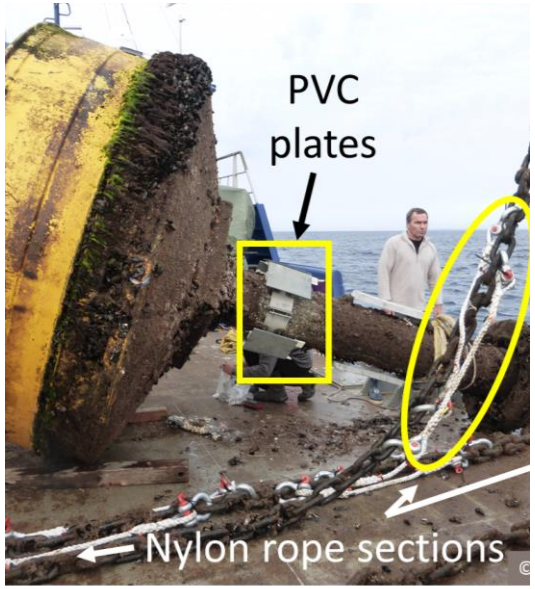
→Feeding **scenarios** / **models**

→Lack of mesurements of biological **variables** needed for **engineering** and at **MRE sites**

→**Development of specific protocols, methods**







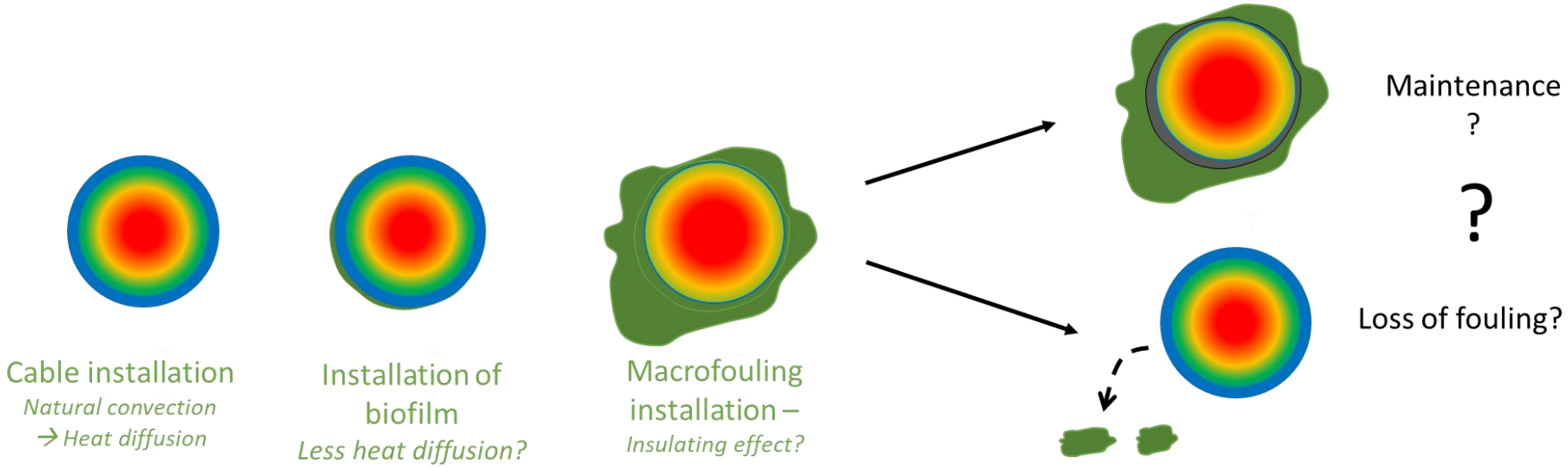
ABIOP+ to carry on ABIOP R&D efforts

- ABIOP = **1 year** project
- **3 years** progam to keep going on **biofouling research** (CoReD 2018)
- Main **objectives:**

→ Provide **standardized** & **target-oriented protocols** for biofouling assessment in MRE context

→ Assess the biocolonisation **effects on specific MRE components**

→ **Gather** and **share data** at **MRE sites** representative of future commercial sites



Thank you for your attention!

www.france-energies-marines.org

nolwenn.quillien@ite-fem.org

FRANCE ENERGIES MARINES

Some references

- **Nall**, Guerin and Cook (2015) Rapid assessment of marine non-native species in northern Scotland and a synthesis of existing Scottish records. Aquatic Invasions (10): 107–121
- **Langhamer**, Wilhelmsson, Engström (2009) Artificial reef effect and fouling impacts on offshore wave power foundations and buoys – a pilot study. Estuar Coast Shelf Sci (82):426–432
- **Krone**, Gutow, Joschko, Schröder (2013) Epifauna dynamics at an offshore foundation - implications of future wind power farming in the North Sea. Mar Environ Res (85):1–12
- **Canning-Clode** and Wahl (2010) Patterns of Fouling on a Global Scale. In: Durr S, Thomason J (eds). Biofouling. Wiley-Blackwell. pp 30-59
- **Connell** and Slatyer (1977) Mechanisms of Succession in Natural Communities and Their Role in Community Stability and Organization. The American Naturalist, Vol. 111, No. 982. (Nov. - Dec., 1977), pp. 1119-1144
- **Anderson** and Underwood (1994) Effects of substratum on the recruitment and development of an intertidal estuarine fouling assemblage.J. Exp. Mar. Biol. Ecol.184,217–36
- **McLeod**, Stanley, Day and Cook (2016) Biofouling community composition across a range of environmental conditions and geographical locations suitable for floating marine renewable energy generation. Biofouling 32, 261–276
- **Want**, Crawford, Kakkonen, Kiddie, Miller, Harris and Porter (2017) Biodiversity characterisation and hydrodynamic consequences of marine fouling communities on marine renewable energy infrastructure in the Orkney Islands Archipelago, Scotland, UK. Biofouling. 10.1080/08927014.2017.1336229