R&D Webinar - NESTORE Project Outcomes | 26/05/2026

Towards cumulative impact assessment of offshore wind farms

With the financial support of:

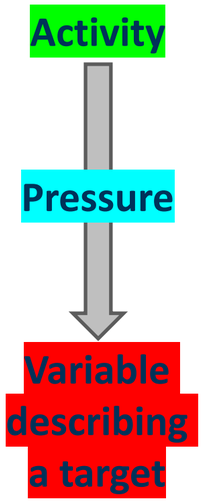
Development of a suite of trophic modelling tools operating at different spatial scales to assess the cumulative impact of marine renewable energy and other human activities.

Nathalie Niquil, Pierre Bourdaud

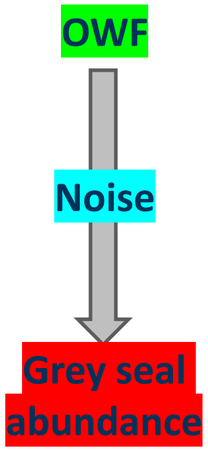
With the participation of :
Emma Araignous, Lise Dulieu, Daniela Banaru, Marie Le Marchand, François Le Loc'h, Frida Lasram, Vincent Faure, Thomas Seyer, Quentin Noguès, Souha Ajmi, Anne-Claire Bennis, Théo Grente, Valérie Girardin, Philippe Regnault, Jacques Bréhelin, Laurie Michaud, Jan Vanaverbeke, Emil de Borger, Ulrike Braeckman, Laëtitia Petit, Georges Safi and others

Cumulative effects

Chain of effects



Example



Network of effects with multiple activities

Network of effects with multiple pressures for one activity

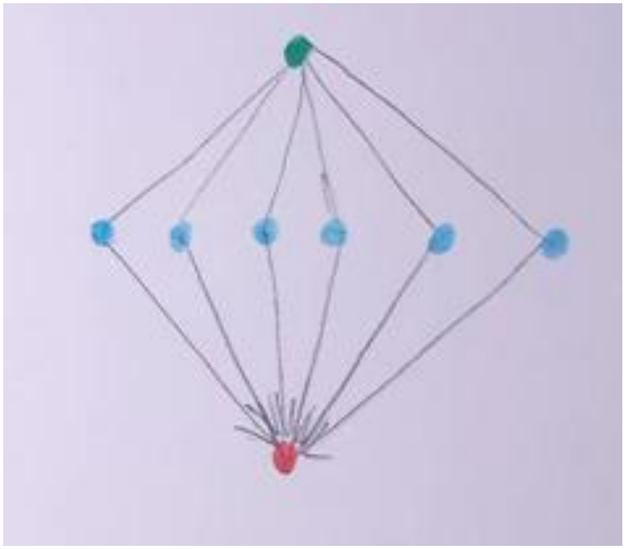
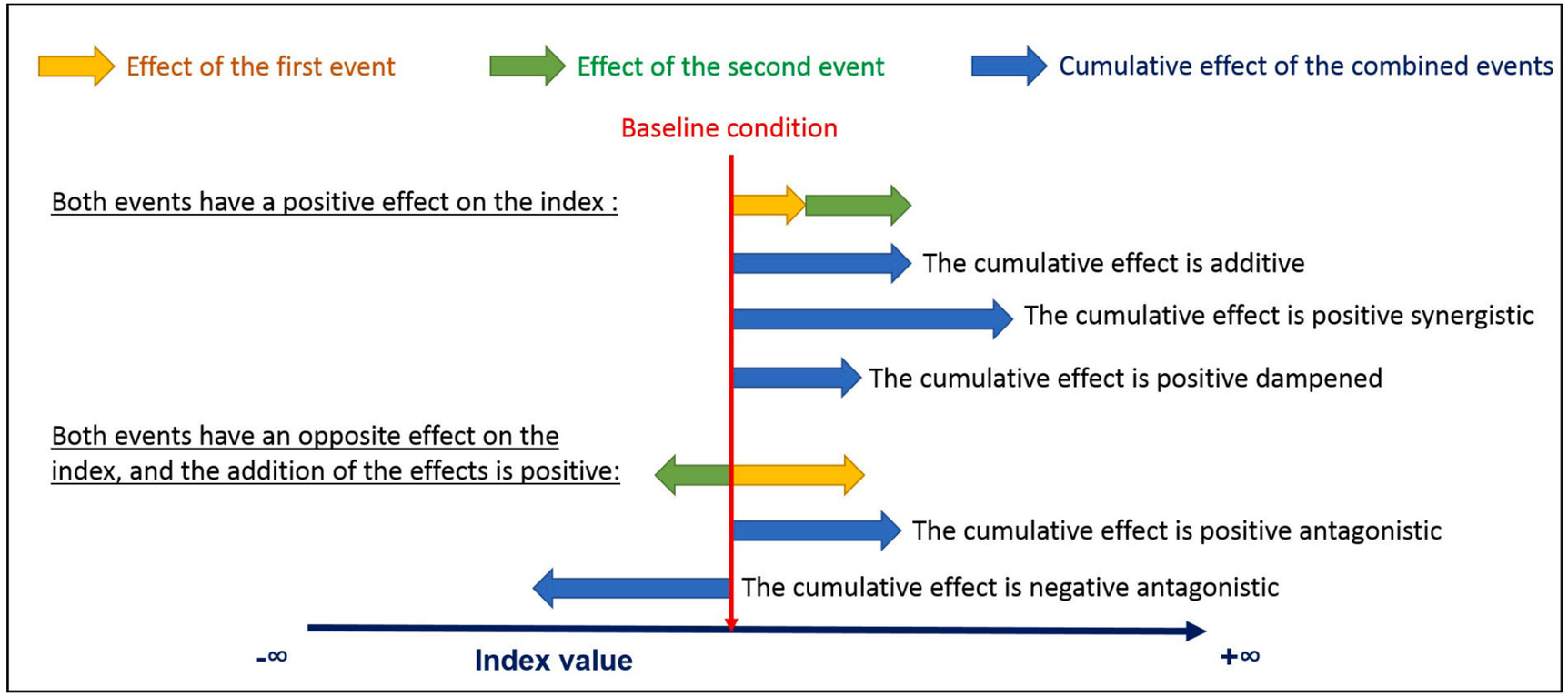


Figure modified by Nathalie Niquil from Knights et al., 2013.

Cumulative effects

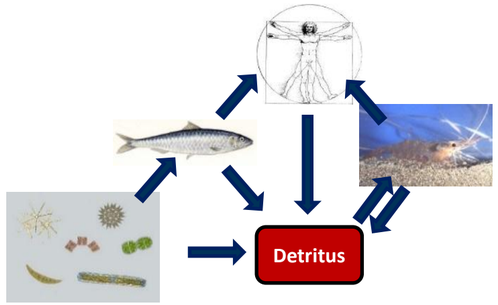


Noguès et al. 2021 derived from Fu et al. 2018

Ecosystem modelling tools

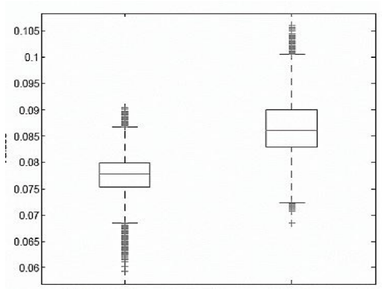
VARIABLE / TARGET

i.e. Ecological Network Analysis =
Numerical indices to define emergent properties



The static way:
Ecopath => ENA

Before After

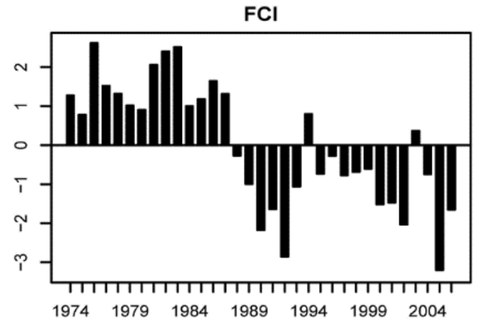


FCI (recycling)

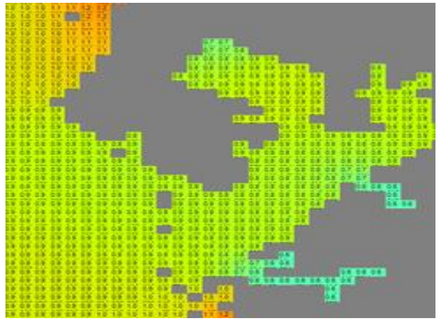
The statistical way:

LIM-MCMC
ENATool

The dynamic way:
Ecosim



Temporal + spatial:
Ecospace + Osmose



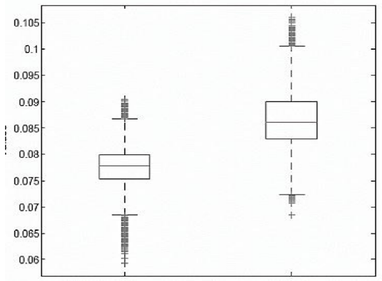
Applications to **human simulations with pressures crossed**

Guesnet et al 2015
Chaalali et al 2015
Tecchio et al 2016
Raoux et al 2017, 2019

Halouani et al 2021
Bourdaud et al 2021
Noguès et al 2021, 2023
Huong et al 2025
de Borger et al 2025

Ecosystem modelling tools :
The development of a new LIM code allowed innovating in LIM applications

Before After



FCI (recycling)

- **Alternative algorithms tested + computational changes to**

The samplelim R-code is available here :

https://github.com/pregnault/samplelim

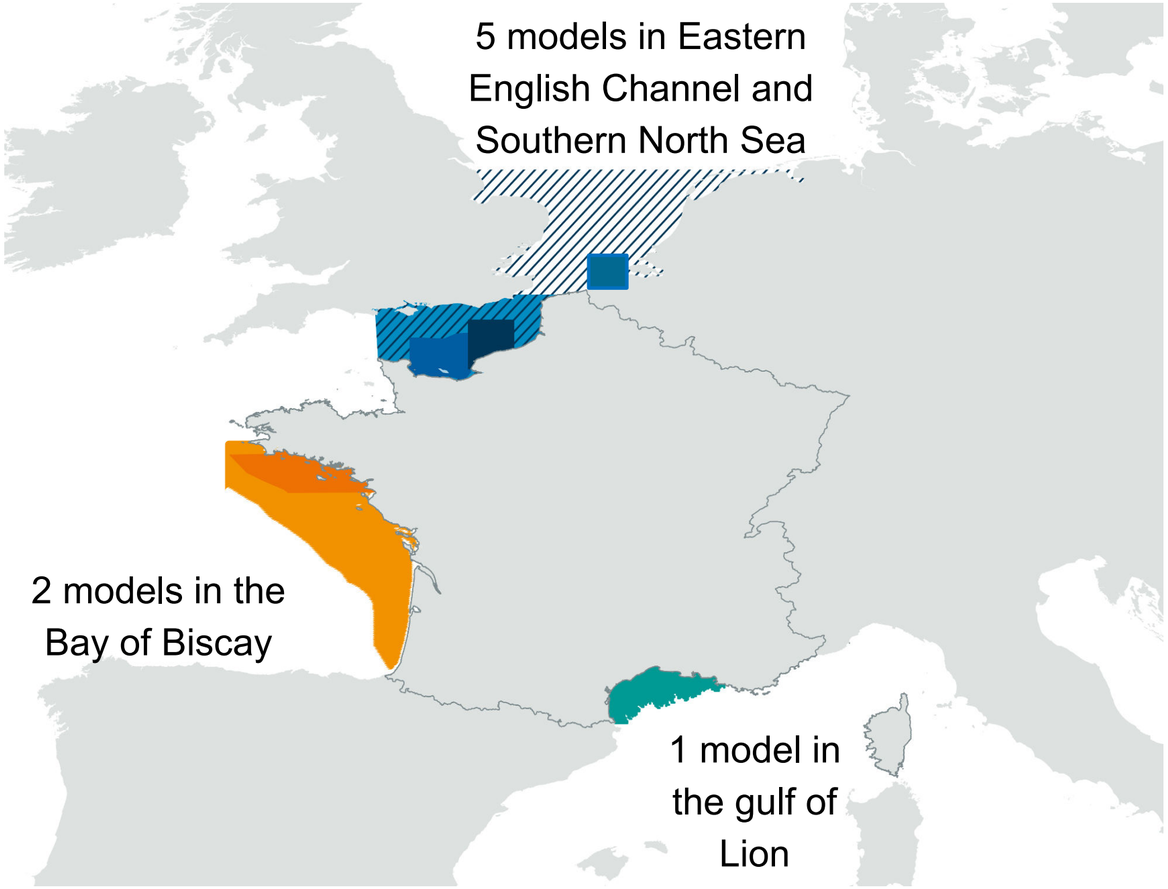
- **Girardin et al. 2025 :** “Application on real data metabolic networks of the three types [food-web, urban, biochemical] shows that {samplelim} gathers the best properties of previous implementations of the MCMC algorithms”

- Food-web models developed inside / outside Belgian OWF Power-C used to **test the sensitivity to Isotopic data of ENA properties**

- Tests realized to force a LIM food web model (Courseulles-sur-mer) with **outputs of hydrodynamic and Lagrangian particle tracking modelling**.

Girardin et al 2025
Ajmi et al in prep
Michaud et al in prep

Models of the ecosystemic approach used in Nestore project



samplelim

LIM

Linear Inverse Modeling: static, statistic, good representation of uncertainty

Ecospace: spatio-temporal, representation of all compartments of the ecosystem

OSMOSE : spatio-temporal, representation of main fish and cephalopods from eggs to senescence

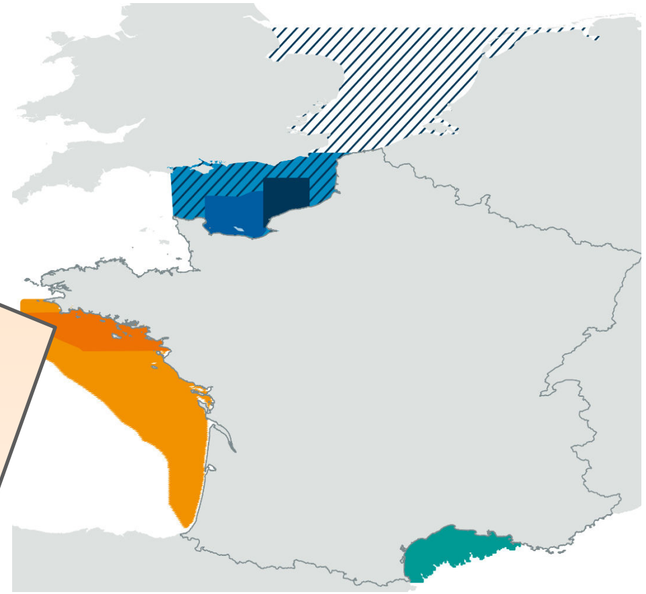
+ forcing of various specialized other models (species distribution, plankton) in Ecospace and OSMOSE

Ecospace models used for simulations : main conclusions

Development of an Ecospace model with a very fine scale in South Brittany to test change in the distance between turbines:

⇒ Benthic invertebrates more influenced by distances between wind turbines than by fishing practices

⇒ Fish more influenced by fishing practices than by distances between wind turbines



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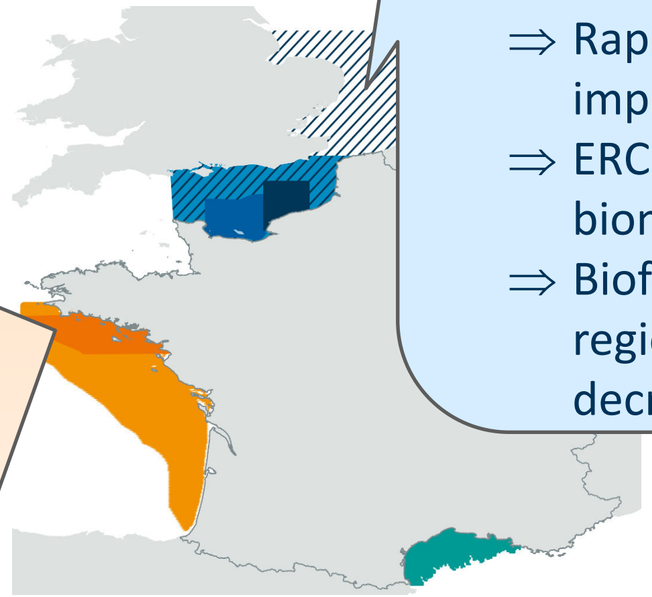

Development of multiple scenarios in the EEC-SNS model with multiple activities, climate change, ERC measures on noise, steps of multiplication of OWFs:

⇒ Rapid succession of construction phases amplify impacts
⇒ ERC measures tested reduce fluctuations in biomasses
⇒ Biofouling and fishing restrictions led to a slight regional overall biomass increase and catch decrease

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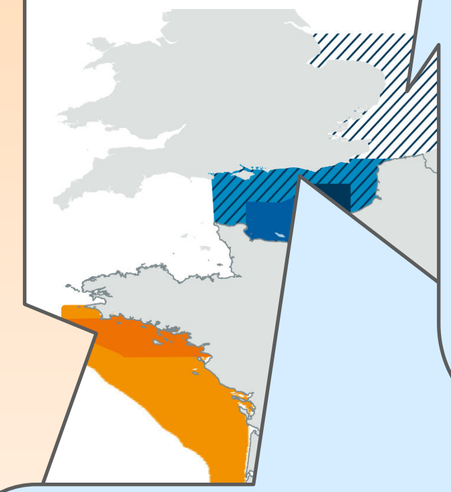

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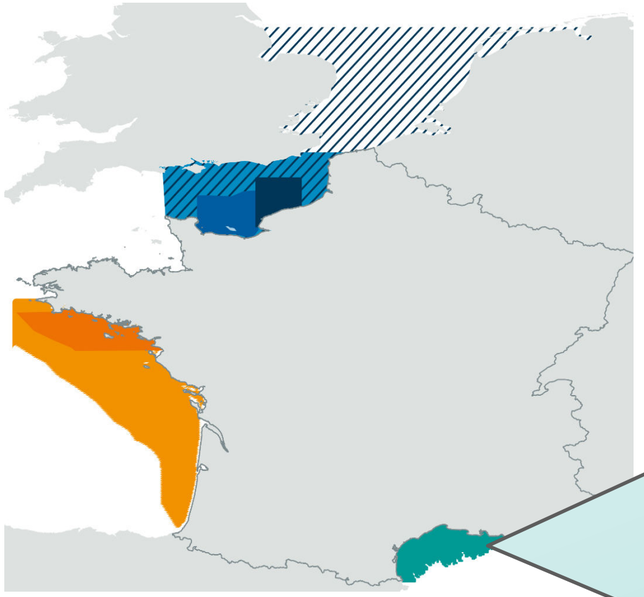
Eastern English Channel : Noise and sediment resuspension during construction phase + different fishing restrictions during construction and operational phases :

⇒ Total fish biomass and catches slightly reduced at regional scale, especially cuttlefish, herring and red mullet
⇒ Most significant impacts during construction phase
⇒ No common pattern at offshore wind farm scale, specificity to local conditions

Ecospace models used for simulations : main conclusions



Gulf of Lion : improvement of megafauna (marine mammals and seabirds) and fisheries representation, test of different wind farm configurations, biofouling levels, and fisheries management measures:

⇒ Moderate biomass changes at regional scale, negligible for marine megafauna

⇒ Potential high local biomass changes (> +50% benthic invertebrates and cephalopods)

⇒ Spillover effect enhancing catches near farm boundaries

Conclusion

- The **gain of time** of the new LIM code + **new assessment tools** of the quality of the results opened the way to new applications
  => sensitivity analysis show how important it is to **add isotopic data to OWF monitoring**
  => **more development needed** to connect physics and food webs

- The Ecospace models developed, **allowed to go further in the cumulative effects estimations**, taking into account more pressures associated to OWF, more steps in OWF development in France

- This is the purely “food web point of view” **to be balanced** with other focus related to evolution, other characterisation of ecosystem health, etc.

- The project Nestore **shows how important it is that the toolbox remains multi-model**, allowing the user to adapt the choice of the model to the constraints and questions
  => comparison of models outputs to study the uncertainty associated to the method

FRANCE ENERGIES MARINES

Thank you for your attention!