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Benthic communities and human activities: a peaceful cohabitation?

Elliot DREUJOU, Philippe ARCHAMBAULT, Christopher McKINDSEY

ARTICLE

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Spatial and temporal changes in cumulative human impacts on the world's ocean

Benjamin S. Halpern[1,2,3], Melanie Frazier[3], John Potapenko[4], Kenneth S. Casey[5], Kellee Koenig[6], Catherine Longo[3], Julia Stewart Lowndes[3], R. Cotton Rockwood[7], Elizabeth R. Selig[6], Kimberly A. Selkoe[3,8] & Shaun Walbridge[9]

Review

An effective set of principles for practical implementation of marine cumulative effects assessment

A.D. Judd [a,*], T. Backhaus [b], F. Goodsir [a]

[a] Centre for Environment, Fisheries and Aquaculture Science, Pakefield Road, Lowestoft NR33 0HT, UK
[b] University of Gothenburg, Department of Biological and Environmental Sciences, Carl Skottsbergs Gata 22B, Box 461, 40530 Göteborg, Sweden

Response of benthic assemblages to multiple stressors: comparative effects of nutrient enrichment and physical disturbance

Joseph M. Kenworthy[1,2,3,*], David M. Paterson[1], Melanie J. Bishop[2]

[1]Sediment Ecology Research Group; Scottish Oceans Institute, School of Biology, University of St Andrews, East Sands, St. Andrews, Fife, KY16 8LB, UK
[2]Department of Biological Sciences, Macquarie University, North Ryde, NSW 2109, Australia
[3]*Present address:* Team 'Diversity and Connectivity in Coastal Marine Landscapes', UMR 7144, Station Biologique de Roscoff, 29680 Roscoff, France

Multiple Stressors in a Changing World: The Need for an Improved Perspective on Physiological Responses to the Dynamic Marine Environment

Alex R. Gunderson, Eric J. Armstrong, and Jonathon H. Stillman

Romberg Tiburon Center and Department of Biology, San Francisco State University, Tiburon, California 94920; email: stillmaj@sfsu.edu
Department of Integrative Biology, University of California, Berkeley, California 94720-3140

Cumulative impact mapping: Advances, relevance and limitations to marine management and conservation, using Canada's Pacific waters as a case study

Natalie C. Ban [a,b,*], Hussein M. Alidina [c], Jeff A. Ardron [d]

[a] UBC Fisheries Centre, Project Seahorse, 2202 Main Mall, Vancouver, BC, V6T 1Z4, Canada
[b] Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Queensland 4810, Australia
[c] WWF-Canada, Pacific Region, Suite 1588, 409 Granville St, Vancouver, BC, V6C 1T2, Canada
[d] Pacific Marine Analysis and Research Association, Sussex Place Suite G7, 1001 Douglas Street, Victoria, BC, V8W 2C5, Canada

Human activities impact marine ecosystems → What are the effects of activities accumulation on benthic communities?... ... at a fine spatial scale (0.01 km²)?

Case study at Sept-Îles, QC

Third port of Quebec

24 MT of exchanged goods (2017)

High international targeting

98 % of imports-exports (2017)

Urbanization and waste waters discharge

Activities and sewers from industry

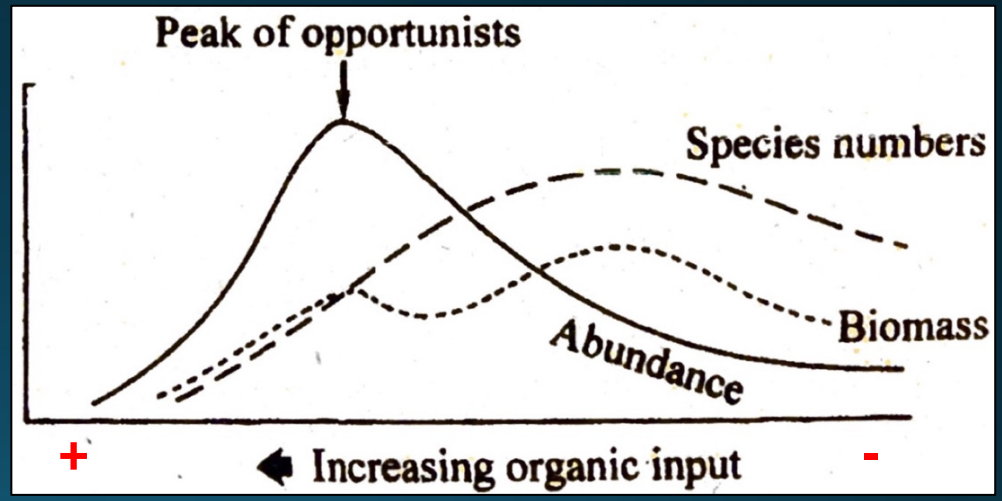
Commercial/Industrial shipping activities

+ Fishing, tourism…

Port de Sept-Îles, 2018

Why benthic species?

- Important for the ecosystem
- Important for mankind
- Respond to anthropogenic perturbations



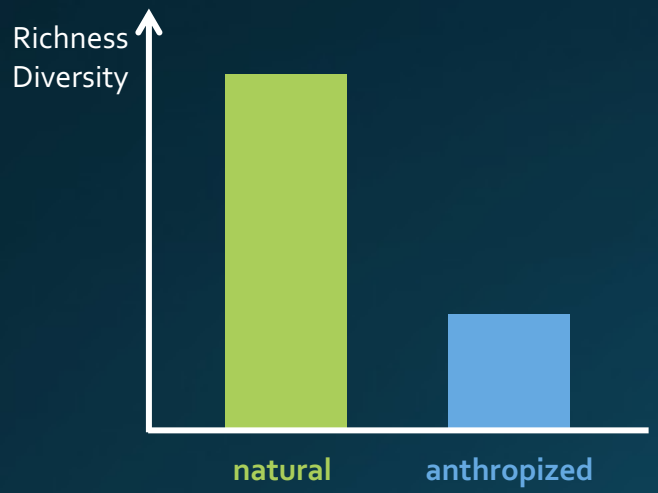
Pearson & Rosenberg, 1978

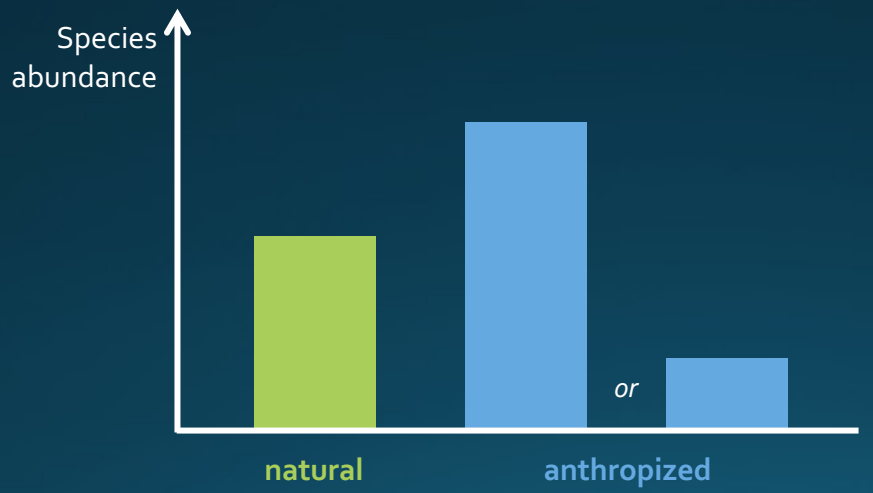
- Describe structure of the benthic subtidal ecosystems

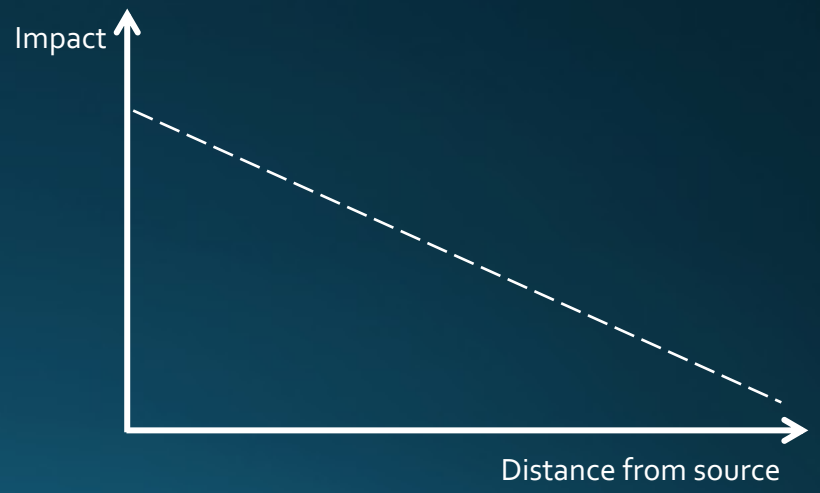
- Characterize human influence on benthic communities

  Hypothesis 1 communities of "anthropized" ecosystems ≠ "natural" ecosystems

  Hypothesis 2 most impacted zones from human activities: closest to their source



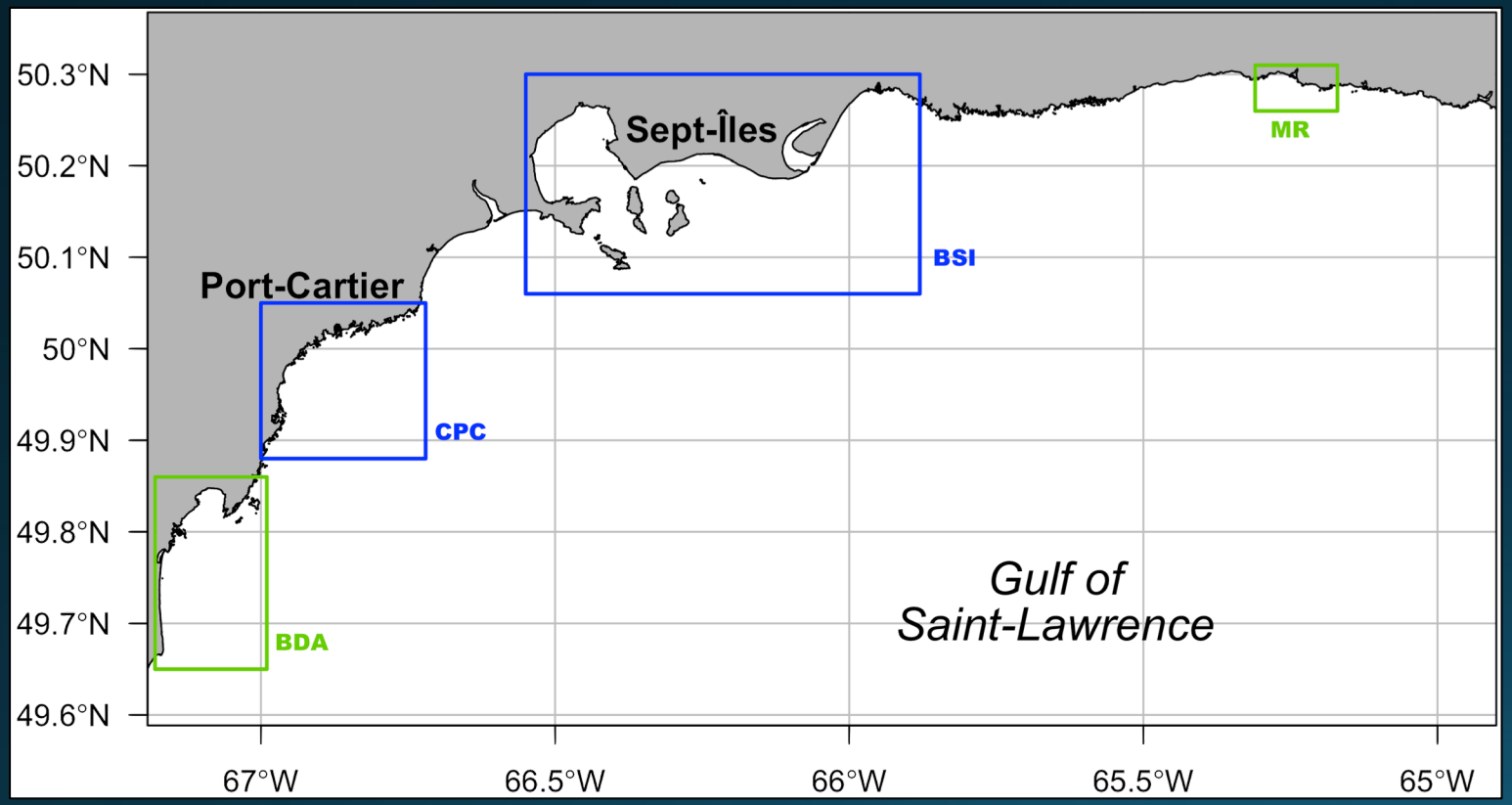




Sampling sites

2 types of ecosystems: anthropized and natural

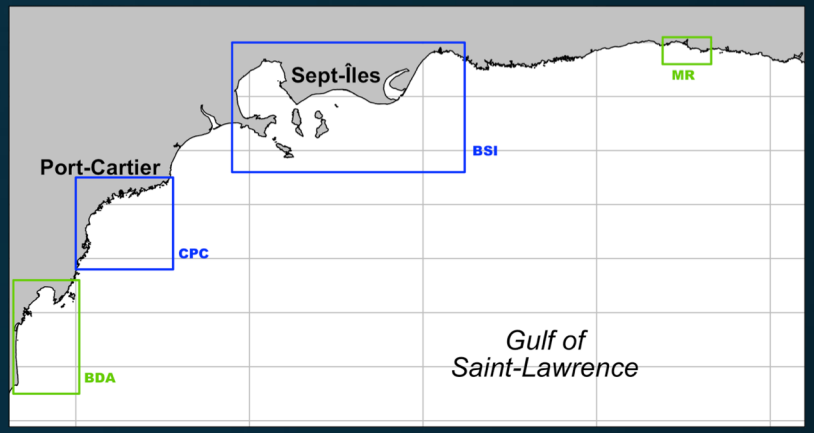
Sampled in 2014, 2016 and 2017

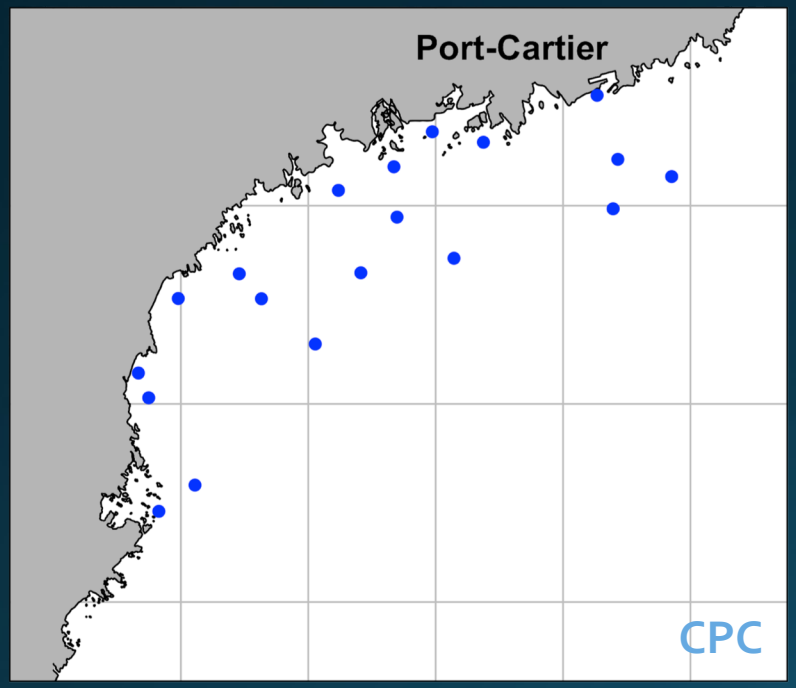


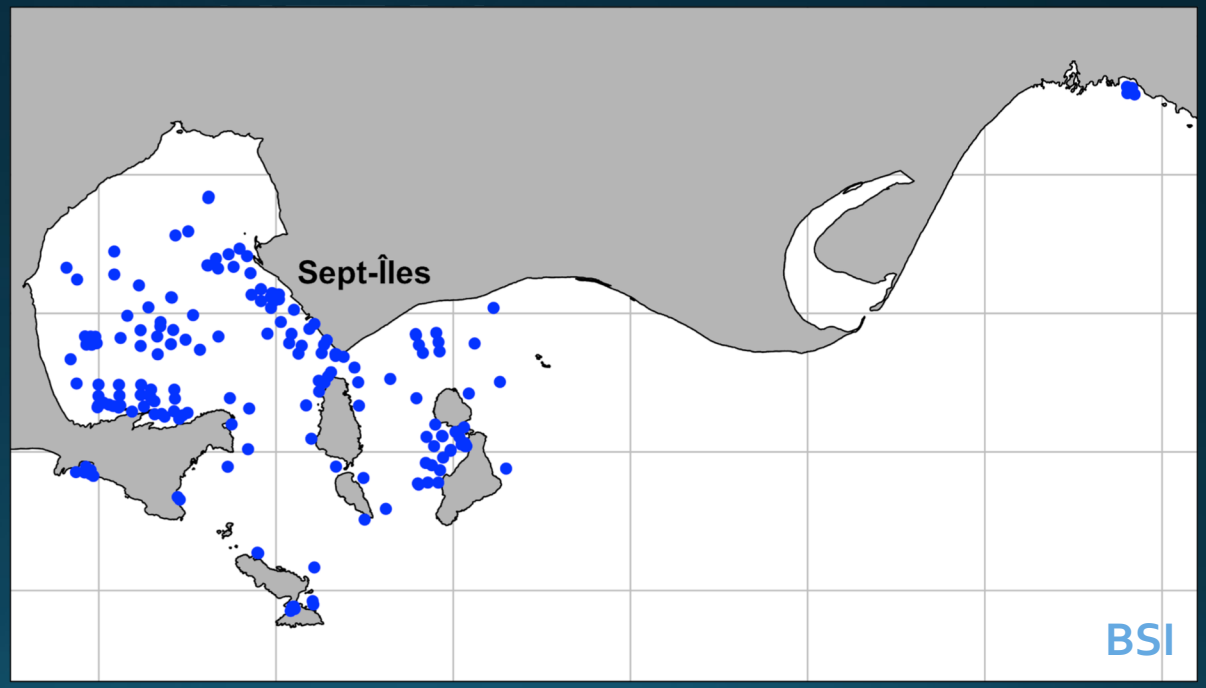
Sampling sites

Anthropized ecosystems:

Bay of Sept-Îles (BSI) – 2014, 2016, 2017
Coast of Port-Cartier (CPC) – 2016



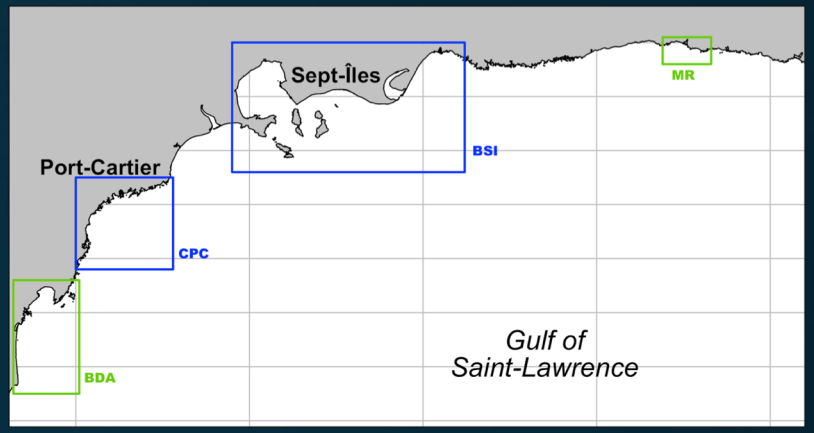


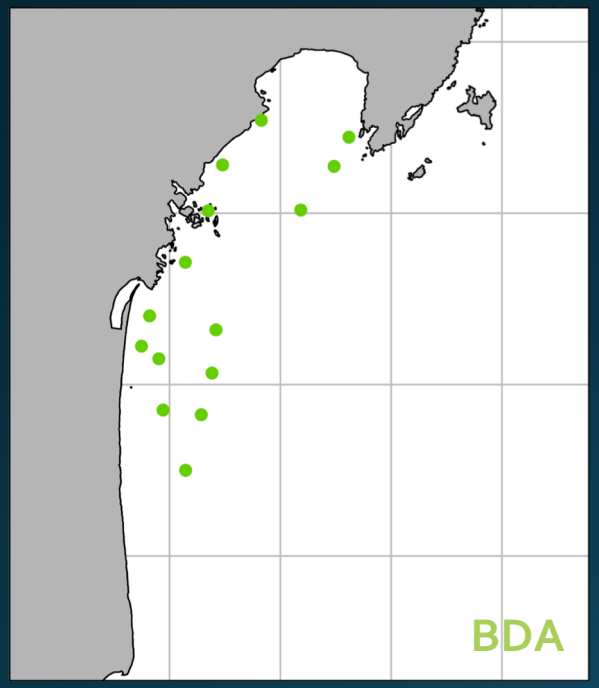


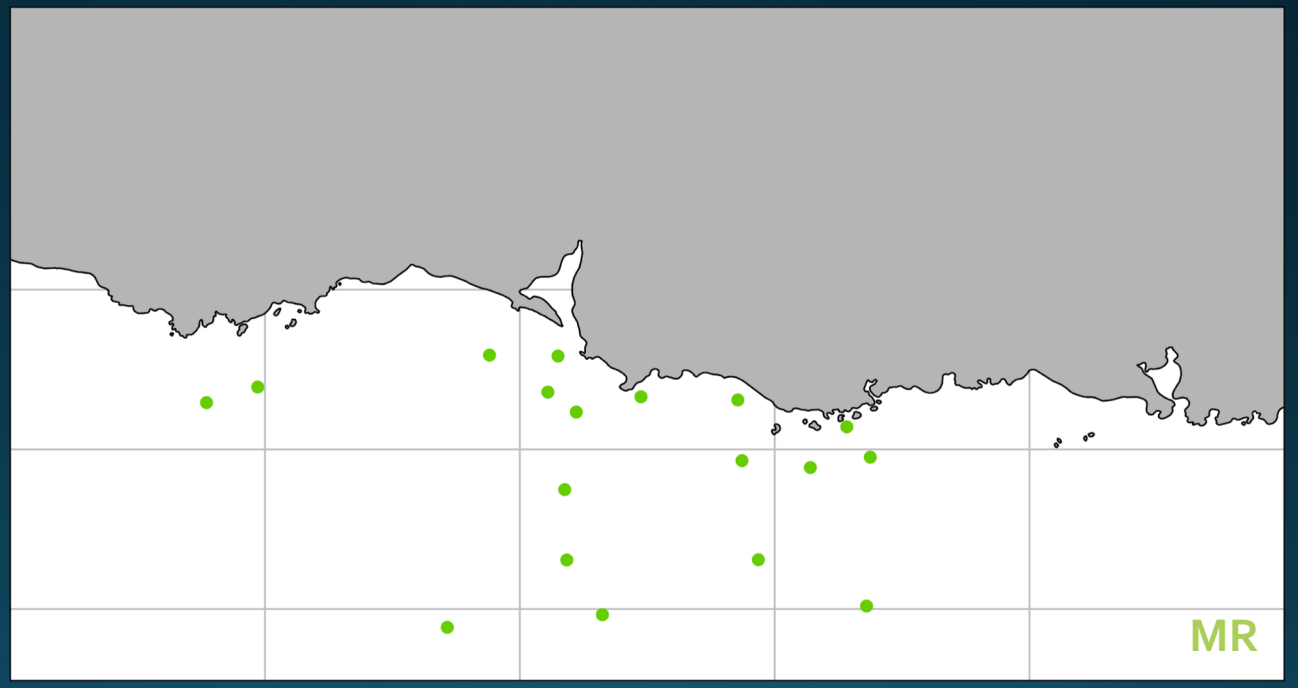
Sampling sites

Natural ecosystems:

Mouth of Manitou River (MR) – 2016, 2017
Baie-des-Anglais (BDA) – 2016







Collected parameters

COMMUNITIES

- species identity
  S

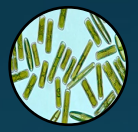
- species abundance
  N

HABITAT

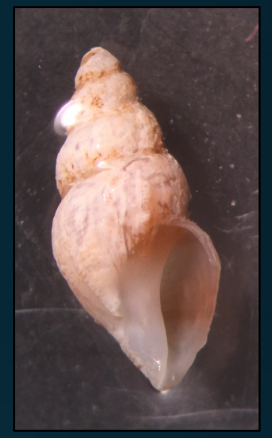
- metadata
  depth

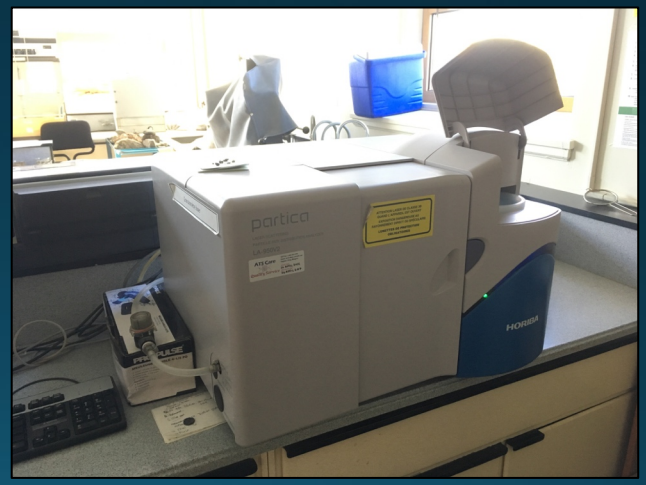
- organic matter content
  $\%_{OM}$

- pigment concentrations
  chla, phaeo

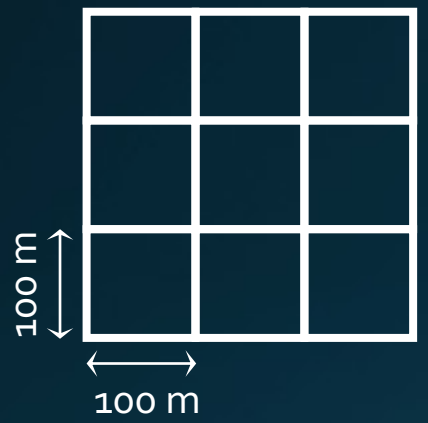


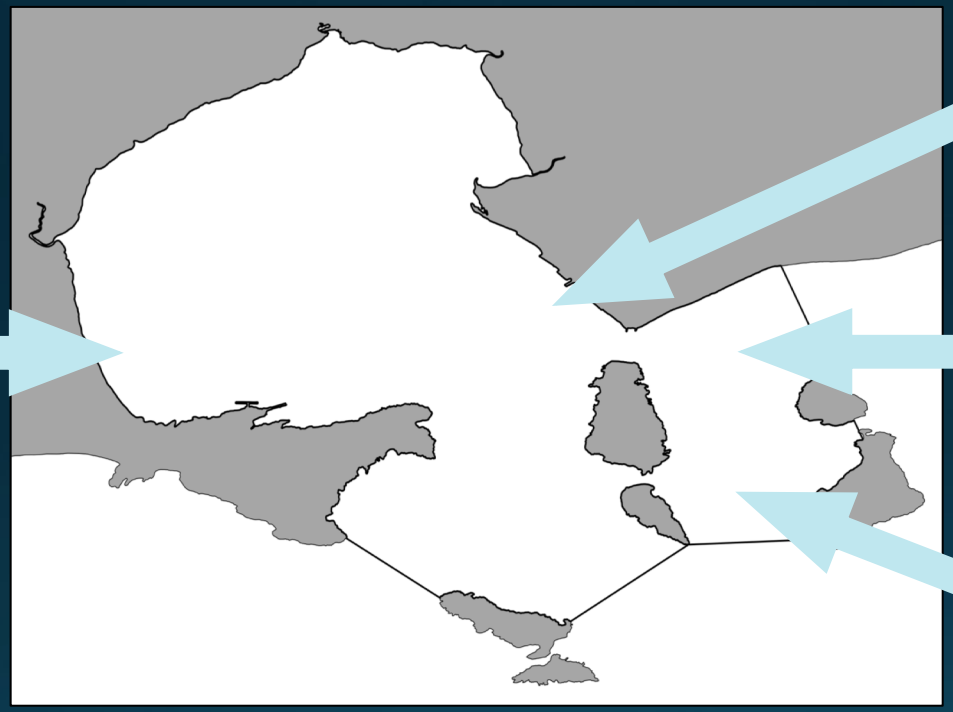
- sediment grain-size distribution
  $\%_{gravel}$, $\%_{sand}$, $\%_{mud}$





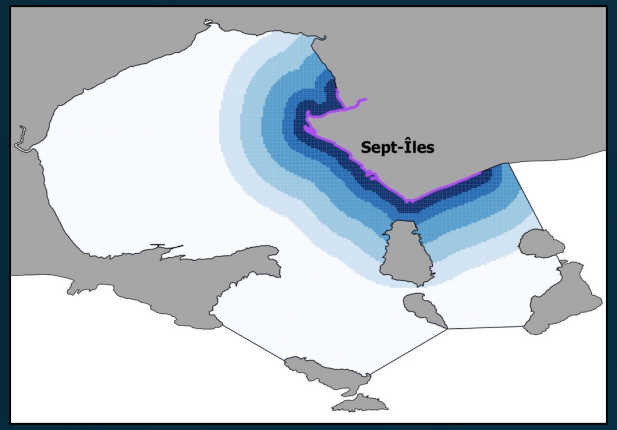
Stress score for each considered activity

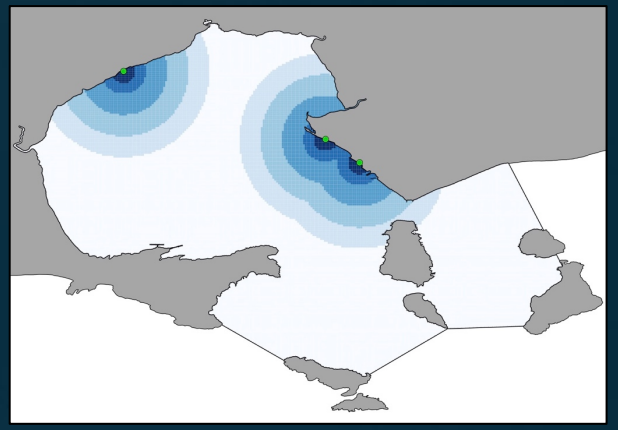




Stress score for each considered activity

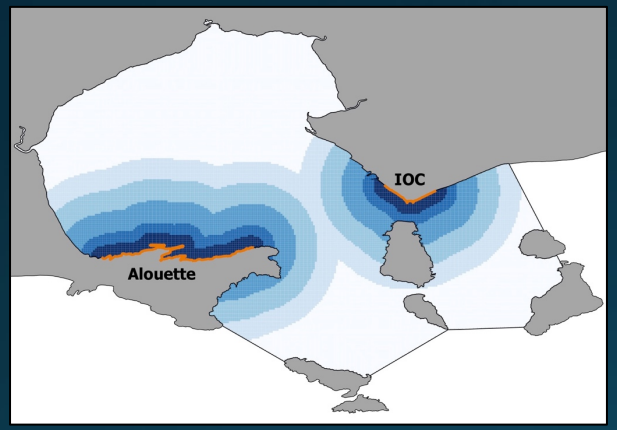
City diffuse runoff

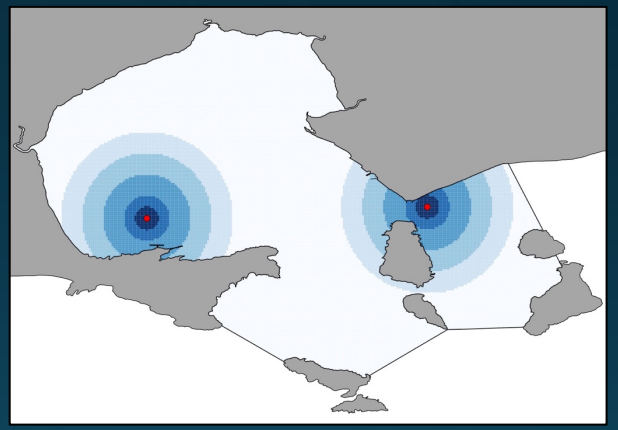




City sewer discharge

Industrial diffuse runoff





Sediment dredging

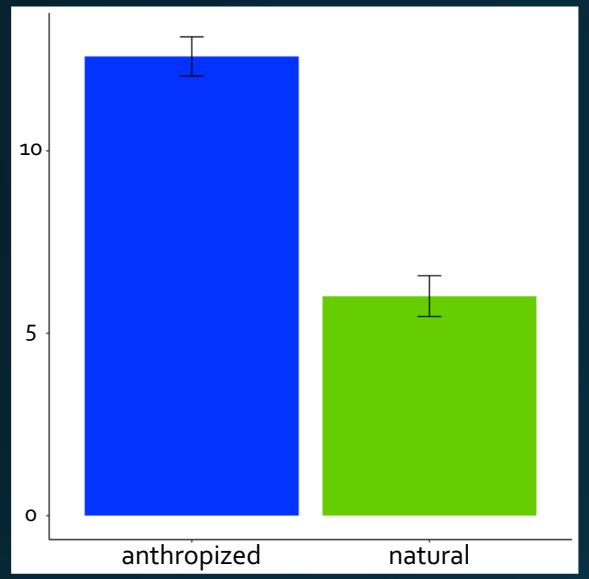
Distance from source

Score :

Hypothesis 1

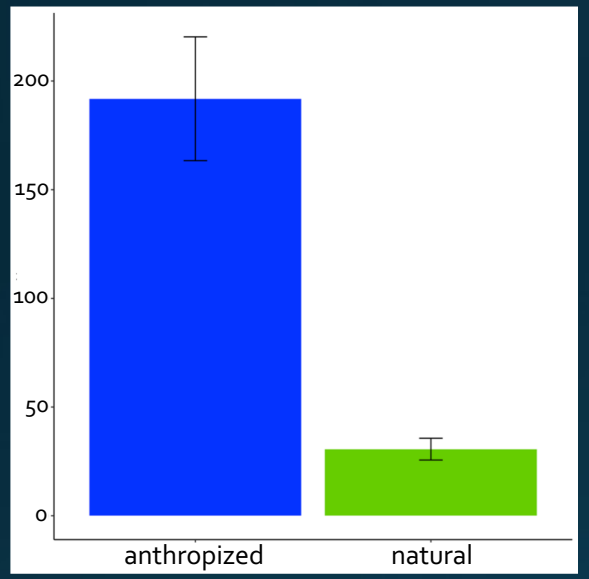
Communities of "anthropized" ecosystems ≠ "natural" ecosystems

Diversity (anthropized vs natural)



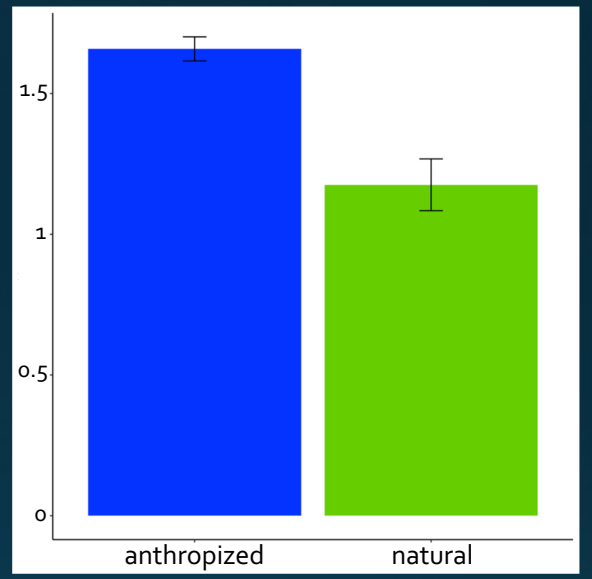
Species richness

1 < S < 36



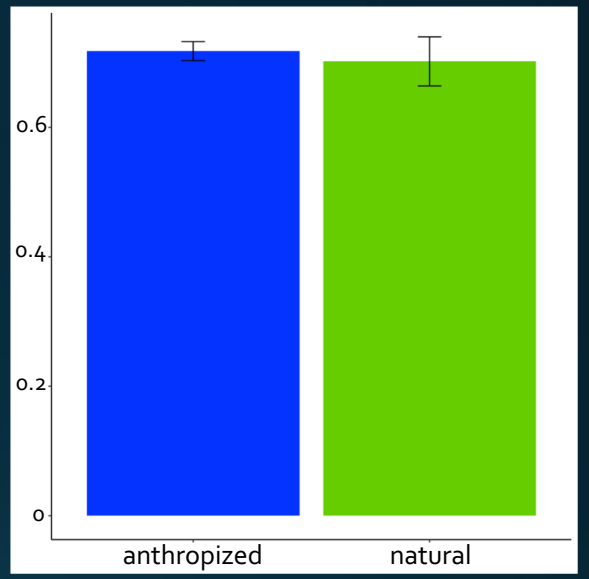
Abundance

1 < N < 2103



Shannon index

0 < H' < 2.7

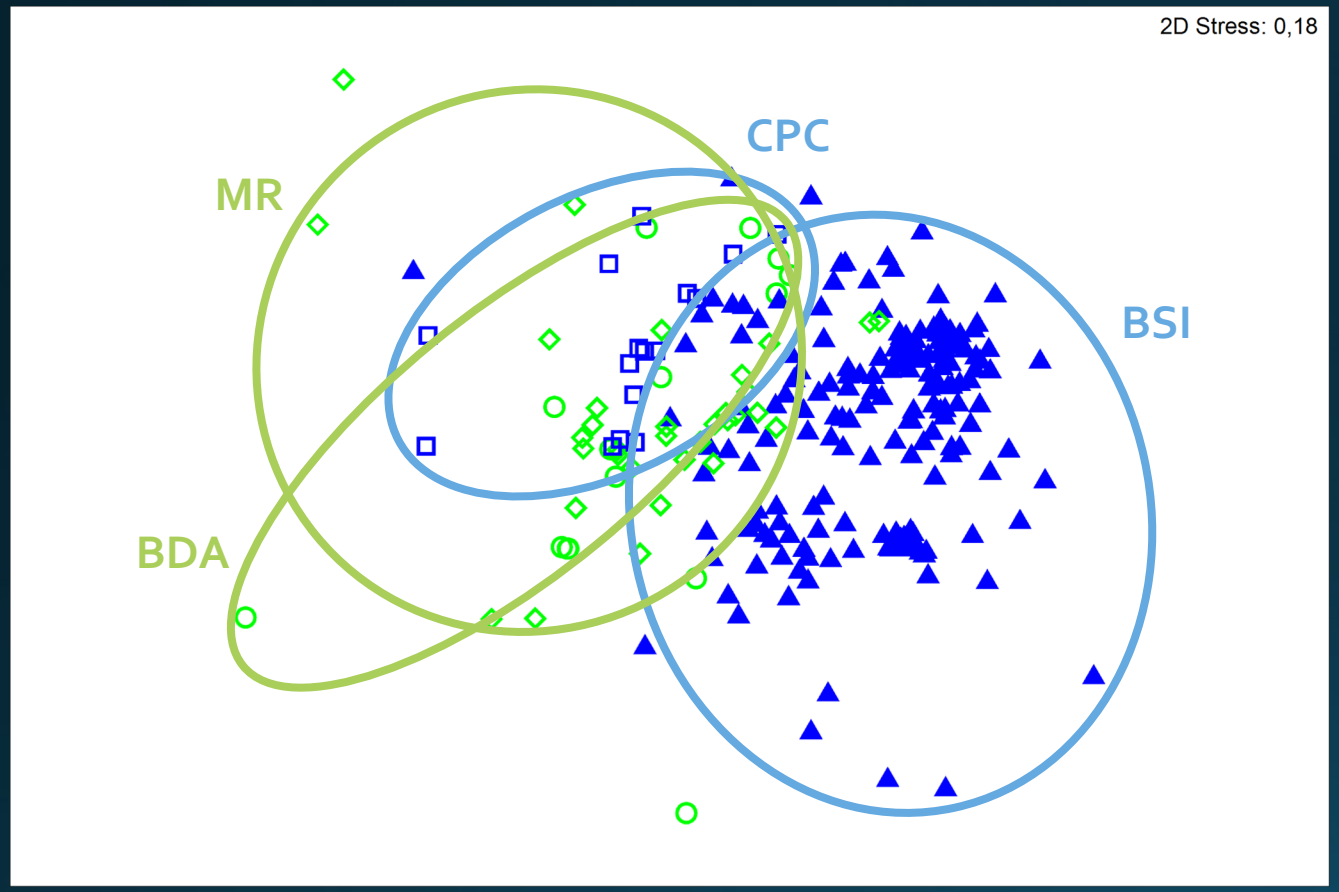


Piélou evenness

0 < J' < 1

Significative differences for S, N and H' (PERMANOVAs: $p < 0.05$)

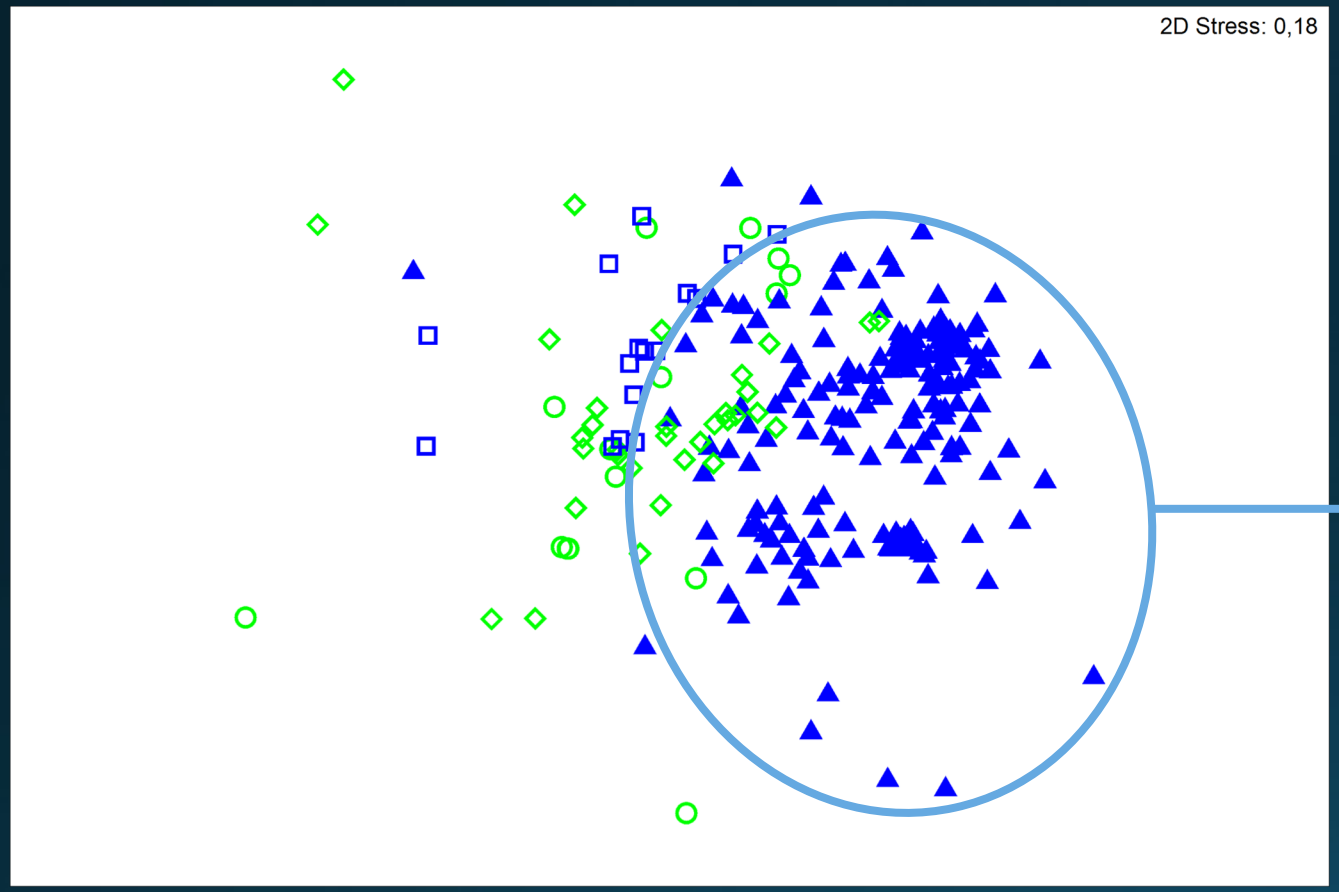
Communities (BSI vs CPC vs MR vs BDA)



Non-metric MDS (logarithm of abundances)

Significative differences between BSI, CPC, MR and BDA (PERMANOVA: $p < 0.05$)

Communities (BSI vs CPC vs MR vs BDA)



Non-metric MDS (logarithm of abundances)

Significative differences between BSI, CPC, MR and BDA (PERMANOVA: $p < 0.05$)

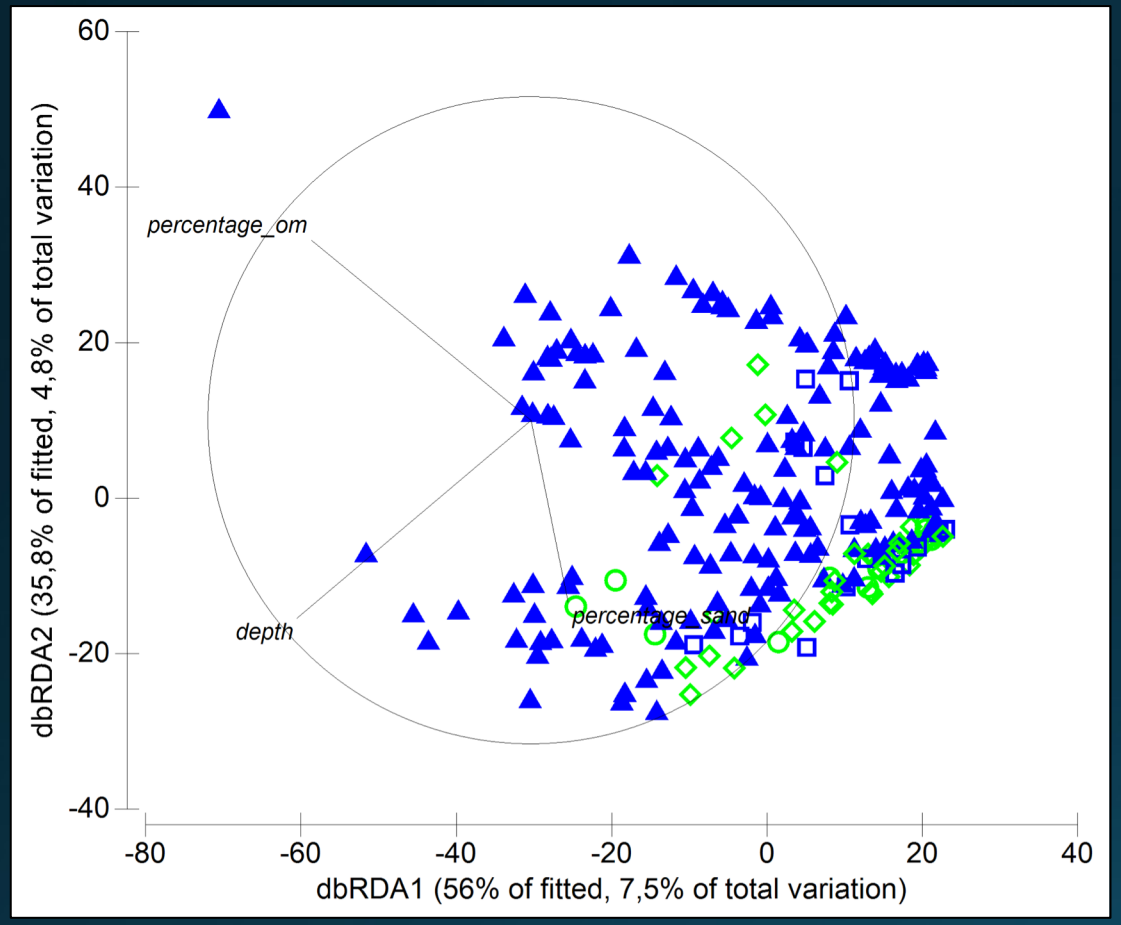
SIMPER analysis for BSI:

Polychaete *B. neotena* (30,5 %)

Chalcky Macoma (12,2 %)

Cumacean *E. integra* (12,1 %)

Habitat influence on the communities



Redundancy analysis (logarithm of abundances)

depth , $\%_{OM}$, $\%_{sand}$ explain the most variability of the communities (DistLM, dbRDA)

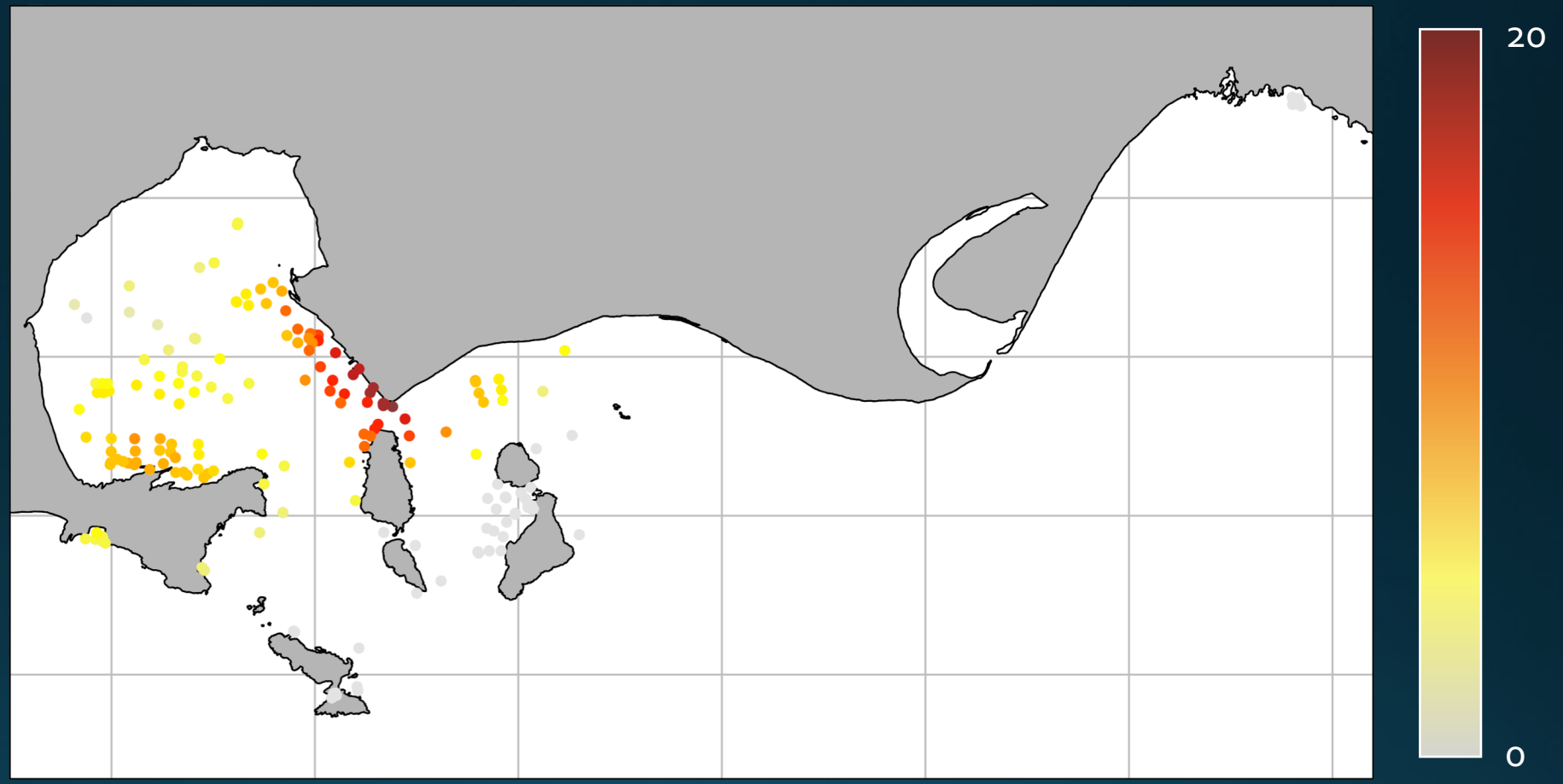
Hypothesis 2

Most impacted zones from human activities: closest to their source

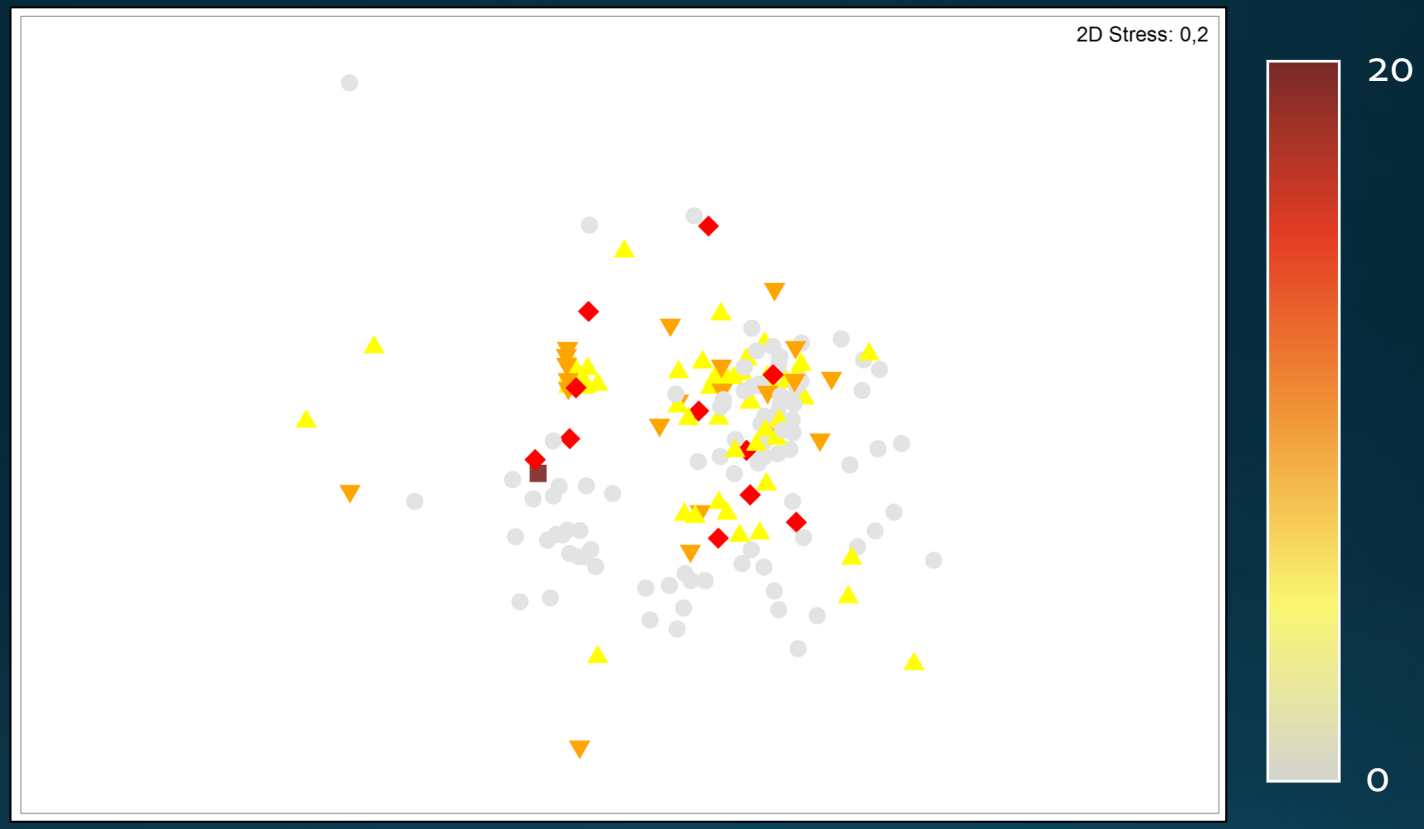
Calculation of stress scores (BSI)

Addition of individual scores for each human activity

Groups of stations based on the cumulative score (5 groups)

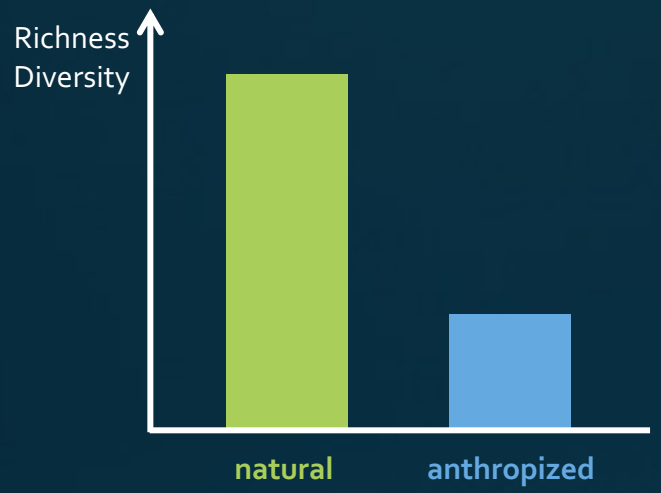


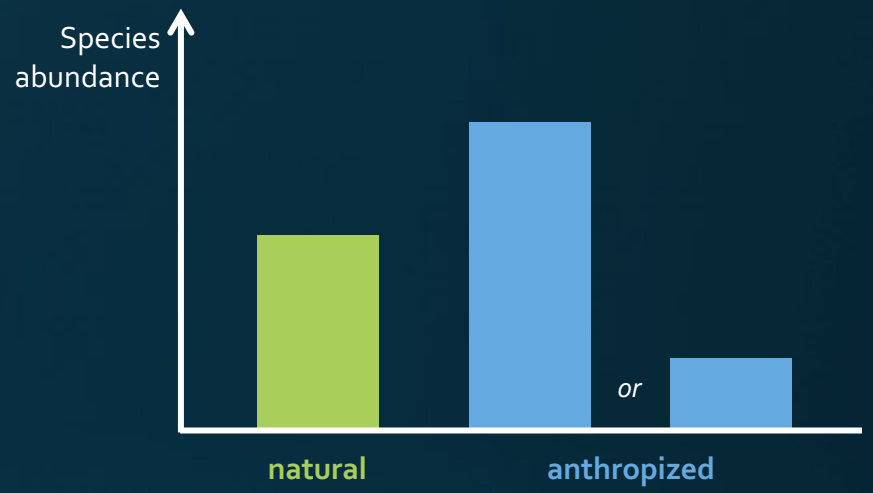
Link with stress scores (BSI)



Significative differences between stress groups (PERMANOVA: $p < 0.05$)
Not the same variability for each group (PERMDISP: $p < 0.05$)

Hypothesis 1



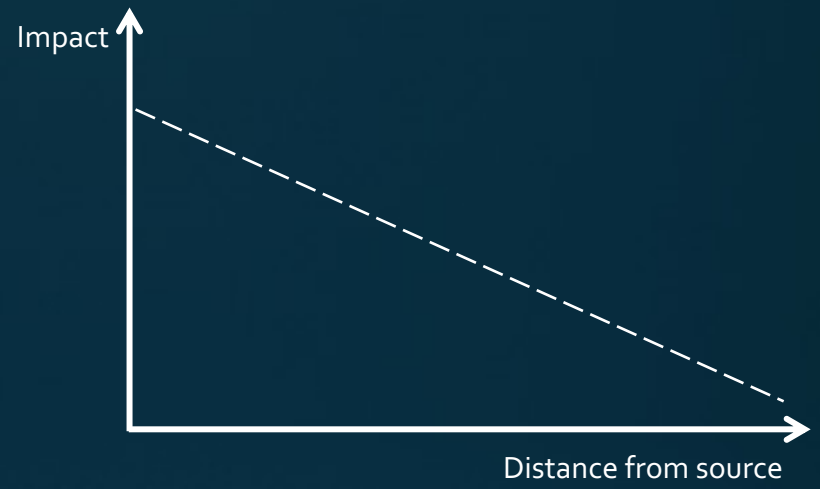


- Communities of anthropized ecosystems are more diverse than natural ones.
  Each region has a different species assemblage.

- Most explanatory variables : *depth* , $\%_{OM}$, $\%_{sand}$

  How much is due to human activities?

Hypothesis 2



- Differences have been detected between stress groups …
  … but results need to be refined.

- Further development:
  Addition of more environmental characteristics (currents, bathymetry…)
  Relative importance of activities

Elliot Dreujou
elliot.dreujou@icloud.com
Alexandre Vachon Building, office 4068

Thanks for your attention!

Questions?

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