Linking anthropogenic activities and benthic communities in industrial and harbour areas: what is the state of the ecosystems?

Elliot Dreujou[1] (elliot.dreujou@icloud.com), Philippe Archambault[2], Christopher McKindsey[3], Nicolas Desroy[4], Aurélie Foveau[4]

[1]Institut des Sciences de la Mer (UQAR), Rimouski ; [2]Laval University, Québec ; [3]Maurice-Lamontagne Institute, Mont-Joli ; [4]Centre de recherche et d'enseignement sur les écosystèmes côtiers, Dinard

This project is funded by NSERC program Canadian Healthy Oceans Network and its partners: Department Fisheries and Oceans Canada and INREST (representing Port de Sept-Îles and Ville de Sept-Îles).

I wish to thank all the personnel from Dinard station for their hospitality, and all the benthos lab for their priceless advices.

To go further:
- Callier *et al.* 2009 (*Mar Pol Bull*)
- Côté *et al.* 2016 (*Proc R Soc B Biol Sci*)
- Halpern *et al.* 2015 (*Nat Comm*)
- Pelletier *et al.* 2018 (*Ecol Ind*)

CONTEXT

In order to determine the ecological state of environments under anthropogenic influence, it is necessary to consider **all human activities** (HA) that are present in the area. HA assessments are generally performed at a high spatial scale (regional, global), **instead of a local scale** (< 100 km), which can limit conservation actions and biodiversity or ecosystem management.

The goal of this project is to develop methods of **local assessment** of HA impacts, by considering the **cumulative effects of their influences**, on the **benthic coastal ecosystems**. As a case study, we selected the industrial area, harbour and the bay of Sept-Îles (BSI), because of the presence of multiple and diverse HA and because Sept-Îles is ranked the 5th Canadian harbour in terms of exchanged ballast waters.

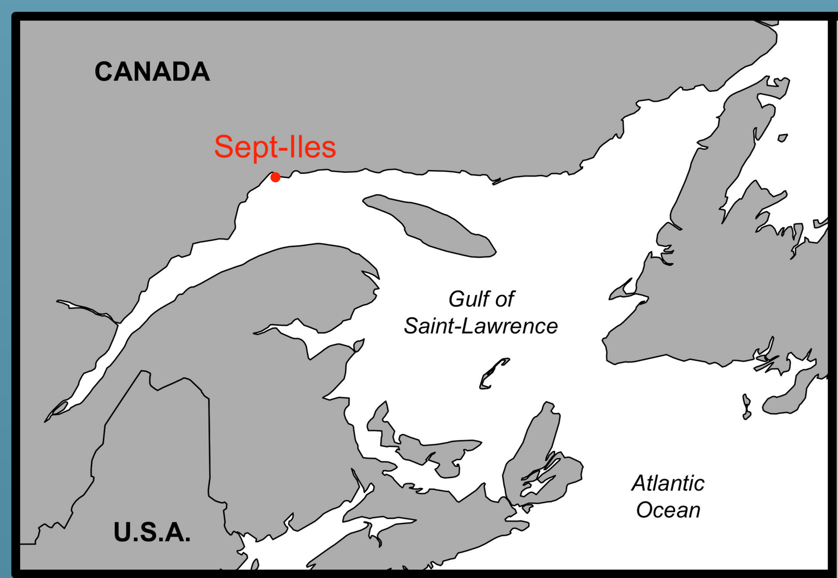
Hypotheses
1. HA impacts the diversity of benthic communities
2. BSI ecological status is correlated to HA distribution

METHODS

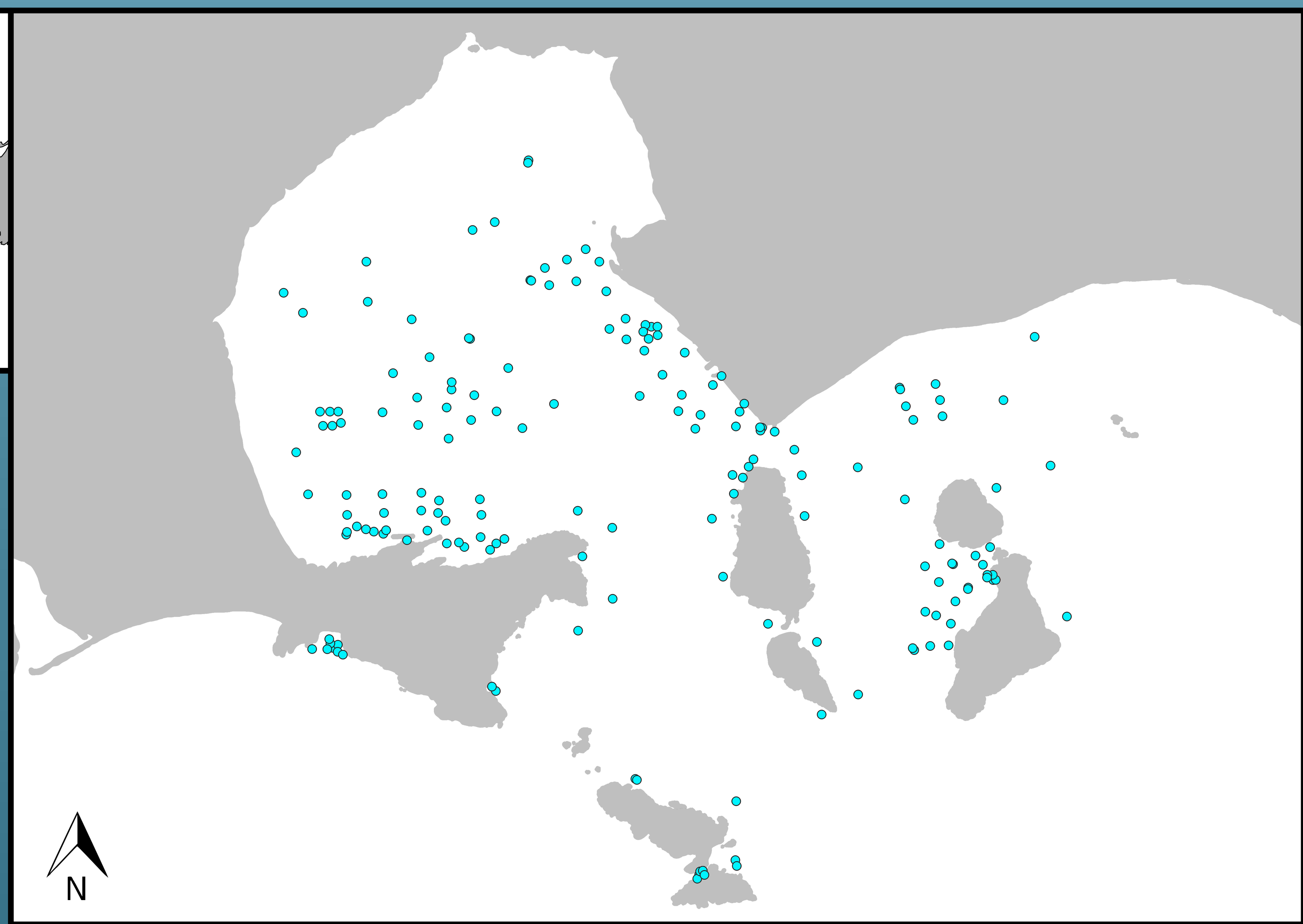
Evaluation of HA influence on the communities
- distance from the AH's source:

- multiple regressions with:
  - abundance of *B. neotena* (*Bneo*)
  - abundance of Nematoda (*Nema*)
  - specific richness (S)
  - total abundance (N)
  - Shannon diversity (H)
  - Piélou evenness (J)

Calculation of M-AMBI index on the communities
- distinction between communities with species longer than **500 µm**, and than **1 mm**
- distinction between **shallow** stations (< 15 m), and **deep** stations (> 15 m)



Bay of Sept-Îles, QC ▶



◀ *B. neotena*

Nematoda ▶

RESULTS

You can place on the map a variable you want to represent!

Available next to this poster: ▶
- source of each HA (1)
- abundances of *Bneo* and *Nema* (2 and 3)
- M-AMBI index scores, by community (4 and 5)

- ▶ Abundances of *B. neotena* and Nematoda are explained **the most** by the considered HA.
- ▶ Diversity indices are **not linked** to HA.
- ▶ Responses to HA are highly variable, **without any particular tendancy**.
- ▶ All regressions have a **low explanatory power** (maximum adjusted r^2: 0.22).

Table 1. *Links between HA and measured variables, as shown by the multiple regressions.*

	Bneo	*Nema*	S	N	H	J
City	+	-	.	+	-	.
Sewers	-	+	.	.	+	.
Industries	+	-	.	+	.	.
Dredging dumping	-	+	.	-	.	.

- ▶ The state of the benthic ecosystems can be considered as "**High**" and "**Good**" in BSI.
- ▶ There are **no important differences** between M-AMBI index values calculated on the 4 types of benthic community.

Table 2. *Reference conditions, used for M-AMBI index, calculated at the 95 % percentile of the measured values.*

	< 15 m		> 15 m	
	500 µm	1 mm	500 µm	1 mm
S	26	12	22	16
H	2.15	1.84	2.54	2.28

FUTURE WORKS

Present conclusions
- ▶ HA impact the communities' characteristic species, along with the total abundance of organisms, but these impacts are not the same.
- ▶ Sept-Îles Bay presents a good ecological status, according to M-AMBI index.

Next steps of this project, in order to increase the robustness of conclusions:
- Addition of HA in the model (e.g. fisheries, shipping routes) and definition of their sources
- Update of the HA's influence values according to water circulation and geography
- Verification of species list and reference conditions used for the M-AMBI index
- Test of other ecological indices (e.g. BenthoVal, BEQI)