# Climate-induced species range shifts and their ecological consequences for Canada's Maritime Region Marine Conservation Network


Amy L. Irvine, Gabriel Reygondeau, Ryan R.E. Stanley, and Derek P. Tittensor


## Background

Climate change can result in:

- Changes in species distributions
- Changes in ecosystem structure

As species shift, novel species compositions and interactions develop[1], posing challenges for spatial marine conservation strategies including:

- Marine Protected Areas (MPAs)[2]
- Other area-based Conservation Measures (OECMs)[3]

**Research Aim:** How can changes in species distributions affect ecosystem structure?

## Problem & Opportunity

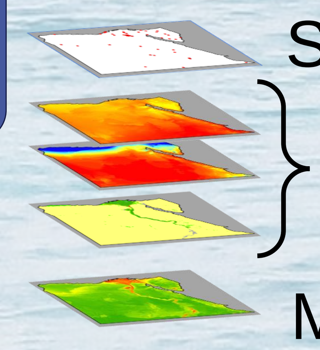
**Problem:** There is limited integration of these climate change impacts into marine conservation worldwide[4,5].

**Opportunity:** Maritime Region (Fig.1.) is the only place in Canada with a public draft and timeline for a conservation network[6].

## Methods

**Climate Change**

Outputs and projections from Species Distribution Models



- Species occurrences
- Environmental variables
- Modelled distribution

Model future distribution (SSP-RCP 2.6 & 8.5)

Reygondeau et al. *(in prep)*

**Change in Species Distribution**

Global outputs for species in Maritime Region and Network

**Change in Ecosystem Structure**

i) Proportion of species range protected

ii) Timing of species presence/ absence

iii) Species composition dissimilarity

## Results

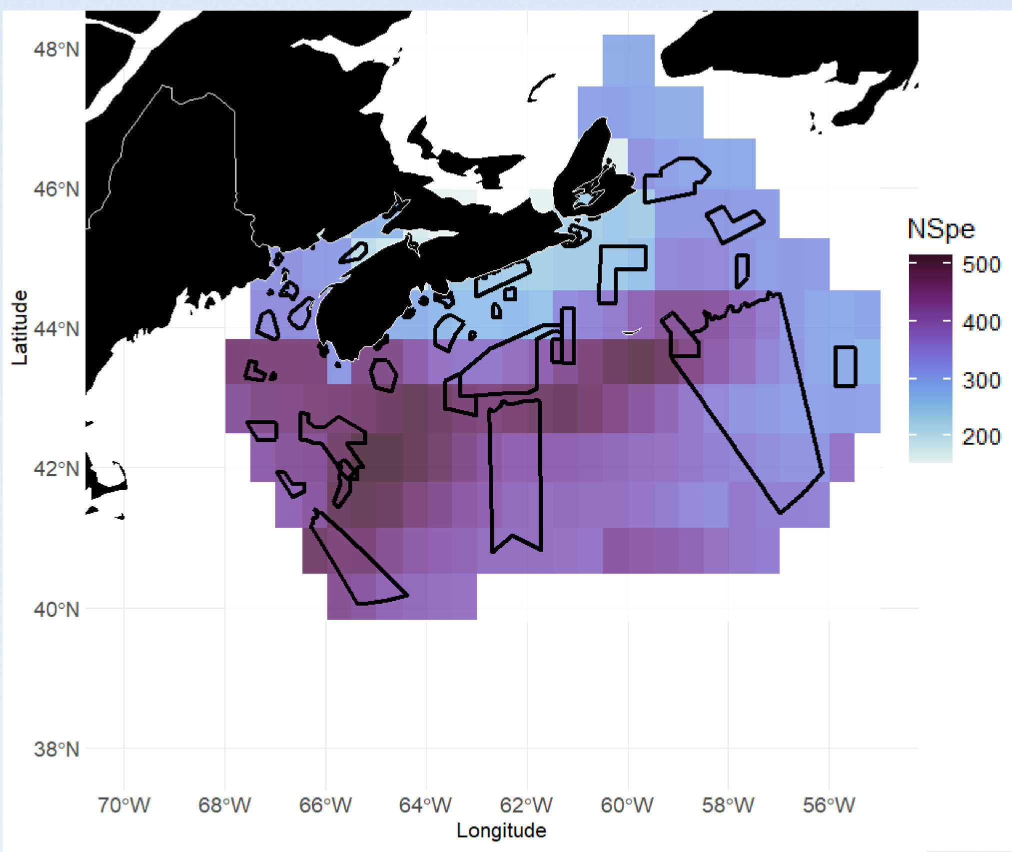



**Fig.1.** Present day richness for the Maritime Conservation Network in the Maritime Region

**Present Day Richness (Fig.1):**

- 960 modelled regional species
- Scotian Shelf has highest richness
- Eastern Canyons Marine Refuge (ECMR) protects most modelled species (696 spp.)

**Future Richness (Fig.2):**

- Lower richness in 2050 (794 spp.)
- Similar richness in 2099 (944 spp.)
- Higher richness in scenarios with higher emissions
- ECMR protects most modelled species in both times/ scenarios

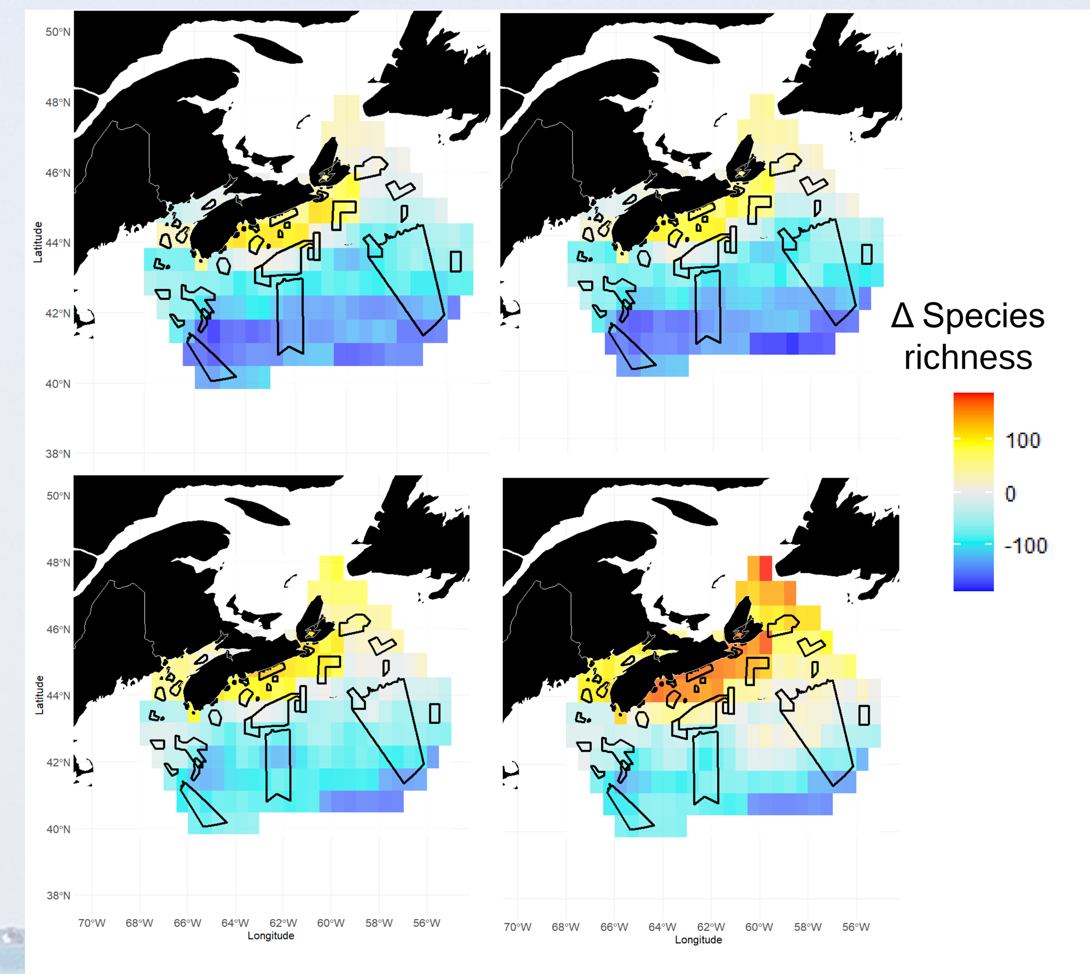



**Fig.2.** Maritime Region species richness, where the rows represent 2050 and 2099 and the columns show SSP1-2.6 and SSP5-8.5, respectively.

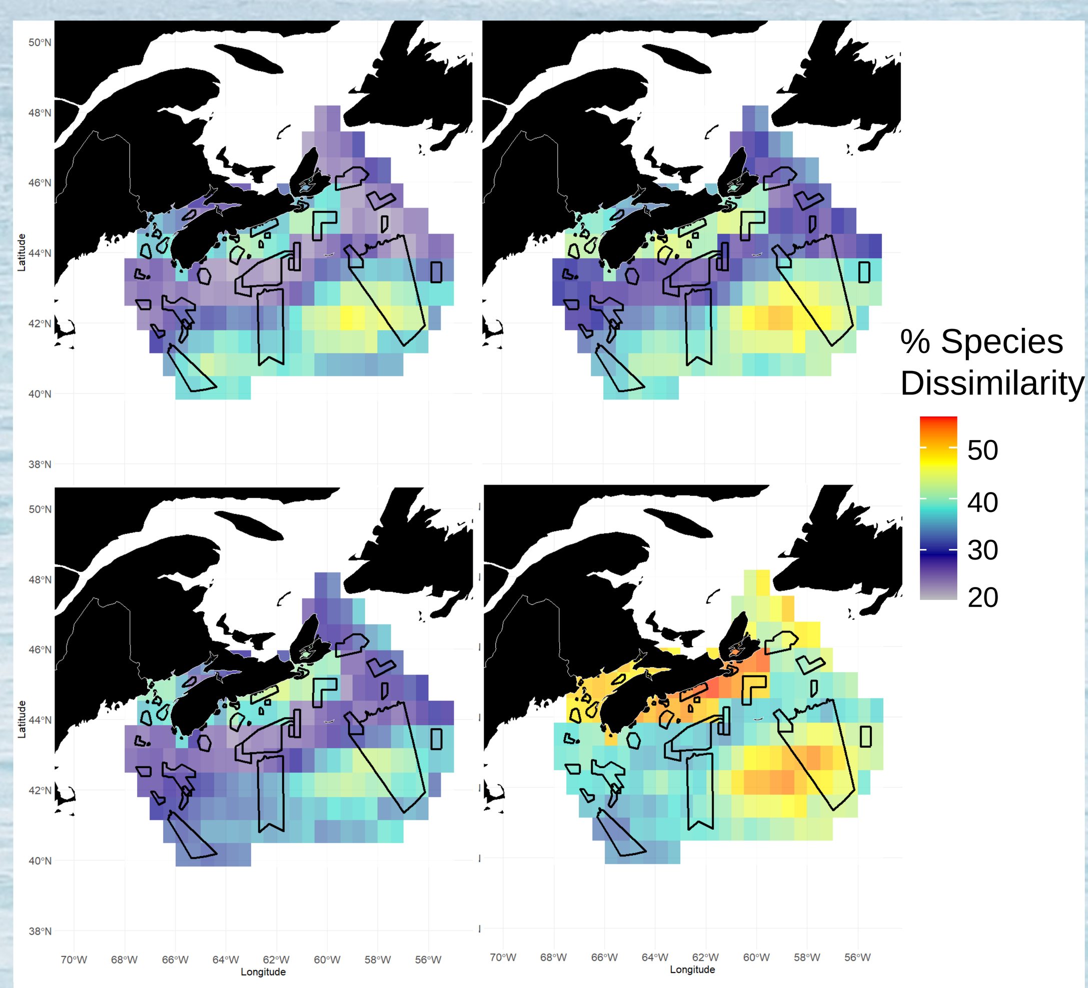



**Fig.3.** The $\beta_{Sørensen}$ for species dissimilarity between a future time point relative to present day in the Maritime Region. The rows are 2050 and 2099 and columns are SSP1-2.6 and SSP5-8.5, respectively.

**Future Dissimilarity (Fig.3):**

- Highest dissimilarity in 2099 SSP5-8.5 (30%; 287 immigrants)
- Higher emissions scenarios with higher dissimilarity
- ECMR with most emigrating and native species
- Some OECMs with >50% dissimilarity

## Significance & Future Directions

- Guide network management as it **adapts to biodiversity and species composition shifts.**
- Support climate change mitigation to **limit ecological change**.
- Provide template for **climate change integration strategies worldwide**.


1. Fossheim M., et al. 2015. Nat. Clim. Chang. doi:10.1038/nclimate2647.
2. Government of Canada 2011
3. DFO. (2022). *Guidance for recognizing marine Other Effective area-based Conservation Measures*.
4. Tittensor, D.P., et al. 2019. Sci. Adv. doi:10.1126/sciadv.aay9969
5. O'Regan, S.M., Archer, S.K., Friesen, S.K., and Hunter, K.L. 2021. Front. Mar. Sci. doi:10.3389/fmars.2021.711085
6. DFO 2022



**Contact:**
Amy.Irvine@dal.ca
Twitter @amyirvinee