Building Climate-Resilient Fisheries in the Northwest Atlantic

JUNE 2024

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▲ A winter flounder (*Pseudopleuronectes americanus*) camouflages against the seafloor near Port Joli, Nova Scotia, Canada. Photo credit: Nick Hawkins.

Climate change poses a growing threat to marine life, creating an urgent need for climate-informed management strategies. The ability to track changing fisheries vulnerability in a spatially explicit, rapid, and cost-effective manner can anticipate future climate risk outcomes and help support climate-resilient fisheries.

A newly developed Climate Risk Index for Biodiversity[1] was used to map critical risk areas for over 2000 marine species and 90 fish stocks in the northwest Atlantic Ocean, a hotspot for global warming.[2] The climate risk index generated detailed data about how fish species in specific areas would be affected under both high- and low-emissions scenarios projected over the next 75 years. It also assessed each species based on 12 climate risk factors in different locations of their geographic distribution.

1 Boyce, D.G., Tittensor, D.P., Garilao, C. *et al.* A climate risk index for marine life. *Nat. Clim. Chang.* 12, 854–862 (2022). https://doi.org/10.1038/s41558-022-01437-y

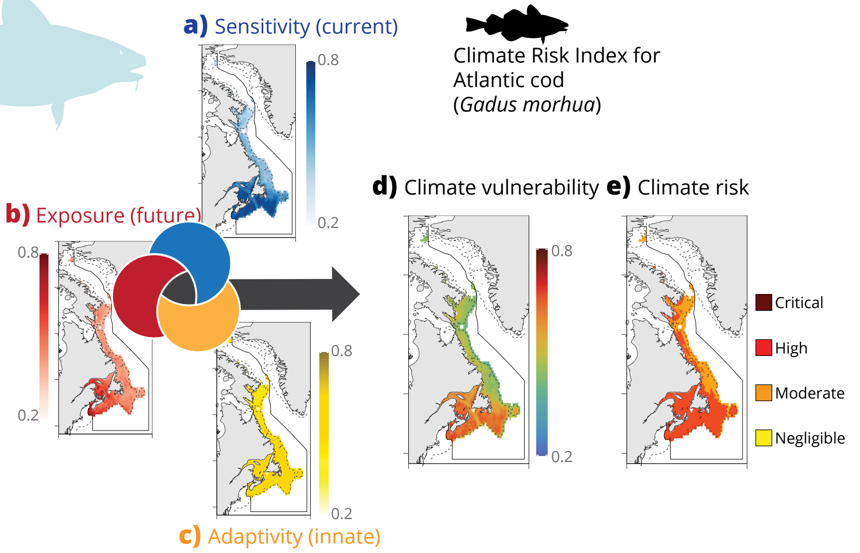
2 Boyce, D.G., Tittensor, D.P., Fuller, S. et al. Operationalizing climate risk in a global warming hotspot. npj Ocean Sustain 3, 33 (2024). https://doi.org/10.1038/s44183-024-00067-5

HIGHLIGHTS

- Overall, species in the Northwest Atlantic were at high or critical risk across 29% or 33% of their native geographic distributions under the low- and high-emission scenarios, respectively.
- Harvested species had markedly higher climate sensitivity and exposure because they tend to live closer to shore and are more sensitive to warming temperatures and other stressors. If emissions are reduced, these species are predicted to fare much better.
- Under both scenarios, the proportion of species at high or critical climate change risk tended to be higher closer to coastlines, particularly in the Gulf of St. Lawrence and on the Grand Banks.
- A large proportion of species were at risk at high latitudes (>60°N), where the variability in climate risk score was also higher.
- Under high emissions, most nearshore ecosystems had between 15-50% of their species at high climate risk, with some high latitude nearshore environments having over 75% of their species at risk.
- The benefits of lowering emissions were highest in nearshore and high-latitude environments.

SPECIES IMPACTS

Photo credit: Nick Hawkins



Atlantic cod is at critical risk from climate change in the southern Gulf of St. Lawrence. Cod experience moderate to high climate risks throughout their distribution areas, but this species is already at critical levels in parts of the southern Gulf of St. Lawrence, where rapid surface warming, increased acidification, and other impacts of climate change are increasing.

Fig 1. Spatially explicit assessment of climate vulnerability and risk for Atlantic cod (*Gadus morhua*). Within each grid cell (here 0.25°) across the native geographic distribution of cod within the the northwest Atlantic, 12 standardized climate indices are calculated and used to define the three dimensions of climate vulnerability: present-day sensitivity (a; blue), projected future exposure (b; red), and innate adaptivity (c; yellow). The dimensions are used to calculate cod climate vulnerability (d), and the relative vulnerability scores are translated into absolute climate risk categories for cod at all locations across its distribution (e). Figure reprinted from Boyce et al., 2024.

Photo credit: Viktor V. Grøtan

Elasmobranchs such as skates and sharks had the greatest range of vulnerability and risk scores, with smooth skates in the southern Gulf of St. Lawrence being the most vulnerable and thorny skates on the Scotian Shelf being the least.

Forage fish benefitted the most under the low-emissions scenario, and herring, capelin, and Northern shrimp stocks were the least climate vulnerable, although most were still at moderate risk.

Photo credit: Nick Hawkins

Many of the highest-value species received considerable benefits from lowering emissions, with efforts to mitigate climate change reducing the proportion of their distributions at high exposure risk. These included **American lobster** (-97%), **sea scallop** (-94%), **Northern shrimp** (-86%), and **snow crab** (-68%).

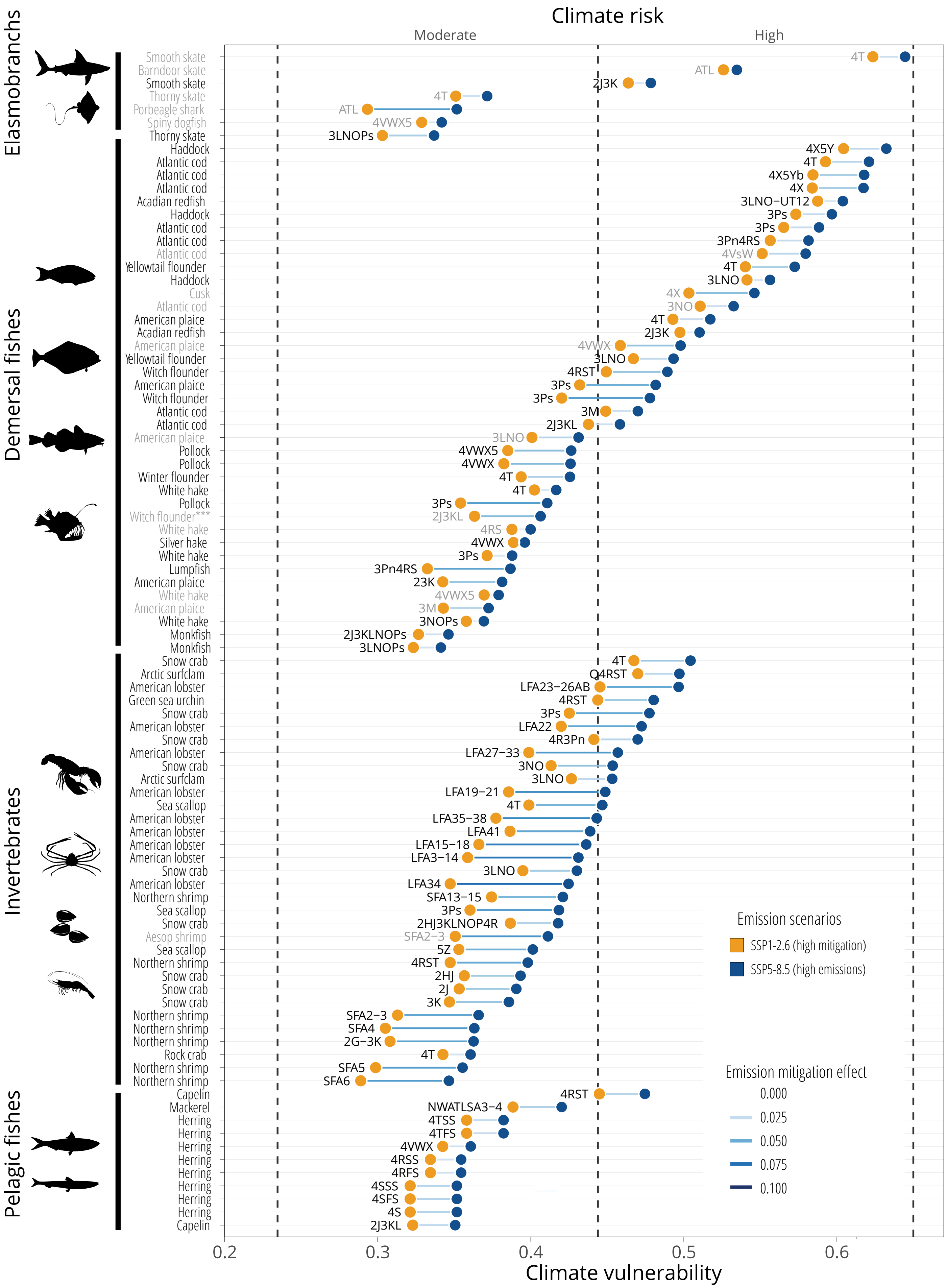


Fig 2. Climate risk and mitigation benefits for fisheries. Points are the average vulnerability scores for 95 stocks that operate across the Northwest Atlantic study area. The coloured points represent the emission scenario (low- emissions=yellow; high-emissions=blue), and coloured lines show the change in the average climate vulnerability of stocks with emission mitigation, where darker blue depicts larger emission mitigation effects. Black labels depict stocks for which there is a directed fishery and gray those fished as bycatch. Figure reprinted from [Boyce et al., 2024](#).

RECOMMENDATIONS FOR DECISION-MAKERS

- Use climate risk tools to identify the species and locations that are most urgently in need of climate adaptation and take the steps necessary to help them, such as integrating climate change considerations into stock assessment, harvest advice, and decision-making.
- Utilize tools such as Scenario Planning Frameworks or Management Strategy Evaluations (MSEs) to explore outcomes of different decisions on species or areas of high climate risk and find candidate management strategies that are robust to future climate scenarios, as well as population and ecosystem dynamics.
- Consider dynamic and adaptive management, where harvest rates can be adopted based on real-time data on changing environmental conditions.
- Broaden single-stock management to ecosystem-based fisheries management that can both predict and accommodate shifting geographical distributions.
- Limit global warming to 1.5°C to mitigate climate change impacts on marine life, including economically important fisheries and at-risk marine species.