Exploring the interaction between larval predation and Winter flounder dynamics from an ecosystem perspective using a multi-stanza Chance and Necessity model

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Rationale and Background

- Winter flounder (WF) stock in the Northeastern US Shelf area collapsed in the 1990's.
- Hypothesis explaining this collapse suggest increased larval mortality due to higher temperature (Able et al., 2014) or intensive fisheries and inappropriate management policies affected the spawning stock (Frisk et al., 2018).
- An alternative hypothesis is that increased predation on winter flounder larvae and juveniles affected the spawning stock biomass.
- No ecosystem-based approach applied to address the hypothesis of multiple stressors.
- **Using a multi-stanza food-web based approach, we investigate the effects of predation on winter flounder larvae and juveniles on adults to assess the major drivers of the winter flounder collapse during the last 40 years.**

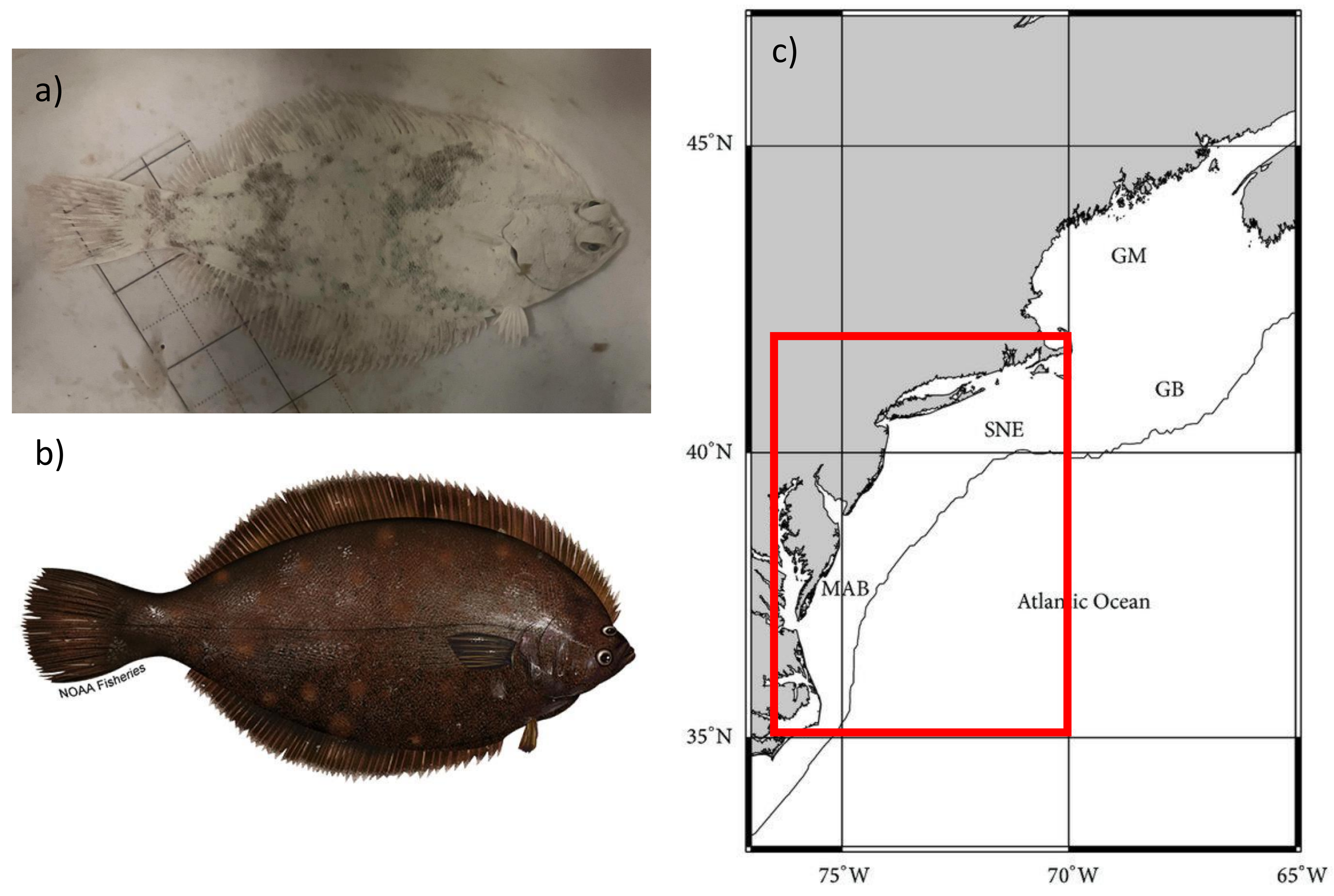

Figure 1. Juvenile winter flounder (courtesy of G.Luke, SoMAS) (a), adult winter flounder (b), map of the NEUS area taken from Ford and Link (2014) (c)

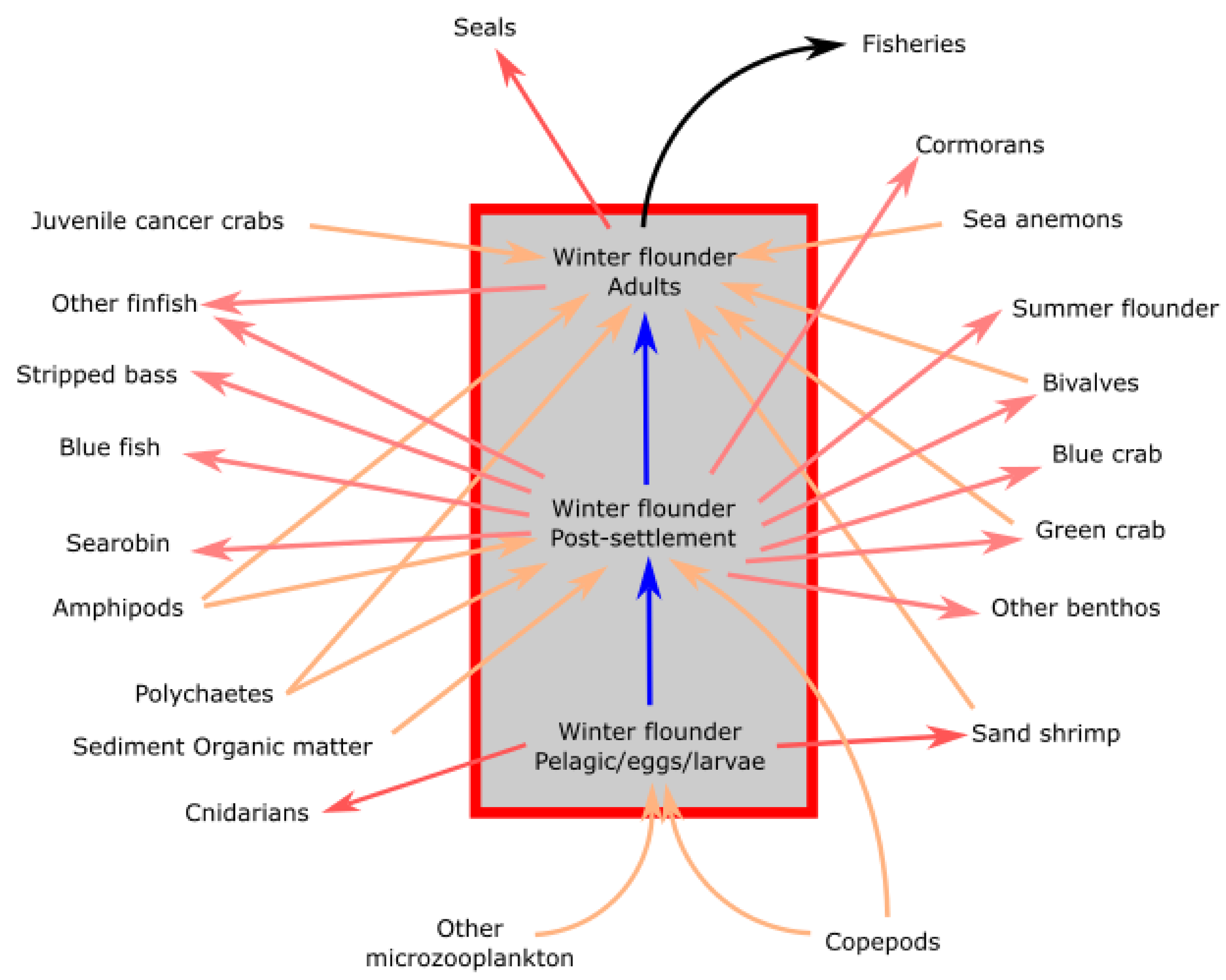

Figure 2. Schematic representation of the trophic interactions involving three winter flounder life stages. Orange arrows represent predation by WF. Red arrows correspond to predation on WF. The black arrow corresponds to the landings. Blue arrows correspond to non-trophic transfers of biomass (here transitions to the next age). The red square corresponds to the model domain.

Material and Methods

- Generalized RCaN modelling framework (stochastic food-web modelling approach, Planque and Mullon, 2020, Drouineau et al., 2023) accounting for larval, juvenile and adult winter flounder life-stages (Figure 2).
- Study-period : 1981-2022
- Data used for model construction derived from surveys and literature.
- 6000 reconstructions of the past trajectories of the food-web
- Interactions between predation on WF larvae and WF adult biomass, and fishing and adult biomass estimated based on Pearson correlation between lagged time-series (lag is 2 between larval predation and adults, and lag is 1 between landings and adults' biomass)

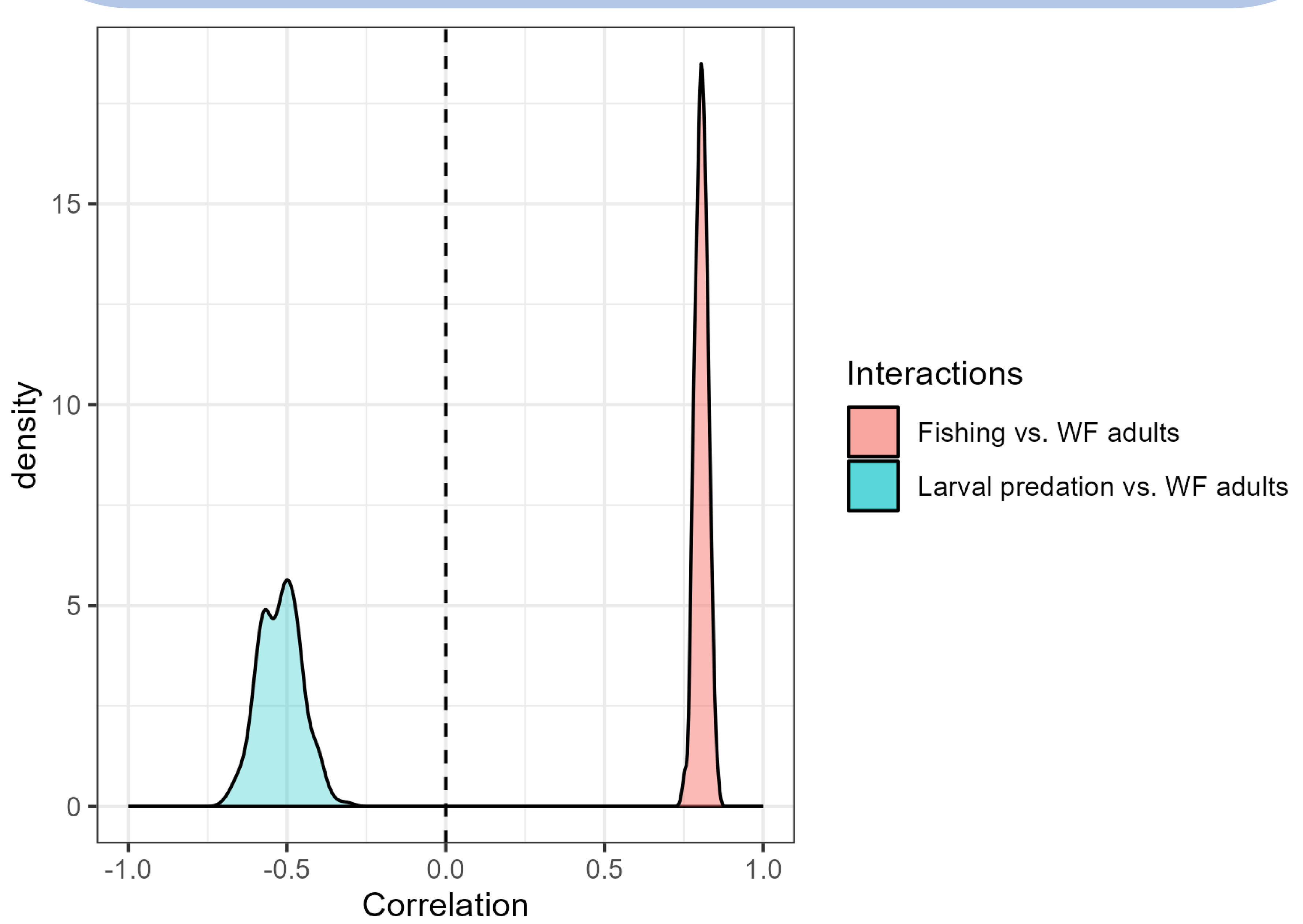

Figure 3. Distribution of correlation coefficients between predation on WF larvae and adult biomass (blue) and WF landings and adult biomass (red).

Results and discussion

- High positive correlation between landings and lagged WF adult biomass (Figure 3) → Landings are major driver of the state of the WF adult stock the next year.
- Average negative correlation between larval predation and lagged WF adult biomass (Figure 3) → Higher predation on WF larvae may have contributed to the decline of the WF adults.
- The data available for WF larvae is not sufficient to resolve accurately the interaction between larval predation and the adult dynamics
- Increased predation on WF larvae might be triggered by increased number of predators migration from southern regions (e.g., summer flounder)

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Drouineau, H., Planque, B., and Mullon, C. 2023. RCaNmodel: An R package for Chance and Necessitymodelling. Journal of Open Source Software, 8: 4955.

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