Evaluating global and regional marine ecosystem model responses to historical climate and fishing drivers

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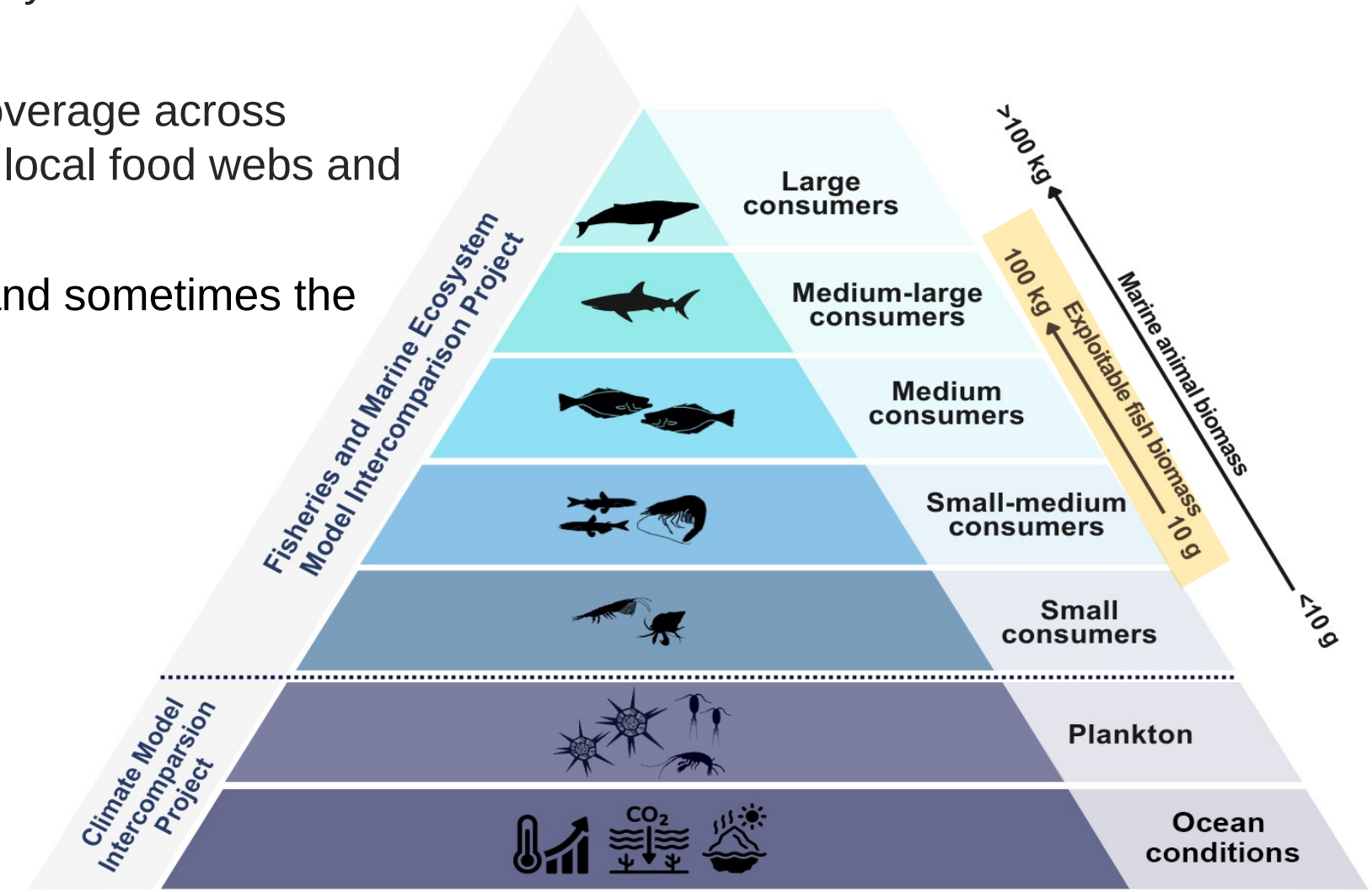
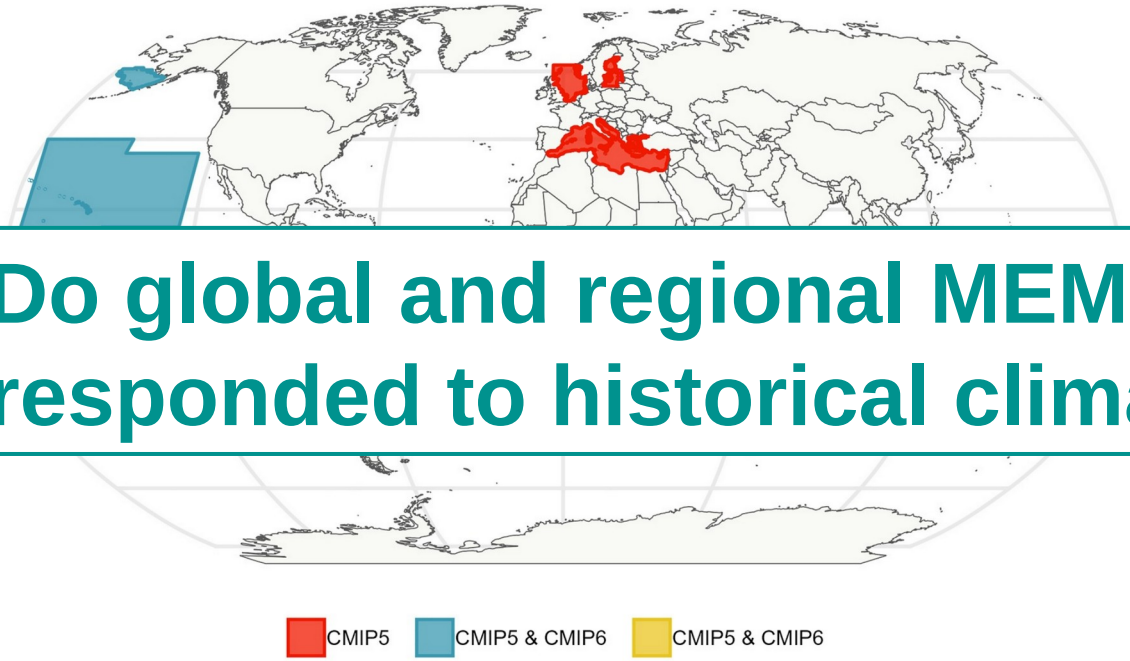
Climate impact assessments rely on models that do not always agree

- Climate impact assessments on marine ecosystems and fisheries rely on marine ecosystem models (MEMs)
- Global MEMs give consistent coverage across oceans; regional MEMs resolve local food webs and fisheries in more detail
- Can diverge in the magnitude, and sometimes the direction, of change

FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

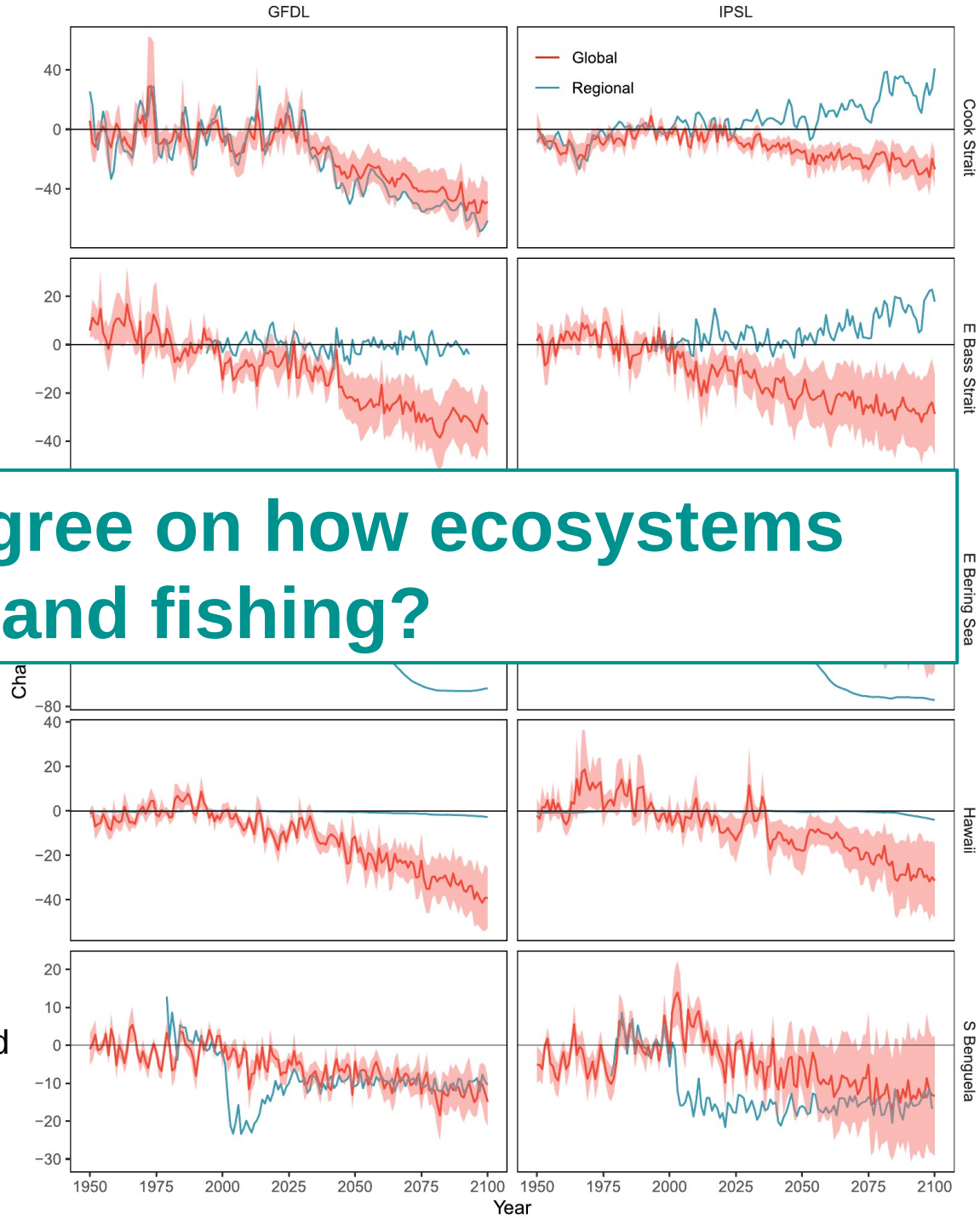


How do regional and global model projections compare?



Do global and regional MEMs agree on how ecosystems responded to historical climate and fishing?

- Global models projected greater declines than regional models
- End of century (CMIP6): regional -18%, global -27%
- All CMIP6 global models projected declines; regional models projected declines in 67%



Eddy et al. (2025) Earth's Future

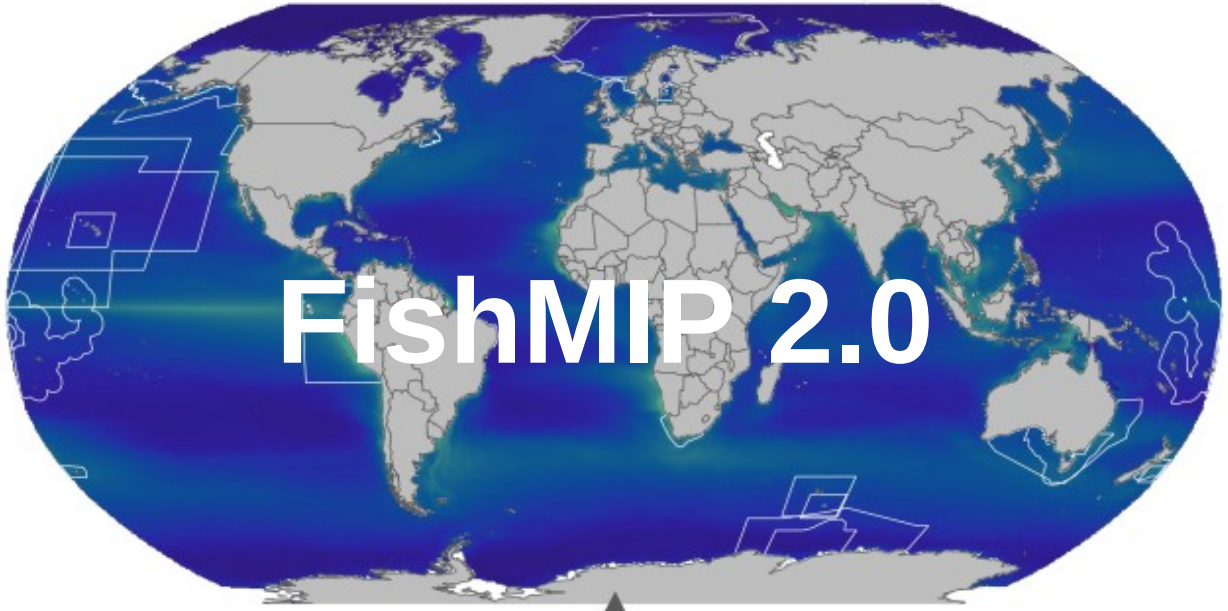
TRACK
A
Past Change
1961-2010

Historical climate

Historical human use

Model calibration and improvement

- Evaluating model skill to reproduce past observations
- Detection and attribution of past ecosystem changes



TRACK
B
Future Scenarios

Climate scenarios

Human use scenarios

Fleets

Aquaculture

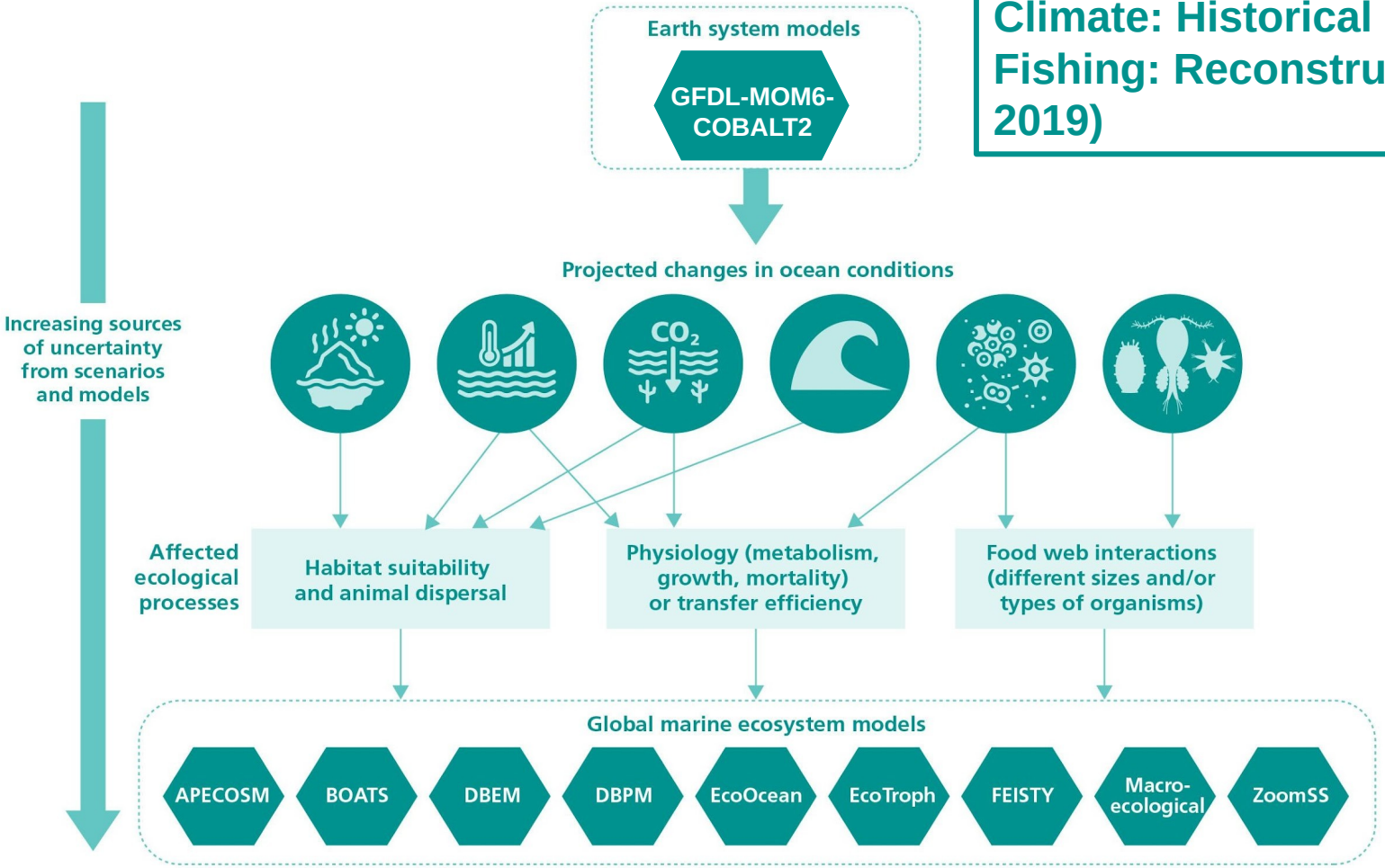
Markets

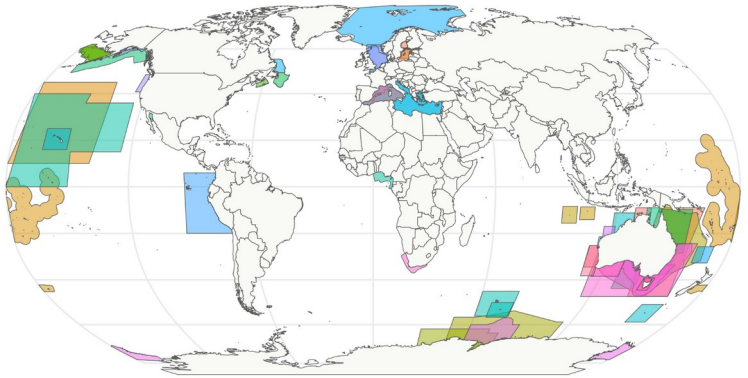
- Future seafood production, ecosystem function, biodiversity
- Vulnerability, risk, and impact assessments
- Adaptation plans

Blanchard et al. 2024 Earth's Future

FishMIP 3a protocol

Climate: Historical ocean conditions 1961-2010
Fishing: Reconstructed effort (Rousseau et al. 2019)



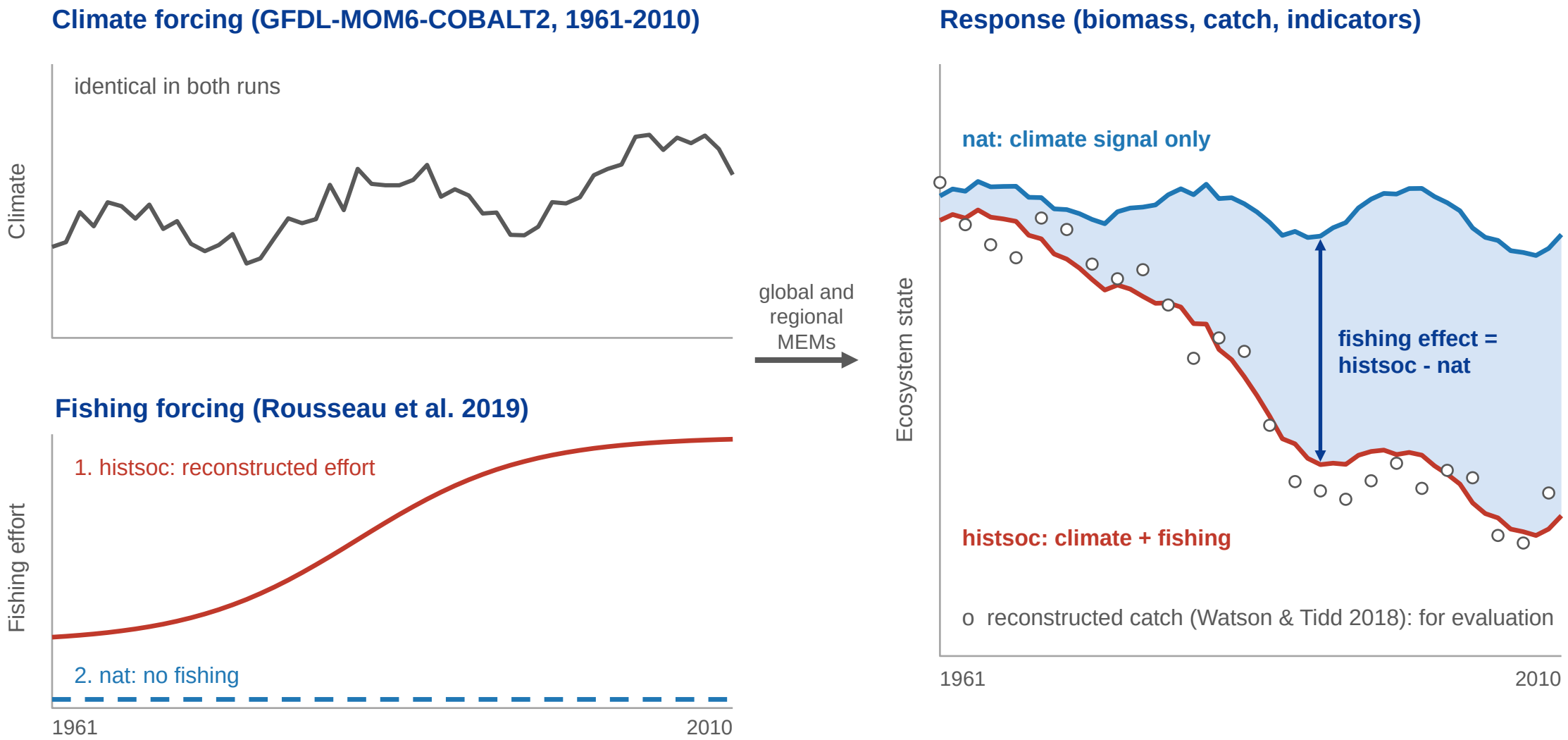


Regional models:

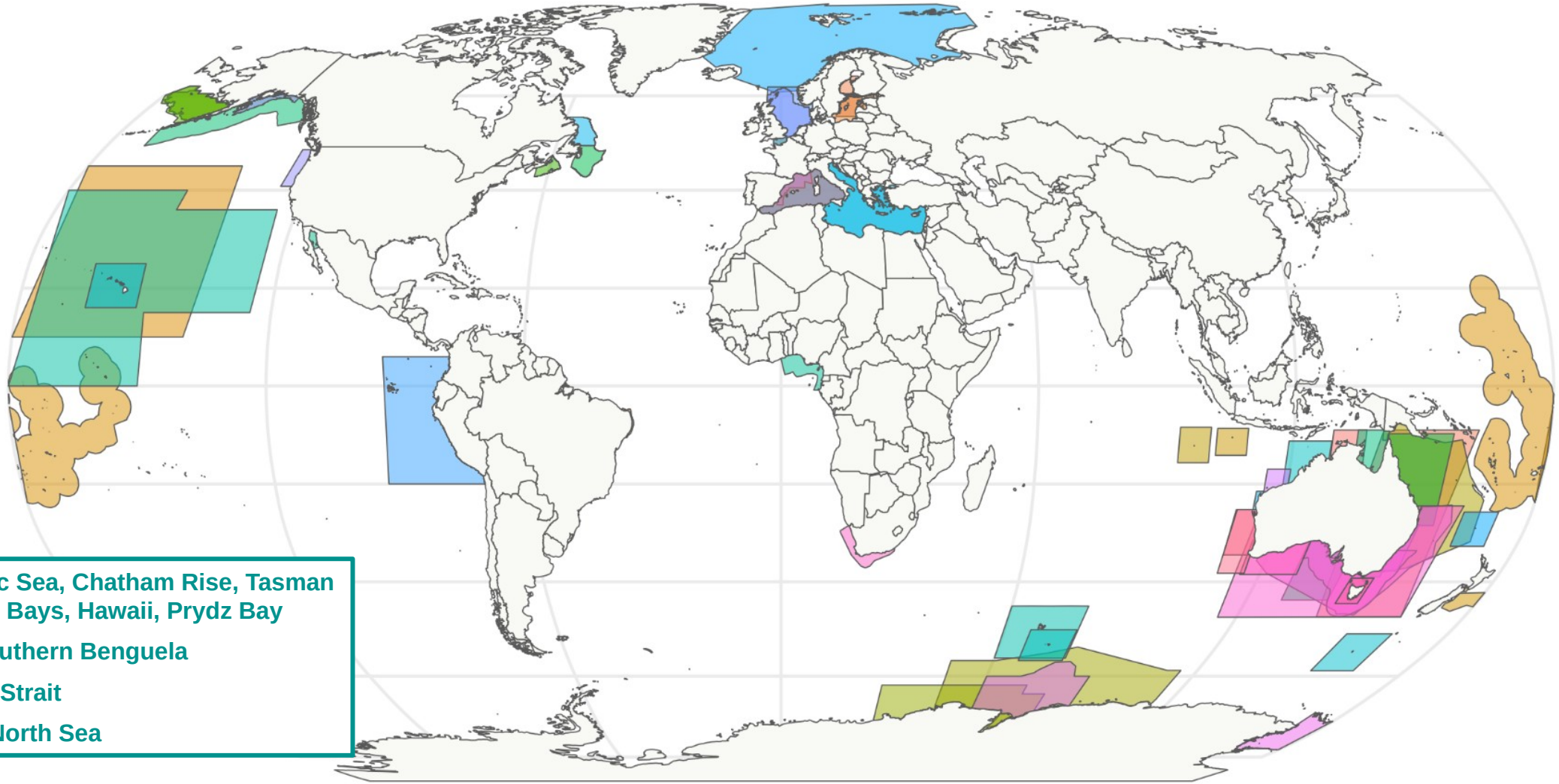
Atlantis | EwE | mizer | OSMOSE

Blanchard & Novaglio (2024) FAO report

FishMIP 3a experimental design



Blanchard et al. 2024 Earth's Future



Mizer: Baltic Sea, Chatham Rise, Tasman and Golden Bays, Hawaii, Prydz Bay

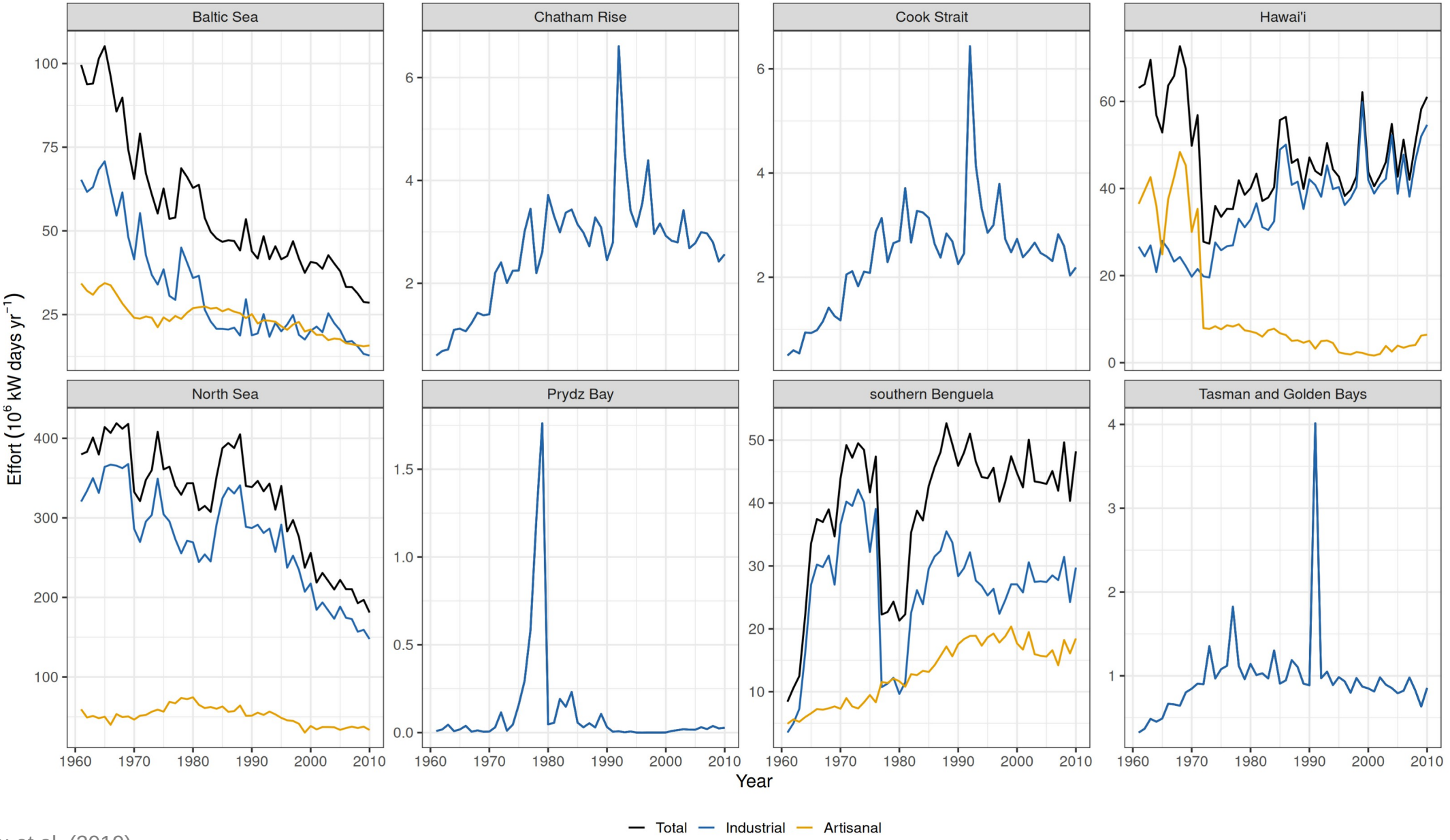
Atlantis: southern Benguela

EwE: Cook Strait

OSMOSE: North Sea

Eight regions: 1 regional MEM each and 5 global MEMs extracted to the same domain

Fishing effort forcing, 1961-2010



Rousseau et al. (2019)

Analysis workflow

1 Model evaluation

- Modelled vs observed catch
- Skill metrics: r, AE, MAE, RMSE, RI, MEF, Taylor diagrams
- 1961-2010 and 2005-2010 (predictive capacity)

2 Detection

Global and regional MEMs

- Depletion ratio
- Exploitation rate
- Total exploitable biomass and catch
- Fishing effect: histsoc vs nat (detection)

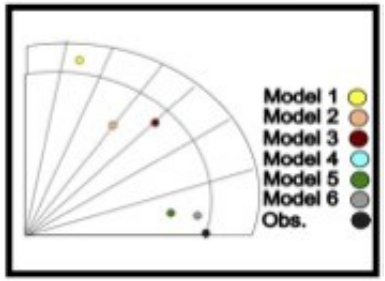
3 Regional indicators

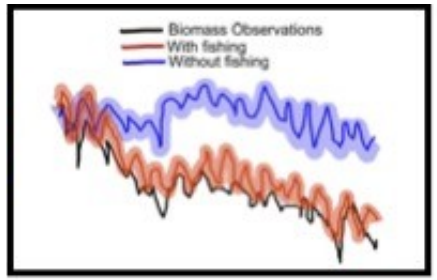
Regional MEMs only

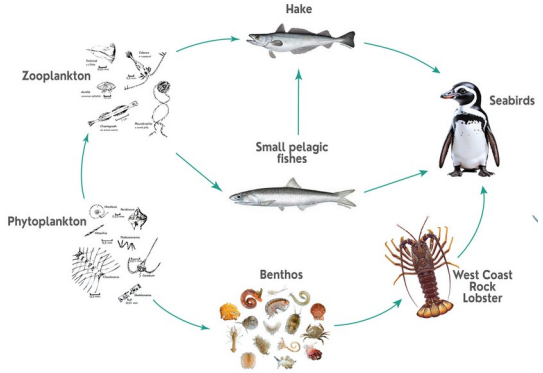
- Species-level outputs
- Use regional-only indicators to explain responses in global models

4 Global-regional agreement

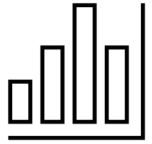
- Can global model indicators predict regional model responses, where and why?
- Does global model skill relate to global-regional agreement?



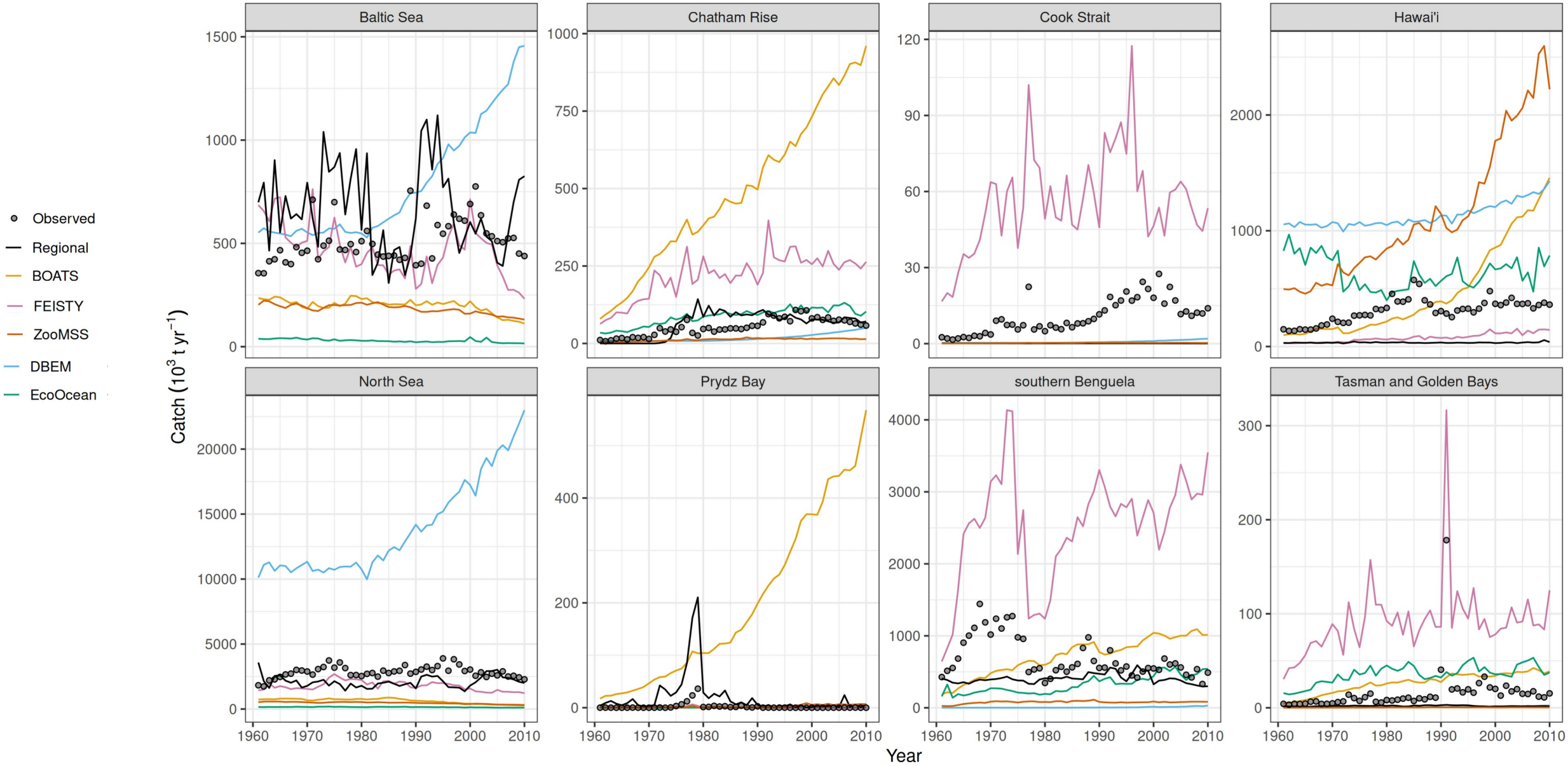




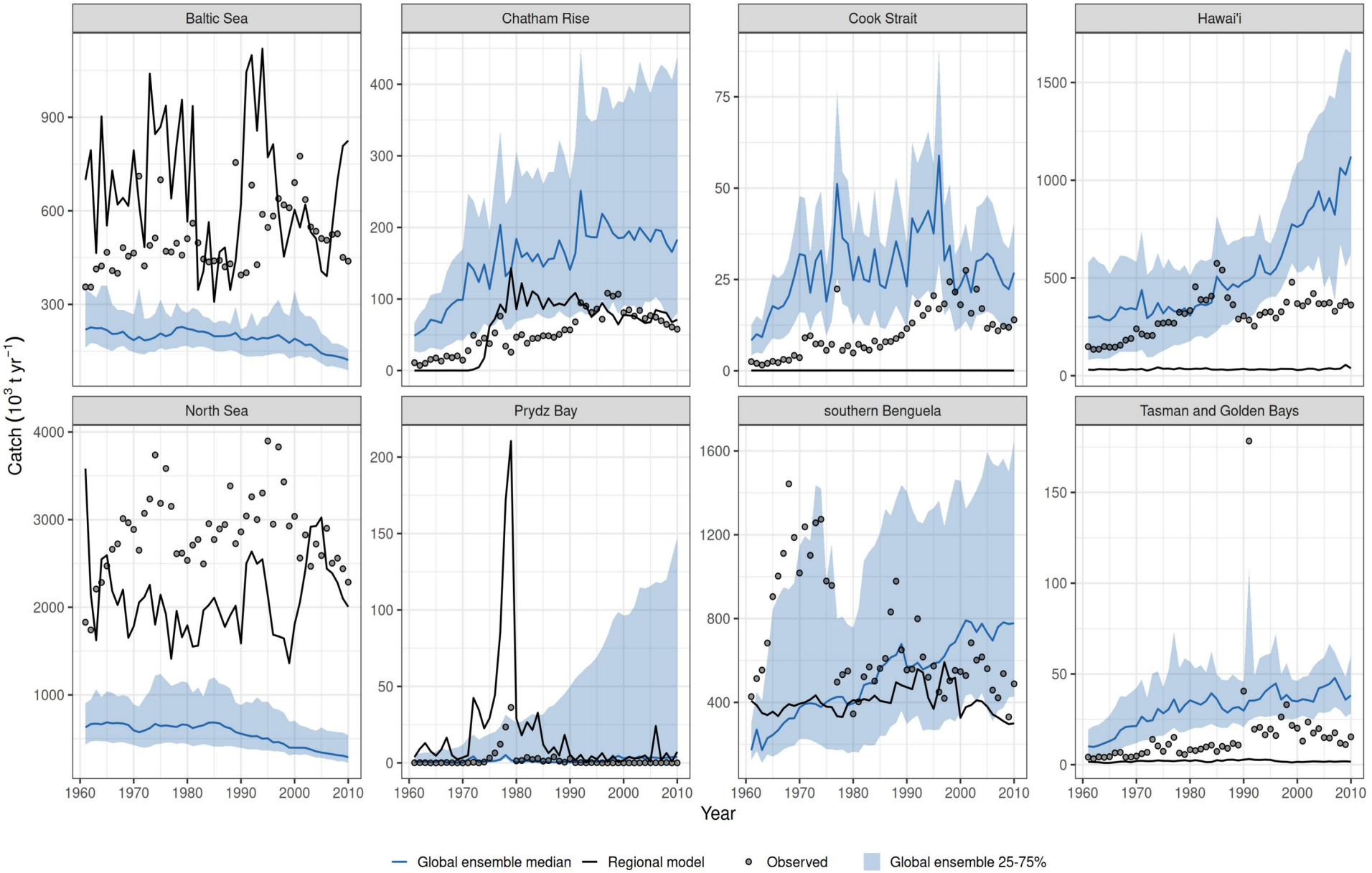




Modelled vs observed catch, by model

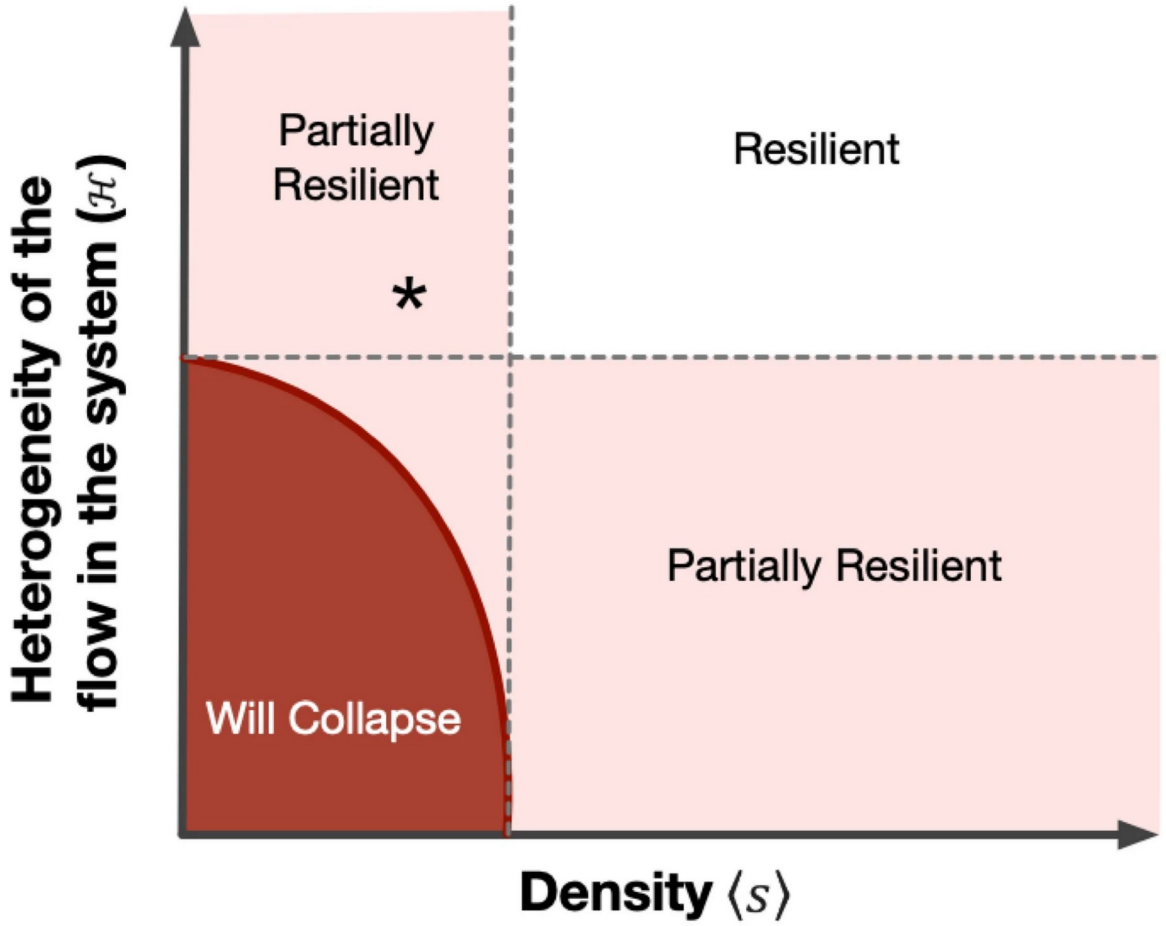


Global ensemble vs regional model



Summary

- Simulations with and without fishing to disentangle climate and fishing effects.
- Regional models seem to reproduce observed catch in most regions.
- Skill estimated before climate and fishing responses are compared.
- Fishing effect on ecosystem indicators, and agreement of global and regional models responses to fishing.



Fulton & Sainsbury, 2025

Thank you for your attention.

And to all FishMIP coordinators, members, and contributors

Schmidt Sciences

TropEcS

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More info and how to join:

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