Marine Institute

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FESA LAB

# THE BOOMS-AND-BUSTS OF MODELLING FORAGE FISH POPULATION DYNAMICS

MAC DONNACHÁ, É.-J., EDDY, T.D., LEWIS, R.S., REGULAR, P., AND ROBERTSON, M.D.

# FORAGE FISH ARE VITALLY IMPORTANT

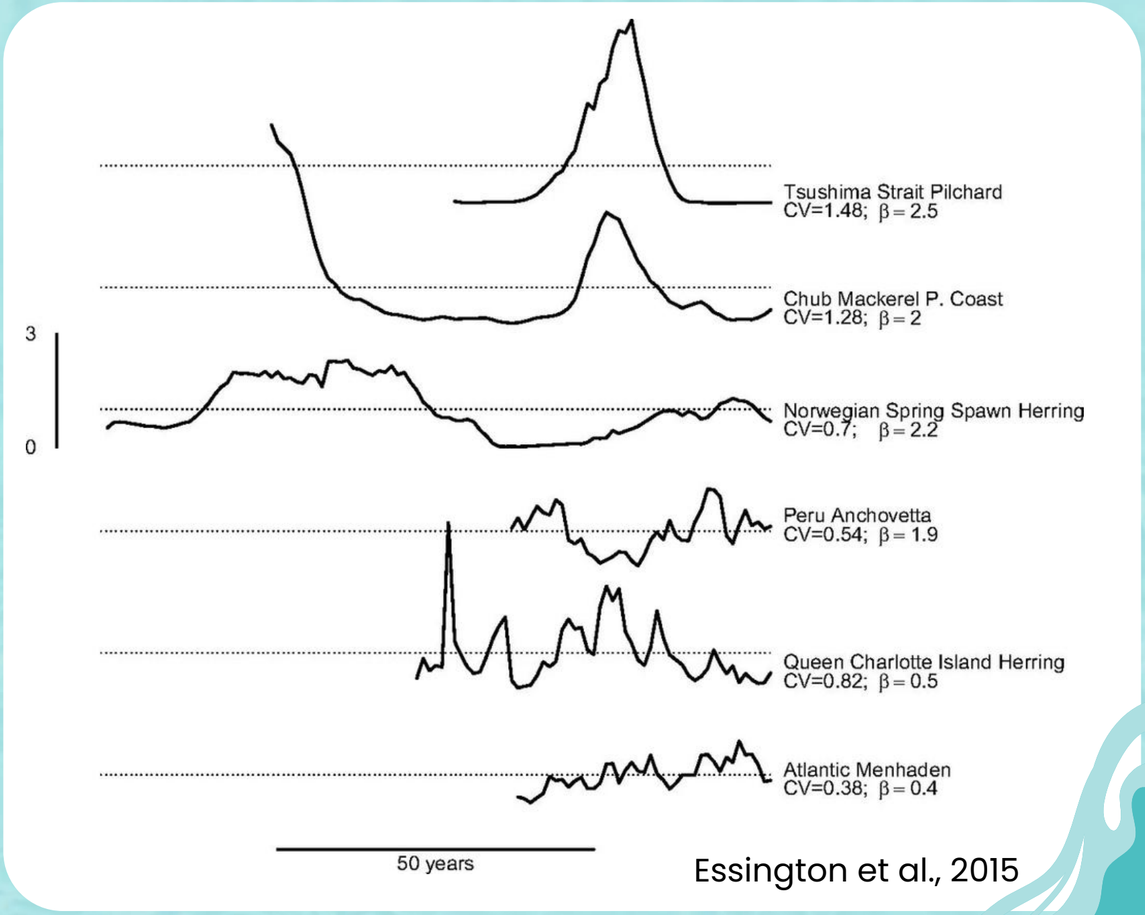
- Culturally, economically, ecologically……
- **Crucial Link**
- **30% of all global removals** and 20% of value

  (Alder et al., 2008; Tacon & Metian, 2009)
- A **critical group** for Ecosystem-Based Fisheries Management (**EBFM**)




# WHY IS MODELLING FORAGE FISH DIFFICULT?

- **Naturally volatile**
- Influenced by **bottom-up** and **top-down** factors
- **Fishing** → frequent and intense **collapses** (Essington et al., 2015)
- So **how** do we **model** their **dynamics**, and **what ecosystem considerations** do we take?



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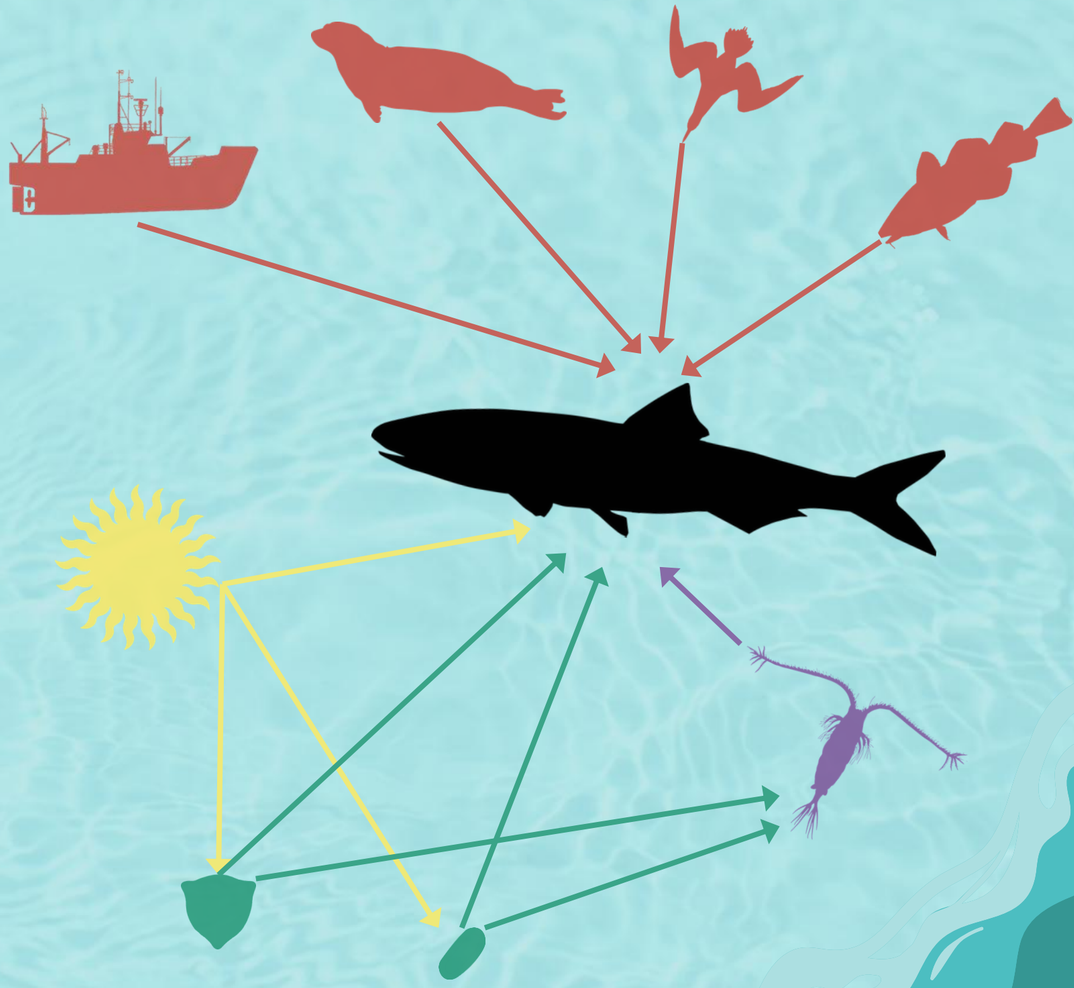
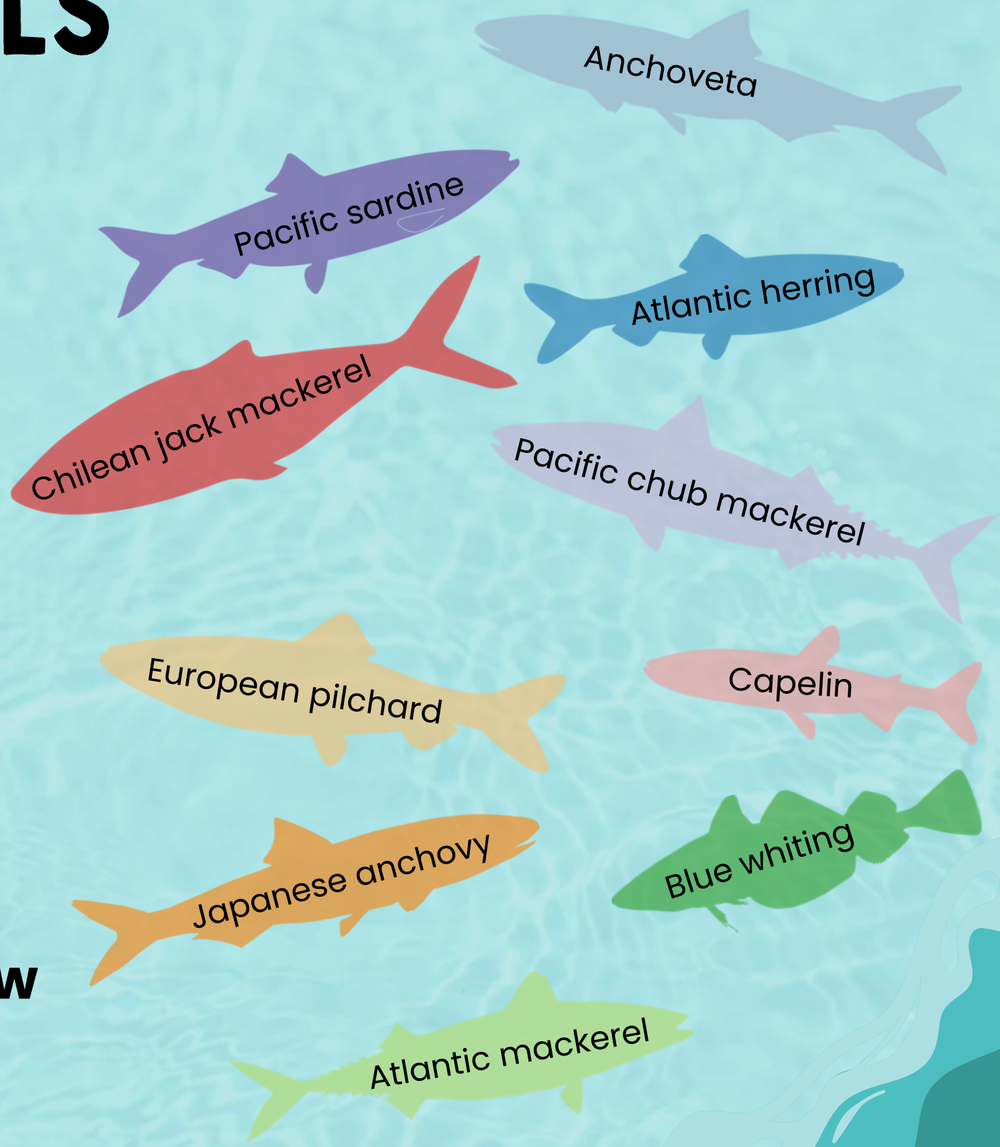


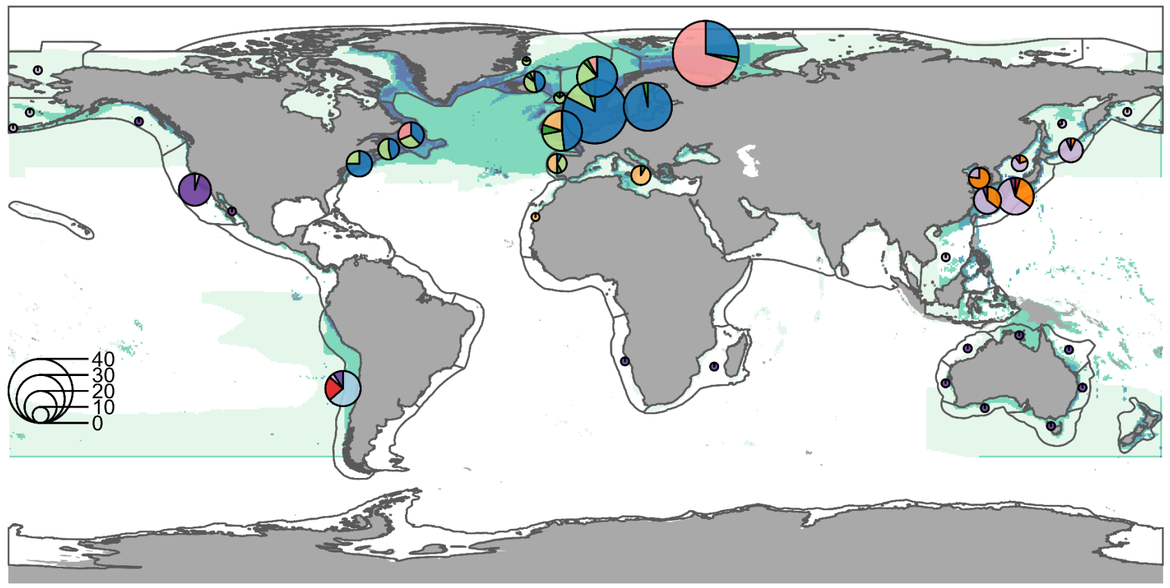
# LITERATURE REVIEW OF MODELS

- **Population dynamics models**
- **10 species** based off **highest global removals** (FAO, 2024)
- 20% of all global removals
- **Published articles** on Web of Science
- **Keywords:** Based off capelin trials
- **Excluded ecosystem models** and **reference points**
- 1,195 articles identified → **248 included in review**
- **Recorded models, covariates, and effects**



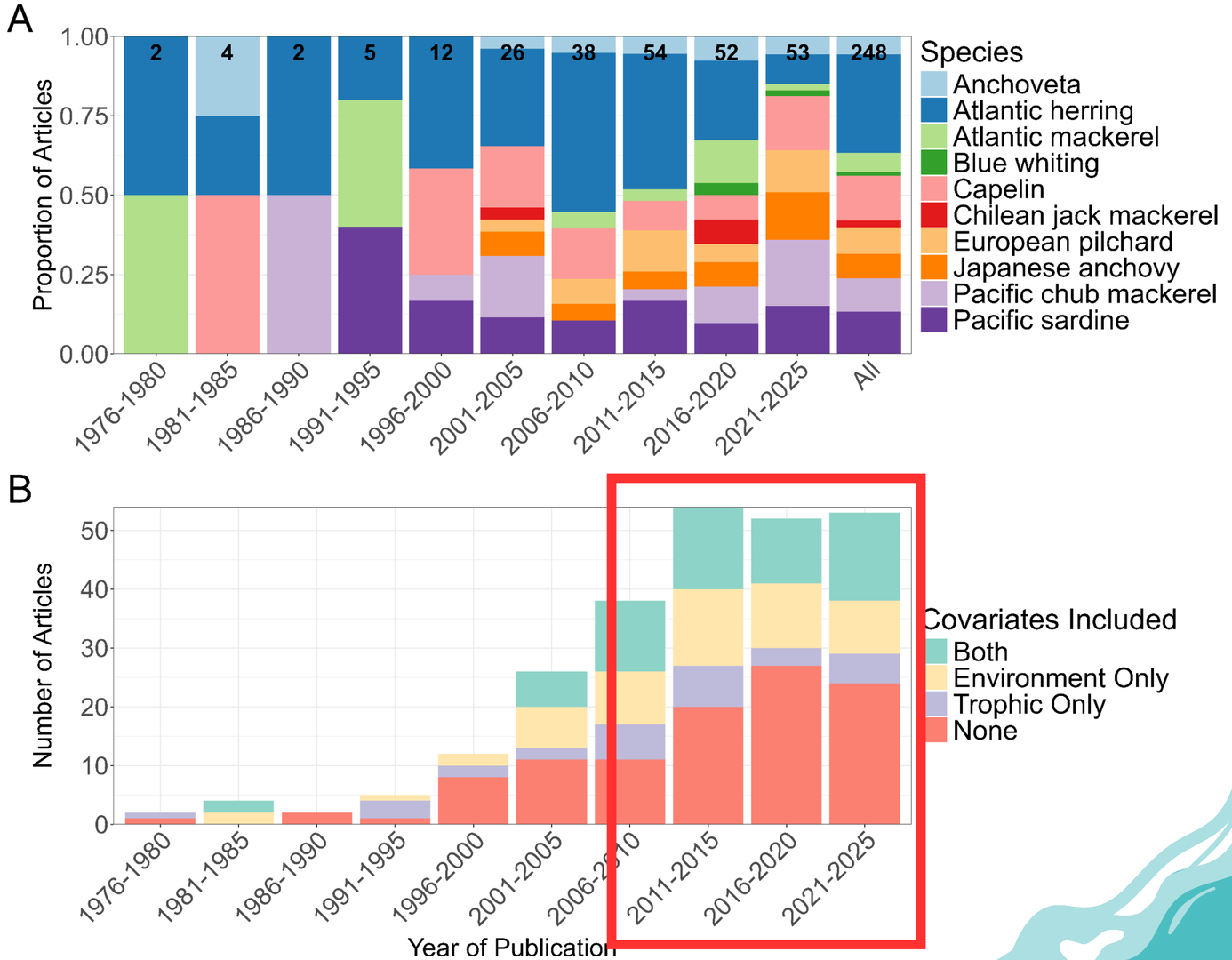
# SPECIES & LARGE MARINE ECOSYSTEM

- **5 main regions** (NE & NW Atlantic, NW Pacific, California Current, Humboldt Current)
- **Regional Gaps** (ES & Central America, N Indian Ocean)
- Regionality of species
- **Atlantic herring** is **dominant** (31% of articles)



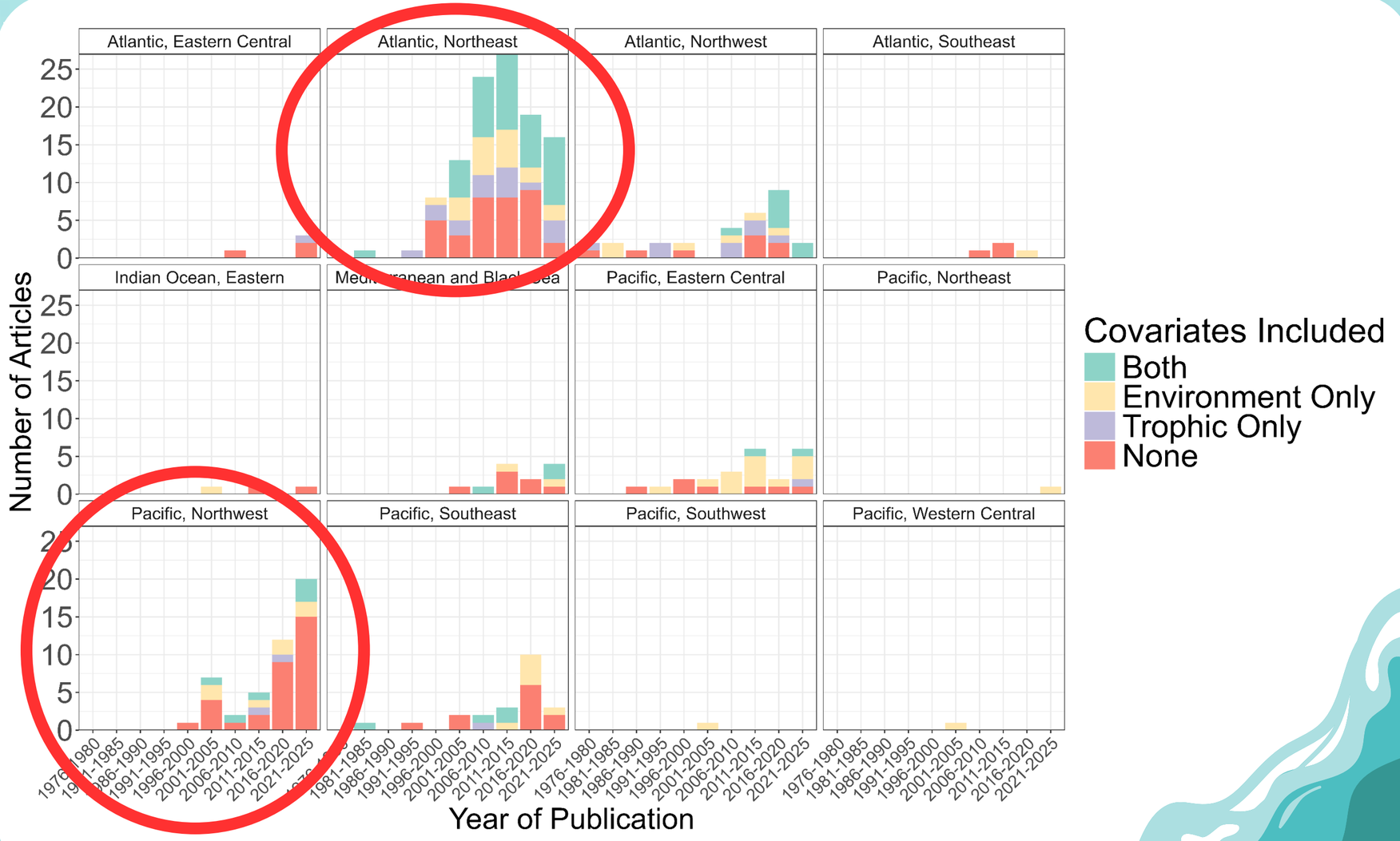
# SPECIES & COVARIATES OVERTIME

- **More species** modelled in recent times
- **Less dominance** of **Atlantic herring**
- Low representation of Chilean jack mackerel and blue whiting
- **Stabilization of ecosystem covariates used globally?**



# COVARIATES & FAO REGION OVERTIME

- **Increased modeling** effort in **NW Pacific** but **limited ecosystem cov.**
- Increased **ecosystem cov. uptake** in **NE Atlantic**



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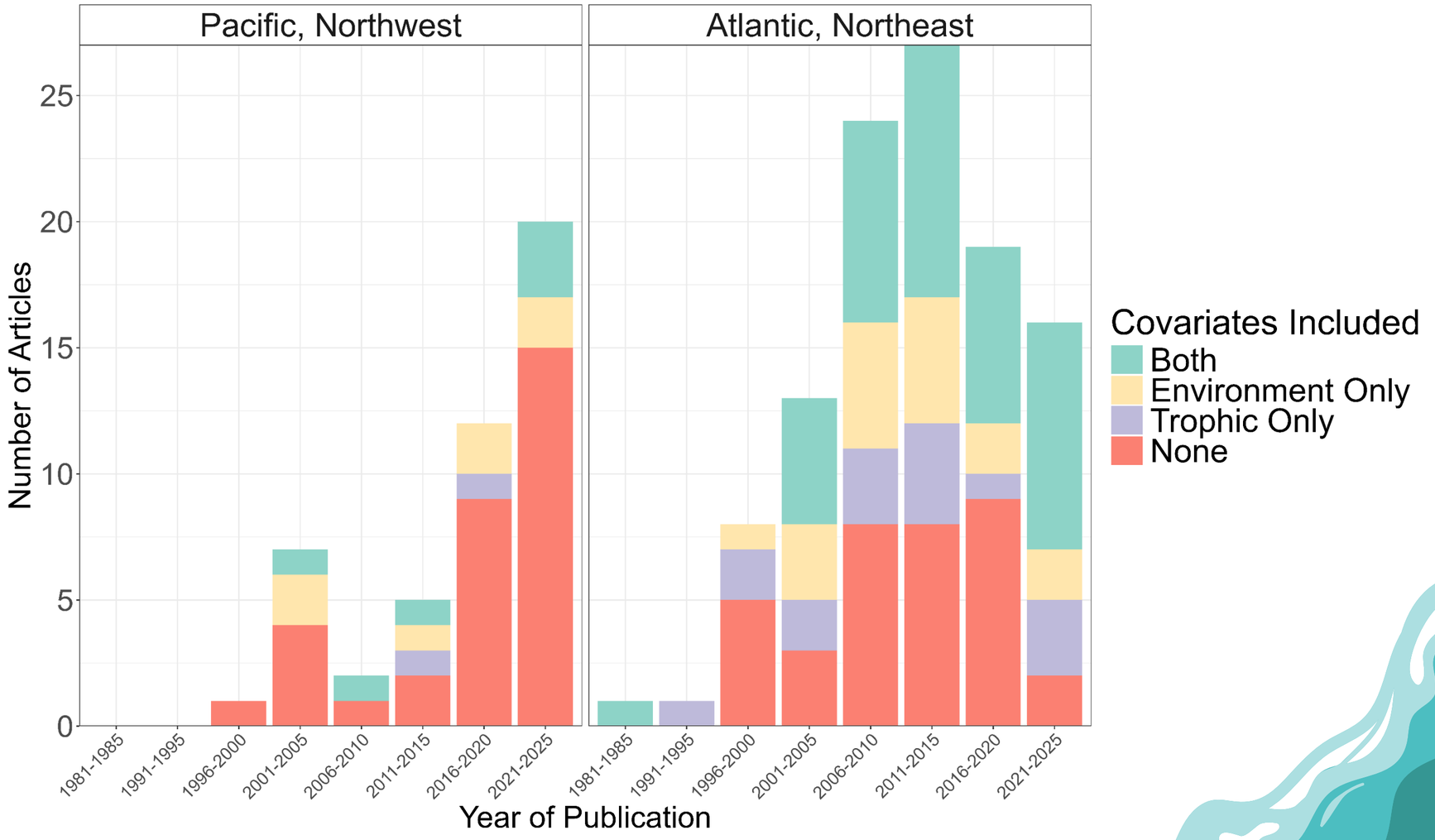
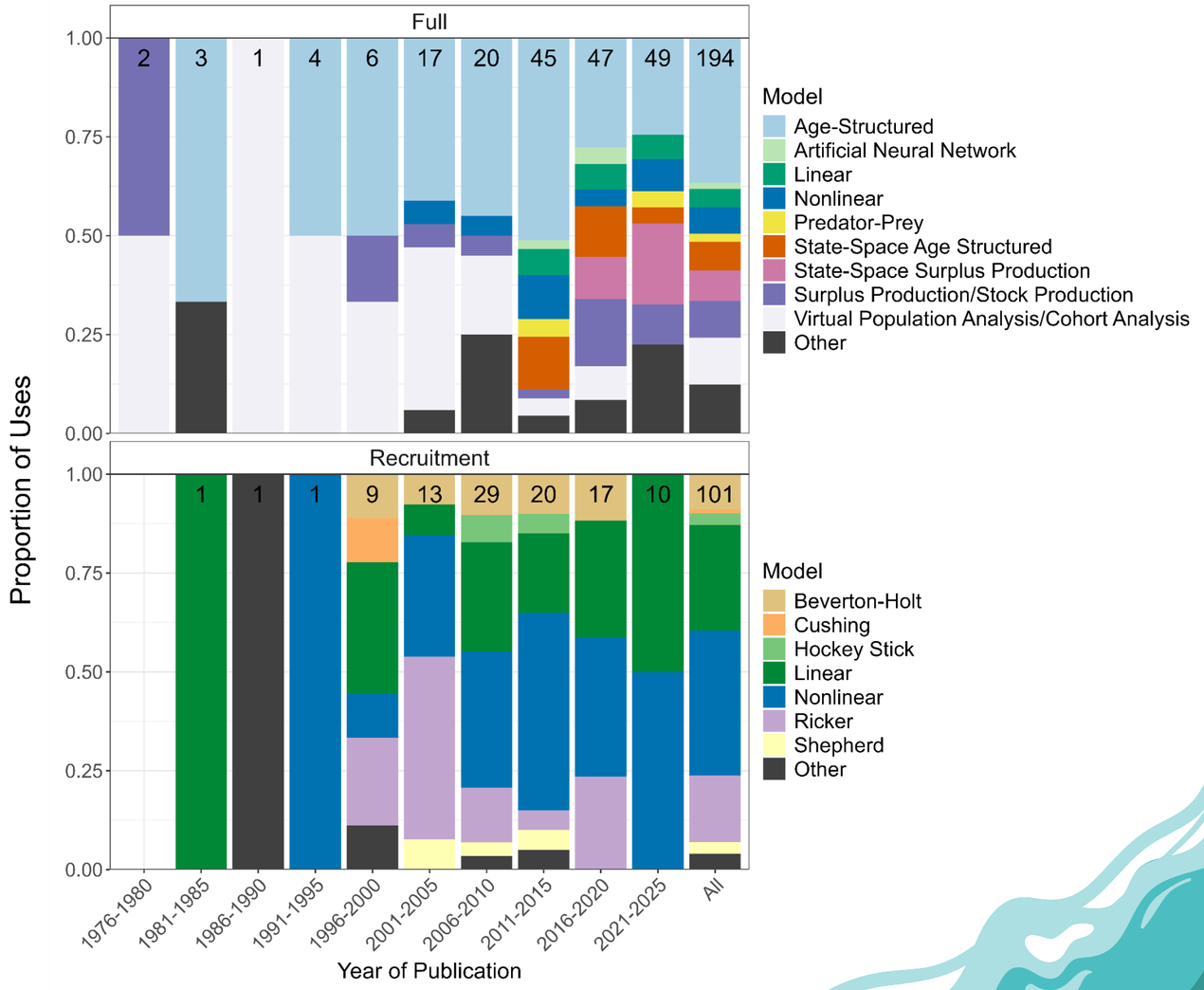


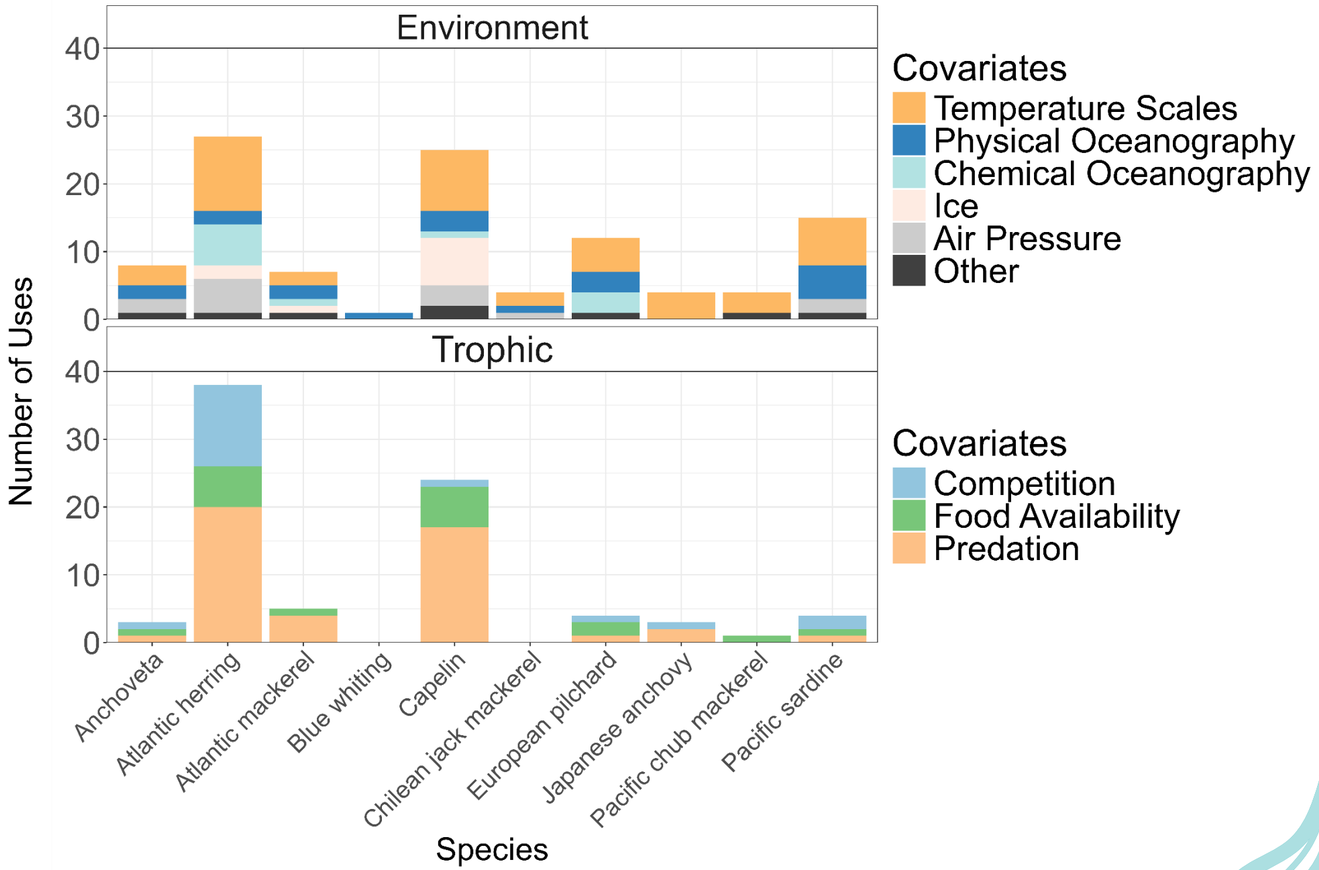
# MODELS OVERTIME

- **Diversification of full models**
- Age-structured models (36.6%)
- **Decrease** use of **VPA**
- **Increase** uptake of **state-space** models since 2011
- **Recruitment** models are **consistent**



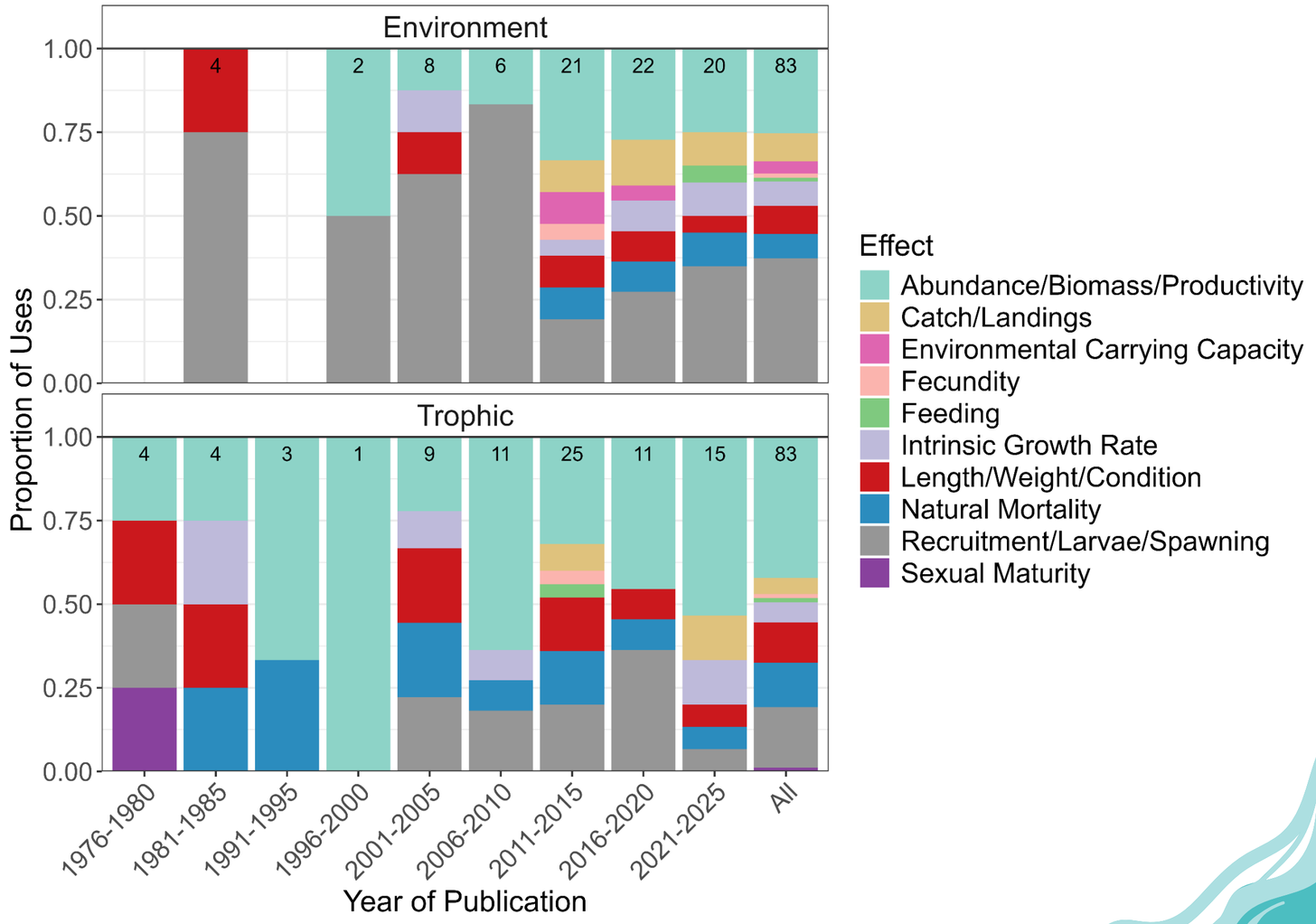
# COVARIATES USED ACROSS SPECIES IN FULL POP. MODELS

- Majority of **capelin models** included **enviro. and trophic cov.** (54.2%)
- **Temperature most used** environmental covariate (43%)
- **Predation most used** trophic covariate (56.1%)



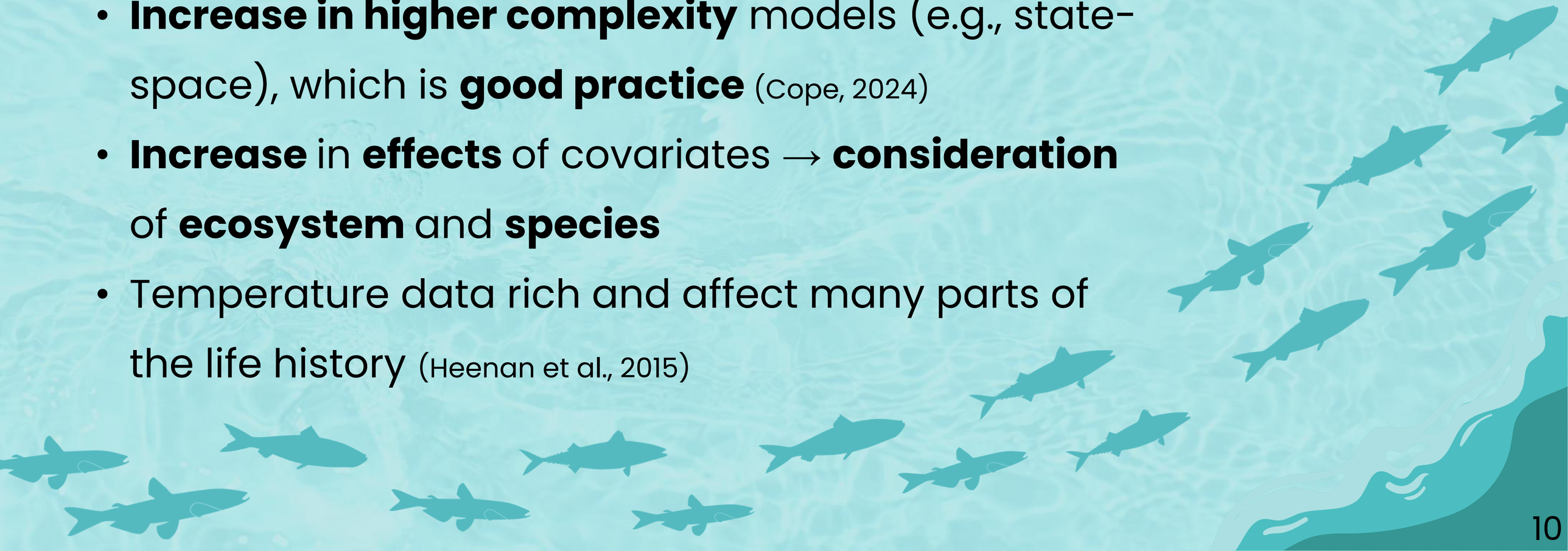
# EFFECT OF COVARIATES

- **Diversification of environmental effects**
- **Environmental** effects on **recruitment** (37.5%)
- Resurgence from 2015
- **Trophic effects** on the **abundance** of species most dominant (42.2%)



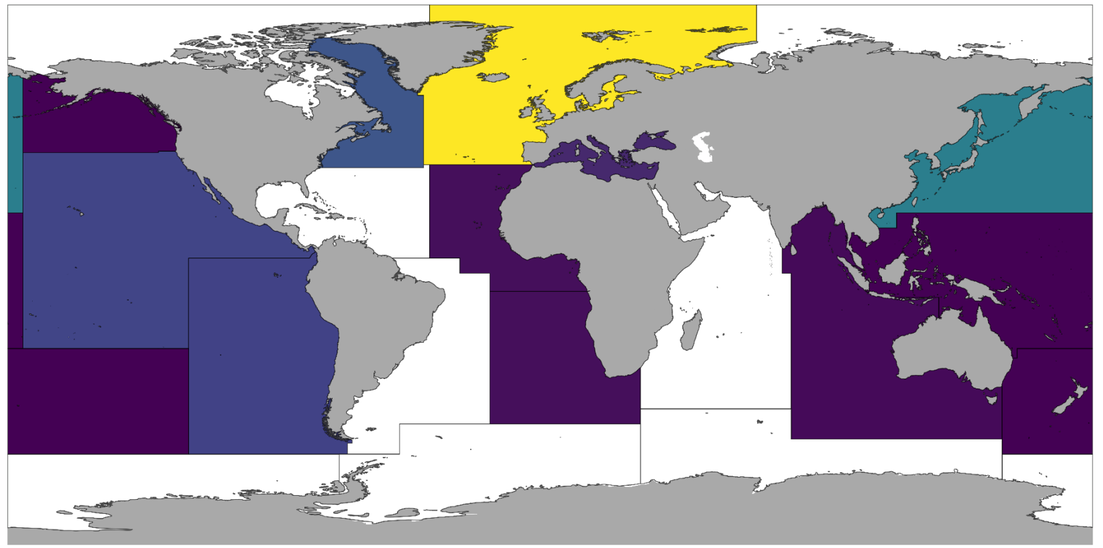
# ARE WE SEEING A MOVE TOWARDS EBFM?

- **More species** modelled → **more data** and **consideration**
- **Increase in higher complexity** models (e.g., state-space), which is **good practice** (Cope, 2024)
- **Increase** in **effects** of covariates → **consideration** of **ecosystem** and **species**
- Temperature data rich and affect many parts of the life history (Heenan et al., 2015)



# BUT THERE ARE GAPS

- Majority of studies **mainly conducted** in the **North Atlantic**- similar to other fisheries research (Aksnes & Browman, 2016)
- **Lack of diversity of recruitment models**- density dependence not expected?
- However, density dependence in 54% of stock (Szuwalski et al. 2019)



# SO WHERE DOES THAT LEAVE US?

- **Moving towards EBFM** goals but **not there** yet
- **Gaps** in **locations** and **species** modelled (e.g., blue whiting and Chilean jack mackerel)
- Aiming for better **understanding** and **modelling** of the **influence** of the **ecosystem**
- So **appropriate management decisions** can be made
- Thanks for listening! And thanks to ICES and PICES for the travel support!