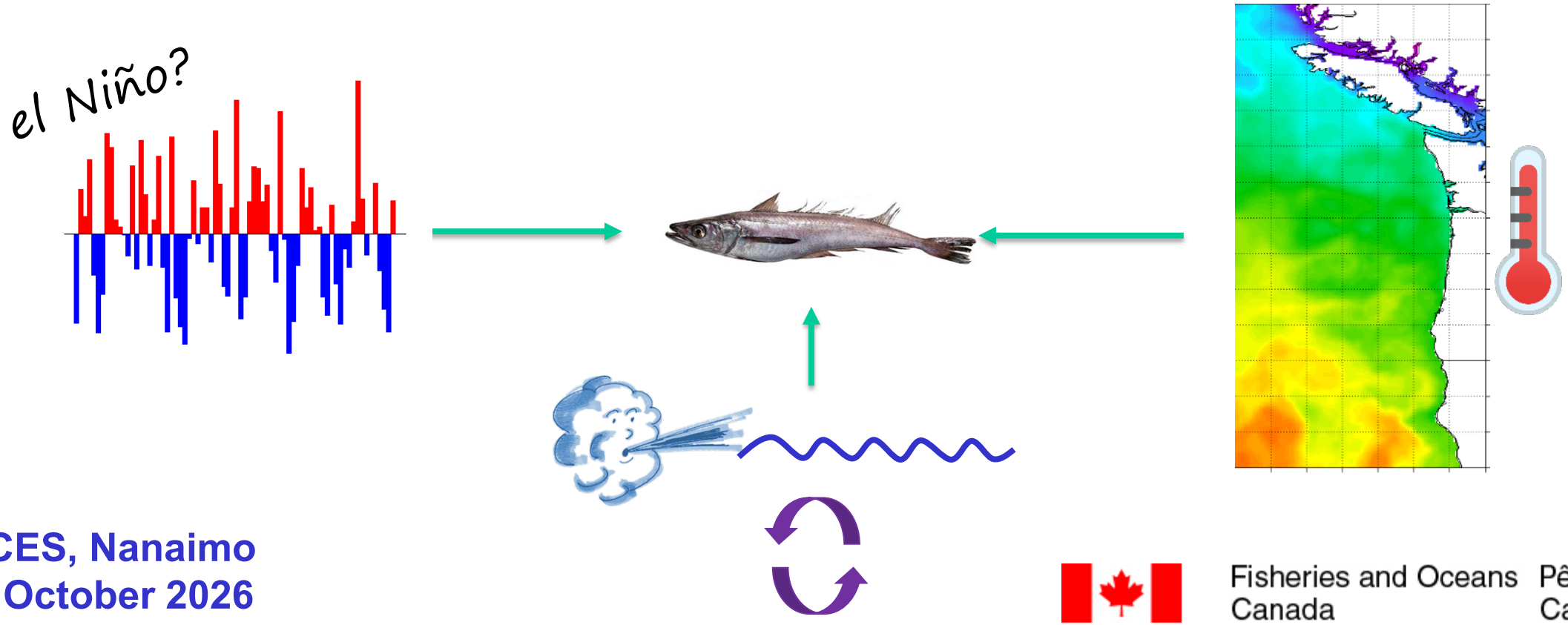
The evolving incorporation of ecosystem information into the stock assessment for Pacific Hake in the eastern North Pacific Ocean

Andrew M. Edwards[1], Mary E. Hunsicker[2], Kristin N. Marshall[2], Aaron M. Berger[2] and Travis Tai[1]

[1]Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC.
[2]Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration, Newport/Seattle, OR/WA, USA.



PICES, Nanaimo
28 October 2026

Fisheries and Oceans Canada | Pêches et Océans Canada

Quotes from Saturday morning talks

Steven Bograd:

"invest in operational ecosystem indicators"

Stephanie Brodie:

"developing tailored environmental indices enhances relevance"

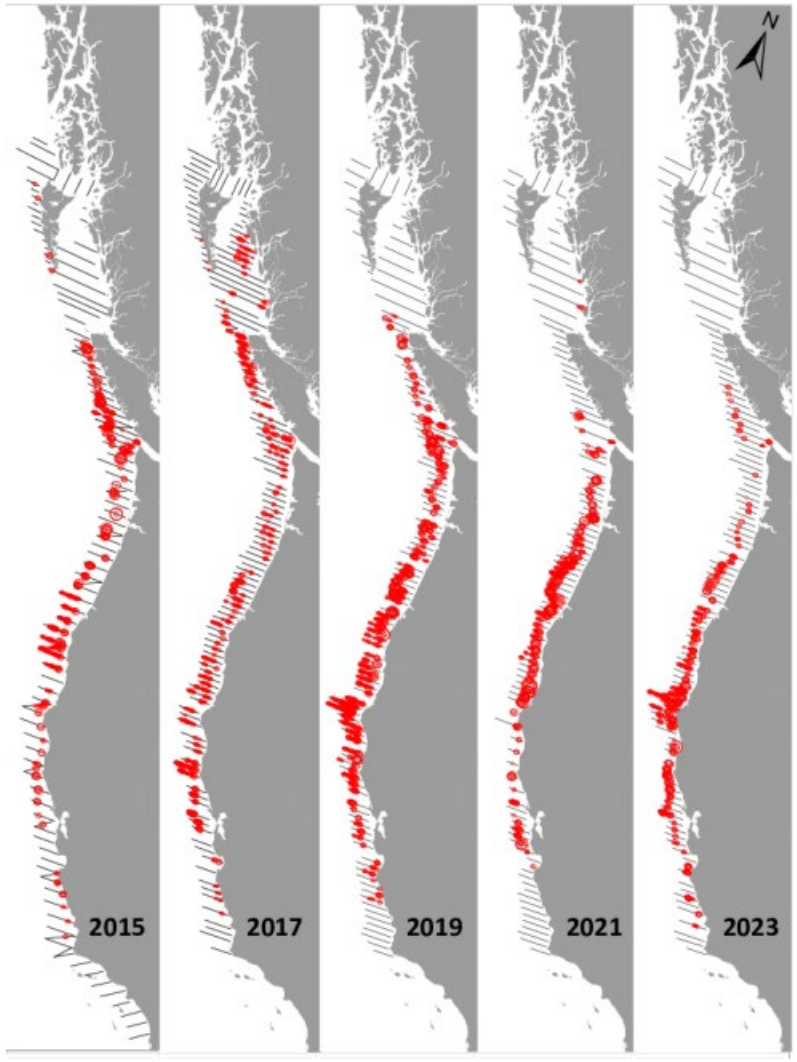

RESEARCH

Check for updates

Building climate-smart fisheries in Australia: insights from climate and ecosystem status reports

Brodie et al. (2026) *Rev. Fish Biol. Fisheries*

Pacific Hake stock assessment





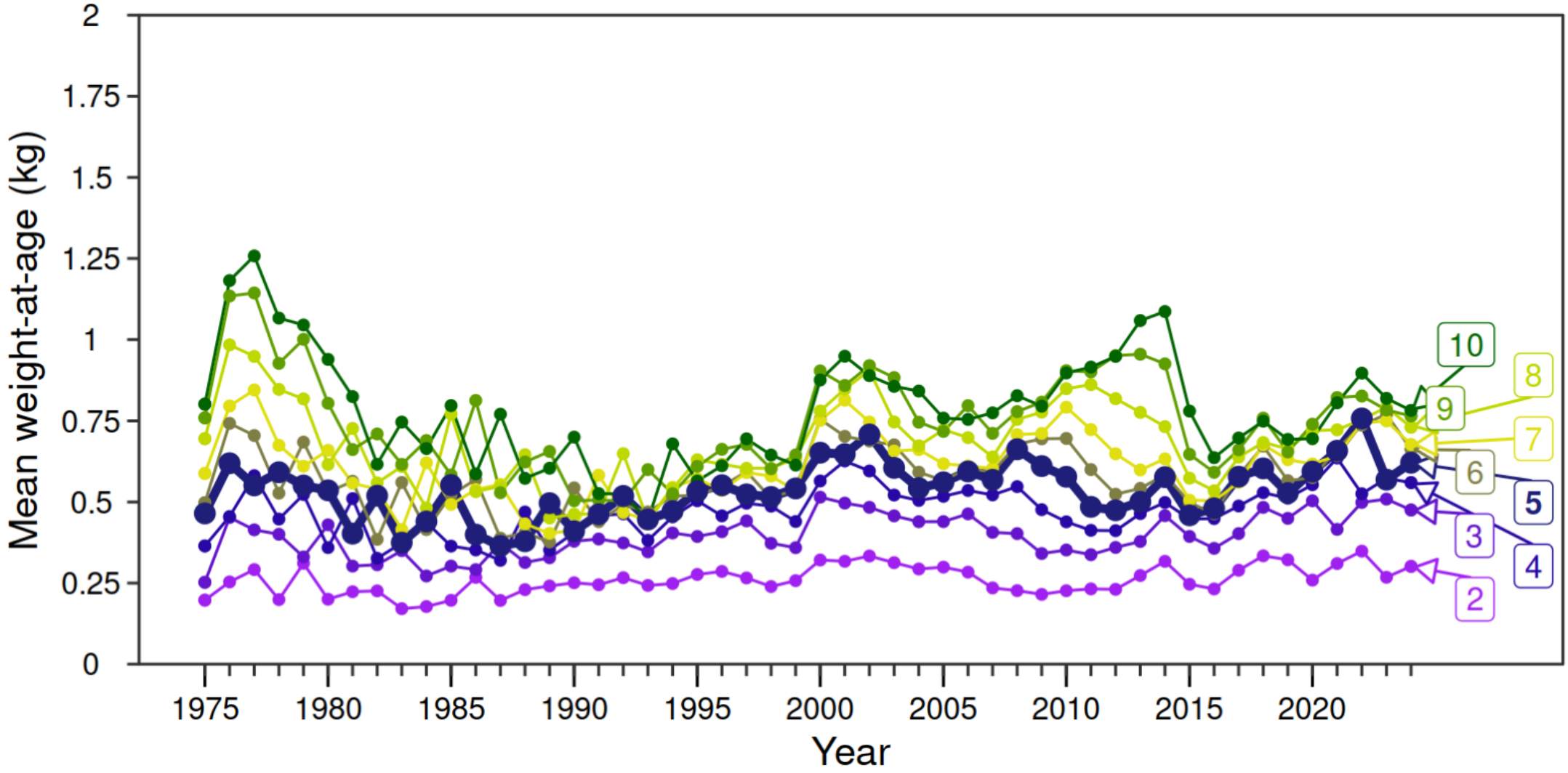
- ecological and economic importance to Canada & USA
- surveyed, assessed & managed jointly by Canada & USA
- 2017-2019 each had coastwide catch >400,000 t

- Bayesian statistical catch-at-age model

- acknowledge hake stock is very data-rich and research-rich and much of this work done by others

Eco. information implicitly included in assessment model

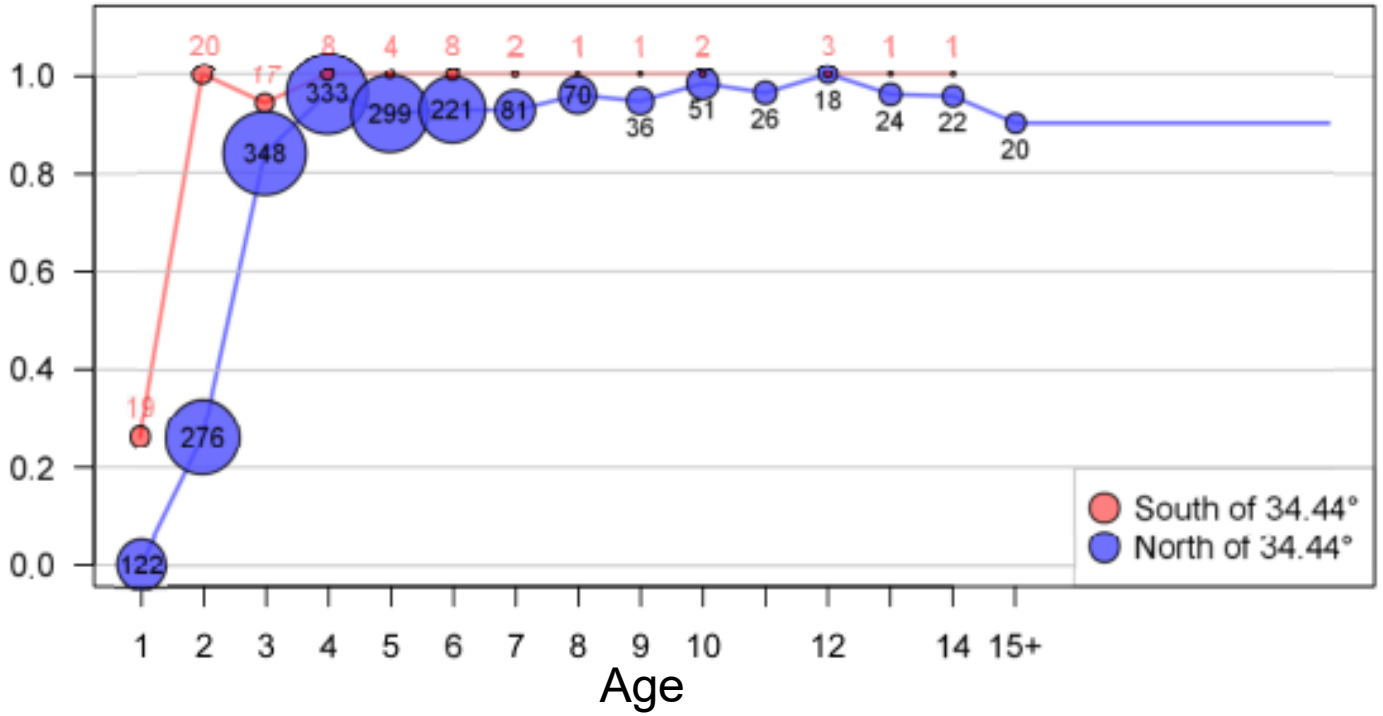
2012 onwards: empirical weight-at-age, which may account for ecosystem effects



Eco. information implicitly included in assessment model

2019 onwards: use the empirical weight-at-age for fecundity

Proportions of individuals that are mature

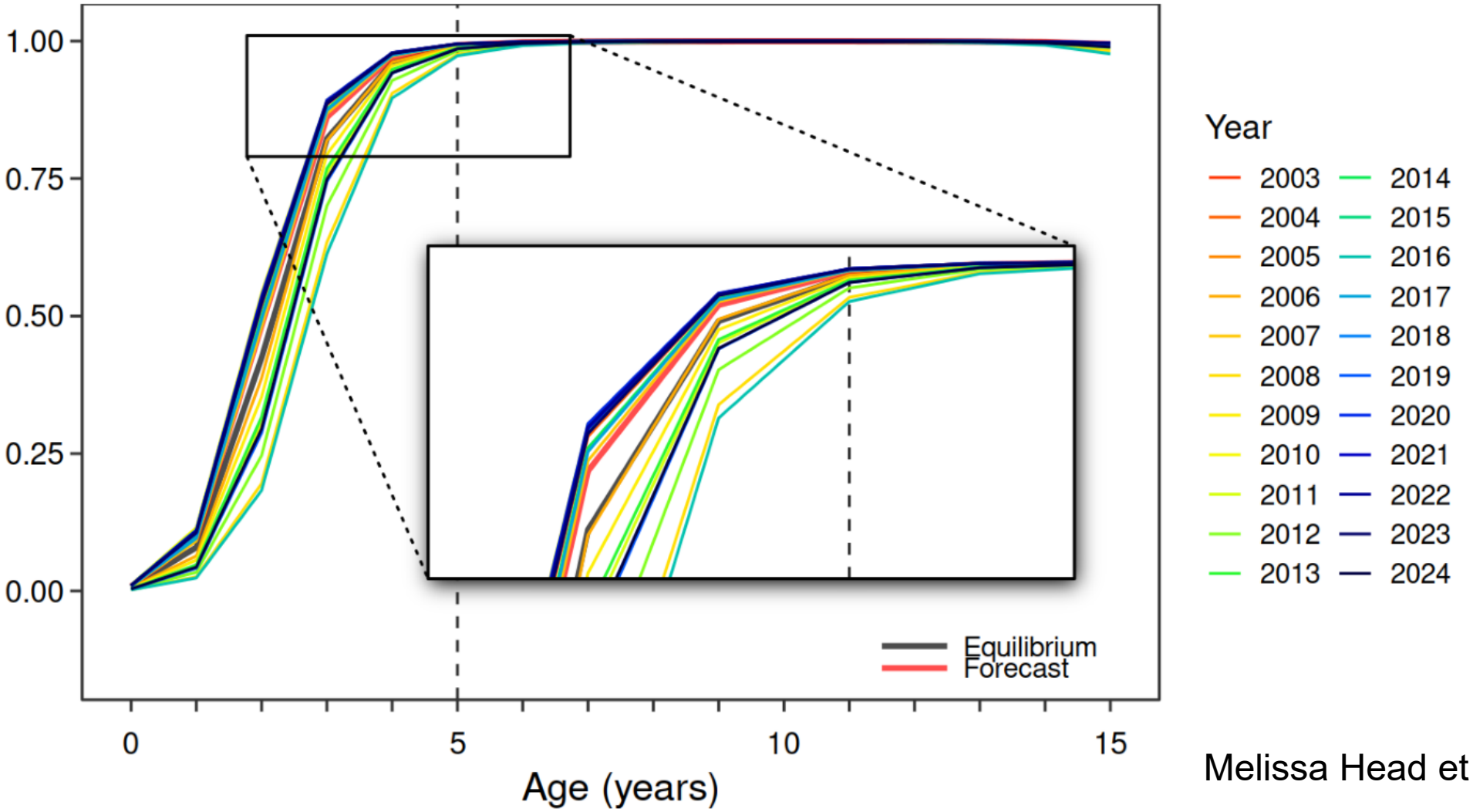


fecundity = maturity x weight-at-age

used time-varying since 2019

Eco. information explicitly included in assessment model

From 2024: maturity based on a spatial GLMM with effects: temperature, data source, day of year, age

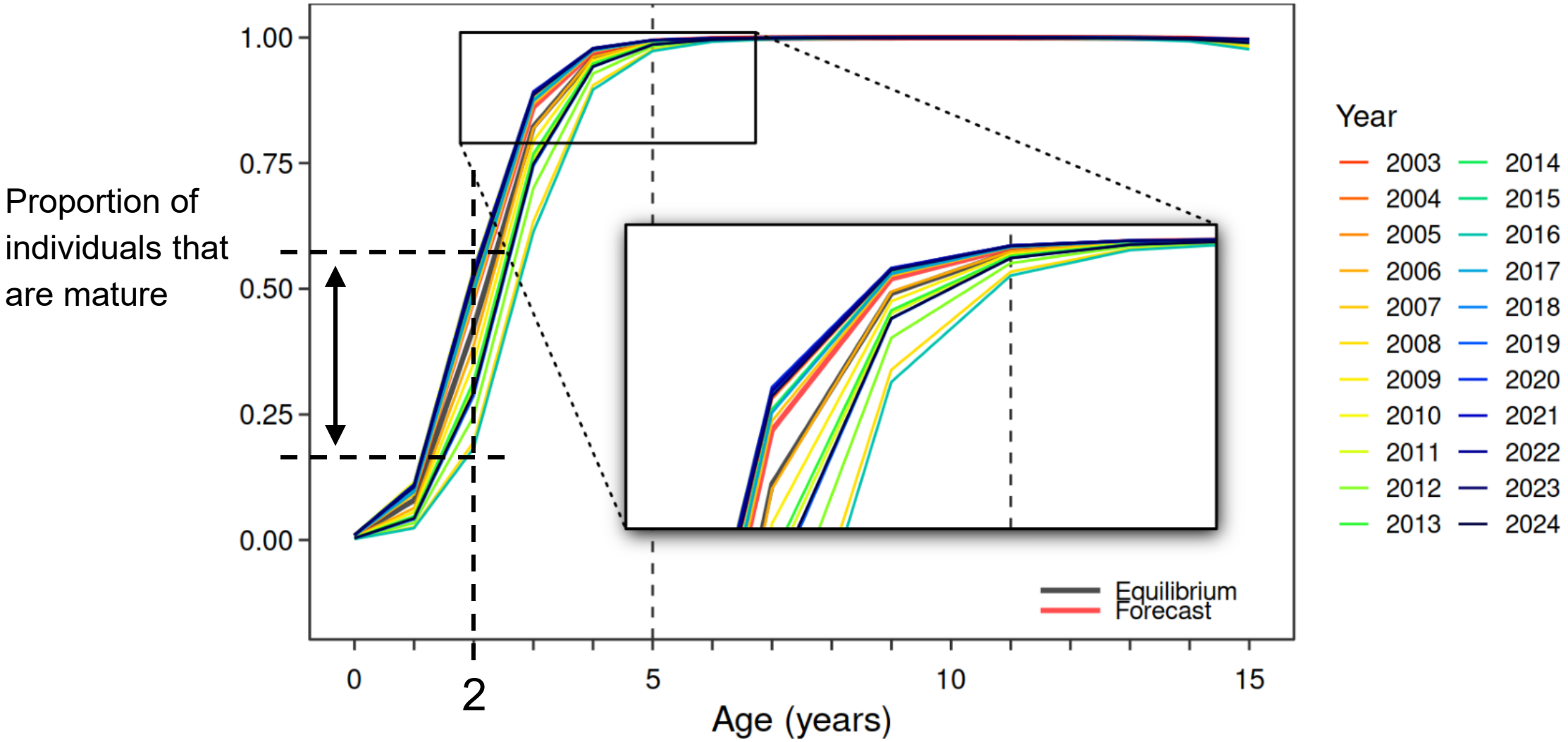


sdmTMB

Melissa Head et al.

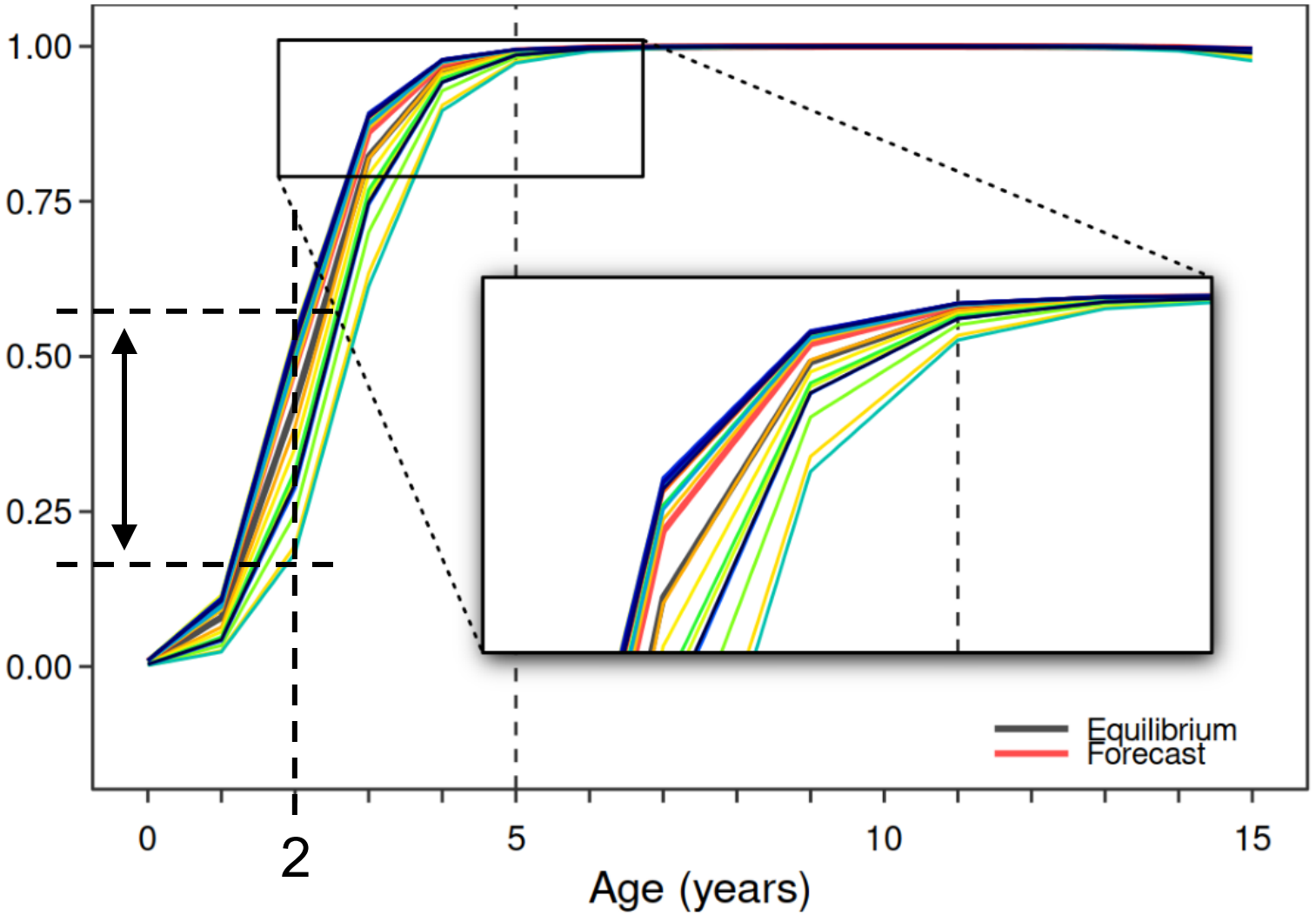
Eco. information explicitly included in assessment model

From 2024: maturity based on a spatial GLMM with effects: temperature, data source, day of year, age



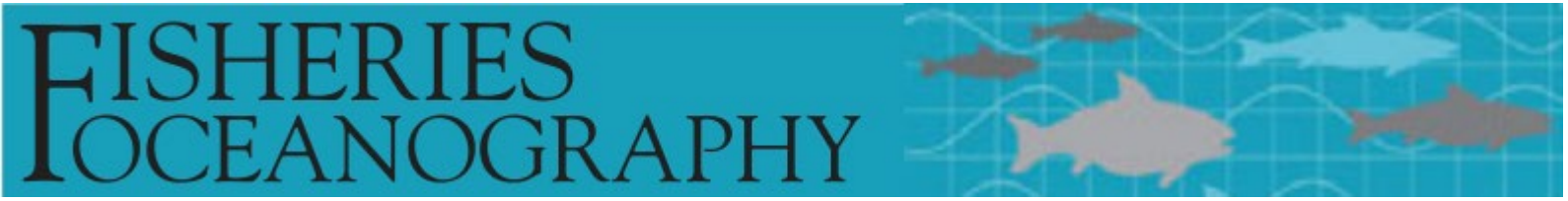
Eco. information explicitly included in assessment model

From 2024: maturity based on a spatial GLMM with effects: temperature, data source, day of year, age



Model used for years when maturity data unavailable, and for two-year projections. Based on GLORYS temperatures.

Additional information outside the model

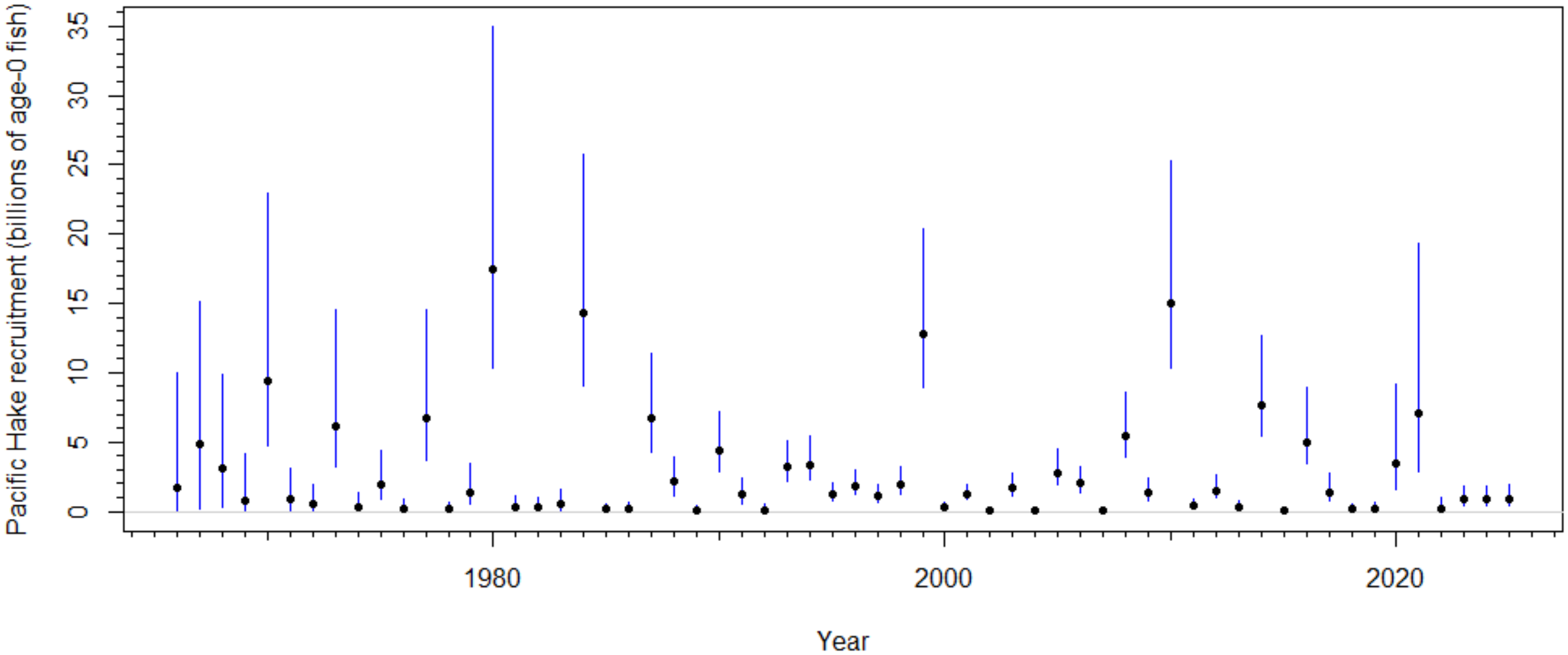


Stage-specific drivers of Pacific hake (*Merluccius productus*) recruitment in the California Current Ecosystem

Cathleen D. Vestfals[1] | Kristin N. Marshall[2] | Nick Tolimieri[3] |
Mary E. Hunsicker[4] | Aaron M. Berger[1] | Ian G. Taylor[2] | Michael G. Jacox[5,6] |
Brendan D. Turley[7,8]

- Found various ecosystem influences on hake recruitment
- Based on estimated recruitment from 1980-2010
- In 2025 assessment we presented 11 such indices that are *easily available*
  - Not comprehensive or definitive – first step to include information operationally in assessment

Hake recruitment



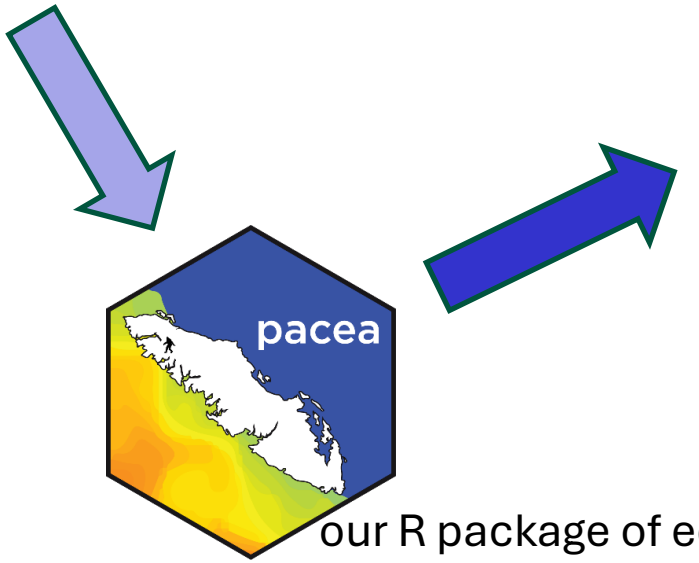
New appendix in 2025 assessment

Present time series of 11 of the indices concluded to influence hake recruitment.

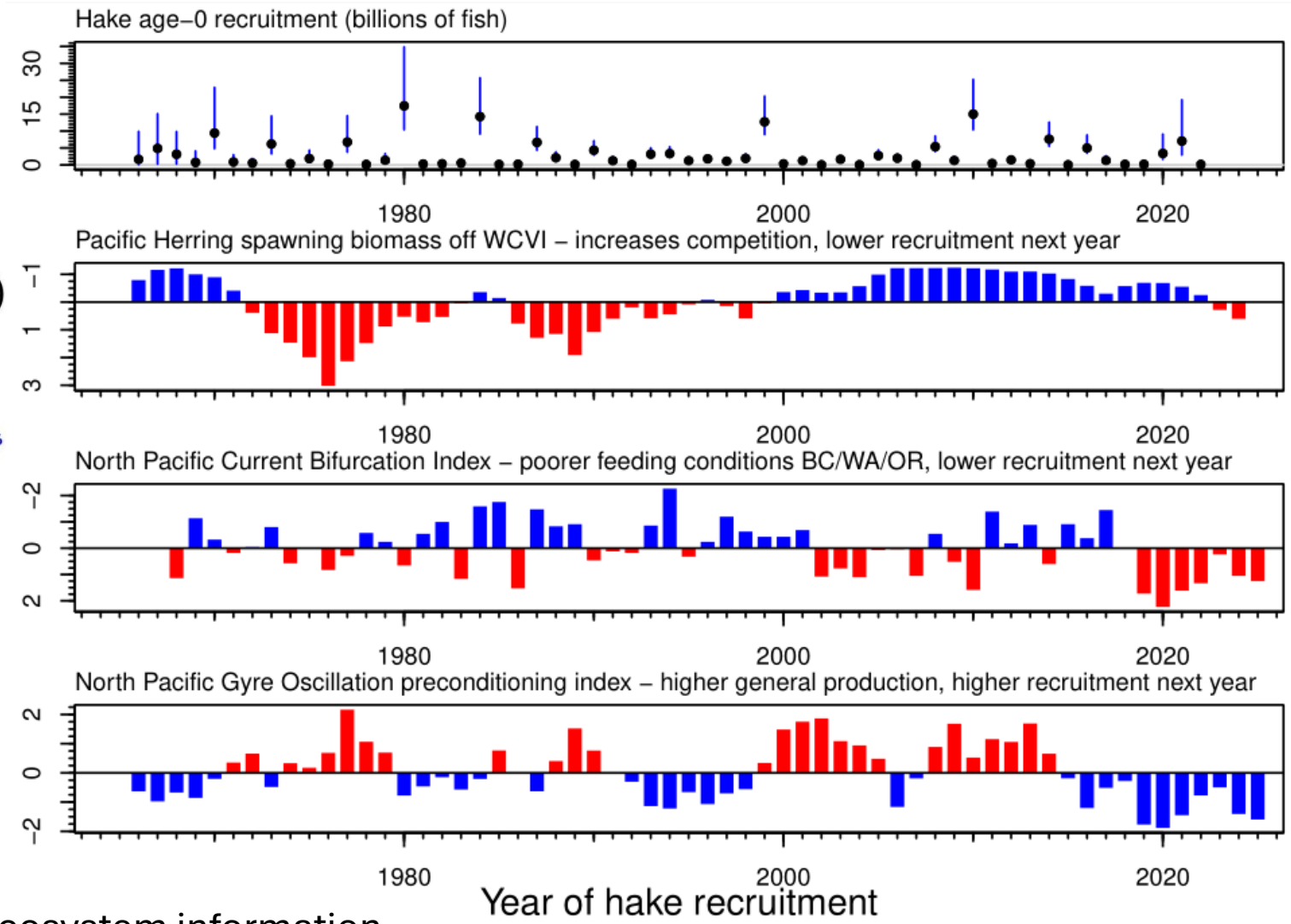
First step to operationalising.

Stage-specific drivers of Pacific hake (*Merluccius productus*) recruitment in the California Current Ecosystem

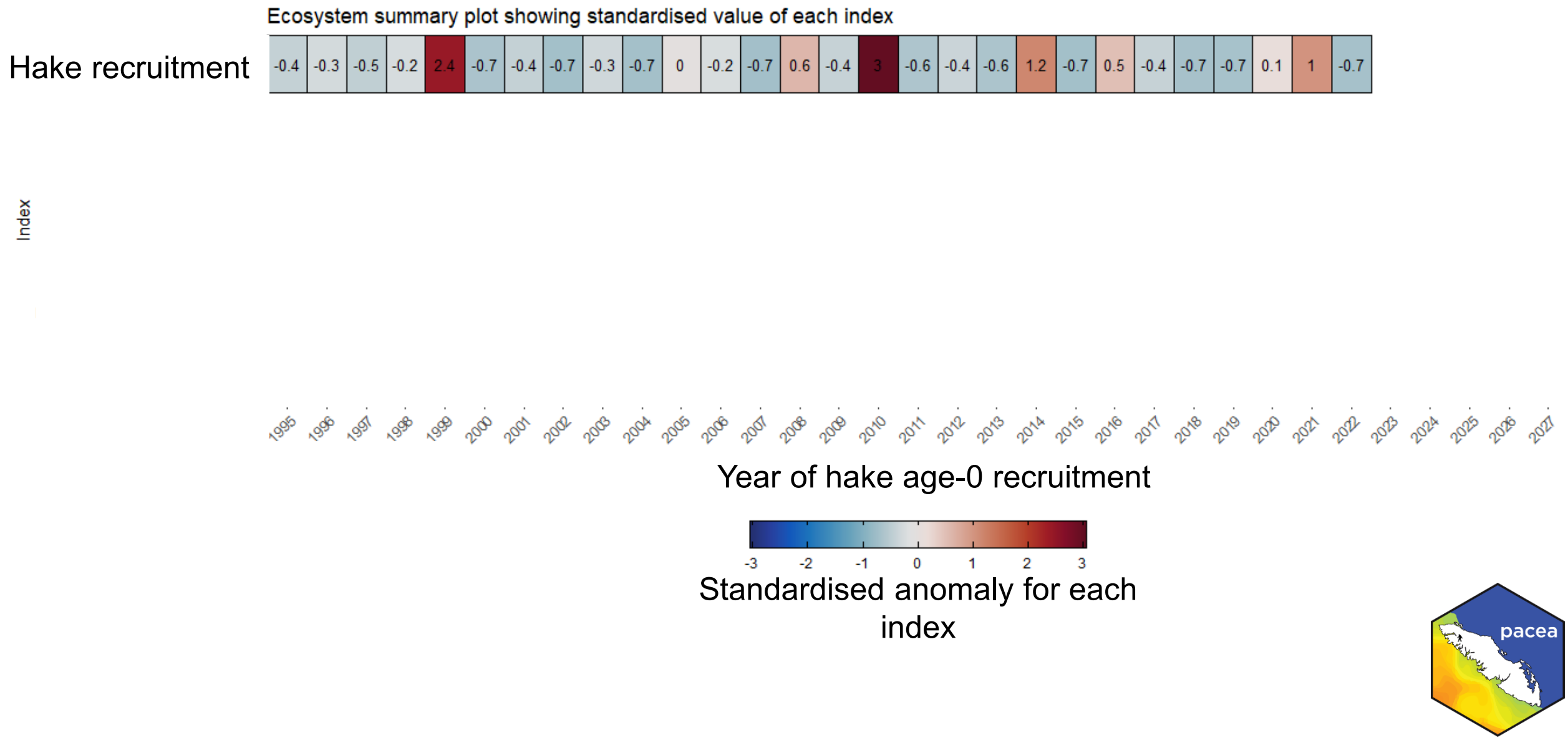
Cathleen D. Vestfals[1] | Kristin N. Marshall[2] | Nick Tolimieri[3] | Mary E. Hunsicker[4] | Aaron M. Berger[1] | Ian G. Taylor[2] | Michael G. Jacox[5,6] Brendan D. Turley[7,8]



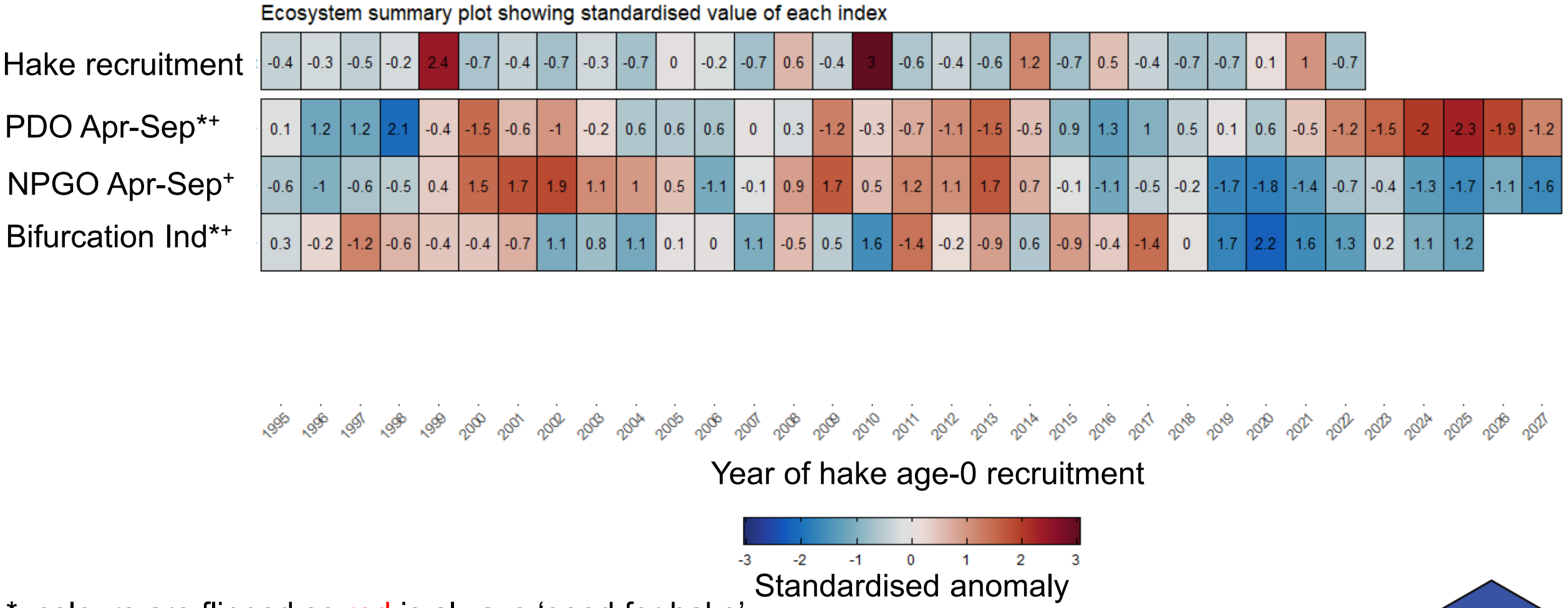
our R package of ecosystem information



Improved figure for 2027 assessment



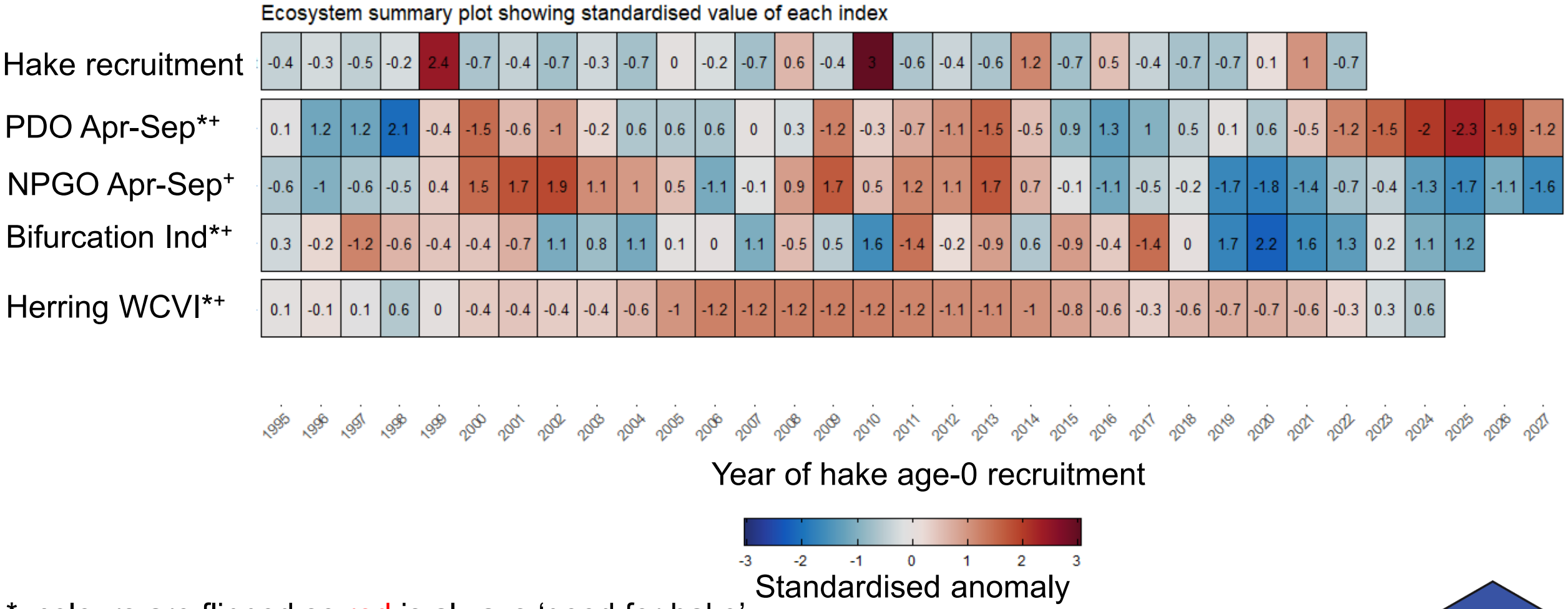
Improved figure for 2027 assessment



* colours are flipped so red is always ‘good for hake’

\+ year shifted by one due to lag of effect

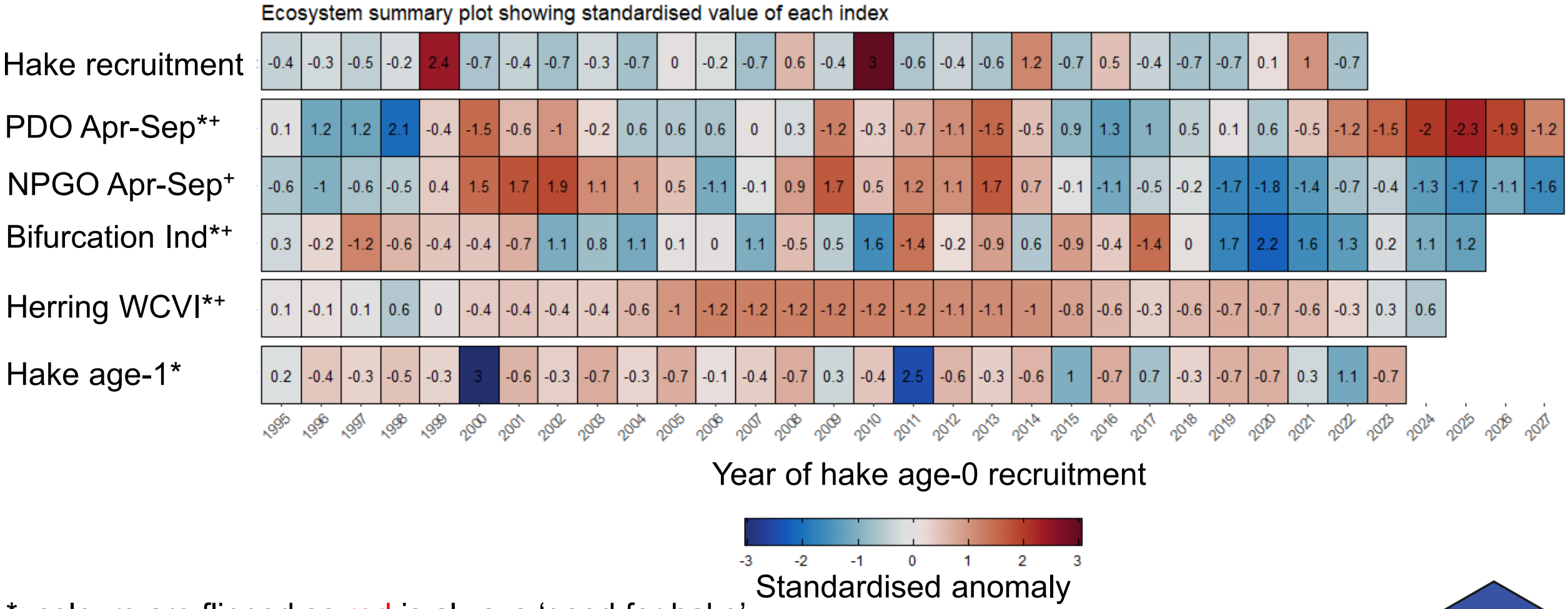
Improved figure for 2027 assessment



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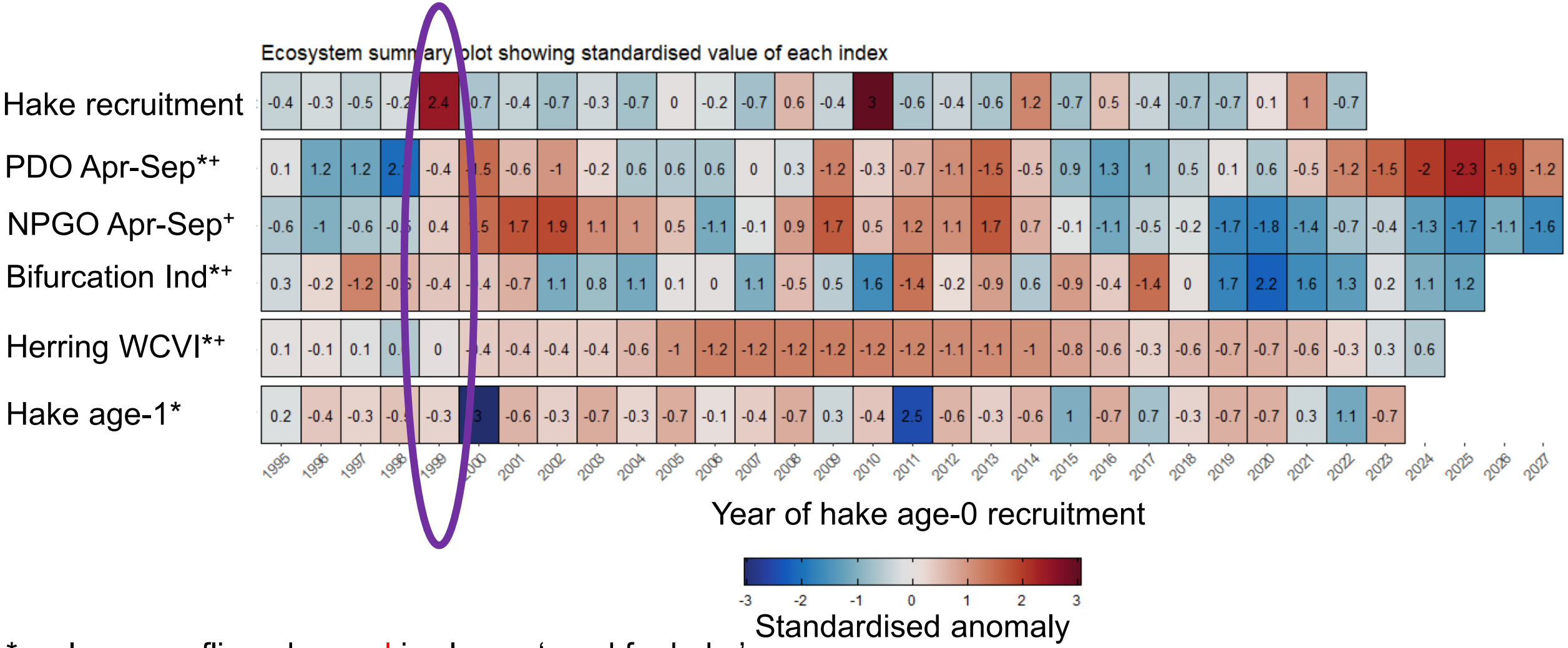
Improved figure for 2027 assessment



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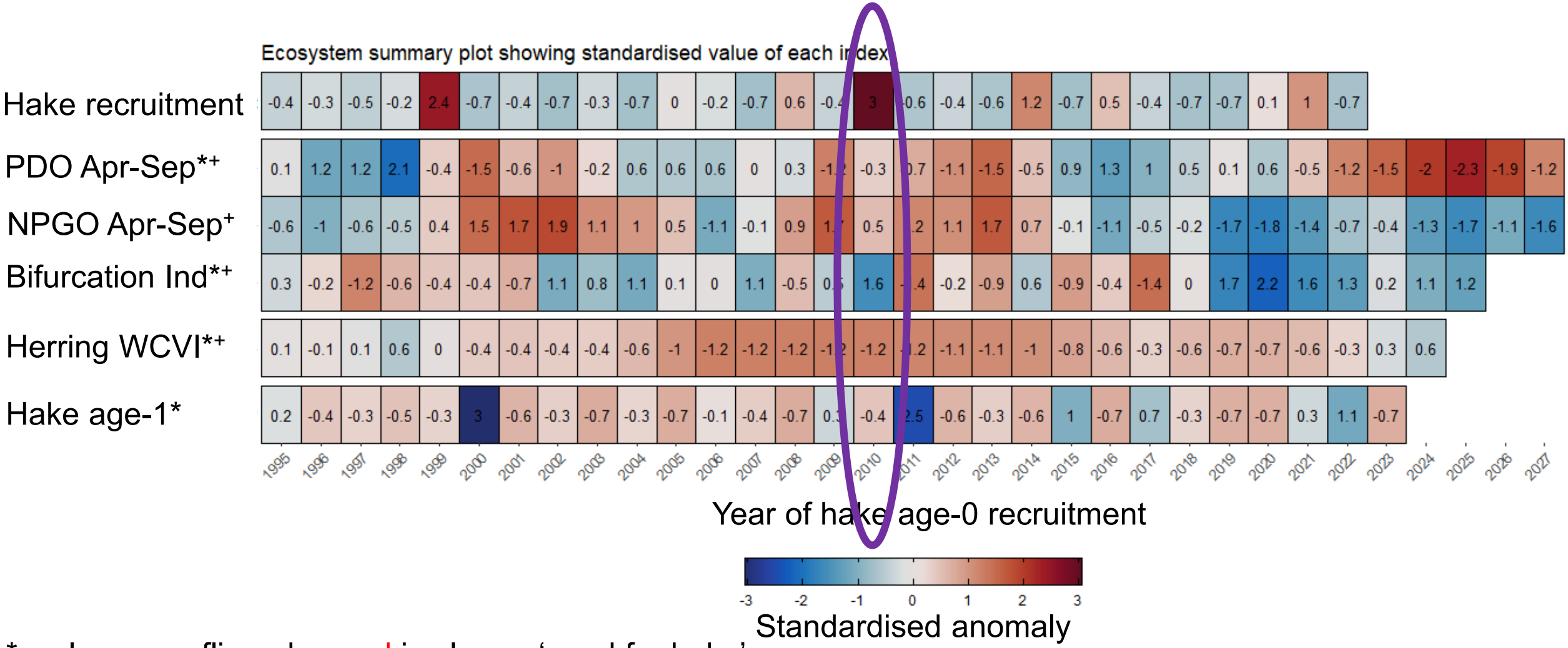
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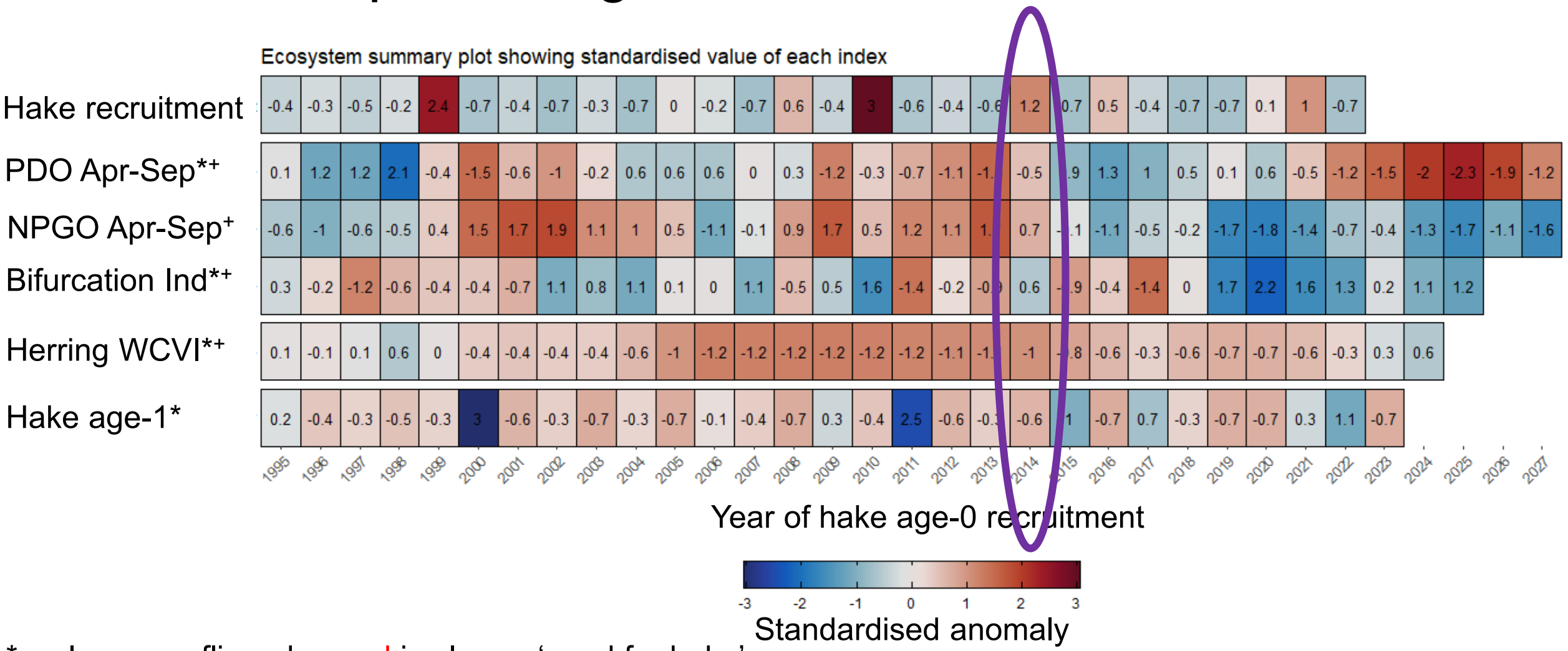
Improved figure for 2027 assessment



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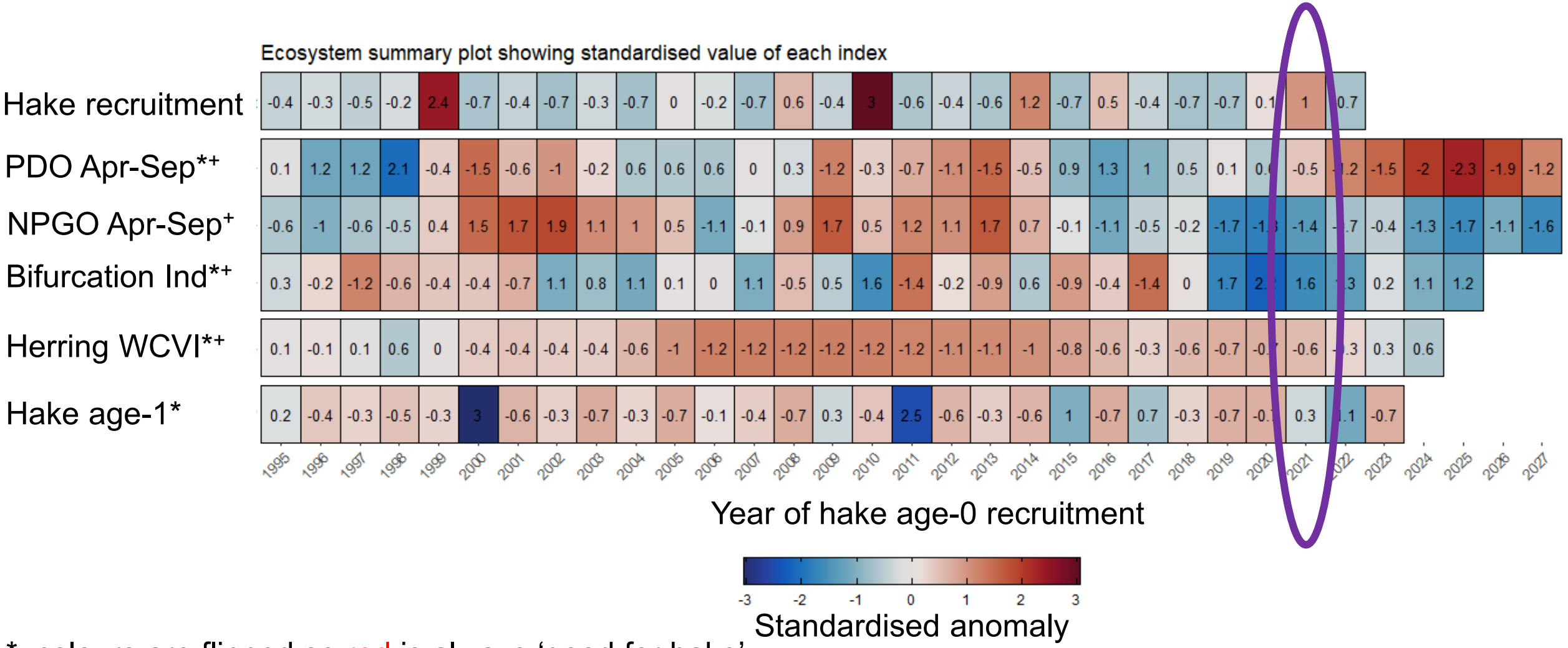
Improved figure for 2027 assessment



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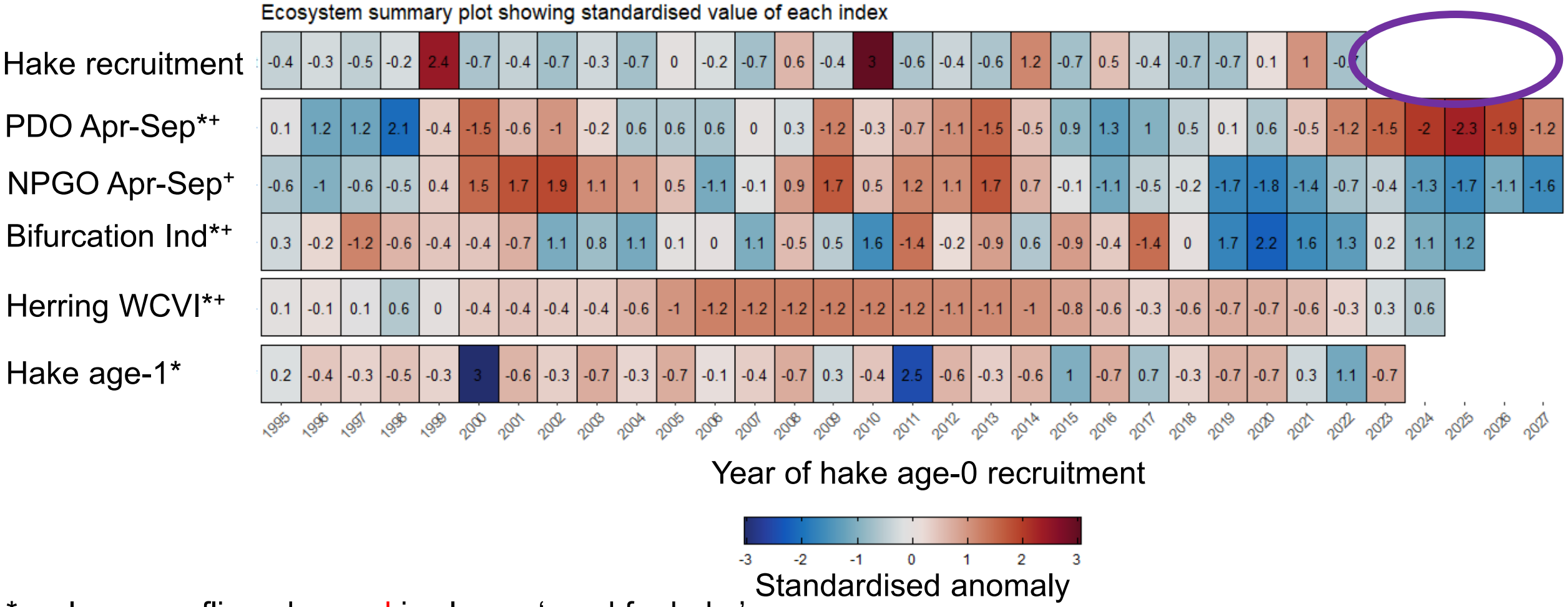
Improved figure for 2027 assessment



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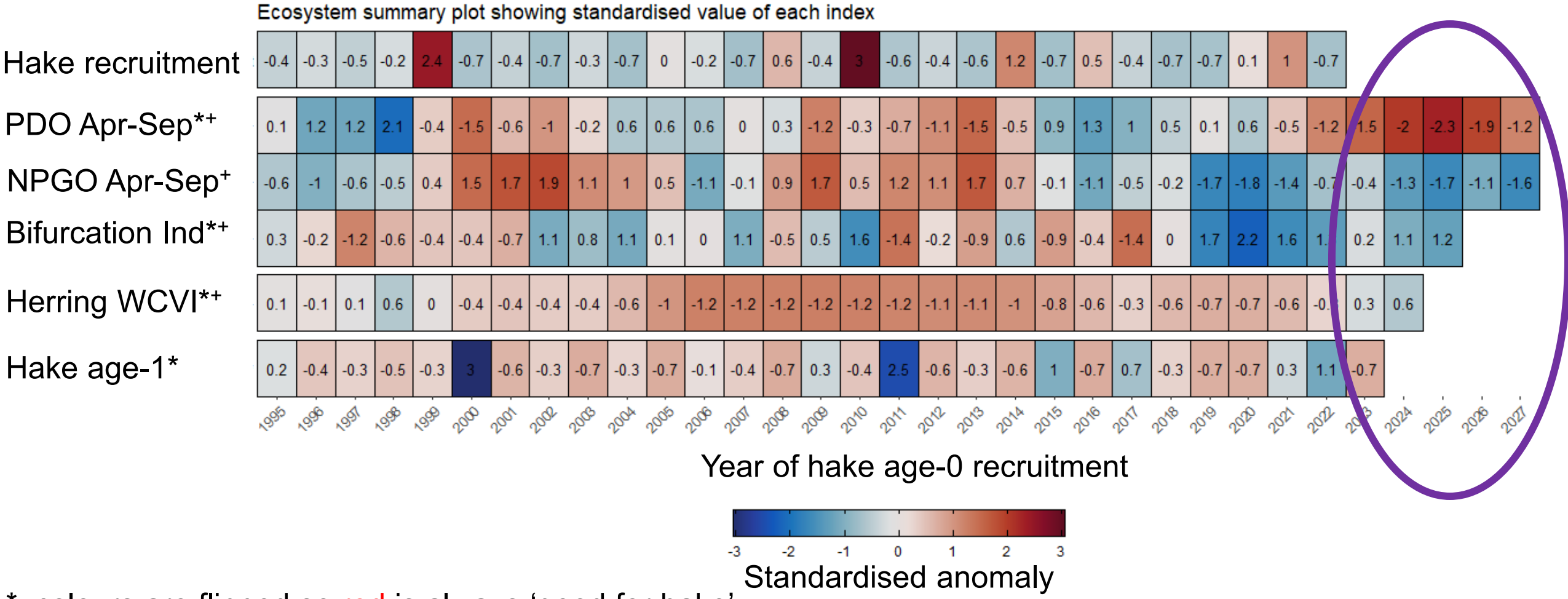
Improved figure for 2027 assessment



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Improved figure for 2027 assessment



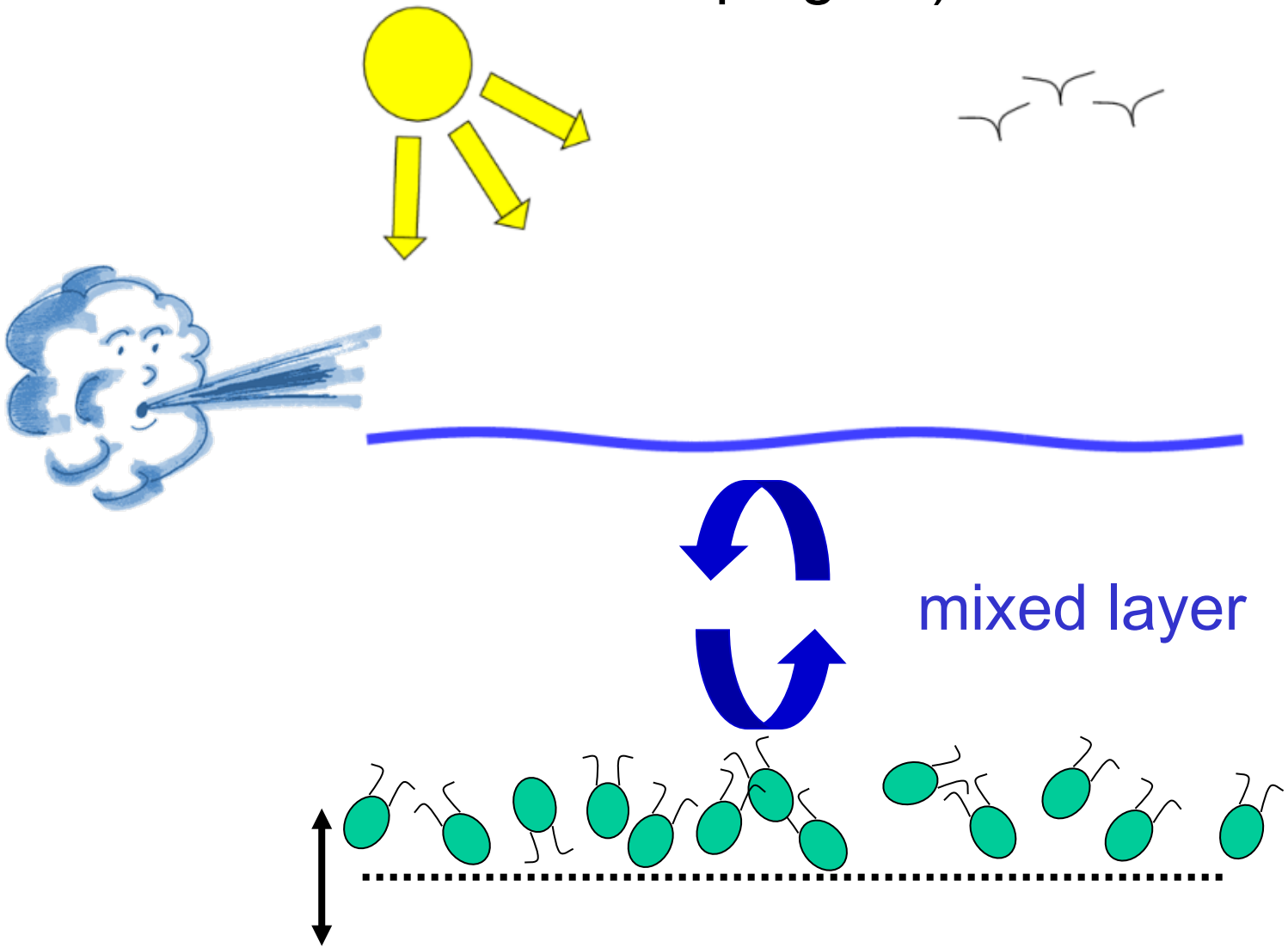
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\+ year shifted by one due to lag of effect

Physical oceanographic indices (2025: new; 2026: improved workflow; 2027: improved workflow and add to heatmap figure)

Examples:

- Mean mixed-layer depth during late larval stage (shelf break, Mar-Jun, 31-37°N); shallower reduces recruitment
- Average sea-surface height off California from Jan-Apr (higher increases recruitment)



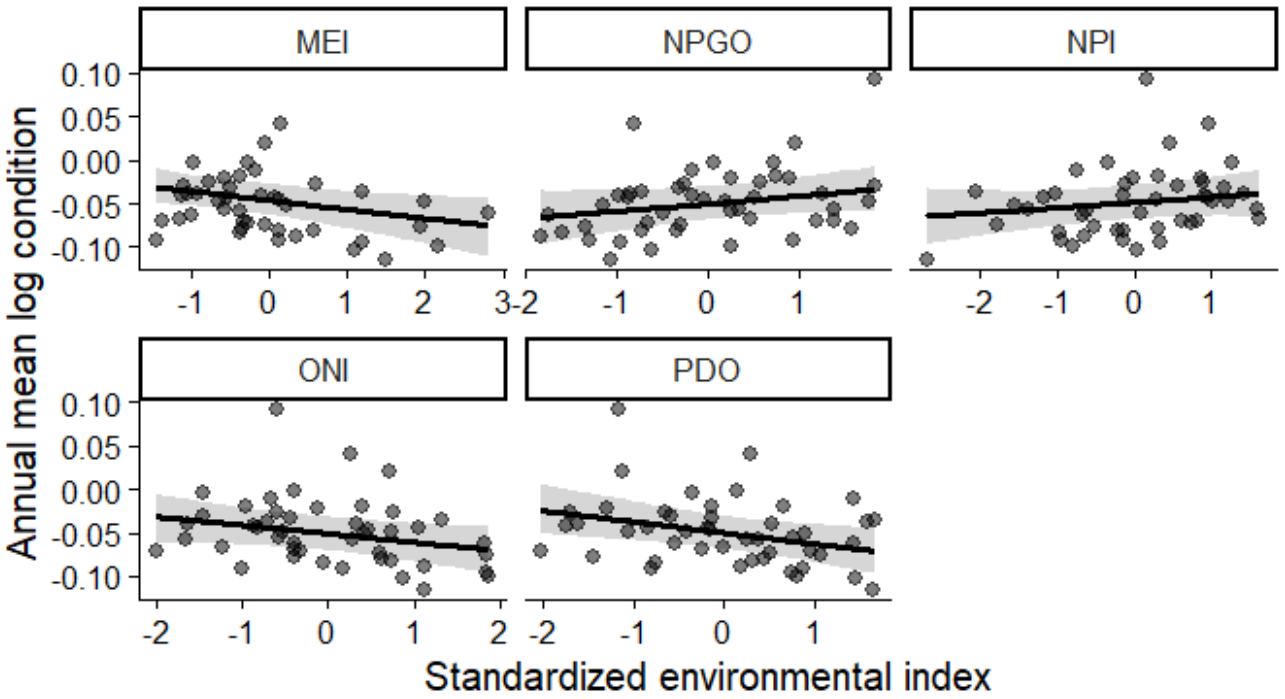
copernicusMarine R package and Wei Cheng

Also an ecosystem risk table

For 2027: body condition with respect to indices

Body condition: how much heavier a fish is
than expected for its length

Tentative results:
early spring: sensitive to environment



FISH and FISHERIES

Body Condition as a Shared Response to Environment in a Commercially Important Demersal Fish Assemblage

Philina A. English[1] | Sean C. Anderson[1,2] | Robyn E. Forrest[1]

Lessons learned

- For hake we have a mixture of:
  - new ideas by others in papers
  - new ideas (often by others) directly in stock assessment document/model
- Having multiple excellent researchers for a high profile data-rich stock helps
- Invaluable to have updatable accessible environmental information



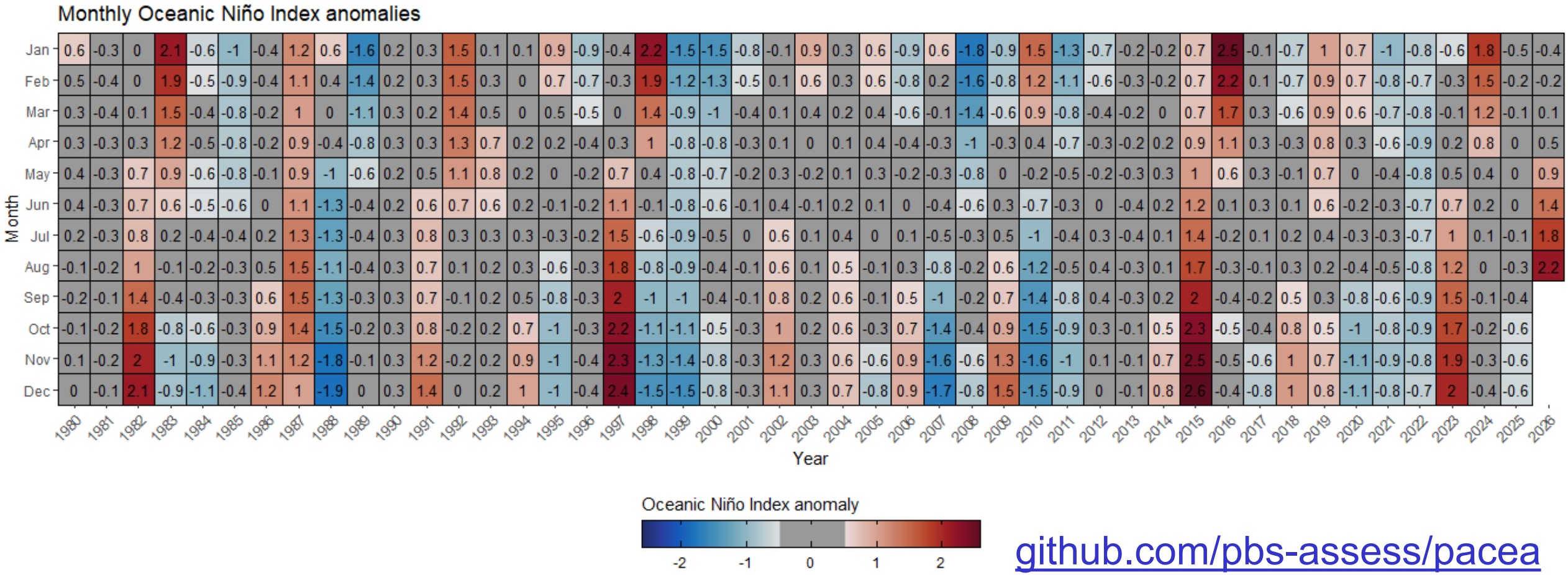
- Reproducible version-controlled (R Markdown, Git) workflow to produce the assessment document with tight deadline
- Need the personal connections
- Good to incrementally introduce new concepts, rather than surprise everyone with an overhaul of the model

Hake assessment other co-authors: Kelli Johnson, Chris Grandin, Chantel Wetzel, Kiva Oken. Others: Melissa Haltuch, Melissa Head, Andrea Odell, Eric Ward, Sophia Wassermann, Wei Cheng, plus DFO & NOAA survey team.

pacea R package

- PACific Ecosystem Approach (Canadian Pacific waters and some of US)
- Includes climatological and oceanographic indices, e.g. Oceanic Niño Index:

```
> plot(oni, heatmap_style = TRUE, neutral_oni_one_colour = TRUE)
```



github.com/pbs-assess/pacea