Australia's National Science Agency

The diversity and power of plankton indicators for assessing ecosystem state and trends

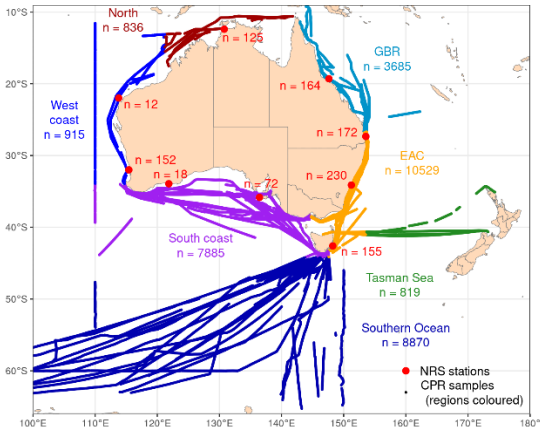
Frank Coman, Claire Davies, Ruth Eriksen, Jason Everett, Felicity McEnnulty, Julian Uribe-Palomino, Wayne Rochester, Anita Slotwinski, Mark Tonks, Anthony J Richardson

7th Zooplankton Production Symposium: Thursday March 21st 2024

Plankton Data

- IMOS Australian Continuous Plankton Recorder survey
- IMOS National Reference Stations BGC sampling
  - 2009 to present
- Historical data sets

Integrated Marine Observing System (IMOS) plankton data, 2007-2024

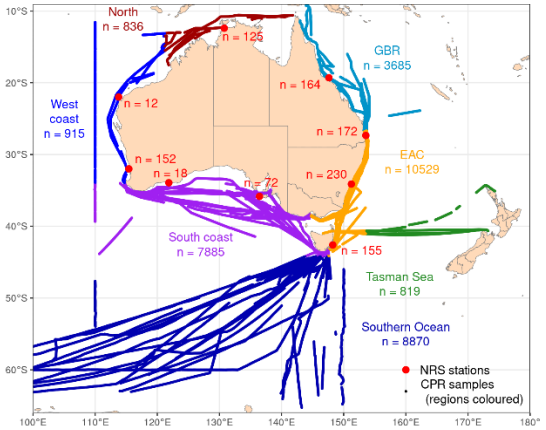


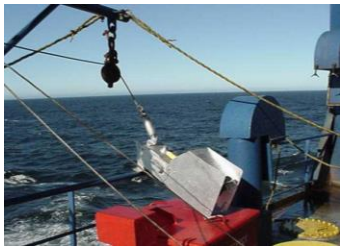
IMOS Integrated Marine Observing System

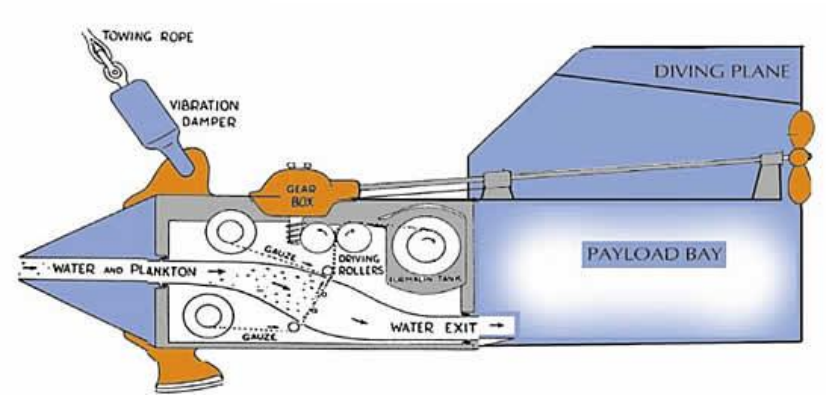
Continuous Plankton Recorder

- Robust design
- Ships of Opportunity and Research vessels
- Large spatial scale: 400-450 nautical miles
- 8-10 m depth
- Seasonal

Integrated Marine Observing System (IMOS) plankton data, 2007-2024



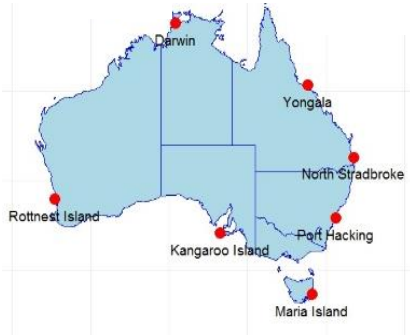




IMOS Integrated Marine Observing System

National Reference station

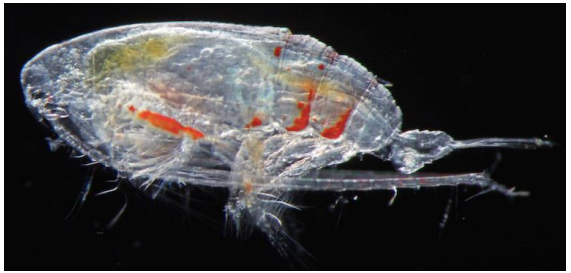
- Small research vessels
- Zooplankton: vertical drop net
- Phytoplankton: Niskin bottle samples
- Whole of water column
- Monthly
- 7 sites around Australia

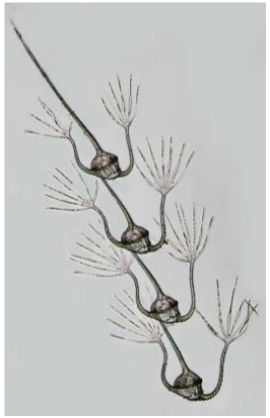


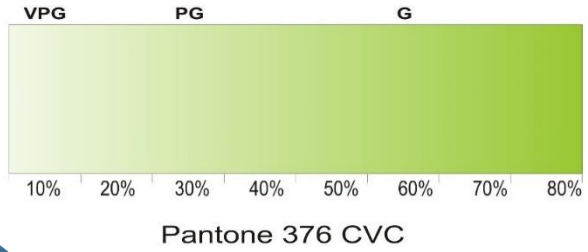
IMOS Integrated Marine Observing System

Plankton measurements

- Phytoplankton:
  - AusCPR: microscope counts and colour index
  - NRS: microscope counts
- Zooplankton:
  - AusCPR and NRS: microscope counts
- Biomass:
  - AusCPR and NRS: total plankton biomass

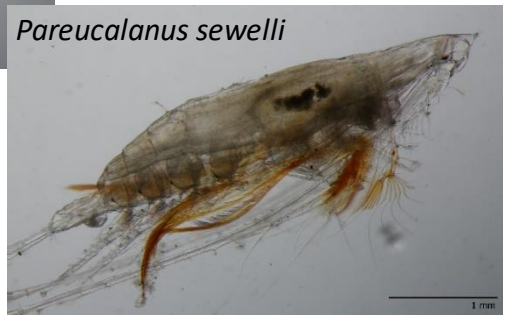






Plankton Indicators

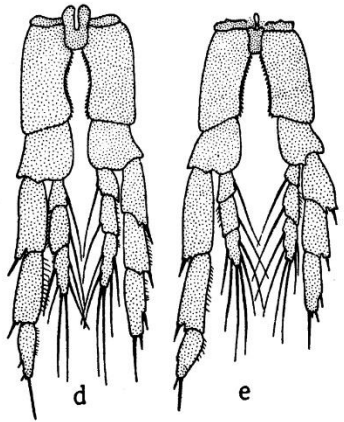
1. Community temperature index
2. EAC current strength index
3. Ocean Acidification index

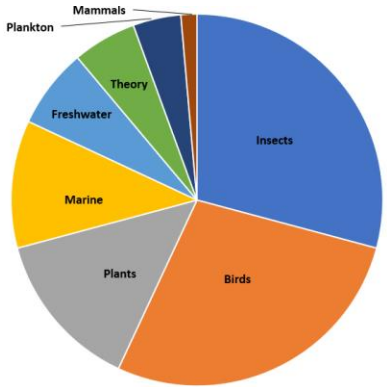


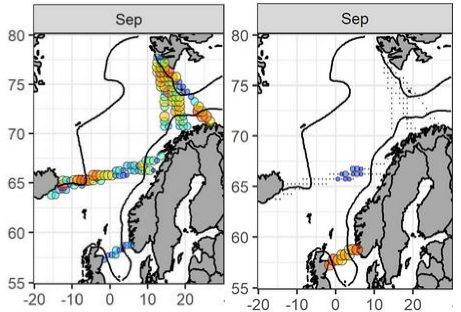
- Plankton as indicator species
  - Few are commercially exploited
  - Small, short lived
  - Extremely sensitive to environment

1. Community Temperature index

- Commonly applied to bird and insect communities
- Species level IDs and abundance
- Temperature preference for individual species
  - *e.g. northern hemisphere:* *Calanus finmarchicus* and *Calanus helgolandicus*







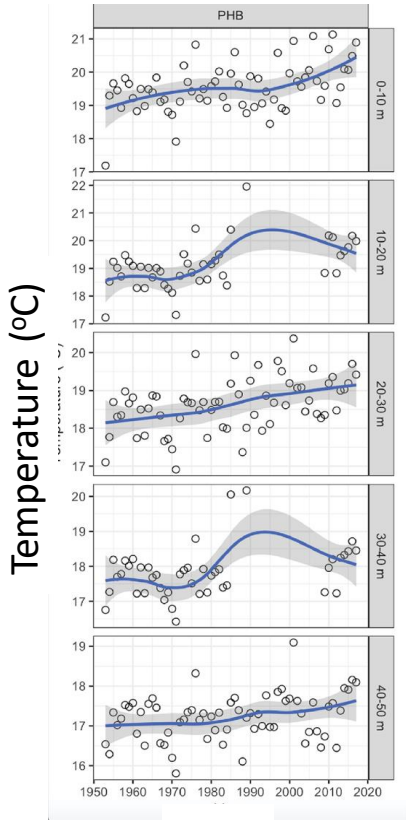
Strand *et.al.* (2020)
Progress in Oceanography

IMOS Integrated Marine Observing System

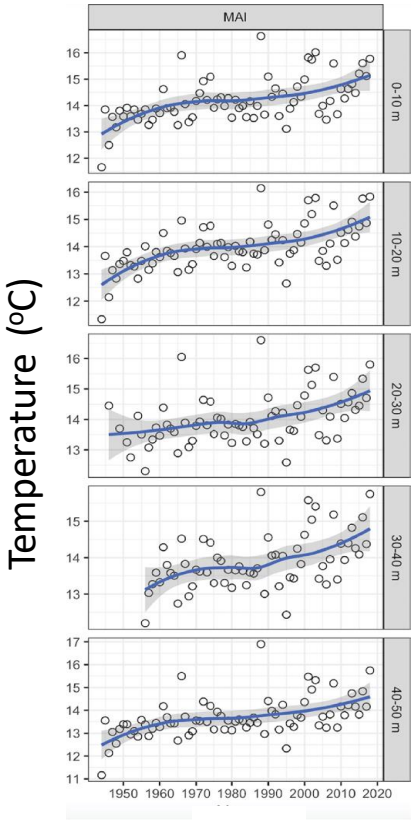
Warming at long-term stations

Depth

Port Hacking - warm temperate

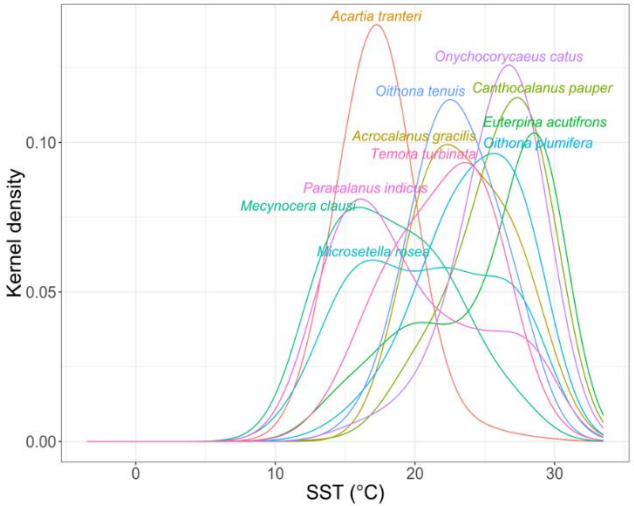


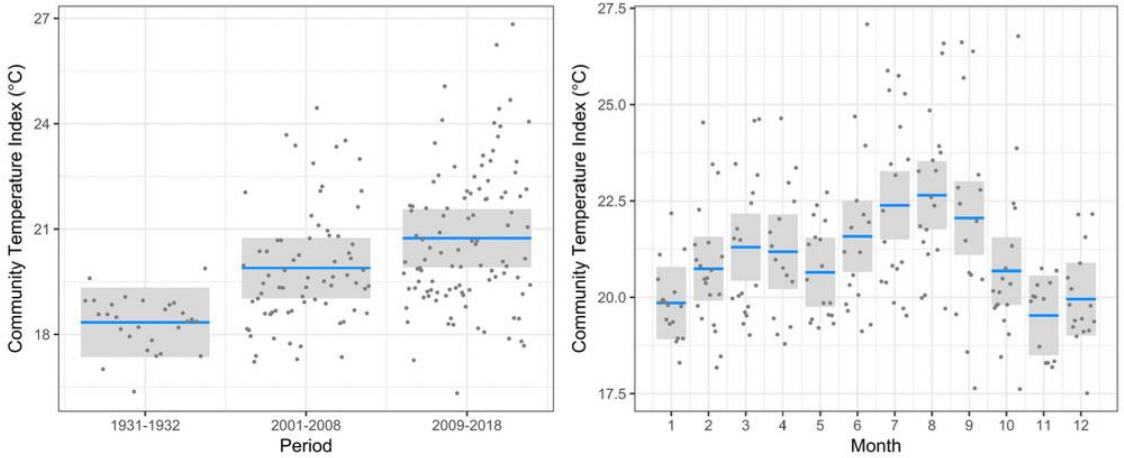
Maria Island - cool temperate



1. Community temperature index: copepods

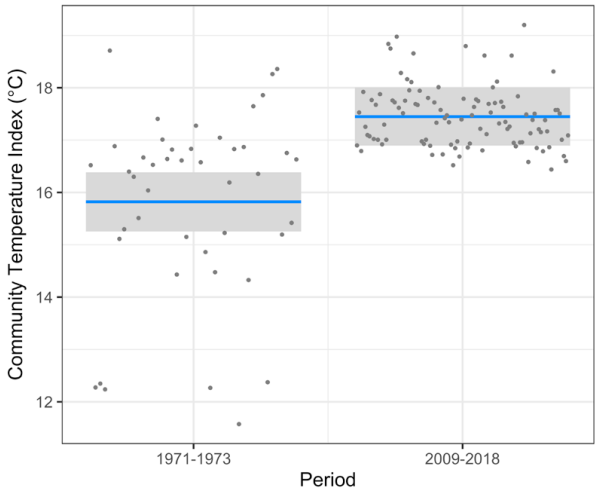
Port Hacking – warm temperate

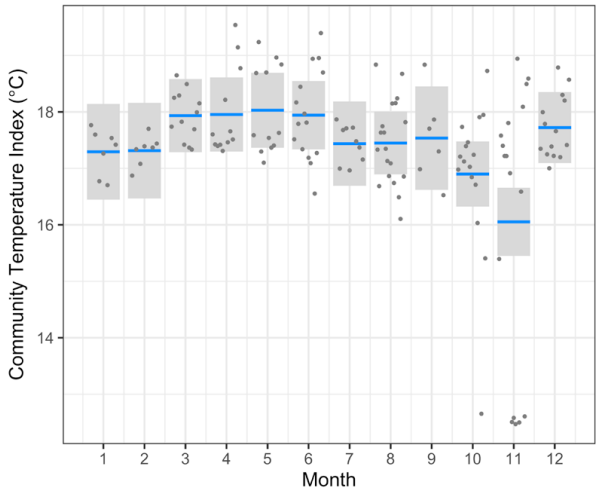


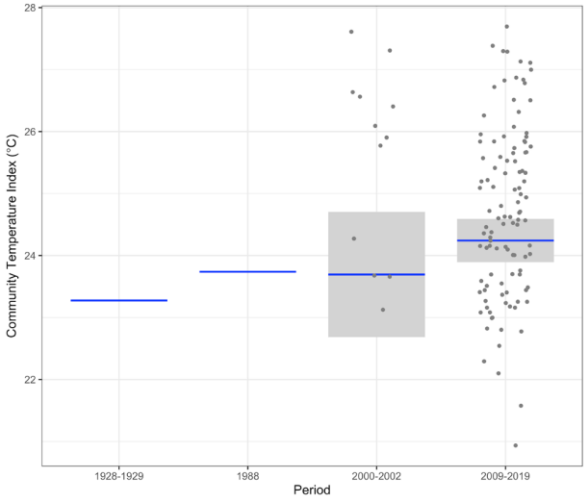


Adjusting model for seasonal cycle gives a better estimate of period effect

1. Community temperature index: copepods







Neocalanus tonsus abundance⇩

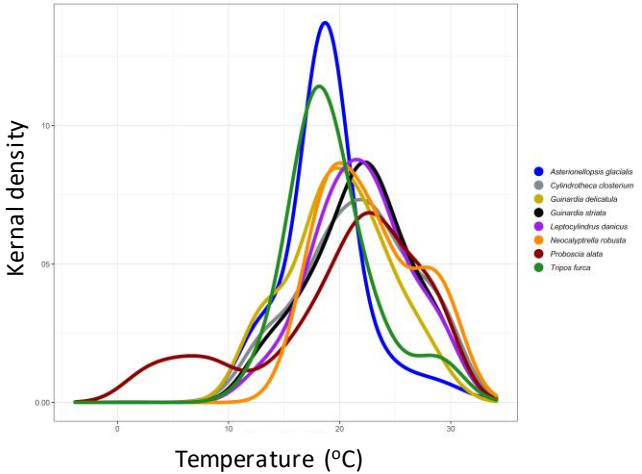
Maria Island – Cool Temperate

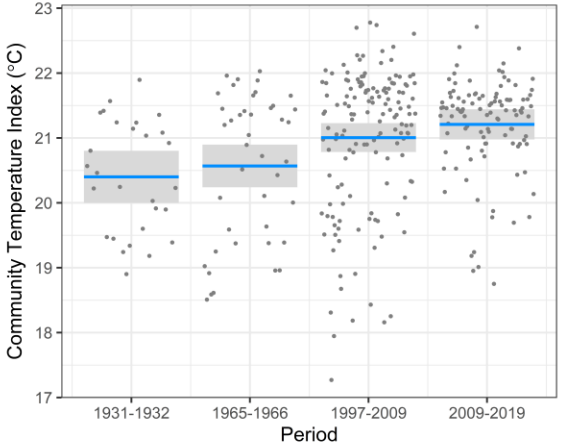
Yongala - Tropical

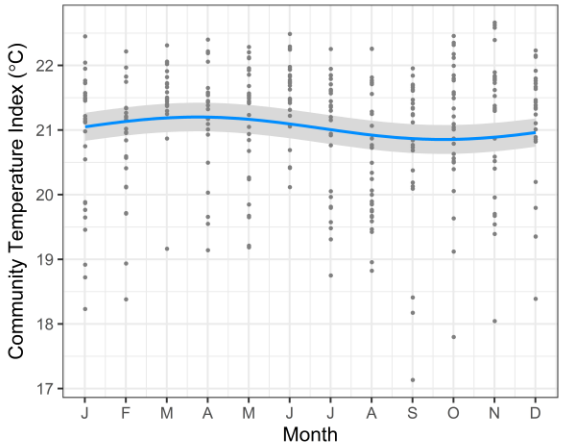
IMOS Integrated Marine Observing System

1. Community temperature index: phytoplankton

Port Hacking – warm temperate







Global Warming Impacts Micro-Phytoplankton at a Long-Term Pacific Ocean Coastal Station

Penny A. Ajani, Claire H. Davies, Ruth S. Eriksen, Anthony J. Richardson (2020)

Frontiers in Marine Science

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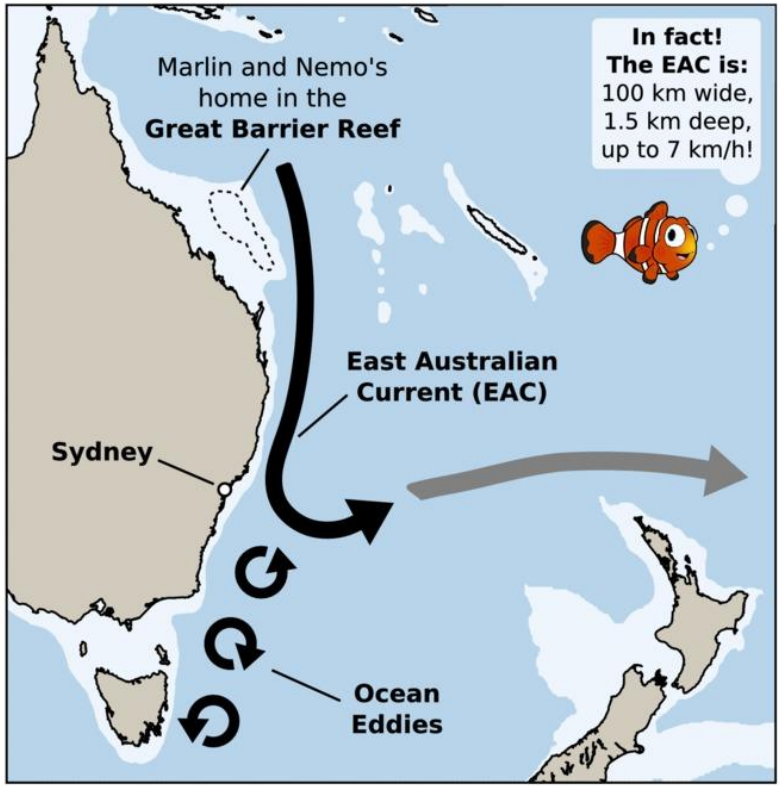
2. EAC Strength Index

- Rationale of index: expectation that warm water species will penetrate further south as current strengthens
- Difficult to directly measure current strength along whole EAC



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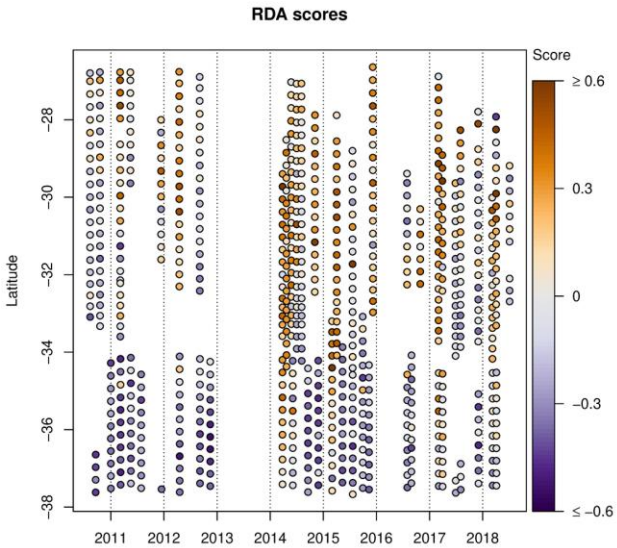

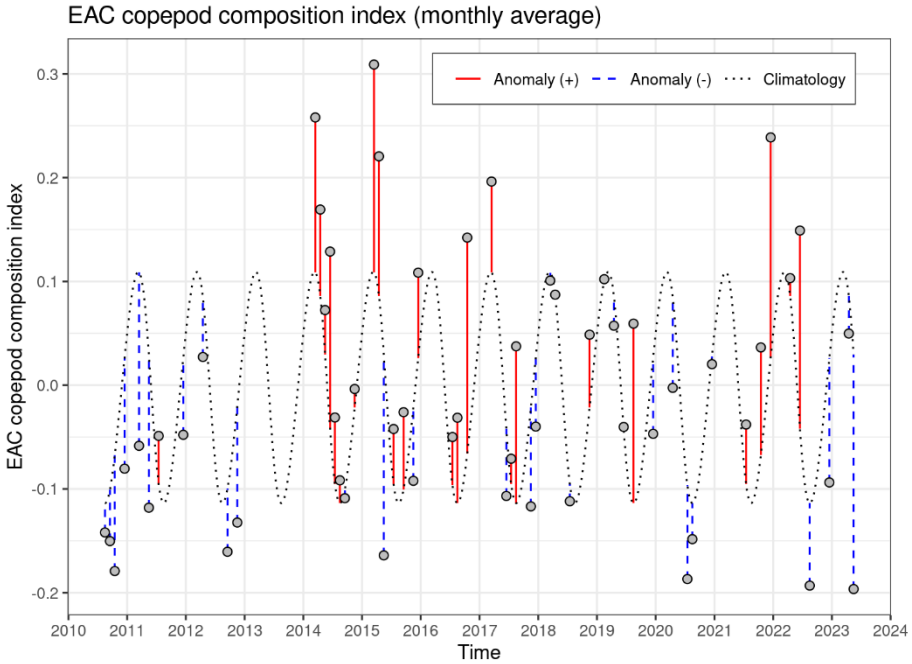

univariate warmth index ⇨ GAM to remove latitude effect before calculating regional average

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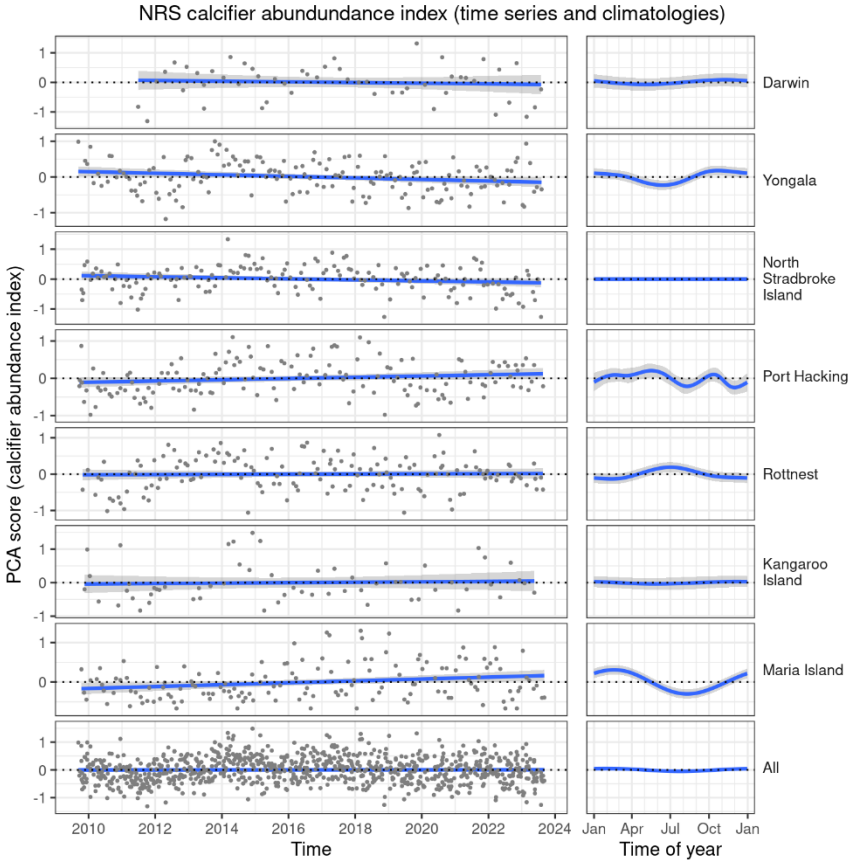
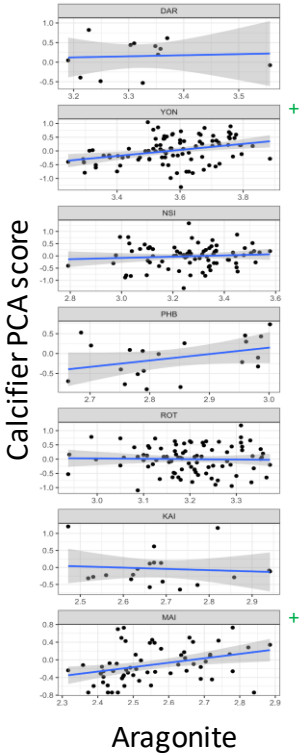
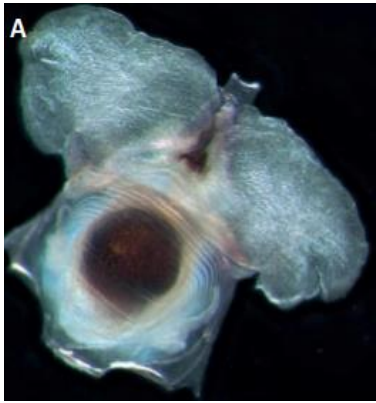
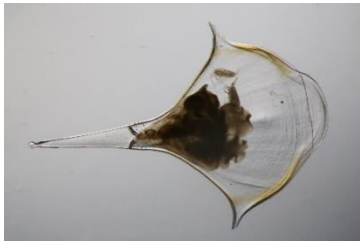
3. Ocean Acidification Index



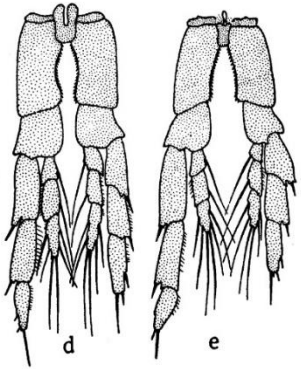


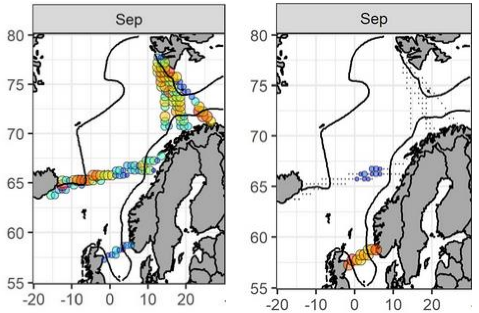




Advantages of IMOS Plankton Data streams

- Long-term
- Repeated
- High level of taxonomic discrimination; often species
- Direct counts
- Data freely available from AODN





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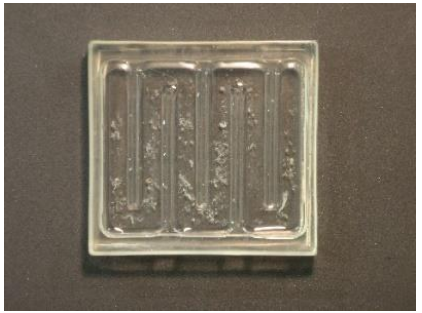
Alternative methodologies



- eDNA / metabarcoding
  - Difficult to determine abundances
    - Species with much external DNA e.g. coral mucous
    - Long-lived plankton species which grow orders of magnitude in size
  - Species level resolution difficult due incomplete gene libraries

- Machine Learning
  - Require reliable reference libraries
  - Difficult to get species level resolution
- Applicability to indices
  - Taxonomic discrimination and abundances required for CTI and EAC current
  - Lower taxonomic resolution for calcifiers index

Thank you

Plankton indicators for ecosystem assessments

Frank Coman, Claire Davies, Ruth Eriksen, Jason Everett, Felicity McEnnulty, Julian Uribe-Palomino, Wayne Rochester, Anita Slotwinski, Mark Tonks, Anthony J Richardson

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Shipping: Wallenius Whilhelmsen, Rio Tinto, Sealord, ANL, Swires, Laeisz