CELEBRATING 20 YEARS
OF SUSTAINED MARINE OBSERVING

IMOS
Integrated Marine Observing System

Retrospective: A long-term plankton observing system in Australian waters

Anthony J. Richardson, Frank Coman, Claire Davies, Ruth Eriksen, Sahan Jayasinghe, Felicity McEnnulty, Anita Slotwinski, Mark Tonks, Julian Uribe

IMOS acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe, and recognise them as Australia's first marine scientists and carers of sea Country. We pay our respects to Aboriginal and Torres Strait Islander peoples past and present.


Zooplankton
2-yr time series off Sydney (1930s) and off Perth (1990s)
Phytoplankton
Longer, but all discontinued

IMOS plankton observing system: 2 complementary approaches

Considerations	National Reference Stations 	Australian Continuous Plankton Recorder survey 
Devices	Bottle (P) and net (Z)	Continuous Plankton Recorder (P and Z)
Region	Near-coastal	Shelf and oceanic
Spatial coverage	Low	High
Temporal coverage	High (monthly)	Moderate (seasonal)
Samples collected by	Researchers	Ships of opportunity
Precision	High (quantitative and often species)	Moderate (semi-quantitative and sometimes species
Supporting variables	In situ (sensors, biogeochemistry)	Remotely sensed

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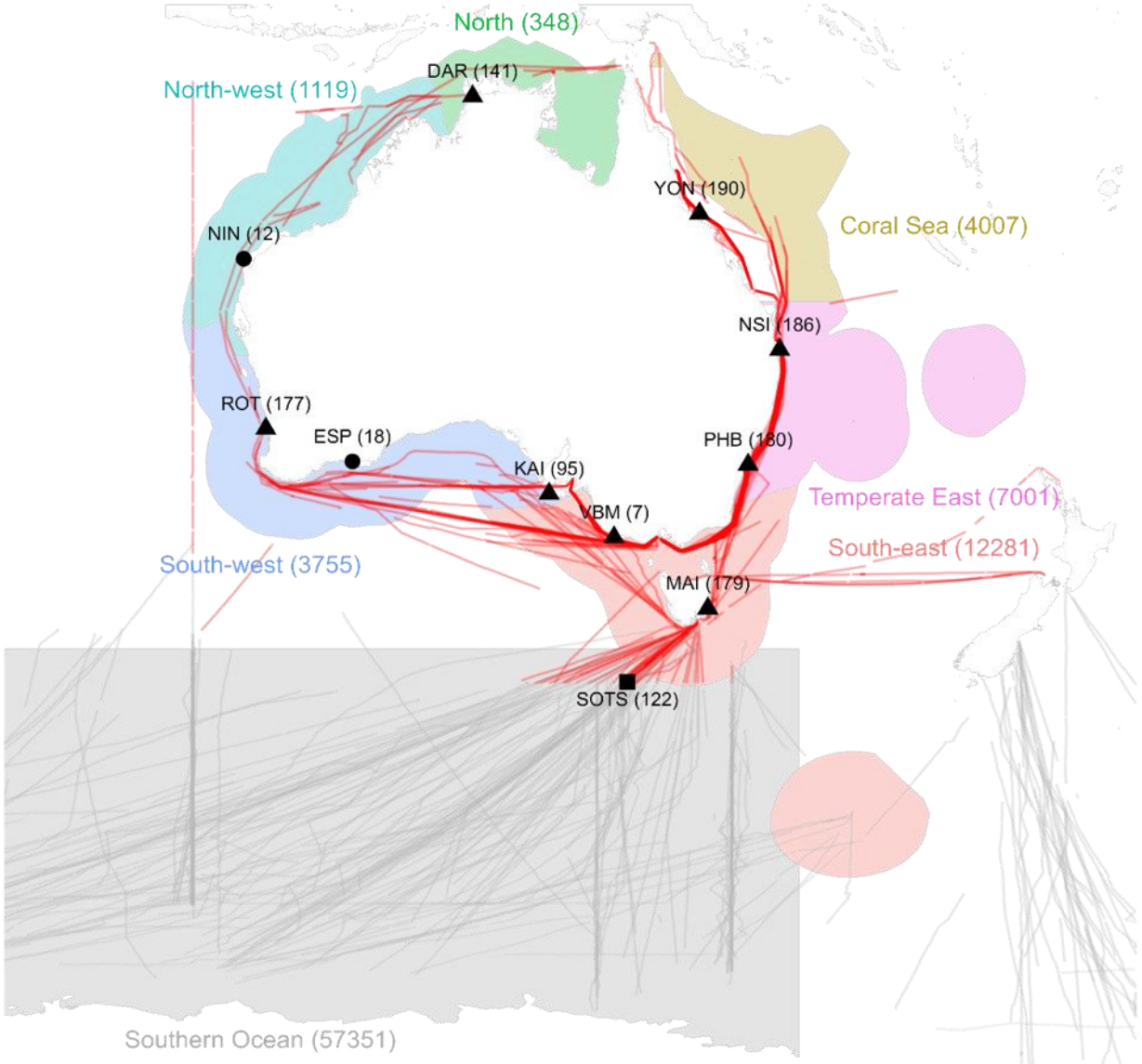
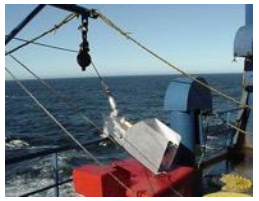
IMOS plankton observing system: Extensive coverage (2007-ongoing)

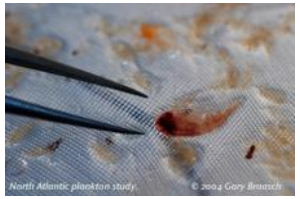


(number of samples)

▲ National Reference Stations

— Continuous Plankton Recorder





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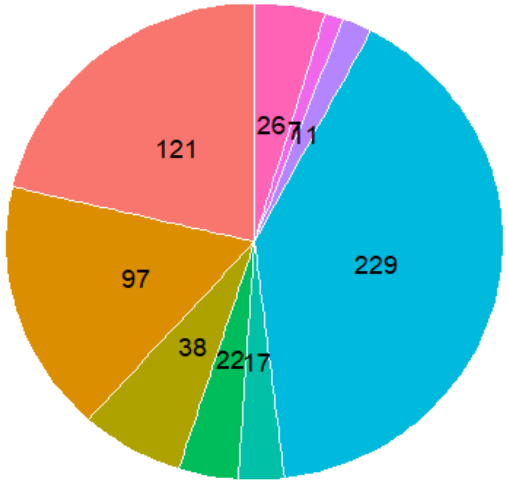
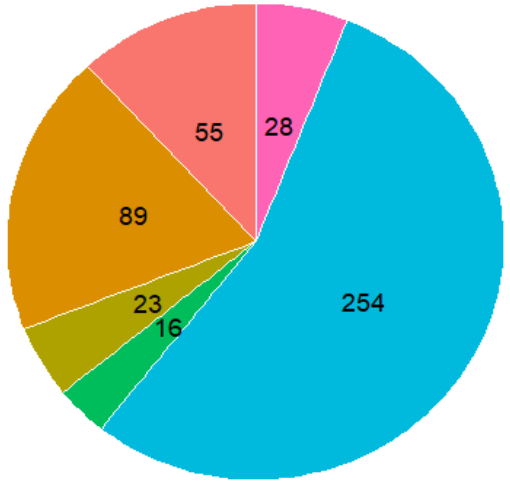
IMOS plankton observing system: Rich biodiversity

Number of species counted

NRS

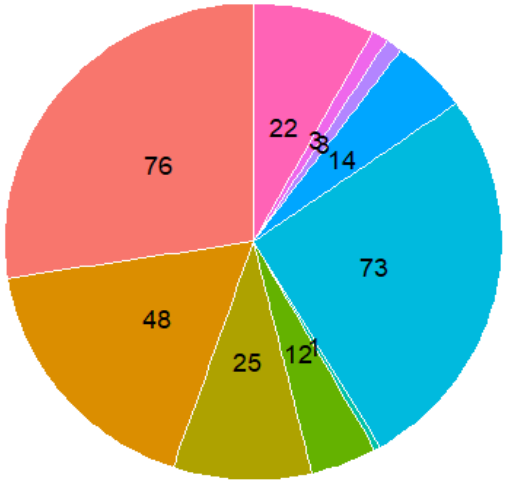


AusCPR



IMOS (P) + AAD (Z)

SO-CPR



Phytoplankton

Zooplankton

Zooplankton

Larval Fish Species

- Bacillariophyceae
- Dinophyceae
- Other phytoplankton
- Amphipoda
- Ciliophora
- Cnidaria
- Copepoda
- Euphausiidacea
- Chaetognatha
- Thaliacea
- Other zooplankton

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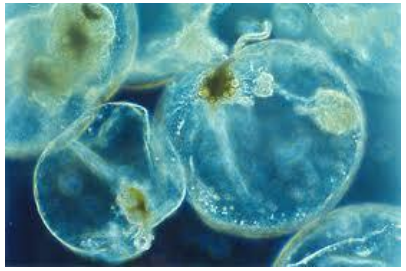
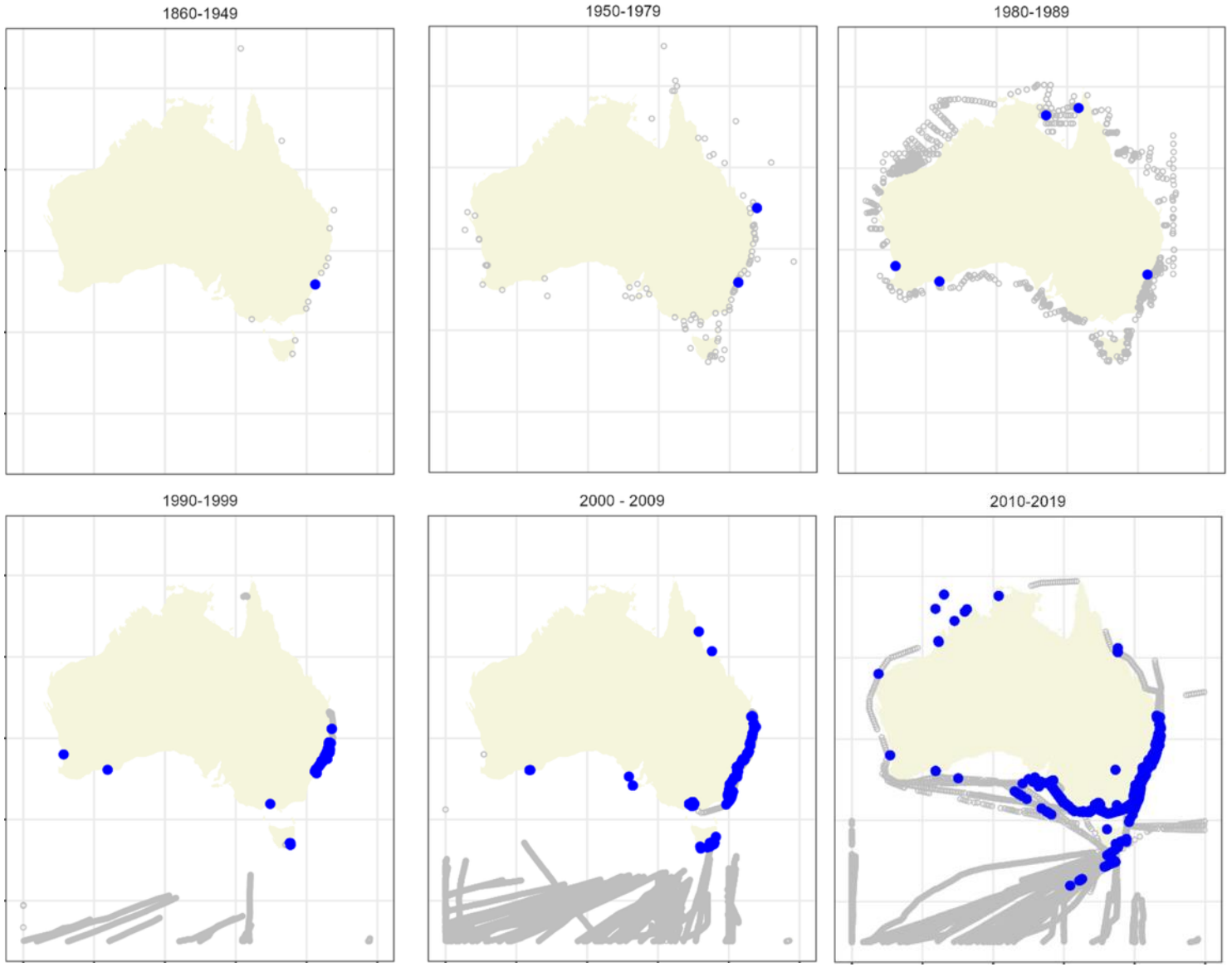
Scientific insights: Impacts of climate change (range expansion)

Noctiluca scintillans





Hallegraeff et al. (2020)

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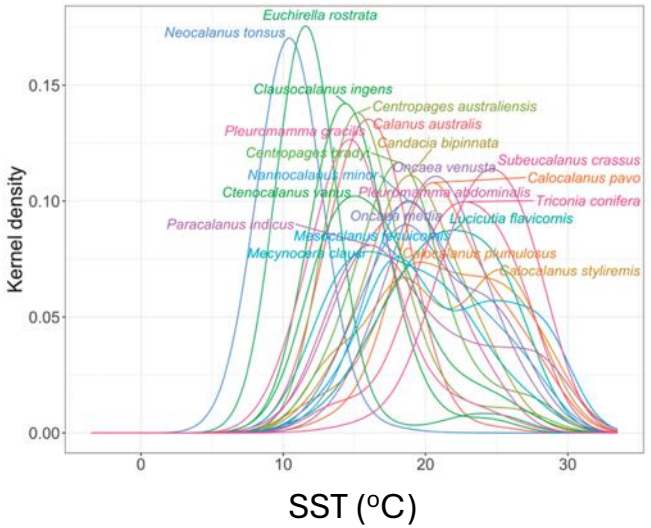
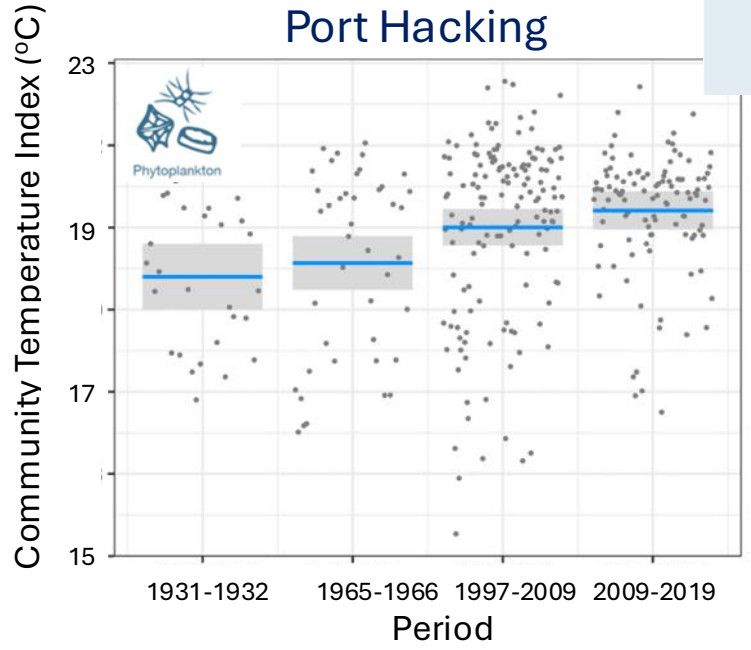
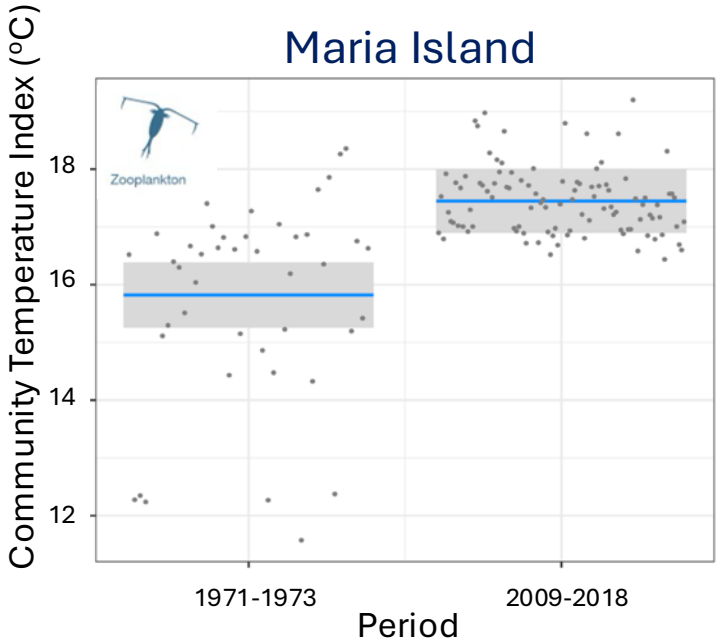
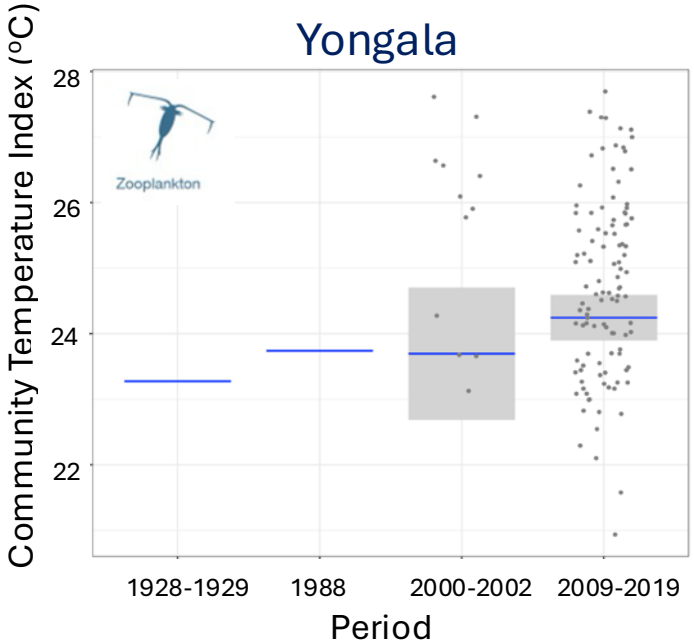
Scientific insights: Impacts of climate change (CTI)

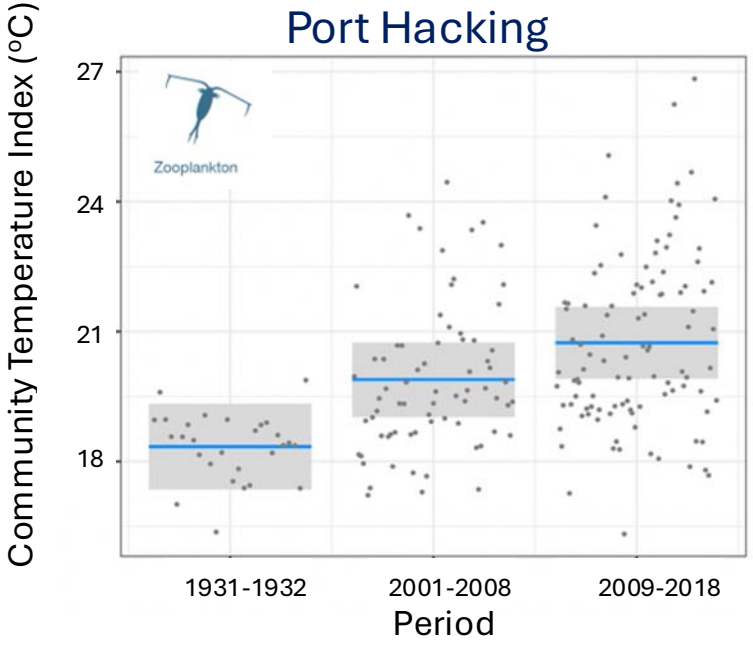
Ajani et al. (2020)
Richardson et al. (2020)



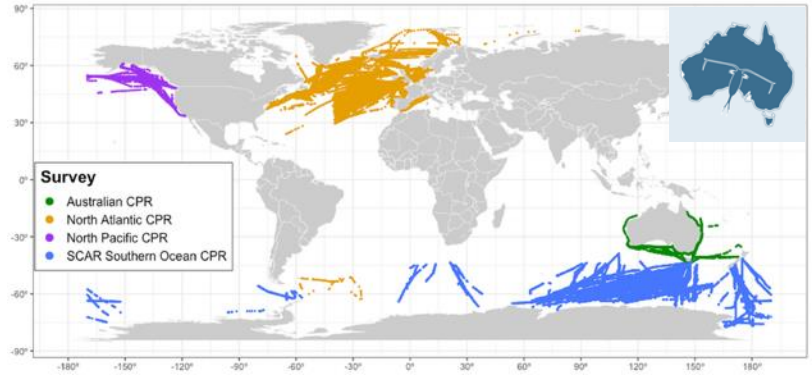


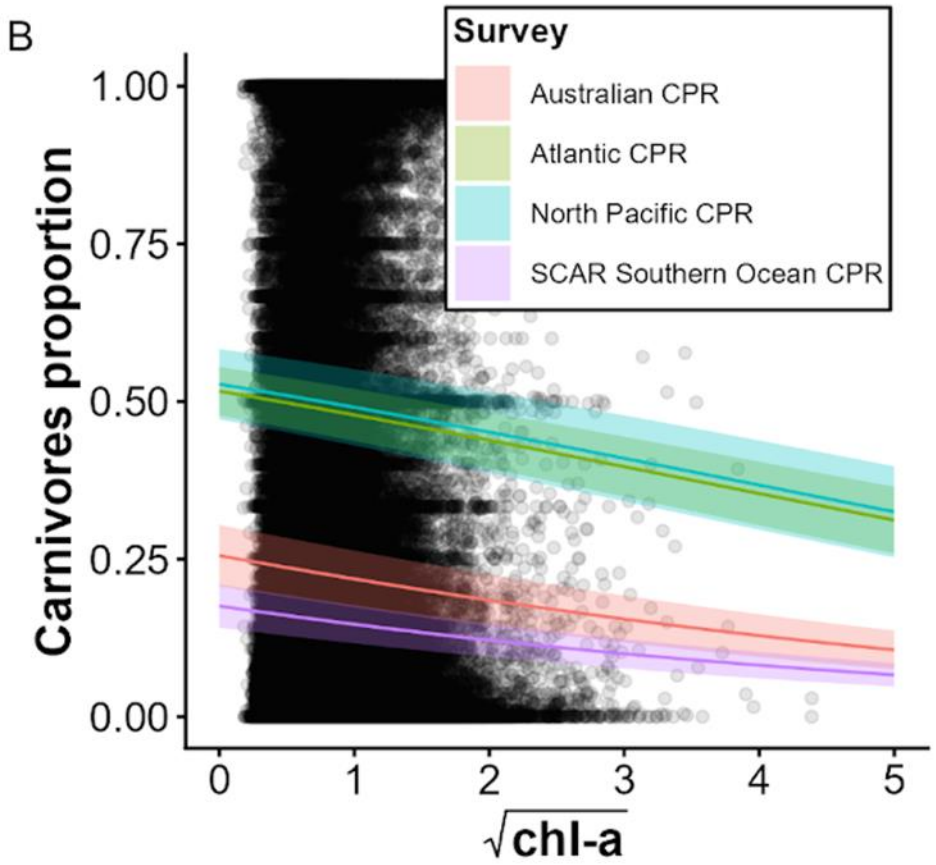




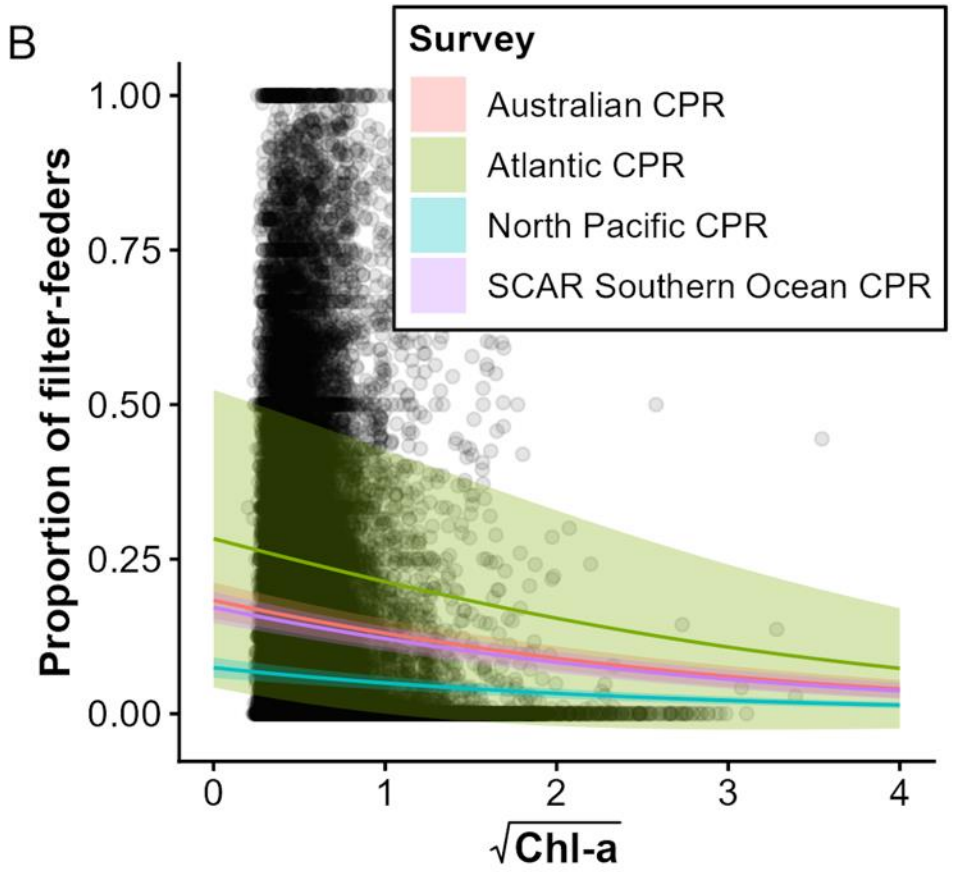


Scientific insights: Impacts of climate change (comparative analysis)





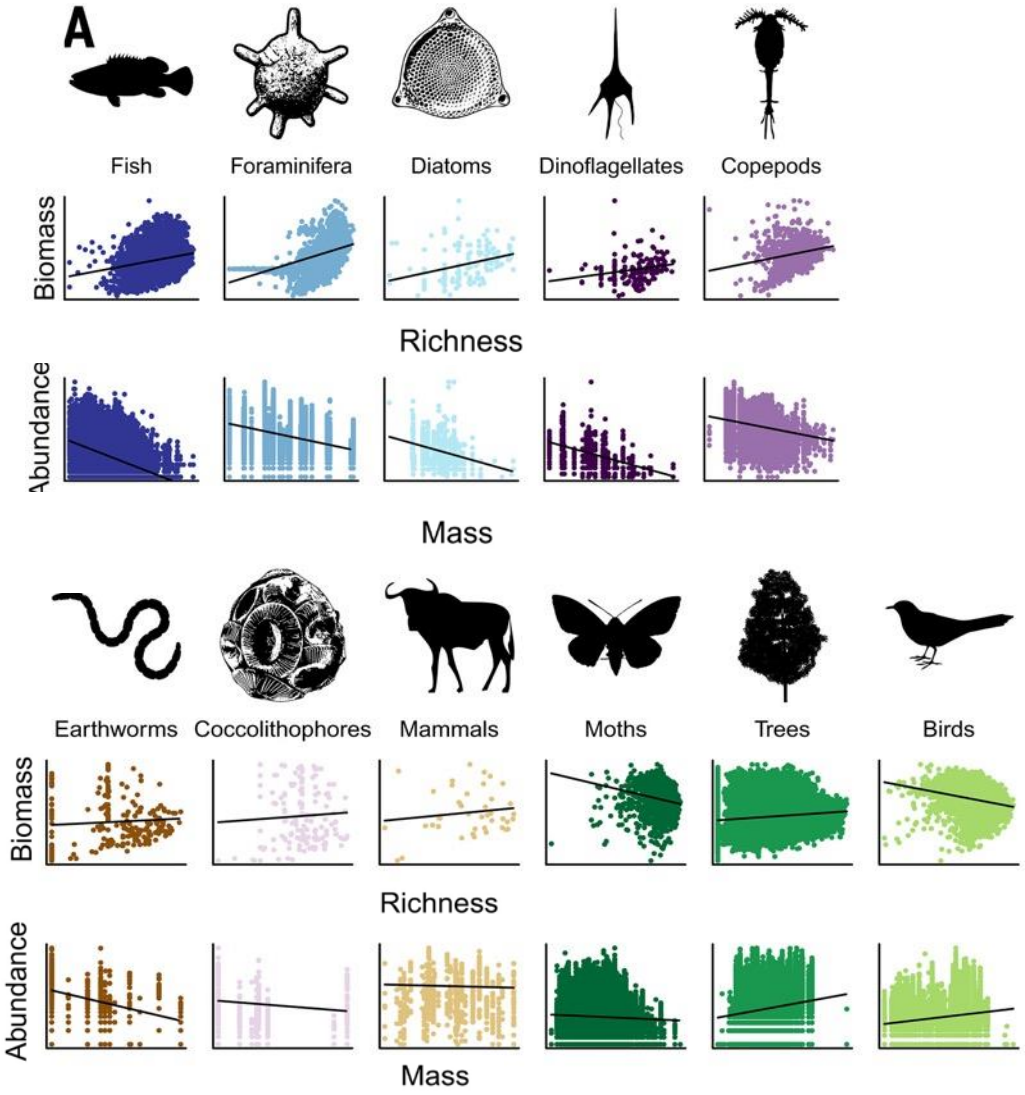
← Climate change

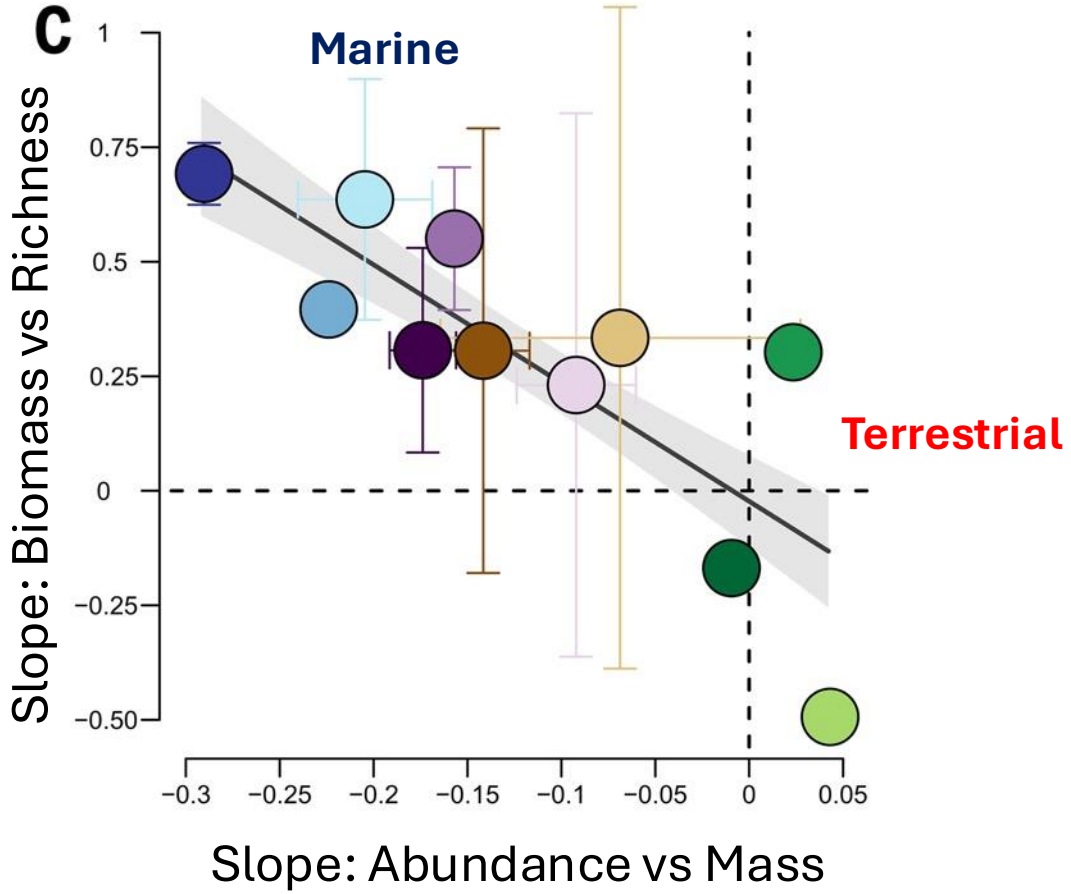


← Climate change

Alpecho et al. (submitted)

Scientific insights: Discovering ecological relationships



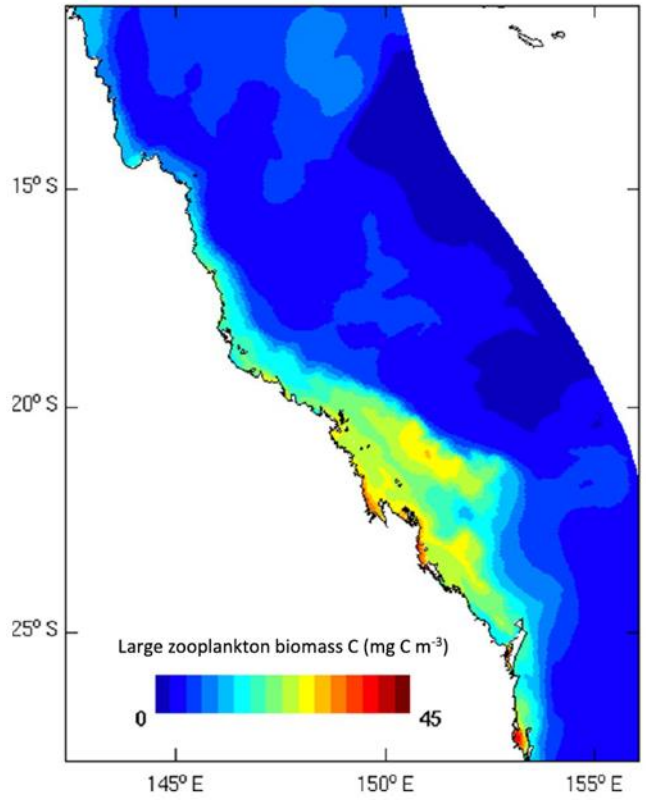


Pigot et al. (2025) *Science*

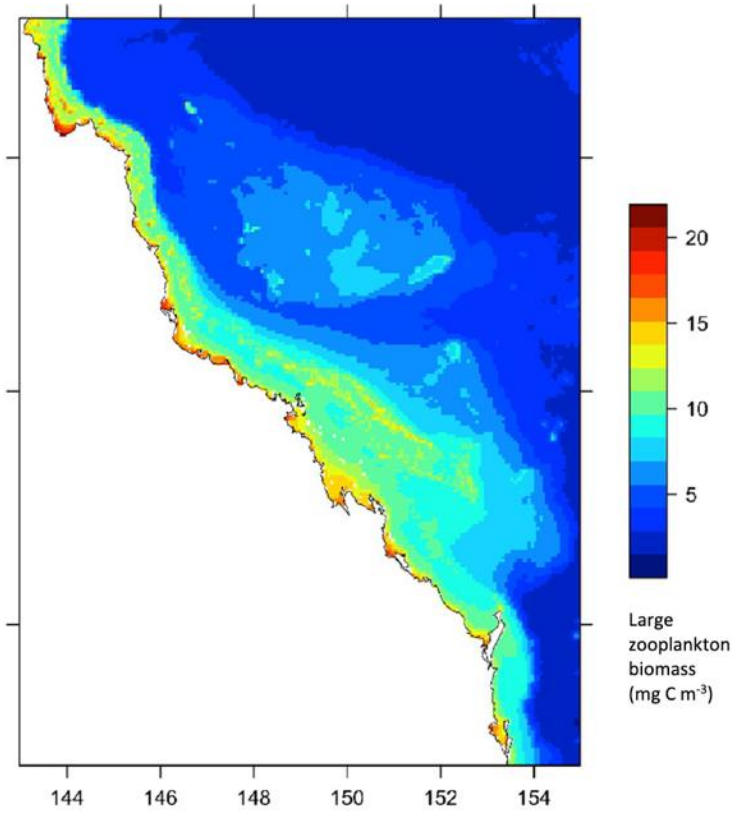
Applications: Model validation

Plankton Biomass

eReefs model (Large Z)



CPR GLM (Large Z)



Skerratt et al. (2019) *J Marine Systems*

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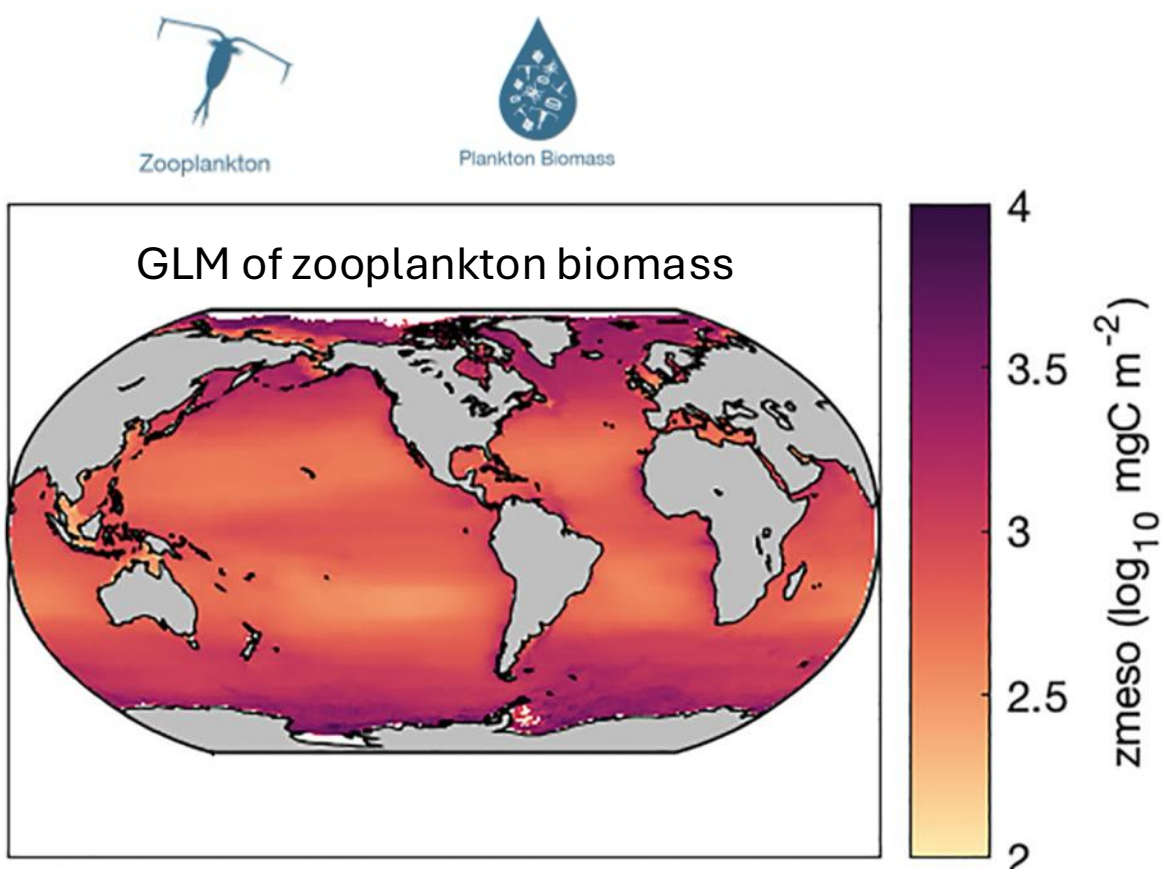
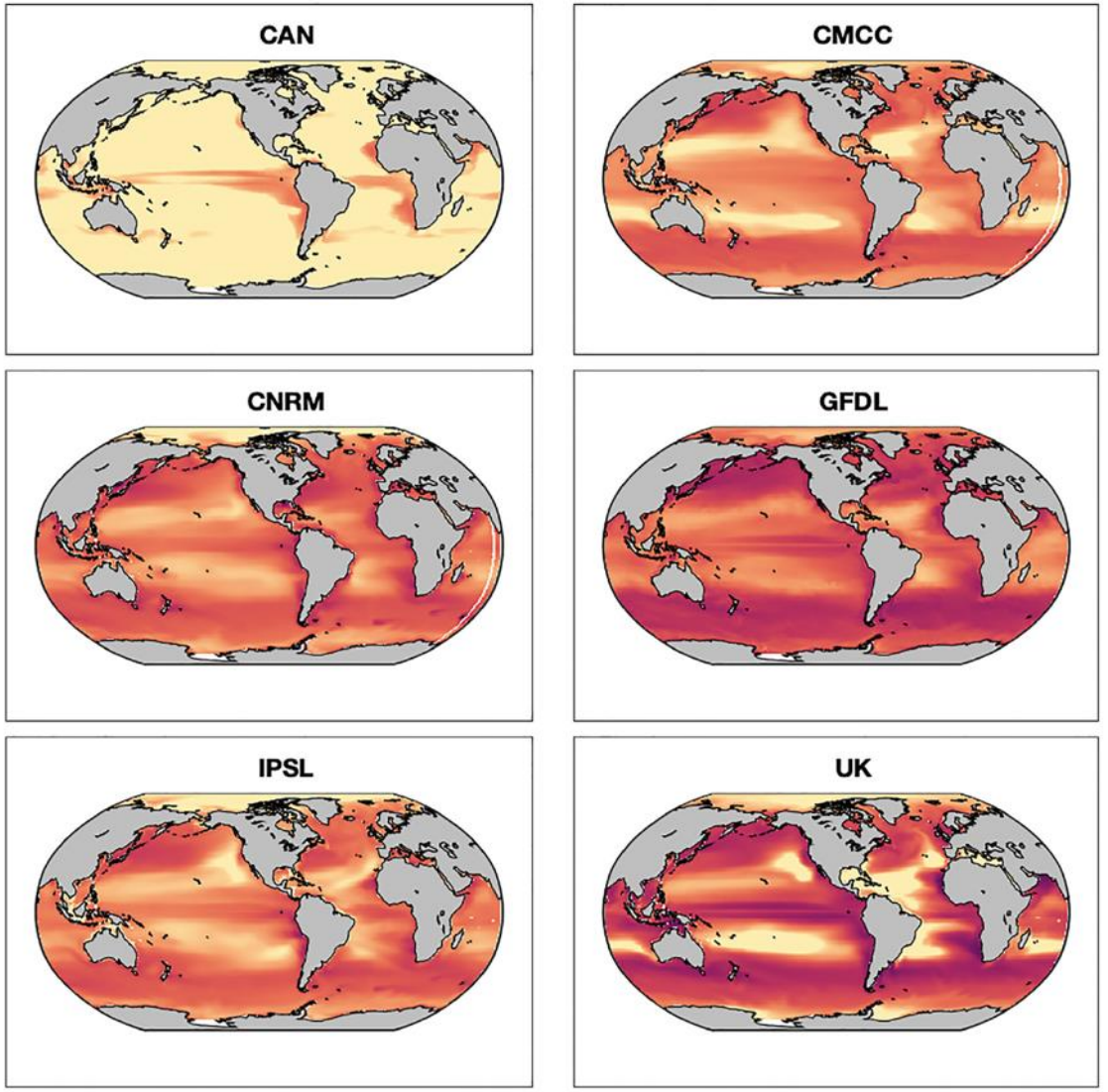
Applications: Model validation





Petrik et al. (2022) *Global Biogeochemical Cycles*

Applications: Ecosystem assessments (SoE 2021)

Assessment Water column habitats and communities – on-shelf (neritic; 0–200 metres)

Limited confidence

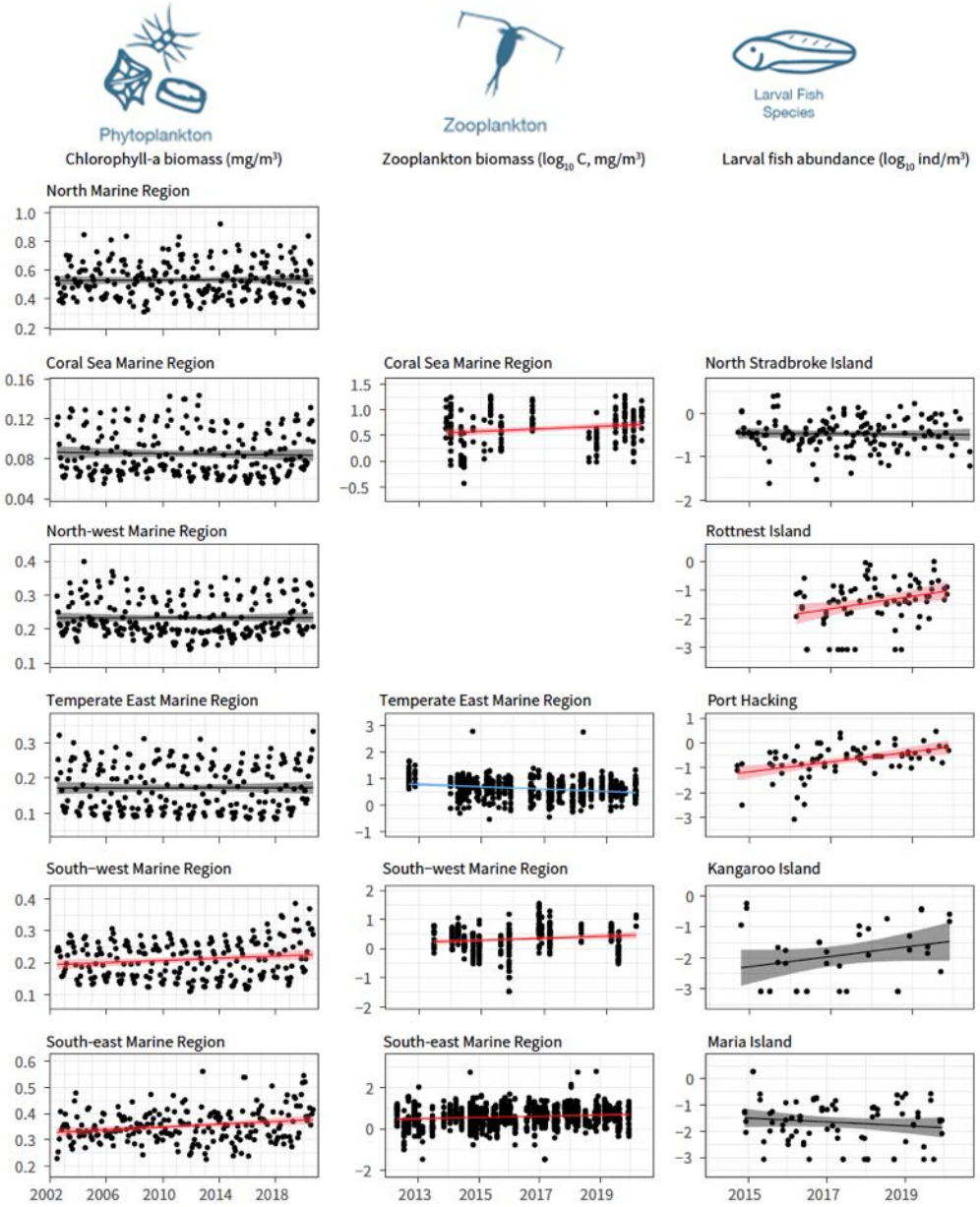
No consistent trend among locations based on an assessment of phytoplankton, zooplankton and fish larvae (Richardson et al. 2021a).

The Indigenous assessment locally was poor, with a deteriorating trend.

Assessment Water column habitats and communities – off-shelf (oceanic) epipelagic (0–200 metres)

Low confidence

No consistent trend among locations based on an assessment of phytoplankton and zooplankton (Richardson et al. 2021c).

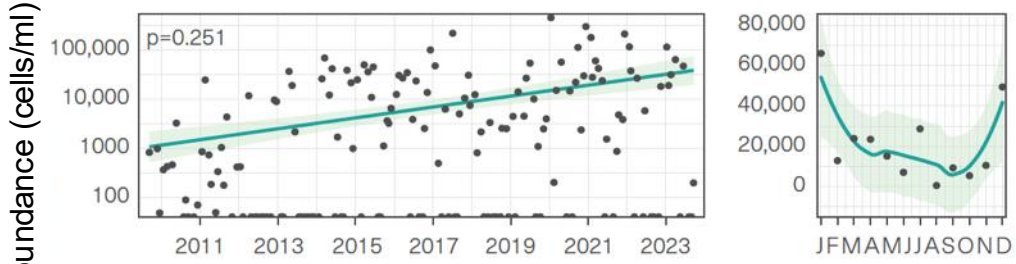


Applications: Ecosystem assessments (GBR Outlook 2024)

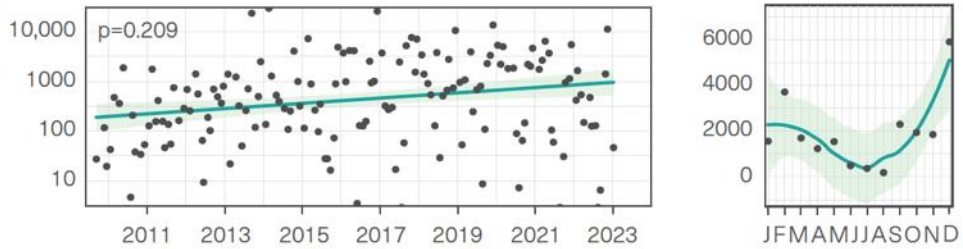
Phytoplankton

Yongala

Bottle samples



Net samples



Criterion and component summaries		Grade and trend	Confidence GRADE	Confidence TREND
Plankton and microbes: Changes in water temperature and availability of inorganic nitrogen likely impact abundance and diversity of phytoplankton within the Region, which has trophic implications for zooplankton and beyond. Calcifying zooplankton may be affected by increasing acidification, though there is no consistent declining trend in calcifier abundance in the Region. From the limited available data, increases in diversity and abundance of warm-water species are evident across many plankton and microbe groups consistent with expectations under climate change.	2024	GOOD	LIMITED	LIMITED
	2019	GOOD		
	2014	VERY GOOD		
	2009	VERY GOOD		

Zooplankton

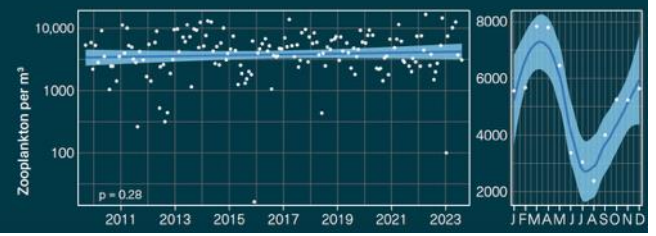
BOX 2.5

Plankton as essential ocean variables: indicators of ecosystem health and ecological change

Plankton are excellent indicators of climate change and ecosystem health because they have short lifecycles, are ectotherms (commonly called 'cold blooded'), and are sensitive to changes in temperature, acidity and nutrients. Phytoplankton and zooplankton biomass and diversity have been recognised as two essential ocean variables (EOVs) by the Global Ocean Observing System.[362] EOVs are components critical to the functioning of marine systems and are crucial for monitoring the current state of ecosystems and how they change.

Plankton EOVs are monitored under 3 programs in the Region: the Integrated Marine Observing System (IMOS) Australian Continuous Plankton Recorder (AusCPR) survey; the IMOS Yongala National Reference Station; and the Great Barrier Reef Marine Monitoring Program (Australian Institute of Marine Science Cairns transect [363]). Time-series analysis of plankton communities provides information on long-term effects of climate variability, including at higher trophic levels, for example, changes to productivity and food security, causes and frequency of harmful algal blooms, biogeographical shifts, regime shifts, and carbon sequestration. Plankton EOVs are considered scalable, in that regional timeseries can inform understanding of the long-term effects of climate change at global scales.

Currently, sufficient sampling in time and space is a primary limitation in plankton monitoring due to the high cost of sample collection and analysis (both genomics and microscopy). Remote sensing technology, though able to estimate total phytoplankton biomass and production does not provide information on species diversity or abundance, including that of archaea, bacteria and zooplankton. Remote sensing also has limited utility in shallow coastal areas. More broadly, little is known of many plankton groups and their dynamics, as they are so diverse. Longer time-series data and data from multiple locations are required to elucidate patterns in plankton communities over time.



Applications: International policy uptake

Food and Agriculture Organization of the United Nations

WORLD METEOROLOGICAL ORGANIZATION

UN environment programme

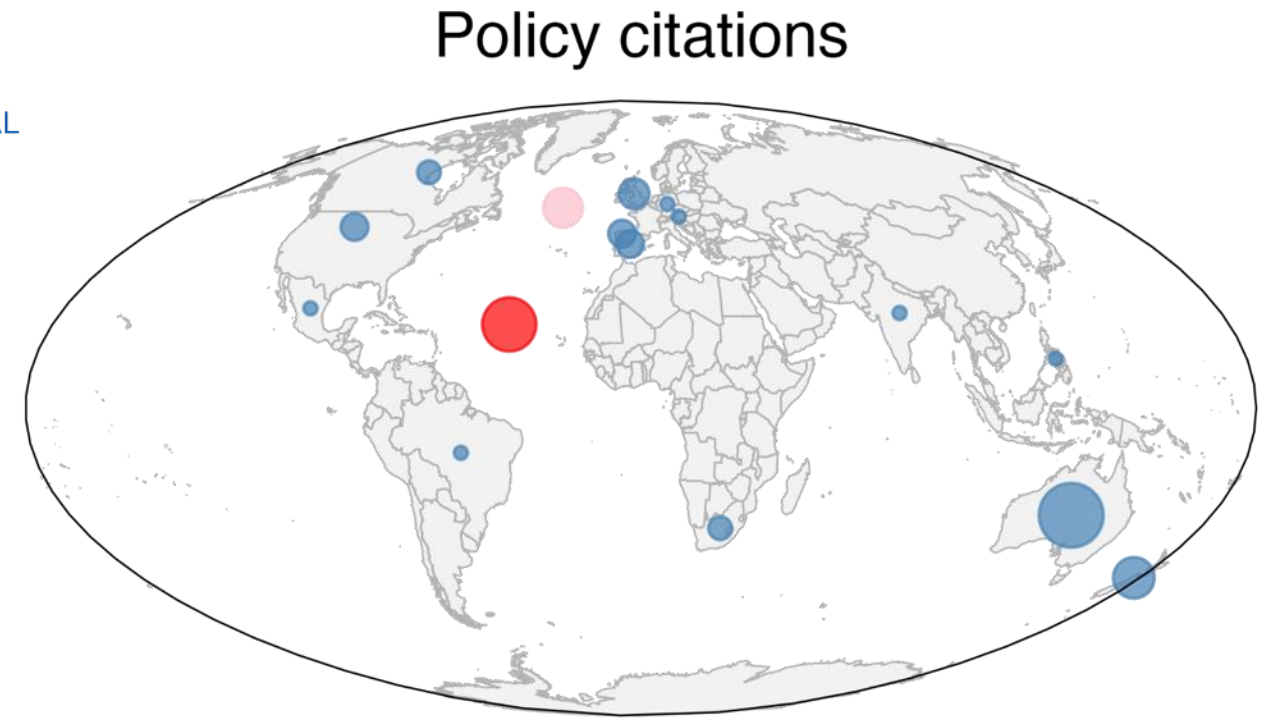
ipcc INTERGOVERNMENTAL PANEL ON climate change

United Nations Framework Convention on Climate Change

ipbes Science and Policy for People and Nature

unesco United Nations Educational, Scientific and Cultural Organization

GBIF Global Biodiversity Information Facility



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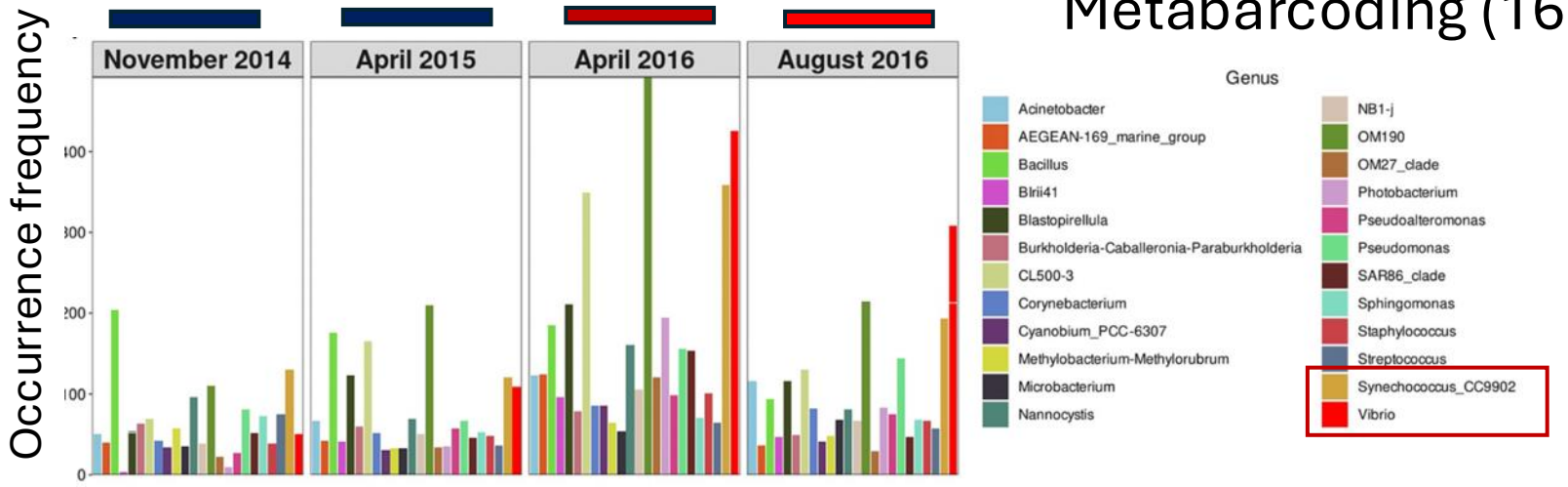
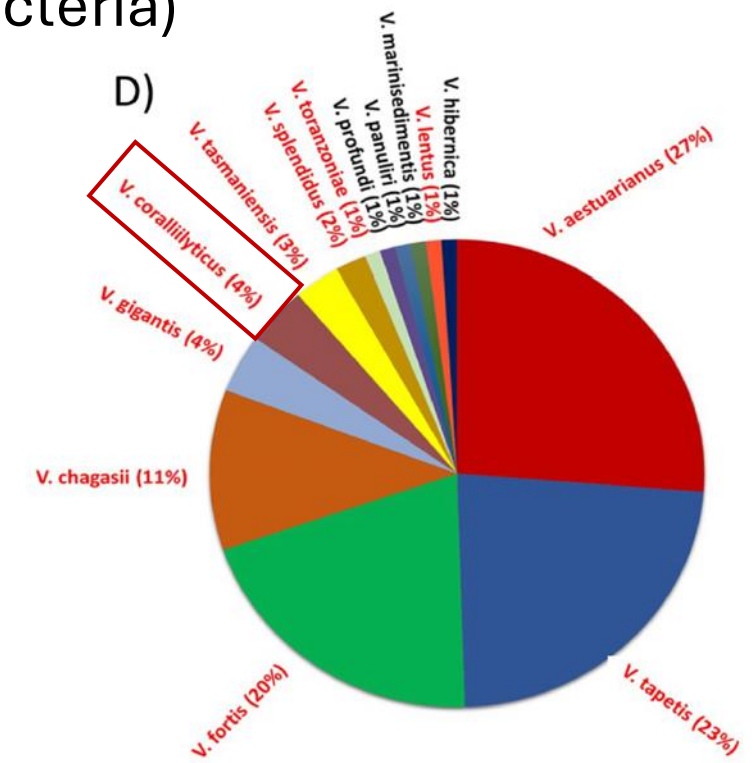
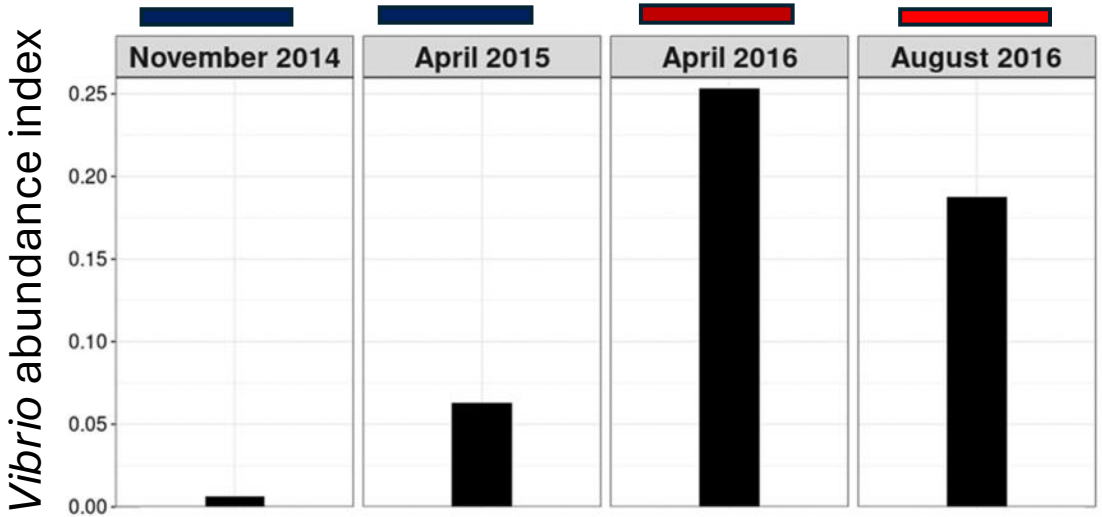
Further discovery: Sample archive, molecular partnerships and climate extremes (GBR)

Metabarcoding (16S bacteria)





qPCR



Doni et al. (2023) *Marine Pollution Bulletin*

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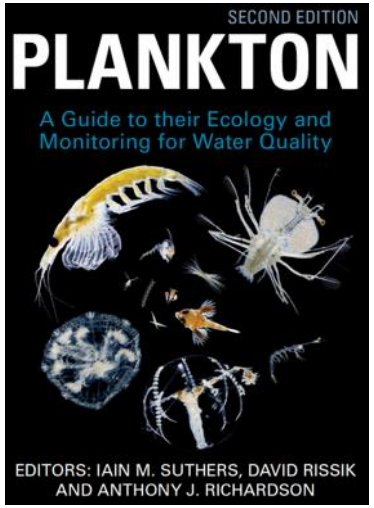
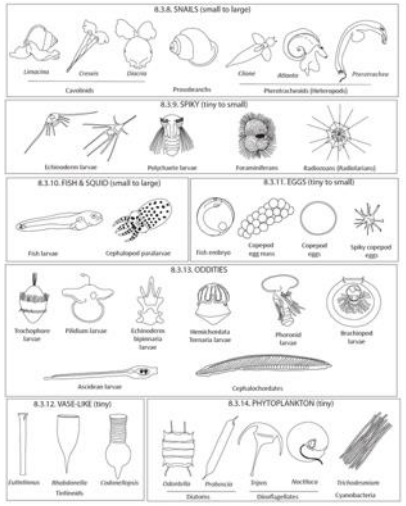
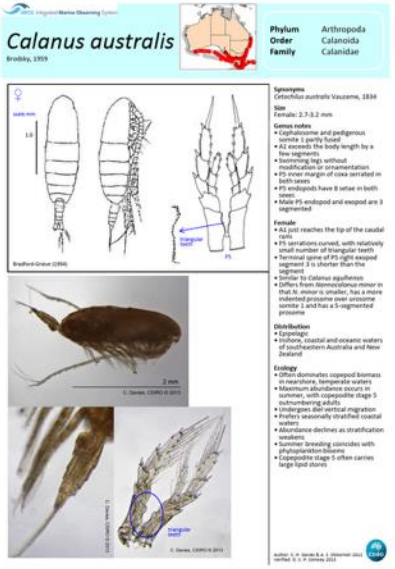
Further discovery: Data dissemination, community resources

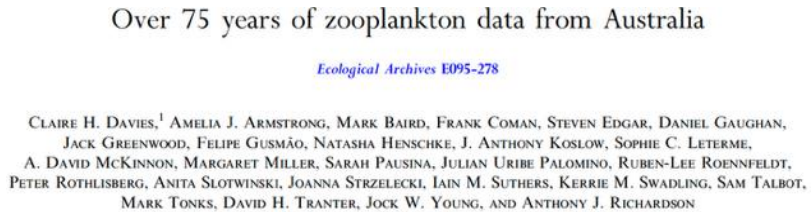
Claire Davies, Jason Everett







UTas
(Kerrie Swadling)

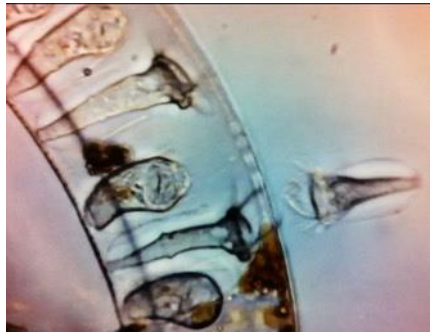

Over 75 years of zooplankton data from Australia

Ecological Archives E095-278

Claire H. Davies,[1] Amelia J. Armstrong, Mark Baird, Frank Coman, Steven Edgar, Daniel Gaughan, Jack Greenwood, Felipe Gusmão, Natasha Henschke, J. Anthony Koslow, Sophie C. Leterme, A. David McKinnon, Margaret Miller, Sarah Pausina, Julian Uribe Palomino, Ruben-Lee Roennfeldt, Peter Rothlisberg, Anita Slotwinski, Joanna Strzelecki, Iain M. Suthers, Kerrie M. Swadling, Sam Talbot, Mark Tonks, David H. Tranter, Jock W. Young, and Anthony J. Richardson

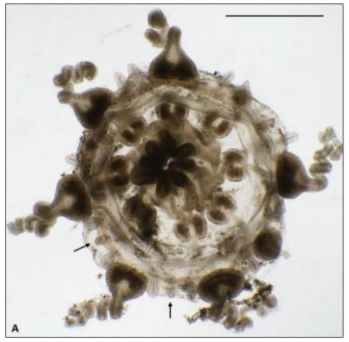
https://www.imas.utas.edu.au/zooplankton/downloadable-species-fact-sheets

Vaginicola collariforma



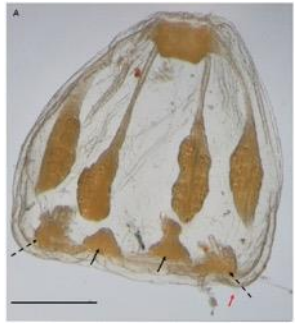
Uribe et al. (2021)

Melicertissa antrichardsoni



Uribe & Gershwin (2018)

Paralovenia yongalanesis



8 new harpacticoid species

Uribe et al. (in prep)

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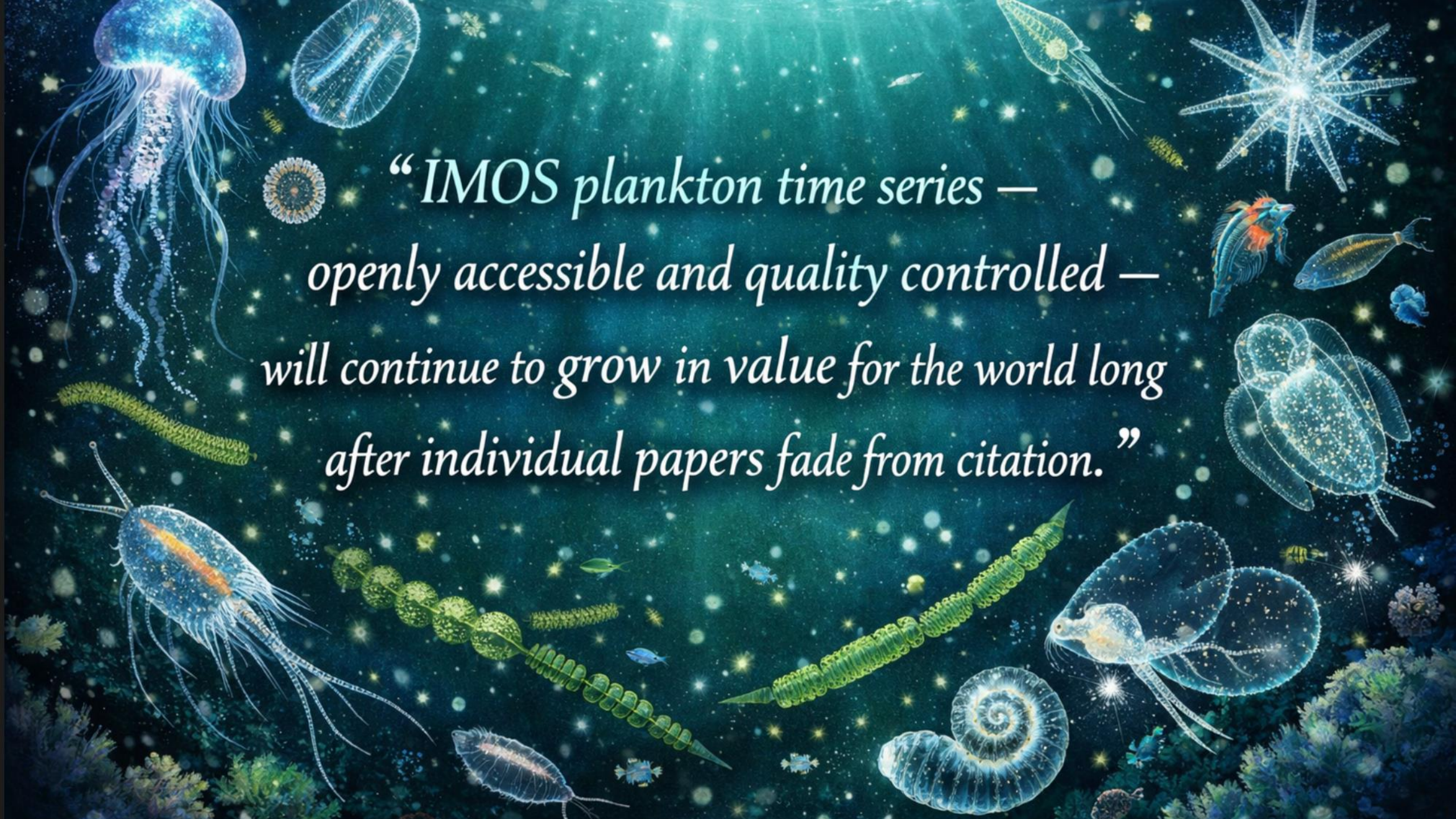
"IMOS plankton time series —
openly accessible and quality controlled —
will continue to grow in value for the world long
after individual papers fade from citation."