



Timeseries, indices & tools lead to understanding

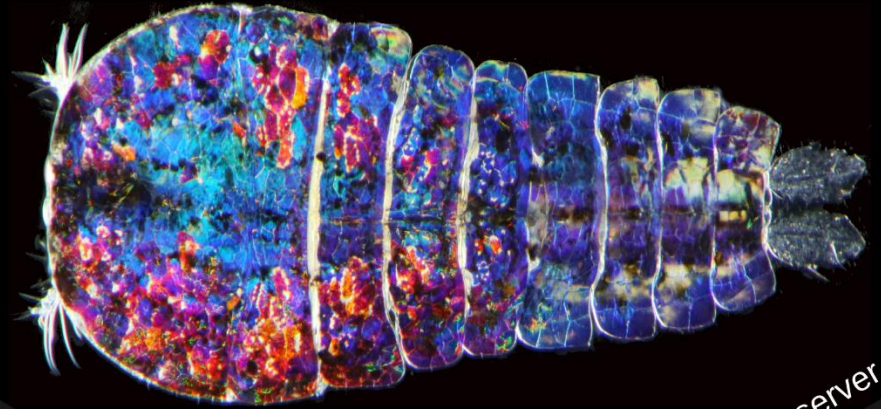
The Biological Ocean Observer

Claire Davies | March 2024

Jason Everett, Anthony Richardson, Frank Coman, Ruth Eriksen,
Felicity McEnnulty, Anita Slotwinski, Mark Tonks, Julian Uribe
Palomino

Australia's National Science Agency

Biological Ocean Observer



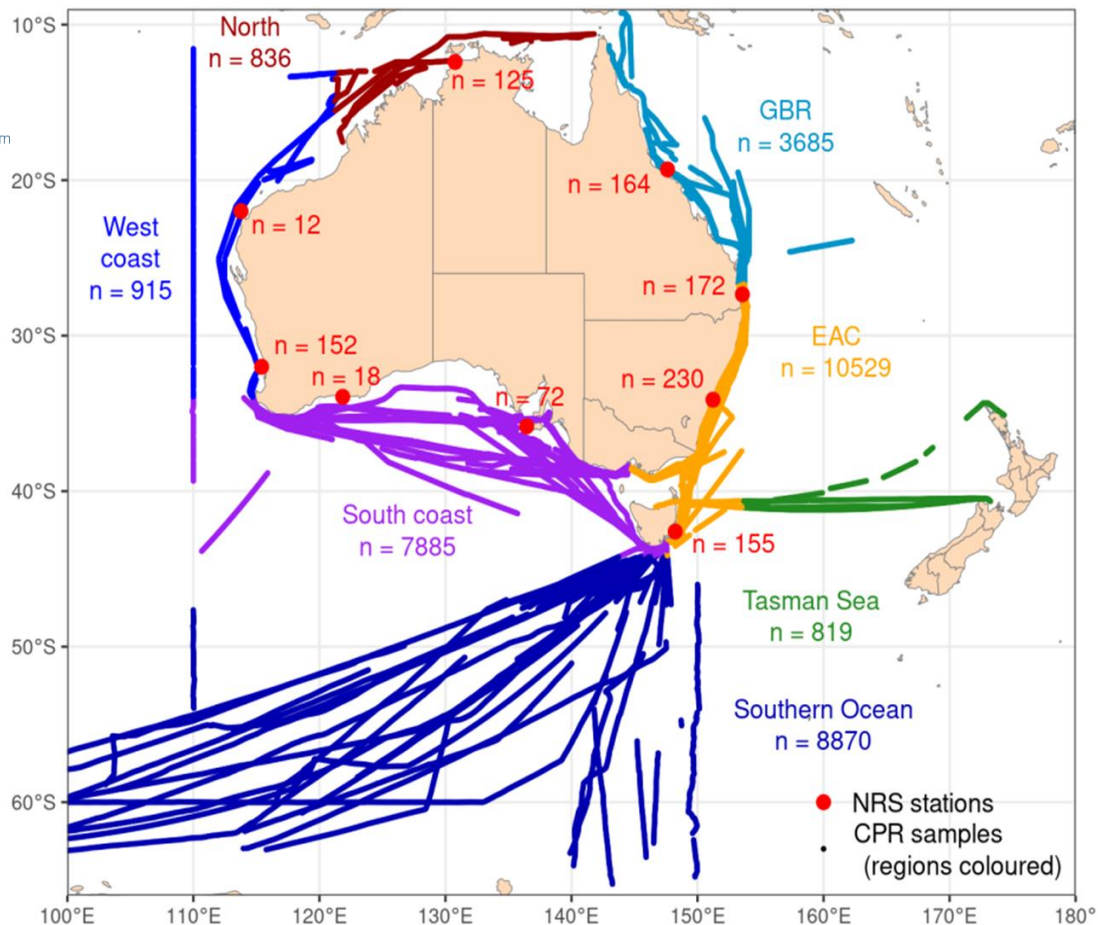
shiny.csiro.au/BioOceanObserver



I would like to begin by acknowledging the Muwinina people as the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.



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



Continuous Plankton Recorder

- Large spatial coverage
- Quarterly sampling
- Since 2009
- PCI, Phyto, Zoo
- ~6-7m depth
- Regular tows over 5 bioregions
- Little ancillary data

National Reference Stations

- 7 stations around Australia
- Monthly sampling
- Since 2009
- Phyto, Zoo, molecular + numerous BGC data streams
- BGC data depth stratified sampling
- Moorings (near real time data)



Multi-variable time series data



- Time series & trends
- Seasonality & anomalies
- Indices & EOVs
- Relationships
- Community level changes
- Species distribution models



I'd like to do some science, but

I swear I saved it

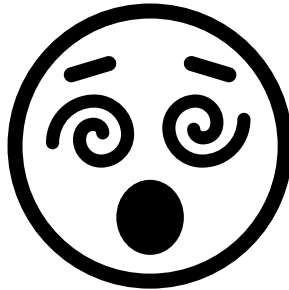
I'm not the best coder, some of the tools are complex?

I didn't know about that dataset

How was it collected, nets, CPR, can I compare?

Why don't I get the same answer this time

I know there's data out there but where is it and how do I get it?



It's got to be FAIR

Is there environmental data too, how do I integrate that data?

My code worked last time

What about satellite data, how do you access that?

Which version did I use?

Do I have to download it, is it big?



Solution



AODN
Data storage

Data products for
advanced users

Portal

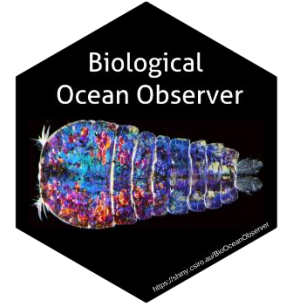
Thredds / S3

Raw data for
advanced users



Plankton
Dedicated R package
Data access and functions
for wrangling and plotting

Tools for advanced
users



<https://shiny.csiro.au/BioOceanObserver/>

IMOS Biological Ocean Observer
R Shiny App
Visualisations & downloads

Tools available &
accessible for all users

[Welcome](#)
[Sampling Progress](#)
[Sampling Status](#)
[Sampling Summary](#)


The Biological Ocean Observer

The goal of this site is to Integrate, Analyse and Visualise data collected by the [Integrated Marine Observing System \(IMOS\)](#). We aim to enhance the availability and understanding of biological data and make it accessible to broader and non-specialist audiences in order to accelerate the next generation of scientific insights.

This project is entirely open source, as are all the IMOS data underlying it. All the code for this tool are freely available on [GitHub](#). We welcome collaborators and pull requests are gratefully accepted. If you encounter a problem with this website or have any feedback, please [log an issue on GitHub](#) or [email the IMOS Office](#).

This tool was originally conceived and developed by Dr Jason Everett (UQ/CSIRO/UNSW) and Claire Davies (CSIRO). Jason is a biological oceanographer and Claire is a plankton ecologist. Both have a strong interest in open data science and encouraging increased data uptake to solve real world problems.

The major categories of data we provide within the app are found across the top bar, and include microbial, phytoplankton, zooplankton, larval fish and environment (chemical) parameters. The snapshot and EOv tab include summary data that may be useful as data overviews for managers and policy makers. Within each tab, the data is often designated by sampling regime, which is generally the [National Reference Stations \(NRS\)](#) or the [Continuous Plankton Recorder \(CPR\)](#). Due to the spatial nature of the CPR data, these data are summarised by [Australia's Marine Bioregions](#). More information about the methods used in this tool, can be found in 'Technical Information' under the 'Information' tab.

Funded by:



Australian Research Data Commons

Citation

If you use this app in any publication, please cite as:

'Davies, Claire H., Everett, Jason D., Ord, Louise (2022) *Integrated Marine Observing System (IMOS) Biological Ocean Observer - Shiny APP*. v9.3. CSIRO. Service Collection. <http://hdl.handle.net/102.100.100/447365?index=1>.

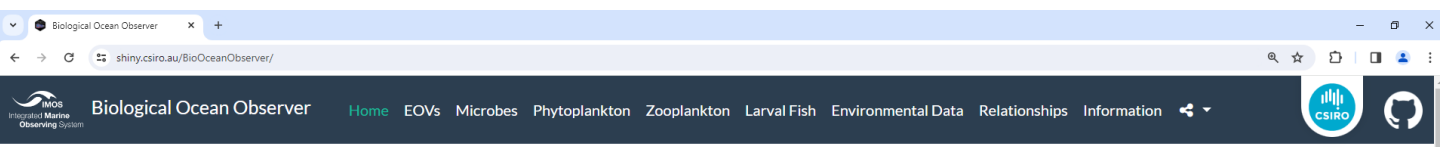
All of the analysis and plotting contained in this application are powered by the *planktonr* package:

Everett Jason D., Davies Claire H. (2022). *planktonr: Analysis and visualisation of plankton data*. R package version 0.5.6.0000, <https://github.com/PlanktonTeam/planktonr>.

Acknowledging IMOS Data

This application is developed using IMOS data, and therefore you are also required to [clearly acknowledge](#) the source material by including the following statement in any publications:

'Data were sourced from Australia's Integrated Marine Observing System (IMOS) - IMOS is enabled by the National Collaborative Research Infrastructure Strategy



Welcome Sampling Progress Sampling Status Sampling Summary



The Biological Ocean Observer

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Interactive
Reproducible
Visualisations
Code
Download plots





Timeseries data applications

- i) Policy and management decision making via **State of the Environment** reporting, improving information that can influence policy
- ii) **Teaching applications**, real examples with annotated code for use in Australian undergraduate and postgraduate courses in marine and environmental science
- iii) **Hypotheses generation & testing**, exploring responses of marine plankton communities to increasing ocean temperatures in a global warming hotspot in Southeast Tasmania

The State of
Australia's Environment

2021 State of the Environment Report



Dr Helen Bostock
@HelenBostock5

So great to have Dr Jason Everett and Claire Davies
@csiro @IMOS_AUS teaching biological
oceanography #plankton to #MARS3012
@UQ_sees





Policy and management

Australia's State of the Environment reporting



Essential Ocean Variables

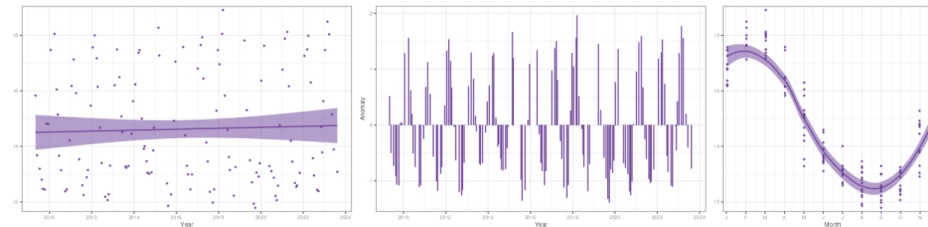
Essential Ocean Variables (EOV) are the important variables that scientists have identified to monitor our oceans. They are chosen based on impact of the measurement and the feasibility to take consistent measurements. They are commonly measured by observing systems and frequently used in policy making and input into reporting such as State of Environment.

Maria Island

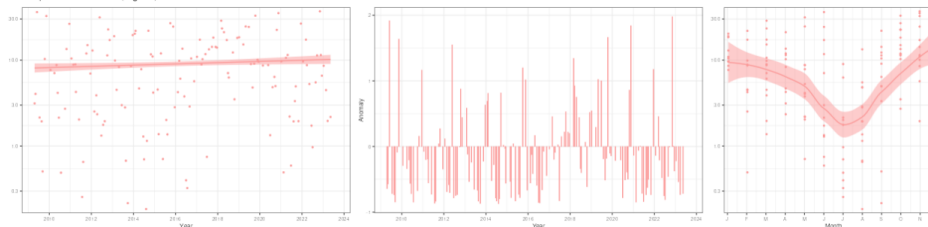
The IMOS Maria Island National Reference Station is located at -42.6°S and 148.23°E. The water depth at the station is 80m and is currently sampled Monthly. The station has been sampled since Sunday 01 October 1944 and is ongoing. Maria Island is in the South-east management bioregion. The station is characterised by very narrow shelf influenced by the EAC and its eddies with temperate neritic communities.

All Biological Chemical Physical

Surface Temperature CTD (°C)



Zooplankton Biomass (mg m⁻³)



Select a station:

- Darwin
- Yongala
- North Stradbroke Island
- Rottnest Island
- Port Hacking
- Kangaroo Island
- Maria Island

Select a parameter:

- Ammonium
- Chlorophyll a
- Copepod Diversity
- Nitrate
- Oxygen
- Phosphate
- Phytoplankton Biomass
- Phytoplankton Diversity
- Salinity
- Silicate
- Temperature
- Zooplankton Biomass

NOTE: Oxygen only available at Maria Island & Rottnest Island

Generation of Essential Ocean Variable timeseries for a location

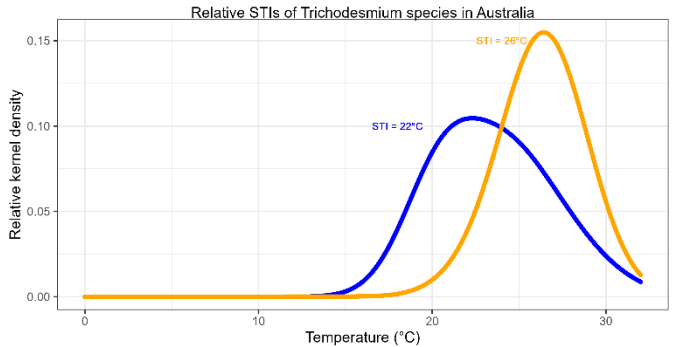
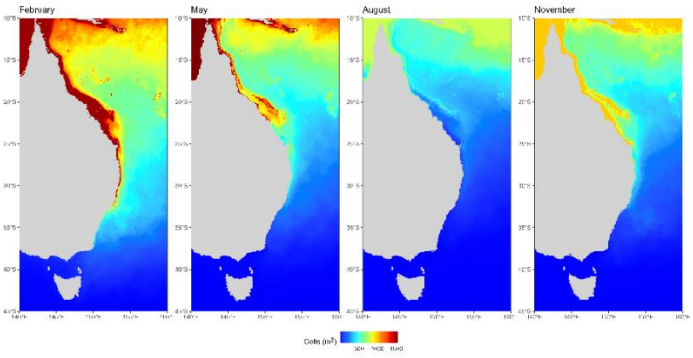
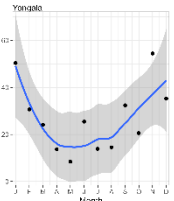
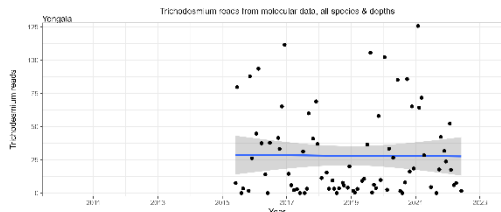
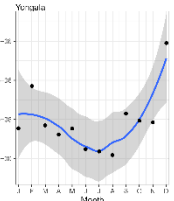
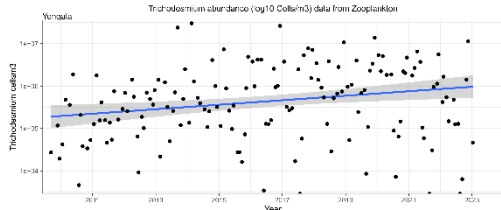
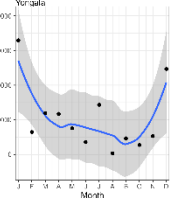
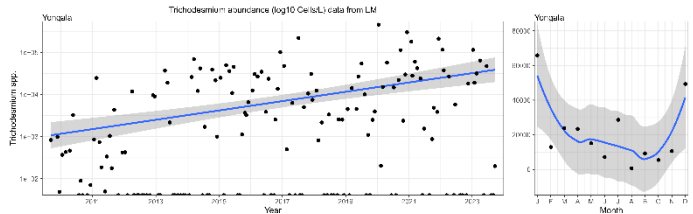
Input into assessments for:

- i) Secondary Productivity
- ii) Water clarity (turbidity, transparency & colour)
- iii) Water column – epipelagic
- iv) Water column – neritic
- v) Harmful algal blooms



Policy and management

GBR Outlook Report - changes in nitrogen fixers on the Great Barrier Reef



• *T. erythraeum* • *T. thiebautii*

Input into state management policy document

Trichodesmium from 3 separate data streams

Compare trends & methods

Separate species

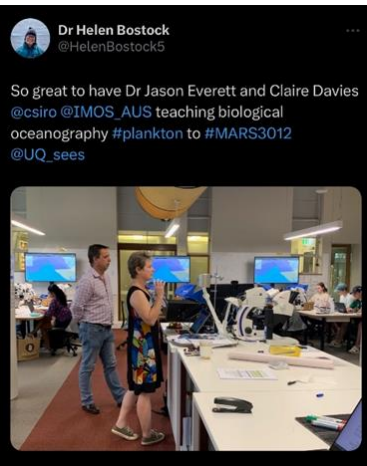


Teaching applications

```

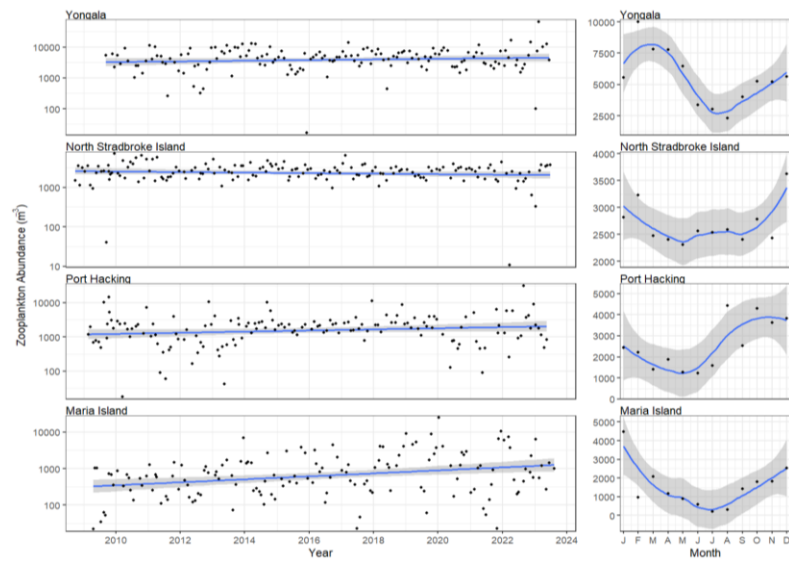
plankton - RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Zooplankton.Rmd
Source Visual
1 ---
2 title: "4. Zooplankton"
3 output:
4 rmarkdown::html_vignette:
5   toc: true
6   number_sections: false
7 vignette: >
8   %\VignetteIndexEntry{4. Zooplankton}
9   %\VignetteEngine{knitr::rmarkdown}
10  %\VignetteEncoding{UTF-8}
11 ---
12
13 **{r, include = FALSE}
14 knitr::opts_chunk$set(
15   collapse = TRUE,
16   comment = "#>",
17   message = FALSE,
18   warning = FALSE,
19   fig.width = 7
20 )
21 ---
22
23 **{r setup}
24 library(plankton)
25 library(dplyr)
26 library(ggplot2)
27 library(patchwork)
28
29 # National Reference Stations
30
31 Have a look at the file and see what is available for plotting, by downloading the file you can inspect the parameters and the Stations available.
32
33 **{r}
34
35 NRSz <- plankton::pr_get_Indices("NRS", "Z")
36 unique(NRSz$Parameters)
37 unique(NRSz$StationName)
38
39
40 ---
41
42 ## Trend Analysis
43
44 Long term plankton monitoring can provide insights into how zooplankton abundance and biomass are changing with time. This has implications for the fish
45 communities they support and the lower trophic levels on which they depend for energy. Abundance and biomass trends don't necessarily show the same temporal
46 trends, here we show zooplankton abundance by time, but biomass can also be chosen as the parameter. Seasonal cycles can also be important for understanding
47 planktonic communities, for examples in these plots it is clear that there is a much stronger seasonal cycle at Maria Island in a temperate location than at
48 Yongala, a more tropical station.
49
50 **{r}
51
52 NRSz <- plankton::pr_get_Indices("NRS", "Z") %>%
53   filter(Parameters == "ZoopAbundance_m3") %>%
54   filter(StationCode %in% c("YON", "NSI", "PHB", "MAI"))
55
56 p1 <- plankton::pr_plot_Trends(NRSz, Trend = "Raw", Survey = "NRS", method = "lm", trans = "log10")
57 p2 <- plankton::pr_plot_Trends(NRSz, Trend = "Month", Survey = "NRS", method = "loess")
58
59 p1 + p2 +
60   ggplot2::theme(axis.title.y = ggplot2::element_blank()) + # Remove y-title from 2nd column
61   plot_layout(widths = c(3, 1), guides = "collect")
62
63 ---
64
65 4. Zooplankton

```



R markdown documents for teaching

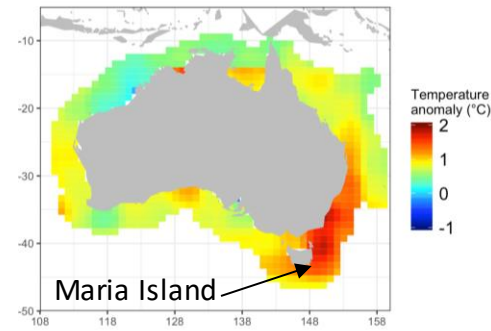
Real data, real situations, real questions



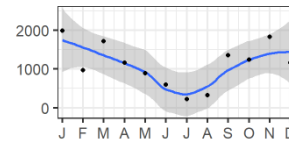
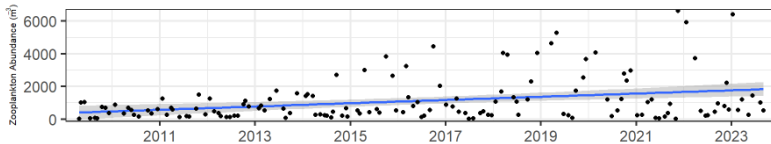


Research applications

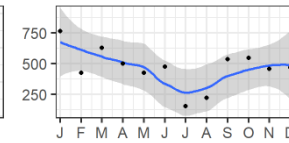
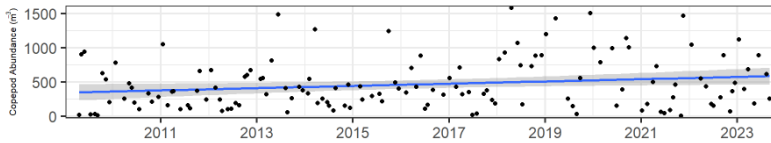
Understanding long term changes at Maria Island



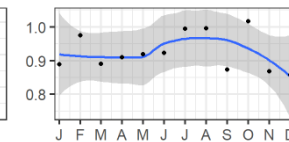
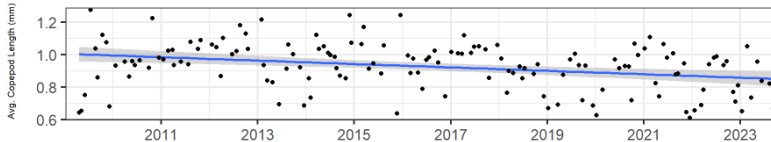
Zooplankton abundance



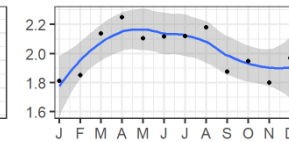
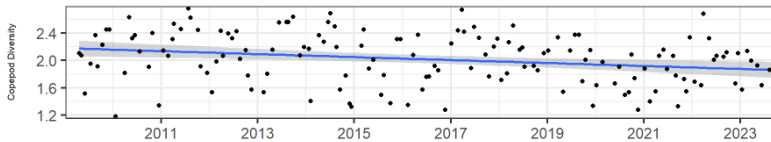
Copepod abundance



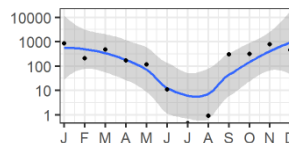
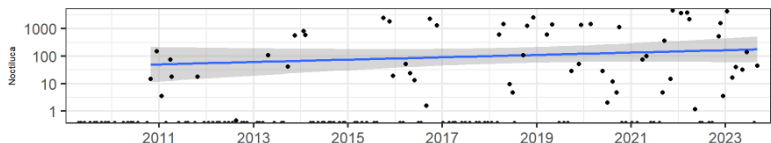
Copepod length



Copepod diversity



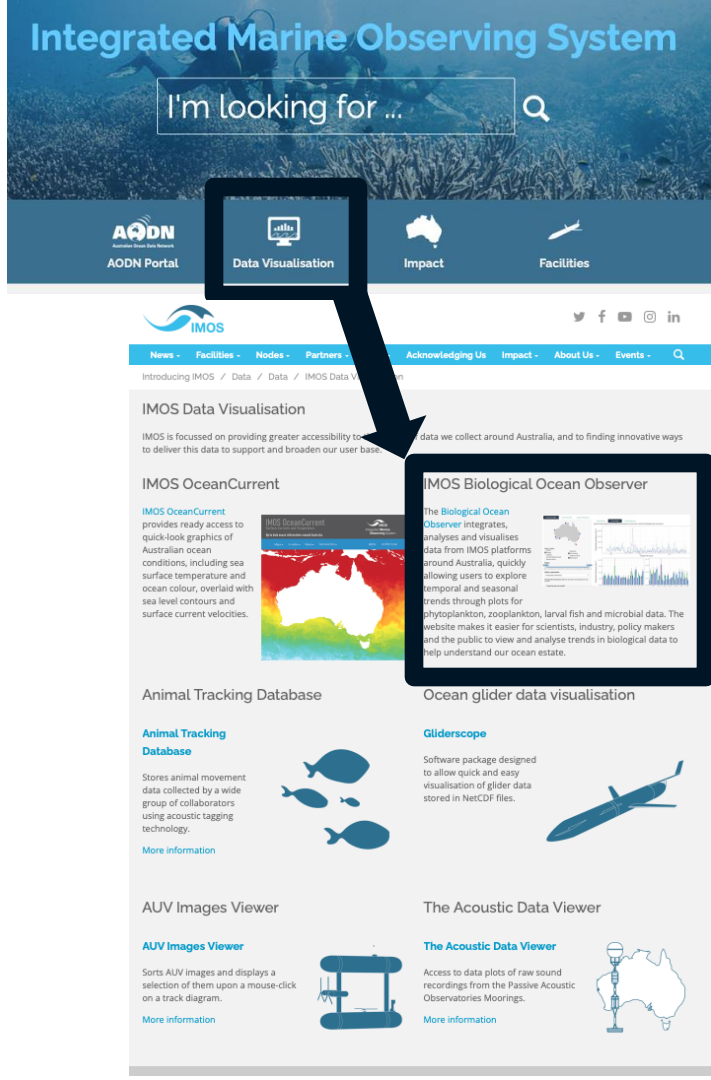
Noctiluca abundance



Significant trends since 2009:
Zooplankton & copepod abundance increasing
Copepod length & copepod diversity decreasing
Noctiluca increasing
More, smaller copepods and *Noctiluca*



Using BioOceanObserver



shiny.csiro.au/BioOceanObserver

We can help with:

- designing tutorials,
- writing code,
- implementing updates



You can help with:

- Collaboration
- Pull Requests
- Reporting issues and feature requests



github.com/PlanktonTeam



Thank you

CSIRO - Environment

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Australia's National Science Agency

Everdat solutions

Jason Everett

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Integrated Marine
Observing System

