



IMOS Australian Plankton Survey 2017 Newsletter

The Australian Continuous Plankton Recorder Survey & National Reference Stations

Directors report Happy new year! 2017 was a busy and successful year for the IMOS Plankton Team and we reached two milestones. The first is that the AusCPR survey has now towed 100,000 nautical miles behind Ships of Opportunity, that is about 5 times around the circumference of the Earth! The second milestone is that we have reached 20,000 samples for PCI (Phytoplankton Colour Index), an estimate of chlorophyll-*a*. This is one of the auxiliary measurements we make that adds value to the species-level information. Well done Team!

This is an appropriate time to highlight the critical role of Mark Tonks and Frank Coman (happy 50th birthday on the 4 January 2018 Frank!) identifying ships, negotiating with owners, and working closely with crew towing CPRs; without this, there would be no CPR survey. On the topic of shipping, we have a new regular Great Barrier Reef route that is starting in the first few months of 2018. This route uses the Rio Tinto vessel Wakmatha, the same ship that the IMOS Biogeochemical sensors subfacility run by Dr Bronte Tilbrook (CSIRO) samples carbon chemistry from. This will be hugely valuable in the providing context for the data on calcifying (those with calcium carbonate shells) zooplankton from the AusCPR. Thanks also to Karl Forcey for developing the hitchhiker sensor, which is now deployed on all CPR tows. This provides concomitant information on temperature, and QC information on depth, pitch and roll.

To ensure our QC is world-class, we had a phytoplankton taxonomy workshop in Hobart in August 2017, with Professor Gustaaf Hallegraeff (UTas), Dr Steve Brett (Microalgal Services) and Dr Ian Jameson (CSIRO) as collaborators. We focused on brainstorming the diagnostic identification features under light microscopy of difficult tropical phytoplankton groups. This workshop will form the basis of a future phytoplankton guide, similar to our successful zooplankton identification guide (<http://www.imas.utas.edu.au/zooplankton>, with Dr Kerrie Swadling at UTas). Thank you Gustaaf, Steve and Ian!

I would like to highlight some hot off-the-press news (5 January); Claire Davies' data paper has just been accepted for publication in the journal *Scientific Data*! The paper collates 173,333 records of chlorophyll *a* collected since 1965 from Australian waters. The Australian Chlorophyll *a* database is freely available through the Australian Ocean Data Network portal (<http://portal.aodn.org.au/>). Well done Claire and the 49 authors involved! Whilst on papers, Julian Uribe has just been informed that his first senior author publication is now in press. It is entitled "Siphonophores from surface waters of the Colombian Pacific Ocean" and will be published in the Journal of the Marine Biological Association of the United Kingdom. Publication is never easy, and this was a particularly long and challenging process, but a good learning process (for all). Julian, we didn't kill each other and you can be very proud of the outcome!

Two key ways that IMOS plankton data are being used is in model assessment and ecosystem assessment. The IMOS Plankton Team has played a key role in the ZOOM (Zooplankton Ocean Observations and Modelling) Task Team, which is increasing the use of plankton data in model assessment. As part of ZOOM, Felicity McEnnulty has meticulously collated zooplankton biomass data from around Australia (see p. 12 of this newsletter for more information, including a map of zooplankton biomass around Australia). The ZOOM Task Team met in Hobart for a workshop in November 2017 (see p. 16-17 for a summary of the meeting). Data products requested by modellers that are being developed from IMOS plankton data include distributions of key taxa (e.g., *Trichodesmium*, Harmful algal blooms), zooplankton biomass in different units (carbon, nitrogen, wet-weight), size fractionated zooplankton biomass, and ratios that provide unique information on ecosystem state (e.g., diatom:dinoflagellate ratios and herbivore:carnivore ratios). Following feedback from modellers, these gridded (mapped) products will be produced at regional, national and global scales. Thank you to Dr Jason Everett for leading ZOOM!

Another key use of IMOS plankton data is ecosystem assessments, which are often mandated to summarise the current state of an ecosystem and inform Government and key stakeholders. Ruth Eriksen, Claire Davies and Wayne Rochester have worked on several ecosystem assessments in the past and will be having considerable input into several assessments this year, the GBR Outlook Report, IMOS Productivity Report, and an ecosystem report for the Victorian EPA.

The IMOS plankton team, particularly Julian Uribe and Anita Slotwinski, have promoted the importance, appeal, and beauty of plankton through community outreach. We now have over 1,000 page likes for our IMOS Australian Plankton Survey Page, which is full of fabulous plankton images, up-to-date information about our project, and mini plankton ID competitions – please join up! An unusual example of community outreach was a Plankton Art Exhibition in Hobart in early 2017 – Claire Davies, Ruth Eriksen and Felicity McEnnulty worked with a Hobart artist Diane Masters to produce stunning water colours. Who would have thought that plankton would be the subject of an art exhibition! Julian Uribe brought plankton to our TV screens with a segment on Scope TV on Channel 11 in June 2017 describing sampling

techniques in aquatic science – see the article in this newsletter on p. 13 (see also the video itself on www.youtube.com/watch?v=HDVQCxksag). Julian was also involved in a superb video showcasing the diversity of plankton, which received >60,000 views on the CSIRO Facebook page (www.facebook.com/CSIROnews).

Thanks to collaborators and students, several of whom have written articles in this newsletter. Dr Micheli Duarte de Paula Costa (University of Queensland) has worked enthusiastically identifying fish larvae for the National Ichthyoplankton Monitoring and Observing (NIMO, led by Professor Iain Suther, UNSW) at the IMOS NRS. Dr Tiago Passos (University of Sydney) describe his work on the biological response to ocean fertilization at the Port Hacking NRS on p. 16, Erin McCosker (Murdoch University) describes her work on the influence of oceanographic conditions on coastal zooplankton assemblages at three IMOS National Reference Stations in WA on p. 18, Sarah Pausina (University of Queensland) describes her work on nutrient cycling by zooplankton in Moreton Bay on p. 19, and Asia Armstrong (University of Queensland) describes her work investigating the feeding of reef manta rays on zooplankton in the Maldives on p. 20.

Finally, I represented AusCPR at the annual GACS (Global Alliance of CPR Surveys) meeting in Plymouth (UK) in December 2017. This is an important meeting to keep up-to-date with the latest developments in CPR surveys globally and to make sure we are maintaining “best practice”. The highlight for me was the discussion of the innovative methods that SAHFOS in the UK is using for ecosystem assessments, many of which we can adopt here. It was also clear that Australia leads the CPR community in working with modellers for data uptake, thanks largely to ZOOM. At the meeting, I was elected the Chair of GACS for 2018/2019, and an important part of my job this year will be to help develop a White Paper on Global Plankton Monitoring using CPRs for the OceanObs’19 conference in Hawaii in September 2019.

Yours in plankton
Anthony

Visit the AusCPR website at <http://imos.org.au/auscpr.html>

Visit the NRS website at <http://imos.org.au/anmnrs.html>

IMOS Australian Plankton Survey Leader

Professor Anthony J. Richardson

Phone: +61 07 3833 5958

Anthony.Richardson@csiro.au

Newsletter - Anita Slotwinski

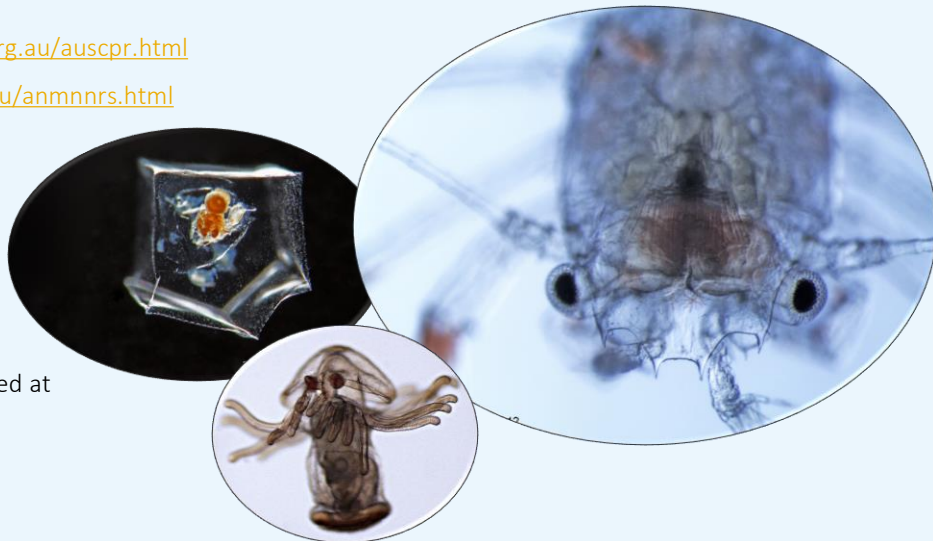
Anita.Slotwinski@csiro.au

Further team contact details can be located at

http://imos.org.au/cpr_staff.html

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Plankton images above : Anita Slotwinski

Don't forget to follow us on Facebook for up to date national and international plankton news, plankton images and videos, free educational resources and stunning plankton posters!

Search IMOS Australian Plankton Survey or go to

<https://www.facebook.com/imosaustralianplanktonsurvey>



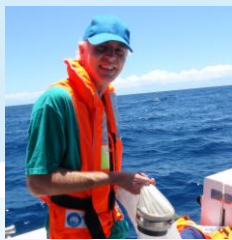


Anthony Richardson

Position: Leader IMOS Australian Plankton Survey

Location: CSIRO, Brisbane, Queensland

I manage the CPR project, I help secure funding, guide research directions, develop relationships with other plankton surveys, and support and develop CPR staff. My research interests are marine climate change ecology, plankton ecology, pelagic ecosystem dynamics, and ecosystem modelling. In my spare time I love to spend time with my family.



Frank Coman

Position: Deputy Leader

Location: CSIRO, Brisbane, Queensland

My role involves liaising with ships that tow the CPR, the management of the North Stradbroke Island NRS sampling, zooplankton sorting of IMOS NRS samples, and plankton analysis of CPR samples. I am interested in plankton biology and ecology, climate change impacts on marine ecosystems and aquaculture. In my spare time I play sport, enjoy fishing, camping and photographing Australian wildlife.



Claire Davies

Position: Plankton Biologist

Location: CSIRO, Brisbane, Queensland

My job includes identifying and counting CPR and NRS samples. I also manage the NRS and CPR databases, and am a boat driver for SE NRS sampling. My research interests include plankton ecology, climate change impacts and the feeding dynamics between zooplankton and megafauna. In my spare time I spend as much time in and out of the water as possible.



Julian Uribe-Palomino

Position: Plankton Biologist
Location: CSIRO, Brisbane, Queensland

My role involves analyses of plankton samples, operational tasks, data collection and quality control and contributing to publications and presentations. I am interested in biological oceanography, environmental modelling, biogeography, remote sensing and GIS.



Anita Slotwinski

Position: Plankton Biologist

Location: CSIRO, Brisbane, Queensland

I analyse CPR & NRS samples. I also manage the project website, communication materials, and the zooplankton species reference collection. My research interests are in marine plankton ecology, environmental change and species response and photomicroscopy. In my spare time I enjoy time with family & friends, photography, gardening and exploring nature.

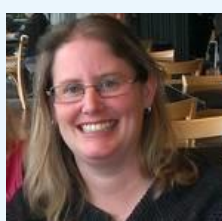


Mark Tonks

Position: Plankton Biologist

Location: CSIRO, Brisbane, Queensland

My tasks include counting CPR & NRS samples, and management of project procedure manuals. I have worked for CSIRO for 19 years and spend 60% of my time working on plankton. My research interests include plankton ecology, bycatch sustainability and fish and crustacean ecology. I also enjoy playing a variety of sports including hockey, touch football and cricket.

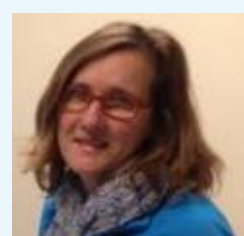


Felicity McEnnulty

Position: Plankton Biologist

Location: CSIRO, Hobart, Tasmania

I analyse CPR and NRS samples, am involved in data collation and quality control and contributing to publications and presentations. My research interests include plankton ecology, deep-sea invertebrates, introduced marine species and Antarctic marine invertebrates and fishes.



Ruth Eriksen

Position: Plankton Biologist

Location: CSIRO, Hobart, Queensland

I analyse CPR and NRS samples, and am involved in data collation and quality control and contributing to publications and presentations. My research interests are phytoplankton ecology and taxonomy, phytoplankton physiology and response to contaminants, tintinnid ciliates and temperate and sub-Antarctic phytoplankton community dynamics.



James McLaughlin

Position: Marine Biologist/ Biogeochemist

Location: CSIRO, Floreat, Western Australia

My job is helping to expand the survey into WA waters and the analysis of phyto- and zooplankton samples. I have been with CSIRO for 5 years and work 10% of my time with AusCPR. My research interests include marine phytoplankton dynamics and ecology, benthic and pelagic primary production, and ocean acidification. I enjoy spending time with my family, travelling and keeping tropical aquarium fish.



Wayne Rochester

Position: Quantitative Ecologist

Location CSIRO, Brisbane, Queensland

I help the survey by the analysis of plankton data for ecosystem health assessment. My research interests are quantitative ecology, spatial ecology and natural resource management.

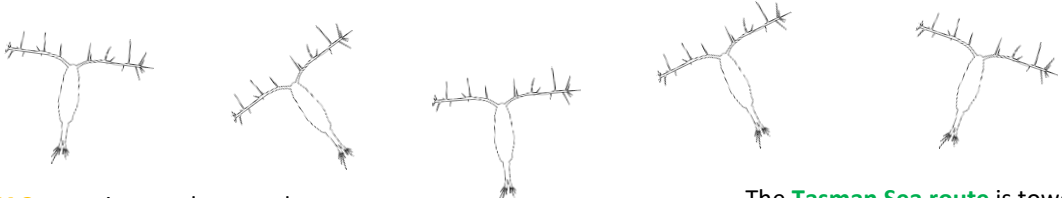


Karl Forcey

Position: Technical Officer

Location CSIRO, Brisbane, Queensland

I am helping the survey by working on the integration of marine instrumentation to CPR projects, data recovery and quality control, maintenance and repair of CPR units and technical advice. My research interests include underwater video systems, oceanographic instrumentation and AUV's gliders and other emerging technologies.

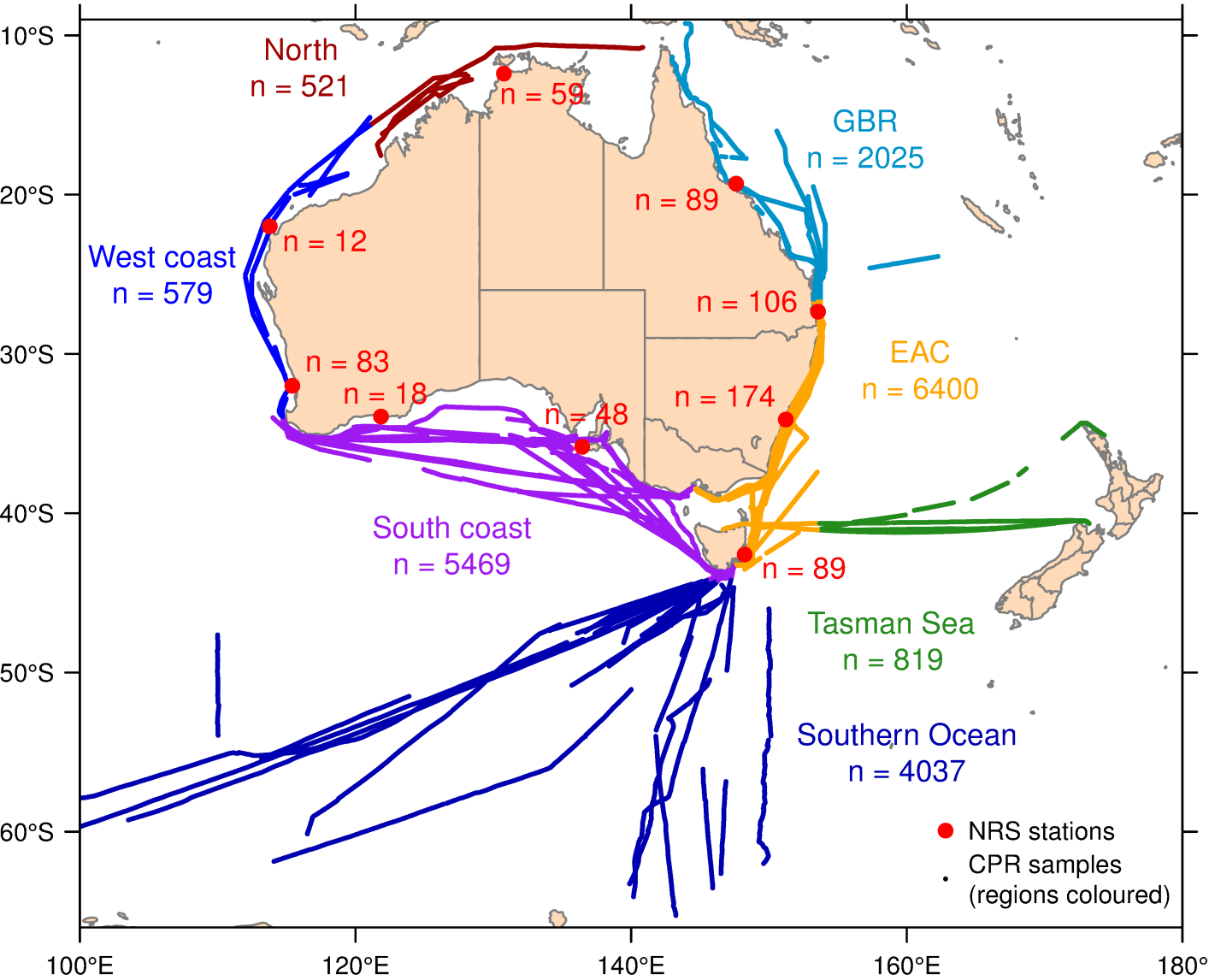


The **EAC route** is towed quarterly from Brisbane to Melbourne and follows the southward-flowing warm-water East Australia Current. This region is forecast to warm more than anywhere else in the Southern Hemisphere this century.

The **NRS** we sampled approximately monthly.

The **Tasman Sea route** is towed annually and extends from Burnie, Tasmania to Nelson, New Zealand. This is an important area for fisheries and our survey links in with the IMOS Bioacoustic Facility.

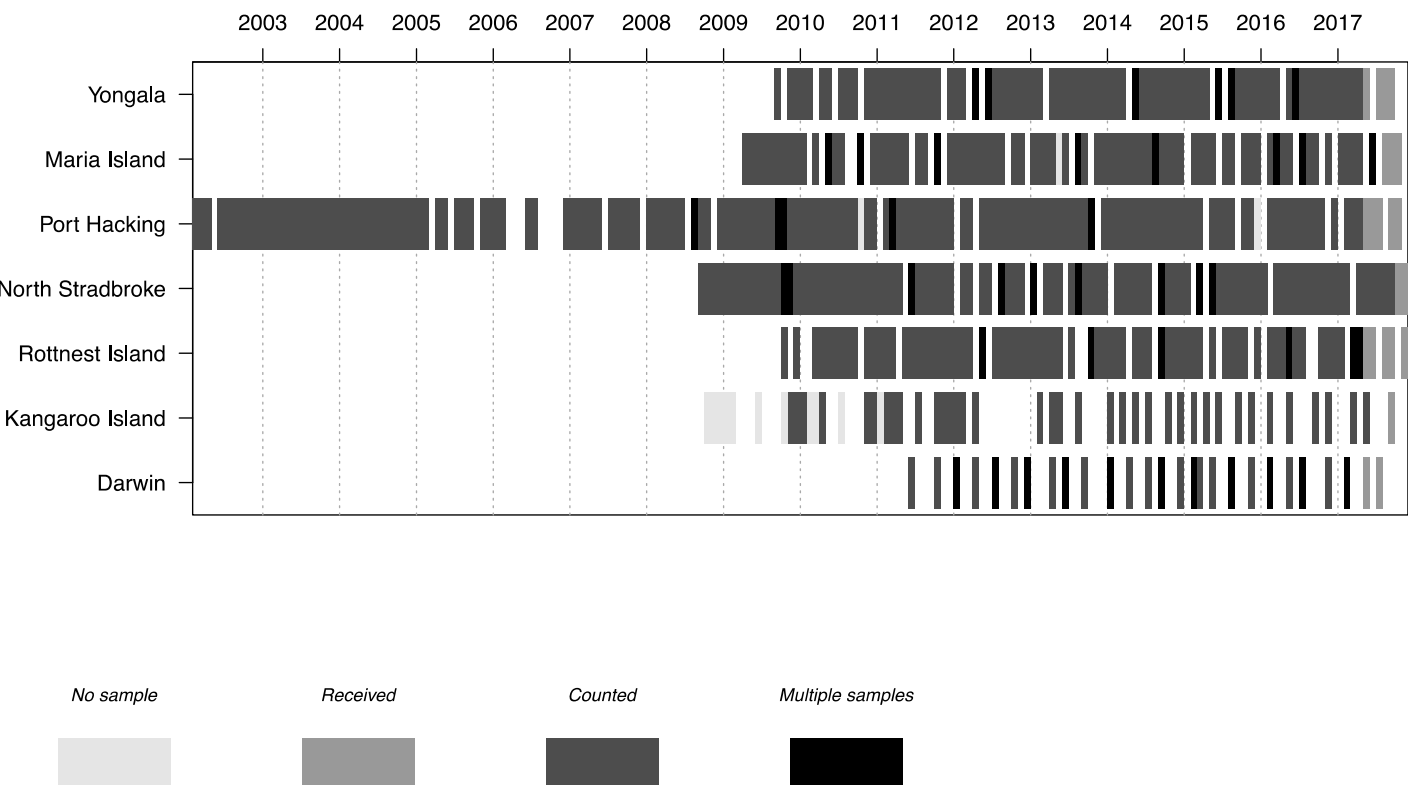
Integrated Marine Observing System (IMOS) plankton data, 2007–2017



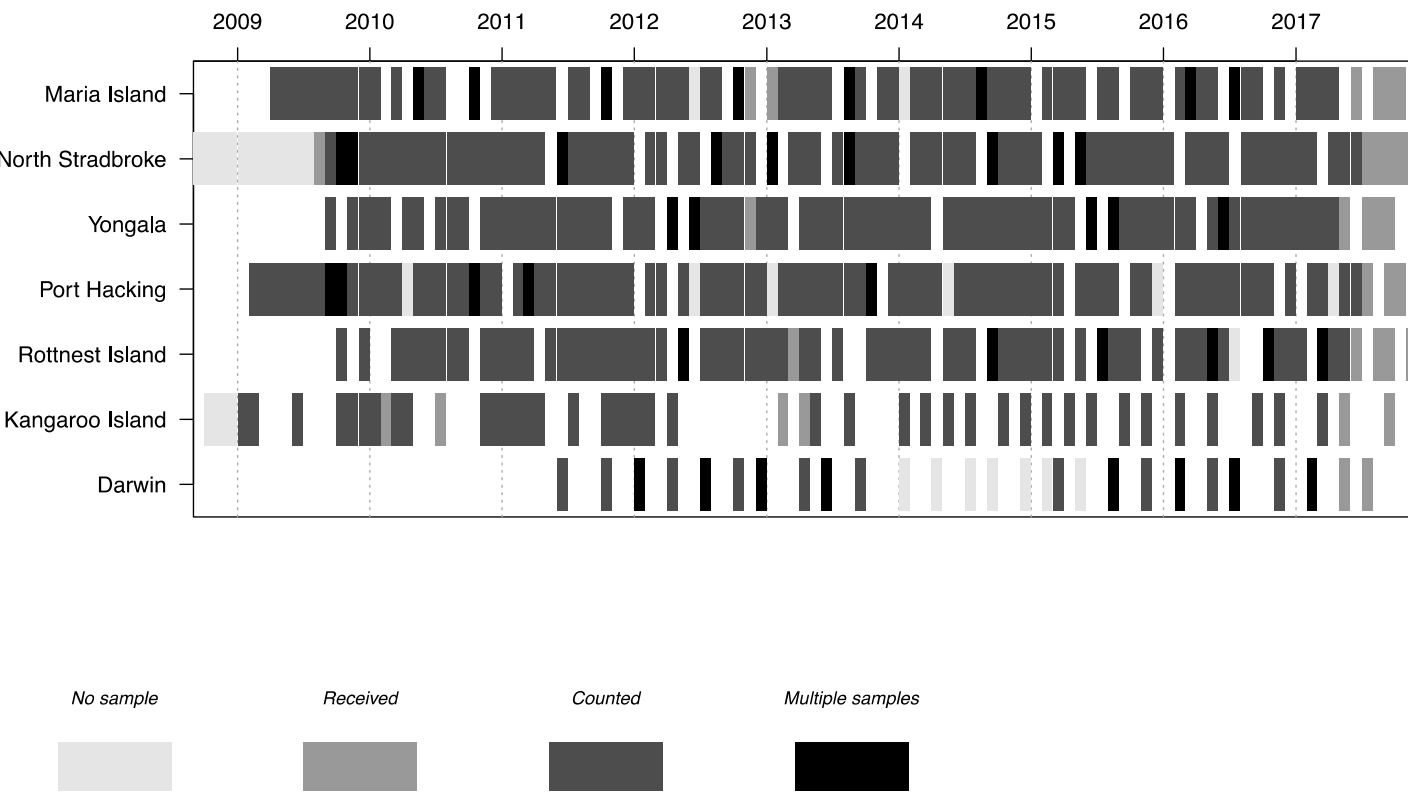
The **South Coast route** is towed quarterly from Melbourne to Fremantle. This route passes through a region of high endemism and is partly funded by the energy company BP.

The **Southern Ocean routes** below Australia are conducted by the SCAR SO-CPR Survey through the AAD and NIPR Japan, in conjunction with the AusCPR. Together with the EAC route, the Southern Ocean sampling provides an almost continuous transect running from warm tropical to polar waters.

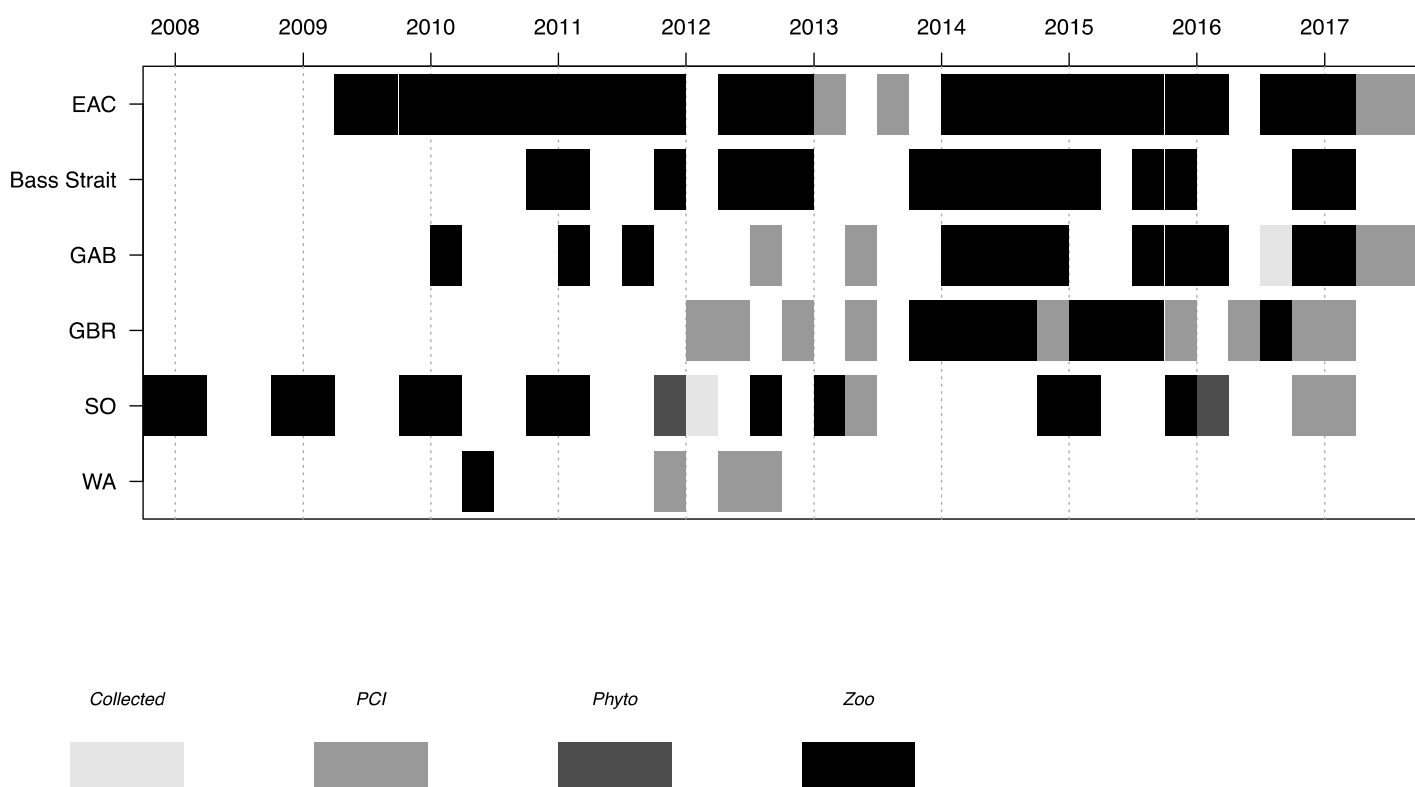
National Reference Stations Zooplankton Progress 30-11-2017



National Reference Stations Phytoplankton Progress 30-11-2017



Australian Continuous Plankton Recorder Progress 30-1-2017



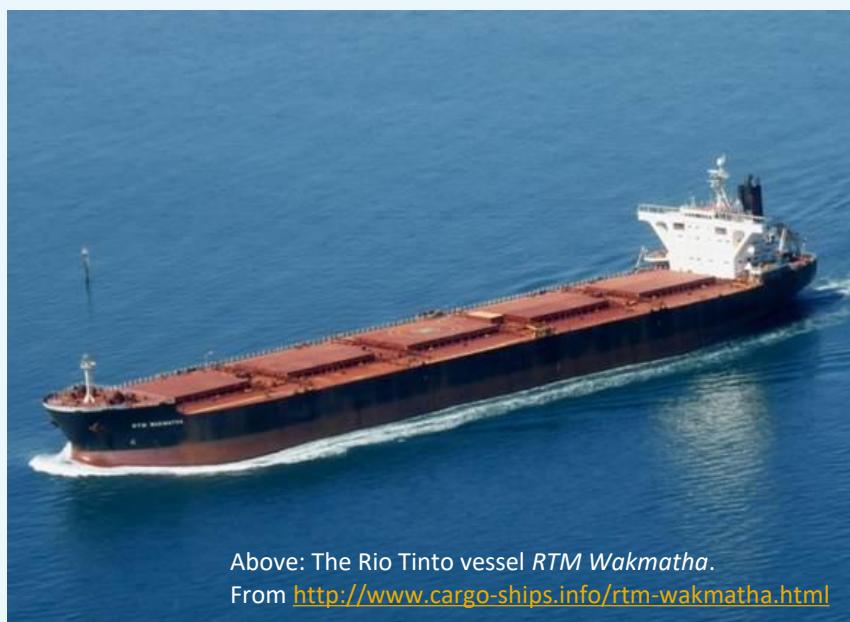
Shipping

Mark Tonks

The eastern and southern Australian coastal waters continue to be sampled by two Wallenius Wilhelmsen ships, the *Tonsberg* and *Salome*, between the ports of Brisbane, Port Kembla and Melbourne, and from Melbourne into the eastern Great Australian Bight. Since our last newsletter (March 2017) both vessels have towed the CPR on three occasions - *Salome* (Mar, Jun, Oct), *Tonsberg* (Apr, Aug, Nov). The company and their personnel have provided incredible support to our plankton survey and in doing so have ensured a very high level of sample quality and return.

In recognition of their assistance with the Australian Plankton Survey we nominated Wallenius Wilhelmsen for the Australian Biosecurity Awards. While they ultimately didn't win an award they did receive a Certificate of Appreciation from the Department of Agriculture and Water Resources acknowledging their efforts in our research and for other involvement in monitoring for invasive species.

The inner Great Barrier Reef route between Gladstone and Cairns had been sampled by the *Kweichow* from Swire Shipping from January 2014 up until February 2017.



Above: The Rio Tinto vessel *RTM Wakmatha*.

From <http://www.cargo-ships.info/rtm-wakmatha.html>

Unfortunately Swire removed the vessel from this route and a suitable replacement with this company could not be identified. After several unsuccessful attempts to find a replacement with other companies we began liaising with Rio Tinto in late July 2017. In August we were informed that Rio Tinto would be able to assist and suggested we tow the CPR from the *Wakmatha*, a ship that already assists CSIRO with monitoring of ocean chemistry along the entire Great Barrier Reef. After numerous logistical discussions we are currently in the design phase of producing a suitable tow point and CPR tows are likely to commence early 2018.



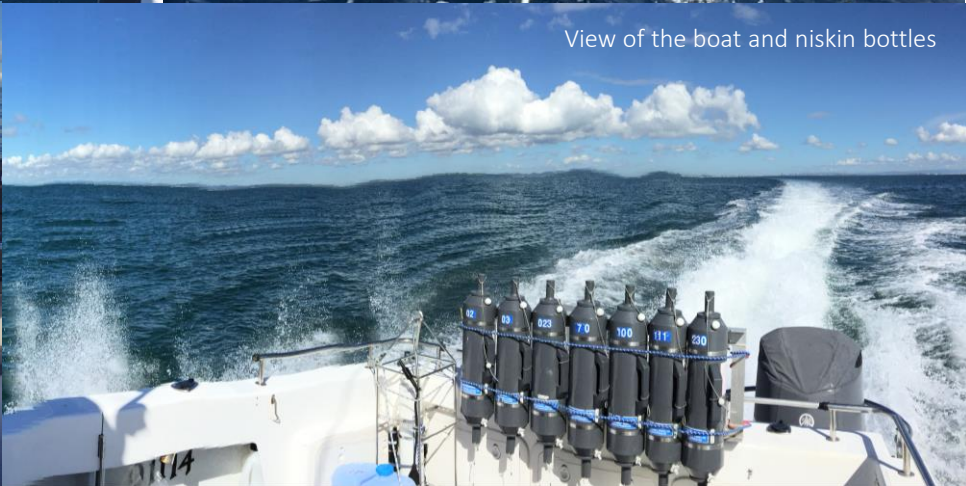
The plankton net going out to collect us some samples



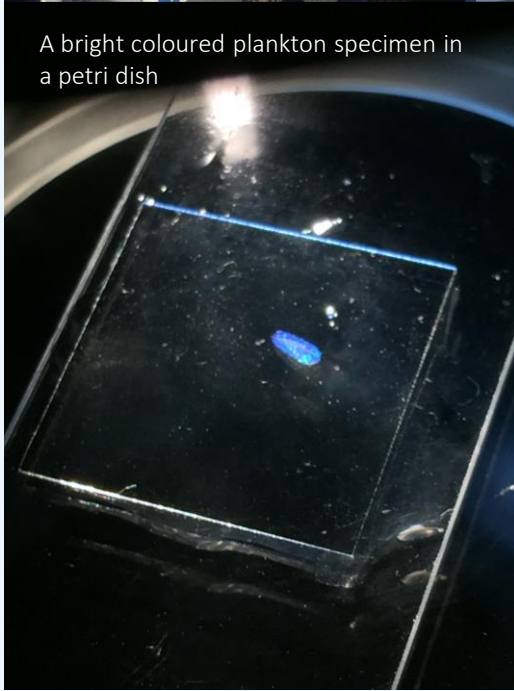
The deployed plankton net



Karl Forcey and Marie Lotti on an NRS trip



View of the boat and niskin bottles



A bright coloured plankton specimen in a petri dish



Microbial genetic plankton samples

NSI 20171023
E-DNA 50m

NSI 20171023
GENMIC 40m

NSI 20171023
GENMIC 50m

NSI 20171023
E-DNA 0m

Brisbane Lab Update

Frank Coman

The main focus of staff at the Brisbane laboratory has again been collecting and analysing samples from both AusCPR and the National Reference Stations (NRS), but like staff from Hobart we have also spent some time improving the taxonomic reference sheets for phytoplankton.

Between August 14th and 18th this year Julian, Mark, Frank and Anthony from the Brisbane laboratory went to CSIRO in Hobart for a phytoplankton taxonomy workshop with the Hobart based staff. Anita was not able to travel to Hobart, but teleconferenced in for a number of days to join in the discussions. with assistance from Gustaaf Halegraeff, Steve Brett and Ian Jameson all provided valuable assistance, sharing with us their strong knowledge of important identification features, but there will be more about the workshop elsewhere in this newsletter.

Over the last year we have had less students working in the laboratory than past years, but we have had Michelli Duarte spending time in the laboratory most weeks working through the ichthyoplankton samples collected at the North Stradbroke Island National Reference Station. Asia Armstrong has been spending some time in the laboratory working on plankton sections of her PhD study into Manta rays, Amelia Armstrong, who has had a long time association with our laboratory has been giving Asia a hand when she can. Sarah Pausina has been continuing to work on writing up her PhD thesis.

Chloe has more recently returned to work on an undergraduate research subject, for which she has been investigating whether there is a detectable change in size of *Temora turbinata* from samples collected at different latitudes.

We have also had several visits to Brisbane from our staff at other sites. Claire Davies and James McLaughlin both visited Brisbane in July to attend an ADAS level 1 commercial diving course, which Mark Tonks was also attending. The course was very intensive, and while James and Claire did not have much time to visit the laboratory it was good to catch up socially. Claire returned to Brisbane again in August to work with Anthony on using IMOS plankton data for other modelling projects.

Ruth Eriksen visited the Brisbane laboratories in September, and found herself very busy for the entire week discussing potential future projects, particularly in terms of Harmful Algal Blooms and climate change, and also working on current and potential manuscripts.

The AusCPR work based from Brisbane has continued well this year, with both the Salome and the Tonsberg collecting samples between Brisbane and Fremantle for us over the last year. We are now looking at collecting more samples from the Great Barrier Reef, and Mark has been having very promising discussions with Rio Tinto about possibly collecting samples from one of their ships. There will be more about this elsewhere in the newsletter.

Sampling at the National Reference station at North Stradbroke Island has continued successfully. Since the last newsletter we have only missed one month of sampling in February 2017 due to bad weather. Mark Tonks, Julian Uribe-Palomino, Kinam Salee and I continue to be the regular crew, and we have also received plenty of help from other staff and students who have been visiting the laboratory. There have been some slight updates to the water sampling and processing at the National Reference Stations, which began in July 2017. It was decided that it was more useful to collect pigment and total suspended data from the surface waters, rather than from an integrated water column sample, so we now collect more samples from the surface. Also in addition to the microbial genetics sampling we have been conducting for the past few years we have also begun collecting samples on the same filters to be analysed for fish DNA.

The other big change coming up for the team in Brisbane will be the move from the Ecosciences Precinct at Dutton Parl to the Queensland Biosciences Precinct at St Lucia (University of Queensland). The exact date of the move is yet to be confirmed. While the team will be moving their desks and laboratory to the new site, there will still be some field equipment and sample storage maintained at the current site. We hope this move has minimal impact on our ability to process samples over the coming months.



Above : Julian filtering a plankton sample (left), Frank identifying phytoplankton from a CPR silk sample (right).

Hobart Lab Update

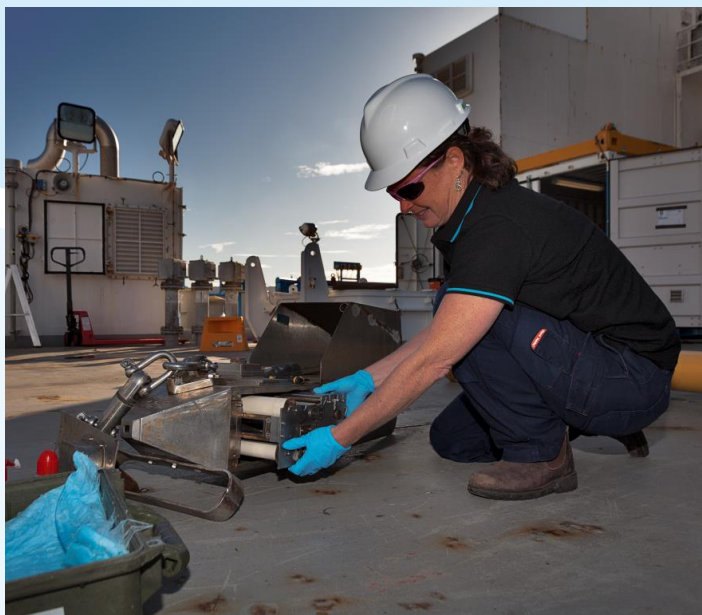
Felicity McEnnulty

Claire took over as BGC co-ordinator for the IMOS Moorings group in July 2017 following the retirement of Val Latham. This is a role to coordinate all the field teams involved in the National Reference Stations Biogeochemical monthly sampling, from which our plankton samples are taken. Her first task was to attend the IMOS QC summit which was held in SARDI this year. The participants discussed improvements to the BGC sampling regime, QC and how to improve the uptake of data from the National Reference Stations.

Claire has continued to participate in field work at the NRS Maria Island site whilst Felicity has filtered some trip samples in the lab. We have counted phytoplankton samples from all the NRS stations as well as CPR silks and zooplankton from the NRS stations of mainly Maria Island but a few tropical ones too to keep us on our toes. Zooplankton was also counted from various AUSCPR sampling tracks and northern SOCPR (a tow from Tasmania to 47°South as collected for us by AAD on RV Aurora Australis x 3 every summer season).

As *RV Investigator's* home port is Hobart it is our team down here that loads/unloads cassettes and organises the CPR towed on the vessel. The *RV Investigator* towed the CPR across the top of the Gulf of Carpentaria in October during its anticlockwise circumnavigation of Australia. This is an exciting development as it is an area which is chronically under sampled and the opportunity does not come up often. The samples will be counted in the Hobart labs and we are looking forward to seeing what exciting critters we have caught. The team also provided a loaded cassette and poster for the CAPSTAN (The Collaborative Australian Postgraduate Sea Training Alliance Network) voyage in November. The students were given a presentation on the CPR program, a demonstration of the CPR and some information about the data we have collected. Unfortunately, the CPR wasn't towed during the voyage as the students were already inundated with samples collected from previous activities. Maybe next year!!

The IMOS plankton team successfully applied for funding internally at CSIRO to improve our phytoplankton taxonomy skills and our reference sheets. Claire and Ruth worked closely with Gustaaf Hallegraeff from March to August on selected groups, namely *Triplos* and *Dinophysis*, to really nut out the details of the taxonomy and understand the reliability of historic datasets. Using this data we plan to make better mapping products using statistical modelling to show actual species distributions around Australia. The team hosted Gustaaf, Steve Brett from Microalgal Services and Ian Jameson from the CSIRO culture collection to participate in a Phytoplankton workshop at the Hobart site in August to develop the reference sheets for other phytoplankton groups.



Above : Claire Davies changing CPR cassettes on the *RV Investigator*.



Above : Phytoplankton Taxonomy Workshop in Hobart with Gustaaf Hallegraeff (UTAS) and Ian Jameson (CSIRO Culture Collection).

These included *Chaetoceros*, differentiating cylindrical diatoms such as *Dactyliosolen*, *Leptocylindrus*, *Skeletonema*, *Stephanopyxis*, *Dentonula*, *Lauderia*, *Ceratulina*, *Hemiaulus* and differentiating between the “sticks” such as *Thalassionema*, *Trichotoxon*, *Lioloma*, *Thalassiothrix*, *Haslea* and *Trichodesmium* as well as *Rhizosolenia/Proboscica* and tintinnids. It was a really valuable process and the team thank the experts for their time and dedication to plankton taxonomy.

Ruth and Felicity went to a Lucid workshop in Canberra in October with support from the CSIRO Capability Development Fund. Lucid is a software package that can be used to design taxonomic keys to help users make an identification. This will be a great aid to our group.

Ruth, Claire and Felicity participated in the IMOS ZOOM workshop in Hobart bring plankton modellers and “observationalists” together to align data products based on IMOS plankton data. Felicity has compiled more data into the Australian Zooplankton Biomass Database, Claire has compiled the chlorophyll data. Claire has been working with BGC modellers to get IMOS zooplankton data into the e-Reefs model.

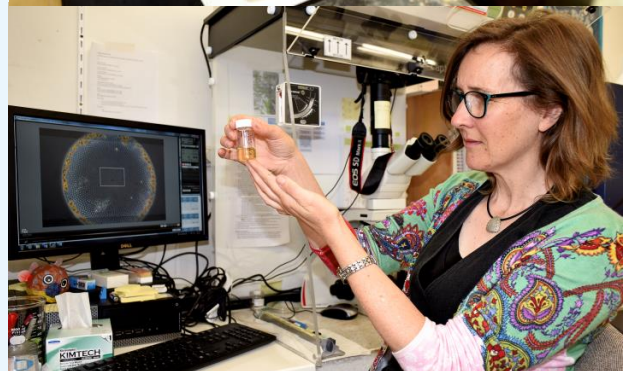
When working with chemical OHSE awareness is important as is compliance with regulations, Ruth, Claire and Felicity participated in training to allow them to use the Biological Containment laboratory on the Hobart Site and we relabelled everything in the lab to meet the new GHS dangerous goods labelling requirements.

Carlie Devine took some photos in the lab of us cutting up silks and on microscopes, and on RV Investigator of Claire loading the CPR. The photos are to be used in various CSIRO publications advertising the science that goes on here by women in the workplace

Ruth went on the Japanese training vessel *TRV Umitaka Maru* voyage to the Southern Ocean for the month of January 2017 (see images on the next page). Following a trial voyage on *Umitaka Maru* in Japan in October, Ruth worked with Christine Weldrick (PhD student, IMAS) and Dr Kohei Matsuno (JSPS Fellow with IMAS) on the voyage from Fremantle to Antarctica, down the 110E line. They sampled extensively, ran plankton grazing experiments, played in the sea-ice, ate ALOT of fish, and thoroughly enjoyed the opportunity to participate in the 20th Kaiyodai Antarctic Research Expedition. Thanks to Kerrie Swadling (IMAS/ACE CRC), So Kawaguchi (AAD), NIPR and TUMSAT for making Ruth’s participation possible. We recently also had the pleasure of a visit from Dr Kunio Takahashi, who leads the Southern Ocean CPR Program, and John Kitchener from the AAD. It was great to learn more about the SOCPR, discuss analyses and explore more linkages with the AusCPR routes and datasets.

Claire and Mark completed the ADAS Part 1 commercial dive course in July as part of their roles as dive co-ordinators at the Hobart and Brisbane sites. The course was tough and tiring but thoroughly enjoyable and informative. Fifteen degrees in zero visibility water with a thick, muddy bottom may not be everyone’s idea of fun.

In our last newsletter we had an article about the “Undercurrent” art exhibition by Diane Masters which featured etchings of plankton inspired by the IMOS plankton group’s photos. Following the exposure from this, her first solo exhibition, Di was subsequently one of 10 artists invited to enter a print in the Print Council of Australia’s PCA Print Commission of 2017.



Above : Claire Davies at the microscope (top), Claire Davies & Felicity McEnulty cutting silks (middle) and Ruth Eriksen at the microscope (bottom).

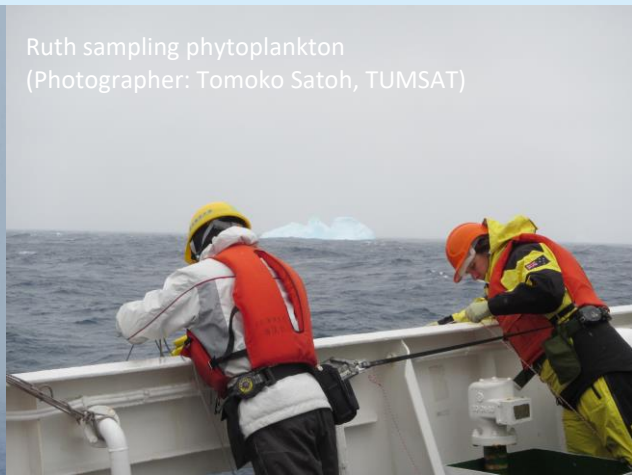


John Kitchener, Ruth Eriksen & Kunio Takahaskii.

Making snow men while waiting for the CTD to come up (Photographer: Ruth Eriksen)



Ruth sampling phytoplankton (Photographer: Tomoko Satoh, TUMSAT)



Ruth sampling phytoplankton (Photographer: Tomoko Satoh, TUMSAT)



Ruth on the scope in the winch room on Umitaka Maru (Photographer: Masato Moteki, TUMSAT)



Collecting zooplankton net sample while the NHK film crew document the process (Photographer: Ruth Eriksen)



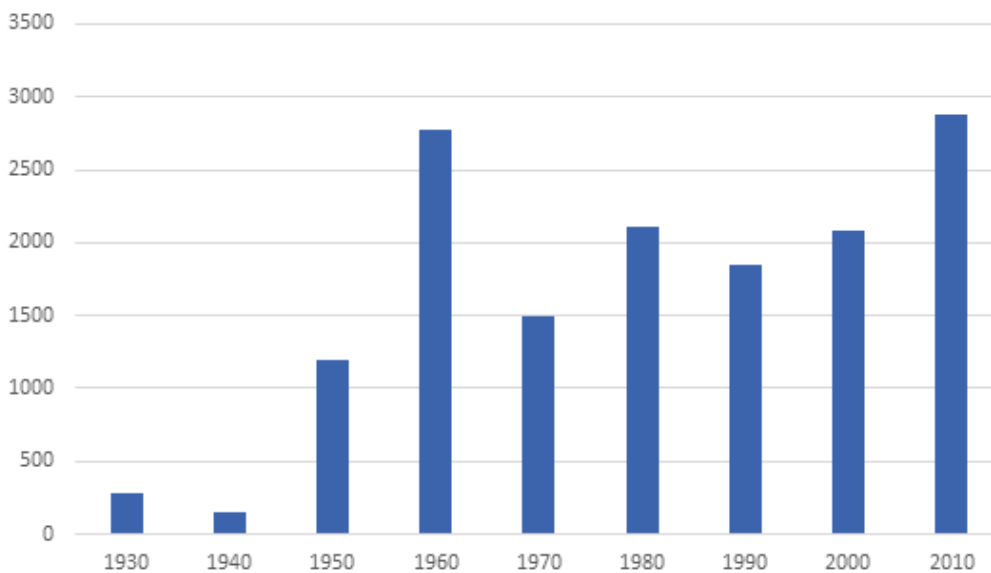
Ruth sampling phytoplankton (Photographer: Christine Weldrick, IMAS)

Australian Zooplankton Biomass Database

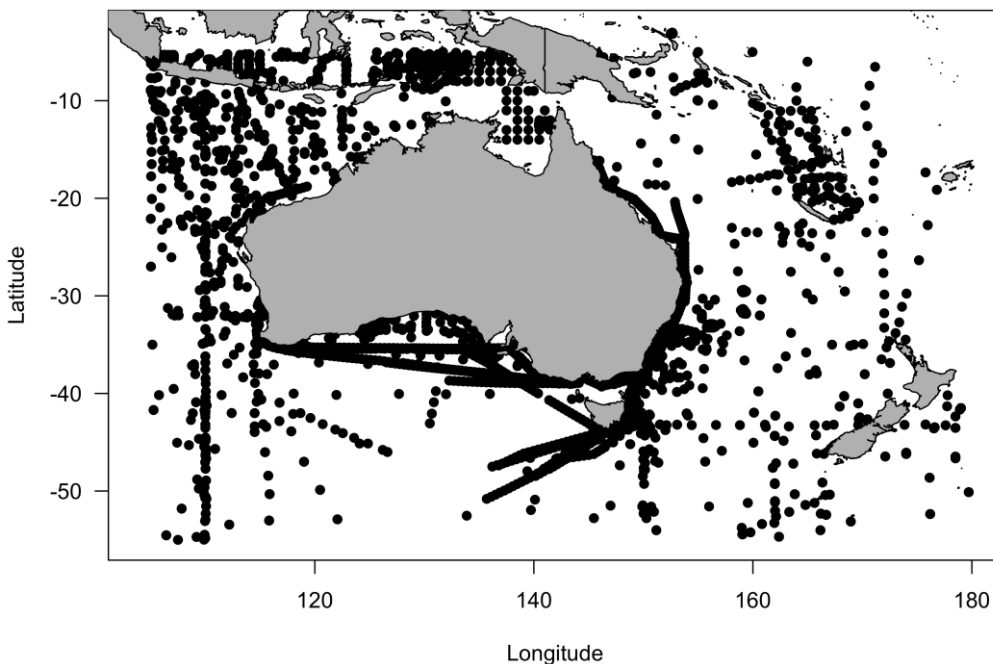
Felicity McEnulty

The Australian Zooplankton Biomass Database has been built over the last two years by compiling datasets of total zooplankton biomass/biovolume collected in the Australian marine region. It contains over 15000 records from researchers, databases, published and grey literature. IMOS NRS data comprise 2100 records and 600 records are from IMOS AUSCP. Zooplankton samples were collected from net drops or tows, or from plankton samplers, such as the Continuous Plankton Recorder (CPR). The dataset will be lodged with the Australian Ocean Data Network (<http://imos.aodn.org.au>) in a similar way to the Australian Phytoplankton Database (Davies *et al.* 2014) and the Australian Zooplankton Abundance Database (Davies *et al.* 2016), allowing full public access. The term “biomass” has been used loosely in the literature to include both true biomass and biovolume measurements. “Biomass” here refers to the weight of the zooplankton sample divided by the volume of water filtered during the collection of the sample. “Biovolume” is the volume of zooplankton divided by the volume of water filtered during the collection of the sample. The different collection and measurement methods used to estimate zooplankton biomass (dry/wet mass, ash free dry weight, displacement volume, settled volume) has resulted in a variety of data measurement units. The Australian Zooplankton Biomass Database has converted the various biomass measurements into standard units of: mg/m³; ug Carbon per litre (ugC/L) and ugN per litre using accepted equations.

Total zooplankton biomass number of records by decade



Left: The number of zooplankton biomass records in the Australia Zooplankton Biomass Database.



Left: Locations of zooplankton biomass data from around Australia (n=13,951)

Plankton features on Channel 10, Australian TV

Julian Uribe-Palomino

We had the opportunity to take part in a TV production for 'Scope' on Channel 10. This TV program shows short episodes about interesting topics related to science and technology. We were invited to talk about plankton. We introduced plankton, the importance of phytoplankton in the production of oxygen, described different methods of collecting plankton, and why we should care about this important group of organisms.

This production was made in collaboration with The Moreton Bay Environmental Education Centre. The Centre gives school students from grade 6–11 the opportunity to participate in short and interactive trips around Moreton Bay, where they learn about marine ecosystems, data collection methodology and research application. The training is held aboard the "*Inspiration*". This vessel has a large TV screen, microscopes, tablets and other infrastructure that facilitates the learning process for the students.

We thank the '*Inspiration*' crew (Tim, David and Diane) and the STEM program from the Moreton Bay Education Centre for having us onboard for their educational trips, where we could participate in teaching students about plankton.

The plankton 'Scope' episode on is available at the following link:

<https://www.youtube.com/watch?v=HDVQCxsksag>

Additional information about the '*Inspiration*' and the Moreton Bay Environmental Education Centre can also be found at:

<https://moretoneec.eq.edu.au/Pages/default.aspx>



Above: Julian talks about the importance of plankton on Scope TV.



Above: A copepod from the Sapphirinidae family collected at North Stradbroke Island.

Plankton Video to celebrate World Oceans Day

Julian Uribe-Palomino, Asaesja Young

Field trips to Moreton Bay are always an opportunity to have a look at the plankton that lives there. Sometimes we take short videos of interesting planktonic creatures while they are alive to capture their natural colours and some of their behaviour. Some of these videos made at the CSIRO plankton lab were put together by Asaesja Young from CSIRO communications to create a collage that opens the possibility to observing this vivid, active and microscopic planktonic world to the general public.

The short video was released to celebrate "World Oceans Day" on 8 June, and it was the inspiration for a blog on the CSIRO website entitled "Critical critters of the ocean: Our precious plankton"

You can read the blog and watch the video in this link: <https://blog.csiro.au/critical-critters-of-the-ocean-our-precious-plankton>

13th International Conference on Copepoda

Julian Uribe-Palomino

Copepoda are a highly diverse and abundant group of organisms in aquatic ecosystems. A good knowledge of copepod morphology, biology and ecology is required for identification. Every 3 years the International Association of Copepodologists get together, and a group of highly skilled researchers, who are passionate about copepods, train a new generation of students in morphology, taxonomy, biology, ecology, and diversity of copepods. I went to California in July 2017 to participate in lectures and workshops, as well as to attend the 13th International Conference on Copepoda in Los Angeles.

The workshops included lectures and practical classes that were taught at the Scripps Institute of Oceanography labs (San Diego, California) from top researchers on copepods, including R. Huys (Natural History Museum, London), Mark Ohman (Scripps, USA), Danny Tang (USA), Janet Bradford-Grieve (NIWA, NZ), Ruth Böttger-Schnack (Germany), Samuel Gomez (Mexico), Diana Galazzi and Barbara Fiasca (Italy).

Participation in such workshops is essential to build our Team copepod identification skills, helping us to analyse samples we collect as part of our two main research projects: The Continuous Plankton Recorder and National Reference Stations. It is also a good opportunity to enhance the quality control of our data that feeds into the IMOS data portal. The workshop is a fantastic opportunity to have access to the knowledge of a niche group of international copepod experts, and to network and promote further international collaborations.



Top right: An old microscope with a *camera lucida* and a digital board to draw specimens.

Middle: The campus at SCRIPPS.

Below: The workshop participants come together for a group picture.

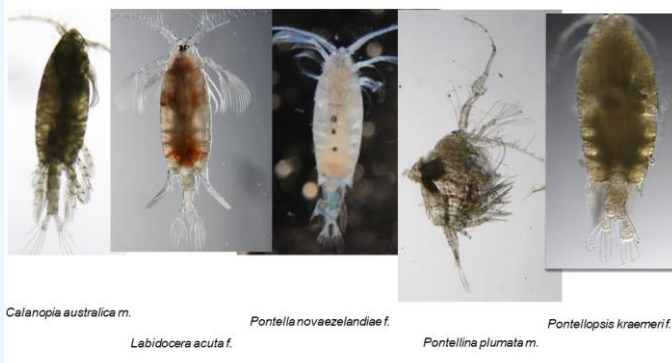


After the workshop, I attended in the 13th International Conference on Copepoda and gave two oral presentations. The first one was entitled “Lessons from the free-living marine copepods found throughout the Australian Plankton Survey and Pontellids from Australian waters” which I presented on behalf of our team including Frank Coman, Mark Tonks, Anita Slotwinski, Claire Davies, Ruth Eriksen, Felicity McEnnulty, Wayne Rocherster, Margaret Miller, Steven Edgar and Anthony Richardson. I raised awareness of the plankton research we are doing in coastal waters from all around Australia. I showcased some of the results and applications of the use of the data we produce from the analysis of samples collected with the CPR and at the NRS, but also from collaborations with domestic and international students as part of their professional experience.

The second presentation was about a particular group of robust and quite large copepods (2–6 mm long), that appear often in our samples and belong to the copepod family Pontellidae. They look quite blue to the naked eye when they are alive as our samples are collected. Pontellids have been poorly studied in Australian waters. Species compositions and some of their distributions have been assessed by Greenwood (1970’s) and McKinnon (1990’s-2000’s) and more recently by the CSIRO-IMOS plankton team analysing samples from the CPR and NRS.

Of the 30 species reported for Australian coastal waters, we found 21 in the samples collected by the CPR and from the National Reference Stations. *Calanopia elliptica*, *Calanopia minor*, *Labidocera minuta* and *Labidocera acuta* are some of the most common species of Pontellids collected in our samples. This presentation was another good example to illustrate use of the data we produce as part of the IMOS-CSIRO collaboration.

They come in different flavours!



Above: A slide from Julian’s presentation on pontellids.



Above: Janet Bradford-Grieve (Marine copepod researcher) and Janet W. Reid (Freshwater copepod researcher). The 13th International Conference on Copepoda gave tribute to this two women in science who have dedicate their life to the research in marine and freshwater copepods.



Above: Mike Schaadt (Director of Cabrillo Marine Aquarium), Eduardo Suarez-Morales (Ex-president International World Association of Copepodologists) and Rony Huys (Copepod researcher Natural History Museum, London).



Above: A male copepod *Pontella fera* from North Stradbroke Island in its natural colours.

Biological response to Ocean Macronutrient Fertilization

Dr Tiago Passos

The University of Sydney, Sydney Institute of Marine Sciences & Ocean Nourishment Foundation (ONF)

Ocean Macronutrient Fertilization (OMF) is a technology that aims to reduce the concentration of carbon dioxide in the atmosphere to mitigate global warming. OMF functioning is based on the introduction of the macronutrients nitrogen (N) & phosphorus (P) into the ocean to increase phytoplankton growth. Increasing primary production of the ocean is expected to increase carbon sequestration to the deep ocean, as well as potentially enhancing the higher trophic levels of the marine food web (Jones, 1996). However, an important question is postulated before the implementation of OMF: What is the biological response to OMF? My research focuses on empirical bottle experiments to investigate the biological impacts of OMF, looking at the responses of ocean fertilization on phytoplankton, zooplankton and marine bacteria. The seawater samples used on this investigation were collected at the Port Hacking long-term monitoring station (Sydney) together with a monthly survey expedition conducted by IMOS. Initial oceanographic data used during the experiment includes data collected and measured by IMOS, such as seawater temperature, chlorophyll and nutrient concentrations and phytoplankton and zooplankton taxonomic composition. These initial data collected and measured by IMOS have a crucial role in my research, since my aim is to investigate the biological response before and after ocean fertilization. Taxonomic identification of my phytoplankton and zooplankton culture was promptly supported by the IMOS scientific research team, which have also provided images of plankton collected during the survey. I would like to acknowledge the support provided by the IMOS team to my research and I wish long life to the Integrated Marine Observing System program!

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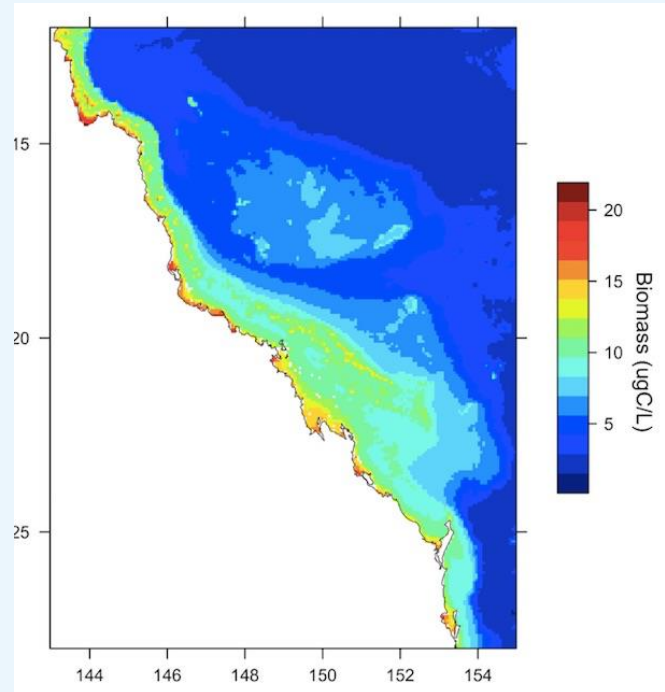
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IMOS Zooplankton Ocean Observations and Modelling (ZOOM) Task Team Meeting - November 2017

Dr Jason Everett

University of NSW & Sydney Institute of Marine Science

The IMOS Zooplankton Ocean Observations and Modelling (ZOOM) Task Team met in Hobart between Monday 27th November and Wednesday 29th November 2017. The ZOOM Task Team is focused on bringing modellers and observationalists together to compile zooplankton observations at multiple scales for use in the development and assessment of biogeochemical, size and ecosystem models. The meeting was led by Professor Anthony Richardson and Dr Jason Everett, and was attended by 22 researchers from CSIRO (Hobart, Brisbane and Perth), The University of NSW, The University of Queensland and The University of Tasmania.



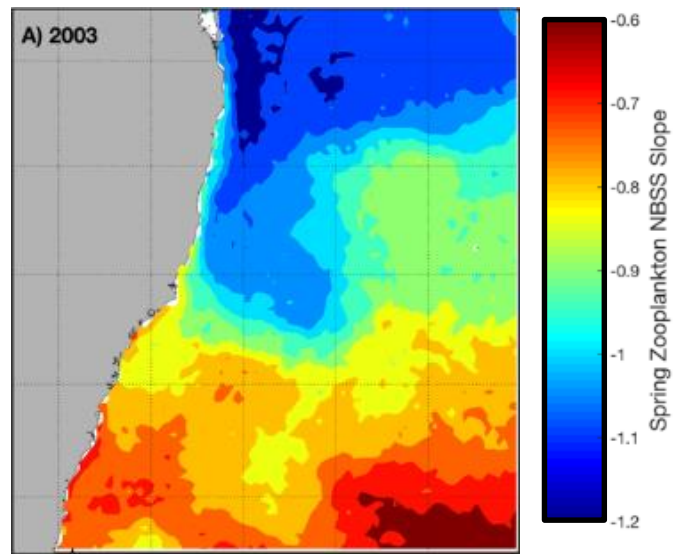
Above: Zooplankton biomass on the Great Barrier Reef.

The aim of the meeting was to gain a better understanding of the data requirements of the modelling community to provide better data products. For the first half of the workshop, the observationalists went back to school, learning from the modellers about zooplankton functional groups in the models, methods of model initialisation, and model assessment. We explored the way the phytoplankton and zooplankton groups within the models are constructed and parameterised. Interspersed between the modelling talks, various observationalists gave presentations about the existing data-products (e.g. size, species compositions and biomass).

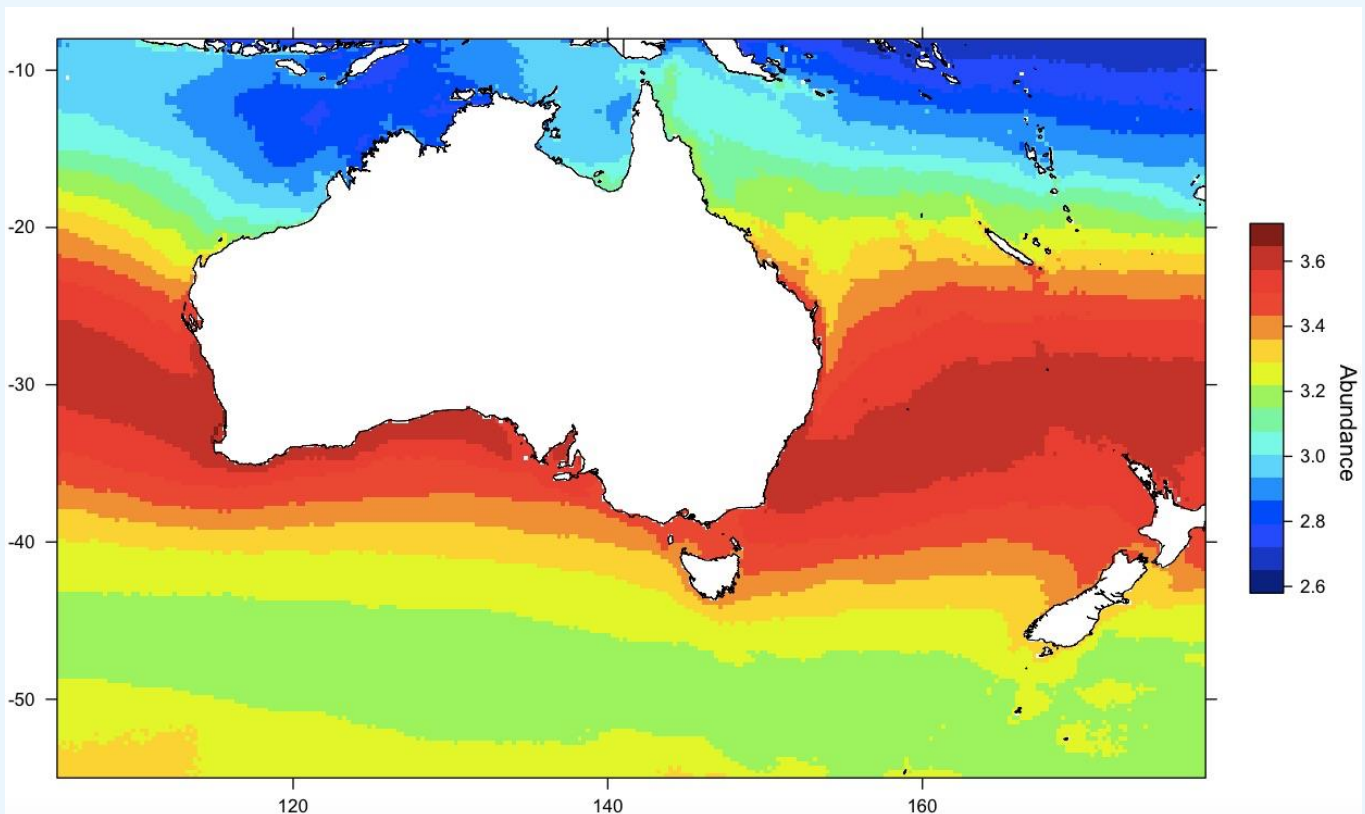
There was a lot of discussion about the ways the existing data can be manipulated (data-wrangling) to provide products at the temporal and spatial scales required by the models. The challenge was certainly thrown down to the observationalists to consider how the existing datasets can be wrangled into different formats and products.

Highlights from the meeting include the presentation of some of the first global maps of zooplankton functional groups, Australian maps of dinoflagellates, diatoms and Trichodesmium, zooplankton biomass on the Great Barrier Reef, and zooplankton size-distribution maps of the Tasman Sea. The modelling presentations demonstrated the diversity of models being developed in Australia and the differing data needs of each model formulation. The modelling teams are certainly keen to get their hands on new data and see how well their models are performing. Data products requested include: ratios of herbivore:carnivore ratios, diatom:dinoflagellate ratios, Trichodesmium distributions, different biomass units of zooplankton (carbon, nitrogen, wet-weight), size fractionated zooplankton biomass. It was also requested that mapped products were presented at global, national and regional scales. The ZOOM Task-Team will continue to work on these questions, with another workshop in 2018 focussed on confronting the models with data to see how the new data products can be used to assess models, and examine how well the models perform. We show here a selection of preliminary data products based on IMOS data and using modelling approaches and environmental predictors.

Below: Slope of the Zooplankton Normalised Biomass Size Spectra in the Tasman Sea for Spring 2003.



Below: Map of Dinoflagellate Distribution, based up on a Generalised Additive Model using in-situ and satellite-derived co-variates.



Influence of oceanographic conditions on coastal zooplankton assemblages at three IMOS National Reference Stations in Western Australia

Erin McCosker- Murdoch University

Supervision by Claire Davies (IMOS) and Professor Lynnath Beckley (Murdoch University)

Zooplankton are widely acknowledged as being important in highlighting change in marine ecosystems. This is demonstrated by the scale that long-term zooplankton monitoring programs currently operate at, with more than thirty countries holding multi-decadal time-series, and valuable findings about ocean-plankton relationships revealed. In Australia, the relatively recent establishment of a zooplankton monitoring program means that comparatively little is known about the influence of oceanography on zooplankton in these waters.

This study examined two years (2011-2012) of physical, chemical and biological (zooplankton) data collected by IMOS at three Western Australian (WA) National Reference Stations (NRS), located at Ningaloo (22° S), Rottnest (32° S) and Esperance (34° S), to elucidate how spatial and temporal variation in copepod assemblage structures relate to the underlying oceanography. The dominant oceanographic feature in this region of the south-east Indian Ocean is the poleward flowing Leeuwin Current, which transports warm, tropical, nutrient poor waters south along the WA coast and east towards Tasmania, an almost 5,500 km long trajectory. This results in a latitudinal gradient of change in the physical and chemical oceanographic characteristics of WA coastal waters.

Analysis of water column properties for the three NRS revealed each to have distinct water mass characteristics, which is largely a function of their distribution across thirteen degrees of latitude. Short-term variation in oceanographic conditions at the three NRS occurred due to seasonal strengthening of the Leeuwin Current and opposing flowing cooler coastal currents, seasonal phytoplankton blooms, localised upwelling, and a strong La Niña event.

The study found strong dissimilarities between NRS copepod assemblages driven by species associations with specific water masses. A compositional change in assemblages occurred north to south along the coast, coinciding with changes in the dominant water mass at the NRS, from Tropical Surface Water at Ningaloo dominated by tropical copepods, to a mixed assemblage in the tropical-temperate transition zone at Rottnest, to a warm-temperate affinity assemblage associated with cooler, Subtropical Surface Water at Esperance. Distance-based linear modelling confirmed the significant influence of seawater density, an indicator of water mass, in shaping changes in copepod assemblages.

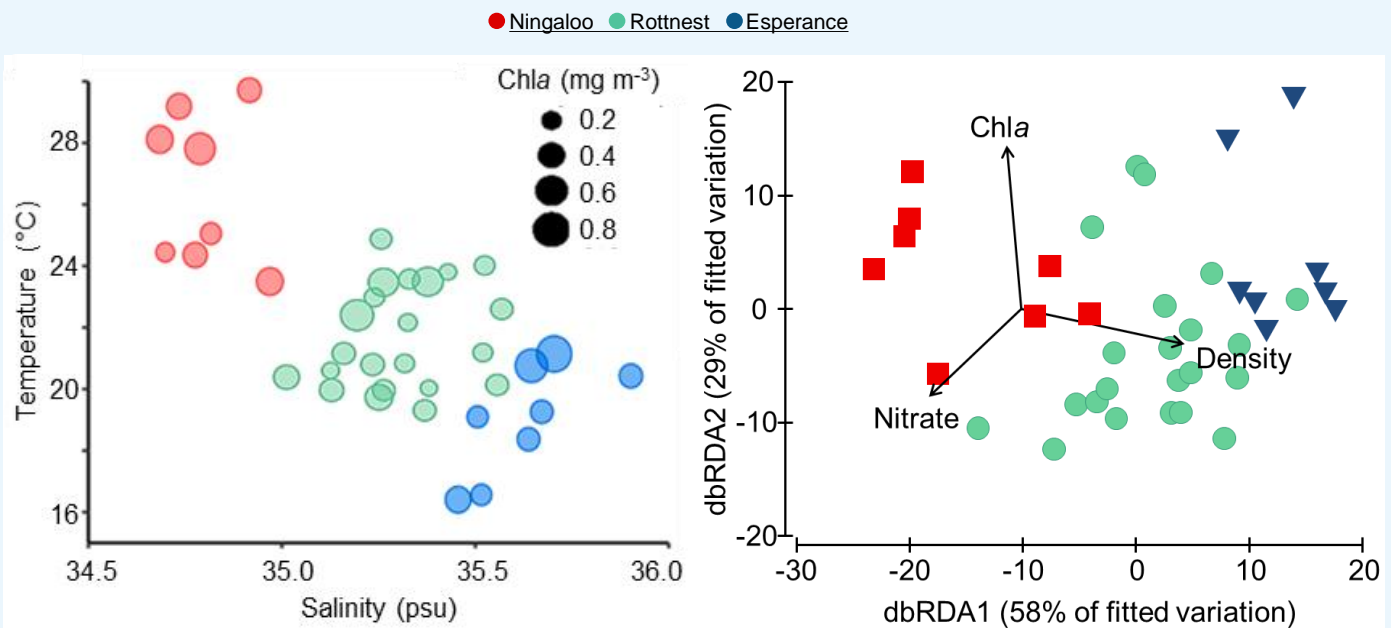


Fig. 1: Mean temperature, mean salinity and depth-integrated chlorophyll a at the three NRS.

Fig. 2: Distance-based redundancy plot of copepod assemblages showing the influence of environmental variables.

Besides water mass characteristics, seasonal oceanographic change was also found to influence zooplankton. Dissimilarities between copepod assemblages at the NRS weakened in winter when the Leeuwin Current intensified, with a greater number of species in common, enhanced species richness and more tropicalised assemblages at Rottnest and Esperance. This suggests that the seasonal oceanography of the Leeuwin Current enhances connectivity between copepod assemblages across a broad latitudinal range, contributing diversity to temperate waters which are otherwise known for their high level of endemism. It is unclear if the presence of tropical copepods in temperate waters at these sites is representative of a broad trend of range extensions and shifts towards dominance by warm-water copepods in temperate waters, or if it is further confirmation of the influence of the Leeuwin Current in providing conditions favourable for these copepods at higher latitudes.

These questions highlight the importance of sustained zooplankton monitoring programs, such as the IMOS NRS program, for investigating future ecological changes in marine systems. This is of particular importance in marine ecosystems such as those in south-west WA, which have been identified as a warming hotspot.

Nutrient cycling by zooplankton in Moreton Bay

Sarah Pausina

University of Queensland & CSIRO Marine and Atmospheric Research

Moreton Bay in Southeast Queensland has globally-important biodiversity, including seabird, turtle and dugong populations, and supports 15% of Queensland's commercial fishing. It is surrounded by the fastest growing population in Australia, which brings with it the challenges of managing nutrient and sediment loads. In this study, we investigate the important role that zooplankton plays in the cycling of nutrients in the Bay. Using monthly data on zooplankton species composition, growth rates, and size structure, we will provide the first robust estimates of zooplankton abundance and rate processes from the Bay and develop indicators of nutrient enrichment. We also undertook contingency monitoring in the wake of the 2011 Brisbane floods to look at how zooplankton communities respond to large nutrient inputs and physico-chemical disturbances. These findings should prove useful for validating the next-generation of ecosystem models for the Bay and could provide new indicators for water quality monitoring.

Right: Sarah Pausina collects plankton in Moreton bay for her study on nutrient cycling in zooplankton.



Investigating reef manta ray food in Hanifaru Bay, Maldives

Asia Armstrong

The University of Queensland

I am currently a PhD student at the University of Queensland, where my research is focused on different aspects of reef manta ray (*Mobula alfredi*) ecology and biology in Australian waters and beyond. My earlier research with Project Manta and the IMOS Plankton Lab involved an investigation into the food environment for reef manta rays at Lady Elliot Island in the southern Great Barrier Reef. This location is the largest known aggregation site for these animals on the east coast of Australia, and they are variously observed attending cleaning stations, involved in courtship behaviours and surface feeding on zooplankton at this site. However, few studies have directly investigated the food environment for these animals, and as such little is known about the importance of surface zooplankton as a food source, or whether the food availability at aggregation sites, such as Lady Elliot Island is representative and comparable to other locations.

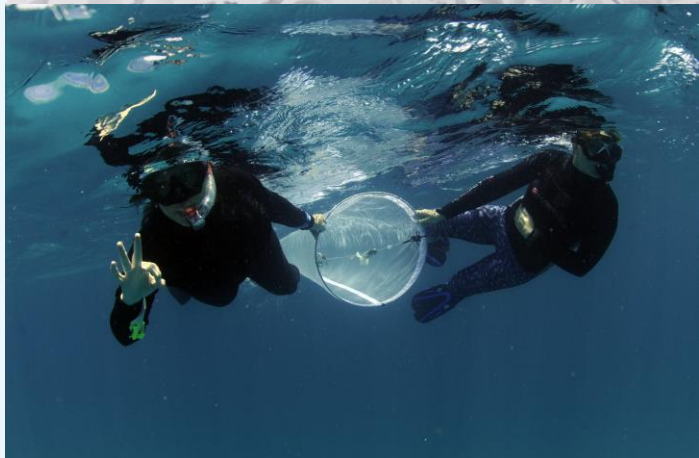
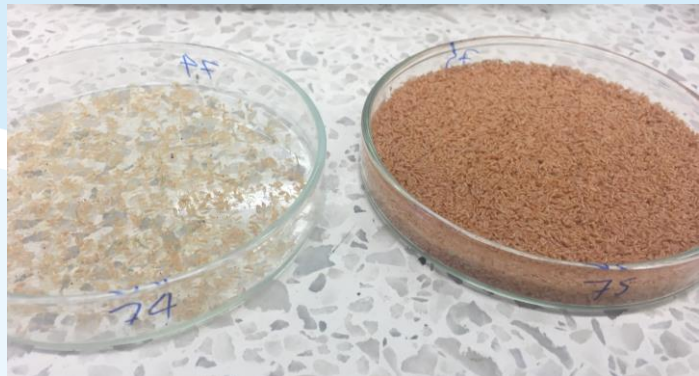
Recently, through a chance invite to join a liveaboard expedition, I was able to join up with the Manta Trust team in the Maldives to expand our research in this area. The Maldives is home to Hanifaru Bay, a small bay in the Baa Atoll that hosts the largest known feeding aggregations for reef manta rays in the world. The focus of our research at this site is to expand our understanding of the food environment for reef manta rays by investigating the biomass, size and composition of the zooplankton community upon which the manta rays feed. Reef manta rays can aggregate in this small bay in their hundreds, and they exhibit a range of feeding strategies to exploit the dense prey patches in these waters, including group feeding behaviours. It is also our aim to understand how changes in biomass and composition may influence the animals feeding strategies at this location.

We have only just got our samples back into the lab and are starting the process of analysis. Initial results reveal magnitude changes in biomass within hours, so watch this space to see what secrets we uncover about the tiny, complex, beautiful prey of these large highly mobile plankton feeders.

Top: The steep change in zooplankton biomass between samples.

Middle: Collecting zooplankton in Hanifaru Bay, Maldives.

Bottom: Manta rays feed in dense patches of plankton.



A selection of our favourite images from 2017
Images by: Julian Uribe-Palomino



Porcelain Crab Larva



Female Copepod, *Oithona plumifera*



Octopus Larva



Male Copepod, *Candacia discaudata*



Mollusc, *Limacina* sp.



Pteropod
Diacria danae



Female Copepod (with eggs), *Euchaeta rimana*



Female Copepod , *Pareucalanus sewelli*

1 mm