IMOS

marinematters

Integrated **Marine Observing** System

ISSUE 28 | DECEMBER 2017

Introducing the new IMOS Sub-Facility, Surface Waves.

Surface Waves will calibrate, collect and distribute ocean surface wave data from current and next-generation satellite missions.

Predicting the abundance of sharks along the NSW coast.

Congratulations to the IMOS Christmas e-card competition winner, Alice Hardy.

Results from the National Ichthyoplankton Monitoring & Observation (NIMO) project.

director's corner

Welcome to the final edition of *Marine Matters* for 2017. IMOS ends the year in very good shape. The stories featured here serve to illustrate how the national marine and climate science community is making fantastic use of our infrastructure, being both highly productive and highly relevant to Australian society.

Though it happens much less often these days, on occasions we still have to dispel the 'urban myth' that IMOS is just about physical oceanography. It is true that the heritage of ocean observing systems comes from the need to understand the role of ocean physics in the global climate system. IMOS, however, was set up from the outset to observe physics, chemistry and biology, across scales from the open ocean, onto the continental shelf and into the coast. It now recognised around the world as an exemplar for how to implement integrated marine observing at a continental scale.

The value of investing in biological datasets and time series is very evident in this edition. The Animal Tracking Facility, Autonomous Underwater Vehicles (AUV) Facility, and National Reference Station Network are three of our 'backbone' facilities. Here we have implemented national systems of representative sites that provide valuable data in their own right, but also act as aggregators and integrators for larger national communities. This is now enabling important work in Commonwealth Marine Parks, on the distribution and abundance of sharks, on the exploitation of reef fish, and on long term trends and changes in larval fish communities.

Of course, the physics of the global ocean remains fundamentally important. Through the Satellite Remote Sensing Facility, IMOS invests in calibration and validation for international satellite constellations, and delivery of national products and services with broad application. In this edition, we feature globally significant work on accurate measurement of sea level, use of exiting new Japanese satellite data providing higher frequency measurements of sea surface temperature, and a new activity in ocean surface wave data from satellites.

The need for surface wave data has been articulated through the **Forum for Operational Ocean Oceanography** (FOO). FOO has rapidly become an important mechanism for IMOS engagement with marine industries. Significant levels of IMOS observations are collected in near real time e.g. from the international satellite missions, as well as Argo profiling floats, gliders, moorings, tagged animals etc. By making all of the data openly accessible, we can enable use and reuse of research data in delivery of operational products and services for the benefit of Australia's valuable and rapidly growing 'blue economy'.

We hope you enjoy reading this edition of Marine Matters, and wish you and your families a safe and happy festive season.

Tim Moltmann

Rob Harcourt, Macquarie University

Launch of the new look Highlights document

This Annual Highlights document covers the eleventh year of operation. It has been a year of significance for IMOS as a national research infrastructure. This year, we have structured the Annual Highlights document into four sections, consistent with our Five-Year Plan i.e. broadscale, backbone, regional and national.

Broadscale facilities play a vital role in connecting IMOS to the global ocean observing system. This brings tremendous benefits through access to additional observations, data and knowledge from many international collaborators. Understanding local issues such as future sea levels in Australia's coastal cities, and future ocean temperatures on the Great Barrier Reef, relies on access to this global information.

Backbone facilities provide a centrepiece for IMOS as a national collaborative research infrastructure. By focusing on building large datasets and long-time series for widespread use and reuse, they create mechanisms for science communities to come together in ways that simply were not possible in the pre-NCRIS era. We now see the animal tracking community making great use of the 70 million detections of 125 species built up in a national database. We see the benthic ecology community making great use of 4 million, precisely georeferenced images collected by the Autonomous Underwater Vehicle facility. Importantly, we see these science outputs being used in policy and management e.g. to assess the State of the (Marine) Environment, and the status of threatened, endangered and protected species.

Regional facilities enable IMOS to intensify effort in areas of high social, economic and environmental value. They are central to the highly productive partnership that IMOS has fostered with the ocean modelling community. This is particularly important because decision makers need ocean forecasts and scenario models to determine what to do next. By making these more accurate and less uncertain, IMOS observations and data can impact the future. Annual highlights demonstrate the relevance of IMOS on the Great Barrier Reef, the New South Wales coast, the Great Australian Bight, and the West Australian coast.

National facilities enable IMOS to be much more than the sum of its parts. A fundamental component is our unerring focus data discovery, access, use and reuse via the Australian Ocean Data Network (AODN). AODN is now officially recognised as Australia's ocean data facility, both nationally and internationally. Access to 'non-IMOS' data via AODN grew impressively over the past year, and this is key to how we will increase use and impact over time. IMOS *OceanCurrent* adds value to observations and data by providing daily products of interest to the scientific community as well as to other users, such as fishers, sailors and ocean swimmers.

All of the achievements of the past year were underpinned by continued, excellent performance of IMOS operating institutions. The program had 295 milestones for the year, of which 90% were achieved and a further 6% in progress at 30 June 2017. An outstanding effort by all of the scientific, technical and administrative staff involved in running the program on a day to day basis.

The Annual Highlights document was published online and is available to download and read at **http://imos.org.au/highlights.html**

Report on National Ichthyoplankton Monitoring & Observation (NIMO) project

WRITTEN BY: Iain Suthers, James Smith, Tony Miskiewicz, Anthony Richardson, Francisco Neira and Ana Lara-Lopez

The seasonal occurrence of larval fish (phenology) is a useful metric for assessing the rapidly changing marine climate. Phenology of ichthyoplankton is a tangible outcome of changing fish reproduction and species distributions. In 2015 the Australian Fisheries Management Authority (AFMA) funded a project to examine if useful trends can be gleaned from long-term observing of larval fish communities. We were tasked to assemble the historical data on larval fish collections; and to begin collecting larval fish assemblages on the monthly trips to the IMOS National Reference Stations. The existing zooplankton samples from the NRS use a smaller net with finer mesh. When fish larval concentrations are only 1 to 2 m^{-3}, a bigger net was needed to sample greater volumes, without compromising the logistics of the small NRS boats.

We held a workshop in Hobart in December 2015, to determine a standard list of 218 distinctive or important taxa (from 144 families) for temperate Australia (there are over 5,000 species of fish around Australia). Valuable input came from a Fisheries Research and Development Corporation (FRDC) project of larval fish distributions (Bradford & Bruce 2001), although that concentrated on 40 commercial species.

Historical data. We have now assembled 11 high-quality data sets from temperate Australia (see Figure 1), recording 480,000 larvae from as early as 1983, with each data set sharing the same standard species list. There were clear 'indicator species' across latitude along the east coast, including lutjanid snapper in the north of NSW and QLD, silver trevally and redfish at mid latitudes of NSW, and jack mackerel near TAS. A key gap in this historical data is regular seasonal sampling, to detect inter-annual trends in phenology, which is why the NRS sampling is so important.

NIMO-NRS sampling. At five of the IMOS National Reference Stations we use an 85 cm diameter net with 0.5 mm mesh, sampling 300-500 m^3 over a 10-minute tow at 3 knots. At each NRS, three samples are collected – an offshore and nearshore sample; and a second offshore sample preserved in ethanol for future genetic analyses.

Initial analyses for just the east coast revealed that the North Stradbroke Island (NSI), Port Hacking (PH), and Maria Island (MAI) NRS have different larval fish communities than what was historically present. In particular, MAI has become more similar to northern and mid latitudes (NSI, PH), and there was evidence from MAI of a southward shift in the spawning of some temperate fish taxa: namely the appearance of larval sardine and wrasse, and an increased abundance of anchovy. Such shifts in species composition may help interpret causes of changes in adult fish communities (such as distinguishing environmental and fisheries-related causes).

Recently an intern at UNSW, Karen Pendleton submitted her report on the eastern NRS data from late 2014, 2015 and 2016. A total of 7,961 individual larvae were identified comprising 131 taxa (97 families and 1 order) across all years and sites from Sep 2014 to Dec 2016 (see Figure 2).

Karen observed a clear latitudinal pattern in abundance, species richness and diversity, with higher abundance, species richness and diversity observed at northern and mid latitudes of NSI and PH, compared with MAI. Clearly, there is a useful ecological signal, even when only sampling once per month at the three eastern NRS (see Figure 3). Distinct larval fish assemblages were associated with each NRS region and distinctive taxa

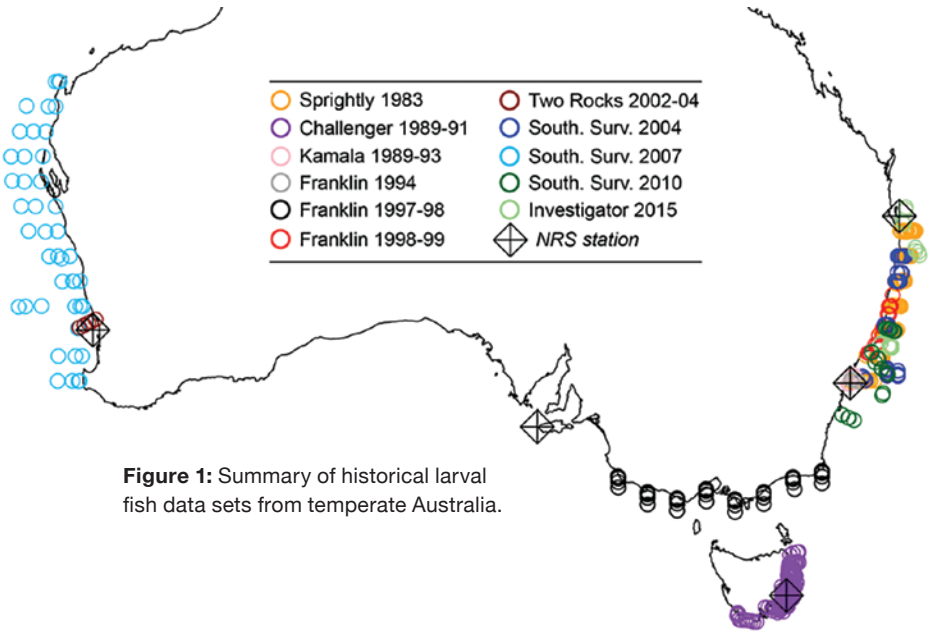


Figure 1: Summary of historical larval fish data sets from temperate Australia.

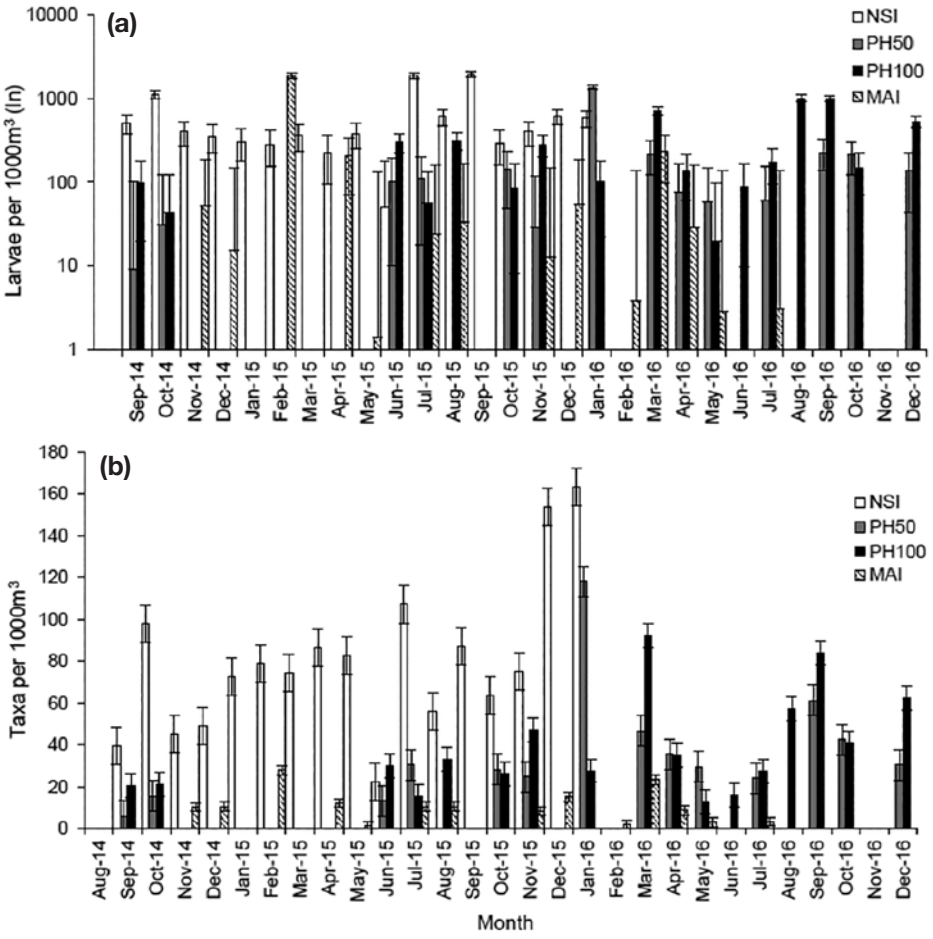


Figure 2: (a) Total larvae and **(b)** total taxa from east coast NIMO, for those sorted-ID'd samples from Sept 2014 to Dec 2016 at North Stradbroke Island (NSI); Port Hacking 100 and 50 m stations (PH); Maria Island (MAI).

were found inshore (PH50) and offshore (PH100). Sampling nearshore and offshore stations at each NRS improves the assemblage representation each month.

Analysis also revealed assemblages associated with seasons – this is a key step that the historical data needs. Without understanding the seasonal variation, it is impossible to estimate the significance of long-term trends. An exciting outcome will be a latitude by season matrix of some key taxa, showing the potential for a signal in larval communities to be detected as fish reproduction shifts in time and space.

Acknowledgements. We are especially grateful for the enthusiasm and can-do attitude of the boat crews working the monthly NRS trips, led by Frank Coman (NSI); Tim Ingleton (PH); Claire Davies (MAI). We acknowledge the financial support of AFMA and the many volunteers including Micheli Costa, Evan Leonard, Thomas Males, Harshitha Sriramachandra Kumar, Derrick Cruz and Anna Burke who have sorted and help identify samples over the past three years.

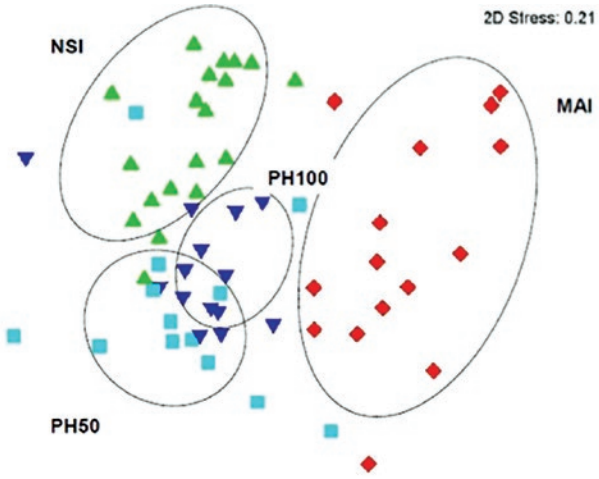


Figure 3: A multivariate representation of more abundant NIMO taxa (MDS) showing the difference among NRS.

Larval fish from the Bothidae family.

J. Uribe-Palomino, CSIRO-IMOS

IMOS Christmas Card competition

As a national infrastructure facility, IMOS is committed to education and training, and to informing society and government decision makers about the changes we see in Australia's marine systems.

Competition winner Alice Hardy.

Dr Ana Lara-Lopez, the IMOS Scientific Officer and Dr Patricia Miloslavich, Project Officer of the GOOS Biology and Ecosystems Panel, also believe we have a role to play in engaging our local community and in particular younger audiences. So, this year they organized a small-scaled competition for primary school children to design our annual IMOS Christmas e-card.

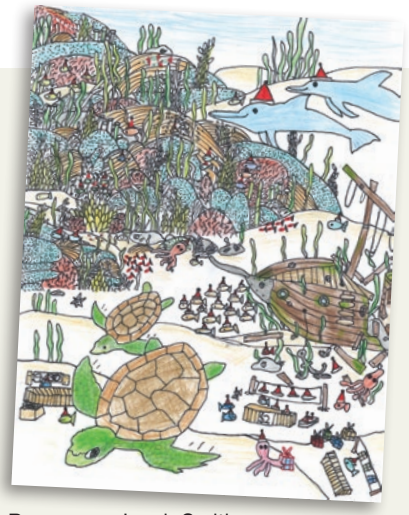
"IMOS has the potential to inspire and nurture the aspirations of young children to extend their knowledge of marine science and technology through engaging more actively with primary schools," says Dr Lara-Lopez.

"We enjoyed the opportunity to speak to the children about the wonders that lie beyond the coast and below the surface of the ocean, and how important they are for our well-being."

Initially this competition has been run in three primary schools close to the IMOS headquarters in Hobart. During November members of the IMOS office went out to the participating schools to present talks about IMOS; describing the observations that IMOS carries out in Australia's seas, and to introduce young students to marine life and the technologies used to describe the environment where they live.

▲ The winning drawing by Alice Hardy from South Hobart Primary.

◀ The finalists in the Christmas e-Card competition, with Dr Ana Lara-Lopez and Dr Patricia Miloslavich, on their tour of the RV *Investigator*.



Runner up: Jacob Smith, Waimea Heights Primary.

Runner up: April Southgate, Albuera Street Primary.

Inspired by the presentation students from South Hobart, Waimea and Albuera Street schools produced an amazing array of beautiful artworks. The schools selected the grade finalists which were then sent into the IMOS office for the final voting for the winner.

The IMOS office would like to congratulate all of the finalists, who for their excellent drawings, received a guided tour of the Marine National Facility the RV *Investigator*.

The winner of the 2017 IMOS Christmas e-card competition is Alice Hardy from South Hobart Primary. As well as the tour of the *Investigator* Alice wins a gift voucher from a local toy shop, and of course her drawing will be sent out as the IMOS Christmas e-card. This reaches hundreds of stakeholders interested in observing the ocean, around Australia and across the world.

New SST images with Himawari-8

IMOS *OceanCurrent* has developed 4-hour composite Sea Surface Temperature (SST*) based on the Bureau of Meteorology's experimental Himawari-8 product. The first images are very promising.

Himawari-8 is Japan's advanced geostationary weather satellite that provides a 'full disc' scan of Earth every 10 minutes. Fortunately for us, the centre of this view (at longitude 140.7°) is close to us.

The result is an SST product spanning 80°E to 200°E with a resolution (2–4 km at the equator) that is nearly as good as the low-earth orbit NOAA satellites. Cloud is, of course, the bane of observers of satellite SST and Himawari-8 cannot see through cloud, but with so many looks there is a much better chance to piece together a clear view.

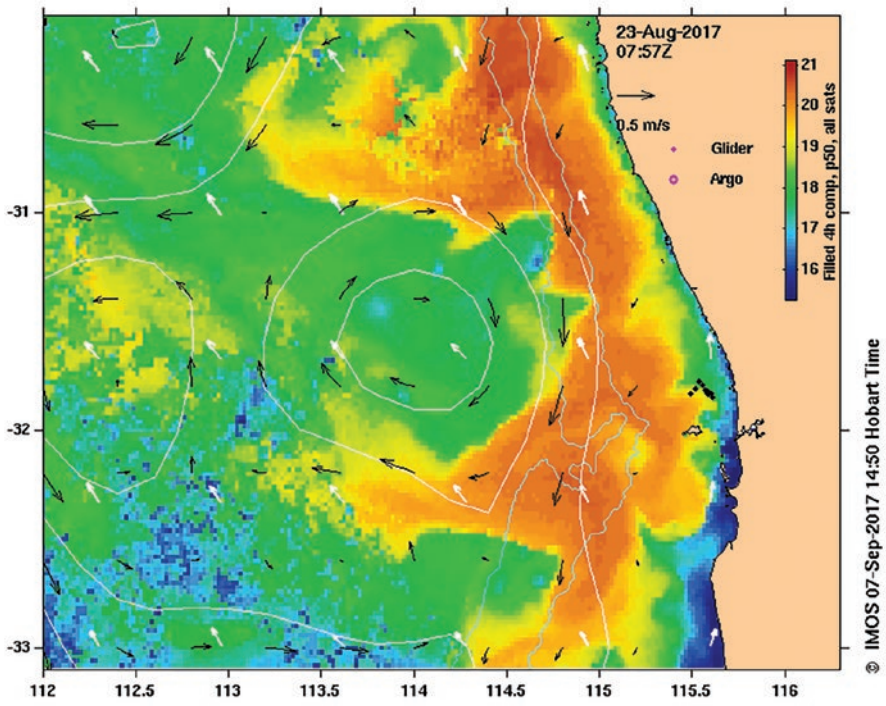
The image (below) is from an **animated gif** of 48 hours of the 4-hour composites offshore from Perth, WA. It shows tiny eddies, about 10 km in diameter, being swirled around the large cyclonic eddy in the centre of the image. There are also a couple of tiny eddies just to the southeast of the central eddy.

Eddies of this size have certainly been seen before but the presence of so many suggests they are much more prevalent than we thought and that they play an important part in mixing between two water masses. Also, the movement of these tiny eddies demonstrates not just the complexity of the SST but also of the surface velocity field.

Note, the black vectors indicate the geostrophic surface velocity and the white vectors indicate wind direction. See also: the Bureau of Meteorology's **viewer** and **information page**.

* All available satellite SST (including NOAA15, NOAA18, NOAA19, VIIRS and MODIS) is used in the composites to get the best coverage to the coast.

This article, by Madeleine Cahill, originally appeared in IMOS OceanCurrent News.



New South Wales IMOS:

Predicting the abundance of sharks along the NSW coast

WRITTEN BY: KATE LEE

After a series of shark attacks along the northern NSW coast, the state government committed $16 million over 5 years to research shark detection and mitigation measures, as well as to understand their movements and what oceanographic processes correlate with areas of high shark abundance.

Part of this funding, together with a Research Attraction and Acceleration Program (RAAP) grant awarded to the Sydney Institute of Marine Science (SIMS), was dedicated to a postdoc position to determine the main oceanographic drivers of the movement of 'potentially dangerous' sharks (bull, white and tiger sharks) and to subsequently build predictive models to help shark mitigation measures.

Dr Kate Lee, based at SIMS, has been analysing both long-term datasets of shark catches from the NSW shark meshing program (more information at **https://www.dpi.nsw.gov.au/fishing/sharks/management/shark-meshing-bather-protection-program**) and shorter-term tracking datasets (of bull and white sharks) and aerial surveys conducted by NSW DPI.

Using satellite data from the Australian Ocean Data Network (AODN) Portal, along with physical datasets from NSW-IMOS partners, this research has identified species-specific drivers highlighting the complexity of mitigating risks from multiple shark species.

Bull sharks are only present along the NSW coast in the summer and early autumn, when the coastal waters are warmest, and annually return to where they were tagged. In contrast, white sharks are most abundant during the spring and early summer when water temperatures are around 17-18°C.

Surprisingly, neither of these species are associated with mesoscale eddies that dominate this region of the East Australian Current. However, further analyses still need to be conducted.

IMOS has been invaluable to conduct this work. The ready availability of satellite and physical datasets on the AODN Portal have made integrating the animal and oceanographic data seamless. Furthermore, the number of researchers contributing to the IMOS Animal Tracking Facility database has allowed the movements of tagged sharks to be monitored along the entire NSW coast.

The results from this project, along with the data available from the AODN Portal, will be integrated into future shark mitigation measures and help identify periods of high shark abundance along this populated coastline.

NSW DPI Fisheries

Southern Australian IMOS:

Real-time ocean forecasts with new eSA-Marine system

South Australia's fishing, aquaculture and other marine industries now have access to high resolution real-time ocean forecasts of ocean currents with the development of eSA-Marine, a revolutionary mapping system underpinned by IMOS observations and data.

Led by researchers from the South Australian Research and Development Institute (SARDI), the research division of Primary Industries and Regions SA, in partnership with the Bureau of Meteorology and the University of Adelaide, eSA-Marine provides forecasts of sea level, water temperature, ocean currents, and wind.

Benefits of the eSA-Marine system

The eSA-Marine system can be used for a range of purposes and may help fisheries, aquaculture and other users of SA's marine environment to:

- predict the trajectories of harmful algal blooms/toxins to allow for mitigation
- save vessel fuel through the prediction of environmental variables important to fishery habitat
- predict marine heat waves and possible fish mass mortalities
- predict ocean conditions to help with aquaculture and maritime maintenance
- predict storm surges and flooding
- help ship routing to save fuel
- help with search and rescue effort
- research into ocean circulation and marine ecosystems.

South Australian Minister for Agriculture, Food and Fisheries Leon Bignell says "eSA-Marine provides a real-time view of ocean conditions from the convenience of our screens. I'm excited to see how eSA-Marine is used by industry to enhance safety and management of our fisheries and aquaculture sites."

To meet the challenge of managing Australia's fisheries and aquaculture, the science underpinning it must be collaborative and integrated to develop improved tools for managers for better decision-making.

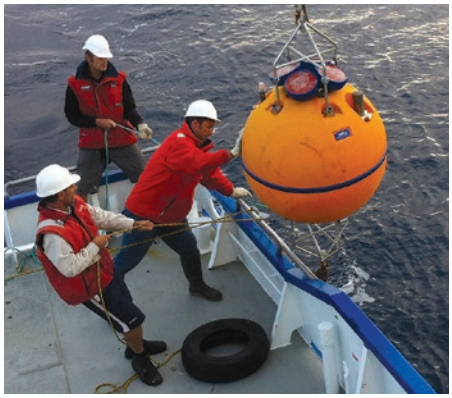
The model/data comparisons and model validation behind eSA-Marine are made using satellite SST, sea surface height anomaly (altimeter) data and any available Argo temperature and salinity profiles for both the Southern Australian Regional Ocean Model (SAROM) historical re-analysis and for the real-time data assimilating now-casts and forecasts. In addition, hind-cast comparisons are to be made with mooring data (currents, temperatures etc) as well as CTD casts obtained through the Southern Australian Integrated Marine Observing System (SAIMOS) that is led by SARDI.

"Having led the development of eSA-Marine from its inception, it is satisfying to see this research readily accessible and available to our fisheries, aquaculture and maritime industries," says SARDI researcher, Professor John Middleton.

"eSA-Marine is a unique forecast system, and is in fact one of only two in-shore ocean data assimilating forecast systems in Australia," says Professor Middleton.

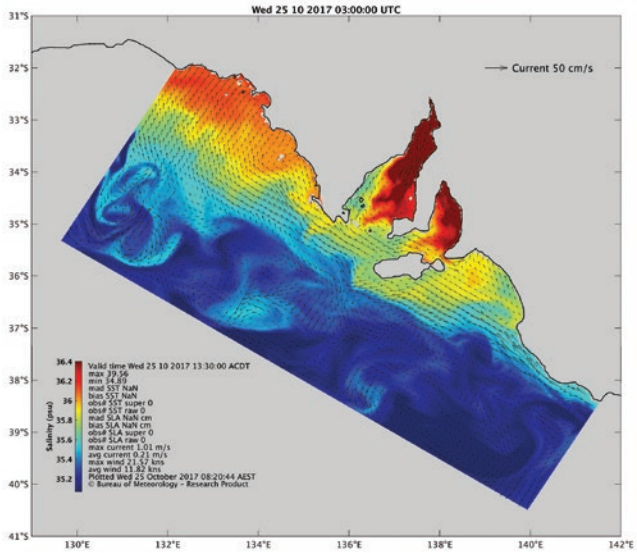
This project was funded by the Fisheries Research and Development Corporation and the Australian Southern Bluefin Tuna Industry Association.

The information is readily available to the public, industry and government on the **Primary Industries and Regions SA website**.

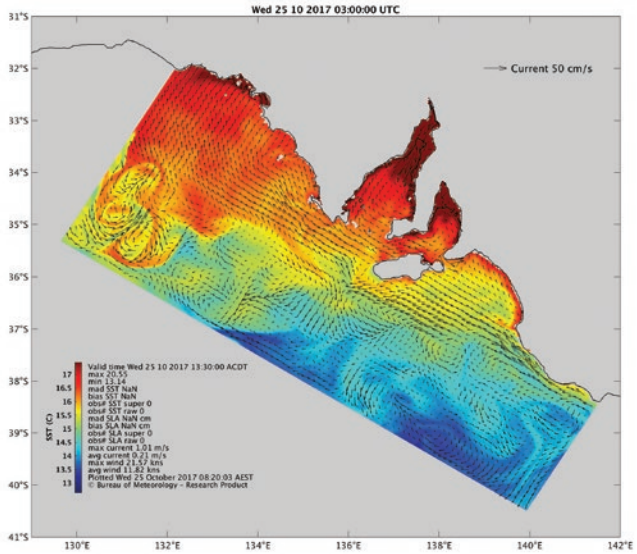


Paul Malthouse, SARDI

Oceanographic mooring being deployed in South Australia.



An example of one of the Southern Australian Regional Ocean Model (SAROM) sea surface salinity and currents maps.



An example of one of the Southern Australian Regional Ocean Model (SAROM) sea surface temperate maps.

Argo: IMOS welcomes Dr Peter Oke in his new role as the Argo Facility leader

Since completing his PhD in coastal ocean modelling at UNSW, in 1998, Dr Oke undertook two Postdocs – one at Oregon State University, where he developed a coastal ocean forecast system for the US West Coast that assimilated HF radar data; and a second Postdoc at the University of New South Wales, where he undertook research in coarse-resolution global ocean modelling.

Dr Oke joined CSIRO in 2002, and developed the ocean data assimilation system that underpins various forecast and reanalysis systems under Bluelink – a partnership between CSIRO, the Bureau of Meteorology, and the Department of Defence. The data assimilation system that Peter developed is used to underpin the Bluelink ReANalysis (BRAN), and OceanMAPS – the Bureau's operational ocean forecast system.

Dr Oke said that "development of a data assimilation system for the global ocean means that you have to get your hands dirty with all types of observations. I've worked in the weeds of satellite data, Argo data, XBT data, and so on – and developed an appreciation for the value of ocean observations, and the challenges."

"A key challenge for the Bluelink project is delivery of ocean forecasts and reanalyses that are fit-for-purpose – and that's only achievable by exploiting all available ocean observations", Dr Oke recalls.

"The role that IMOS plays in supporting the Argo Program, Ship of Opportunity measurements, and satellite oceanography – including calibration and validation – have been incredibly important to Bluelink."

"I'm really excited to formerly join IMOS as the new Argo Facility Leader. I'm hoping to build on the past success of the Argo team, and to strengthen the engagement between ocean forecasting and IMOS."

Dr Peter Oke

Ocean Gliders: Underwater glider sets world distance record

The Challenger mission set out to send an underwater glider from Fremantle, Western Australia to Galle, Sri Lanka. The challenger glider, also known as RU29, reached Sri Lanka in early October after 330 days at sea, setting a new world record for distance travelled – 7,570 km.

The time the glider spent at sea (330 days) was a record for Rutgers University glider missions. It covered a distance of 7,570 km, setting a new world record for an underwater glider flight. This beats Rutgers University's own record of 7,420 km set by another glider, RU27, in 2009. In addition to this, even after 330 days at sea there was virtually no biofouling of the glider, it looked the same as the day it was deployed – give or take a couple of random barnacles.

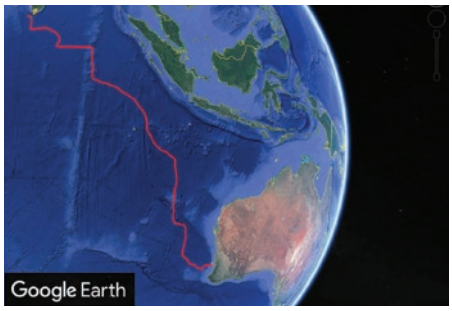
This journey completes Leg 1 of the Indian Ocean Circumnavigation led by Rutgers University with support from the University of Western Australia at sea and the Universidad de Las Palmas de Gran Canaria on shore.

Challenger was welcomed at a special ceremony in Colombo, Sri Lanka, on October 2, 2017. In attendance to welcome the glider and read its cargo of letters of support for its journey, were Dave Aragon, Travis Miles and Scott Glenn (Rutgers University), Michael Cragun (US Embassy Representative), Hon Eran Wickremaratne (Sri Lankan State Minister for Finance), Hon Bryce Hutcheson (Australian High Commissioner) and IMOS Ocean Glider Facility leader, Professor Chari Pattiaratchi (University of Western Australia).

Challenger was then redeployed on Leg 2 of the mission, a 7,000 km flight from Sri Lanka back to South Africa, where the team will test new battery packs and the ability of a thruster to help navigate the strong currents of the Agulhas system. The mission is a component of the **International Indian Ocean Expedition-2** (IIOE-2).

One year from now, the team hopes to again deploy Challenger on the most ambitions mission to date, an 8,400 km flight from South Africa back to Perth, Australia, during which models of the Antarctic Circumpolar Current will be tested in preparation for even grander missions in the future.

The data gathered by Challenger will enable scientists to see how conditions in the Indian Ocean have changed over time. Temperature and salinity at specific depths and locations recorded by Challenger will be compared with measurements taken up to 40 years ago. These comparisons will help scientists to predict ocean conditions and their impact on climate.



The journey of the Challenger mission.

Challenger Ocean Glider Welcome Ceremony, Colombo, Sri Lanka. October 2, 2017. Pictured Left to Right: Dave Aragon (Rutgers University), Travis Miles (Rutgers), Michael Cragun (US Embassy Representative), Hon Eran Wickremaratne (Sri Lankan State Minister for Finance), Hon Bryce Hutcheson (Australian High Commissioner), Chari Pattiaratchi (University of Western Australia), Scott Glenn (Rutgers University)

Autonomous Underwater Vehicles:

IMOS AUV captures an unusually large group of Port Jackson sharks in the Beagle Commonwealth Marine Reserve

Asher Flatt

This was the tenth mission in Tasmanian waters for the IMOS AUV Sirius, which is operated by engineers from the University of Sydney and the Australian Centre for Field Robotics.

An unusually large assemblage of Port Jackson sharks was a surprise highlight for scientists surveying life in the Beagle Commonwealth Marine Reserve (CMR) earlier this year.

Hundreds of the distinctive, dark-striped sharks were massed on the sandy seafloor among low rocky reefs covered with brightly coloured sponges.

"This is the largest aggregation of Port Jackson sharks I've ever seen," research leader Neville Barrett of the University of Tasmania Institute of Marine and Antarctic Studies (IMAS) says.

"While these sharks (known as 'Sleepy Joes') often gather in places like ledges and appear to sleep, they are very rarely seen in numbers more than half a dozen, so this aggregation appears unique.

"We know they lay their eggs further north (typically mid to southern NSW) in August to September, so they were unlikely to be spawning, but it may have been a mating aggregation where the eggs are first fertilised.

"This is a valuable insight to their biology, and given that this CMR is protected from potentially disruptive activities (such as trawling), it shows that a species such as this may benefit from such closures, particularly at vulnerable life history stages such as mating."

The Beagle CMR reaches across Bass Strait from south-east of Wilson's Promontory to north-west of Flinders Island, covering almost 3000 square kilometres of seafloor in depths of 50–70 metres.

Examples of its rocky reef habitats were surveyed using the IMOS autonomous underwater vehicle Sirius during July as part of a pilot survey nested within a 10-day research voyage of the Australian Maritime College (AMC) research vessel Bluefin off Tasmania.

The voyage was part of national surveys run by the Integrated Marine Observing System and the National Environmental Science Programme Marine Biodiversity Hub to survey and monitor seafloor life beyond diving depths in the waters of Australia's continental shelf. It was supported by funding from Parks Australia which manages the Commonwealth Marine Reserve Network.

While only one day was able to be spent in the Beagle CMR due to weather constraints, the information gathered will be invaluable for planning a more comprehensive survey in this CMR in 2018.

The sponge garden surveys were carried out using the IMOS AUV. Images taken by Sirius reveal that while reef outcrops in this region are rare, they support an incredible density and diversity of sponge species.

"An important aim of the survey was to gain insights into the distribution and nature of sponge habitats in this region," Dr Barrett says. "Before the survey we had no biological data on seabed habitats in the Beagle CMR, an area smack in the middle of Bass Strait believed to hold a richness of sponge gardens.

"We're just starting to appreciate the important role that sponges play by concentrating the nutrients swept past in the currents, providing a range of food for the other species that live there. We want to understand how fast the sponge communities grow, what sort of things influence them, and whether their cover changes a lot from year to year."

After encountering wild weather in Bass Strait, the Bluefin headed south to the Flinders CMR off eastern Tasmania to conduct repeat surveys at core reference sites near Cape Barren Island.

"With repeated surveys we can get a reasonable understanding of natural variability: how change is driven by ocean currents, temperature shifts, storms, introduced species and climate change," Dr Barrett says.

"We can also assess the impacts of human activities such as trawl fishing, scallop dredging, and oil and gas operations, and management interventions such as various levels of protection from fishing."

The Bluefin surveys form part of a long-term observation program on deep water reefs surrounding Tasmania that in turn is part of a larger national program observing reef systems such as these at the continental scale. The overall program is facilitated by IMOS, with IMAS coordinating the Tasmanian component, and AMC assisting with logistical support.

This story was originally published as 'Port Jackson sharks assemble among the sponge gardens of Beagle Commonwealth Marine Reserve', written by Bryony Bennett and published on the NESP Marine Biodiversity Hub website.

IMOS

Part of a large group of Port Jackson sharks pictured by the Sirius autonomous underwater vehicle during a pilot survey of deep rocky reefs in Beagle Commonwealth Marine Reserve conducted from the RV *Bluefin*.

Animal Tracking:

Data from the IMOS Animal Tracking infrastructure is highlighted in a special issue of Marine and Freshwater Research

The special issue showcased the important role that acoustic telemetry plays in the management of aquatic systems across Australia, and highlighted how the IMOS acoustic telemetry network helped to achieve this.

Acoustic telemetry is used to investigate a diverse suite of questions regarding the biology and ecology of a range of aquatic species, and is an important tool for fisheries and conversation management.

The lead paper written by Dr. Matt Taylor presents a brief review of the Australian acoustic telemetry literature in the context of key areas of progress, drawing from several recent studies and identifying areas for future progress. Acoustic telemetry has been increasingly used in Australia over the past decade.

Through the IMOS Animal Tracking Facility there has been substantial investment in a national acoustic array and the associated development of a national acoustic telemetry database (**https://animaltracking.aodn.org.au/**) that enables tag deployment and detection data to be shared among researchers.

Acoustic telemetry has contributed to important areas of management, including public safety, design and management of marine protected areas, the use of closures in fisheries management, informing environmental flow regimes and the impacts of fisheries enhancements, and is most powerful when used as a complementary tool. However, individual variability in movement often confounds our ability to draw general conclusions when attempting to characterise broad-scale patterns, and more work is required to address this issue.

The review paper provides insight into the important role that acoustic telemetry plays in the research and management of Australian aquatic ecosystems. Application of the technology transcends aquatic environments and bureaucracies, and the patterns revealed are relevant to many of the contemporary challenges facing decision makers with oversight of aquatic populations or ecosystems.

The special issue also included several contributions on freshwater systems, however 10 of the 15 papers used the IMOS Animal Tracking infrastructure. The full special issue can be found at **http://www.publish.csiro.au/mf**.

Andrew Boomer, SIMS

Grey reef shark near an IMOS acoustic receiver at Ningaloo.

Australian Ocean Data Network (AODN):

The New South Wales Office of Environment and Heritage (OEH) experience of data submission to the AODN.

In 2016, the Australian Ocean Data Network (AODN) staff worked with the NSW Office of Environment and Heritage (OEH) to enable the AODN to host the Manly Hydraulics Laboratory Waverider buoy data, which had previously been managed by the Royal Australian Navy Hydrography & METOC branch (now known simply as the Hydrography & METOC branch).

Following on from this, the AODN office started working with the OEH staff to publish their NSW bathymetry data on the AODN Portal. Early in 2017, the multi-beam data collection was published, which was then followed by the single-beam data last month:

> **NSW Office of Environment and Heritage (OEH) Multi-beam Bathymetry Surveys**

> **NSW Office of Environment and Heritage (OEH) Single-beam Bathymetry and Coastal Topography Surveys**

These data collections represent the first state government generated marine datasets discoverable through the AODN Portal.

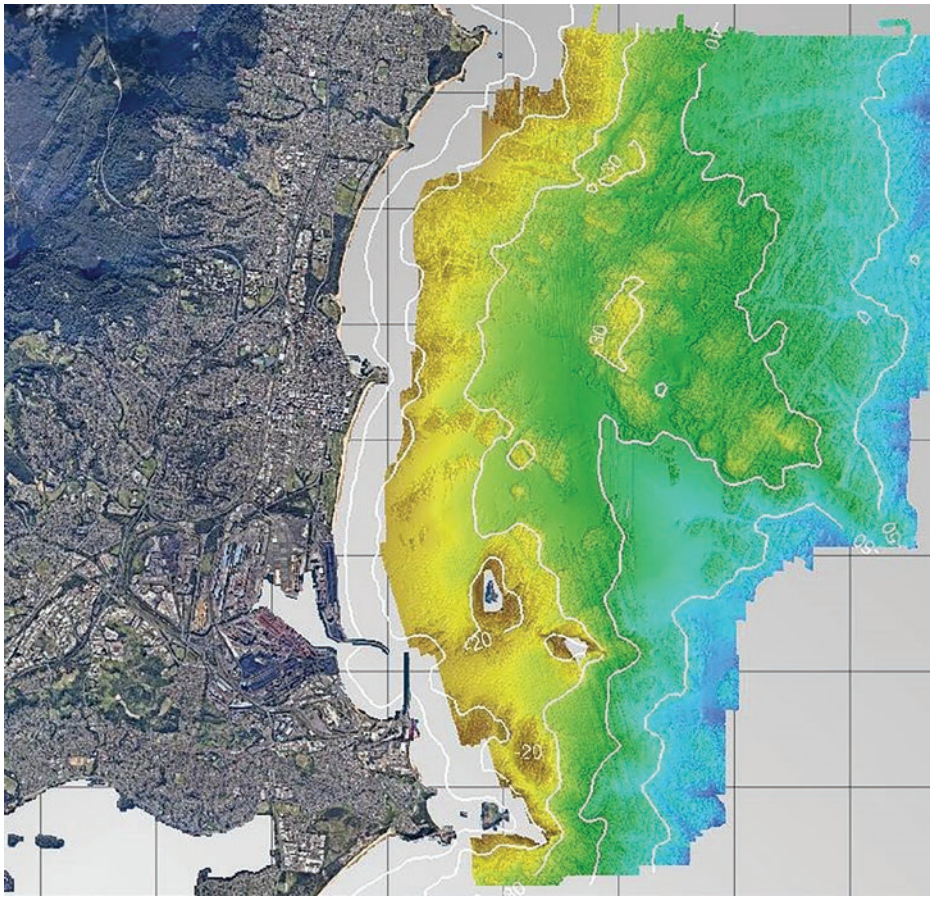
The AODN approached Tim Ingleton and Edwina Foulsham of OEH to recount their experience of submitting data to the AODN:

Access to the AODN and delivery of our datasets on-line is saving 20-30 person days a year! It's also leading to better use and much greater accessibility of our datasets. Last year we fielded between 40-50 data requests for our datasets each taking from an hour to days.

Working with AODN was really simple and very efficient. They set up an FTP staging point that we access through Filezilla using a login and password. With each new dataset, all we had to do was decide on a standardised naming format and write a general metadata statement for the AODN team. They created an automated process on the FTP site to upload the data, check for errors, to provide email reports about successful uploads or to detail issues on our end. Once the FTP site was fully operational, we were able to deliver our entire multibeam survey back catalogue online and we are currently working on making some of our other data collections available.

It was a significant corporate milestone finally getting data up and fully accessible.

Getting bathymetric survey catalogue online has also been supported by NESP.



Tim Ingleton

False-colour bathymetry off Port Kembla harbour and the Five Islands – NSW OEH multibeam data is being collected as part of a Statewide program mapping sediment compartments for improved coastal risk management.

Tim Ingleton

Single beam surveys on jet skis.

Tim Smith

Tim Ingleton with sonar.

Satellite Remote Sensing: Contributions to sea-level rise have increased by half since 1993, largely because of Greenland's ice

The potential impact of sea level rise is well documented with around 250,000 Australian homes and much of the related transport, energy, communication and waste infrastructure vulnerable to a 1.1 metre sea level rise.

Global mean sea level has been rising at a faster rate during the satellite altimetry period (1993–2014) than previous decades, and is expected to accelerate further over the coming century. However, the accelerations observed over century and longer periods have not been clearly detected in altimeter satellite data spanning the past two decades.

A recent study that incorporated IMOS satellite altimeter time series data, has shown the factors contributing to sea-level rise (called contributions) have increased by half since 1993, largely due to an increased contribution from Greenland's ice. This result increases confidence in our altimetry observations (including the associated calibration and validation supported by IMOS) and improves our understanding of recent changes and emerging increases to the rate of sea-level rise.

The study can be viewed here: **'The increasing rate of global mean sea-level rise during 1993–2014'**

An accompanying piece in *The Conversation* can be viewed here: **Contributions to sea-level rise have increased by half since 1993, largely because of Greenland's ice**.

New Sub-Facility joins the Satellite Remote Sensing Facility: Surface Waves

Surface waves have been identified as a key ocean variable for a range of priority activities within the Australian National Marine Science Plan. Furthermore, the need for surface wave data has been articulated through the **Forum for Operational Ocean Oceanography (FOO)**.

This led to the establishment of a FOO working group, which sought to identify current limitations of the existing Australian surface wave observing platforms to deliver impact, particularly in an operational oceanography context. Wave data was consequently identified as an area of potential growth for IMOS.

The IMOS Satellite Remote Sensing Facility is growing with a new Surface Waves Sub-Facility, that will calibrate, collect and distribute ocean surface wave data from current and next-generation satellite missions.

The new Surface Waves Sub-Facility will enhance existing IMOS facilities to deliver national Satellite Remotely Sensed (SRS) wave products to support ongoing and emerging research and operations in Australia.

The Surface Waves Sub-Facility will build Australia's capability in SRS wave data-streams and deliver global validated, processed SRS wave data streams, with a focused effort in the Australian region. Activities will include:

- building on the wave measurements obtained from the Bass Strait altimeter calibration sites for calibration of the current satellite missions in the Australian region,
- using the Southern Ocean Flux Station to validate SRS wave data in the extreme Southern Ocean wave climate,
- delivering historical and near-real-time altimeter-derived significant wave heights to the IMOS *OceanCurrent* Facility, producing daily maps and animations that will be used by researchers and the broader community,
- managing the delivery of wind-wave data derived from altimeter and synthetic aperture radar (SAR) satellite platforms to the Australian marine and coastal science community.

The Surface Waves Sub-Facility will be led by Dr Mark Hemer, a Principal Research Scientist at CSIRO, in collaboration with Professor Ian Young from the University of Melbourne.

"We are entering a period with an unprecedented number of satellites capable of measuring surface waves," says Dr Hemer.

"The IMOS sub-facility will see processing, validation and delivery of these data, which have applications for assessing coastal hazards, the potential impacts of climate change and the implications for coastal risk management, and offshore energy (both for established oil and gas, and emergent renewable sectors)."

"We are entering a period with an unprecedented number of satellites capable of measuring surface waves"

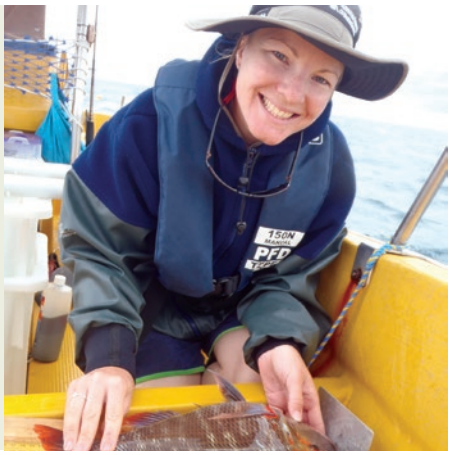
Dr Mark Hemer.

Postgraduate Student | **Leanne Currey**

PROJECT TITLE:

Movement of an exploited reef fish across spatial and temporal scales using multiple methods

James Cook University, AIMS@JCU and Australian Institute of Marine Science



Movement of fishes occurs at multiple spatial and temporal scales, including long-distance migration over multiple years, and daily activity in a home range. The spatial ecology for many reef fishes is little understood, and a better understanding can be gained by using multiple methods to study movements at different scales.

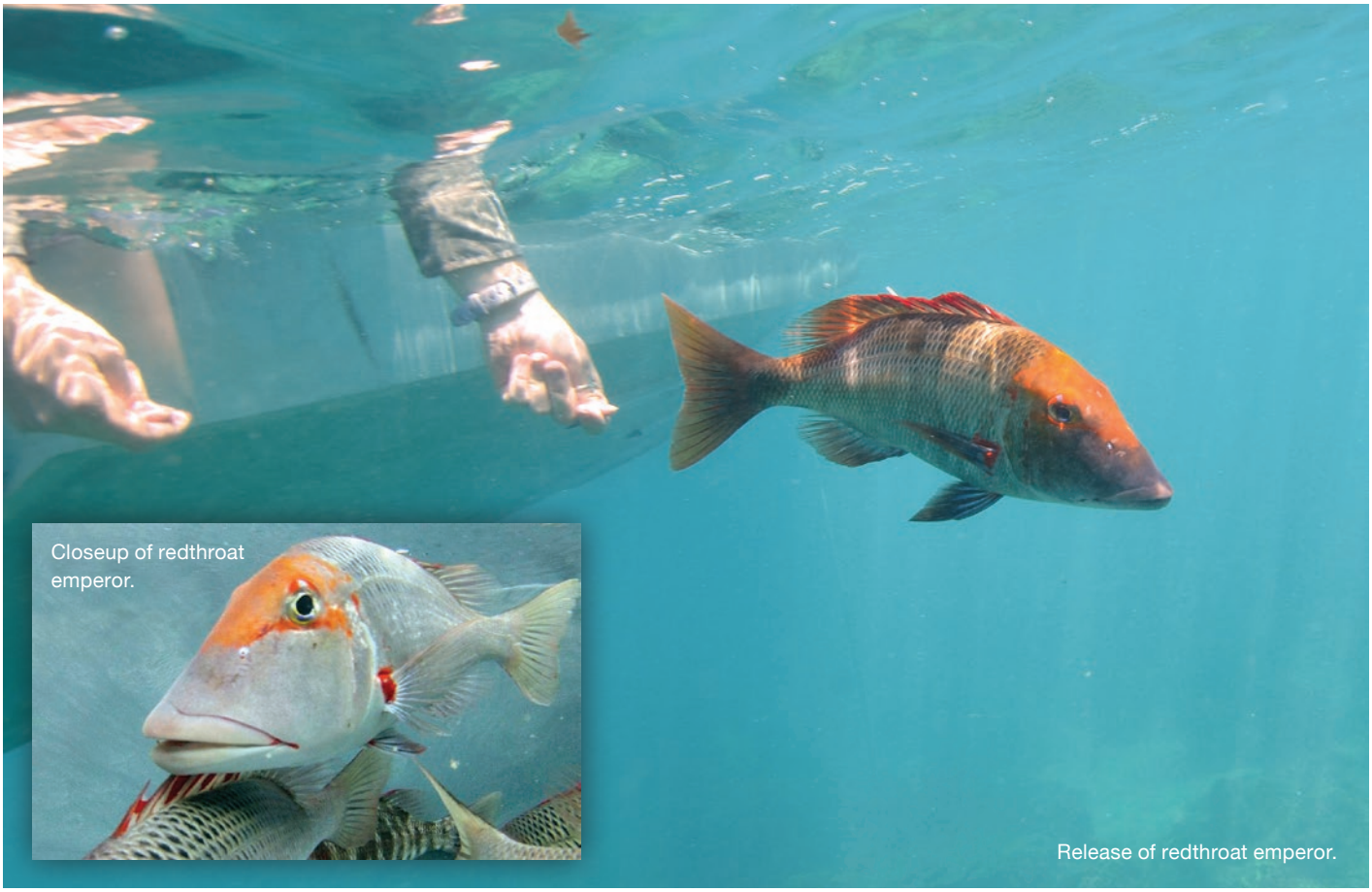
Leanne's PhD research utilised an innovative combination of techniques to identify the scales at which movements of exploited reef fish (adult redthroat emperor, Lethrinus miniatus) occurred, and identified the factors that influenced movement patterns.

Acoustic telemetry was used to monitor movements of redthroat emperor among reefs and finer-scale reef habitats. When within range, adult fish fitted with transmitters were detected by the IMOS Animal Tracking network of underwater receivers (listening stations) around Heron Island Reef. Individual variability in space use was observed, with evidence for long-distance migration for a proportion of the tagged fish (e.g. one fish travelled 180 km), and characteristics of both mobile and sedentary lifestyles around reef platforms (e.g. variation in depth use, high site fidelity).

Reef-scale fish movement was related to environmental parameters monitored at Heron Island using data obtained from other IMOS platforms: the wireless sensor network and a mooring. Individuals were more likely to be present on the reef slope during days of cooler temperature, which indicates a thermal tolerance threshold may exist and is an avenue for further research. Fine-scale space use reflected the nocturnal nature of the species, with larger areas used at night-time particularly during full moon periods, potentially related to foraging behaviour.

Leanne's research highlights that investigation across multiple spatial and temporal scales is required to gain a complete picture of species-specific spatial ecology, and these methods can be applied to other fishes of importance.

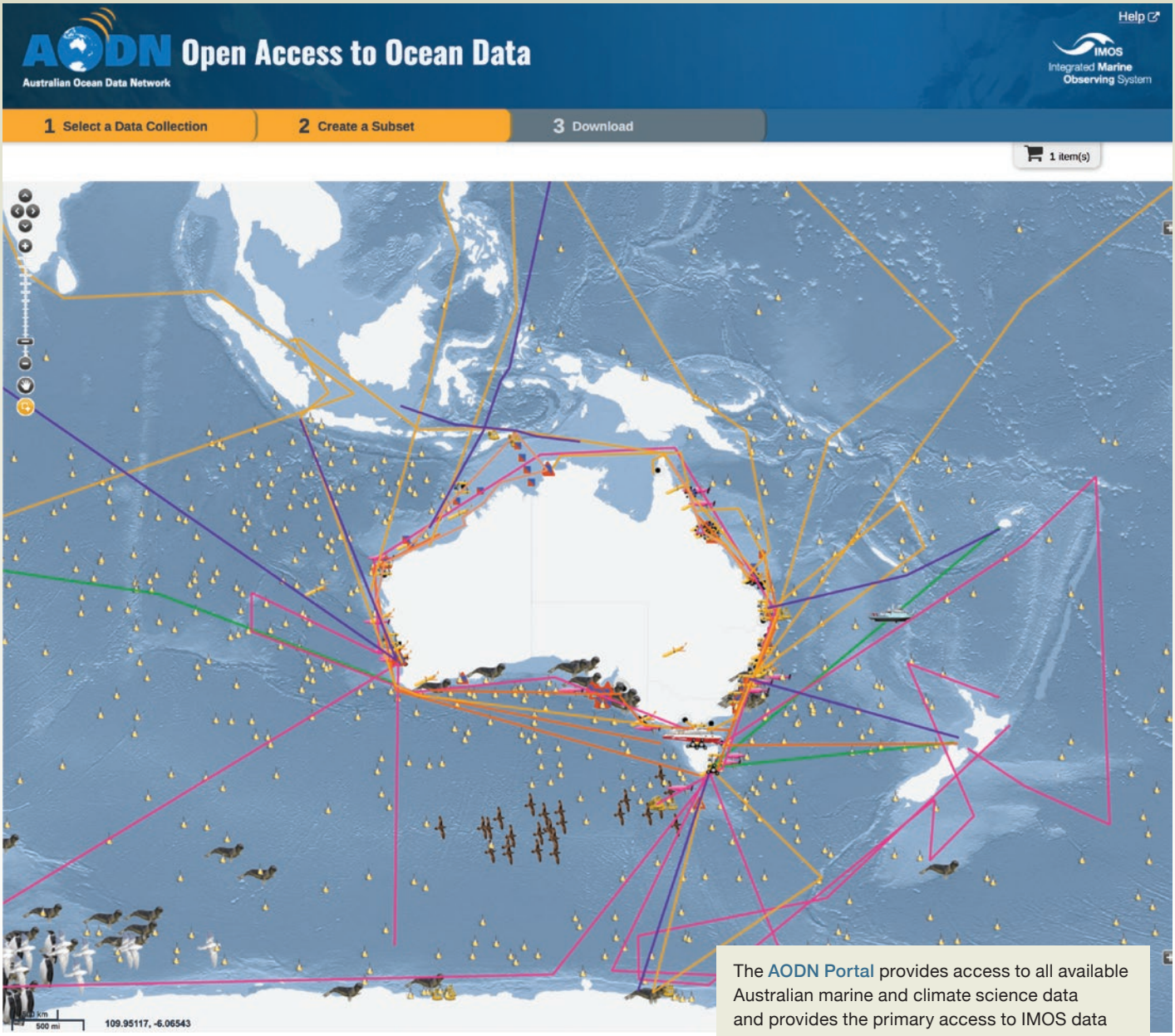
Leanne was supported by an AIMS@JCU PhD scholarship.



Closeup of redthroat emperor.

Release of redthroat emperor.

Michelle Heupel



The AODN Portal provides access to all available Australian marine and climate science data and provides the primary access to IMOS data including access to the IMOS metadata.

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For more information about IMOS please visit the website www.imos.org.au

IMOS

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent.

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