RECENT IMPACT
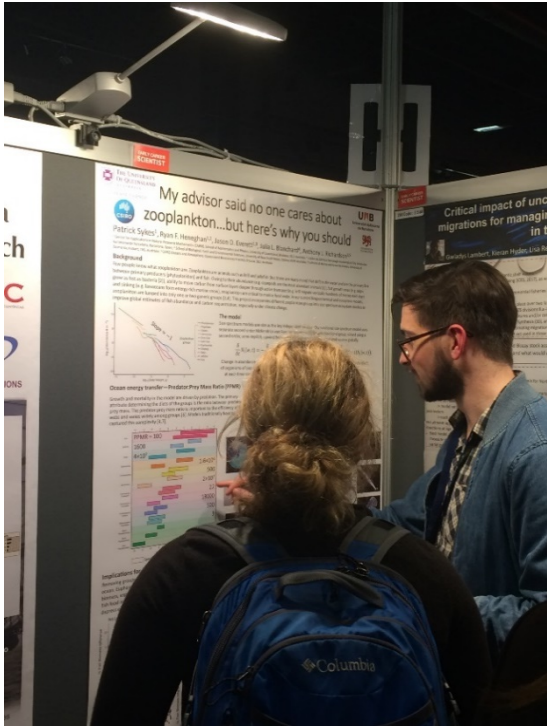
ICES Annual Science Conference in Sweden, September, 2019

Anthony Richardson, Jason Everett and Ryan Heneghan presented talks at the **one-day workshop on "Advances in size spectrum modelling"** and Patrick Sykes presented at the **two-day course on the R package "mizer".** The workshop and course were both held in Lysekil, Sweden at the Swedish University of Agricultural Sciences (SLU) campus.

The CARM team then attended the ICES Annual Science Conference in Gothenburg, Sweden from 9-12 September, 2019. The conference is dedicated to the latest research on marine science.
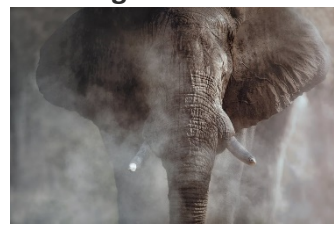
Patrick Sykes and poster ICES, Sweden
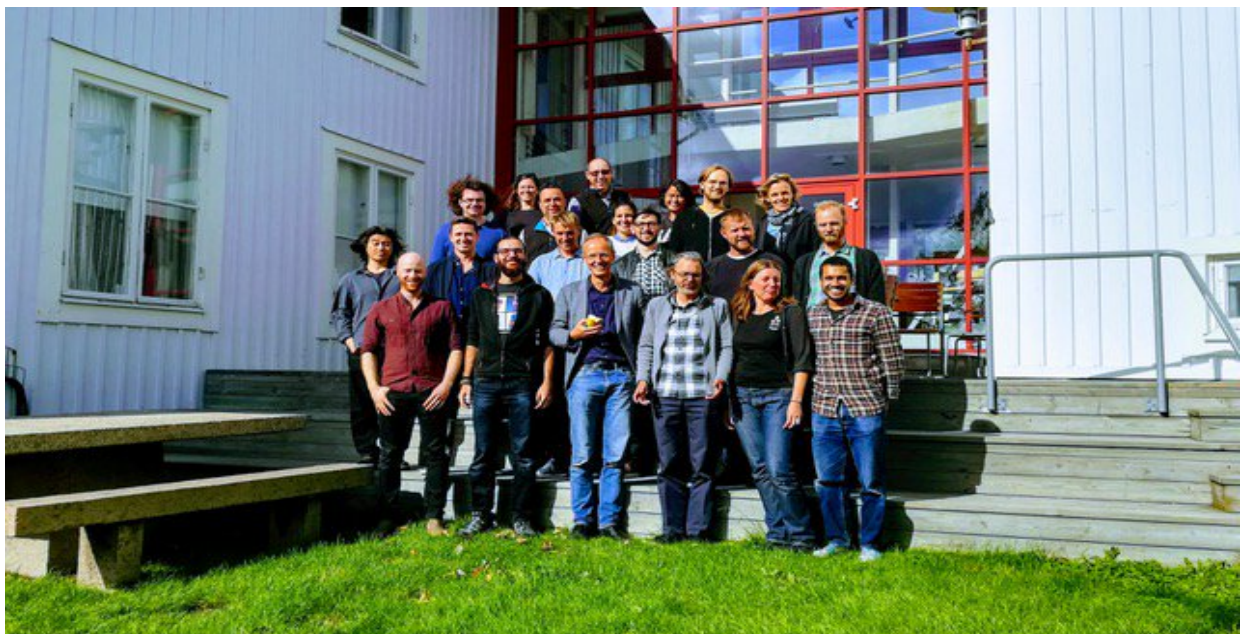
The workshop and course group photo at Lysekil, Sweden

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Breaking the deadlock over Africa's ivory trade.

Matthew Holden and Duan Biggs, Griffith University are using mathematics to break the deadlock over Africa's ivory trade. New approaches to stakeholder discussions focusing on agreed objectives and providing avenues for smaller discussions and working groups provide ways of moving forward with successful resolutions.

The full article can be accessed at the The Conversation

Visit to Australian Mathematical Centres with relevant focus.

Roxanne Jemison was given an opportunity by the UQ, Faculty of Science to visit two other Mathematical Centres specialising in the environment. On Thursday 12th September Roxanne visited Wollongong University to meet the Centre for Environmental Informatics (CEI) team where they kindly presented their research and discussed the workings and culture of the centre.

Michele Boatswain and Karin Karr
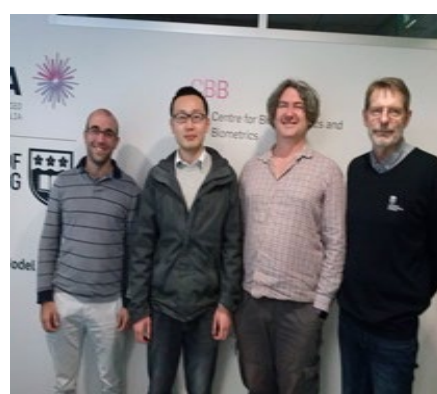
*Andrew Zammit Mangion, James Ng, Matt Moores and Noel Cressie*

Yi Cao

CEI's research focuses on statistical remote sensing, regional methane flux mapping, multivariate stochastic modelling, exceedances and their uncertainty quantification, reproducibility and visualisation in environmental modelling and inference, deep spatial processes for modelling complex environmental phenomena and Raman spectroscopic data analysis.

You can freely download the new book on "Spatio-Temporal Statistics with R" at https://spacetimewithr.org

Bibliographic reference: Wikle, C.K., Zammit-Mangion, A., and Cressie, N. (2019). Spatio-Temporal Statistics with R. Chapman & Hall/CRC, Boca Raton, FL.

Cover Illustration: Julinu (Julian Mallia) www.julinu.com
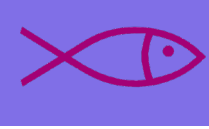
Then to UniSA on Friday 13th September to the Centre for Industrial & Applied Mathematics (CIAM) based at Mawson Lakes, South Australia. CIAM's strengths lie in scheduling and control, environmental modelling, energy saving and renewable energy among the breadth of their research. CIAM Director, John Boland, supervises eight higher degree students. John and his team use mathematical tools to evaluate the benefits of ecological footprints and monitor systems to check that the goals are being fulfilled. That provides opportunities to find out what has worked and what hasn't. John is a member on the Program Committee and Editorial Board for the upcoming International Congress on Modelling and Simulation (MODSIM2019), National Convention Centre in Canberra from 1 – 6 December, 2019. The Congress will provide a great avenue to test concepts with a theme of, "Supporting evidence based decision making: the role of modelling and simulation".

Mina Rouhollahi, Charles Ling and John Boland

Mawson Lakes campus

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Visit to Melbourne

Fima Klebaner, Director, Monash Centre for Modelling of Stochastic Systems invited Jerzy Filar to talk at the centre seminar. His presentation titled, "Threshold risk and uncertainty quantification in environmental modelling" was on September 19th.

Jerzy Filar returned to Kew High School (KHS) on September 20th and presented a talk to the two senior maths methods classes on, "Mathematical Modelling related to sustainability and the environment." Jerzy completed year 12 studies at KHS in 1967. He welcomed the opportunity to return and see the school, staff and students.

CONGRATULATIONS

Congratulations to CARM authors for accepted publications.

Filar, J.A., **Qiao, Z**., Ye, N. (accepted). POMDPs for sustainable fishery management, 23rd International Congress On Modelling and Simulation, Canberra, Australia 1-6 December, 2019.

Bohner, M., **Streipert, S** and Torres, D. (accepted). An integrable SIS model on time scales. Proceedings of the 24th International Conference on Difference Equations and Applications (ICDEA 2018), Springer.

Cuchta, T. and **Streipert, S**. (accepted). Dynamic Gompertz model. Applied Mathematics and Information Sciences.

Congratulations to **Wen-Hsi Wang** for an accepted talk.
"Doing stock assessment using UDMB, Stock Synthesis or TMB? A case study on the Queensland Saucer Scallop" for the CAPAM workshop on the creation of frameworks for the next generation general stock assessment models, Victoria University of Wellington, New Zealand November 4-8, 2019.
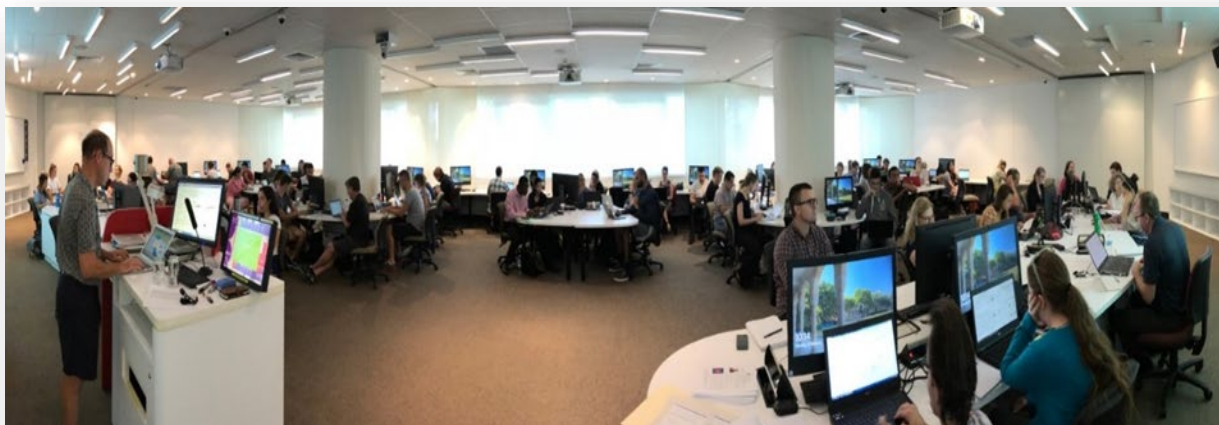
Congratulations to Matt Holden, Sharon Lee and Wen-Hsi Yang for the Special Issue on Natural Resource Mathematics in Environmental Modeling & Assessment

Holden, M. H., Lee, S.X., Yang, W-H. Editors. (2019). WANRM special issue. Environmental Modeling & Assessment, 24,4: 365 – 456.

UPCOMING WORKSHOPS

The 2020 workshops will run from the 11-14 February at the St Lucia campus.
Registration is open
Introduction to R:
11th February 2020 Professor Anthony J. Richardson, Professor Dave Schoeman and Dr Chris Brown
Day 1 is ideal if you have had little or even no experience with R and want to produce robust analyses and effective graphics.

Intermediate to R:
12th – 13th February 2020 Professor Anthony J. Richardson, Professor Dave Schoeman and Dr Chris Brown
Days 2 and 3 are ideal for intermediate users or beginners wanting to go beyond the basics.
The focus throughout is on ecological applications, particularly marine.

Advanced R:
11th – 13th February 2020 Dr Bill Venables
For those who know R well. Advanced data manipulation and visualisation. Advanced graphics. Statistical model building using traditional and machine learning techniques. Programming and software development in R.

tidyr and ggplot in R:
14th February 2020 Professor Anthony J. Richardson, Professor Dave Schoeman and Dr Chris Brown
Use ggplot for basic plots and advanced multilayer mapping.

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PROJECTS

Supervisor: Professor Jerzy Filar. Risk and uncertainty quantification in environmental modelling
Honours/Masters/PhD

Mathematical models of environmental problems often demand understanding of complex dynamics and interactions between many physical and biological variables on the one hand, and human inputs on the other. Uncertainties accompanying such models stem from multiple sources. Sometimes they manifest themselves as cascading errors and at other times they involve the risk of key variables crossing undesirable thresholds. In both cases they undermine confidence in either the model or, worse still, the underlying science.

The accompanying mathematical problems can be studied using a wide range of approaches including (but not limited to) perturbation theory, stochastic processes, partially observable Markov decision processes, statistical methods, dynamical systems and simulation. They can also be applied in several important contexts including (but not limited to) conservation of natural resources, optimizing harvests of fish subject to sustainability constraints or generating warning signals for species whose abundance drops to low levels. One particularly challenging problem is that of designing controls that minimize the probability of a catastrophe, consistently over time, while achieving satisfactory and sustainable resource consumption. A related problem, also stemming from fishery science applications, is that of devising a "balanced harvest" strategy that ultimately restores the proportions of age cohorts of the harvested species to those that are natural for that species.

There are several PhD, Masters' or Honours' research projects that can be designed on this general theme and tailored to the particular student's background and interests. For some projects co-supervision with scientists from the Queensland Department of Agriculture and Fisheries, or CSIRO may be required.

Supervisor: Professor Anthony Richardson. Forecasting future global fisheries production under climate change using systems of differential equations
Honours/Masters/PhD

The student will develop state-of-the-art size spectrum models – based on systems of DEs – for the plankton and fish in the global ocean. These will be solved by using ode solvers in R. These models will then be forced by climate change scenarios to see how many fish are likely to be in the ocean in the future, how their distributions could change, and how this would affect the fish catch in nations of the world. As wild fisheries and aquaculture provide at least 3 billion people with 20% of their protein intake, forecasting future global fisheries is a real-world and pressing problem.

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Supervisor: Professor Jerzy Filar. Fishery-dependent monitoring of Queensland's fisheries
Honours/Masters/PhD
Review and evaluate efficient sampling programs: Is the right amount of sampling occurring for each species? Are there any significant biases in the sampling programs for each species? Assess whether routine analyses are being carried out correctly and develop new analyses for fisheries management. Project components include developing: Quantitative analyses to optimise fishery-dependent sampling across multiple species and regions. Routine methods for assessing precision of current sampling of fish length and age. New methods for turning fish length and age data into advice (indicators) about fishing pressure and the status of fish stocks. A corresponding harvest strategy and reference points for judging the performance of the indicators.

Supervisor: Professor Jerzy Filar. Queensland state-wide estimation of recreational fish catches
Masters/PhD
Improved estimation of state-wide recreational harvests, including resampling, bootstrap and MCMC techniques. Quantify changes in survey angler avidity and recall bias between survey years and methodologies; adjust previous survey data to obtain improved estimates. Evaluating sampling frames - develop methods to generate state-wide harvest estimates (and associated measures of uncertainty) from several synchronous samples taken from different sampling frames (e.g. a licence frame and a residential telephone number list). Develop hierarchical and conditional mixed models for estimation of recreational fish catch and catch rates. Investigate the statistical modelling of recreational survey data collected from multiple survey methods. From survey to analysis: dealing with differences in the scale at which survey data are collected and the scale at which data are analysed. Examine appropriate estimation methods for different fish species. Develop statistical methods for low fish abundance or recreational species caught by 'hard-to-reach' fishers. Develop methods to engage and retain recreational fishers in volunteer data contribution programs.

Supervisor: Professor Anthony Richardson. How could marine heatwaves impact marine biodiversity in the future?
PhD
The common perception is that climate change is gradual and that its impact on natural and human systems is similarly incremental. However, there is increasing evidence that climate change is increasing the severity and frequency of extreme climate events, including heatwaves, such as coral bleaching on the Great Barrier Reef. This project will explore how the frequency and intensity of marine heatwaves will change in the future and the associated implications for marine life. The student will use state-of-the-art CMIP6 General Circulation Models (GCMs) that have daily estimates of temperature from the present to the year 2300.

The student will need to develop statistical and/or differential equation models to describe impacts of heatwaves on marine life, and drive these using GCM output. GCMs are advanced Earth System Models and experience with these models will set up the student for future work in research, Government agencies and the private sector. We are looking for a student with solid mathematical and/or statistical expertise.

Supervisor: Professor Anthony Richardson. How are global tuna fisheries supported in oceanic deserts?
PhD
Tuna fisheries are some of the biggest, most valuable and iconic globally, but are found in the marine equivalent of deserts on land. How the marine food web supports these productive fisheries is an open question, as is how these fisheries will respond to climate change. This project will answer these questions by modelling the global marine ecosystem from bacteria to whales using size spectrum models, based on systems of partial differential equations. The successful student needs a background in applied mathematics and an interest in the natural world. The project will support travel to an international conference during the PhD.

Students will enrol through the School of Mathematics and Physics. To apply, go to https://graduate-school.uq.edu.au/phd-scholarships-science. For more information contact Professor Anthony Richardson (a.richardson@maths.uq.edu.au) or Professor Jerzy Filar (j.filar@uq.edu.au).

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