



Rachel Fewster: Recipient of NZSA Campbell Award 2018

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The origins of Rachel Fewster's tenure in The Department of Statistics at the University of Auckland can be traced back to the 1997 meeting of the Australasian Region of the International Biometrics Society, held at Paradise Cove in South Australia. It was there that some newly converted Bayesians (Renate Meyer and Russell Millar) met a keen young PhD student from the University of St Andrews. She had an intense enthusiasm for statistics, ecology and the kind of outdoors opportunities available down-under. A bit of snooping around upon their return to Auckland showed that this was no ordinary PhD student. By 1999 a post-doc had been offered and accepted, and the rest as they say, is history. Indeed, history was made in August of this year when Rachel was promoted to full Professor, the first woman to have achieved this milestone since the establishment of the department in the early 1990s.

Rachel has made outstanding contributions in research, statistical education and has had a major impact on the use and promotion of statistics in New Zealand and internationally. In 2018, she received the NZSA Campbell Award.

Rachel has published over 50 peer-reviewed papers during her 20-year career, including 14 papers in the major statistical journals *Biometrics*, *Biometrika*, *Statistical Science*, and *J. Multivariate Analysis*, numerous papers in high-ranking journals in ecology and genetics, and a total of 28 publications in journals ranked A*/A. She has led three Marsden grants and one MBIE grant, all comprising novel statistical research with direct relevance to conservation in NZ, totalling \$1.5M. She has been a keynote speaker at seven international conferences in the last 7 years. She has also supervised about 15 PhD students, both in statistics and biology, who have gone on to achieve prestigious awards and employment, including two Rutherford Discovery Fellowships, one Prime Minister's Emerging Scientist award, 11 current academic appointments worldwide, and numerous conference prizes. For biology PhDs in particular, the injection of novel statistical content has not only given the students a competitive edge in gaining awards and employment, but has also created firm interdisciplinary links and raised the profile of statistics among researchers in biological sciences.

Rachel's research highlights include the following:

- Pioneering role in developing genetic analysis methods to source invasive predators on New Zealand islands, now extended into a generic tool for visualising population genetic structure. These techniques are now widely used by the NZ Department of Conservation, regional councils, and landcare trusts as a routine part of eradication planning and resource consent.
- With co-authors, creator of the new 'cluster capture-recapture' methodology for mark-recapture studies with uncertain identification of individuals: for example, for monitoring kiwi populations using acoustic surveys.

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- Numerous contributions to theoretical, methodological and practical aspects of animal abundance estimation, including new variance estimators for distance sampling now used by thousands of practitioners via the software *Distance*.
- Analysis of population trends using smooth trend curves, and related applications such as analysis of spatial trends in genetic diversity or periodic trends in animal behaviour patterns. Several works with over 1200 citations combined are used by dozens of wildlife agencies worldwide.
- Extensive applied work on populations of conservation concern, especially marine mammals and invasive predators.

Rachel’s work in revitalising the mathematical statistics curriculum at Auckland saw student enrolments increase by 3-to-6 fold from 2001 to the present. Her improvements to the curriculum and presentation of these technical courses made the material accessible and appealing to a wider range of students. As a result, the Statistics department was able to institute a theory course as a prerequisite for a Statistics major, which had not been possible with the previous low enrolments, thus improving the preparation of students throughout the Auckland statistics programme and enabling higher numbers to proceed to postgraduate study. This work resulted in Rachel winning a National Tertiary Teaching Excellence



Figure 1. Rachel giving a keynote address at the 2017 International Biometric Society Australasian Region Conference.

award in 2009. Since then she has introduced numerous further innovations, especially by creating a team-based learning initiative and creating two online interactive teaching tools: *Maths Tutor* for students to improve their basic maths skills; and *StatQuiz*, an R-Shiny application for the large Stats 20x course in Data Analysis that generates realistic datasets and analysis output for students to test their interpretation skills. She was a keynote speaker at the foremost international Statistics Education conference (ICOTS 2014), showcasing her innovative ways of transforming mathematical statistics into team activities, one of just five keynotes, including such notables as Professor Sir David Spiegelhalter and the directors of the ASA and the ISI. Her ideas for classroom teaching activities have been adopted by other educators internationally, including an activity published by renowned probabilist David Aldous FRS (Berkeley) underpinned by Rachel's publication on explaining the famous Benford's Law. She has delivered some 20 workshops, talks, and professional development courses for NZ school teachers and pupils, and another 20 workshops to University of Auckland staff and doctoral students covering more general principles of university teaching.

A major focus over the last few years has been the CatchIT citizen science project. CatchIT is a software system for NZ community conservation groups to manage and analyse their predator trapping and monitoring records. Rachel created the CatchIT project in 2011, and has since coordinated all aspects of it, including securing funds for a full-time software developer for 10 years, running a team of student assistants, and writing the statistical code and user interfaces for interactive graphics and analyses. The system has nearly 1000 users from over 150 community groups nationwide and now stores over 1 million data records, covering up to 15 years of trapping results in some cases. Community users can visualise their results using interactive maps and graphics, test the efficiency of different baits or trap types, view animated heat-maps through time, and compare their progress with other groups. The user groups range from suburban trappers (including all of Auckland Council's



Figure 2. Too many penguins for even Rachel and David to count at Macquarie Island.

city parks), to large iconic back-country conservation projects such as the Coromandel and Taranaki kiwi sanctuaries. The system won a Conservation Innovation Award from WWF-NZ in 2014, and is set to expand substantially in the near future by completing links with other biosecurity databases including those operated by the Department of Conservation and local councils, which will make the associated statistical graphics and analysis tools available at a landscape scale. CatchIT has also created authentic project material for numerous statistics research and consulting students.

The CatchIT project also has an educational spinoff, 'CatchIT-Schools', in collaboration with a community trust and initiated by Rachel's MBIE grant. CatchIT-Schools is a term-long programme for primary schools involving several classroom sessions to teach children about conservation, help them to collect their own monitoring data, and analyse it using child-friendly interactive graphing tools created by Rachel and her students. Rachel's team also produced a computer game called 'CatchIT-Experiments' to teach children the principles of scientific experimentation in a conservation context, while having fun and collecting points. So far, about 1000 children from 15 rural primary schools have been through the programme, which won the Schools category in the inaugural Auckland Mayoral Conservation Awards in 2018. The CatchIT-Schools programme is a great way for children to learn about the scientific enquiry cycle, and for them to see statistical analysis as a primary – and enjoyable – component of a scientific investigation. The children learn about statistics in an engaging and authentic setting, while making a positive difference to their own environment.

In her spare time, Rachel's greatest passion is for getting out into the great New Zealand outdoors with her husband David Gauld. A recent highlight was a trip back to the south of Australia where it all started – but this time to the deep, deep, deep south of Macquarie Island: an awe-inspiring place populated by thousands of giant elephant seals and millions of very noisy penguins. Counting them all proved too stiff a challenge even for a seasoned wildlife statistician, so instead they relaxed to enjoy the jaw-dropping spectacle via a fully qualitative approach.