

Newsletter

Mathematics & Statistics

ISSUE 7/08

August 2008

THIS ISSUE

1. Erskine Building's 10th Anniversary
2. Congratulations
3. Departmental Visitors
4. HoD News
5. Book Chapter Published
6. Conferences & Visits

SCENES FROM THE ERSKINE BUILDING'S 10TH ANNIVERSARY PARTY




CONGRATULATIONS!

EU Grant Application Succeeds

The application *Constructive Mathematics: Proof and Computation*, which was submitted to the European Commission earlier this year for funding under its new IRSES scheme, has been successful. The project, with **Douglas Bridges** as one of the non-EU applicants, will link groups working in the Universities of Munich, Padova and Uppsala, the Japan Advanced Institute of Science & Technology, and our department here at Canterbury. This two-year funding from the EU will support research visits here, and to Japan, by the EU-based researchers. Counterpart funding from New Zealand will support visits by Canterbury-based mathematicians to the EU groups involved in the project.

Prize-Winning Poster – SMB2008, Toronto

Congratulations to **Alex James, Britta Basse, Richard Brown et al**, whose poster below won the postdoctoral section of the poster competition at the Society for Mathematical Biology's annual meeting (SMB 2008) in Toronto recently. The poster is currently on display in the Biomath pod.




agresearch

The Importance of Heterogeneity in Metapopulations using Nassella Tussock as an example

A. James¹, B. Basse¹, R. Brown¹, G. Bourdof², S. Lamoureux², M. Roberts³, D. Saville²

1. Department of Mathematics and Statistics, University of Canterbury, New Zealand
2. AgResearch, Lincoln New Zealand
3. Centre for Mathematical Biology, Massey University, Albany, New Zealand

Address correspondence to R. Brown@math.canterbury.ac.nz




UNIVERSITY OF
CANTERBURY
Te Whare Wānanga o Waitaki
CHRISTCHURCH NEW ZEALAND

Introduction

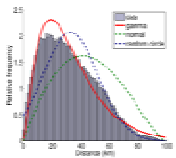
Nassella tussock is a major pest plant in Australia and New Zealand. We develop a generic mathematical model in order to understand aspects of its population dynamics, using data from the Hurumai district of the South Island of New Zealand, a region prone to infestation.

A model is developed based on meta-populations, where the Hurumai region is divided into ~300 discrete land parcels. Local growth and spread rates are drawn from probability distributions fit to data measured in the region.

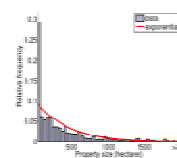


Parameter Fitting

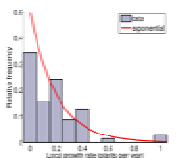
(a) Distance distribution



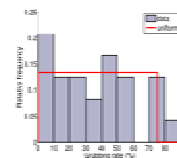
(b) Property size distribution



(c) Growth rate distribution



(d) Grubbing rate distribution



Model Inputs

- Carrying capacity - assumed proportional to property size. Best fit is exponential with mean $\bar{C} = 430 \times 10^3$

$$C_i(s) \sim \frac{1}{C} \exp\left(-\frac{s}{C}\right)$$
- Local reproduction rates - Fit from measurements of plant numbers over a six year period in the absence of grubbing. Best fit is exponential with mean $\bar{r} = 0.1$

$$r_i(s) \sim \frac{1}{r} \exp\left(-\frac{s}{r}\right)$$
- Grubbing rates - Verkaaik et al. (LJMS) estimated from a sample of 24 properties in the Hurumai district to be uniformly distributed

$$g_i \sim U(0, 0.75)$$
- Spread rates - Spread is assumed to be Gaussian

$$k_{ij} \sim \frac{C_i}{C_j} \exp\left(-\frac{d_{ij}}{\alpha}\right)$$

where d_{ij} is the distance between properties i and j , which is best fit by a gamma distribution with shape parameter $\gamma = 3$

$$d_{ij} \sim \text{Gamma}(k, \gamma = 3, \beta = 1)$$

and α, k are fit by comparing the model to the density data.
- External source - Difficult to estimate, and anecdotal evidence suggests it is very small, so is taken to be constant

$$c_i = 10^{-3}$$

Model

The region is modelled by M land parcels or properties, with populations $x_i(t)$. The rate of change of plants per year on property i gives a dynamically changing meta-population and is modelled by the ODE system, assuming logistic growth:


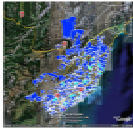
$$\frac{dx_i}{dt} = (r_i x_i) \left(1 - \sum_j A_{ij} x_j\right) - c_i \left(1 - \frac{x_i}{C_i}\right) - g_i x_i$$

where for property i :

- k_{ij} is the per-capita spread rate (plants / year) from property j to property i
- r_i is the per-capita growth rate (no. of plants produced per year by each plant)
- g_i is the per-capita grubbing rate
- c_i is the no. of plants per year arriving from an external source
- C_i is carrying capacity on property i

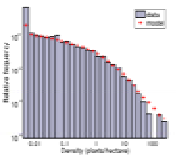
There is a unique attracting steady state x^* , which is positive if any $c_i \neq 0$ and zero if all $c_i = 0$ and grubbing rates g_i are sufficiently high.

Each parameter is drawn from a distribution fit to data measured from a collection of farms in the Hurumai region in Canterbury, New Zealand

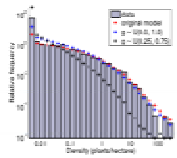



Results

(e) Resulting density distribution



(f) Effect of changing grubbing distribution



Discussion

- Heterogeneity is essential - If mean rates of the parameters were used in the homogeneous model, the estimated steady state density is wrong by several orders of magnitude
- Two alternative grubbing distributions were considered, $g_i \sim U(0, 1.0)$ and $g_i \sim U(0.25, 0.75)$, both of which have mean grubbing rate of 50%. Figure (f) shows the effect of these two strategies on the steady state density distribution. The results suggest it may be far more effective for a tussock management programme to concentrate on properties done little or no grubbing, rather than or blanket campaigns that encourage all property owners to grub more effectively.

References:

[1] Bourdof, G. and Saville, D. (2008) Modelling Nassella tussock invasions under Environment Canterbury's Regional Pest Management Strategy. Technical Report. AgResearch.

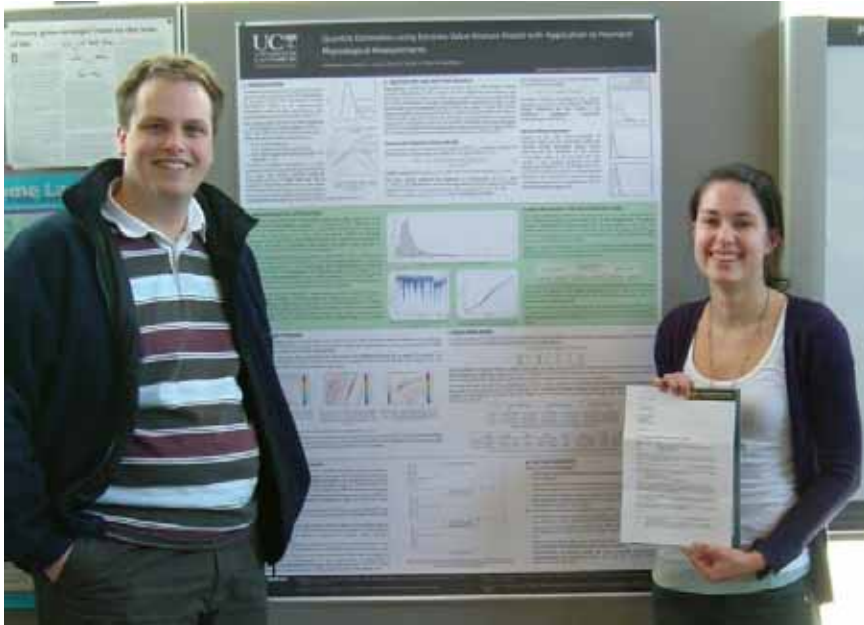
[2] Verkaaik, M., Lamoureux, S. and Bourdof, G. (2006) Effects of grubbing a plant on adjacent to nearby tussocks. In: 25th Australian Weeds Conference, pages 180-82.

PhD Success

Congratulations to **Klaas Hartmann**, who successfully defended his PhD thesis (*Biodiversity Conservation and Evolutionary Models*) in the oral exam on 12 August. Klaas and wife Christine are currently living in Hobart, Tasmania, and Klaas has begun a 3-year postdoctoral fellowship working for a marine conservation agency where he is reportedly in charge of a small submarine. Klaas will be returning here briefly in February 2009 to attend a conference and workshop we will be running.

- Mike Steel

Double Bonus Points This Month!



Carl Scarrott & Anna MacDonald with her prize-winning poster & top achiever award



Anna with Australian poster prize

Statistics PhD student **Anna MacDonald** has received two honours this month recognising her research achievements and potential. Anna presented a poster on her recent PhD research entitled *Quantile Estimation using Extreme Value Mixture Models with Application to Neonatal Physiological Measurements* at the Australian Statistical Conference 2008 in Melbourne and won second prize in the poster competition. (Thanks to Paul Brouwers for his artistic wizardry!) This work is part of joint work within the Neonatal Research Group at the University of Canterbury currently consisting of Drs Carl Scarrott, Dominic Lee, Marco Reale, Glyn Russell (Guy's and St Thomas's Hospital, London) and Brian Darlow (Canterbury DHB). Also involved in this work are Statistics PhD students Xin Zhao and Marina Zahari.

Anna has also been awarded a highly competitive TEC Top Achievers PhD scholarship, which recognises not only her past academic excellence but also her potential in ongoing research with her supervisors Carl Scarrott, Dominic Lee, Glynn Russell and Brian Darlow. Anna will be researching extreme value modelling techniques for determination of neonatal health status. Well done, Anna!

- Carl Scarrott

UC Student Association Lecturer of the Year

Congratulations to **Clemency Montelle**, who was voted one of the top three lecturers in the College of Engineering. Congratulations also to **Carl Scarrott** and **Bill Taylor**, 2 of the 3 other lecturers from this department who were nominated.

WELCOME TO OUR DEPARTMENTAL VISITORS (E = Erskine Fellow)

<u>Visitor</u>	<u>Organization</u>	<u>Host</u>	<u>From</u>	<u>To</u>	<u>Room</u>	<u>Extn</u>
David Sutton	University of York, UK	A James	1/5/08	15/9/08	616	8876
Prof. Christopher Bose	University of Victoria, Canada	R Murray	1/7/08	31/12/08	605	8028
Prof Tsugunori Nogura	Ehime University, Japan	G Steinke	19/8/08	21/8/08	605	8028
Prof James Oxley	Louisiana State University, USA	C Semple	17/8/08	24/8/08	720	8337
Prof Geoff Whittle	Victoria University, Wellington	C Semple	17/8/08	24/8/08	720	8337
Prof. Horst Malchow (E)	University of Osnabrück, Germany	A James	1/9/08	2/11/08	607	8875
Prof. Brian Sleeman (E)	University of Leeds, UK	M Plank	6/9/08	19/10/08	607	8875
Prof. Eamonn O'Brien	University of Auckland	B Martin	15/10/08	17/10/08	605	8028

HoD NEWS

We've reached the end of Term 3 already! Where has the year gone?

A lot is going on around this Department, apart from teaching:

Mike Steel and Chris Price are back from study leave so we welcome them back into the fold for the coming term.

We are currently awaiting referees' reports for our long-listed candidates for what could possibly be two lecturing positions. In the meantime, we look forward to the arrival of James Degnan, our new Statistics lecturer, who has been held up in the USA with visa problems. I am hoping he will be here within the next two weeks.

Department consultation for the academic promotions round was done last Wednesday, and general staff reviews are just starting.

The Department's response to the BSc postgraduate degree review has been prepared and the panel for this review meets in late September.

The College of Engineering budgets for 2009 will be discussed at this Thursday's meeting of the College Management Team.

Arno Berger has recently been made an Adjunct Fellow of the Department.

Have a nice break from teaching until we head into the last term of the year.

- David Wall

BOOK CHAPTER PUBLISHED:

Lee D S: *Exact Markov chain Monte Carlo algorithms and their applications in probabilistic data analysis and inference* (Intelligent Data Analysis: Developing New Methodologies Through Pattern Discovery and Recovery; Information Science Reference IGI Global, pp 161-183, In Wang, H F ed.)

CONFERENCES & VISITS

Joshua Collins: to attend the 4th International Conference on Combinatorial Mathematics and Combinatorial Computing at Auckland University, 15-19 December 2008.

Kyoko Fukuda: to attend the NZSA Conference at Waikato University, 1-2 September 2008. Talk entitled: *The K-Maximum Subarray as an alternative clustering analysis for the spatial weed aggregation pattern.*

Alex James: to attend the NZ Ecological Society Conference in Auckland, 29 September – 2 October 2008. Talk entitled: *Modelling the impact of garden waste dumping.*

Michael Snook: to attend the 4th International Conference on Combinatorial Mathematics and Combinatorial Computing at Auckland University, 15-19 December 2008.

THE LAST WORD GOES TO THE POSTGRADS

Captured at a recent sartorial soir ee (aka a "John & Jane" Party) were, from L to R: **Ron Begg** as John Belushi (Jake from The Blues Brothers); **Shannon Ezzat** as John Rambo; **Daniel Lond** as Johnny Rotten; and **Hannes Diener** as one of the Pope Johns.

