

DEPARTMENT OF ZOOLOGY

SUGGESTED THESIS TOPICS FOR 2013



This booklet contains a list of suggested thesis topics for 2013.

If you are interested in doing a project in an area or on a topic that does not appear in this list, please discuss your interests with a member of staff whose research interests are in a similar field.

Remember, it is often appropriate to have two supervisors within the department, or one in Zoology and one in another department or government agency.

Dr Caroline Beck

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Room: P107



As a developmental biologist, I am interested in how a single cell, the fertilized egg, develops into a complex multicellular organism that progressively acquires the form and function of its parents. It has become apparent that a handful of genetic pathways not only pattern the development of the basic embryo, but that co-option of these pathways in later life can drive appendage formation, tissue repair and regeneration, and diseases such as cancer. My lab uses mainly amphibian models (*Xenopus laevis*, the African clawed frog, and *Ambystoma mexicanum*, the axolotl, to study development and regeneration. Possible projects are outlined below but alternatives can also be discussed. I will have room for 1 or 2 Masters or PhD students in 2013.

Visualising and manipulating morphogen gradients in the developing vertebrate limb bud

Embryonic pattern is controlled, in part, by a number of morphogens, diffusible gene products that act via signalling pathways to activate differential gene expression in cells according to their position along the gradient. The output of these pathways depends on specific binding of transcription complexes to regulatory DNA sequences. While the source of such gradients can be easily visualised by *in situ* hybridisation, the range of these signals cannot be predicted accurately. A few years ago, transient transgenic zebrafish were developed (Dorsky et al, 2002) that express GFP under the control of a Wnt/ β -catenin responsive Lef binding site (TOP-GFP). The advantage of the destabilised GFP reporter was that it could be visualised in living embryos to identify novel sites of Wnt signalling activity as well as to confirm known roles.

Retinoic acid, Wnt, Notch, Hedgehog, and BMP signalling are all thought to be involved in limb patterning and development. You will generate reporter lines in the frog *Xenopus* using destabilised GFP or RFP to observe readout of morphogen gradients within living developing limbs. You will then manipulate the conditions under which the tadpoles develop using chemicals that interact with specific molecular genetic pathways to see if the gradients can be altered. This project will involve molecular cloning and the generation of F0 stable transgenic *Xenopus* embryos by sperm nuclear injection into eggs, as well as the use of chemical genetics to alter gene expression and analysis of transcriptome data.

Ref: Dorsky, R. I., Sheldahl, L. C. and Moon, R. T. A transgenic Lef1/ β -catenin dependent reporter is expressed in spatially restricted domains throughout zebrafish development. (2002) *Developmental Biology* 241: 229-237.

What makes corneal cells change into lens cells in a regeneration competent species? During development, most of our cells become progressively adapted to different functional roles, a process known as terminal differentiation. Normally, differentiation is a one-way process, and so when an entire organ or tissue is damaged or removed, nearby cells cannot step in and do the job. In rare cases, however, differentiated cells can somehow become reprogrammed to adopt different fates, a process termed transdifferentiation. Transdifferentiation is one strategy by which tissues or organs can regenerate. Transcription factors are thought to be the key to such cell plasticity, but these are likely triggered in the first instance by aberrant signal transduction resulting from external cues. The African clawed frog *Xenopus laevis* is an emerging international model for the functional study of regenerative strategies. *Xenopus* tadpoles can regenerate limbs and tails as tadpoles. Over the past few years, functional *in vivo* assays in *Xenopus* have illuminated

many aspects of this remarkable process and the emerging picture is that both developmental (genes involved in patterning the embryo) and non-developmental (e.g. electric currents, immune system) mechanisms are employed. In all of the above cases, regeneration is driven by expansion of existing cell populations without transdifferentiation. There is, however, one documented case of transdifferentiation-based regeneration in vertebrates, that of lens regeneration in the *Xenopus* eye.

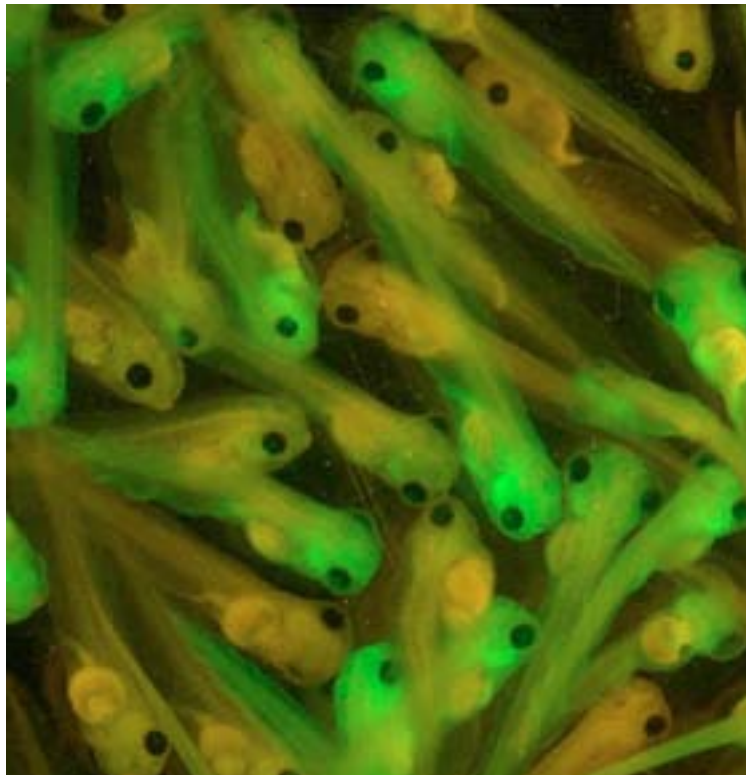
The lens of the vertebrate eye is made up of highly specialised differentiated lens fibre cells that contain no nuclei, and lens epithelial cells that retain the ability to divide. During development, the lens, together with the overlying outer cornea, arises from contact between the optic cup and field of competent epidermal epithelial cells known as the lentogenic area and defined by expression of Pax6. Removal of the lens of a *Xenopus* tadpole leads to a remarkable process in which the overlying central corneal epithelial cells become reprogrammed to a lens fate, eventually replacing the lens, a phenomenon first observed by Freeman nearly 50 years ago. This process, known as cornea-to-lens transdifferentiation or CLT, has been well described. We know from classical experiments that CLT is triggered by contact with an inductive signal originating from the optic cup (retina), and present in the vitreous. Normally this factor is prevented from contact with outer corneal cells by a mechanical barrier formed by the lens itself and the inner cornea, a developmentally unrelated structure derived from the neural crest. The identity of this factor, and the mechanism by which corneal cells are able to transdifferentiate in response to it, remains a mystery.

Aims: i) To determine the specificity of the vitreous factor/corneal cell interaction by culture of corneal cells from axolotls, related amphibians that cannot regenerate the lens, with *Xenopus* vitreous, and culture of *Xenopus* corneal cells in vitreous from non-regenerating organisms.

ii) To use mass spectrometry/HPLC to identify protein components of the vitreous of *Xenopus* in order to identify candidate inducing factors.

iii) To test putative factors by exposing corneal cells directly to purified proteins.

Ref: Rao, N et al., 2009. Proteomic analysis of blastema formation in regenerating axolotl limb



Associate Professor Phil Bishop

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Room: AG07, Annexe



My main interests centre around amphibian conservation and communication and these present good opportunities for MSc and PhD studies. Currently I have three species of native frogs (*Leiopelma* spp.) in captivity and my frog research group studies their breeding and social behaviour, aspects of amphibian diseases and captive husbandry. Others projects involving population monitoring translocations, and behaviour of native frogs in the field, as well as acoustic behaviour of introduced frogs or tropical frogs in Australia or Fiji may also be offered. Please visit my website for more information (www.nzfrogs.org).



Professor Carolyn Burns/ Dr Marc Schallenberg

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Room: B217, MG06



Carolyn's research interests centre around biological processes in lakes, particularly trophic interactions, microbial food webs and plankton ecology. Her current research focuses on:

- (i) the effects of land development and climate change on Otago lakes of recreational and conservation value,
- (ii) the trophic transfer of fatty acids in freshwater plankton and their use as tracers,
- (iii) water bloom formation and management,
- (iv) behaviour and life history strategies of freshwater crustaceans, related to invasive species

Dr Marc Schallenberg, a research fellow, is working with Carolyn on research programmes that relate water quality to land use centered on deep, glaciated lakes as well as shallow, coastal lakes and wetlands. Carolyn and Marc will be happy to discuss possible research projects in these and in other lakes, relating to water quality, biodiversity, conservation and restoration of freshwater ecosystems.

Associate Professor Gerry Closs

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Room: B213



My research covers a range of topics in the area of freshwater and estuarine ecology, with a more specialist interest in ecology and biology of freshwater fish. Currently, I am particularly interested in the factors influencing the life histories of fish and invertebrates, particularly in relation to migration and dispersal, and early life history.

Current and recent projects include:

- Life history and population dynamics of amphidromous fishes.
- Early life history and larval ecology of amphidromous fishes.
- Life history and population dynamics of salmonids, particularly brown trout.
- Ecology of mysid shrimps.

Visit my webpage for an overview of my research interests (<http://www.otago.ac.nz/zoology/staff/otago008918.html>). I am interested to receive expressions of interest and research proposals from students at any level of postgraduate study.



Associate Professor Alison Cree

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Room: MG02



My primary interests lie in the effects of temperature on reproduction of terrestrial ectotherms, especially reptiles. Current and recent projects that I have supervised or co-supervised include studies on the thermal suitability of Orokonui Ecosanctuary for reintroduction of tuatara, variation in life-history with altitude in common geckos, reproductive cycles in skinks and the use of endocrine tools for assessing sex and reproductive condition in frogs. During 2013 I would be interested in discussing a potential PhD relating to reintroduction of tuatara to Orokonui Ecosanctuary. This topic is likely to marry aspects of ecophysiology and conservation biology, the details to be developed in discussion with a suitable candidate.



Professor Lloyd Davis

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Room: Science Communication



Lloyd's science research has been primarily in the area of the behavioural ecology of penguins and seals, particularly aspects of behaviour pertaining to sexual selection, kin selection, and foraging. Currently most of his research is focused in the area of science communication.

However, Lloyd is open to the possibility of supervising a Masters or PhD project on:



- the conservation and breeding biology of sub-Antarctic penguins, especially if there is a science communication aspect to it, or
- the portrayal of penguins in documentaries.

Associate Professor Ian Jamieson

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Room: M118



A few projects are potentially available for MSc and PhD students to be part of a long term study of the behaviour, ecology and genetics of recently re-introduced threatened forest species of birds to determine if and why some family lineages are more successful than others in establishing and dominating in new populations.

In addition to experience in avian ecology, Ian is also looking for students with interests in molecular genetics or population modelling.



Dr Mark Lokman

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Room: B113



My research focus is centered around (the endocrine control of) reproduction in teleost fish and evolution of endocrine systems related to steroid hormone synthesis in echinoderms and osmoregulation in basal tetrapods. Where relevant, molecular tools are (can be) used to address research questions.

Main themes:

Growth vs reproduction (MSc / PhD)

Female germ cells (oocytes) pass through several developmental stages, i.e. previtellogenic growth, vitellogenic growth ('yolking') and final maturation and ovulation. The latter processes have been well-described, but very little is known about the endocrine control of previtellogenic growth and the factors governing fecundity. Signalling by the growth axis seems evident. We recently identified significant effects of 11-ketotestosterone and growth factors on in vitro previtellogenic growth in eel, and are currently evaluating which genes may be switched on or off in response to steroid hormone exposure. It is proposed that these in vitro and molecular studies will be complemented by in vivo studies to determine the signalling between growth and reproductive axes, for which inanga ('whitebait') and perch may make suitable models.

Metamorphosis (Hons / Postgrad Dip / MSc)

Eels undergo a dramatic life history change associated with a remarkable long distance spawning migration of thousands of kilometers. This change results in numerous morphological, behavioural and physiological modifications that pre-adapt freshwater eels to a life in the ocean. What sets off this change? Steroids and hormones from the growth axis have been implicated, but their involvement requires further study.

Echinoderm reproduction (Hons / MSc / PhD)

Steroids are crucial for development and release of gametes in vertebrates. These hormones are also present in starfish, but little is known about steroid physiology in these animals. Which tissues are responsible for steroid hormone synthesis? How is steroid synthesis regulated, and what is the role of these steroids in gametogenesis? Is control of steroidogenesis at the molecular level comparable to that in vertebrates?



Professor Alison Mercer

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Room: B111



Title: Dopamine modulation of honey bee central olfactory neurons

The aim of this study is to establish, using RNA interference, the identity of receptors that mediate the effects of dopamine on central olfactory neurons in the honey bee.

We have recently shown that honey bee queens use chemical signals (pheromones) to manipulate dopamine pathways in the brain of young worker honey bees, pathways that play a key role in behavioural regulation and motor control. Exposing young bees to queen pheromone not only alters brain dopamine levels in young workers, but also selectively alters the expression of dopamine receptor genes. But what impact does this have on brain function, and ultimately, the behaviour of the bee? Our studies have shown that changes in dopamine function in the worker brain have a significant impact on associative olfactory learning in this insect. For this reason, we have focused our attention on dopamine modulation of neurons in two key regions of the brain: primary olfactory centres (the antennal lobes) and mushroom bodies, centres known to play a key role in the formation of olfactory memories. This study aims to reveal more clearly the cellular mechanisms through which dopamine operates. Using honey bee antennal-lobe neurons *in vitro*, previous studies from our laboratory have identified calcium-activated potassium currents as key targets of dopamine modulation in these cells, but the receptors that mediate the effects of dopamine on these currents have yet to be identified. Three dopamine receptor genes have been cloned and characterized in honey bee, *Amdop1*, *Amdop2* and *Amdop3*. All 3 are expressed by neurons in antennal lobes and mushroom bodies of the brain. RNA interference techniques will be used in this project to selectively block the expression of dopamine receptor genes in olfactory interneurons *in vitro*. Whole-cell voltage clamp recordings from the cells will then be used to assess the impact of down-regulating the expression of dopamine receptor genes on responses to exogenously applied dopamine.

Suitable for PhD research project.



Dr Shinichi Nakagawa

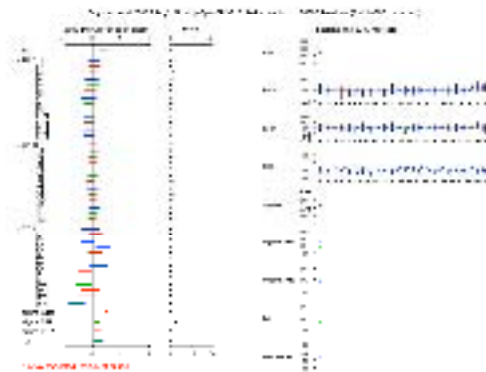
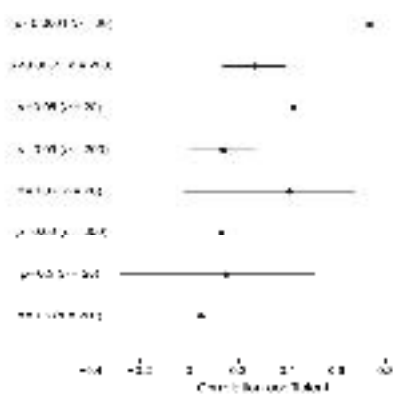
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My main research interests are evolutionary and behavioural ecology using primarily birds as model systems but I am happy to work with any animals. My research has involved investigating kin recognition, parental care and mate choice. I use a range of methods to answer questions including observations, experiments, molecular techniques, comparative analyses, meta-analyses and theoretical approaches. I will collaborate with other members of zoology staff such as Prof Robert Poulin, Dr Ian Jamieson, Dr Mark Lokman and Dr Gerry Closs. My recent interests are animal personality and Bayesian statistical modelling. A few projects may be available for students who are committed and motivated. I look for students who have a multitude of interests including statistics, genetics and endocrinology as well as animal behaviour and evolution. I especially welcome students with Statistics majors.



Associate Professor Mike Paulin

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How do animals move so smoothly and efficiently? In contrast, why are robot movements so ... robotic? We know that the cerebellum plays a key role in animal agility, but it is not clear exactly what its role is. It is also clear that the mechanical design of organisms has a lot to do with their agility. In my lab we build computer models – virtual animals – to combine data at different levels, from neurons to mechanics and behaviour. These models are used to test theories about animal agility and cerebellar function, to develop design principles for agile robots, and virtual creatures for applications in computer gaming and animation.

Currently we have a virtual shark, a virtual spider and a virtual dog.

Some student projects are entirely computational, but others involve experiments and observations on neurophysiology, mechanics and behaviour of animals. We have access to high quality motion capture and high speed video for kinematic analysis. Recently we've looked at sharks, spiders, bees and dogs, but just about any animal – agile or not – could be a useful subject for this research. We collaborate with neurophysiologists, physicists, mathematicians and engineers in NZ, USA and Japan. Generally I am willing to consider (co-)supervising any project that applies



Professor Robert Poulin

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Room: M117



My interests include all ecological, behavioural and evolutionary aspects of host-parasite interactions, in all animal taxa. In particular, I'm currently interested in the role of parasitism in the maintenance of biodiversity and community structure in intertidal ecosystems.

Most intertidal molluscs and crustaceans harbour parasites that either directly increase their mortality or reduce their growth, or indirectly modify their phenotype. These present ideal opportunities for field and lab studies appropriate for BSc Hons, MSc or PhD degrees.

Other areas of current interest include: the evolution of alternative transmission routes in trematode parasitic in NZ freshwater animals; the evolution of parasitism and host exploitation strategies; biogeography and diversity of parasitic lineages; the evolution of host specificity; the population genetics of parasites.

Dr Bruce Robertson

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My research takes an integrative approach to investigating behavioural ecological, evolutionary, wildlife management and conservation biology questions using New Zealand native species, including the kakapo *Strigops habroptilus* and the NZ sea lion *Phocarctos hookeri*. I also have research interests in invasive species management. I employ various molecular genetic techniques (e.g., PCR, DNA sequencing, microsatellite and minisatellite DNA fingerprinting, DNA cloning), laboratory and field based experiments, observations and analyses to examine issues such as sex allocation, mate choice, heterozygosity-fitness correlates, parentage, mating systems, bioacoustics, immunocompetence, identification of management units, genetic population structure, phylogeography, and phylogenetic affinities.

Current projects in my research group include:

- Mate choice, reproductive behaviour, and conservation genetics of the kakapo *S. habroptilus*
- NZ parrot *Mhc* genes: genetic variation and immunocompetence
- Conservation genetics of the kea *Nestor notabilis*
- The genetic basis of exploratory behaviour of kea *N. notabilis*
- Conservation genetics of the rock wren *Xenicus gilviventris*
- Sex allocation in the kaki *Himantopus novaezelandiae*
- Reproductive behaviour, paternity and genetic population structure of the New Zealand sea lion *P. hookeri*
- Phylogenetic affinities of the New Zealand storm-petrel

These projects (or aspects of them) are appropriate for BSc Hons, MSc or PhD degrees. Please also contact me if you have a project idea aligned with my other research interests.



Dr Jennifer Rock

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Room: Centre for Science Communication, 303a Great King Street



Jenny is a lecturer in the Centre for Science Communication. Her current research in this area is continuously being updated so please see her web page at <http://www.sciencecommunication.info/people/jenny.html>

Understanding expectations both inside and outside science is critical both to good science and to its effective interaction with society. Key to this is understanding that aesthetics drive the origin, continuation and change of scientific and societal paradigms.

My research in the **aesthetics of science** addresses

- *how aesthetics contribute to conceptualisation and craft within science,*
- *and how they can be better integrated into science communication.*

My background extends from a BA in Human Ecology, and trackrecord in visual/creative arts, to a PhD in Zoology with research encompassing environmental physiology, molecular ecology and evolutionary genomics. I find all these fields crossfertilise and integrate productively: *Our understanding of the world is only limited by our reluctance to think outside our box!* I think when we recognise more of the common ground between science and “other” (e.g. humanities) then we can begin to understand science as a deeply human enterprise ... and in so doing, recast science as more inclusive and interactive.

CURRENT PROJECTS ON:

Climate change and ocean warming:

- Impacts of Southern Ocean warming on marine connectivity: Integrating oceanographic modeling with molecular ecology and developmental biology. (biological research focusing on Antarctic fishes, but also has component on public engagement)
- 2°DIFFERENT : a sci-art project investigating representation and engagement with the effect of climate warming
- Climate Change science and representation in the media

Paradigms in Science & their Aesthetic Drivers

- Conservation: The Aesthetics of Time and Taxonomy
- Marine Connectivity, the Boundless Sea, and the ‘Myth of the Primitive Isolate’
- Junk or Not Junk? How to Recycle the Public Aesthetic of DNA
- The Composition of Place & Identity
- Scientific Controversy Mapping: Dissecting Paradigms

Thinking across Dichotomy

- Sci-art and Cognition
- Citizen Science
- Cross-disciplinary Science Communication: Finding the Babel Fish
- Metaphor, Analogy & Visual Narrative: Contextual Thinking and Science Communication
- Traditional Ecological Knowledge (TEK) and Science



Associate Professor Philip Seddon

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Room: M202



Phil is Director of the Postgraduate Diploma in Wildlife Management, and his research interests therefore relate to the management and restoration of threatened species and habitats.

My primary research interests and current collaborations relate to species translocations, including reintroductions and conservation introductions. My students and I are currently collaborating in a team with students and colleagues from the Department of Physics in the development and application of new GPS tracking technology to improve post-release monitoring for a variety of avian species in New Zealand. I'm also interested in the development of risk assessment frameworks for Assisted Colonization and other climate-change mitigation translocations. In addition, current studies in my group are working on topics relating to the spatial and breeding ecology of a range of native and introduced species.

My supervisory load is full for 2013, but I am willing to discuss project possibilities for 2014 and beyond. I welcome enquiries from students with a strong applied GIS background.



Associate Professor Liz Slooten

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Room: 5, Annexe



Liz's research interests include population biology and population models for estimating the risk imposed by human impacts on animal populations. Her research focusses on the environmental impacts of fishing, in particular the effects of fisheries bycatch on marine mammal populations. Liz may be able to supervise 1 more student providing there is a strong overlap between their research interests and hers.



Professor Hamish Spencer

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Room: M113

Hamish's research involves the application of mathematics and computing in population biology, especially population genetics. He is also interested in the phylogenetics of several animal groups, including molluscs and birds, and the use of phylogenetic trees in the interpretation of patterns of biodiversity. He is happy to discuss any ideas you might have for research projects in these areas. Recent research projects include the population genetics of genomic imprinting and the phylogeography of kauri snails and intertidal molluscs.



Models for the Evolution of Plasticity (BSc Hons, MSc, PhD)

Phenotypic plasticity is the ability of a single genotype to give rise to different, appropriate phenotypes in different environmental conditions. Mathematical models for the evolution of plasticity have recently been developed that reveal the sorts of conditions that favour the evolution of plasticity. This project would involve expanding some of these models, especially to situations in which the plastic response occurs a long time after the environmental cue.

Reference: Nishimura, K. 2006. Inducible plasticity: Optimal waiting time for the development of an inducible phenotype. *Evolutionary Ecology Research* 8: 553-559.

Mathematical Models that Maintain Genetic Variability

One of the central questions in population genetics is "Why do we observe so much genetic variation in populations?" This project involves constructing computer simulation models of various forms of natural selection and assessing their ability to maintain variation.

Reference: Trotter, M.V. and H.G. Spencer 2008. The generation and maintenance of genetic variation by frequency-dependent selection: Constructing polymorphisms under the pairwise interaction model. *Genetics* 180: 1547-1557.



Phylogeny of Australian and New Zealand Molluscs (BSc Hons/MSc)

Several groups of Australian and New Zealand molluscs display interesting biogeographic patterns. Some examples are the small limpets of the genus *Notoacmea* carnivorous whelks, and the sponge-eating tiger shells, *Calliostoma*. This project would involve sequencing a portion of the mitochondrial DNA and using these results to estimate genetic differentiation within species and the phylogeny of the chosen group. It could be expanded into a PhD thesis with the inclusion of related overseas taxa. This topic requires no maths background. Reference: Nakano, T., B.A. Marshall, M. Kennedy and H.G. Spencer. 2009. The phylogeny and taxonomy of New Zealand *Notoacmea* and *Patelloida* species (Mollusca: Patellogastropoda: Lottiidae), inferred from DNA sequences. *Molluscan Research* 29: 33-59.



Population-level consequences of genomic imprinting (BSc Hons/MSc/PhD)

Genomic imprinting describes the non-Mendelian phenomenon in which the sex of the parent passing on the genes affects that gene's expression. Imprinting has been implicated in a number of human genetic diseases, e.g. Huntington's chorea and fragile-X syndrome. Although there is a large body of work on genomic imprinting, there is less published concerning its population genetics. This project would involve constructing novel (yet simple) models to describe the effects of various kinds of imprinting on populations. Prospective students should enjoy working with equations. Alternatively, more complicated models could be simulated on computer.

Reference: Spencer, H.G., T. Dorn and T. LoFaro. 2006. Population models of genomic imprinting. II. Maternal and fertility selection. *Genetics* 173: 2391-2398.



The effect of within-individual variability in perception on foraging decisions (BSc Hons)

The way in which animals distribute themselves in an environment with a patchy food distribution is of great interest to behavioural and ecological biologists. It is well established that animals' imperfect perception of available food resources can affect their decisions. But animals are not all the same and one animal does not always do the same thing in the same situation. Recent work has shown that among-individual variation in perceptual ability - animals not all being the same - can have an additional effect. This project would look at possible effects of within-individual variation - one animal doing different things - using computer simulation. Students should enjoy working with computers.

Reference: Spencer, H.G. M. Kennedy & R.D. Gray (1996). Perceptual constraints on optimal foraging: the effects of variation among foragers. *Evolutionary Ecology* 10: 331-339.

Population genetics in spatially structured environments (joint with Peter Whigham, Information Science) (BSc Hons/MSc/PhD)

Most population-genetic models of spatially structured populations are based on so-called island models: subpopulations connected by migration. This framework, however, ignores any structure within the subpopulations. This project involves building individual-based computer simulations comparable to those in landscape ecology to look at populations in continuously varying environments. Prospective students should have some background in computer programming.

Reference: Whigham, P.A., G.C. Dick and H.G. Spencer. 2008. Genetic drift on networks: Ploidy and the time to fixation. *Theoretical Population Biology* 74: 283-290.

Please also see under Jon Waters.

Professor Colin Townsend/ Dr Christoph Matthaei

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Colin is head of a leading New Zealand stream ecology and catchment research programme. Dr Christoph Matthaei is a Senior Research Fellow working in this group. The research programme has three main themes:

- (i) the consequences of agricultural, forestry and other land uses for stream ecosystems and stream health.
- (ii) the impact of flow-related disturbances and biotic interactions on stream communities; and
- (iii) the role of multiple stressors in streams.

Colin and Christoph will be pleased to explore with you research projects in any of these areas.



Dr Yolanda van Heezik

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My research concerns the ecology of urban areas: abundance and distributions of birds and other animals; spatial ecology, including home ranges and resource selection of urban species; impacts of predators within urban areas; the role of private gardens and householder knowledge and attitudes in maintaining biodiversity on private land. I also supervise some research projects on penguins, as I have a history of active involvement in penguin research. I would be happy to discuss project ideas from potential students at BSc Hons/MSc and PhD levels.

Recent projects from my research group and collaborations include:

- Impacts and spatial ecology of domestic cats in urban and rural areas.
- Home range and resource selection by urban possums.
- Estimation of rat abundance across urban habitats.
- Density estimation of birds across a range of urban habitats.
- Efficacy of belled collars in mitigating impacts of cats on wildlife.
- Documenting the biodiversity of private gardens and attitudes and knowledge of householders.
- Value of specimen trees within an urban landscape.
- Factors influencing lifetime reproductive success in yellow-eyed penguins.



Professor Graham Wallis

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Room: B116



My research interests include molecular evolution, molecular systematics, genetics of hybrid zones and phylogeography, particularly using endemic fish and insects. In the evolutionary genetics lab, we ask questions about gene flow, population subdivision and species relatedness. We test geological hypotheses and infer evolutionary process using molecular genetic patterns to understand better the evolutionary history of the NZ biota. Molecular approaches that we use include: PCR of mitochondrial and nuclear DNA sequences, DNA sequencing, microsatellite DNA analysis and AFLP analysis, usually in conjunction with morphological and behavioural data and field observations.

I suggest some project titles below, but they can be modified to suit your interests. Joint supervision is welcomed. See my departmental web page for publications in these areas.

Darwinian evolution of a new zona-pellucida domain gene in galaxiid fishes

Contact zones and hybridisation in common river galaxiids.

Hybrid zones in alpine weta- the evolution of melanism in relation to ecology

Hybrid zones in cicadas- gene flow in relation to song type

Mixed modes of reproduction in the brittle star *Ophiomyxa brevirima*

If you have an interest in evolution, and would like to combine it with questions in systematics or ecology, come and talk to me!



Professor Jonathan Waters

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Room: B115



Population connectivity and biogeography of rafting invertebrate communities (BSc Hons/MSc/PhD)

The dense bull-kelp forests (*Durvillaea antarctica*) that characterise southern coastlines support exceptionally high invertebrate biodiversity. As bull-kelp is highly buoyant, detached plants form natural rafts that may float for vast distances. It is therefore likely that rafting is an important ecological and evolutionary process in the Southern Ocean. By focusing on marine invertebrates that have an ecological propensity for rafting, we can begin to assess the biogeographic significance of this fundamental process.

Several projects are available, integrating genetic and ecological approaches to assess population connectivity in rafting versus non-rafting marine invertebrate species. This research program has Marsden funding from 2008 through 2010, and is designed for students who have a diverse interests, including topics such as marine ecology, biogeography, and population genetics. Projects will be cosupervised by Dr Jon Waters and Professor Hamish Spencer.

References:

Waters JM (2007) Driven by the West Wind Drift? A synthesis of southern temperate marine biogeography, with new directions for dispersalism. *Journal of Biogeography* (online early: doi:10.1111/j.1365-2699.2007.01724.x)

Waters JM & Roy MS (2004) Out of Africa: the slow train to Australasia. *Systematic Biology* 53:18-24.



Beachcast bull-kelp (*Durvillaea*) containing holdfast invertebrates

Associate Professor David Wharton

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Room: B308



David's research interest is environmental physiology (particularly responses to extreme cold and desiccation). Here are some suggested projects.

Panagrolaimid nematodes as models for studying extreme environmental stress (BSc Hons, MSc)

Panagrolaimids are bacterial-feeding nematodes with a cosmopolitan distribution from polar and subpolar regions to temperate and semi-arid soils and terrestrial moss. Two *Panagrolaimus* species associated with extreme environments in the Arctic and Antarctic are currently the subject of genomic and transcriptomic studies. In this project you will work with two Antarctic panagrolaimids and attempt to isolate further *Panagrolaimus* species from New Zealand. You will compare the freezing and desiccation tolerance of these species. The aim is to find species with differing levels of tolerance that can be used to investigate the physiological and molecular mechanisms involved in the survival of these stressors.

Phylogenetics and Phylogeography of Antarctic nematodes (BSc Hons in Zoology or Genetics, with Craig Marshall, Biochemistry)

Genetic data are used in phylogeographic studies to give insight into the historic processes that explain current geographic distributions. In terrestrial Antarctica, phylogeographic studies have the potential to help explain the relative roles of vicariance and dispersal in the evolution of the extant fauna, add to, or contest, the geological evidence for the extent of historical glaciation events, and give a time-frame for the evolution of the observed physiological adaptations of the fauna. Antarctic nematodes are highly endemic and are thought to be descendants of Gondwanan ancestors. We have made collections of Antarctic soil from a variety of sites that contain nematodes, which can be used for such studies. We hope to make further trips to Antarctica in the future.

Anhydrobiosis in Nematodes BSc(Hons)/MSc/PhD

Some nematodes have the remarkable ability to lose all their body water and enter into a state of suspended animation (anhydrobiosis – life without water). This ability has been linked to the production of trehalose but other mechanisms seem to be involved.

Some possible projects include:

- Determining the relative importance of osmotically-active and osmotically-inactive water in anhydrobiotic and non-anhydrobiotic nematodes (using differential scanning calorimetry).
- Changes in the cuticle during desiccation and the role and origin of an oily material that is secreted onto the surface
 - The role of LEA proteins in desiccation and vitrification
- Gene silencing (RNAi) to determine the role of genes associated with anhydrobiosis.

Ice Active Proteins in Alpine Plants

BSc(Hons)/MSc/PhD

New Zealand's alpine flora has evolved in relative isolation and may have developed some novel mechanisms of coping with the low temperatures to which they are exposed. We can recognise three groups of ice active proteins in cold tolerant organisms: ice nucleation proteins trigger ice formation, antifreeze proteins inhibit it and recrystallisation inhibition proteins stabilise ice once it's formed. You will use assays for these three classes of ice active proteins to determine their presence in a variety of alpine plants and to purify and sequence the proteins involved.

Cold Tolerance Mechanisms in New Zealand Terrestrial Amphipods

(MSc, BSc (Hons))

Almost nothing is known about the cold tolerance mechanisms of terrestrial crustaceans and yet in some parts of their range they are likely to be exposed to subzero temperatures. Terrestrial amphipods (sometimes called 'lawn prawns') are found in the alpine zone in NZ. You will determine their cold tolerance strategy and their ability to survive subzero temperatures.

Responses of *Caenorhabditis elegans* to Low Temperature

(PhD)

How can animals survive an unpredictable and changing environment? There are many kinds of stress, both abiotic and biotic, but cold is the most pervasive, being the 'fiercest and most widespread enemy of life on earth'. Low temperatures may be harmful in themselves and, once below the melting point of its body fluids, the animal risks freezing. Where only a small proportion of animals survive we might expect cold tolerance to be enhanced if we breed from the survivors. You will determine the cold tolerance responses of a model organism, the free-living nematode *Caenorhabditis elegans*, select a cold tolerant strain of this organism and compare the responses of cold tolerant and non cold tolerant strains, including a transcriptome approach using RNA sequencing.

Nematode osmoregulation

(MSc, BSc (Hons))

Nematodes living in soil have to face fluctuating osmotic stress as the soil is flooded or dries out. Free-living nematodes (and many parasitic nematodes) are too small to extract fluid for analysis. I have recently developed a technique using a nanolitre osmometer that enables their internal osmotic concentration to be determined. You will look at the relationship between internal and external osmotic concentration in a range of nematode species (soil, marine and parasitic) to see whether they are osmoregulators or osmoconformers and whether they are capable of hyperosmotic or hyposmotic regulation.

