# PHILLIP CHARLES WATTS

## 1.1. PERSONAL INFORMATION & CONTACT DETAILS


**Date of Birth:** 30 July, 1973 **Nationality:** British **Email:** phill@liv.ac.uk
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**Home:** *24 Ranelagh Drive North, Liverpool, L19 9DS. UK.*
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## 1.2. HIGHER EDUCATION

**2005–2008** **Certificate in Professional Studies in Learning and Teaching** in Higher Education (Distinction).
*School of Biological Sciences, University of Liverpool, Liverpool, UK. L69 7ZB.*

**1994–1997** **PhD. Population-genetic & biogeographic consequences of dispersal** in cheilostome Bryozoa.
*Port Erin Marine Biological Laboratory, University of Liverpool, Port Erin, Isle of Man. IM9 6JA.*

**1991–1994** **BSc. (Hons.) Marine Biology** First Class (overall mark 75%)
*Dept. Environmental and Evolutionary Biology, University of Liverpool, Liverpool, UK. L69 3BX.*

## 1.3. EMPLOYMENT RECORD

**10/09–** **Senior Lecturer in Ecological Genomics**. (no end date: tenured academic position)
*Institute of Integrative Biology, University of Liverpool, Liverpool, L69 7ZB.* UK.

**09/05–09/09** Lecturer in Marine and Freshwater Biology. (tenured academic position)
*School of Biological Sciences, University of Liverpool, Liverpool, L69 7ZB.* UK.

**04/05–08/05** Post-doctoral Research Assistant (PDRA). Field estimates of fitness and fitness correlates in a population of damselflies as determined by molecular genetic markers.
*University of Liverpool, UK.*

**04/02–03/05** PDRA. Spatial genetic structure, migration and the determinants of effective population size in a patchily distributed endangered damselfly.
*University of Liverpool, UK.*

**04/01–03/02** PDRA. Molecular genetic investigations of pollutant tolerance mechanisms in resistant populations of estuarine fish: tools for microarray investigations.
*University of Stirling, UK.*

**10/98–03/01** PDRA. Assessment of the diversity of sub-Saharan sheep and goat genetic resources.
*International Livestock Research Institute, Kenya & University of Liverpool, UK.*

**07/98–09/98** PDRA. Developing microsatellite markers to investigate the metapopulation dynamics of Irish Sea plaice, *Pleuronectes platessa*.
*University of Liverpool, UK.*

**01/98–06/98** Higher Scientific Officer. Environmental impact assessment of Northeast Atlantic fisheries resources.
*Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK.*

## 1.4. SCIENTIFIC EXPERT POSITIONS

My commitment to communicating complex scientific ideas to an often non-specialist audience is reflected by my invited membership on a range of councils and committees that make decisions about funding and publishing, as well as integrating scientific ideas into conservation and education. I have acted as the external examiner for PhD theses and promote a wider understanding of science through radio interviews and discussion forums.

**2012–** 2013 International Congress of Odonatology, 17-21 June 2013, Friesburg, Germany – Session Convenor: *Odonate genomics*.

**2010–** Portuguese Foundation for Science and Technology (FCT) – External grant assessor.

**2009–** North of England Zoological Society – Member of the Conservation and Education Committee.

**2009** 44th European Marine Biology Symposium, 7-11 September, Liverpool, UK – Theme co-ordinator & Session Chair: *The consequences of catastrophic events*.

**2007–** *Biological Conservation* – Member of the Editorial Board.

**2007–2011** NERC Peer Review College – Full Member (3 years + 1 year invited extension).

**2006–** British Ecological Society – Member of the BES Grants Assessment Panel.

**2005–2010** Marine Biological Association of the UK (MBA) – Meetings Secretary for the MBA.

**External Postgraduate (PhD) Student Examination**

**2010** Scott Tompsett, University of Aberystwyth, UK, *Taxonomy, morphometrics and phylogeography of the cheilostome bryozoan* Schizoporella *in Europe* (supervisors: Dr JS Porter, Dr Paul Taylor).

**2009** María Olalla Lorenzo Carballa, University of Vigo, Spain, *Reproducción sin sexo: el caso de la libélula* Ischnura hastata *en las islas Azores* – Reproduction without sex: the case of the damselfly *Ischnura hastata* in the Azores islands (supervisor: Prof A Cordero).

**Public Understanding of Science**

**2012** Interviewed about parthenogenesis: Brian Switek for *Nature News*.

**2012** Interviewed about Antarctic octopus: Samantha Martin for NERC.

**2010** Presentation to Liverpool SciBar: What would you tell Darwin? Ducks and dispersal.

**2008** Interviewee/scientific advisor about parthenogenesis: Amanda Hargreaves (BBC Radio Features) and Dr Aarathi Prasad (Sense About Science) for "*The Quest for Virgin Birth*" (Interview Broadcast on BBC Radio 4, 1 January, 2009).

**2008** Interviewed about parthenogenesis: Henry Nicholls for Female Future: The Bygone Age of Man. *BBC Focus Magazine*, **189 May**, 24-30.

**2008** Panellist on BAckChat: Marine Environments. BA Festival of Science, Liverpool.

**Manuscript Reviewing**

As expected for a research-active scientist with an international reputation, I am **regularly asked to review manuscripts for scientific journals** to provide informed comment on a variety of topics in conservation biology, molecular ecology, evolutionary theory and genetics/genomics; for example, *Annales Zoologici Fennici*; *Aquatic Living Resources*; *Biological Conservation*; *Ecological Entomology*; *Evolution*; *Freshwater Biology*; *Hydrobiologia*; *ICES Journal of Marine Science*; *Journal of Applied Ecology*; *Journal Experimental Marine Biology and Ecology*; *Journal of Fish Biology*; *Journal of the Marine Biological Association of the UK*; *Journal of Natural History*; *Journal of Sea Research*; *Journal of Zoology*; *Marine Biology; Molecular Ecology*; *New Zealand Journal of Marine and Freshwater Research*; *Organisms; Diversity and Evolution*; *Proceedings of the Royal Society of London B; Zoologischer Anzeiger* and *Zoological Journal of the Linnean Society*.

## 1.5. Scientific Positions of Trust and Administration

**University Administration**

As a group leader, I **am responsible for mentoring and professional development** of members of my research team. This is achieved through annual Professional Development Review (PDR) where, following one-to-one discussion, I make recommendations for career progression. An example of my support for the career development of my research group, beyond their standard research duties, is provided by my encouragement that my post-doctoral research assistant Dr Chris Lowe obtains his Certificate in Professional Studies in Teaching & Learning, and also by supporting my technician Laura Martin to acquire her MPhil (part-time).

More widely, I have proven experience of a broad range of administrative roles relevant to the Academic workplace, including postgraduate student supervision (see section 6 for list of PhD students) and student monitoring/assessment (listed below), curriculum development, co-ordinating and developing new teaching modules and ensuring that these modules comply with University policy on Standards and Quality in Learning

and Teaching, co-ordinating module staff meetings and subsequent team responses to student evaluation, preparation of exams, collating and scrutinising examination scripts, and sitting on examination boards. Where appropriate, I have developed these roles beyond the basic duties that are outlined; for example, as exams secretary, I co-ordinate review for all teaching staff to ensure (1) the quality and consistency of the programme's assessment and (2) that each member of staff is aware of the core programme content.

**2010–2011** Convener of departmental groups meetings: Evolutionary Ecology.

**2008–2011** Module co-ordinator: ENVS310: Adaptation, Behaviour and Conservation… (Level 3).

**2008–2009** Design and development of the aquarium facilities.

**2007–** Level 1 & 2 Mitigating Circumstances Committee / Board of Examiners.

**2006–** Module co-ordinator: ENVS150: Patterns of Biodiversity… (Level 1).

**2005–2011** Examination Secretary for Marine Biology (Honours) BSc.

**Internal Postgraduate (PhD) Assessment**

Specific duties associated with postgraduate (PhD) assessment include acting as an advisor and mentor, assessing research progress via written reports (at 3 months, 1 year and 2 years) and oral vivas (after 1 and 2 years of study), making formal recommendations about the candidate's ability to progress from an MPhil (the mandatory initial registration) to PhD pathway and, if necessary, resolving any conflict between students and their supervisory panel. At the end of a student's research, one internal assessor acts as an internal thesis examiner to assess quality of the thesis and liaise with the external examiner. I act or have acted as the internal PhD assessor for;

**2009–** James Davies, University of Liverpool, *The Ecological genetics of size and dispersal in the Orange-tip butterfly,* Anthocharis cardamines *Linnaeus (Lepidoptera: Pieridae)*. (supervisors: Dr IJ Saccheri, Prof G Hurst).

**2008–** Katie Edwards, University of Liverpool, *Understanding links between environment, behaviour, and reproduction in the endangered black rhino (*Diceros bicornis*)*. (supervisors: Dr S Shultz, Prof J Hurst, Dr S Walker).

**2007–2011** Scott Mirceta, University of Liverpool, *Molecular evolution and structure-function relationships of myoglobin in diving mammals.* (supervisors: Dr M Berenbrink, Dr D Rigden).

**2006–2009** Diane Jones, University of Liverpool, *Biodiversity of the marine benthos: do species matter?* (supervisors: Prof CLJ Frid, Dr DJS Montagnes).

**2006–2009** Heidi Tillin, University of Liverpool, *Assessing marine benthic habitat quality: developing tools for management.* (supervisors: Prof CLJ Frid, Dr SI Rogers, Dr IJ Saccheri).

**2006** Tammy Trott, University of Liverpool, *Age, Growth and Reproductive Biology of the Coney,* Cephalopholis fulva*, in Burmuda* (supervisor: Dr AR Brand; external examiner: Prof C Roberts, University of York). (**Internal Student Examiner**).

**2005–2010** Eva Raebel, University of Liverpool & University of Oxford, *Ecology and conservation of Dragonflies (Odonata) in lowland farmland in the Upper Thames*. (supervisors: Prof DJ Thompson, Prof DW Macdonald). (**Internal Student Examiner**).

**2002–2005** Chris Lowe, University of Liverpool, *An Interdisciplinary approach to assessing functional diversity amongst microscopic free-living eukaryotes*. (supervisors: Dr DJS Montagnes, Prof SJ Kemp).

### 1.6. KEY FOREIGN VISITS

**2011–2012** **Research Sabbatical. Department of Ecology and Evolutionary Biology, University of Jyväskylä, Finland**. 14 months. Part of an ongoing collaboration with Prof T Mappes and Dr E Koskela where we secured funding (£45,539) to cover my teaching that allowed me to undertake a 14-month sabbatical at the University of Jyväskylä. During this time, we developed a programme centred about the eco-evolutionary consequences of genetic polymorphisms that regulate animal behaviour by integrating genomic techniques, selective breeding and field

experiments. We are now developing a bank vole whole genome sequence and future work will examine the consequences of selection to anthropogenic habitat modification (parallel responses to exposure to radioactivity at Chernobyl and Fukushima).

**2002–2003** **Knowledge Exchange. Chengdu Research Base for Giant Panda Breeding, Chengdu, PR China**. 2x1 week visits. Provided training and guidance about effective genetic marker development to enable paternity analysis (of giant pandas) that facilitates captive breeding programmes.

**2000** **Research. International Livestock Research Institute, Nairobi, Kenya**. 3 months. Genetic analysis of sub-Saharan sheep and goat genetic resources.

### 1.7. SCIENTIFIC ACKNOWLEDGEMENTS AND AWARDS

Recent invitations to speak at international conferences and workshops, give keynote speeches, and present seminars at foreign university departments acknowledge the impact of my research, and include;

**2012** **Invitation.** Centro de Investigação em Biodiversidade e Recursos Genéticos (CIBIO), Portugal. Research Centre in Biodiversity and Genetic Resources: Seminar Series.
*Dragonfly fitness: from populations to individuals to molecules, and back?*

**2012** **Invitation.** University of Jyväskylä, Finland. Dept. Ecology and Evolution Seminar Series.
*Field estimates of fitness in dragonfly populations*.

**2011** **Invitation.** University of Lund, Sweden. Dept. Aquatic Sciences Seminar Series.
*Quantifying the influence of seascape in driving adaptive divergence in the ubiquitous* protist Oxyrrhis marina.

**2011** **Plenary Address.** Population genetics and intraspecific diversity of aquatic protists across habitats and eucaryotic clades – PRODIVERSA - Tvärminne Zoological Station, University of Helsinki, Finland.
*What drives adaptive divergence in protist populations?*

**2009** **Keynote Address.** Ecological Networks: Science and Practice. IALE – International Association of Landscape Ecologists (UK), 1-3 September 2009, Edinburgh, UK.
*How molecular-genetic techniques help us understand the importance of landscape in determining spatially structured populations.*

**2007** **Invitation.** North of England Zoological Society, Chester Zoo, UK.
*Parthenogenesis in Komodo dragons: what it is, and what it means for conservation.*

**2006** **Invitation.** IX International workshops on opportunistic protists (IWOP-9) and international society of protistologists (ISOP) 57$^{th}$ annual meetings, Lisbon, Portugal. *An ecological perspective on protistan molecular genetics*.

**2006** **Invitation.** North of England Zoological Society, Chester Zoo, UK.
*The role of genetics in conservation*.

**Scientific Prizes**

**2007** **Best Research Project - Commendation**. British and Irish Association of Zoos and Aquariums.
*Parthenogenesis in Komodo dragons*.

Research excellence is attested by my strong publication record, with more than 70 ISI-listed papers (additional papers under review are listed at the end of section) and 9 book chapters published since 1998, on topics that align with the Oulu University's Department of Biology's research interests in integrative studies of animal ecology, biodiversity, conservation and evolutionary biology; moreover, my research portfolio will strengthen Oulu's reputation for applying genomics techniques to study non-model organisms, which is a key foundation to quantifying adaptive divergence.

**ISI-Listed Scientific Journals**

1. Yang Z, Lowe CD, Crowther W, Fenton A, **Watts PC**, Montagnes (2012) DJS Strain-specific functional and numerical responses are required to evaluate impacts on predator-prey dynamics. *ISME Journal*, in press.
2. Strugnell JM, **Watts PC**, Smith PJ, Allcock AL (2012) Persistent genetic signatures of historic climatic events in an Antarctic octopus. *Molecular Ecology*, **21**, 2775-2787.
   *First genetic evidence to support the Pleistocene collapse of the West-Antarctic Ice Sheet that promoted connectivity between now distant areas.*
3. Thomson JS, **Watts PC**, Pottinger TG, Sneddon LU (2012) Plasticity of boldness in rainbow trout, *Oncorhynchus mykiss*: do hunger and predation influence risk-taking behaviour? *Hormones and Behavior*, **61**, 750-757.
4. Huxley-Jones E, Shaw JLA, Fletcher C, Parnell J, **Watts PC** (2012) Use of DNA barcoding to reveal species composition of convenience seafood. *Conservation Biology*, **26**, 368-371.
5. **Watts PC**, Thompson DJ (2012) Developmental plasticity as a cohesive evolutionary process between sympatric alternate-year insect cohorts as determined by molecular genetic markers. *Heredity*. **108**, 236-241.
   *Quantifies the evolutionary impact of intrapopulation variation in development rate and its role in limiting the extent of allochronic divergence.*
6. Md. Naim D, Telfer S, Tatman S, Bird S, Kemp SJ, Hughes R, **Watts PC** (2012) Patterns of genetic divergence among populations of the common dormouse, *Muscardinus avellanarius*, in the UK. *Molecular Biology Reports*, **39**, 1205-1215.
7. Lowe CD, Mello LV, Samatar N, Martin LE, Montagnes DJS, **Watts PC** (2011) The novel transcriptome of the flagellate *Oxyrrhis marina* (Alveolata: Dinophyceae): response to salinity examined by 454 sequencing. *BMC Genomics*, **12**, 519.
8. Thompson DJ, Hassall C, Lowe CD, **Watts PC** (2011) Field estimates of reproductive success in a model insect: behavioural surrogates are poor predictors of fitness. *Ecology Letters*, **14**, 905-913.
   *One of only two studies to quantify drivers of fitness in wild insect populations and the first evidence that parasitism impacts upon mate choice and realised reproductive success; this paper also highlights the discrepancy between behavioural observations of mating and realised production of offspring.*
9. Md. Naim D, Telfer S, Sanderson S, Kemp SJ, **Watts PC** (2011) High levels of multiple paternity in natural and reintroduced populations of the common dormouse, *Muscardinus avellanarius*. *Conservation Genetics*, **12**, 971-979.
10. Ciofi C, Tzika AC, Natali C, **Watts PC**, Sulandari S, Zein M, Milinkovitch MC (2011) Development of a multiplex PCR assay for fine-scale population genetic analysis of the Komodo monitor *Varanus komodoensis* based on 18 polymorphic microsatellite loci. *Molecular Ecology Resources*, **11**, 550-556.
11. Green JA, Paramor OAL, Robinson LA, Spencer M, **Watts PC**, Frid CLJ (2011) Marine biology in time and space. *Marine Ecology*, **32 (Suppl. 1)**, v-vii.
12. Montagnes DJS, Lowe CD, Martin LE, **Watts PC**, Downes-Tettmar N, Yang Z, Roberts EC, Davidson K (2011) *Oxyrrhis marina* growth, sex, and reproduction. *Journal of Plankton Research*, **33**, 615-627.
13. **Watts PC**, Martin LE, Kimmance SE, Montagnes DJS, Lowe CD (2011) The distribution of *Oxyrrhis marina* - a global disperser or poorly characterised endemic? *Journal of Plankton Research*, **33**, 579-589.

14. Lowe CD, Martin LE, Roberts EC, **Watts PC**, Wootton EC, Montagnes DJS (2011) Collection, isolation, and culturing strategies for *Oxyrrhis marina*. *Journal of Plankton Research*, **33**, 569-578.
15. Lowe CD, Keeling PJ, Martin LE, Slamovits C, **Watts PC**, Montagnes DJS (2011) Who is *Oxyrrhis marina*? Morphological and phylogenetic studies on an unusual dinoflagellate. *Journal of Plankton Research*, **33**, 555-567.
16. Montagnes DJS, Lowe CD, Roberts EC, Breckels MN, Boakes DE, Davidson K, Keeling PJ, Slamovits C, Steinke M, Yang Z, **Watts PC** (2011) An introduction to the special issue: *Oxyrrhis marina*, a model organism? *Journal of Plankton Research*, **33**, 549-554.
17. Thomson JS, **Watts PC**, Pottinger TG, Sneddon LU (2011) Physiological and genetic control of boldness: characterising the mechanisms of behavioural variation in rainbow trout, *Oncorhynchus mykiss*. *Hormones and Behavior*, **59**, 67-74.
18. Lowe CD, Montagnes DJS, Martin LE, **Watts PC** (2010) High genetic diversity and fine-scale spatial structure in the marine flagellate *Oxyrrhis marina* (Dinophyceae) uncovered by microsatellite loci. *PLoS ONE*, **5**, e15557.
19. **Watts PC**, Keat S, Thompson DJ (2010) Patterns of spatial genetic structure and diversity at the onset of a rapid range expansion: colonisation of the UK by the small red-eyed damselfly *Erythromma viridulum*. *Biological Invasions*, **12**, 3887–3903.
20. Sherratt TN, Laird RA, Hassall C, Lowe CD, Harvey IF, **Watts PC**, Cordero-Rivera A, Thompson DJ (2010) Empirical evidence of senescence in adult damselflies (Odonata: Zygoptera). *Journal of Animal Ecology*, **79**, 1034-1044.
    *First convincing evidence of senescence (age-dependant mortality) in wild insect populations, which is typically unexpected for animals with short lifespans.*
21. Hassall C, Lowe CD, Harvey IF, **Watts PC**, Thompson DJ (2010) Phenology determines seasonal variation in ectoparasite loads in a natural insect population. *Ecological Entomology*, **35**, 514-522.
22. **Watts PC**, Kay SM, Wolfenden D, Fox CJ, Geffen AJ, Kemp SJ, Nash RDM (2010) Temporal patterns of spatial genetic structure and effective population size in European plaice (*Pleuronectes platessa* L.) along the west coast of Scotland and the Irish Sea. *ICES Journal of Marine Science*, **67**, 607-616.
23. Lowe CD, Montagnes DJS, Martin L, **Watts PC** (2010) Patterns of genetic diversity in the marine heterotrophic flagellate *Oxyrrhis marina* (Alveolata: Dinophyceae). *Protist*, **161**, 212-221.
24. **Watts PC** (2009) Characteristics of microsatellite loci in Odonata. *International Journal of Odonatology*, **12**, 275-286.
25. Strugnell JM, Allcock AL, **Watts PC** (2009) A panel of microsatellite loci from two species of octopus, *Pareledone turqueti* (Joubin, 1905) and *Pareledone charcoti* (Joubin, 1905), which are endemic to the Southern Ocean. *Molecular Ecology Resources*, **9**, 1239-1242.
26. Strugnell JM, Allcock AL, **Watts PC** (2009) Microsatellite loci from the endemic Southern Ocean octopus *Adelieledone polymorpha* (Robson, 1930). *Molecular Ecology Resources*, **9**, 1068-1070.
27. Lowe CD, Harvey IF, **Watts PC** Thompson DJ (2009) Reproductive timing and patterns of development in for the damselfly *Coenagrion puella* in the field. *Ecology*, **90**, 2202-2212.
    *Integrated behavioural observations, molecular data and quantitative genetics (estimates of heritability) to quantify the factors that determine developmental rates and thus the level of reproductive synchronisation.*
28. Md. Naim D, Kemp SJ, Telfer S, **Watts PC** (2009) Isolation and characterisation of ten microsatellite loci in the common dormouse, *Muscardinus avellanarius*. *Molecular Ecology Resources*, **9**, 1010-1012.
29. Fitzpatrick S, **Watts PC**, Feliciangeli MD, Miles MA, Kemp SJ (2009) A panel of ten microsatellite loci for the Chagas disease vector *Rhodnius prolixus* (Hemiptera: Reduviidae). *Infection, Genetics and Evolution*, **9**, 206–209.
30. Gordon LK, Hurst GDD, **Watts PC** (2009) Eight microsatellite loci for the sexually-transmitted, parasitic mite *Coccipolipus hippodamiae*. *Molecular Ecology Resources*, **9**, 619-621.

31. Saccheri IJ, Rousset F, **Watts PC**, Brakefield PM, Cook LM (2008) Selection and gene flow on a diminishing cline of melanic peppered moths. *Proceedings of the National Academy of Sciences, USA*, **105**, 16212-16217.

    *Use changes in the shape of a melanic cline to estimate the joint action of selection and dispersal, indicating the timescale over which clines decay in the face of changes in selective pressure.*

32. **Watts PC**, O'Leary D, Cross MC, Coughlan J, Dillane E, Kay SM, Wylde S, Stet R, Nash RDM, Hatfield EMC, Cross TF (2008) Contrasting levels of genetic differentiation among putative neutral microsatellite loci in Atlantic herring *Clupea harengus* populations and the implications for assessing stock structure. *Hydrobiologia*, **606**, 27-33.

33. Lowe CD, Harvey IF, Thompson DJ, **Watts PC** (2008) Strong genetic divergence indicates that congeneric damselflies *Coenagrion puella* and *C. pulchellum* (Odonata: Zygoptera: Coenagrionidae) do not hybridise. *Hydrobiologia*, **605**, 55-63.

34. Shen F-J, **Watts PC**, He W, Zhang Z-H, Zhang A-J, Sanderson S, Kemp SJ, Yue B-S (2007) Di-, tri- and tetranucleotide microsatellite loci for the giant panda, *Ailuropoda melanoleuca*. *Molecular Ecology Notes*, **7**, 1268-1270.

35. Cunha HA, **Watts PC** (2007) Twelve polymorphic microsatellite loci for marine and riverine tucuxi dolphins (*Sotalia fluviatilis* and *S. guayanensis*). *Molecular Ecology Notes*, **7**, 1229-1231.

36. Lowe CD, Kemp SJ, Harvey IF, Thompson DJ, **Watts PC** (2007) Variable microsatellite loci isolated from the azure damselfly, *Coenagrion puella* (L.) (Zygoptera; Coenagrionidae). *Molecular Ecology Notes*, **7**, 880-882.

37. **Watts PC**, Saccheri IJ, Kemp SJ, Thompson DJ (2007) Effective population sizes and migration rates in fragmented populations of an endangered insect (*Coenagrion mercuriale*: Odonata). *Journal of Animal Ecology*, **76**, 790-800.

    *Quantify spatial variation in effective population size ($N_e$) and the ratio $N_e/N$ (where N=the number of adults) in an endangered insect metapopulation, and use these data to estimate the scale of local adaptation.*

38. **Watts PC**, Thompson DJ, Allen KA, Kemp SJ (2007) How useful is DNA extracted from the legs of archived insects for microsatellite-based population genetic analyses? *Journal of Insect Conservation*, **11**, 195-198.

39. Cross MA, Collins C, Campbell N, **Watts PC**, Chubb JC, Cunningham CO, Hatfield EMC, MacKenzie K (2007) Levels of intra-host and temporal sequence variation in large *CO*I sub-units from *Anisakis simplex* sensu stricto (Rudolphi. 1809) (Nematoda: Anisakidae): implications for fisheries management. *Marine Biology*, **151**, 695-702.

40. **Watts PC**, Rousset F, Saccheri IJ, Leblois R, Kemp SJ, Thompson DJ (2007) Compatible genetic and ecological estimates of dispersal rates in insect (*Coenagrion mercuriale*: Odonata: Zygoptera) populations: analysis of 'neighbourhood size' using a more precise estimator. *Molecular Ecology*, **16**, 737-751.

    *Developed and validated a method of estimating ecologically-relevant dispersal using genotype data.*

41. **Watts PC**, Buley KR, Sanderson S, Boardman W, Ciofi C, Gibson R (2006) Parthenogenesis in Komodo dragons, *Nature*, **444**, 1021-1022.

    *Evidence for parthenogenesis in captive reptile populations that has led to the general realisation that asexual reproduction can occur quite readily in many reptiles and amphibians; this impacts upon management of ex-situ populations and also directs new research into the processes that drive asexuality in the wild.*

42. Williams TD, Diab AM, George SG, Godfrey RE, Sabine V, Conesa A, Minchin SD, **Watts PC**, Chipman JK (2006) Development of the GENIPOL European flounder (*Platichthys flesus*) microarray and determination of temporal transcriptional responses to cadmium at low dose. *Environmental Science and Technology*, **40**, 6479-6488.

43. **Watts PC**, Thorpe JP (2006) Influence of contrasting larval developmental types upon the population-genetic structure of cheilostome bryozoans. *Marine Biology*, **149**, 1093-1101.

44. **Watts PC**, Saccheri IJ, Kemp SJ, Thompson DJ (2006) Population structure and the impact of regional and local habitat isolation upon genetic diversity of the endangered damselfly *Coenagrion mercuriale* (Odonata: Zygoptera). *Freshwater Biology*, **51**, 193-205.

45. **Watts PC,** Mallanaphy PJ, McCarthy C, Beukers-Stewart BD, Mosley MWJ, Brand AR, Saccheri IJ (2005) Polymorphic microsatellite loci isolated from the great scallop, *Pecten maximus* (Bivalvia: Pectinidae). *Molecular Ecology Notes*, **5**, 902-904.

46. Keat S, Thompson DJ, Kemp SJ, **Watts PC** (2005) Ten microsatellite loci for the small red-eyed damselfly *Erythromma viridulum* (Charpentier). *Molecular Ecology Notes*, **5**, 788-790.

47. **Watts PC**, Hamilton JGC, Ward RD, Noyes HA, Souza NA, Kemp SJ, Feliciangeli DM, Brazil R, Maingon RDC (2005) Male sex pheromones and the phylogeographic structure of the *Lutzomyia longipalpis* complex (Diptera: Psychodidae) from Brazil and Venezuela. *American Journal of Tropical Medicine and Hygiene*, **73**, 734-743.

48. **Watts PC**, Kemp SJ, Saccheri IJ, Thompson DJ (2005) Conservation implications of genetic variation between spatially and temporally distinct colonies of the damselfly *Coenagrion mercuriale*. *Ecological Entomology*, **30**, 541-547.

49. Shen F-J, **Watts PC**, Zhang Z-H, Zhang A-J, Sanderson S, Kemp SJ, Yue B-S (2005) Enrichment of giant panda microsatellite markers using Dynal magnet beads. *Acta Genetica Sinica*, **5**, 457-462.

50. **Watts PC**, Daguet C, Thompson DJ, Kemp SJ (2005) Exuviae as a reliable source of DNA for population-genetic analysis of odonates. *Odonatologica*, **34**, 183-187.

51. **Watts PC**, Daly D, Kayani A, Culver FA, Kelly VM, Parker GA, Kemp SJ (2005) Polymorphic microsatellite loci for the yellow dungfly *Scatophaga stercoraria*. *Molecular Ecology Notes*, **5**, 30-32.

52. Jamjoom MB, Ashford RW, Bates PA, Chance ML, Kemp SJ, **Watts PC**, Noyes HA (2004) Only *Leishmania donovani* causes visceral leishmaniasis in East Africa; previous descriptions of *L. infantum* and "*L. archibaldi*" from this region are artefacts of isoenzyme classifications. *Parasitology*, **129**, 399-409.

53. **Watts PC**, Rouquette J, Saccheri IJ, Kemp SJ, Thompson DJ (2004) Molecular and ecological evidence for small-scale isolation by distance in an endangered damselfly, *Coenagrion mercuriale*. *Molecular Ecology*, **13**, 2931-2945.
*Landscape-genetic approach to conservation that demonstrates how urbanisation can limit dispersal (and gene flow) and promote loss of diversity and strong genetic divergence in populations that become isolated.*

54. Daly D, Waltham K, Mulley J, **Watts PC**, Rosin A, Kemp SJ, Saccheri IJ (2004) Trinucleotide microsatellite loci for the peppered moth (*Biston betularia*). *Molecular Ecology Notes*, **4**, 179-181.

55. **Watts PC**, Nash RDM, Kemp SJ (2004) Genetic structure of juvenile plaice, *Pleuronectes platessa*, on nursery grounds in the Irish Sea. *Journal of Sea Research*, **51**, 191-197.

56. **Watts PC**, Veltsos P, Soffa BJ, Gill AB, Kemp SJ (2004) Polymorphic microsatellite loci in the black-and-gold chromis, *Neoglyphidodon nigroris* (Teleostei: Pomacentridae). *Molecular Ecology Notes*, **4**, 93-95.

57. **Watts PC**, Thompson DJ, Kemp SJ (2004) Cross-species amplification of microsatellite loci in some European zygopteran species (Odonata: Coenagrionidae). *International Journal of Odonatology*, **7**, 87-96.

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**Overview:** My research integrates **population genetics, ecological genomics** and **evolutionary biology**, with an emphasis on assessing the impact of a heterogeneous landscape upon driving patterns of spatial genetic structure and adaptive divergence (both genetic and phenotypic), and also identifying the intrinsic and external factors behind individual variation in fitness. In addition I use molecular markers to address applied biological problems relevant to wildlife conservation and ecosystem health in response to a changing environment, *e.g*. defining conservation areas, understanding the impact of habitat change/loss upon genetic diversity, identifying the sources of biological invasions and exploring the genetic/genomic consequences of inhabiting the margins of a species'range. I am also interested in identifying genes, and patterns of gene expression, that underlie the expression of complex behavioural traits (such as boldness and aggression) in order to understand the fitness consequences of such genetic polymorphisms and, more generally, identify the mechanisms that prevent (limit) the erosion of putative adaptive polymorphisms.

To realise my research goals I employ a range of **molecular-genetic techniques** (*e.g*. DNA/RNA extraction, PCR and sequencing, real-time PCR, assays of telomere length), **genomic technology** (next–generation sequencing to characterise novel genes/genetic markers from a transcriptome or identify and then genotype SNPs in target genes using DNA capture) and subsequent **population/landscape-genetic** and **bioinformatic** analyses. A key feature of my research is multidisciplinarity by **integrating genetic/genomic techniques with ecological data, field studies and/or laboratory experimentation** (*e.g*. using capture mark recapture to understand dispersal, fitness and senescence, or integrating genetic information with behavioural observations and ecophysiology).

**1. Evolutionary ecology and genome architecture in protists**.

Research into protists (eukaryotic microbes) has fundamental impact because of their substantial ecological and evolutionary relevance, however **microbial systems also provide an unparalleled opportunity to conduct experimental evolutionary studies over contemporary timescales**. My core funding (section 5) supports analyses into spatial genetic structure and adaptive divergence in the near-cosmopolitan protist *Oxyrrhis marina*. In addition to acquiring extensive genetic and ecophysiological data from samples across the European seascape, next-generation sequencing is used to identify genes that are differentially expressed in response to environmental stress and to detect signatures of selection. This is a strategic investment in a key experimental model (*cf*. papers 12-16 in section 2; and work by MR Droop at Tvärminne, Finland in the 1950s) that until recently lacked ecological and genomic data. I will develop two research avenues that integrate experimental evolution and genomics: (1) to determine the mechanisms that allow species to cope/adapt to a changing environment and (2) to understand the significance of gene duplication in organisms with large genomes.

The first avenue of research falls within the themes of "functional biology of adaptation" and "phenotypic and genetic adaptation in temporally and spatially varying environments" by making **an evaluation of the function and competitiveness of genetic diversity.** Our data, like emerging studies of other aquatic protists, indicate a puzzlingly-high level of genetic diversity at small spatial scales, with neither the environmental drivers nor the functional significance of which actually understood. To determine whether such genetic diversity "has function" or is "effectively neutral", different strains of *O. marina* (using a hierarchical scale of adaptive divergence) are grown in mixed cultures under (*i*) their present ecological conditions and (*ii*) scenarios of environment change and/or disturbance. The foundation for this research is provided by experiments to determine the response to ocean acidification (PhD project: *Evolutionary responses to ocean acidification in free-living protists*), where we developed molecular techniques to identify the relative abundance of specific clones within mixed cultures (*i.e*. microcosms) and thus the "fitness pathway" (the temporal dynamics of relative performance of strains) and ultimate outcome of competition and selection experiments. Although no other laboratory has yet attempted such ambitious experiments involving multiple mixed strains, the innovation for this research is the integration of (*i*) natural/contemporary patterns of spatial genetic structure, ecophysiological variation and adaptation (*i.e*. exploiting our extensive empirical knowledge to set formal hypothesis about competitiveness outcomes) with (*ii*) laboratory experiments that mimic environmental

forecasts. The new project would assess the effects of a wide range of biotic and abiotic variables (such as temperature changes, ecotoxicological responses, grazers, potential response of colonisers and individuals living in conditions at the edge of their range) and a synergy of factors (as well as the effects of rate of change, stochasticity and migration). I will incorporate molecular techniques to identify genomic regions that confer an advantage and/or respond to selection. In this way we can test explicit hypotheses about the potential for strains from certain regions to better cope with environment change or act as invaders, and also identify the adaptive role of polymorphisms at specific candidate genes as well as more general levels of genomic diversity. The experimental set-up will integrate assessments of phenotype (*e.g*. gene expression, growth rates, productivity) and population/community stability that are used to determine the link between genotype and phenotype and the wider effects of changing environments on ecosystem function and health, with the latter aspect requiring collaboration with an ecological modeller. These ideas may be extended to genomic model protists (*e.g*. *Paramecium*, *Tetrahymena*) to allow a detailed analysis of variation in genomic architecture in soil/freshwater systems that vary in key ecological parameters (*e.g*. using a space for time substitution to study the effects of eutrophication or pollution).

These themes of "adaptation and function" will be extended in a second project that focuses on species that readily form dormant resting stages (cysts). Reviving material from cysts collected from sediment cores (cysts of many protists remain viable for 50-100 years) allows one to explicitly examine known habitat alteration (*e.g*. events associated with industrialisation such as eutrophication and heavy metal pollution) whereby key events are calibrated from the sediment, and cysts prior to and after the events are a direct representation of the effect upon genomic structure and population/community function. Thus, I intend to study another Baltic Sea protist (*e.g. Scripsiella hangoei* as *O. marina* cysts are not abundant in sediments) to **determine the historic and contemporary response to anthropogenic environment change**. Strain-specific genotyping integrated with assessment of phenotype is used to quantify the relative fitness pathway of many strains within mixed cultures under conditions that mimic known environmental challenges. Present studies on protists highlight functional differences between a few strains but no-one has yet examined how strains perform under intraspecific competition; this is a serious limitation to realistic models that predict response to environment change. Moreover, by reviving cysts that existed prior to- and during environmental disturbances we can make an explicit assessment of the ability of laboratory selection experiments to recreate the outcome of the long-term "experiment" of human habitat modification. These data are essential if we are to make a meaningful prediction of future species' responses. Again, this work is truly integrative, with specific assessments of divergent strains, variation at candidate genes as well as the extent of variation in traits that affect productivity to quantify the links between genetic diversity, phenotype and population/community function, a fundamental aspect to the understanding the impact of anthropogenic disturbance upon ecosystem resilience. The next step of this work would be to determine the potential future consequences of anthropogenic changes by employing the series of experiments described above to understand whether contemporary or historic strains are better suited to face future environmental challenges. I am well-positioned to deliver this due to an emerging collaboration in Finland with Dr Anke Kremp (Finnish Academy Research Fellow, SYKE), and more generally an established network of Nordic contacts made through the PRODIVERSA network (*Population genetics and intraspecific diversity of aquatic protists across habitats and eukaryotic clades*). Moreover, these ideas and the approach can be extended to other species that form resting stages such as *Daphnia* and also plant species that form seedbanks (*e.g*. we are presently developing a project to study the genetic and phenotypic impact of different fire regimes on heather *Calluna vulgaris*). Thus, an emerging theme is to **understand the wider action of humans as a dominant selective force on the biosphere**.

The second research avenue on *Oxyrrhis marina* exploits its position as a basal dinoflagellate and is thus a model of eukaryotic genome evolution. Indeed, in addition to their ecological importance dinoflagellates are interesting because most have huge genomes (often more than 50 times larger than the human genome), largely achieved by extensive gene duplication with many genes existing as actively transcribed gene variants. Such genome size and gene duplication has prevented the acquisition of an entire dinoflagellate genome sequence. Nonetheless, to **understand the functional and evolutionary significance of this complex genome**

**architecture**, I intend to identify genes that are present as transcribed variants from EST libraries and use this information to capture and sequence important gene families/functions (defined by gene ontology) from a wider sample of genomic DNA. I can then identify whether (1) genes with certain functions tend to exist as duplicated variants and (2) this gene duplication has an adaptive role (*e.g.* driven by environmental characteristics) or is a more passive process, for example relating population demography. To understand the functional significance of duplicated gene variants it would be essential to collaborate with informaticians (protein modellers) to quantify functional differences among gene variants (*i.e*. tangible changes in protein kinetics) and feed these data into the types of laboratory experiments described above where I formally test whether specific variants (and also copy number) impact upon a strains' competitive ability (and also population/community function). To understand the drivers of variation in polymorphism/copy number, I would employ a combination of (1) experimental evolution and (2) an empirical assessment of variation in copy number/genetic polymorphisms/gene expression among strains distributed throughout a spatially- and temporally-varied landscape; such research potentially extends into quantifying the adaptive significance of gene loss. A longer-term research goal is to obtain a working draft dinoflagellate genome, which will be feasible with reducing costs and increasing efficiencies associated with advances in next-generation sequencing technology.

**2. Drivers of fitness in odonates.**

I will continue my long-standing research interests at the forefront of molecular ecology, evolution and conservation of odonates (dragonflies and damselflies) through two research avenues: (1) quantifying the drivers of individual differences in fitness and (2) understanding how variation in landscape impacts upon the pattern of population structure and adaptive divergence.

Understanding the factors that determine an individual's fitness, numbers of offspring produced, remains a central issue in evolutionary biology. I have made the first integrated behavioural, morphometric and genetic study of the factors that determine individual variation in fitness in any wild insect population (the damselfly *Coenagrion puella*). While fitness (number of offspring) is rather poorly-predicted by behavioural observations of mating success, it does correlate with the level of ectoparasitism in females. The next step is to determine **(1) the mechanisms by which parasitism affects fitness** and **(2) the processes that drive spatial variation in parasitism**. The proposed research programme would thus aim to quantify the level of co-infection by assaying for internal parasites (gregarine and a recently-discovered virus [relative of a *Varroa destructor* virus-1] that infects *Coenagrion* sp. – PC Watts, unpublished) as well as ectoparasitic mites under the hypothesis that mite infection leads to a compromised immune system. I would also quantify the key components of fitness (such as variation in fecundity, offspring viability) in parasitised and unparasitised individuals, identify any sex-specific processes under the hypothesis that the sexes have divergent optimal strategies to maximise reproductive success, quantify the role of candidate molecular mechanisms behind the immune response (*e.g*. melanism, phenoloxidase pathways) and assess the correlations (potential constraints) associated with the overall phenotypic response to parasitism. Finally, the work would be placed in wider context to determine how variation in land use (*e.g*. agriculture, urbanisation) affects parasite density and thus impacts upon individual fitness – whether any response to parasitism has a genetic or plastic basis; thus this work integrates blue-skies science with applied aspects to impact upon land-use and conservation policy. Since the molecular basis of mating success and fitness has not been well-studied, an additional research direction is **to identify the role of candidate fitness genes**. An initial focus is phosphoglucose isomerase (*pgi*) as this gene determines metabolic efficiency (flight capacity). Several polymorphisms that affect the kinetic properties and thermal stability of *pgi* have been identified in lepidopterans and may drive population dynamics. This gene likely has fundamental fitness consequences within insect populations but this has not been studied. It is straightforward to characterise *pgi* (I have *pgi* coding sequence for three odonates: *Coenagrion puella*, *C. mercuriale* & *Pyrrhosoma nymphula*) and test the hypothesis that specific alleles determine the capacity of individual to be active (present at the mating site, hold a territory and/or obtain a mate) at certain temperatures (temperature a key variable for mating success in odonates); this work thus examines a potential link between genotype and fitness. A crucial aspect would be to understand the fitness benefits/cost and trade-offs associated with different alleles and thus the potential mechanisms that maintain

polymorphisms in wild populations. A particular challenge to understanding fitness in organisms with complex life histories is the suite of events that occur during the larval (and less well studied) phase. I envisage research into the role that *pgi* play in determining larval and adult survival as part of the first step towards quantifying the more general genomic and behavioural correlations (or antagonisms) between distinct life history phases (*i.e*. the aquatic larval phase and terrestrial adult in odonates), which is another long-term, future research goal.

The second research direction, well-suited to Masters students, a PhD program or attracting a Marie Curie Research Fellow (through an Intra-European Fellowship), extends my present work into the **effect of landscape upon patterns of spatial structure and genetic diversity**, with emphasis on the genomic and phenotypic consequences of inhabiting a range margin (either by range expansion or contraction). Potential research topics include the effect of habitat matrix (*e.g*. forest, roads, urban areas) on the pattern of spatial genetic structure (*e.g*. source-sink structure, adaptive divergence, effective population size) and also to determine how dispersal capability/propensity varies across species' ranges. Such research would include an appraisal of body morphology (with reference to flight capability) and variation at candidate genes that affect thermal efficiency (such as *pgi* and potentially genes in the melanisation pathway) within and among populations of odonates across their range; indeed, since many odonates are expanding their ranges in response to climate change the sampling would make explicit comparisons between populations at the advancing edge of a species' range compared with those in older, more central locations and use laboratory rearing to separate the heritable and plastic components of life-history characteristics (*e.g*. relating to development, phenotype). An additional direction is provided by my ongoing transcriptomic analysis of an odonate population at its range that is being used to identify candidate genes associated with stress (in one population this potentially includes inbreeding). Such work explicitly falls with the University of Oulu's research strengths in the "ecology of northern environments", and I believe that odonates, as a principally tropical taxon, represent an intriguing group of organisms to study under this theme.

**3. Mammalian evolutionary ecology and behavioural genetics.**

A third aspect to my intended research is to continue to strengthen my collaboration with Prof T. Mappes and Dr E Koskela at the University of Jyväskylä, which integrates the themes of "… adaptation in temporally and spatially varying environments" and "ecological interactions and evolutionary conflicts". Our emerging, multidisciplinary research programme, funded by the Finnish Academy through three projects (section 5) combines my expertise in genetics and genomics with Mappes and Koskela's unparalleled expertise with using the bank vole *Myodes glareolus* as an evolutionary model. After selective breeding based on polymorphisms in candidate genes (*e.g.* vasopressin 1a receptor, oxytocin receptor) we use experiments under semi-natural conditions **to determine the fitness consequences of genetic polymorphisms, and understand how adaptive variation is maintained in the natural environment**; for example, is the fitness value of a polymorphism dependent upon population density? is the expression of certain genes sexually-antagonistic? We are presently working to obtain a draft bank vole genome so that we can exploit the numerous research possibilities that are offered by the combination of a genome sequence and experimental tractability. One aspect of this future research is to understand the pattern of adaptive divergence of *M. glareolus* throughout the Finland's environment, at both national and landscape scale. A second aspect to the work is to use our understanding of the genetic basis of behaviour to understand **how behaviour (*e.g*. bold/shy/aggressive/ passive) impacts upon disease transmission**; this latter project is being developed in collaboration with Dr E Kallio (Finnish Academy Research Fellow at the University of Jyväskylä). An additional research possibility raised by the collaboration with Dr Kallio and a position at Oulu would be the capacity to examine the "edge of its range" transmission dynamics of tick and tick-borne encephalitis.

**My interdisciplinarity, scientific capability and flexibility, and experience of working and securing research funding in Finland will foster cross-collaboration with the research community at the University of Oulu, with the integrated research themes described above (landscape genomics, experimental evolution, individual basis of fitness, behavioural genetics, and adaptation to anthropogenic change) certainly relevant and complementary to aims of many research groups present at the University of Oulu.**

I **am fully-committed to high-quality and stimulating teaching and learning across all academic levels**, as evidenced by my Certificate in Professional Studies in Learning and Teaching in Higher Education (with Distinction – awarded in 2008). Support to undergraduate students is provided through fortnightly small-group tutorial sessions (Levels 1-3) that cover a range of topics, from finding appropriate literature in the library, data analysis and preparations of CVs and mock job interviews. Small group tutorials are both important and rewarding by providing a clear and immediate point of contact for new students in the initially unfamiliar environment, and allow staff to closely-follow, and have a large impact upon, the development of students during their subsequent academic progress. I encourage final year BSc students to undertake innovative and challenging research projects; hence, 16 of my BSc (Hons) students have acquired peer-reviewed publications (most recently in *Conservation Biology*), which they find rewarding and certainly helps them to "stand out" in applications for postgraduate courses or jobs. I am also part of the Level 1 & 2 Mitigating Circumstances Committee/Board of Examiners, where we examine reasons for student underperformance during exams and determine the appropriate path for progress.

My teaching philosophy arises from a passion for biological research and enthusiasm to discuss ideas and concepts. I believe that;

- students deserve excellence and stimulation during teaching and that the University Research setting should be relevant to their experience,
- teaching should delivered in a structured way that builds student confidence and progressively increases their capabilities,
- the demands that we place on our students are clearly expressed and reasonable,
- that student opinions should be sought and valued, and
- that teachers/mentors benefit when they deliver these values by engaging with keen and motivated students.

In the first instance these aims are achieved by **keeping course material relevant, interesting and contemporary, and, as much as possible, ensuring that the content reflects the surrounding University research environment to deliver research-informed teaching**. Since a key part of learning is through experience and practice, where possible, students should be allowed to acquire hands-on familiarity with organisms, their environment and the appropriate methods of study – whether in the laboratory or in the field. I strive to make the learning experience enjoyable and challenging, and not only deliver a range of specific scientific techniques that are relevant to the course, but also impart a panel of broader, generic skills that are essential to gain employability in the wider sector.

**Teaching is delivered in a variety of settings** from classes that fill large lecture theatres to working with small groups and individuals. I ensure that teaching is enjoyable and challenging, and accessible to a diverse audience as this is important to meet the challenges of widening participation. Teaching delivery is supported by a variety of media (including use of an on-line learning tool to mediate discussion as well as incorporating video clips and quizzes) and by using an appropriate mode of delivery, for example, encompassing workshops, practical exercises, student group presentations, class discussions about key literature and/or debates about controversial and topical subjects. On a personal basis, I believe that students benefit from my approachability and sense of humour, and that staff-student communication is essential to encourage discussion of ideas and improve confidence and learning.

All of my teaching was developed *de novo* by myself, in dialogue with other module staff to ensure a balanced structure. I have designed, co-ordinated and taught a range of new undergraduate modules that embrace a mixture of lecture-, practical- and fieldwork-based teaching. Crucially, these were **a key part of the curriculum development** of Liverpool University's new Marine Biology BSc. (Hons.) programme, with my interdisciplinary research expertise at the interface of molecular genetics, ecology and evolution, and wildlife conservation fulfilling a key research and teaching component of our vision of "21st century biology". I am now engaged with the development of **curriculum review for evolutionary biology and animal behaviour** for the Zoology BSc. (Hons.) degree. My undergraduate teaching encompasses key issues in evolutionary ecology,

biodiversity and animal behaviour, as well as the practical applications of molecular genetics and forensics as applied to wildlife conservation, which are logical corollarys of my research interests. I am therefore well-positioned to teach within the University of Oulu's Undergraduate programme in Biology and the Master's programme in Ecology and Population Genetics.

Some example modules that I teach (or have taught) include;

- **Patterns of Biodiversity and Production in the Marine Environment (*Module co-ordinator*) (Level 1, 7.5 credits).** This module delivers the students' first taste of marine science and is designed to stimulate students' knowledge and enthusiasm for biodiversity at the outset of their studies by focussing on exciting evolutionary adaptations while still providing an understanding of core themes in biodiversity. I use media clips and interactive, small group discussion to assess student's understanding of key topics, followed by guidance and assessment to prepare the students for their exams.
- **Physiology, Behaviour and Genetics (Level 2, 7.5 credits)**. This module fills a knowledge gap in the zoology and marine biology curricula. I introduce contemporary genetics and genomics methods that are applied to study animal behaviour and conservation, and introduce the concept of model organisms. My commitment to improving students' learning experience is evidenced by the positive review of the interactive revision sessions that are used to revise lecture material and improve essay-writing technique.
- **Ecology Field Studies (Level 2, 15 credits).** This field-course delivers an enjoyable and intensive experience of field surveys, data analysis and report writing. I teach identification and survey skills, and a short introduction to some techniques used to manipulate data and perform and interpret statistical analyses; I use a combination of introductory and summary lectures and a computer-based workshop to engage all students with the practical computer and analytical skills. The workshop ensures students learn through experience and allows students to complete tasks at their own pace, thus responding to diversity of capabilities and learning styles. In addition, I am responsible for the general welfare of students away from the University environment.
- **Marine Biology Practical Skills (Level 2, 7.5 credits).** A practical module that provides students with skills related to biodiversity surveys. I provide students with a background on fish form and function and life-history traits, with an emphasis on shark conservation. I work with collaborators at Liverpool World Museum and use a combination of behavioural & morphological observations and internet research to deliver teaching objectives. Students are taken "behind the scenes" at the aquarium to better understand this type of career path, and they are informed about local conservation of thornback rays.
- **Surviving the Marine Environment: Adaptation, Behaviour and Conservation (*Module co-ordinator*) (Level 3, 7.5 credits)**. A research-lead module that uses blended learning to teach students about behavioural ecology and evolutionary theory and how this is applied to conservation. To enhance the student experience I use a combination of discussion lectures that are supported by student-lead presentations about key topics. I have also introduced formal class debates to the curriculum as an engaging and original method of learning that also explores a skill set that students rarely get to experience elsewhere in their time at the University. Moreover, I run a student-centred workshop and data handling exercise that is designed specifically to reinforce the students' appreciation of genetic data analysis and improves numeracy, data handling skills and presentation of results, which improves their ability to prepare their honours project dissertations.
- **Advanced Skills in Zoology (Level 3, 30 credits).** An innovative module that employs a tutorial-style setting to improve students' capability to be independent and understand the evolutionary, ecological and conservation issues related to a specific animal group. I mentor students to critically-evaluate research papers and seminars, produce their own "transaction-style" papers and communicate scientific topics through alternative media (posters, podcasts, *etc*.).
- **Honours Project (Level 3, 30 credits).** I supervise students from Bioveterinary Science, Conservation Medicine, Genetics, Marine Biology, Molecular Biology, and Zoology honours programmes. My

students benefit from the contemporary techniques used in my laboratory that enables me to provide challenging and stimulating projects and close interaction with research staff. I support students to be independent and design their own project so that it is personal and memorable; at the same time, I ensure a solid project design that it delivers a broad range of skills and a solid foundation for a good degree.

I actively engage postgraduate teaching on the University of Liverpool's *MSc/MRes Advanced Biological Sciences* (*Conservation Biology* and *Animal Science* pathways) through two modules

- **Introduction to Research (Level M, 30 credits).** This module delivers students with a specific introduction to the panel of research skills that will be necessary to complete their chosen pathway. Students actively seek some initial laboratory experience, and also complete a reflective log, portfolio of activities, and a literature review in close consultation and guidance with their mentor to ensure appropriate planning and development.
- **Research Project (Level M, 60 or 120 credits).** I guide students to design their own independent and original research projects that provide them with an enhanced experience of scientific research that is tailored to their future career aspirations. Projects are planned to provide essential transferable skills in data analyses and interpretation, and effective communication, such as scientific writing, poster presentation and oral delivery.

moreover,

- I have taught on the *MSc in Zoo Conservation Biology* and *MSc in Conservation Biology with Zoo Studies* that is run by Manchester Metropolitan University and Chester Zoo, where I developed a research-lead discussion lecture and interactive workshop that improves students' paper-writing skills.

I **consistently develop a range of novel undergraduate (BSc) and postgraduate (MPhil, MRes. MSc) research projects** (*e.g*. analysis of genes that regulate behaviour, developing new genetic markers for fisheries management and conservation, using DNA barcoding for wildlife forensics, and conducting behavioural analysis to understand drivers of aggression) so that I can engage diverse student interests and abilities. Project topics are continually developed according to current research questions, technical advances and, of course, the students' interests. Developing novel projects motivates students through the processes of discovery and ownership. My general role for undergraduate and post-graduate research projects thus includes mentoring, providing feedback on draft project reports, aiding students with project design and analysis, co-ordinating regular laboratory meetings. Where possible I seek to incorporate student projects with the research interests of my local and international collaborators to demonstrate the value of professional partnerships.

**Feedback to students is crucial to maintain teaching quality and enhance the student learning experience**. In particular, every effort is made to provide students with formative feedback during the coursework so that students are able to improve gaps in their abilities before the assessment deadline. Feedback is provided through a number of mechanisms. Thus all of my modules have self-assessment exercises and interactive discussion sessions, with practice MCQs, SAQs and essays as appropriate. For example, during the Level 3 module "*Adaptation, Behaviour and Conservation*", I run two workshops and drop-in sessions that cover effective data analysis, data presentation and report–writing as these are also essential skills for their final year project report and subsequent career path. I provide formative feedback on reports prior to the final deadline for coursework submission; in addition, students gain a second opportunity for feedback when the material is returned after it has been assessed – thus, students can identify how they have improved their skills during the module and, crucially, recognise and then focus on remaining areas for improvement that can be implemented for their subsequent studies. Similarly, I offer guidance and practice with oral presentations and feedback on draft reports and essays completed by tutorial students and undergraduate/postgraduate project students. Both tutorial and project students are encouraged to complete portfolios of activity and reflective logs that track their progression during their academic studies.

It is important that **students are informed about the demands we place on them and that these demands are reasonable**. Thus, all of my teaching material is prepared, and revised as appropriate, well in advance of

its delivery; Information about coursework and assessment is presented to students in the module specifications and handbooks, which are available on-line and also as a hard-copy from a Teaching Support Office, so that the students are appropriately knowledgeable about expected workloads and all specific deadlines before they take a module – such information should allow students to organise and manage their work. All of my assessment complies with the University's code of practice on assessment (COPA) and is delivered appropriately to students according to the level and the mode of teaching delivery. Nonetheless, revisions to improve course content and style (*e.g*. teaching delivery/assessment/syllabus) are made in response to both informal discussions with students during contact hours as well as through anonymous student evaluation of modules, and also from my reflective notes that are made after teaching delivery. Discussions among teaching staff during annual module review meetings and programme monitoring provide the platform to ensure that learning outcomes are met and to ensure that it meets the Teaching Quality Support Division's policy on standards and Quality in Teaching and Learning as well as meeting my own commitment to delivering quality and innovation during teaching. Moreover, as examination secretary I co-ordinate examination meetings to promote dialogue among staff and the external examiner, and ensure that our methods of assessment achieve consistently high standards, are consistent across modules and are set at an appropriate level throughout the degree programme. Accordingly, professional recognition for the quality of this new Marine Biology degree programme was achieved by accreditation by the Institute of Marine Engineering, Science and Technology (IMarEST) (www.imarest.org/).

**Direct Funding**

I have acquired some £912,046 (=€1,135,643) of external grant support directly to my laboratory from a variety of academic, charitable, and industrial funding sources, thus confirming my established position as an independent research leader. Several large grants have allowed me to pursue specific research interests in integrated ecological genomics, while smaller research awards demonstrate my commitment to developing innovative projects with pump-priming.

**2012** **Watts PC**, Lowe CD NERC. £59,853.
*Crossing the divide: population genomics of adaptation to salinity in a model protist*.

**2012** **Watts PC** Conservatoire des Sites Naturels du Nord et du Pas-de-Calais, France. €20,000.
*Dispersal in a rare damselfly and a strategy for its management (translated)*.

**2010** Brockhurst MA, Montagnes DJS, **Watts PC** NERC. £68,865.
*Evolutionary responses to ocean acidification in free-living protists*.

**2009** Ball R, **Watts PC** SharkTrust. £1,500.
*Conservation genetic analysis of thornback rays,* Raja clavata.

**2008** Montagnes DJS, **Watts PC** EAU Ltd. £73,447.
*Study with Water 4 Investments Limited and EAU+ Limited*.

**2008** Jones MG, Hartwell J, **Watts PC** Genetics Society, undergraduate research bursaries. £2,000.
*Population genetics of* Ophrys apifera *in North-West England*.

**2008** Strugnell JM, **Watts PC** CoSyst. £11,661.
*Gene flow, adaptation and speciation in Antarctic octopus: the consequences of climate change*.

**2007** **Watts PC**, Montagnes DJS, Lowe CD NERC. £409,730.
*Breaking boundaries: quantifying the influence of demography and seascape in driving adaptive variation in the ubiquitous protist* Oxyrrhis marina.

**2007** **Watts PC**, Sneddon LU, Pottinger TP Leverhulme Trust. £72,072.
*Proximate mechanisms underlying a behavioural trait: boldness in fish*.

**2007** **Watts PC** Nuffield Foundation, undergraduate research bursaries. £1,360.
*Molecular conservation: uncovering the genetic basis of ecological specialisation.*

**2007** **Watts PC** Esmée Fairburn Foundation. £8,650.
*Development of genetic markers for* Leptopsammia pruvoti*.*

**2007** **Watts PC** North of England Zoological Society. £2,675.
*Identifying the mechanism of parthenogenesis in Komodo dragons.*

**2007** Leah RT, **Watts PC**. Environment Agency. £1,500.
*Where do Mersey salmon come from?*

**2007** **Watts PC** Hymettus Ltd., Natural England. £5,000.
*Genetic approaches to insect conservation.*

**2006** **Watts PC** Hymettus Ltd., English Nature. £3,000.
*Genetic analysis of* Andrena marginata *and* Nomada argentata*.*

**2005** **Watts PC** University of Liverpool RDF. £4,000.
*Assessing the benefits of Marine Protected Areas: a molecular approach.*

**2004** Brand AR, Saccheri IJ, **Watts PC** Esmée Fairburn Foundation. £18,000.
*Isle of Man: Conservation and fishery replenishment effects of a mobile fishing gear closure.*

**2003** Nash RDM, **Watts PC** EU 5th Framework program. £135,490 (University of Liverpool, Genetics Workpackage) - £1.1 million (total consortium grant).
*WESTHER: A multidisciplinary approach to the identification of herring (*Clupea harengus *L.) stock components west of the British Isles using biological tags and genetic markers.*

**2002** Shen FJ, **Watts PC**, Kemp SJ The Wellcome Trust. £13,181.
*Development of genetic markers for use in pedigree analysis and the conservation of genetic diversity in the giant panda,* Ailuropoda melanoleuca*.*

**1999** Nash RDM, **Watts PC** University of Liverpool RDF. £4,000.
*Developing microsatellite markers to investigate the metapopulation dynamics of Irish Sea plaice,* Pleuronectes platessa*.*

**External Collaboration**

A range of past and ongoing **international, collaborative projects, notably in Finland,** show my capability to communicate with people with diverse cultural backgrounds and research capabilities, my enthusiasm for interdisciplinary research and ability to be innovative and solve problems. Recent awards for projects that I co-wrote and explicitly incorporate my contribution represent an excess of €1.4 million in grant support;

**2012** Koskela E. University of Jyväskylä, Finland. Finnish Academy. €675,232.
*The benefit of being rare – frequency dependent selection maintaining sexually antagonistic alleles in mammalian population.*

**2012** Ferreria S, Alves PC, Watts PC, Thompson DJ, Brito JC, El Haissoufi M. Centro de Investigação em Biodiversidade e Recursos Genéticos (CIBIO), Portugal. Presentado a la Convocatoria de Ayudas a la Investigación del Instituto de Estudios Ceutíes. ~€5,000.
Coenagrion mercuriale*: distribución, diversidad genética y estado de conservación*.

**2011** Lönn E. University of Jyväskylä, Finland. Finnish Ministry of Education and Culture. ~€80,000.
*Frequency dependent selection maintaining sexually antagonistic alleles in mammalian populations.*

**2011** Rivera AC. Departamento de Ecoloxía e Bioloxía Animal, Universidade de Vigo, Spain. Convocatoria de ayudas de Proyectos de Investigación Fundamental no orientada. ~€15,000.
*Ancient responses to new challenges: ecology and evolution of the Odonata (ODOEVO2011)*.

**2011** Ferreria S. Centro de Investigação em Biodiversidade e Recursos Genéticos (CIBIO), Portugal. Portuguese Foundation for Science and Technology (FCT). ~€45,000.
*Phylogeographic history and Mediteranean refugia in Odonates*.

**2010** Hunger H. Institut für Naturschutz und Landschaftsanalyse (INULA), Germany. ~€3,500.
*Genetic variation in a rare damselfly in a fragmented landscape at its range margin*.

**2009** Stoks R. University of Leuven, Belgium. Fund for Scientific Research - Flanders. ~€65,000.
*Eco-evolutionary dynamics in natural and anthropogenic communities*.

**2009** Mappes T. University of Jyväskylä, Finland. Finnish Academy. €330,000.
*Neurogenetics of reproductive strategies in natural populations*.

**2009** Begon ME, McElhinney L. University of Liverpool, UK. DEFRA. £105,164.
*Targeted surveillance for Ljungan virus & Hantavirus in urban rodents*.

**2009** Rivera AC. Departamento de Ecoloxía e Bioloxía Animal, Universidade de Vigo, Spain. Convocatoria de ayudas de Proyectos de Investigación Fundamental no orientada. €53,186.
*Sexual selection and the evolution of mating strategies in odonates (ODOEVO)*.

**Overview**. I presently mentor and supervise 6 PhD students (with UK and international funding, one of whom is part-time), with the first 6 of my PhD students graduating successfully. My students' career development is important to me and I manage their research experience using (1) formal meetings and records of training that are logged on-line and (2) a combination of less-formal individual research meetings (weekly), bi-weekly group meetings and a separate on-line record of work (*i.e*. new results/analyses, thesis chapters, draft papers) that provides the entire group with a resource of key literature relevant to current research. In this way my research group provide support for each other and also learn make constructive but critical evaluations of their own and others' research. This forum provides an effective mechanism to work in an interdisciplinary environment and provides knowledge transfer of a diverse range of research expertise that the group collectively possess.

**2011–** Eija Lönn, University of Jyväskylä, Finland, *Frequency dependent selection maintaining sexually antagonistic alleles in mammalian populations*.
Finnish Ministry of Education and Culture-funded through the Biological Interactions Graduate School (with Prof T Mappes, Dr E Koskela, Dr M Mökkönen).

**2011–** Samantha Barlow, University of Liverpool, *Temperature sensitivity of oxygen transport in Atlantic cod.*
BBSRC-CASE funded (with Dr M Berenbrink).

**2010–** Ewan Minter, University of Liverpool & University of York, *Evolutionary responses to ocean acidification in free-living protists.*
NERC-funded (with Dr MA Brockhurst, Dr DJS Montagnes).

**2009–** Kieran Pounder, University of Liverpool, *Targeted surveillance for Ljungan virus and Hantavirus in urban rodents.*
DEFRA-funded (with Prof ME Begon, Dr L McElhinney, Dr ER Kallio).

**2008–** Karen Evans, University of Liverpool, *Biodiversity of freshwater sponges.*
Privately-funded, part-time (with Dr DJS Montagnes).

**2008–submitted** Angela Sims, University of Liverpool, *Genomic analysis of stress, aggression and boldness in rainbow trout.*
Leverhulme Trust-funded (Principal supervisor, with Dr LU Sneddon, Dr T Pottinger).

**2007–2011** Jack Thomson, University of Liverpool, *Stability of an evolutionary relevant behavioural trait in fish: impact of environmental variation on behaviour and physiology.*
NERC-CASE funded (Principal supervisor, with Dr LU Sneddon, Dr T Pottinger).

**2007–2011** Katherine Nisbet, University of Liverpool, *Designing an ecologically and biologically viable network of marine protected areas.*
University of Liverpool-funded (with Dr LA Robinson, Prof CLJ Frid).

**2006–2012** Bradley Cain, Manchester Metropolitan University, *Conservation genetics of enclosed black rhinoceros populations in Kenya.*
NEZS/Manchester Metropolitan University-funded (with Dr B Stevens-Wood, Dr S Shawcross).

**2006–2011** Nicola Edmonds, University of Liverpool, *Ecological genomics of defence in the peppered moth*.
NERC-funded (with Dr IJ Saccheri).

**2006–2010** Darlina Md. Naim, University of Liverpool, *Population structure and conservation genetics of the dormouse,* Muscardinus avellanarius.
Malaysian Government-funded (Principal supervisor, with Prof SJ Kemp, Dr S Telfer).

**2003–2007** Simon Keat, University of Liverpool, *Range expansion, population structure and life history of the small red-eyed damselfly* Erythromma viridulum *(Charpentier, 1840) at its northwest margin*.
NERC-funded (with Prof DJ Thompson, Prof SJ Kemp).

## 7. Contact Details of 2 to 4 Persons available for Recommendation

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## 8. Total Number of Citations and H-Index

**Web of Science**
Citations: 680
Cites/year: 45.33
h-index: 14

**Google Scholar - using Publish or Perish**
Citations: 897
Cites/year: 59.80
h-index: 17