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CSIRO

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CSIRO-UTAS JOINT PHD PROGRAM IN QUANTITATIVE MARINE SCIENCE

Associate Professor Barry Hughes
Executive Director
National Strategic Review of Mathematical Sciences Research

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Dear Barry

Please find enclosed a summary of the CSIRO-UTAS Joint PhD Program in Quantitative Marine Science and related information about the PhD cohort that I promised to supply to the Working Party following an interview Dr Trevor McDougall and I had with the committee in February.

With regards

Richard Coleman

Professor Richard Coleman
Director, CSIRO-UTAS Joint PhD program in Quantitative Marine Science

University of Tasmania and CSIRO
Joint Program in Quantitative Marine Science

INTRODUCTION

A Joint PhD Program in Quantitative Marine Science (QMS) has been initiated between the University of Tasmania and CSIRO, with a focus on graduating PhD students with expertise to work in areas of marine science that require highly developed quantitative skills. On August 14, 2003, CSIRO and the University of Tasmania launched the multi-million dollar joint research program to build the nation's capability in marine environment and resource management, with the first intake of PhD students into the joint QMS Program starting in February 2004. The investment will generate a new tier of young research scientists specialising in emerging marine research fields.

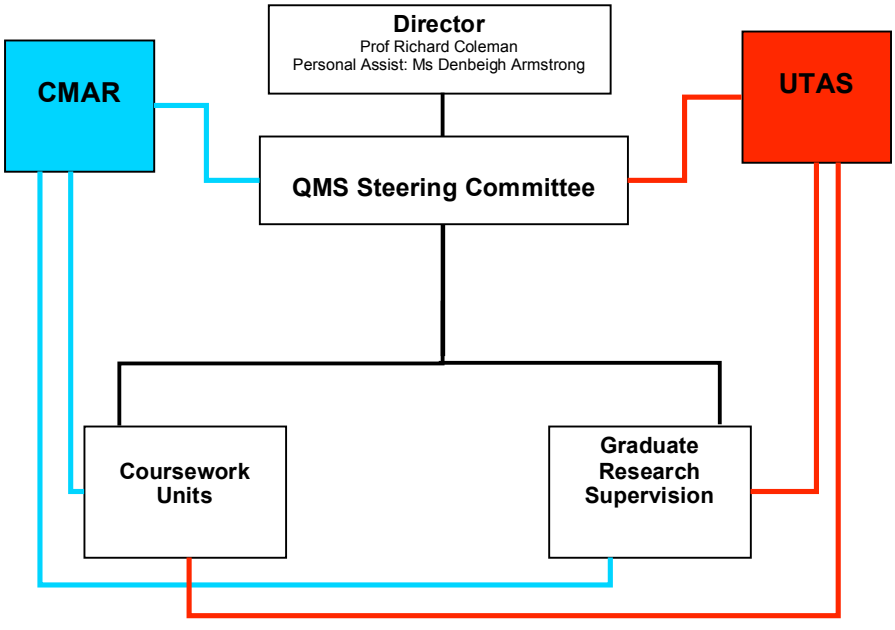
The Joint Program acts as a catalyst for multidisciplinary research between CSIRO and UTAS, focusing on the nation's research priorities. A feature of the Joint Program is that it is a 'virtual entity' rather than a physical centre and is managed by a Joint Management Committee of high-profile University and CSIRO research and academic staff.

The primary motivation for establishing this kind of program is to enhance the quality and number of Australian PhD graduates in marine science. The partner agencies believe that a Joint Program will be more attractive to prospective students, nationally and internationally, and that the combined research and teaching skills of the people within the two organisations will provide the strongest and most diverse academic training ground for marine science in Australia. The postgraduate students will not only have the benefit of working in an outstanding academic institution but will also be exposed to unique opportunities by working in leading edge marine research at CSIRO Marine and Atmospheric Research.

Modelled after a similar program between Massachusetts Institution of Technology and Woods Hole Oceanographic Institution in the USA, the program draws on staff from both organisations across a wide range of disciplines, creating a joint research environment within which postgraduate education and training has flourished.

With over 100 marine science academics/researchers within the two agencies, high quality research infrastructure, a long-standing culture of collaboration, and Hobart's international reputation as a centre of excellence in marine science, we have developed an exciting and innovative postgraduate program that has attracted some of the best students from around Australia and from overseas.

Structure of the CSIRO-UTAS Joint PhD Program in Quantitative Marine Science



RATIONALE AND DEMAND

CSIRO and the University of Tasmania have a long-standing collaborative relationship in several academic areas, notably Antarctic and Southern Ocean studies (including the Antarctic Climate and Ecosystems CRC), aquaculture (including the Aquafin CRC), biological oceanography, fisheries science, fisheries management, marine ecosystems, introduced marine pests and climate research. While they have worked well in their own spheres, there has been no comprehensive program of education or research that formally links the two institutions. The high level of expertise in the two institutions offers a unique opportunity for postgraduate education in quantitative marine science for Australia.

Over the past several years, CSIRO has found it increasingly difficult to recruit scientists with quantitative training in marine science. This scarcity of scientists with quantitative marine science PhDs in Australia occurs despite a number of graduate programs in marine science in Australian universities (see table 1 on page 4). A range of factors may contribute to this situation, including a decreasing total number of applicants for postgraduate places, decreasing numbers of fellowships, decreasing student interest in the mathematical and physical sciences, and the increased need for honours and postgraduate level courses in order to teach students the quantitative skills required.

Looking ahead to its future skill base, CSIRO recognises the importance of human capital development and the need to invest in its own Australian-trained graduates. As a result, CSIRO sought to engage in some form of joint education program with the University of Tasmania, where CSIRO Marine and Atmospheric Research has an involvement with the curriculum as well as the supervision of postgraduate students.

The University of Tasmania is ideally situated to partner CSIRO in this venture. It also has a strong interest in enhancing its research capability in marine science, and is working more closely with CSIRO in new research ventures in this area.

Tasmania is uniquely positioned to take advantage of this opportunity because it has a single university and a concentration of marine scientists in Hobart, including those in the Australian Antarctic Division as well as the University and CSIRO. Additionally, the National Oceans Office in Hobart offers opportunities for collaborative research. Currently, no similar quantitative marine science program exists at postgraduate level in other Australian universities and this is the first such joint graduate program within Australia.

Table 1: Marine Science in Australia: People and Resource Summary

Institution	Where	Discipline strengths	Research Scientists (RS)	Funding $M
AUSTRALIA – TOTAL			**586**	**$365**
COMMONWEALTH			**227**	**$162**
CSIRO	TAS, QLD, WA	Biology, physics, chemistry, ecology, fisheries, aquaculture, biotech	85	$48
Antarctic Division	TAS	Biology, ecology	37	$38
Geosciences Australia	ACT	Geoscience	53	$35
AIMS	QLD, WA, NT	Biology, ecology, biotech, chemistry, aquaculture	32	$30
Bureau of Meteorology		Physics	20	$11
UNIVERSITIES			**238**	**$134**[1]
University of Tasmania	TAS	Physics, ecology, fisheries, aquaculture, geography, geomatics	52	$29
James Cook University	QLD	Biology, geoscience, aquaculture	28	$16
ANU	ACT	Physics, geoscience	23	$13
UNSW	NSW	Physics	23	$13
U Sydney	NSW	Ecology	23	$13
Flinders	SA	Physics, biology	14	$8
Curtin	WA	Engineering	13	$7
University of Queensland	QLD	Biology, ecology	13	$7
Monash	VIC	Physics	13	$7
UWA	WA	Physics, biology	10	$6
Adelaide University	SA	Ecology, geoscience	9	$5
Murdoch	WA	Biology	8	$5
Melbourne University	VIC	Physics	5	$3
UNE & Southern Cross	NSW	Biology	4	$2
STATE DEPARTMENTS			**121**	**$69**
Western Australia		Fisheries, ecology	39	$22
Queensland[2]		Fisheries, ecology		
South Australia		Fisheries, ecology	12	$7
Victoria		Fisheries, ecology	26	$15
New South Wales		Fisheries, ecology	37	
Northern Territory		Fisheries	7	$4
NEW ZEALAND--NIWA[3]			**137**	**$64**

[1] Funding numbers for universities and state departments derived as $.56M per RS—ratio from CMR. Funding for university research not generally available.
[2] Unable to find scientific staff numbers for Queensland state agencies.
[3] Resource numbers include freshwater research.

SOURCE OF STUDENTS

Within the University of Tasmania, graduate students have be attracted to this program from a number of sources, including the existing honours degree programs of Bachelor of Science (8), Bachelor of Marine, Freshwater and Antarctic Biology (2), Bachelor of Antarctic Studies (1) and Master of Engineering (1). Two of these students joined UTAS from mainland universities and one from the United States of America.

The program has attracted 9 students from a variety of mainland Australian universities and 5 international students. The target number of postgraduate students within the quantitative marine science program is 36 by year 2008. The program is well on the way to achieving this target with a total of 27 students currently enrolled (see appendix 1 for further information about the characteristics of QMS PhD Candidates).

It is anticipated that there will be some flow on of students from the new Bachelor of Marine Science degree[4] in years to come, with the first round of honours graduates from this degree likely to graduate in 2008/9.

PROFESSIONAL RECOGNITION AND CAREER OPPORTUNITIES

The Joint Program PhD Program will act as a catalyst to build a collaborative research program that operates at the interface of different disciplines, focusing on those areas most relevant to solving marine issues of national priority. The students will take courses based in disciplinary areas, and conduct research within interdisciplinary projects. In conducting their thesis research, each student will play an integral role in a major research project, and will have access not only to the faculty and staff of both institutions, but also to the facilities including laboratories, libraries and research vessels.

Graduates will find job opportunities within CSIRO and other research agencies, such as the Australian Antarctic Division, Geoscience Australia, the Australian Institute of Marine Science, the Bureau of Meteorology, Inland Fisheries Service, Tasmanian Aquaculture and Fisheries Institute (TAFI), State and Federal Government agencies dealing in marine and freshwater research. These agencies employ over 600 research scientists specialising in marine disciplines.

This Joint Program offers a unique opportunity in research training. It is the first such program within Australia to offer specialised graduate level coursework in quantitative marine science (see description of coursework below). Graduates will be well equipped with high-level skills in this area upon graduation through the provision of research focused coursework, taught by key international researchers in their field. The Joint Program provides an unparalleled opportunity for the development of Australian marine scientists and guarantees a cooperative focus on marine research, backed up by the niche area of research expertise at the University of Tasmania and CSIRO Marine and Atmospheric Research.

The key output from the Joint Program is the flow of highly trained research/teaching professionals capable of working in quantitative marine science. When the program reaches full strength, 10 to 15 PhD graduands are anticipated each year. In 2004 10 candidates were admitted to the program; in 2005, 11 candidates and in 2006, 7 candidates, with another 2-4 scholarship supported positions to be filled in June 2006.

Other outputs, less easily quantified, include the close research collaboration between CSIRO and UTas that the program has generated, increased opportunities for attracting external research funds, and a higher research profile in marine sciences for the two organizations.

[4] The Bachelor of Marine Science replaces the Bachelor of Marine, Freshwater and Antarctic Biology.

RESEARCH AREAS

Marine Environment Prediction utilises advanced skills to make physical, biological or chemical marine science increasingly predictive and quantitative. New ocean observing systems, numerical models and advanced approaches to model-data assimilation are leading to research projects in ocean-circulation modelling, estimation of the physical state of the ocean, down-scaling to coastal environments, biogeochemical and ecosystem-modelling and new applications in interdisciplinary sciences, such as fishery-based oceanography and ecosystem-management.

Climate Variability and Resource Management employs skills that allow economic sectors to respond efficiently to climate variability by providing useful predictions based on understanding ocean processes. This project builds on CMR's *Oceans to Farms* project and capabilities within the University, developing skills in statistical and dynamical methods of climate prediction and targeting predictions for specific economic management decisions in both terrestrial and marine environments.

Climate and Ecosystems examines ocean processes at basin-wide scales, the role of ocean processes in climate change and the influence of the oceanic environment on large marine ecosystems. This area links into the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) research, with a focus on delivering environmental, economic and social value from Australia's engagement in Antarctica, and developing research skills on the dynamics of the role of oceans in the climate system and feedback from ecosystems to the climate system.

Environmental Conservation and Management provides the quantitative decision tools and processes to enable Australia to effectively manage marine biodiversity, ecosystem function and use of marine resources. This area aims to train researchers and managers to use tools to 'see' and understand environmental problems at the systems level. Specific components will include habitat and spatial dynamics, population dynamics, the science of fisheries management, environmental risk assessment; management strategy evaluation and ecological economics.

COURSEWORK

The coursework component of the QMS PhD program aims to expand the knowledge base of students and enhance their research experience. The program consists of six units: an introductory unit, four compulsory core units and an elective unit. Most units are taught intensively over 5 days and include lectures and laboratory classes. Coursework is typically completed in the first two years, constituting a maximum of one-third of the PhD program. Units are typically run either as a summer school (February) or a winter school (June-July).

Core Units

QMS910 Introduction of Quantitative Marine Science and Skills in Quantitative Marine Science
The purpose of this unit is to give new students an introduction to the program and to bring all students up to a minimal level of computing skill. In this unit, students will be introduced to some of the most important research-issues that are being addressed at UTAS and CMAR. Students will also be taught how to use basic programming language and statistics packages Matlab and R. Students will meet the teaching-faculty and other researchers who are supervising students, as well as continuing students and visit the infrastructure that is available to support marine research.

QMS911 Physical oceanography
The unit will address several themes and conceptual issues associated with physical oceanography. The aim of this lecture series is to give participants a “feel’ for the basic concepts of open ocean and coastal oceanography. These physical concepts form the basis of oceanographic knowlegde that carries through into areas, such as biogeochemical cycles and ecosystems.

QMS912 Marine biogeochemistry
The purpose of this unit is to introduce students to the chemical processes that maintain plankton, the initial level of the food chain in the oceans. Students will learn fundamental concepts that govern biogeochemical structure and its roles in primary biological production and the climate system.

QMS 913 Fisheries science
This unit discusses how oceanographic behaviours and events influence fisheries, and introduces key concepts in fisheries population dynamics, assessment of fisheries stocks, interpreting data from tagged fish, and how fish behaviour influences fisheries and the way they are assessed and managed.

QMS914 Structure and function of marine ecosystems
This unit introduces key concepts, software and a range of models concerned with understanding the dynamics of marine ecosystems, and quantifying energy and material flows in ecosystems. Particular consideration will be given to spatial issues; the issues in representing physical, ecological and biogeochemical components of ecosystems in a single model; and the importance and challenge of considering ecosystem behaviour in management.

Current Elective Units

QMS915 Techniques in remote sensing and GIS
Satellite remote sensing linked with information systems has revolutionized the way we see the oceans and assess the biophysical processes in them. The student will gain proficiency in some of the commonly used techniques used in marine research with satellite data.

QMS916 Management strategy evaluation
Because there are always several ways of modelling a given system, and several different approaches to particular management issues, in selecting an 'optimal' management solution, it is important to use a systematic approach to compare alternative possible management strategies, including assessing their different strengths and weaknesses. This unit will introduce the concepts and techniques of formal comparison of alternative options for management of marine systems and resources.

Appendix One

Candidate	*Undergraduate/Masters Degree*	*Institution where Ugrad/MA Degree was completed*	*QMS PhD Thesis topic*	**Citizenship**
1	B.Commerce B Science	UTAS	Use and Application of Area Closures for Pelagic Fisheries Resources Management	Australian
	B Science (hons)	UTAS		
2	BSc Mathematics	UTAS	Improved Mark-Recapture Tagging Models for Fisheries	Australian
	BSc Mathematics (Hons)	UTAS		
3	BSc Biochemistry and Microbiology	UTAS	Variation in the EAC and impacts on the distribution and abundance of east coast pelagic species	Australian
	BSc Zoology (Hons)	UTAS		
4	BSc Marine, Freshwater and Antarctic Biology	UTAS	Population dynamics of the long-spined sea urchin in Tasmania	Australian
	BSc Marine, Freshwater and Antarctic Biology (Hons)	UTAS		
5	BSc Mathematics and Physics	UTAS	Dynamics of the Southern Ocean variability	Australian
	BAntarctic Studies (Hons)	UTAS		
6	BSc Mathematics and Zoology	UTAS	Statistical methods for the analysis of electronic tag data: from individuals to populations	Australian
	BSc Zoology (Hons)	UTAS		

7	BSc Marine, Freshwater and Antarctic Biology BSc Marine, Freshwater and Antarctic Biology (Hons)	UTAS UTAS	Impacts of the introduced New Zealand Screwshell (Maoricolpus roseus) on commercial scallops and other native epibenthic species in Tasmania	Australian
8	B.App.Sc (Biol & Chem Tech) BSc Zoology (Hons)	UWS (NSW) UTAS	Independent stock assessment tecniques for the Tasmanian Blacklip Abolone Fishery	Australian
9	B InfoTech GradDip Science (Hons)	UMonash (Vic) UTAS	How do seabirds make foraging decisions: an analysis of behaviour in the flesh-footed shearwater	Australian
10	BSc Electronics and Automation (Hons) Master of Engineering Science	Moscow State Institute of Radio Eingineering UTAS	The role of the ocean in Australian climate variability	Australian
11	BSc (Marine Biology) BA (Env Studies) BSc Zoology (Hons)	UCLA (USA) UCLA (USA) UTAS	Climate driven changes in upwelling and mixing in waters around Australia: possible impacts on regional productivity and marine fisheries	USA
12	BSc (Botany and Zoology) BSc (Hons)	Australian National University (ACT) Australian National University (ACT)	Biology and Foraging Ecology of the Shy Albatross	Australian

13	BSc BSc (Hons)	University of Newcastle (NSW) University of Newcastle (NSW)	Effects of marine protected areas on reef ecosystem function	Australian
14	BSc Environmental Science BSc Biological Environments Marine (Hons)	UNSW (NSW) UNSW (NSW)	Understanding the timing and spatial extent of annual migrations undertaken by juvenile southern bluefin tuna	Australian
15	BSc (Marine Science) BSc (Marine Science) (Hons)	University of Sydney (NSW) University of Sydney (NSW)	A heat balance of the Great Barrier Reef with particular emphasis on recent sea surface temperature trends	Australian
16	BScience Marine Biology BScience (Hons)	James Cook QLD James Cook QLD	Movement patterns, home ranges and predator-prey interactions of seven gill sharks Notorynchus cepedianus	Australian
17	BSc BSc (Hons)	University of Queensland (QLD) University of Queensland (QLD)	Population dynamics, assessment, and interspecific relationships of Tasmanian rock lobsters	Australian
18	B Marine and Environmental Science B Science (Hons)	Murdoch University (WA) Murdoch University (WA)	Ocean Climate Change with Emphasis on the Southern Hemisphere	Australian
19	BSc (Env. Sci.) BSc(Hons)	Murdoch University (WA) Murdoch University (WA)	Numerical modelling of the circulation & melt/freeze pattern under ice shelves	Australian

20	BSc Zoology BSc Zoology (Hons)	UMEL (VIC) UMEL (VIC)	Ecosystem modelling using loop analysis and Ecopath to investigate the eastern Tasmanian inshore reef ecosystem with an emphasis on gillnet fishing and bycatch	Australian
21	BSc (Hons)	Monash University (VIC)	Can fishing abalone trigger changes towards habitat types unsuitable for commercial abolone fisheries	Australian
22	BSc MSc	Universite Paul Sabatier, France James Cook University (QLD)	The role and impact of cephalopods in the coastal ecosystem	French
23	Licenciatura in Marine Science	Universidad de Las Palmas de Gran Canaria	Variability of Sub-Antarctic Mode Water and Antarctic Intermediate Water in the Australian sector of the Southern Ocean	Spain
24	BSc Marine Science (hons) MSc EOS Climate	University of Southampton University of Victoria Canada	Dynamics and impacts of the EAC variability off the south-east coast of Australia	United Kingdom
25	BEnvSc (Hons)	Carl von Ossietzky University, Germany	Why is the ocean so skinny and what are the consequences of this spareness?	Germany
26	BSc Zoology BSc (Hons) MSc Applied Mathematics	University of Cape Town University of Cape Town University of Cape Town	Investigating movement modelling of harvested marine animals	South Africa
27	BSc (Hons) MSc	Exeter University, UK Cranfield University, UK	Building Models of Pelagic Marine Ecosystems	United Kingdom