The Victorian Marine Science Consortium is a collaborative venture between:

2007

CONTENTS

INTRODUCTION & BACKGROUND

In 1989 four major marine research and teaching agencies in Victoria established the Queenscliff Marine Station to provide a facility dedicated to marine research and tertiary education in south-eastern Australia.

Foundation partners were the universities of Melbourne, Monash and RMIT, along with the statutory body of the Victorian Institute of Marine Sciences (VIMS). In 1992 Deakin and Victoria universities joined the organisation, and in 1996 VIMS became part of the Victorian Government's marine research institute. Two years later the VIMS Act was repealed. The Marine and Freshwater Fisheries Research Institute (MAFFRI) is now the State Government partner (formerly Primary Industries Research Victoria up until December 2007).

In early 2004, after fifteen years, the *Queenscliff Marine Station* was relaunched as the *Victorian Marine Science Consortium (VMSC)*.

VMSC operates by pooling resources and working collaboratively. It embodies an active research community from a range of institutions, facilitating relevant and sustainable research to effectively manage Victoria's coastline.

Queenscliff is at the tip of the Bellarine Peninsula where Port Phillip Bay meets Bass Strait. It is an area offering a diverse range of marine habitats, from high-energy ocean beaches to low-energy sheltered beaches, rocky intertidal platforms and sub-tidal reefs, estuaries, mud flats, seagrass meadows, mangroves, salt marshes, and bay and shelf waters. It is a geographical area offering a unique combination for marine research and teaching.

Visiting researchers and educators have easy access to field locations with boats available for general work or diving.

Researchers at VMSC have strong links to other state and federal marine agencies together with interstate universities. A wide range of grants from national competitive funds, state sources and private sector contracts supports research. The major current research areas are fisheries biology and ecology, environmental biology, ecotoxicology, and animal physiology.

VMSC is used by all partners for undergraduate courses in marine science at all levels. Some courses are taught collaboratively between members of the consortium.

The original facility was small and best suited for field-based studies. The construction of an ecotoxicology laboratory in 1994 resulted in a remarkable increase in the range of research conducted, and in the overall general use of the facility. In November 2004, VMSC relocated to the new DPI Queenscliff Centre, and now shares a state-of-the-art marine research facility with its state government partner, MAFFRI.

CHAIR'S REPORT

I am pleased to present the 2007 VMSC Chair's Report.

During 2007 a total of 239 undergraduate students attended field courses in marine zoology, ecology, biology, botany, and marine and coastal ecosystems. The majority of courses offer students access to a diverse and specialist pool of knowledge provided from within individual institutes, and taught collectively with experts in the field.

Thirty-one PhD, and fourteen Honours projects were either underway or commenced during the year; making VMSC an active hub for postgraduate students.

VMSC facilitated the research and visits of a number of international scientists. Professor Susumu Hyodo (University of Tokyo) returned for the fourth consecutive year to continue studies on osmoregulation in elephant fish. Professor Richard Emlet (University of Oregon USA) undertook research on echinoid development, during a six month sabbatical in Queenscliff. Professor Pat Butler (University of Birmingham UK) in collaboration with Deakin University and La Trobe University carried out research on free-ranging birds of Port Phillip Bay. Dr/s. Martina Doblin and Kate Rawlinson (University of Technology Sydney) researched heavy metals in Port Phillip Bay waters.

In May, the Management Committee hosted a successful presentation morning at Queenscliff. Invited stakeholders were provided an overview on the background of VMSC, along with the benefits and opportunities afforded to consortium members. A showcase of postgraduate research projects and a tour of the facility were included in the program.

The winner of the 2007 VMSC Postgraduate Award was Peter Macreadie from the University of Melbourne. The Management Committee initiated this award in 2004 to support and encourage young scientists based at Queenscliff, and whose research will significantly contribute to marine science in Victoria. Peter's PhD project aims to investigate the effects of seagrass fragmentation on fish species.

Kathryn Hassell from RMIT University was awarded the Department of Primary Industries (Marine and Freshwater Systems) *2007 Young Scientist of the Year*. The award was presented to Kathryn in recognition of her research on black bream.

Allyson O'Brien from the University of Melbourne received the inaugural and highly prestigious Medal for the *best student-authored paper* published in *Marine & Freshwater Research.* The award was initiated to recognise the contribution by postgraduate students to innovative and significant research in the aquatic sciences.

VMSC also sponsored an award for best presentation on temperate marine science made at the Australian Marine Sciences Association annual conference. In its inaugural year, the AMSA judges could not separate two student presenters, Joyce Ong and Trudy Costa, both of the University of Melbourne.

Past and current postgraduate students from VMSC have, and will continue to contribute significantly to our knowledge and better management of the temperate marine environs in south-eastern Australia.

I express my thanks to the staff at VMSC – Liz McGrath and Rod Watson – for the dedicated administrative and technical support they readily provide to the postgraduate students, researchers and staff.

Thank you to each member of the Management Committee for your continued support and valued contribution to VMSC throughout the year.

I am pleased to be involved with this unique partnership that exists to enhance the temperate marine ecosystems of south-eastern Australia, through the support and education of our future marine scientists.

Mr Terry I Walker
Chair

MANAGEMENT COMMITTEE

A management committee comprising representatives from each institute administers VMSC. A Director is elected from the management committee each year to provide academic leadership, oversee and maintain quality scientific practices and organisational standards, and manage general operations at Queenscliff.

Professor Michael J. Keough of the Zoology Department at the University of Melbourne continued on in this role during 2007.

Australian Maritime College

Professor Chad Hewitt	National Centre for Marine and Coastal Conservation

CSIRO

Dr David C Smith	Centre for Marine and Atmospheric Research

Deakin University

Associate Professor Geoffrey Wescott	School of Ecology and Environment

Monash University

Professor John Beardall	School of Biological Sciences

Primary Industries Research Victoria

Mr Terry Walker	(Acting) Research Director

RMIT University

Associate Professor Dayanthi Nugegoda	School of Applied Sciences

The University of Melbourne

Professor Michael J. Keough	Department of Zoology

Victoria University

Dr Carol Scarpaci	Faculty of Health Engineering and Science

Staff

Elizabeth McGrath	Administration Officer
Rod Watson BAppSc (Deakin)	Technical Officer

RESEARCH VESSELS AND FIELD TRIPS

During the year, 180 assignments were carried out; the majority of these trips were undertaken in *Pelagia*, VMSC's 6.5-metre, purpose-built research vessel. Our smaller punt was used in Port Phillip and Western Port Bays, the Barwon River and Lake Connewarre, and inland waters of Victoria.

To help offset fuel and maintenance costs, a nominal fee is charged to consortium members for vessel use. Users are charged at the following rates :

Pelagia : students and researchers $15 and $30 per engine running hour, respectively. Night use is charged at $20 to students and $40 to researchers.

The punt is charged at a flat daily rate of $5 to students, and $50 to researchers. An additional overnight charge of $25.00 is charged to researchers over continuous days use.

In 2007, $4,732.00 was recovered from vessel use.

Field trips and activities relating to the following projects were conducted from the two vessels:

- Reef fish ecology – Port Phillip Bay
- Introduced species – Port Phillip Bay
- Benthic sampling – Yarra river
- Flathead physiology – West Channel Entrance
- Fish-seagrass associations – Swan Bay
- Meiofauna ecology – Barwon River and Lake Connewarre
- Australasian gannets – Pope's Eye
- Whiting larval dispersion – Swan Bay and Port Phillip Bay
- Fish ageing – Port Phillip Bay
- Plankton tows – Port Phillip Bay
- Collection of material for laboratory work
- Crested terns breeding ecology – Mud Islands
- Storm petrel breeding ecology – Mud Islands
- Collection of introduced ascidian – Port Phillip Bay
- Reef fish larval collection – Port Phillip Bay
- Asterias collection – Port Phillip Bay
- Acoustic tagging – Swan Bay and Port Phillip Bay
- Fish recruitment in marine parks (MPA's)
- Echinoderm breeding strategies – Port Phillip Heads
- Undergraduate field excursions – Port Phillip Bay
- Stingaree physiology – Swan Bay
- Salinity tolerance of *Xenostrobus secures* - Lake Connewarre
- Measuring heavy metals - Port Phillip Bay waters

DIVING

During 2007, 52 dives were logged. The majority of dives were shallow, in less than 10 metres.

Dives involved research into:

- Fish-seagrass associations
- Various species collection for ecotoxicology and undergraduate classes
- Reef fish ecology, light trap placement
- Introduced species collection
- Photography
- Echinoderm collection
- Fish 'attracters' placement
- Acoustic tagging

Undergraduate off-shore snorkelling trips were conducted during the summer courses.

RESOURCES AND FACILITIES

VMSC is located at the DPI Queenscliff Centre, together with the state government marine research platform and the Marine Discovery Centre.

This outstanding facility allows access to the following infrastructure available to all VMSC users:

TEACHING

- A conference room equipped with the latest in audio visual and video conferencing; accommodates up to 50
- A General/Teaching lab with bench space for 45 students. Ambient seawater is on-tap

RESEARCH

- Bench space is available in the General/Teaching lab
- An Ecotoxicology lab with bench-top aquaria individually serviced with compressed air, ambient and temperature controlled seawater
- Separate bench space is also available
- Separate preparation and washrooms are adjacent to the Ecotoxicology lab
- A controlled temperature room supplied with ambient seawater and compressed air
- An Aquarium equipped with dissecting table, 6 double-tiered and 4 single aquarium stands. Ambient and temperature controlled seawater, freshwater, and compressed air supplied to each stand
- Storage area for dive gear

VESSELS

- *Pelagia* – VMSC's 6.5-metre, purpose-built research vessel
- A 4.2-metre punt
- Various other small craft can be made available by arrangement

OTHER

- A comprehensive range of scientific equipment is available for use
- Office space for visiting researchers and postgraduate students
- Computing and web access
- Access to the comprehensive collection and resources of the MAFFRI Information Centre is available to all researchers and postgraduate students

ACCOMMODATION

- Accommodation for visiting researchers can be arranged at the University of Melbourne research residence in Ocean Grove. Bookings are essential and can be organised through the Zoology Department at the University of Melbourne, or through VMSC
- A range of accommodation options are available in Queenscliff and Point Lonsdale; contact VMSC for assistance

UNDERGRADUATE COURSES

Undergraduate field courses were held during February, August, September and November/December. These ranged from two days to two weeks and were attended by 239 undergraduate students. The Marine Discovery Centre also utilised our teaching lab for practical sessions during the year.

2007	Institute	Course	U/Grads	Other
3-10 February	U.Melb.	Marine zoology	31	
10-17 February	U.Melb.	Experimental marine ecology	32	
19-23 February	Monash	Marine biology	14	
16 March	MDC	Lab session		25
21-23 August	MDC	Lab session – National Science Week		23
25-26 August	Deakin	The seas, their use and misuse	45	
15-16 September	Deakin	The seas, their use and misuse	45	
17 September	MDC	Lab session		16
25-28 September	Deakin	Marine and coastal ecosystems	40	
16 October	MDC	Lab session		16
27 Nov-9 December	U.Melb	Marine botany	32	
			239	80

OTHER VISITORS

Individual researchers from the following institutes utilised VMSC during the year:

Professor Susumu Hyodo – University of Tokyo in collaboration with Deakin University; continuing investigation into osmoregulation in elephant fish, *Callorhynchus millii* (Holocephali)

Professor Pat Butler – University of Birmingham UK in collaboration with Deakin University and La Trobe University; researching the heart rate and physiology of free-ranging birds

Professor Richard Emlett – University of Oregon (USA) in collaboration with the University of Melbourne. Richard spent five months sabbatical at VMSC undertaking research on the development of echinoids in southern Australia (September 2006 – January 2007).

Dr Martina Doblin and **Dr Kate Rawlinson** – University of Technology Sydney, undertook investigation of heavy metals in Port Phillip Bay Waters

RESEARCH

Numerous projects involving environmental biology, fisheries biology and ecology, ecotoxicology, marine botany and animal physiology were undertaken throughout the year. Project funding was derived from national competitive funds, state sources and private sector contracts.

The following researchers and postgraduate students were in varying stages of their projects during 2007; project abstracts commence on page 13

STAFF RESEARCH

Professor Richard Emlet
University of Oregon

Studies of unusual developmental patterns in Australasian marine invertebrates

Dr Janet Gwyther
Deakin University

A spatial and temporal study of the diversity of meiofauna from Lake Connewarre to the Barwon estuary

Professor Susumu S. Hyodo; Dr A. Kawakoshi; Mr Justin Bell; Dr John A. Donald; Professor Y. Takei; Dr Tes Toop
University of Tokyo / Deakin University

Osmoregulation in elephant fish, *Callorhynchus millii* (Holocephali)

Dr Greg P. Jenkins, Dr Liz Morris, Mr Andrew Longmore
The University of Melbourne / MAFFRI

The effects of nutrient enrichment on seagrass epiphytes in Western Port

Dr Greg P. Jenkins, Dr Jeremy Hindell, Dr Rod Connolly
The University of Melbourne / MAFFRI / Griffith University

The importance of edge effects in determining the value of seagrass landscapes as fish nurseries

Dr Dayanthi Nugegoda
RMIT University

Marine and Freshwater Ecotoxicology

Dr Theo Macrides
RMIT University

Effects of gonadal tissue extracts from the marine invertebrate, *Coscinasterias muricata,* on arachidonic acid metabolism

Dr Sylvia Urban
RMIT University

Drugs from the Marine and Terrestrial Environments

PHD CANDIDATES

Rachael Bathgate
The University of Melbourne

Connectivity of intertidal gastropod populations in a system of marine protected areas

Justin Bell
Deakin University / MAFFRI

Age, growth and reproduction of southern Australian holocephalans (*Rhinochimaera*, *Chimaera* and *Hydrolagus spp.)* and the white-fin swell shark (*Cephaloscyllium spp*.).

Jonathan Daly
Monash University
Assisted Reproductive Technologies (ART) in elasmobranchs

Warren Davies
RMIT University

The effects of *Nodularia spumigena* and an extract of *N. spumigena* on aquatic fauna

Daniel Dias
RMIT University

Natural product studies of terrestrial and marine organisms

Isla Fitridge
The University of Melbourne

Seasonality, seduction & foul play: the hydroid fauna of Port Phillip Bay

Lorenz Frick
Monash University / MAFFRI

Capture stress physiology and post-release fate of small Australian elasmobranchs

Jacquelle Gorski
RMIT University

The effects of trace metals on the Australian abalone, *Haliotis rubra*

Corey Green
University of Tasmania

Temporal and spatial population structure of arrow squid, *Nototodarus gouldi*, off south-eastern Australia

Daniel Grixti
Deakin University / MAFFRI

Estimating and improving the survival of recreationally caught and released fish

Kathryn Hassell
RMIT University / MAFFRI
Effects of environmental stressors on growth, reproduction and survival in black bream, *Acanthopagrus butcheri*

Christian Jung
The University of Melbourne
Anthropogenic effects on the fish fauna in Port Phillip Bay, Victoria

Jodie Kemp
The University of Melbourne
Population and trophic dynamics of red cod, *Pseudophycis bachus*

Malcolm Lindsay
The University of Melbourne
Larval recruitment patterns in Victoria's marine reserves

Prue McKenzie
Deakin University
Dispersal of the important habitat-forming alga, *Hormosira banksii* (Phaeophyceae, Fucales)

Peter Macreadie
The University of Melbourne / MAFFRI
Fish responses to seagrass habitat fragmentation

Hintsa Mateos
Victoria University
The effect of feed supplemented with Omega – 3 polyunsaturated fatty acids on cultured abalone

Jackie Myers
Monash University / MAFFRI
Factors affecting the ecophysiology of *Nodularia sp.,* a cyanobacterial species isolated from the Gippsland Lakes, Victoria, Australia

Allyson O'Brien
The University of Melbourne
Variability in the effects of nutrients in structuring intertidal soft sediments assemblages

David Phillips
Deakin University / MAFFRI
Ecological risk assessment from the effects of fishing for batoids in south-eastern Australia

Tania Pyk
Deakin University
Variation in individual quality of Australasian gannets, *Morus serrator*: implications for seabird conservation and management

Matthew Reardon
The University of Melbourne
Uterine accommodations for gestation and ecological risk assessment in the southern fiddler ray, *Trygonorrhina fasciata*

Ralph Roob
The University of Melbourne
The effectiveness of hydro-acoustic and imaging techniques to characterise benthic habitats and communities

Michael Sams
The University of Melbourne
The influence of variable recruitment on the structure and development of marine epifaunal communities

David Semmens
The University of Melbourne
Effects of embryonic and larval experience on growth, condition and survival in the common jollytail, *Galaxias maculatus*

Tim Smith
The University of Melbourne / MAFFRI / Griffith University
The importance of edge effects in determining the value of seagrass landscapes as fish nurseries

Anna Syme
The University of Melbourne
The systematics and biogeography of the southern Australian Cylindroleberididae *Crustacea: Ostracoda*

Lisa Toogood
RMIT University
Sublethal effects of mercury and DDE on Australian black bream, *Acanthopagrus butcheri*

Fabian Trinnie
Deakin University / MAFFRI
Life history attributes and stock assessments of Urolophids (stingarees) found in south-eastern Australia

Megan Underwood
Deakin University
The breeding biology of the white-faced storm petrel, *Pelagodroma marina*, in Victoria

Joel Williams
The University of Melbourne
The influence of freshwater flow on salt-wedge dynamics and fisheries productivity in the Gippsland Lakes

Honours projects

Emily Cornwell
Deakin University
Coping with an unpredictable environment: salinity tolerance in a native Australian mollusc, *Xenostrobus securis*

Meagan Dewar
Victoria University
Gastrointestinal microflora of little penguins, *Eudyptula minor*, at St Kilda Breakwater, Victoria

Jessica Kerrigan
Deakin University
The relationship between benthic components in an estuarine Lake

Alexis Marshall
The University of Melbourne / MAFFRI
Relaxin family expression in the oviparous elasmobranch, *Heterodontus portusjacksoni*

Hannah Murphy
The University of Melbourne / MAFFRI / Australian Rivers Institute / Griffith University
Response of meiofauna to edge effects, patch attributes, and hydrodynamics

Amy Newman
The University of Melbourne
Does variable larval growth influence survival of early life history stages of snapper?

Calvin Quick
Deakin University / MAFFRI
Habitat utilisation of gummy shark, *Mustelus antarcticus*, in Swan Bay

Richard Stafford-Bell
Victoria University
Behavioural studies of fur seals at Chinaman's Hat, Port Phillip Bay, in relation to changes in ambient noise

Lauren Veale
Australian Maritime College / MAFFRI
The population dynamics of ribaldo, *Mora moro*

Fiona Warry
The University of Melbourne / MAFFRI
Integrating edge effects into studies of fragmentation: a seagrass perspective

Daniel Weller
The University of Melbourne / Phillip Island Nature Park
Inter-colony movements of the crested tern, *Sterna bergii*, as a result of food resource quality and availability

Caroline Wilson
Deakin University
The influence of age on the reproductive performance of crested terns, *Sterna bergii*, breeding at Mud Islands, Port Phillip Bay, Victoria

Carly Wishart
Deakin University
Diurnal activity budgets and nest defence behaviour in Australasian gannets, *Morus serrator*, breeding at Pope's Eye, Victoria

STUDENT AWARDS

VMSC POSTGRADUATE AWARD

The winner of the 2007 VMSC Postgraduate award was **Peter Macreadie.**

Peter is undertaking his PhD at the University of Melbourne, co-supervised by Professor Mick Keough, Dr Jeremy Hindell and Dr Greg Jenkins.

Peter's project investigates effects of seagrass fragmentation on fish species. Seagrass are a conspicuous element of Australian marine environments, and are crucial in the conservation and maintenance of biodiversity. Degradation of seagrass ecosystems from climatic extremes, increased sediment and nutrients in the water, and other pollutants results in loss and fragmentation of meadows. These changes to seagrass have been linked to the collapse of fisheries. A large-scale project using artificial seagrass to simulate seagrass habitat fragmentation has just been completed by Peter. It is anticipated this work will improve our understanding of how fish respond to seagrass fragmentation, and lead to better management of Australia's threatened coastal habitats.

In 2007 Peter was also awarded the 2007 Victorian Coastal Awards for Excellence Media Award for *Out of the Blue* Team; and the Fisheries Research and Development Corporation (FRDC) prize for best student presentation at AMSA07 conference for his presentation on *Responses of fish to the fragmentation of seagrass habitats*.

Congratulations Peter

Peter with Minister John Thwaites

BEST STUDENT PAPER 2007

The Editorial Advisory Committee of *Marine & Freshwater Research* initiated an annual Medal for the best student-authored paper published in the Journal. The award recognises the contribution by postgraduate students to innovative and significant research in the aquatic sciences and is designed to highlight the quality of the papers published by younger scientists. The key judging criteria includes the overall significance of the paper to aquatic science, its interdisciplinary nature, and the quality of the research design, analysis and discussion.

Allyson O'Brien was the winner of the inaugural and highly prestigious award in 2007.

Allyson's paper examined the impact of the invasive polychaete species *Sabella spallanzanii* in Port Phillip Bay. The study was part of Allyson's Honours project undertaken through the University of Melbourne.

O´Brien A.L., Ross D.J. and Keough M.J. Effects of *Sabella spallanzanii* physical structure on soft sediment macrofaunal assemblages. *Marine and Freshwater Water Research*, 2006, 57, 363-371.

YOUNG SCIENTIST OF THE YEAR

Kathryn Hassell was awarded the Department of Primary Industries (Marine and Freshwater Systems) **Young Scientist of the Year** in 2007. The award was presented to Kathryn in recognition of her interesting and relevant studies on black bream embryo development and larval survival.

Kathryn is currently working towards a PhD at RMIT University; her project is jointly supervised by Associate Professor Dayanthi Nugegoda (RMIT University), Dr Patrick Coutin (MAFFRI) and Dr Susan Codi King (AIMS).

Kathryn's research investigates the influence of water quality and pollutants on the reproductive biology of black bream, *Acanthopagrus butcheri*, in Victorian estuaries.

With several papers already published, Kathryn's work will help focus management efforts on improving the environmental health of estuaries to provide fish for the future.

VMSC / AMSA AWARD

In 2007 the VMSC Management Committee decided to make available an annual student prize to be awarded in conjunction with the Australian Marine Sciences Association Inc. (AMSA) annual conference. The prize supports the best student presentation with a focus on temperate marine science.

In its inaugural year, the AMSA judges could not separate two outstanding student presenters, **Joyce Ong** and **Trudy Costa**, both of the University of Melbourne.

Joyce presented the results of her Honours project - *Identifying larval dispersal scales of Galaxias maculatus, a diadromous fish, in Victoria*. Joyce was supervised by Dr Stephen Swearer and Dr Nicole Barbee.

Trudy's presentation - *Detecting anthropogenic disturbances in the rocky intertidal: a study of rocky shores in Victoria* - was based on work done on the Mornington Peninsula for her PhD project. Trudy is supervised by Professor Mick Keough at the University of Melbourne, and Dr Tim O'Hara at Museum Victoria.

Other VMSC students to receive recognition in 2007 included :

Daniel Grixti (Deakin University). Daniel was awarded the 2007 *Loch Award*. This award is made to the best Environmental Science postgraduate research student at Deakin University, who has completed the equivalent of one year's full-time candidature.

Kate Naughton (the University of Melbourne). Kate was awarded The Ron Kenny Student Presentation at AMSA 2007 for the best oral presentation of research results. Her presentation was a result of her Honours work on sea stars in Port Phillip Bay.

Daniel Dias (RMIT University). Daniel received the Royal Australian Chemical Institute (Victorian Branch) Student Travel Assistance Award Scheme in 2007.

RESEARCH ABSTRACTS

STAFF RESEARCH

Studies of unusual developmental patterns in Australasian marine invertebrates

Professor Richard Emlet
University of Oregon, Institute of Marine Biology

The final demise of Gondwana occurred approximately 53 million years ago (mya) as Australia/New Zealand broke away from Antarctica creating the extensive east –west trending coastline along southern Australia (Kennett, 1982). South America, Africa and India, also part of the Gonda wan supercontinent, had already separated beginning some 60 million years earlier. As Australia and other land masses drifted northward away from Antarctica, circum-equatorial oceanic circulation was constricted (Kennett, 1982). A new circulation path, the circumantarctic current, became established some 30-35 mya, the Southern Ocean began to cool, and the thermally isolated Antarctica grew increasingly cold (Kennett, 1982). The biotic consequences of these tectonic and circulation processes have been enormous and complex for both terrestrial and marine organisms. The current proposal will examine what appears to be a biogeographically unique pattern of abbreviated or nonplanktonic development among shallow water marine invertebrates found along the southern coast of Australia (Perth, WA to Sydney, NSW). The fauna that occurs there today was derived from warmer water lineages many of which became endemic to southern Australia (Knox 1980).

Marine invertebrates display a tremendous (and bewildering) variety of developmental patterns across taxa and between closely related species (e.g. Strathmann 1978, 1985, Young et al. 2002). These patterns have both ecological significance and evolutionary heritage. Taxa can be parsed into a) those with feeding larvae that are planktonic for days to weeks, b) those with nonfeeding larvae that are planktonic for hours to days, and c) those that brood or encapsulate developing offspring that are never planktonic. Different developmental patterns impact ecological aspects of species including offspring number and size, dispersal, gene flow between populations, and recruitment (Morgan 2000, Underwood & Keough 2000). Larval development also reflects the evolutionary history of lineages because a particular pattern of development is passed from ancestor to descendent. Occasionally a given pattern is modified, presumably due to ecological conditions. In many instances the morphological and ecological circumstances associated with developmental modification limit their reversibility (Strathmann 1978, 1993, Emlet et al. 1987; Havenhand 1995, Wray 1995, McEdward & Miner 2001). Despite a rich history of study including examination of latitudinal patterns (gastropods, Thorson 1946, echinoids Emlet et al 1987), theoretical modeling (e.g. Vance 1973 a,b, Levitan 1996, McEdward 1997), and phylogenetic mapping (e.g. Hart et al. 1997, Jeffery et al. 2003, Jeffery & Emlet 2003, Meyer 2003), the environmental and historical reasons for developmental variations are poorly understood.

We will explore developmental patterns in living sea stars, snails and fossil snails to determine the generality of a biogeographical signal of abbreviated or nonplanktonic development documented among shallow water sea urchins of southern Australia (here after **soA**) and that may also be present in other taxa. Of the 15 lineages of extant sea urchins that have independently evolved nonfeeding larvae or brooded development, 7 occur along the western and southern coasts of Australia (Emlet 1990, 1995). Of the 26 species living at depths < 100m and known to have pelagic nonfeeding larvae, 19 species occur in **soA** (Emlet 1995, Jeffery et al. 2003). Among Oligocene and Miocene (fossil) sea urchins of **soA**, there are numerous lineages with nonfeeding larvae or brooded development relative to contemporaneous urchin faunas of other regional locations (Philip & Foster 1971, Jeffery & Emlet 2003, Emlet unpubl. data). These fossil lineages are unrelated to the lecithotrophic lineages that occupy the same coast today. In **soA**, this pattern of relatively high occurrence of abbreviated planktonic or brooded development occurs in several other Recent marine invertebrate taxa such as cypraeid and conid gastropods (Wilson 1985, Meyer 2003, Kohn 1993), chitons (Pearse 1979, Eernisse 1988), and some brachyuran crab families: Dromiacea, Majidae, and Xanthidae (McLay et al. 2001, Morgan 1987, Hale 1931). The broad biogeographical occurrence of unusual development along the 4000 km coastline of **soA**, and the multiple temporal occurrences of unusual development among the sea urchins (35-15 mya – Oligocene to Miocene) and Recent suggest global scale causation such as climate, oceanographic currents or both. We wish to collect additional data on development of sea stars and gastropods in order to try to evaluate the magnitude of occurrence of unusual developmental patterns and test

hypotheses about causation of these unusual patterns.

A spatial and temporal study of the diversity of meiofauna from Lake Connewarre to the Barwon estuary

Dr Janet Gwyther

Deakin University, School of Ecology and Environment

The aim is to identify some of the factors that control the diversity, measured over two years of sampling. Free-living nematodes are being used as an ecological tool because these are consistently the most numerous and diverse component of the estuarine meiofauna in the soft sediment of the estuary.

I have established the importance of the indirect effects on diversity of a top-down control (grazing by macrofauna) on meiofauna within the mangroves of the estuary, and am presently investigating the effect of fluctuations of abiotic features on assemblage diversity and abundance. Correlation of nemato-diversity with the range of salinity is of particular interest in this study, and an improved model (compared with the current text-book standard derived from Baltic Sea data by Remane) for estuarine diversity in a Victorian system will be developed from the results.

Osmoregulation in elephant fish, *Callorhynchus millii* (Holocephali)

Professor Susumu Hyodo [1], Dr A. Kawakoshi [1], Mr Justin Bell [2], Dr John A. Donald [2], Professor Y. Takei [1] and Dr Tes Toop [2]

University of Tokyo, Ocean Research Institute[1] / Deakin University, School of Biological and Chemical Sciences[2]

Osmoregulatory mechanisms in holocephalan fishes are unknown except that they conduct urea-based osmoregulation as in elasmobranchs. We therefore examined changes in plasma parameters of elephant fish, *Callorhynchus millii*, after gradual transfer to concentrated (120%) or diluted (80%) seawater (SW). In control fish, plasma Na and urea concentrations were about 300mM and 450mM, respectively. These values were equivalent to those of sharks and rays, but the plasma urea concentration of elephant fish was considerably higher than that reported for chimaeras, another holocephalan. After transfer to 120% SW, the plasma Na concentration markedly increased, while a conspicuous decrease in plasma urea concentration was observed following transfer to 80% SW. In elephant fish, we could not find a discrete rectal gland. Instead, approximately 10 tubular structures were located in the wall of post-valvular intestine. Each tubular structure was composed of a putative salt-secreting component consisting of a single-layered columnar epithelium, which was stained with anti-Na^+,K^+-ATPase serum. It is most likely that the tubular structures in the posterior intestine represent a primitive form of the rectal gland in elephant fish. In addition, we have identified two C-type natriuretic peptides (CNPs) from the heart and brain of elephant fish, which may contribute to the control of NaCl excretion from the rectal gland of elephant fish as it does in elasmobranchs.

The effects of nutrient enrichment on seagrass epiphytes in Western Port

Dr Greg P. Jenkins, Dr Liz Morris, Mr Andrew Longmore

The University of Melbourne / MAFFRI

Seagrasses and seagrass detritus are critical to the food webs supporting fish and migratory waders in Western Port. Loss of seagrass in Western Port through the 1970's correlated strongly with a decline in commercial fish catches, but the cause(s) for the seagrass loss have never been positively identified. Loss of seagrass beds in other systems has been attributed to shading of seagrass fronds by epiphytic growth, stimulated by nutrient enrichment.

With increasing development of the Western Port catchment, and corresponding potential for increased nutrients entering the bay, there is a need to experimentally determine the potential effects of increased nutrients on the seagrasses in the bay. We propose to investigate the effects of increased water-borne nutrients on epiphyte growth, seagrass health and grazer populations in seagrass beds. Nutrient dosing will involve the controlled release of nutrients (N and P) into the water column surrounding seagrass beds.

The importance of edge effects in determining the value of seagrass landscapes as fish nurseries

Dr Greg P. Jenkins, Dr Jeremy Hindell, Dr Rod Connolly

The University of Melbourne / MAFFRI / Griffith University

Seagrasses are a conspicuous element of Australian marine environments and are crucial in the conservation and maintenance of biodiversity. Degradation of seagrass ecosystems from climatic extremes, increased sediment and nutrients in the water, and other pollutants results in loss and fragmentation of meadows. These changes to

seagrass are linked with increased coastal erosion, severe loss of biodiversity, and collapse of fisheries. Increased understanding of how biological processes such as predation and food availability influence animal associations with seagrasses and how these effects change with landscape structure, will have important applications in the sustainable management of Australia's threatened coastal habitats.

Effects of gonadal tissue extracts from the marine invertebrate, *Coscinasterias muricata,* on arachidonic acid metabolism

A/Professor Theo Macrides, Mr Leith Fremlin, Dr Lyn Hodges, Dr Paul Wright; Dr Paul Wynne
RMIT University / Analytical Services Pty Ltd

The echinoderm, *Coscinasterias muricata*, commonly known as the 11-armed sea star, is native to Port Phillip Bay, Victoria, Australia.[1] A number of bioactive compounds have been isolated from marine invertebrates, the presence of such compounds in echinoderm extracts[2] suggests that secondary metabolites extracted from *C. muricata* may also exhibit some biological activity. The relevance of cyclo-oxygenase (COX) and lipoxygenase (LOX) to inflammation, thrombosis, gastroprotection and the immune response is well known[3]. We have therefore used the inhibition of purified ovine COX-1 and COX-2 isoforms, and 5-LOX from stimulated porcine neutrophils to screen for potential bioactivity of *C. muricata* secondary metabolites. Dichloromethane (DCM), methanol, and aqueous extracts of gonadal tissue from both male and female *C. muricata* were obtained by sequential solvent extraction methods. Male and female aqueous and methanol extracts were capable of significant inhibition of the COX-2 enzyme. This anti-COX-2 activity was accompanied by weak inhibition of the COX-1 enzyme. The DCM extracts showed marked inhibition of both COX isoforms. All methanol and DCM extracts inhibited significantly the 5-LOX production of 5-hydroeicosatetraenoic acids by porcine neutrophils in vitro. The male methanol extract was additionally found to inhibit leukotriene B_4 production by 5-LOX in this same assay. The results indicate that *C. muricata* secondary metabolites extracted from gonadal tissue act selectively upon the mammalian arachidonic acid cascade.

1. The Northern Pacific Seastar in Port Phillip Bay. (2001). *Natural Resources and Environment.*
2. Minale L., D'Auria M.V., Paloma L.G., Lorrizi M., Zampella A., Zollo F. (1997). Bioactive metabolites from echinoderms and porifera. *Gazetta Chimica Italiana* 127:771-777.
3. Bertolini A., Ottani A., Sandrini M. (2001). Dual acting anti-inflammatory drugs: a reappraisal. *Pharmacological Research* 44:437-450.

Marine and Freshwater Ecotoxicology at RMIT University

Associate Professor Dayanthi Nugegoda
RMIT University, School of Applied Sciences

The Ecotoxicology research group at RMIT University has been an integral part of the Victorian Marine Science Consortium since its establishment in 1990. It is currently led by Associate Professor Dayanthi Nugegoda of the School of Applied Sciences with a number of Honours, postgraduate and postdoctoral researchers based at VMSC. The group has a number of research projects evaluating the effects of toxicants and environmental stressors on native aquatic organisms with special emphasis on biomarkers of exposure to toxicants and developing new methods of assessing risk to biodiversity. In 2007, the research group consisted of one postdoctoral fellow, six PhD, one Masters and one Honours student. In 2008 we have 2 new postdoctoral research fellows joining the research group, one of whom is from Germany on a German research fellowship. The group operates out of the VMSC laboratories, a research laboratory on the RMIT Bundoora campus with an adjacent aquatic facility and an aquatic lab at the RMIT centre on Bullock Island in East Gippsland.

Marine research projects currently in progress within the group include a study on the effects of environmental stressors on black bream (PhD candidate Kathryn Hassell) in collaboration with the EPA, DPI and the Australian Institute of Marine Sciences (AIMS); assessing the tolerance of Antarctic and sub-Antarctic invertebrates to metal contaminants (Post Doctoral Fellow Dr Ben Kefford) in collaboration with the Australian Antarctic Division; and risk assessment from cyanobacterial toxins in seafood from the Gippsland Lakes (post doctoral researcher Jackie Myers) funded by the DHS.

For further details on the research group activities contact dayanthi.nugegoda@rmit.edu.au.

Drugs from the Marine and Terrestrial Environments

Dr Sylvia Urban

RMIT University, School of Applied Sciences

The Marine and Terrestrial Natural Product (MATNAP) research group, established in 2003 and led by Dr Sylvia Urban of the School of Applied Sciences (Discipline of Applied Chemistry), RMIT University, has a focus of isolating and characterizing secondary metabolites from marine organisms and Australian flora for the purposes of drug discovery. The research group in 2005 consisted of one postdoctoral fellow, one PhD, one Masters and one Honours student. In 2006 the research group consists of 1 PhD student (Daniel Dias), 1 Masters by research student (Priyanka Reddy) and 1 Honours student (Michael Timmers).

Between 2004-2007 major support for the group activities were secured through the Victorian Institute for Chemical Sciences (VICS) for a project entitled “Drugs from the Marine and Terrestrial Environments”. In this project the unique biodiversity of southern Australia’s marine and terrestrial organisms is being explored as a rich source of bioactive molecules.

Marine organism collections provided by Roderick Watson of VMSC such as sponges, ascidians and algae amongst others, have allowed the group to continue to build up a database of marine extracts. The crude extract of marine and terrestrial organisms are assessed for anti-tumour, anti-viral and anti-microbial activities. Other collections are carried out by the research group (eg. Intertidal collections for marine algae) with permits being held for both marine and terrestrial collections. For further details on the MATNAP research group activities go to:
http://home.iprimus.com.au/sylvia_urban/.

PhD

Connectivity of intertidal gastropod populations in a system of marine protected areas

Rachael Bathgate
The University of Melbourne, Department of Zoology

Supervisors - Professor Michael J. Keough and Dr Steven Swearer

My project focuses on gastropod assemblages found on intertidal rocky reefs in marine protected areas (MPAs) in Victoria. The overarching objective of my PhD research has been to determine how the recently proclaimed Marine National Parks and Marine Sanctuaries may act as larval sources or sinks for gastropods with different larval dispersal potentials. One of the ways that highly protected MPAs may help to conserve biological diversity is by protecting and enhancing resident spawning stocks. An increase in the size and number of reproductive individuals may result in increased production of gametes or larvae that then disperse to other areas or are retained locally. For most species of marine gastropods, the extent and direction of larval dispersal, and degree of connectivity between local populations are unknown. The creation of a system of MPAs in Victoria (Marine National Parks and Marine Sanctuaries) provides a unique opportunity to investigate these processes in a local context. I am combining biological data (e.g. abundance of adults recruits, reproductive output, larval duration and abundance) and physical measures (e.g. wind direction, current direction and speed) to see if populations within MPAs are likely to be self-replenishing and the extent to which they act as recruitment sources or sinks.

I have completed the field work component of my project and am currently focusing on finishing laboratory tasks such as plankton sorting, dissection of specimens for gonad indices and analysing egg masses. I have also undertaken a genetic study to determine the extent of population differentiation in 3 gastropod species having short, long or no larval dispersal. I am currently due to submit in March, 2009.

Age, growth and reproduction of southern Australian holocephalans (*Rhinochimaera, Chimaera* and *Hydrolagus spp.*) and the white-fin swell shark (*Cephaloscyllium spp.*)

Justin D Bell

Deakin University, School of Ecology and Environment / MAFFRI

Supervisors - Dr Laurie Laurenson; Mr Terry Walker

Holocephalans are an ancient lineage of cartilaginous fishes (chondrichthyans) closely related to elasmobranches (sharks, skates and rays). Holocephalans typically inhabit waters beyond the continental shelf and in consequence have received little scientific research, despite being a regular commercial catch. Similarly, the white-fin swell shark (*Cephaloscyllium spp. A*) is one of the most commonly caught bycatch species in Australia however has received no biological research.

My PhD research aims to gain biological information relating to age and growth, diet, reproductive biology and fishery interactions of all southern Australian holocephalan species and the white-fin swell shark, thus providing a basis for sustainable management.

Assisted Reproductive Technologies (ART) in Elasmobranchs

Jonathan Daly

Monash University, Monash Medical Centre

Supervisor – Professor David Galloway

Captive breeding programs for large sharks are becoming increasingly important, especially for existing display species that are threatened in their natural habitat. The low fecundity of large sharks in captivity indicates a need for aquaria to take an active role in shark reproductive research. ART (such as determining female reproductive cycles, sperm collection and cryopreservation, and artificial insemination) could help to maintain genetic diversity and enhance aquaria-based breeding programs for endangered species such as the grey nurse shark, *Carcharias taurus*.

As grey nurse sharks in aquaria are extremely valuable, the project uses model species to develop techniques. Ultrasonography is performed on female sevengills, *Notorynchus cepedianus,* at Melbourne Aquarium to determine reproductive cycles and follow follicular and foetal growth. Ultrasound has shown the growth of follicles through to ovulation, as well as follicle regression in sevengill ovaries. Methods for semen collection and cryopreservation have been developed for male sparsely spotted stingarees, *Urolophus paucimaculatus* at MAFFRI, Queenscliff. Collected semen is processed and frozen in liquid nitrogen at -196°C to examine the effect of various diluents on post-thaw survival of spermatozoa. Spermatozoa assessed visually under light microscope after thawing have shown up to 60% still active. Spermatozoal morphology is being studied with light and electron microscopy to determine species differences and the effects of freezing and thawing on cellular integrity.

The effects of *Nodularia spumigena* and an extract of *N. spumigena* on aquatic fauna

Warren Davies

RMIT University, Department of Biotechnology and Environmental Biology

Supervisor – Dr Dayanthi Nugegoda

Harmful algal blooms (HAB's) in the Gippsland Lakes have been identified as a major concern to the economy and environment of the Gippsland Lakes, Victoria. Of most concern is the cyanobacteria, *Nodularia spumigena*. This blue – green algae in recent years reached bloom proportions in the Gippsland Lakes and has resulted in government closure of recreational and commercial fishing in the region. *Nodularia spumigena* possesses an intracellular toxin called nodularin. This toxin has been the associated cause of death to livestock in the past. Cell breakdown of the blue – green algae liberates the toxin and other unknown toxic components into the environment. Aquatic fauna that have to endure episodes of *N. spumigena* blooms may be subject to toxic affects, which potentially could lead to death or physiological impairment. Changes in the health of key aquatic fauna from *N. spumigena* toxicity may alter ecosystem balance by changing population and community structures.

My PhD thesis looked at the toxic cyanobacteria *Nodularia spumigena* which causes recurrent blooms in the Gippsland Lakes. In summary my research provided results in the following areas:

- Developing a new method to remove the main toxin of *N. spumigena* (nodularin) from water samples for quantification using a technique called Solid Phase Microextraction (SPME)
- Investigated concentrations of nodularin over time in animals collected during a bloom of *N. spumigena* in the Gippsland Lakes
- Measured how lethal the soluble content (an extract) of *N. spumigena* is to animals in the Gippsland Lakes
- Measured sublethal changes in animals from the Gippsland Lakes from exposure to the *N.*

spumigena extract, which provided insight in how these animals eliminate the toxins
- Reported how the *N. spumigena* extract caused damage to important animal cell structure such as DNA damage
- Investigated how *N. spumigena*, if consumed by an animal caused sublethal effects and if these were comparable to effects seen after exposure to the extract

The overall outcomes of the PhD provided insight into the toxicity of *N. spumigena* and its toxic products and may help in further development of human health guidelines for seafood consumption as well us giving an understanding of how animal defenses cope with algal blooms and could lead to higher studies of these toxic organismic effects.

Thesis submitted – July 2007.

Natural Product Studies of terrestrial and marine organisms

Daniel Dias

RMIT University, School of Applied Sciences

Supervisor – Dr Sylvia Urban

The history of natural products in relation to current medicinal agents is well recognised in drug discovery ventures. Natural products offer a diverse array of unique structures, which simply cannot be matched through even the most active imaginations of organic synthetic chemists. An untapped source is the marine environment which has resulted in “lead compounds” that have successfully passed through the arduous, drug discovery process (Phase I, II and III clinical trials) and resulted in the successful manufacture and commercialisation of synthetic analogues for treatment of disease and illness.

The Marine and Terrestrial Natural Product Research Group (MATNAP) at RMIT endeavours to identify biologically active secondary metabolites from both marine and terrestrial sources. The identification of novel bioactive active secondary metabolites could lead to the development of new therapeutic agents. My research project investigates novel biologically active compounds derived from Australian marine and terrestrial sources for the purposes of drug discovery and/or agrochemical applications (eg. herbicides and/or pesticides). This research involves collaborations with other institutes or universities, for example with the Victorian Institute for Chemical Sciences (VICS). Associate Professor Ann Lawrie (RMIT, Bundoora) has aided with fungal collections, classification and fungal culturing procedures. Associate Professor Jonathan White has assisted with single-crystal x-ray analysis of natural products (the University of Melbourne) and Dr Jonathan Burton (University of Cambridge, UK) in which collaborative studies of a selected marine organism have resulted in a structural revision. Some marine collections have been organised with the Victorian Marine Science Consortium at Queenscliff and Dr Brian Leonard (RMIT, Bundoora) during the period of my candidature.

Last year’s research focused on several marine algae including, *P. merternsii, P. angustum, L. filiformis, and L. elata*. Chemical and biological investigations have resulted in interesting and exciting chemistry including the first report of potent antitumour activity for a known marine natural product, the isolation of several novel compounds, a new single-crystal x-ray structure of a previously isolated marine natural product, the proposed relative stereochemistry of a structurally revised marine natural product and the novel application of hyphenated techniques have aided in the rapid dereplication of marine natural products.

Seasonality, seduction and foul play: the hydroid fauna of Port Phillip Bay

Isla Fitridge

The University of Melbourne, Department of Zoology

Supervisors – Professor Michael J Keough and Dr Jan Watson

Hydroids (Hydrozoa: Cnidaria) are plant-like, sessile, colony-forming suspension feeders, and are abundant in many marine benthic communities. Hydroids are considered complex subjects for ecological work as they are often small and difficult to identify, and are consequently frequently overlooked. Ecology-based hydroid studies are in the minority and have been generally neglected in comparison to those on faunistics, systematics and biology.

Port Phillip Bay has a widespread and diverse hydroid fauna, but surprisingly there has been no comprehensive study investigating the life history of Port Phillip hydroids and their distribution. In temperate waters, hydroid species are almost always missing from the local fauna for some time during the year, resulting in changes in the hydroid population over the course of the seasons. Identifying quantitatively important hydroid species and how their populations change seasonally is pivotal in terms of understanding the role of hydroids in temperate marine ecosystems. This research seeks to examine how the hydroid communities of Port Phillip Bay change temporally

and spatially, by recording data on their presence and absence, recruitment, growth and fertility. It represents the first documented assessment of the hydroid fauna of this region.

The study will also examine the role of hydroids as fouling species within mussel culture operations. Biofouling is a consistent problem in mussel farms, with the potential to affect mussel productivity. Filamentous materials are known to provide an attractive settlement surface for bivalve larvae, and several studies have reported on the apparent success of hydroids as providing optimum settlement substrate for bivalve larvae. Ironically, many species of hydroids are known to favour mussel shells as a substrate for growth, and consequently can have a large impact as fouling species in mussel farms. In Port Phillip Bay, hydroids are known to foul both mussel shells and spat-catching ropes. It is not known how these hydroids may be affecting mussel productivity and there is currently no concentrated research effort investigating the relationship between mussel culture and hydroids. An important factor in managing biofouling by hydroids is the ability to accurately predict the occurrence of fouling episodes, but their patterns of recruitment within mussel farms are unknown. The potential of hydroids to be utilised as spat 'attractors', the impact of hydroids on mussel culture productivity, and patterns of hydroid recruitment will be investigated, using Port Phillip Bay and (potentially) New Zealand long-line mussel farms as research case studies.

The opportunity to investigate the hydroid ecology of Port Phillip Bay, how their population changes with time and the nature of the relationship between hydroids and mussels, both in Port Phillip Bay and in other parts of the world, will go some way towards addressing the knowledge gaps within this field. I began my research in August 2007. Over the remainder of the year I planned my fieldwork, visited my proposed field sites, sourced and constructed my field equipment and conducted some pilot studies to establish my sampling protocols, in preparation for beginning my fieldwork in earnest in 2008.

Capture stress physiology and post-release fate of small Australian elasmobranchs

Lorenz Frick

Monash University, School of Biological Sciences / MAFFRI

Supervisors – Dr Richard Reina and Mr Terry Walker

Recent declines in shark populations worldwide call for intensified and applied shark research, effective management plans are urgently needed. Only a few shark species are targeted by commercial fisheries in Australia, while many more are caught as bycatch, and are subsequently discarded dead or alive. The fate of those sharks released alive is an essential factor for the assessment of the impact of fisheries on shark populations, but is so far completely unknown. Some will probably survive, while others will succumb to injuries suffered during capture or to infections resulting from such injuries, or may die as an indirect consequence of the deleterious effects of capture, such as fatal physiological stress or impaired predator evasion or foraging behaviour. Furthermore, a single minor stressful event, such as handling, is sufficient to significantly depress circulating levels of reproductive steroid hormones in elasmobranchs for many days.

Only a few studies have addressed the effect of capture on elasmobranchs, all of them used sharks caught in the wild. Because many factors, including water temperature, dissolved oxygen, and most likely also the nutritional state of an animal, affect exercise-related physiological processes, an unambiguous interpretation of results obtained in the wild can be difficult. The duration of stress exposure has a major influence on the magnitude of the stress response. Even though it is a key parameter to be considered, it is often impossible to be measured accurately in the field.

To avoid these uncertainties, capture is simulated in aquaculture tanks using captive sharks in this project. With this approach the above mentioned parameters can be controlled, and the recovery phase of the individual sharks can be monitored. Baseline levels in captivity may not be the same as in a natural environment, but relative changes in blood parameters upon stress exposure are expected to be similar.

The primary aim of this study is to establish reference curves of physiological parameters relevant to the sharks' stress reaction in the lab, demonstrating the change of these parameters over time. Sharks are subjected to various durations of capture stress exposure, after which several blood samples are taken during a recovery period of 24 hours. Simulated capture gear types include hook-and-line, gill-nets and trawl-nets, and

all experiments are conducted in circular 5000 litre aquaculture tanks. Hook-and-line and gill-nets are suspended from a tripod frame sitting on top of the tank, and are connected to a load cell measuring tension caused by struggling sharks. These struggling activity profiles are used to quantify struggling effort. Trawling is simulated by placing sharks into trawl-net codends that are being pulled around the experimental tank by two rotating arms powered by an electric motor.

Aside from providing insight into a so far poorly understood aspect of elasmobranch physiology, the results of this study will help to increase the accuracy and power of large scale tagging studies by providing information on a so far unknown, but important factor influencing the probability of recapture of an animal. Data on the post-capture fate of sharks will refine mathematical fisheries management models, and being able to account for the effect of initial capture will benefit other studies that interact with animals in the wild.

The effects of trace metals on the Australian abalone, *Haliotis rubra*

Jacquelle Gorski

RMIT University, Department of Biotechnology and Environmental Biology

Supervisor – Dr Dayanthi Nugegoda

The purpose of my thesis and the research encompassed within was to determine the tolerance of a commercially, aesthetically and environmentally important species to trace metals. The species of choice, *Haliotis rubra* are distributed along the southern Australian coastline, stretching from South Australia to New South Wales. This species of abalone is extensively farmed and an important species for the wild stock fishery. The demise of abalone populations throughout the world can be attributed to exploitation by fishing activities and decline in quality of their natural habitats. Limited emphasis has been placed on the impacts of water quality within open coastal waters that abalone inhabit. The development of *Haliotis* species is complicated by various phases that are integral to its proliferation in the marine environment. Exposure of trace metals to different stages of abalone development, and for different durations has allowed this research to provide an indication of the sensitivity of abalone at various periods of development to trace metal exposure in the water column.

The importance of this research lies in the fact that abalone have not been extensively studied to determine their sensitivity to trace metal exposure. My thesis focussed on the effects of a range of both essential and non-essential trace metals on various stages of *H.rubra* development. The trace metals assessed in this thesis were the essential metals Cu and Zn, and to a limited extent Fe; and, the non-essential metals Hg and Cd, and to a limited extent Pb. Acute and chronic exposures to trace metals were investigated and the effects on survival, behaviour, and ATPase enzyme activity are the key components of this research. Cu and Hg proved to be the two most toxic metals to each of the life stages of *H.rubra* studied.

In the first series of experiments, fertilised eggs of *Haliotis rubra* were exposed to a range of dissolved nominal concentrations of Cd, Cu, Fe, Pb, Hg, and Zn in individual solutions for 48hr. After 48hr of exposure, the test was completed by recording survival success and morphological abnormalities of pelagic veliger larvae in each trace metal treatment. The mean 48hr median effective concentrations affecting normal morphological development of veliger larvae determined in this test showed a decreasing order of toxicity of 7 µg Cu/L, 21µg Hg/L, 35 µg Zn/L, 4,102 µg Fe/L, 4,515 µg Cd/L, and 5,111 µg Pb/L.

Settlement and metamorphosis are key characteristics to the successful recruitment of populations of *H.rubra*. In the next series of experiments, veliger larvae of *H.rubra* were exposed to dissolved concentrations of Cu, Zn, Hg and Cd for 48h. After this time, larvae aged 5 days displayed the characteristics of competent larvae with the ability to commence the benthic existence. Artificial nursery microcosms were developed containing microscope slides inoculated with the settlement inducing microalgae, *Ulvella lens*. Within 24hr of introduction into the nursery microcosms, 82% of control *H.rubra* larvae were actively crawling on the settlement surface. Crawling success was impaired by 128µg/L Cu and Hg, and 1250µg Cd/L. After 48hr in the nursery microcosm, 50% of control larvae displayed settlement characteristics. Settlement was inhibited by 128µg Cu/L, 32µg Hg/L, and 2500µg Cd/L. Metamorphosis of larvae 96hr after addition into the microcosms was inhibited by 32µg Cu/L, 512µg Zn/L, 4µg Hg/L and 2500µg Cd/L compared to 90% of control larvae that had either settled or metamorphosed. The rate of larval metamorphosis was enhanced after exposure to Cu and Hg at 0.5µg/L and >64µg Zn/L. Exposure to Zn at concentrations 64, 128 and 256 µg Zn/L caused an increased rate of settlement and metamorphosis after 96hr.

The concentrations of trace metals that resulted in mortality of *H.rubra* were investigated by exposing juveniles to acute concentrations of Cu, Zn, Hg

and Cd for 96hr. Cu produced the most toxic response and a 96hr LC50 of 87µg Cu/L. Hg resulted in more sudden mortality rate after 24hr exposure compared to Cu yet produced a 96hr LC50 of 173µg Hg/L. Juvenile *H.rubra* were relatively insensitive to Zn and Cd with the 96hr LC50 established for these metals at 2700µg Zn/L and 3700µg Cd/L, respectively. During exposure, *H.rubra* displayed alterations in their behaviour including increased mucus production from the gills, decreased sensory capacity, and the inability to adhere using the foot muscle.

To determine the effects of chronic trace metal exposure and the ability of *H.rubra* to bioaccumulate metals, juveniles were exposed in individual exposure tests to three concentrations each of Cu, Zn, Hg and Cd for 28 days followed by 28 days depuration in clean seawater. The bioaccumulation of each individual metal was determined in three tissue compartments; the mantle, viscera and edible foot muscle. Exposure to Cu, Zn and Cd produced significant accumulation in the viscera<mantle<edible foot muscle. Accumulation of Hg was greater in the mantle<viscera<edible foot muscle. Depuration for 28 days produced varying results for each metal and tissue compartment.

Changes in the ouabain sensitive sodium-potassium activated ATPase (Na+,K+-ATPase) activity were examined in gills of juvenile *H.rubra* to assess the sublethal effects of the selected trace metals, Cu, Zn, Hg and Cd on enzyme activity. *H.rubra* were exposed to individual trace metals in solution for 28 days followed by 28 days depuration in clean seawater. The Na+,K+-ATPase activity in gills of the abalone was significantly affected by the dissolved trace metals, with Hg producing the greatest effect. The decreasing order of effect on Na+,K+-ATPase activity was Hg>Cu>Cd>Zn. Depuration of *H.rubra* in clean seawater resulted in the recovery of Na+,K+-ATPase activity to varying degrees after exposure to each of the trace metals. The recovery of ATPase activity was more efficient following exposure to Cd>Zn>Cu>Hg. The abalone species, *H. rubra* appeared to have a higher ATPase activity than other marine invertebrate species, and this may be attributed to the isolation and measurement of other gill ATPases such as Ca2+, Na+, and Mg2+-ATPase in the methodology employed.

The overall results of my thesis have provided initial baseline information to evaluate the sensitivity of *H.rubra* to trace metal toxicants, and these results may be utilised by regulators for the setting of marine water quality guidelines to protect *H.rubra* and other abalone species in their natural habitats.

Thesis submitted - June 2007.

Temporal and spatial population structure of arrow squid, *Nototodarus gouldi*, off south-eastern Australia

Corey Green

University of Tasmania / MAFFRI / CSIRO

Supervisors – Dr George Jackson; Mr Terry Walker; Dr David Smith

Traditional stock assessment and management frameworks developed for finfish fisheries are not appropriate for squid stocks due to their unique biology and ecology. Squid display a large degree of variability at an individual level through extreme plasticity in their biology and life history strategies. While at the population level, a short life and rapid population turnover amplify this variability.

Due to seasonal upwelling and nutrient loads, arrow squid, found on major Australian fishing grounds, are subject to large variations in environmental and oceanographic conditions over small spatial and temporal scales. The influence of these oceanographic processes, quantified through satellite image data (e.g. sea surface colour and sea surface temperature) will be investigated with respect to arrow squid growth and population dynamics. Growth will be determined through ageing of squid samples using their statoliths. Stochastic growth trajectories will be used to model the plasticity of growth, while statolith shape analysis and microchemistry techniques will be used to determine whether squid stocks are spatially differentiated. Light-trapping and the selectiveness of fishing gears will be studied to determine juvenile recruitment success and the effectiveness of trawl and jig fishing gears. The affect climate change may have on the fishery will also be hypothesized with the attempt to develop alternative management strategies for sustainable development.

Estimating and improving the survival of recreationally caught and released fish

Daniel Grixti

Deakin University / MAFFRI

Supervisors – Professor Gerry Quinn; Mr Simon Conron

Legal minimum length (LML) and daily bag limit (DBL) are widely used management tools for recreational fisheries. The use of a LML and DBL is based on the presumption that released fish survive. If survival rates after capture and release

are low then the total kill in the fishery will be under-estimated and the value of management measures will be compromised. Snapper, *Pagrus auratus* and black bream, *Acanthopagrus butcheri*, are two principal target species in Victorian marine and estuarine recreational fisheries and both are managed by LML and DBL. The National Recreational and Indigenous Fishing Survey (NRIFS) (Henry and Lyle 2003) reported that 401,000 snapper and 840,000 black bream were caught and released by anglers fishing in Victorian waters in 2000/01.

My PhD is investigating the survival of recreationally caught snapper and black bream after their release to the water. Experiments are based on capture and holding methods commonly used in this type of research. I am also is exploring ways of improving this release survival through hook and angling technique changes. A post mortem procedure has been developed to enhance outcomes of this released fish survival research.

My project is part of the National Released Fish Survival program initiated by Fisheries Research and Development Corporation (FRDC). FRDC and Fisheries Victoria have jointly funded this research.

Effects of environmental stressors on growth, reproduction and survival in black bream, *Acanthopagrus butcheri*

Kathryn Hassell

RMIT University / MAFFRI / AIMS

Supervisors – A/Professor Dayanthi Nugegoda; Dr Patrick Coutin; Dr Susan Codi King

Throughout 2006 and the early part of 2007 I conducted a number of experiments in the VMSC labs on black bream embryos and yolk-sac larvae. The results indicate that bream embryos are very sensitive to changes in water quality, and are particularly vulnerable to combinations of stressors. I tested combinations of low dissolved oxygen (hypoxia), increased and decreased salinity and increased and decreased temperature, since all three factors are especially important variables in estuarine environments (where black bream spawn). Significant reductions in hatch rates and larval survival and length, along with developmental retardation and increased rates of deformity were all observed. The results provide some explanation as to why recruitment can be so variable in black bream and indicate that this trend is likely to continue into the future as estuarine environments are altered as a result of climate change.

The second theme of my PhD has been to develop methods to assess the reproductive condition of adult black bream using the blood protein vitellogenin as a biomarker. Vitellogenin is produced by female fish and is required for yolk synthesis and subsequent egg production. By measuring the levels of vitellogenin in the blood of females we can hopefully get some indication of their reproductive condition. What makes vitellogenin so useful is that it is produced in response to estrogen, so it can also be used as an indicator of exposure to estrogenic chemicals in male fish (endocrine disruption). After developing a suitable bioassay in the laboratory which confirmed that vitellogenin could be induced in males, it was time to get out in the field and sample black bream from a number of different estuaries around Victoria.

With the much appreciated assistance of both recreational and commercial fishermen, black bream have been sampled from the Yarra, Maribyrnong, Little and Werribee Rivers as well as Mallacoota Inlet. I am now analysing the results in terms of growth, age, gonad histology, GSI, LSI, condition factor and blood vitellogenin levels to get some idea of how black bream from different estuaries are fairing in relation to environmental conditions. Melbourne Water and the Victorian EPA are collaborating on this project, as well as Dr. Susan Jobling from Brunel University, UK.

Anthropogenic effects on the fish fauna in Port Phillip Bay, Victoria

Christian Jung

The University of Melbourne, Department of Zoology

Supervisors – Dr Stephen E. Swearer and Professor Michael J Keough

I am in the second year of my PhD studies, working on anthropogenic effects on the fish fauna in Port Phillip. Studies assessing the spatial and temporal variation of ichthyo-assemblages on shallow rocky reefs around the Bay are concluded. Studies assessing whether any evidence for impact of boating and angling on fish communities can be found will be concluded by the end of 2008. Simultaneously I am analysing whether those impacts, or 'natural' habitat features seem to be of more importance in shaping the fish communities in the areas I survey. To assess the angling and boating activity I am using time lapse photography. This enables me to gather direct empirical data of those disturbances.

Of all the anthropogenic impacts, I am particularly interested in noise pollution. Contrary to popular

belief, the underwater world is a noisy environment. Fishes utilise sound as a source of information about their immediate surroundings and actively communicate via sound. Yet growing input of sound from anthropogenic sources, i.e. noise pollution from boats, ships etc., threatens to mask natural sound signals or otherwise disturb the reef fish communities. I am currently compiling a 'soundscape' of Port Phillip, recording and analysing sound, both natural and anthropogenic. Experiments around the effect of such noise pollution are under way and will continue until mid 2009.

Finally my studies entail a sociological component. I am conducting qualitative interviews with long time bay divers and anglers, about their perception of changes in and around the waters of Port Phillip. I plan to complete my PhD studies by the end of 2009.

Population and trophic dynamics of red cod, *Pseudophycis bachus*

Jodie Kemp

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Supervisors - Dr Stephen E. Swearer; Dr Greg P. Jenkins

Otolith shape is often used to facilitate the identification of teleost prey species in marine diet studies. However, fine-scale variation in otolith shape among different species, and the added effect of partial digestion of otoliths, can often limit the ability to identify prey species. The objective of this research was to evaluate the potential use of 1) fine-scale shape differences using Fourier shape analysis and 2) microchemical differences using laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), in digested otoliths to identify fish prey species within the diet of predators. Belonging to the family Moridae, red cod *Pseudophycis bachus* and bearded rock cod *Pseudophycis barbata* are found in the shelf waters of south-eastern Australia and New Zealand. Pseudophycis species are important to a range of predators including the Australian fur seal (*Arctcephalus pusillus doriferus*) at Phillip Island Australia. Pseudophycis species from within the foraging range of the Australian fur seal at Phillip Island were examined for evidence of species-specific differences in otolith shape and microchemistry, with the objective of using these differences to identify prey species using otoliths collected from seal faecal and regurgitate samples at the Phillip Island seal colony. Both techniques revealed that the abundance of red cod is higher in the diet of the seals relative to bearded rock cod. The use of otolith shape analysis techniques to identify prey species where otoliths have fine-scale shape differences were found to be effective however should be used with caution as the effects of digestive processes can be significant. The use of core-region otolith microchemistry as a method to distinguish prey species was also found to be effective, and furthermore showed potential to provide a means to establish more direct links between predators and the geographical source of their prey.

Larval recruitment patterns in Victoria's marine reserves

Malcolm Lindsay

The University of Melbourne, Department of Zoology / Parks Victoria

Supervisors - Dr Stephen E Swearer, Professor Michael J. Keough; Dr Anthony Boxshall

Worldwide, marine reserves are being widely advocated as a tool for the conservation and management of biodiversity and fisheries. The successful siting and management of a marine reserve is dependent on the biological processes of the species involved. Of these processes, larval dispersal and recruitment is critical yet difficult to manage due to knowledge gaps and logistical difficulties. My project aims to investigate the recruitment patterns of different taxa at a number of Victoria's marine reserves. I will achieve this through quantifying both the oceanographic and recruitment conditions within and around the marine reserves. Oceanographic data collected using Acoustic Doppler Current Profilers (ADCP) and temperature loggers will be matched to weather conditions to look for commonly occurring oceanographic patterns. This will then be linked to recruitment data, gathered from different larval collectors, to model links between the oceanographic and recruitment patterns. Different areas within and around the reserves can then be given dispersive indices, which directly relate to management goals. For example, highly dispersive sites allow spillover to unprotected areas, while low dispersive sites allow self-recruitment and population persistence. Through the linkage of this project with Parks Victoria, Victoria's reserve management body, the results will directly aid the management of the current reserves and the siting of any in the future.

Dispersal of the important habitat-forming alga, *Hormosira banksii* (Phaeophyceae, Fucales)

Prue McKenzie

Deakin University, School of Life and Environmental Sciences

Supervisor – Dr Alecia Bellgrove

Hormosira banksii (Neptune's Necklace) is a habitat-forming brown seaweed that dominates most of the intertidal coastline in southern Australasia, contributing tangibly to the biodiversity of rocky intertidal communities. Where this species is lost (or reduced) due to human disturbance (eg. sewage effluent discharge, trampling) the biodiversity is also changed. Successful rehabilitation of this species depends on the knowledge of the dispersal capabilities of *H. banksii* and its ability to successfully regenerate. We currently lack this knowledge.

H. banksii is characterized by having limited dispersal of zygotes, however it has a broad distribution throughout southern Australasia. It is possible that reproductive fronds of *H. banksii* are dislodged from the substratum and drift with ocean currents to arrive and establish at new sites. Long-distance dispersal achieved through floating reproductive fronds has been suggested to be an important means of dispersal for marine algae.

This project investigates the dispersal potential of *H. banksii* using genetic analyses and conducting complimentary ecological surveys and experiments.

Fish responses to seagrass habitat fragmentation

Peter Macreadie

The University of Melbourne, Department of Zoology / MAFFRI

Supervisors – Professor Michael J. Keough; Dr Greg Jenkins, Dr Jeremy Hindell

Seagrasses are a conspicuous element of Australian marine environments and are crucial in the conservation and maintenance of biodiversity. Degradation of seagrass ecosystems from climatic extremes, increased sediment and nutrients in the water, and other pollutants results in loss and fragmentation of meadows. These changes to seagrass have been linked to the collapse of fisheries.

The aim of my project is to understand the importance of seagrass to fish species and determine the impact of fragmentation. In 2006 I completed a large-scale experiment where I used artificial seagrass to simulate seagrass habitat fragmentation. I found that fragmentation had no effect on fish abundance but that patchy seagrass had fewer species. My work suggested that positive edge effects can offset the negative effects of habitat loss. I explored this idea further by sampling the inner and outer areas of seagrass patches and found that some fish were significantly more abundant at patch edges. This season I am testing the hypothesis that greater food availability is the cause of these positive edge effects. With seagrass being continually fragmented across the Victorian coastline, I anticipate that my research will address a number of gaps in our current knowledge and may be used to assist the management of Australia's increasingly fragmented coastal landscapes.

The effect of feed supplemented with Omega – 3 polyunsaturated fatty acids on cultured abalone

Hintsa Mateos

Victoria University, School of Biomedical and Clinical Sciences

Supervisors – Dr Xiao Su, Dr Paul Lewandowski

Abalone is a rich source of omega -3 long chain polyunsaturated fatty acids. There is an increasing interest in these fatty acids because studies have shown that they can reduce the risk of cardiovascular disease, lowering the blood pressure and plasma triacylglycerol level. In addition, they have been found to reduce the risk of Type II Diabetes, dementia and Alzheimer disease as well as a range of other disorders.

Abalone is an important fishery in Australia and its production accounts for more than 50% of the global market. Currently the Australian wild abalone fishery earns about AU$200 million each year. However, due to rapidly increasing demands from both local and global markets, the wild fisheries are under strict and limited production quotas, and there is now growing investment and research interest in aquaculture production of abalone.

Previous studies showed that cultured abalone contained lower level of n-3 PUFA than wild abalone. The similar results have also been reported on fish. Therefore concern has been expressed in recent years worldwide that consumption of cultured marine species would not give the same nutritional value as the wild species.

Vegetable oils stand out as the most likely candidates to substitute partially for marine oils in abalone feeds as their total global production is 100 times higher than that of fish oils. This is relevant because commercial aquaculture depends on marine lipids in feed production but, in future, marine lipid may be limited due to the fast growth of aquaculture industry. To date only little information is available on the inclusion of vegetable oils in commercial artificial diets for

Australian juvenile abalone. There is no study on the cultured adult hybrid abalone (*H. laevigata x H. rubra*).

Fatty acid biosynthesis in fish has been well studied and it has been found that the overall conversion of 18-carbon PUFA to LC PUFA occurs poorly in marine species. For abalone, however, there is still no direct evidence on the pathways of fatty acid biosynthesis. Further investigations are required to elucidate the detailed pathways of fatty acid biosynthesis and their regulation in abalone.

The proposed research will investigate the effects of feed incorporated with fish oil on the lipid profiles of cultured adult hybrid abalone (*H. laevigata x H. rubra*). The study also aims to examine the growth and development of cultured adult abalone fed by different concentrations of fish oil supplements. In addition this project will investigate the effects of replacement of fish oil with vegetable oils on the growth performance and lipid profiles of cultured abalone. Furthermore the effects of fish oil and vegetable oil supplementation on mRNA proteins (delta-5 and delta-6 fatty acid desaturases and fatty acid elongases enzymes) associated with lipid metabolism in abalone will be investigated.

It is expected that this study will provide valuable information for aquaculture and food industries on the improvement of nutritional value of cultured abalone, and boost Australian seafood market. It will also provide useful information to nutrition and consumer groups.

Factors affecting the ecophysiology of *Nodularia sp* a cyanobacterial species isolated from the Gippsland Lakes, Victoria, Australia

Jackie Myers

Monash University, School of Biological Sciences / MAFFRI

Supervisors – Dr Graeme Allinson; Professor John Beardall; Dr Leanne Gunthorpe

Blooms of *Nodularia sp.* occur worldwide, mostly in salty or brackish waters, and typically in estuaries and coastal lagoons (Hobson et al 1999). The Gippsland Lakes in the south-east of Victoria have a long history of blooms of *Nodularia sp*., which in recent years have become more frequent and intense.

A great deal of information regarding the chemical and physical features which promote the development of *Nodularia sp*. blooms has been gained in recent years, however significant gaps still exist. For instance, isolates of *Nodularia sp*. from different regions show varying responses of cell growth to environmental variables (Huber 1984; Jones et al 1994; Blackburn et al 1996; Hobson et al 1999).

The objective of this work is to determine the influence of various environmental parameters to cell growth, macromolecular composition, photosynthesis, toxin production, germination and akinete formation in *Nodularia sp*. isolated from the Gippsland Lakes, Victoria, Australia. The results of this project will be used to develop models of algal blooms in the Gippsland Lakes and develop management procedures for these blooms.

Variability in the effects of nutrients in structuring intertidal soft sediments assemblages

Allyson O'Brien

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Supervisors - Professor Michael J. Keough and Dr Liz Morris

Biological disturbances are important processes that can affect the structure and function of intertidal marine assemblages. Identifying the effects of disturbances requires an understanding of the frequency at which they occur and the magnitude of the event relative to the existing conditions. Nutrient enrichment is a common disturbance in intertidal habitats and can come from anthropogenic or natural sources such as sewage discharge, river run-off or decomposing algae. It can affect assemblages at a variety of magnitudes and frequencies from regular pulses, sustained or one-off events. The detrimental effects of sustained, high level nutrient enrichment from anthropogenic sources of nutrients is well understood yet little is known about other sources that provide medium to low levels of enrichment. It is suggested drift algae that washes up on intertidal soft sediments may be one such source of nutrients affecting the structure and function of macrofauna assemblages. Drift algae may provide irregular or regular short term pulses of nutrients into the system or sustained inputs from large dumps during storms and high winds.

Ecological risk assessment from the effects of fishing for batoids in south-eastern Australia

David Phillips

Deakin University, School of Ecology and Environment / MAFFRI

Supervisors – Dr Janet Gwyther; Mr Terry Walker

Declines have been reported in chondrichthyan by-catch populations around the world. Chondrichthyan populations are particularly vulnerable to harvesting pressure because of the life history traits they exhibit, such as low fecundity, low natural mortality, delayed maturation and slow population growth. Most population analyses require large data sets collected over an extended period. In the case of many chondrichthyan species, management action is required long before such data sets can be available. Rapid assessment of ecological risk should be applied to chondrichthyan species to evaluate and rank on their need for immediate management and further research. Such assessments require information about the basic biology of species, such as age at maturity, average fecundity and maximum age. These variables can be used to rate species in their ability to withstand harvesting pressure.

This project aims to collect biological information about the basic biology for the purpose of ecological risk assessment for three species of large batoid chondrichthyans; southern eagle ray *Myliobatis australis*, smooth stingray *Dasyatis brevicaudata* and the black stingray *Dasyatis thetidis*.

Animal movements are being studied with manual acoustic tracking, and 24 Vemco VR2 passive acoustic listening stations set up in Swan Bay (Port Phillip Heads Marine National Park), and off Queenscliff and St Leonards. Southern fiddler rays, *Trygonorrhina fasciata* and eastern shovelnose stingree, *Trygonoptera sp*. have been both manually tracked to study detailed habitat preference and movements. Passive monitoring has revealed broader differences in habitat preference, emigration rates and site fidelity. The degree of protection provided by the marine protected areas has been quantified. Smooth stingray and southern eagle ray are also to be tagged, tracked and monitored. The existing ecological risk assessment framework is being adapted to include these data.

Variation in individual quality of Australasian gannets, *Morus serrator*: implications for seabird conservation and management

Tanya Pyk

Deakin University, School of Ecology and Environment

Supervisor – Dr Janet Gwyther

A series of recent long-term studies have indicated that only a few 'high quality' individuals within a population may contribute most to subsequent generations. Protecting these 'high quality' individuals is therefore of critical conservation importance in ensuring the long-term survival of a population. However, identifying these 'high quality' individuals and defining what distinguishes them (e.g. increased foraging ability, nutritional reserves or body condition) has proven difficult due to technical limitations in studying the foraging behaviour and energetics of marine predators at sea. Recent developments in technology have enabled the creation of 'bio-loggers', small recording devices capable of collecting detailed information on the foraging behaviour and energy expenditure of marine predators at sea. Taking advantage of this recent advance in technology, this project is using multiple recording devices attached to free-ranging Australasian gannets breeding in Port Phillip Bay to measure the foraging performance (e.g. depth and duration of dives, number of dives per foraging journey) and movements of individuals (e.g. foraging location, distance travelled during each foraging trip) of differing parental quality (determined using lifetime reproductive success data). Therefore, this project will improve our ability to identify and protect those 'high quality' individuals within a population that will make a significant contribution to subsequent generations. Such information is of critical conservation importance, particularly for populations of threatened or endangered species.

The fieldwork for this study is being conducted at the colony of Australasian gannets, *Morus serrator,* established at Pope's Eye marine Reserve (38°16'42''S. 144°41'48''E.). This site is part of the Port Phillip Heads Marine National Park, located near the entrance to Port Phillip Bay, approximately 3km southeast of Queenscliff, Victoria. Pope's Eye consists of an artificial rock annulus, on which a wooden platform and walkway and a concrete structure with a tower and navigational aids have been built. The colony was established in the mid 1980s and all suitable nesting space is now fully occupied, with approximately 200 pairs breeding annually.

Uterine accommodations for gestation and ecological risk assessment in the southern fiddler ray, *Trygonorrhina fasciata*

Matthew Reardon

The University of Melbourne, Department of Zoology / MAFFRI / The University of Indiana

Supervisors – Professor Marilyn Renfree; Mr Terry Walker; Dr W.C. Hamlett

The southern fiddler ray presents an interesting case study of the myriad reproductive modes of chondrichthyans. My project is investigating what role the uterus plays in nutrient transfer, waste disposal and gas exchange during gestation. I'll be investigating this through histology, electron microscopy and analysis of uterine fluids. This will give a picture of what function the uterus performs at various stages of gestation by looking at cell morphology, and identifying any secretory activity and its composition. The southern fiddler ray is viviparous yet the embryos are contained in a substantial tertiary egg envelope similar in appearance and thickness to some egg-laying, or oviparous species. This species may represent a kind of transitory phase between viviparity and oviparity and will provide an interesting insight into the modifications of uterine function if this is the case.

This project is also a part of a larger project assessing the ecological risk of chondrichthyans affected by commercial and recreational fishing activities. By taking length and weight measurements and classifying the reproductive state of animals through the use of both validated and un-validated indices we can construct models of the populations being studied. Most chondrichthyans reach maturity relatively late in their life, and produce relatively few offspring. Their reproductive potential, and thus their ability to recover from exploitation, or mortality from incidental bycatch is therefore usually low. By constructing population models we can infer the relative risk each species faces from a particular fishing activity.

I will be incorporating my reproductive studies as a means to validate assumptions of the stage of maturity that are essential to the accuracy of these population models. This will determine if previously used indices are accurate for the southern fiddler ray.

The effectiveness of hydro-acoustic and imaging techniques to characterise benthic habitats and communities

Ralph Roob

The University of Melbourne, Department of Geomatics

Supervisor – Dr Joseph Leach

The aims of this study are to determine the effectiveness, both in terms of spatial resolution and level of classification, of hydro-acoustic and imaging techniques to map habitats and identify the communities they support. An examination into the level at which various geo spatial information relating to the physical nature of the ocean floor can be used as a surrogate to determine the extent of benthic communities will be carried out. Geo-spatial analytical and interpolation techniques that can be used to represent the distribution of benthic communities from remotely sensed information will be explored. Geo-spatial layers of benthic habitat and community classes will be generated at a higher resolution than could previously be interpolated from a network of point samples

Finally the technical limits of these techniques in classifying communities and identifying habitats in various marine environments will be determined. A study of marine benthic habitats will define community structure and assist in understanding associated biophysical processes. Identifying the spatial extent of habitats may assist in the design and implementation of appropriate conservation strategies and management protocols. This investigation will supplement and enhance several studies that are part of the macrobenthic study designed and implemented by The Central Queensland University in Port Curtis and by MAFFRI in Port Phillip Bay.

The influence of variable recruitment on the structure and development of marine epifaunal communities

Michael Sams

The University of Melbourne, Department of Zoology

Supervisor – Professor Michael J Keough

The presence of planktonic larval life stages in many marine animals creates great variability in the timing and location of recruitment. This variation in recruitment is considered to have important consequences for marine populations and communities. Whilst the sources of variation in recruitment and its consequences on populations have been relatively well studied in many marine environments, the influence of variable recruitment on the structure and development of whole communities is poorly understood. I am adopting an experimental approach that examines how variation in recruitment influences the development and structure of local communities of sessile invertebrates (epifauna) at three sites in Port Phillip Bay, Australia.

Using artificial substrates, I am manipulating the recruitment patterns of common species of sessile

invertebrates and following the subsequent development of communities. More specifically, I am examining a) how variation in initial recruitment of single species influence community structure; b) how different temporal patterns of recruitment influence community structure (including the influence of ongoing recruitment); and c) how variation in recruitment interacts with the properties of established communities (e.g. species diversity, structural complexity etc.) to influence changes in community structure. By separating out these various factors I hope to elucidate the complex ways that variation in the recruitment can influence marine community development.

Effects of embryonic and larval experience on growth, condition and survival in the common jollytail, *Galaxias maculatus*

David Semmens

The University of Melbourne, Department of Zoology

Supervisor – Dr Stephen E. Swearer

Most fish species possess complex life histories that involve the metamorphosis of a larval stage into a morphologically and ecologically distinct juvenile stage. Variation in larval experience, including maternal effects and food availability has been shown to affect the age, size and nutritional condition of larvae at metamorphosis (e.g. Chambers & Leggett, 1987; Chambers et al., 1988; McCormick & Kerrigan 1996). These factors can, in turn, affect juvenile growth (Chambers et al., 1988; Bertram et al., 1993; Tupper & Boutilier, 1995; Bertram et al., 1997), survival (Searcy & Sponagule, 2001; Shima & Findlay, 2002) and possibly fecundity (Ochi, 1986; Forrester, 1990).

Many fish populations show marked variability in the growth rate, size, age and condition of recruits within and between years (reviewed by McCormick 1998). However, variation within larval cohorts explains much more of the variability in these traits than differences between cohorts sampled over time (McCormick, 1994; Kerrigan, 1996). This suggests that larval fish commonly experience a wide range of environmental conditions independent of temporal variation in the planktonic environment.

To date, most research has focused on the effect of larval experience on the variation in numbers of fish surviving to settlement (McCormick, 1998). Recently, however, researchers have begun to acknowledge that the effects of larval experience can carry over into the juvenile period (reviewed in McCormick, 1998; Pechenik et al., 1998). A handful of studies have shown that traits exhibited at settlement have consequences for future fitness (Ochi 1986; Forrester, 1990; Tupper & Boutilier, 1995; Searcy & Sponaugle, 2001; Shima & Findlay, 2002). For example, in the damselfish, *Dascyllus aruanus*, size differences persisted for at least 10 months after settlement and only the largest individuals reached maturity within this period (Forrester, 1990). Therefore, advantages or disadvantages acquired in the larval period may have major implications for survival, growth and age at maturity.

The primary goal of this research is to explore the consequences of individual variation in traits such as size, growth and condition on fitness in subsequent life history stages. Manipulative and correlative approaches will be used to evaluate the influence of these traits on growth, condition and survival in the Common Galaxias, *Galaxias maculatus*. The Common Galaxias is an ideal subject for such a study because multiple life history stages can be easily collected and a great deal of valuable life history information is recorded in the daily growth rings of their otoliths (ear bones). In addition, Common Galaxias possess unusual life history strategies such as diadromy and emergent egg development.

The importance of edge effects in determining the value of seagrass landscapes as fish nurseries

Tim Smith

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Supervisors – Dr Jeremy Hindell; Dr Greg P. Jenkins and Professor Michael J. Keough

Seagrass is a common habitat in shallow waters around Australia, where it can range in size from beds 100's of metres long to less than a metre, often forming mosaics with other habitats. Natural and human disturbance are an increasing threat to seagrass in Australia and around the world. Seagrass beds support a greater abundance of juvenile fish than adjacent sand patches by providing increased food availability and a refuge from predation. Less well known is the role that the seagrass/sand interface (seagrass edge) plays in determining fish distribution within seagrass beds.

Few studies have focused on the role seagrass edges play in determining fish assemblages with equivocal results. My early results suggest that fish prefer the seagrass edge than more interior microhabitats, however a swathe of other variables, including seagrass structure, edge location and depth need to be taken into

consideration when assessing within patch fish dynamics. Further investigations will examine the impact of patch size and distance into a patch on fish patterns associated with seagrass edges and what causes such patterns (food availability, predation etc).

The systematics and biogeography of the southern Australian Cylindroleberididae *Crustacea: Ostracoda*

Anna Syme

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Supervisor – Professor David Macmillan

Ostracods of the family Cylindroleberididae are speciose, widespread, and well-defined by morphological features including the possession of gills. Despite the family having been divided into three subfamilies, five tribes, 32 genera, and more than 200 species, the relationships between its species have never been analysed phylogenetically. Twenty-five of the 32 genera are not defined by unique features but rather combinations of characters, and may therefore be historical constructions rather than evolutionary groups. The classification is of limited functional and predictive use, and requires a systematic revision. This work resolves several outstanding taxonomic issues. A checklist of the 219 described species is presented, including comments on taxonomic uncertainty. One of the key points of uncertainty concerns the missing specimen upon which the type species *Cypridina mariae* and the type genus of the family (Cylindroleberis) is based. A neotype is therefore described which clarifies taxonomically important morphological characters, particularly of the first antenna and mandible. To facilitate identification of cylindroleberidid species in ecological surveys and biodiversity estimates, an interactive key is produced, applicable to species in all geographic areas. Three new cylindroleberidid species are described from coastal Australian waters. A cladistic analysis is undertaken in order to test current subfamily and generic concepts against phylogenetic criteria. Using Bayesian likelihood methods, a phylogeny is inferred from both morphological and molecular data. The morphological data come from 141 species and 66 characters. The molecular data are based on predominantly new sequences of both nuclear (28S) and mitochondrial (16S) DNA, for 22 species. The results of the phylogenetic analyses of both morphological and molecular data strongly support the monophyly of the Cylindroleberididae; however, the two phylogenies differ in the topology of subfamily relationships. Where the morphology-based phylogeny suggests that Asteropteroninae and Cyclasteropinae are sister taxa, and then sister to Cylindroleberidinae, the molecular-based phylogeny places Asteropteroninae within the paraphyletic Cylindroleberidinae. The position of the Cyclasteropinae is uncertain. There is much homoplasy in the morphological characters, and the molecular phylogeny is considered more accurate in its representation of relationships within the family. Character mapping on both the morphology- and molecular-based phylogenies indicates that most existing generic diagnostic character states do not uniquely define clades and are likely to be of limited use in any phylogenetically-based classification. However, one character of use is the posterior ridge on the inner carapace which defines two genus level clades. Two new characters are identified of taxonomic use: a lateral seta on the first antenna, and the shape of the posterior of the body. A known fossil cylindroleberidid is dated at 425 million years old; this date was used to calibrate divergence times between clades in the molecular phylogeny. A genus-level clade in the phylogeny is calibrated to 110 million years old. In the light of this temporal framework, it is not surprising that morphological characters show high levels of homoplasy, representing potential evolutionary convergence. Based on the resolution of taxonomic issues and phylogenetic results, six genera are revised. Cylindroleberis is re-diagnosed based on the neotype *Cypridina mariae*. The emended diagnosis results in the synonymy of the monotypic Polyleberis with Cylindroleberis. Synasterope is re-diagnosed based on the important morphological character of the posterior ridge, and Postasterope and Heptonema become synonymized with it. Although the monophyly of Parasterope is not demonstrated, it is retained as a broadly-defined genus and its diagnosis expanded to accommodate all former species of Synasterope that lack the posterior ridge.

Thesis passed March 2007.

Sublethal effects of mercury and DDE on Australian black bream, *Acanthopagrus butcheri*

Lisa Toogood

RMIT University, Department of Biotechnology and Environmental Biology / MAFFRI

Supervisors – Associate Professor Dayanthi Nugegoda; Dr Leanne Gunthorpe

Current age structures of *Acanthopagrus butcheri* within the Gippsland Lakes suggest that recruitment have been episodic since 1981 and

low for three years in succession. Indications of strong recruitment have been infrequent over the past 10 years, with the absence or low abundance in commercial catches of the Gippsland Lakes black bream cohorts spawned in 1988, 1990 and 1991. This indicates poor spawning success and/or low survival of early life history stages of the fish spawned in these years. Due to the nature of the Gippsland Lakes system, it is likely that toxicants such as mercury and organochlorine pesticides will remain trapped within the system. Toxicants can exert a direct effect on fish, which can range from death (where concentrations are high) to impaired reproduction and growth (as a result of chronic or intermittent exposures). Organochlorine pesticides (such as DDT and its derivatives) are known to have mild oestrogenic effects on fish, leading to reproductive impairment, however, scientific knowledge relating to the endocrine disruptive properties of this pesticide are still developing. As mercury and DDT are present in the Gippsland Lakes, it is important to understand their physiological effects on the reproductive and thyroid hormone concentrations of *A. butcheri*.

Evidence from toxicological literature suggests the gamete (eggs and sperm), embryo and larval stages of many fish species are the most sensitive to pollutants. There has been little or no biological or physiological assessment of the impacts of contaminants on the early life stages of fish in the Gippsland Lakes. Specific tolerances of *A. butcheri* eggs and larvae to waterborne contaminants (such as heavy metals and organochlorine pesticides) are not known. Thyroid hormones, thyroxine (T_4) and triiodothyronine (T_3) have been implicated as important regulators of early developmental rates in the embryos and larvae of teleosts.

It is important to examine these hormones and the effects of mercury, organochlorine pesticides on these hormones, as a possible explanation for the recruitment failure of *A. butcheri* in the Gippsland Lakes.

Life history attributes and stock assessments of Urolophids (stingarees) found in south-eastern Australia

Fabian Trinnie

Deakin University, School of Ecology and Environment / MAFFRI

Supervisors – Dr Paul Jones, Dr Laurie Laurenson; Mr Terry Walker

Studies of the life history attributes such as reproduction, age and diet of the sparsely-spotted stingaree, *Urolophus paucimaculatus*, eastern shovelnose stingaree, *Trygonoptera sp B.*, banded stingaree, *U. cruciatus*, wide stingaree, spotted stingaree, greenback stingaree, *U. viridis*, and sandyback stingaree, *U. bucculentus*, of south eastern Australia will be undertaken during this project.

Commercial fisheries including Danish seiners, trawl netters and beach seiners that catch these animals, discard them as bycatch as they have no commercial value, but it is unknown as to whether these fishing techniques have a impact on there populations. The aim of this project is to better understand the life history characteristics of each species, their susceptibility to each fishing method and then apply this information to stock assessment and population density models.

The breeding biology of the white-faced storm petrel, *Pelagodroma marina*, in Victoria

Megan Underwood

Deakin University, School of Life and Environmental Sciences

Supervisors – Dr John Arnould and Dr Janet Gwyther

The white-faced storm petrel, *Pelagodroma marina*, is restricted to three breeding colonies within Victoria: Mud Islands and South Channel Fort in Port Phillip Bay, and Tullaberga Island off Mallacoota. Numbers of storm petrels breeding on Mud Islands have declined considerably since early last century possibly a result of the significant vegetation changes, together with increases in local populations of other species of birds, most notably, silver gulls, *Larus novaehollandiae*, Australian white ibis, *Threskoirnis molucca*, and straw-necked ibis, *T. spinicollis*. The breeding area available to the storm petrels appears to be limited by the recent arrival of the ibis which now breed on the islands in large numbers (approximately 50,000 pairs). The impact of these changes on the storm petrels is poorly understood, and knowledge of the breeding biology of this species is currently limited. This study aims to examine the interactions between the storm petrels, ibis, and vegetation through experimental manipulation of different habitat types and recording of the breeding success, burrow density, and chick growth. In addition, further information regarding the breeding biology and ecology of the storm petrels will also be obtained. This information will assist in appropriate management and conservation of this species in the future.

During the 2006/2007 breeding period (August to March) more than 65 days and 39 nights were spent on Mud Islands, 4 days on Tullaberga Island and 1 day on South Channel Fort.

Breeding data was collected from Mud Islands from 50 study burrows which included information on arrival, incubation length, nestling period, chick departure, and breeding success. Information was also obtained on attendance patterns of the storm petrels at 16 burrows. Small microchips were taped to the tail of the birds and antennas located at the burrow entrance recorded the bird's arrival and departure from the burrow. This data was collected during the incubation and chick rearing stages to provide information on foraging trip durations and feeding frequencies. The growth rates of 25 chicks were monitored by regularly weighing and measuring chicks. Information on the meal sizes fed to chicks and feeding frequency was obtained from 20 nights (including 10 consecutive nights) throughout the nestling period by weighing chicks at 8pm, midnight, 4am and 8am to determine if a meal had been received.

Additional blood samples and morphological measurements were collected from storm petrels at each site, approximately 70 from Mud Islands, 21 from Tullaberga Island, and 5 from South Channel Fort. Blood samples were also collected from the 25 study chicks. The samples are currently being analysed in the lab. Statistical analysis will then determine if there are any differences in morphological measurements of the sexes.

During this season diet samples were also collected from the storm petrels on Mud Islands and Tullaberga Island (35 and 21 samples respectively). Samples will be sorted and prey species identified in the lab during the next few months to determine if there is a difference in diet between these two sites.

The influence of freshwater flow on salt-wedge dynamics and fisheries productivity in the Gippsland Lakes

Joel Williams

The University of Melbourne, Department of Zoology

Supervisors – Dr Stephen E Swearer, Dr Greg P Jenkins; Dr Jeremy Hindell

Over the past decade there has been a dramatic decrease in rainfall due to the changing climate. This has resulted in less freshwater flowing from the catchments into the estuarine habitats. Freshwater flow into estuaries is important as it controls the extent and dynamics of the freshwater-saltwater interface (salt-wedge), which is a region of high productivity critical to the survival of early life stages of fish and invertebrates. It is of major concern that there is little knowledge of how freshwater flow impacts the productivity of estuaries. In this study, I aimed to determine the impact of freshwater flow events on the production, survival and growth of several key fishery species including black bream, *Acanthopagrus butcheri*, estuary perch, *Macquaria colonorum* and Australian anchovy, *Engraulis australis* antipodum. In the spring/summer of 2007 I used oblique plankton tows to determine the location and timing of spawning events in relation to the physico-chemical structure of the salt-wedge. During late September estuary perch began to spawn high up the Mitchell River within salinities ranging from 10-14 ppt. Bream began spawning in the Mitchell, Nicholson and Tambo Rivers in early October when the salinity and temperature had risen to 17 ppt and 18 °c respectively. Bream and anchovy spawning peaked in late October when the salt-wedge was highly stratified and well up the rivers. Eggs that were spawned in waters with greater than 50 % dissolved oxygen waters appeared to be healthier than those spawned in water with less than 50 % dissolved oxygen. These results suggest that salinity and temperature, and consequently freshwater flows control the location and timing of spawning events in the Gippsland Lakes.

Honours

Coping with an unpredictable environment: salinity tolerance in a native Australian mollusc, *Xenostrobus securis*

Emily R Cornwell

Deakin University, School of Life and Environmental Sciences / Kalamazoo College, Michegan USA – Fullbright Scholar

Supervisor – Dr Janet Gwyther

Salinity is an important environmental stressor that affects many organisms, particularly those living in estuarine environments. Exposure to extreme salinities results in changes at the mechanical, physiological, and cellular level of organisms. Specifically, this exposure can result in changes in behaviour, oxygen consumption, the activity of inorganic ion and free amino acid transporters, and the expression of heat shock proteins (hsps), among others. The mussel, *Xenostrobus securis*, is found in Lake Connewarre, an estuarine lake that experiences extreme oscillations in salinity

(from 0 to 40 ppt). There is evidence that *X. securis* can survive in salinities as low as 3 parts per thousand (ppt; Wilson, 1968), however, there are few studies on its tolerance of hyper-saline conditions, or of salinities below 3 ppt. In this study, ecological, physiological and molecular techniques were used to more closely investigate the hyper- and hypo-salinity tolerance of *X. securis* from Lake Connewarre. Population censuses revealed that *X. securis* is able to survive year-round in Lake Connewarre, and that the population size is growing. Measurements of weight changes and pallial fluid osmolarities during acclimations to salinities from 0 to 50 ppt for 1 and 7 days suggested that the mussel is a short-term osmoregulator at extreme salinities. Changes in oxygen consumption with acclimation to different salinities revealed the role shell-closure and anaerobic metabolism play in the adaptive strategy utilized by *X. securis* and measurements of free amino acids confirm this role. The function of Na^+/K^+ ATPase in salinity acclimation remains unclear, however. The transporter was localized to both the gill and mantle of *X. securis*, with significantly more activity in the mantle. However its activity was not significantly affected by changes in salinity. A portion of hsp70 was successfully sequenced from *X. securis* and localized to both the gill and mantle; although mRNA and protein expression studies reveal a complicated relationship with salinity.

The results from this study highlight the remarkable physiological tolerance of *X. securis* in the face of extreme environmental variability and suggest some of the possible mechanisms behind this ability. Possible variations in the salinity tolerance of different populations and the effects this salinity tolerance could have on the management of invasive populations of *X. securis* in Europe and Asia are also discussed.

Gastrointestinal microflora of little penguins, *Eudyptula minor*, at St Kilda Breakwater, Victoria

Meagan Dewar

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Supervisor – Dr Carol Scarpaci

This research study documented the gastrointestinal microflora of little penguins at St Kilda. In addition to this an investigation of the microbial implications of the current stomach flushing technique was conducted. In addition to the field experiment, a laboratory experiment was set up to examine the effectiveness of three cleaning solutions against three known bacteria. Finally, the risk of zoonotic diseases for researchers working with little penguins was documented and recommendations were made.

To document the gastrointestinal bacteria of an urban population of little penguins, bacterial swabs were collected on three separate field trips. During the first field trip in May, samples were collected from the mouth, faecal and regurgitate samples of little penguins in collaboration with a dietary analysis research project. In addition, swabs were taken from the stomach flushing tube immediately after flushing on all field trips. During July and August a trial was conducted to document the effectiveness of two disinfectants (Milton in July & F10SC in August).

In the laboratory all swabs were streaked on to three different media (Horse blood agar, Nutrient agar and MacConkey agar) and incubated at 37^{o}C for 48 hours. Specimens were identified via gram stains, motility tests and biochemical analysis. From the results seen, 70% (N = 57) of the gram negative specimens from the mouth, faecal and regurgitate samples were identified. In total 13 different species were identified. From the gram positive specimens collected, 82% (N = 51) were positively identified from the mouth, faecal and regurgitate samples. In total 12 species were identified. From the results of the stomach flushing tube 20 species were identified. There was no significant difference in the mean number of bacteria present on the stomach flushing tube between the two months. However, there was a significant difference between the number of bacteria present on the stomach flushing tube before and after cleaning with Milton, and F10SC. From the results presented, the Milton and F10Sc were 100% effective against *Escherichia coli* and *Pseudomonas fluorescens* and were 90% effective against *Serratia marcescens*. The Johnson & Johnson baby wipes on the other hand was effective 50% of the time against E.coli, 80% of the time against *S.marcescens* and 90% effective against *Ps. fluorescens*.

The documentation of bacteria sample of little penguins has provided valuable information in regards to the different types of bacteria present in St Kilda little penguins. However, there is still no conclusive data available on what the endemic species and non-endemic species of little penguins are.

The results from the stomach flushing tube investigations highlighted the tubes ability to be a vehicle for transmitting pathogenic species from one penguin to another. The two cleaning solutions trialled in the field were proven to be significantly effective at reducing the number of

bacterial species present on the stomach flushing tube including spore forming Bacillus species and to be a cost effective and efficient cleaning method to be implemented in the field.

From the documentation of potential zoonotic pathogens present in little penguins, I found that 81% of species identified were known human pathogens. The routes of infection were outlined and recommendations for methods to prevent infection provided.

The Relationship between benthic components in an estuarine Lake

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Supervisor – Dr Janet Gwyther

A recent study on the existence of positive interactions between benthic components in aquatic ecosystems (Altieri et al., 2007) proposes that marine communities relate to one another through certain hierarchical roles. Macrobenthic algae have proven to play an integral role in aquatic ecosystems as a mechanism for regenerating and recycling nutrients and carbon, ensuring a high rate of productivity for the surrounding environment (Nybakken & Bertness, 2004) and can be considered a Primary source of interaction for community hierarchy.

Diversity and abundance between organisms can directly relate to their environmental surroundings, it is this diversity that forms complex community interactions. The present study aims to address biotic and abiotic values of Lake Connewarre including seasonal salinity levels, water temperature and depth measurements, sediment deposition and nutrients, macrofaunal and flora abundance and diversity in order to understand benthic relationships. A report written by Altieri and associates (2007) investigated hierarchical organisation via a facilitation cascade in intertidal cordgrass bed communities in New England. Altieri's report tested facilitation between cordgrass and ribbed mussels, *Geukensia demissa* and associated organisms by buffering against certain environmental stressors and providing stable attachment of substrate. This report utilises Altieri's (2007) theory to analyse Lake Connewarre benthic communities taking a particular interest into the relationship between seagrass *Ruppia maritima* and mussel *Xenostrobus securis*. Results did suggest enhanced relationships within the benthic community of Lake Connewarre. Macro-invertebrate abundance varied between sites and seagrassed areas indicating an interaction between these factors.

Relaxin family expression in the oviparous elasmobranch, *Heterodontus portusjacksoni*

Alexis Marshall

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Supervisors – Dr Rob Day; Dr Greg Parry

In mammals there are two variants of the relaxin gene, relaxin and relaxin-3. The peptide hormone relaxin is instrumental for the success of pregnancy and parturition, whereas relaxin-3 is thought to be a neuropeptide. Current hypothesis suggest that relaxin-3 evolved before the evolution of bony fishes, whereas relaxin evolved during mammalian radiation. The aim of this study was to examine the expression of relaxin and relaxin-3, and the receptors, LGR7 and GPCR135 in the reproductive tissues of an oviparous chondrichthyan, *Heterodontus portusjacksoni*. Specific primers were designed for relaxin, relaxin-3, LGR7 and GPCR135 and amplified in PCR reactions. The products were successfully ligated and transformed into *E. coli* vectors. However, this study was unable to confirm the identity of these genes through sequencing. The key findings of this study were that both mammalian specific relaxin and LGR7 primers and *T. ribripes* specific relaxin-3 and GPCR135 primers are capable of detecting and amplifying an expected size product in ovarian and reproductive tract tissue of *H. portusjacksoni*. This result suggests that relaxin and/or relaxin-3 may have evolved a particular reproductive function in *H. portusjacksoni*. However, further research is needed to confirm this.

Response of meiofauna to edge effects, patch attributes, and hydrodynamics

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Supervisors – Dr Greg Jenkins, Dr Jeremy Hindell; Dr Rod Connolly

This study has highlighted the taxon specific responses of meiofauna to patch edges, patch attributes, and hydrodynamics in the seagrass habitat. Meiofauna abundances were sampled at the edge, at 2 meters into (fixed measurement), and in the middle (proportional measurement) of ten patches of variable size in Port Phillip Bay,

Australia. The abundances of five of the nine meiofauna taxa varied with respect to the patch edge in this study. For porcellid harpacticoids, isopods, and tanaids (using fixed measurement), there was a consistent response to the patch edge (edge effect). There were higher abundances at the edge of the patch compared to the middle for porcellid harpacticoids and isopods, and an increase in abundance from the edge to the middle of the patch for tanaids. For caprellid and gammarid amphipods, and tanaids (using proportional measurement), the edge effect varied across patches. Changes in current within the patch and patch size explained the variability in caprellid abundances, and changes in current within the patch explained the variability in tanaid abundances. Higher abundances of these taxa tended to occur where the currents were strongest within the patch. Patch size and differences in current, water depth, and seagrass biomass did not have a role in the edge effect pattern for gammarids. The distribution of six of the meiofauna taxa in this study was related to differences in patch attributes amongst the patches. Differences in average water depth, average seagrass biomass, and patch size explained the distribution of these six taxa throughout the study site. Positive relationships between density and patch size for some taxa have implications for seagrass fragmentation that is increasingly occurring in the marine environment. My study indicates that edge effect patterns cannot be generalised across this habitat, as meiofauna taxa react differently to edge habitats, patch attributes, and hydrodynamics.

Does variable larval growth influence survival of early life history stages of snapper?

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Supervisors – Dr Greg Jenkins, Dr Paul Hamer

The introduction of new individuals to marine fish populations (juvenile recruitment) shows large variability inter-annually, and this variation is often reflected in catch rates of commercially exploited species. Variable mortality of the larval stages is thought to be a major driver of variation in juvenile recruitment, and hence the abundance of year-classes. Larval mortality is thought to be selective, relating to the growth rates experienced by members of the cohort during the larval stage.

In this study larval and juvenile (< 4 months) snapper of the same cohort were collected in December 2004 and March 2005 respectively. To ensure temporal overlap of hatch dates a subsample of these collections were aged by counts of daily otolith increments. Daily aging demonstrated that most surviving juveniles originated from spawning in December when water temperature exceeded 18°C. Otolith microstructure was then used to investigate the influence of larval growth rate on the survival of young snapper. The growth rates experienced in the larval phase of juveniles that survived to three-four months of age showed no difference from the growth rates of the larval population from which they originated. There was a trend for increased growth rate in larvae as the water temperature increased through December, but it remains unclear if this was coupled with increased survivorship. Further research, comparing larval growth rates across cohorts of high and low recruitment years in conjunction with assessment of variability of spawning output and food availability, is critical for progress towards understanding the role of environmental and biological agents in driving recruitment variation in this marine fish species.

Habitat utilisation of gummy shark, *Mustelus antarcticus,* in Swan Bay

Calvin Quick

Deakin University, School of Life and Environmental Sciences / MAFFRI

Supervisors – Dr Janine McBurnie and Mr Terry Walker

The gummy shark, *Mustelus antarcticus,* is a significant commercial and recreational shark species in southern Australian waters. Like other chondrichthyes gummy sharks exhibit life history traits such as slow population growth, late maturation and small litter sizes that increase the vulnerability of the species to negative impacts such as intense fishing activities and habitat loss.

Despite the multitude of literature available on gummy sharks little is definitively understood of their fine-scale habitat use. It is important to understand the habitat usage patterns of the gummy shark in order to gain a greater understanding of their ecology.

This study aims to determine the spatial and temporal distribution of gummy sharks using automated acoustic tags within Swan Bay. It is aimed that 10 individuals, 5 juveniles and 5 female adults, will be tagged. This data will be used to determine the habitat utilization, movement patterns, home range, and density of gummy sharks within Swan Bay and its surrounds.

Behavioural studies of fur seals at Chinaman's Hat, Port Phillip Bay, in relation to changes in ambient noise

Richard Stafford-Bell

Victoria University, School of Biomedical and Clinical Sciences

Supervisor – Dr Carol Scarpaci

The desire of humans to interact with marine species has led to the development of a seal-swim industry at Chinaman's Hat in Port Phillip Bay, Victoria, where tourists can swim with a population Australian fur seals, *Arctocephalus pusillus doriferus*. This industry has no government-enforced regulations and is managed only by The Code of Conduct for Seal Tourism in Port Phillip Bay, a voluntary set of guidelines drafted by the Victorian Tourism Operators Association.

In order to determine the effectiveness of voluntary guidelines in protecting the target species, tour operator compliance to four conditions in the code of conduct, and seal behavioural responses to the physical presence of vessels and underwater noise variables were documented over the recent peak tourism season (Nov 2007-Feb 2008).

Results indicate that tour operators were, for the majority, compliant (≥80%) to the conditions of the code researched in this study. However, the code of conduct was deemed to be ineffective in protecting the target species as a result of the physical presence of vessels and the number of tour-operators interacting with seals at Chinaman's Hat having a significant influence on seal behaviour. When vessels approached to within 39m or when more than two tour-operators were present at Chinaman's Hat seal behaviour was altered. Underwater noise emissions were found to have no influence on seal behaviour.

It was found that the presence of codes of conduct does not necessarily imply that management frameworks are effective for the protection of the industry within Port Phillip Bay. As a result the following recommendations were made, 1) the code of conduct becomes regulatory, 2) vessels are prohibited from approaching to within 50m of Chinaman's Hat and 3) the number of tour-operators interacting with seals at Chinaman's Hat be limited to two at any time.

The population dynamics of ribaldo, *Mora moro*

Lauren Veale

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Supervisors – Dr James Haddy; Mr Kyne Krusic-Golub

This study investigated the population dynamics of ribaldo, *Mora moro*, with an emphasis on collecting biological data on age, growth, reproductive biology and mortality rates. Monthly samples were collected from commercial fishers from May to October (2007) from the South East Fishery (SEF) at an average depth of 300 m. Ribaldo ranged in length from 20–74 cm TL, with an estimated age range of 4–56 years. The von Bertalanffy growth parameters for males were $L\infty$ = 59.5 cm TL, k = 0.05 and t0 = -9.68, and $L\infty$ = 65.2 cm TL, k = 0.05 and t0 = -7.97 for females. Differences in the growth between sexes were observed, with females growing faster than males after 10–15 years of age. Variability in growth appears linked to the onset of sexual maturity, with males maturing at 8 years and females maturing at 14 years. Higher growth rates in females facilitated greater mean lengths at age, resulting in the increased dominance observed in the larger size classes. Ribaldo are fully recruited to the fishery at 35 cm TL, while sexual maturity is not reached until 36 cm for males and 45 cm TL for females. Seasonal reproductive data from macroscopic staging, gonosomatic indices and egg size frequencies suggest ribaldo are batch spawners with asynchronous oocyte development, with a winter spawning season. Total fecundity ranged from 1.1–5.1 million eggs. The sex ratio of ribaldo was 1 female to 1.9 males, and was biased towards males during peak spawning periods suggesting seasonal migration in females. Estimates of natural mortality were derived from aged-based catch curves of under-exploited fish stocks, and ranged 0.62–0.75 yr-1. Higher proportions of both older and larger fish were sampled from under-exploited areas compared to fished populations, confirming the effects of increased fishing pressure on stocks. This study highlighted that ribaldo have a high longevity, slow growth, low natural mortality and large size and age-at-maturity. The low species productivity, coupled with the high proportion of immature fish retained by the fishery, suggests caution needs to be applied in the management of this species to avoid potential over-fishing.

Integrating edge effects into studies of fragmentation: a seagrass perspective

Fiona Warry

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Supervisor –Dr Jeremy Hindell

Seagrass fragmentation is widespread in marine and estuarine systems, and leads to smaller, more numerous patches with an increased proportion of edge to area. There are three major gaps in our understanding of how habitat fragmentation affects marine fauna: 1) do faunal assemblages differ between habitats that have been actively fragmented versus those that are simply patchy; 2) do faunal assemblages vary across habitat edges; and, 3) do edge effects and habitat fragmentation interact? In a series of complementary experiments, changes in meiofaunal densities at different distances across the edges of four artificial seagrass treatments (Continuous – single 9 m^2 patch, Fragmented – single 9 m^2 patch to 4 × 1 m^2 patches, Procedural control – single, disturbed 9 m^2 patch, and Patchy – 4 × 1 m^2 patches) were quantified through time. Densities of meiofaunal copepods were greater at the edge than 0.5 m, and this pattern was consistent across all treatments except fragmented plots, where densities were similar between the edge and 0.5 m. Densities of meiofauna did not change between 0.5 and 1 m into continuous plots, and densities were similar between internal and external edges of patchy plots. Fine-scale sampling between the edge and 0.5 m into plots revealed log-linear reductions in the densities of meiofauna with distance into a patch. The meiofauna studied here demonstrated strong edge effects within the first 0.5 m of a patch edge, regardless of patch size, but edge effects were 'lost' in fragmented habitat. These findings have implications for the management and conservation of marine fauna in increasingly fragmented coastal habitats.

Inter-colony movements of the crested tern, *Sterna bergii*, as a result of food resource quality and availability

Daniel Weller

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Supervisor/s – Dr Stephen E Swearer / Dr Andre Chiaradia, Roz Jessop

Crested terns in Victoria breed in two major colonies at Phillip Island and Mud Islands. The Phillip Island colony, located at The Nobbies, has increased from no birds in 1994 to 5600 birds in 2007, and is now the largest colony in Victoria. As the majority of these birds are tagged, I knew that many of them were originally from the Mud Islands colony. I identified and considered several hypotheses for this movement, and decided that spatial differences in food resource availability were the mostly likely cause.

In this study, diet of nesting terns from both islands was examined. Through detailed diet analysis of regurgitates collected from terns from each colony in 2001-2007, I found significant differences in the mean lengths and weights of prey fish between sites and breeding seasons, with larger and heavier fish being caught by birds from The Nobbies in general. Using Fulton's K, a condition index linking fish length and weight, I also found significant differences in prey fish condition between both sites and years, with fish in better condition being caught by birds at The Nobbies in all breeding seasons. System productivity, estimated from cumulative fish biomass:fish length relationships, was also different between the two sites, with a higher proportion of relatively larger prey fish present in dietary samples from birds at The Nobbies indicating enhanced movement of energy up trophic levels. There were no significant differences in species richness between sites and between breeding seasons.

In addition, I undertook a descriptive study of the birds' diving behaviour using miniature time-depth data recorders, in an attempt to uncover the extent to which they access the water column, their daily feeding patterns, and maximum dive depth. I recorded a strictly diurnal foraging pattern, an average dive depth of 0.83m, and a deepest dive of 3.74m, which are consistent with the prey composition of the birds' diet. The differences observed in fish condition, weight and length and also system productivity support the hypothesis that differences in prey availability, quality and abundance are influencing the shift in numbers of breeding birds between sites. The variability in spatial and temporal distributions of prey fish and their relative condition is likely to persist in future breeding seasons.

The influence of age on the reproductive performance of crested terns, *Sterna bergii*, breeding at Mud Islands, Port Phillip Bay, Victoria

Caroline Wilson

Deakin University, School of Life and Environmental Sciences

Supervisor – Dr Rohan Clarke

In most animals that reproduce up to several times in a lifetime, individual reproductive performance increases with age during the first reproductive years of life and decreases only at very old ages (Pärt 1995). The influence of age on the breeding performance of crested terns (*Sterna bergii*) was

examined at Mud Islands, during the 2006/2007 breeding season. Breeding pairs from 89 study nests were assigned to 'young' (4 to 6 years), 'middle-aged' (7 to 11 years) and 'old' (>12 years) age classes; pairs containing individuals from two different age classes were placed into a 'mixed' age class. Comparisons of their reproductive performance including timing of breeding, reproductive success, incubation length, chick growth rates, nesting position, foraging trip duration and provisioning rates, were made during the breeding period. Significant differences were found in timing of laying and hatching, incubation length, hatching success and provisioning rates. Only slight differences were found in chick growth rates; there was also an apparent trend for young pairs to nest on the edges of the colony, though this was not significant. There was a slight decline in some of these parameters for pairs in the old age class, possibly as a result of reproductive senescence.

Breeding success for the entire colony was much lower when compared to past years; this may have been attributed to changes in food supply combined with increased predation. Two of the three primary hypotheses that attempt to explain age-related breeding performance, the restraint and constraint hypotheses, were discussed in relation to the findings; though observed differences with age in reproductive performance were better explained by the constraint hypothesis.

Overall, this study offers further insight into the field of age-related reproductive performance and provides additional information on the breeding biology of the crested tern; a species that has generally been little-studied in Victoria.

Diurnal activity budgets and nest defence behaviour in Australasian gannets, *Morus serrator*, breeding at Pope's Eye, Victoria

Carly Wishart

Deakin University, School of Ecology and Environment

Supervisors – Dr Ashley Bunce; Dr Ian Norman

Nest defence behaviour entails both costs and benefits to individuals and is a critical component of parental care. The purpose of this study was to examine patterns of reproductive behaviour in nesting Australasian gannets, *Morus serrator* with a particular emphasis on nest defence behaviour during the 2006 – 2007 breeding period at Pope's Eye Marine Reserve, Port Phillip Bay, Victoria. Temporal patterns and individual influences on nest defence behaviour were also investigated in breeding periods, parental sex, parental age, nest location, activity of nest and nest defence interactions between adults. Significant differences were found in nest defence behaviour and breeding periods with higher levels observed during brood rearing periods than incubation phases. Observed differences in nest defence behaviour during the breeding period were best explained by a predicted lower renesting potential (renesting potential hypothesis) and increased value of offspring (offspring reproductive value hypothesis). Significant differences were also found in male to male nest defence interactions, with males attacking other males more frequently than females. Behavioural responses to nest defence attacks were also significantly 'non aggressive' and most target adults avoided further nest defence interaction. Other comparisons however were not found to differ significantly and only incremental differences were observed. This study provides first accounts of activity budgets and nest defence behaviour recorded in Australasian gannets at Pope's Eye, Victoria and since that of Warham (1958) and Waghorn (1982), there have previously been no other behavioural studies conducted on nesting individuals of this species.

PUBLICATIONS

Dewar M. (2007). Gastrointestinal microflora of little penguins, *Eudyptula minor*, at St Kilda Breakwater, Victoria. *Thesis* – Bachelor of Applied Biology (Honours), Victoria University

Dias D; White J. and Urban S. (2007). Pinastric acid revisited: a complete NMR and x-ray structure assignment. *Natural Product Research* 21: 368-378

Grixti D., Conron S.D. and Jones P.L. (2007). The effect of hook/bait size and angling technique on the hooking location and the catch of recreationally caught black bream, *Acanthopagrus butcheri. Fisheries Research* 84: 338–344

Hamer P.A. and Jenkins G.P. (2007). Comparison of spatial variation in otolith chemistry of two fish species and relationships with water chemistry and otolith growth. *Journal of Fish Biology* 71: 1035-1055

Hyodo S., Bell J., Healy J., Kaneko T., Hasegawa S., Takei Y., Donald J. and Toop T. (2007). Osmoregulation in elephant fish, *Callorhinchus milii* (Holocephali), with special reference to the rectal gland. *Journal of Experimental Biology* 210: 1303-1310

James D.S., Day R.W. and Shepherd S.A. (2007). Experimental abalone ranching on artificial reef in Port Phillip Bay, Victoria. *Journal of Shellfish Research* 26 (3): 687-695

Jennings B., Bell J., Hyodo S., Toop T. and Donald J. (2007). Mechanisms of vasodilation in the dorsal aorta of the elephant fish, *Callorhinchus milii* (Chimaeriformes: Holocephali) *Journal of Comparative Physiolology B*. 177: 557 – 567

Keough M.J. and Swearer S.E. (2007). Early life histories of marine invertebrates and fishes. Pages 17-46 in S. D. Connell and B. M. Gillanders, editors. *Marine Ecology*, Oxford University Press, Melbourne

Kerrigan J. (2007). The relationship between benthic components in an estuarine lake. *Thesis* – Bachelor of Environmental Sciences (Honours), Deakin University

Marshall A. (2007). Relaxin family expression in the oviparous elasmobranch, *Heterodontus portusjacksoni*. *Thesis* – Bachelor of Science (Honours); the University of Melbourne

Marshall D.J. and Keough M.J. (2007). The evolutionary ecology of offspring size in marine invertebrates. *Advances in Marine Biology* 53: 1-60

Morris L., Jenkins G.P., Hatton D. and Smith T. (2007). Effects of nutrient additions on intertidal seagrass, *Zostera Muelleri*, habitat in Western Port, Victoria, Australia. *Marine and Freshwater Research* 58, 666-674

Murphy H. (2007). Response of meiofauna to edge effects, patch attributes and hydrodynamics. *Thesis* – Bachelor of Science (Honours); the University of Melbourne

Newman A. (2007). Does variable larval growth influence survival of early life history stages of snapper? *Thesis* – Bachelor of Science (Honours); the University of Melbourne

Ross D.J., Keough M.J. and Longmore A.R. (2007). Impacts of two introduced species on a soft sediment assemblage in Port Phillip Bay, Australia: the polychaete, *Sabella spallanzanii* and ascidian, *Styela clava*. *Marine Ecology Progress Series* 340: 41-53

Sams M.A. and Keough M.J. (2007). Predation during early post-settlement varies in importance for shaping marine sessile communities. *Marine Ecology Progress Series* 348: 85-101

Tovar-Avila J., Walker T.I. and Day R.W. (2007). Reproduction of *Heterodontus portusjacksoni* in Victoria, Australia: evidence of two populations and reproductive parameters for the eastern population. *Marine and Freshwater Research* 58 (10): 956-965

Veale L. The population dynamics of ribaldo, *Mora moro. Thesis* – Honours degree (Fisheries); Australian Maritime College

Warry F. (2007). Integrating edge effects into studies of fragmentation: a seagrass

perspective. *Thesis* – Bachelor of Science (Honours); the University of Melbourne

Weller D. (2007). Inter-colony movements of the crested tern, *Sterna bergii*, as a result of food resource quality and availability. *Thesis* - Bachelor of Science (Honours); the University of Melbourne

Wilson C. (2007). The influence of age on the reproductive performance of crested terns, *Sterna bergii*, breeding at Mud Islands, Port Phillip Bay, Victoria. *Thesis* – Bachelor of Environmental Science (Honours); Deakin University

Wishart C. (2007). Diurnal activity budgets and nest defence behaviour in Australasian gannets, *Morus serrator*, breeding at Pope's Eye, Victoria. *Thesis* – Bachelor of Environmental Science (Honours); Deakin University

CONFERENCE PRESENTATIONS

Daniel Dias

Dias D. and Urban S.

Application of On-flow LC-NMR analysis to profile Natural Products from marine extracts

Oral presentation : 12th International Conference on Marine Natural Products (Manapro XII), Queenstown New Zealand, February 2007

Dias D. and Urban S.

Application of LC-NMR using stop-flow analysis to identify Natural Products from marine extracts

Poster presentation : 12th International Conference on Marine Natural Products (Manapro XII), Queenstown New Zealand, February 2007

Dias D., Timmers M. and Urban S.

Application of On-flow LC-NMR analysis to profile Natural Products from marine extracts

Poster presentation : 12th International Conference on Marine Natural Products (Manapro XII), Queenstown New Zealand, February 2007

Dias D. and Sheldrake H.; Burton J.; White J. and Urban S.

Chemical investigation of the southern Australian marine alga, *Laurencia elata*

Poster presentation : 12th International Conference on Marine Natural Products (Manapro XII),

Queenstown New Zealand, February 2007 Awarded conference Poster Prize in (Methodology)

Lorenz Frick

Physiological response of sharks to gill net capture

Oral presentation : Oceania Chondrichtyan society Queenscliff, October 2007

Kathryn Hassell

The effects of environmental stressors on growth and reproduction in black bream, *Acanthopagrus butcheri*

Oral presentation : Australian Society for Ecotoxicology (ASE) Forum, Queenscliff, November 2007

Hassell K.L., Coutin P.C. and Nugegoda D.

Black bream embryo survival and development is impaired by exposure to hypoxia

Oral presentation : 5th International Conference on Marine Pollution and Ecotoxicology, Hong Kong, June 2007

Codi King S., Hassell K.L. and Nugegoda D.

Induction of vitellogenin in barramundi and black bream as a biomarker of exposure to EDCs in Australian waters

Oral presentation : 5th International Conference on Marine Pollution and Ecotoxicology, Hong Kong, June 2007

Hassell K.L., Coutin P.C. and Nugegoda D.

Climate change: impacts on embryos of the estuarine black bream

Oral presentation : 45th Australian Marine Science Association (AMSA) Annual Conference, Melbourne, July 2007

Codi King S., Hassell K.L. and Nugegoda D.

Vitellogenin induction *in vivo* in two Australian fish, barramundi and black bream, as a biomarker of exposure to estrogenic compounds

Oral presentation : 2nd Australian Symposium on Ecological Risk Assessment and Management of Endocrine Disrupting Chemicals (EDCs), Pharmaceuticals and Personal Care Products (PPCPs) in the Australasian Environment, CSIRO Canberra, November 2007

Christian Jung

Anthropogenic effects of ichthyofauna on shallow rocky reefs

Oral presentation : 45th Australian Marine Science Association (AMSA) Conference, Melbourne, July 2007

Peter Macreadie

Fish responses to seagrass fragmentation

Oral presentation : 45th Australian Marine Science Association (AMSA) Conference, Melbourne, July 2007

Tim Smith

Fish assemblages change according to within-patch location, patch size and season

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