The Victorian Marine Science Consortium is a collaborative venture between:

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Front cover – *Macrocystis angustifolia* at the Barwon Bluff Marine Sanctuary; photograph Rod Watson

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 Two years later the VIMS Act was repealed.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.

DIRECTOR'S REPORT

I am pleased to present the 2008 VMSC Director's Report.

During 2008, 211 undergraduate students attended field courses in marine zoology, ecology, biology, botany, and marine and coastal ecosystems. The courses offer students access to a diverse and specialist pool of knowledge provided from within individual institutes, and collectively with experts in the field.

Postgraduate research underway at Queenscliff during the year consisted of thirty-one PhD, and six Honours projects. A number of visiting international scientists also utilised the VMSC facilities throughout the year.

A successful open day was held in August for guests and associated stakeholders to visit the Queenscliff facility. Presentations were given by postgraduate students and members of VMSC Management Committee.

The winner of the 2008 VMSC Postgraduate Award was Corey Green from the University of Tasmania. Corey's PhD project aims to investigate the temporal and spatial population structure of arrow squid, Nototodarus gouldi, off south-eastern Australia. The Management Committee initiated this award in 2004 to offer support and encouragement to young scientists based at Queenscliff. The Award is presented as part of the Victorian Coastal Awards for Excellence, hosted by the Victorian Coastal Council and Coast Action/Coast Care. Corey was presented with the award by the Minister for Environment and Climate Change, the Hon. Gavin Jennings.

VMSC continued its support of young scientists at the Australian Marine Sciences Association annual conference, by awarding a prize for best presentation on temperate marine science. The prize went to Alexandra Campbell from the University of New South Wales for her talk on the effects of herbivorous amphipods on macroalgae.

In January, VMSC extended its support to 'young scientists' by co-hosting the Siemens SCIENCE Experience at Queenscliff. The program offers 3 days of science activities held in a university environment to enthusiastic Year 9 students.

Together with the Marine Discovery Centre, VMSC also coordinated the accreditation of undergraduate students in Certificate 111 Tourism (Guiding). This certificate provides formal training to undergraduates who are enthusiastic about communicating marine science to the broader community.

Past and current postgraduate students from VMSC 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 cheerfully provide to the postgraduate students, researchers and academic staff.

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

Professor Michael J Keough
Director

MANAGEMENT COMMITTEE

A management committee comprising representatives from each institute governs 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 University of Melbourne was nominated as VMSC Director for a 3 year period, until February 2011.

CSIRO

Dr David C Smith	Centre for Marine and Atmospheric Research

Deakin University

Associate Professor Geoffrey Wescott	School of Ecology and Environment

EPA Victoria

Ms Dianne Rose	Marine Sciences

Monash University

Professor John Beardall	School of Biological Sciences

Department of Primary Industries

Mr Terry Walker (January-June)	Marine & Freshwater Fisheries Research Institute
Mr Jon Presser (June-December)	

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

VMSC's *Pelagia* carried out the majority of boat work assignments in Swan Bay, Port Phillip and Westernport Bays throughout 2008. The 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 (students) and $40 (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.

$2830.00 was recovered from vessel users in 2008.

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, Grassy point, Blairgowrie
- 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 ascidians – 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, Swan Bay, Barwon Heads, Barwon River
- Stingaree physiology – Swan Bay
- Salinity tolerance of *Xenostrobus secures* - Lake Connewarre
- Measuring heavy metals - Port Phillip Bay waters

DIVING

During 2008, 80 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
- Hydroid settlement plates
- Temperature loggers
- Artificial seagrass units placement
- Acoustic tagging

Undergraduate snorkelling trips were conducted during some field courses. Classes involved reef assemblages, modular organisms, fish diversity and fouling organisms.

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 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 are available for use

OTHER

- A comprehensive range of scientific equipment 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 diverse range of accommodation options are available in Queenscliff and Point Lonsdale

UNDERGRADUATE COURSES

Undergraduate field courses were held during February, March, April, September and December. These ranged from two days to two weeks and were attended by 211 undergraduate students.

The teaching lab was utilised over the year by the Marine Discovery Centre, an analytical instrument supplier for staff training, visiting researchers, and our resident postgraduate students.

2008	Institute	Course	U/Grads
2-8 February	U. Melb.	Marine zoology	33
11-15 February	U. Melb.	Experimental marine ecology	29
18-22 February	Monash	Marine biology	35
14 March	VU	Marine biology	12
11-13 April	RMIT	Marine biology	26
29 September–3 October	Deakin	Marine and coastal ecosystems	60
2-14 December	U. Melb.	Marine botany	16
			211
Other users			
22-24 January		The Siemens SCIENCE Experience	23
12 March	MDC	Lab sessions	50
13 March	MEP Instruments	Staff training session	15
24 April	MDC	Lab session	25
13 May	MDC	Lab session	25
21 & 22 August	MDC	Lab sessions	50
5 & 18 September	MDC	Lab sessions	50
6, 8 & 10 October	MDC	Lab sessions	75
6-12 December		Undergraduate training in Certificate 111 Tourism (Guiding)	23
			336

VISITING RESEARCHERS

During 2008, VMSC hosted the following international researchers at Queenscliff over varying periods :

Professor Richard Emlet – University of Oregon (USA) in collaboration with the University of Melbourne. Richard returned to Queenscliff to continue his research on the development of echinoids in southern Australia.

Professor Susumu Hyodo – University of Tokyo in collaboration with Deakin University. Susumu continued his investigations into osmoregulation in elephant fish, *Callorhynchus millii* (Holocephali).

Professor Byrappa Venkatesh – Institute of Molecular & Cell Biology (IMCB), National University of Singapore. Justin Bell (PhD candidate) of Deakin University coordinated the visit of Professor Venkatesh, in conjunction with Professor Hyodo (University of Tokyo), Dr Janine Danks (RMIT University), Dr Tariq Ezaz and Mr Tim Hore (ANU), to analyse and collect samples from elephant fish. Professor Venkatesh has identified the elephant shark as a model cartilaginous fish genome and initiated the Elephant Shark Genome Project.

Andrew Gillis – (PhD candidate) University of Chicago. Andrew carried out research on the skeletal and branchial development of elephant fish, *Callorhinchus milii*.

Dr Kate Rawlinson - Smithsonian Marine Station, Port Pierce, Florida. Kate carried out a survey and data collection on the local polyclad fauna. Her post-doc is researching the evolution and development of Platyhelminthes or flatworms. The research

was in collaboration with Museum Victoria and conducted out of VMSC.

OTHER INITIATIVES

The Siemens SCIENCE Experience

In January, VMSC and the Marine Discovery Centre (MDC) jointly hosted the Siemens SCIENCE Experience at Queenscliff. The program is designed to provide Year 9 students who have an interest in science with an opportunity to participate in a range of fascinating science activities under the guidance of scientists. Over 36 universities across Australia support the program.

Twenty-three enthusiastic students with an interest in the marine sciences, enrolled in the VMSC / MDC program at Queenscliff, held over 3 days in January. The students had the advantage of working with, and learning from, scientists and postgraduate students representative of five Victorian universities, embodied through VMSC at Queenscliff.

Certificate 111 Tourism (Guiding)

Undergraduate students were offered the opportunity of obtaining accreditation in Certificate 111 in Tourism (Guiding) provided by the William Angliss Institute, the largest provider of tourism training in Australia. The course covered basic theory in ecotourism communications, introductory tourism, ecotourism marketing, eco-tour guiding, plant and animal identification, and outdoor recreation skills.

Twenty-three students enrolled in the inaugural course conducted over 6 days in December. Enrolment was open to students from member universities, who had previously undertaken study at VMSC in marine ecology, biology or marine botany. The program was streamlined in recognition of these previous studies.

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 2008 (see project abstracts commencing 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 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
Aquatic Ecotoxicology and Environmental Biology at RMIT University

Dr Kate Rawlinson
Smithsonian Marine Station, Florida
The evolution and development of Platyhelminthes or flatworms

PHD CANDIDATES

Emi Sherizan Ab Rahim
Deakin University / MAFFRI
Aspects of genetics of blue mussels, Mytilus species in Australia

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*.)

Joanna Browne
Griffith University / Museum of Victoria
Biodiversity of gelatinous zooplankton and their symbionts in eastern Australia

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

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

John Ford
The University of Melbourne
Meta population dynamics in temperate reef fish

Lorenz Frick
Monash University / MAFFRI
Capture-related stress physiology and post-release survival of sharks

Andrew Gillis
University of Chicago
The development and evolution of the branchial arch endoskeleton in chondrichthyans (sharks, skates and holocephalans)

Corey Green
University of Tasmania / MAFFRI / CSIRO
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 / AIMS
Effects of environmental stressors on 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 / MAFFRI / The University of Indiana
Uterine accommodations for gestation and ecological risk assessment in the southern fiddler ray, *Trygonorrhina fasciata*

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

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

Fabian Trinnie
Deakin University / MAFFRI
Reproductive biology 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 secures*

Lauren Dagley
The University of Melbourne / MAFFRI
Life history and ecology of the spotted stingaree, *Urolophus gigas,* in south-eastern Australian waters

Leia Howes
Victoria University
Evaluating management strategies for cetacean-based tourism: a case study of Port Phillip Bay, Victoria

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

Jay Van Rijn
Monash University / MAFFRI
Physiological stress associated with the capture, handling and captivity of the Australian swellshark (*Cephaloscyllium laticeps*), an abundant by-catch species in southern Australian fisheries

STUDENT AWARDS

VMSC POSTGRADUATE AWARD

The VMSC Management Committee continue to provide support and encouragement to young scientists by providing a yearly stipend award. The award is made to a postgraduate student based at Queenscliff in the early degree phase, whose research the Management Committee consider will significantly contribute to marine science in Victoria.

The recipient of the 2008 VMSC Postgraduate Award was **Corey Green**.

Corey commenced his PhD project early in 2007 through the Institute of Antarctic and Southern Ocean Studies at the University of Tasmania (UTAS), in collaboration with the Marine and Freshwater Fisheries Research Institute (MAFFRI) and CSIRO. Corey's supervisor is Dr George Jackson (UTAS); co-supervisors are Mr Terry Walker (MAFFRI), and Dr David Smith (CSIRO).

Corey's project, *Temporal and spatial population structure of arrow squid, (Nototodarus gouldi), off south-eastern Australia,* aims to gather new detailed research concerning the effect environmental conditions have on squid populations. As the Southern Squid Jig Fishery (SSJF) encompasses waters of South Australia, Victoria and Tasmania, the dynamic influence of their environment and oceanographic conditions is very important when studying population dynamics. All areas are subjected to measurable differences in temperature and productivity, both of which are thought to be extremely important in defining population characteristics. Other areas that will be researched include identifying populations and cohorts by applying microchemistry and shape analysis techniques to their statoliths (balance bones), determining the selectivity of fishing gears (jig and trawl), and determining the effect climate change may have on future populations.

Corey with The Hon. Gavin Jennings MLC, Minister for Environment and Climate Change at the *Victorian Coastal Awards for Excellence 2008* ceremony

VMSC / AMSA AWARD

Alexandra Campbell from the University of New South Wales was awarded the VMSC sponsored prize for best presentation on temperate marine science at the 2008 Australian Marine Sciences Association annual conference held in Christchurch NZ in July.

Alexandra's presentation was based on her Honours project completed in 2002 at UNSW, titled *The effects of herbivorous amphipods on macroalgae.*

In 2006 Alexandra commenced a PhD at UNSW, under the supervision of Professor Peter Steinberg, titled *Climate change and emerging disease: bleaching and bacterial infection of a macroalga*.

The following VMSC students also received recognition in 2008:

Joanna Browne - PhD candidate, Griffith University
- Travel grant to attend AMSA2008

Isla Fitridge - PhD candidate, the University of Melbourne
- Travel grant to attend AMSA2008
- FRDC Best Poster prize (AMSA2008)
- 2008 VMSC Postgraduate Award – runner-up

Peter Macreadie - PhD candidate, the University of Melbourne
- Travel grant to attend AMSA2008
- Ron Kenny Premier Conference Award for Oral Presentation (AMSA2008)
- CSIRO Publishing *Marine and Freshwater Research* Editor's Choice Award (AMSA2008)
- ASFB John Glover travel bursary
- Gilbert P Whitley Memorial Student Award (Senior) at ASFB08
- Society for Conservation Biology award for oral presentation at ESA08

Michael Sams - PhD candidate, the University of Melbourne
- Travel grant to attend AMSA2008

Tim Smith - PhD candidate, the University of Melbourne
- Travel grant to attend AMSA2008
- John Glover travel grant to attend ASFB

Joel Williams - PhD candidate, the University of Melbourne
- Travel grant to attend AMSA2008

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. South America, Africa and India, also part of the Gondwana 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. 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 . 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.

Marine invertebrates display a tremendous (and bewildering) variety of developmental patterns across taxa and between closely related species . 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 . Occasionally a given pattern is modified, presumably due to ecological conditions. Despite a rich history of study including examination of latitudinal patterns, theoretical modeling and phylogenetic mapping, 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. Of the 26 species living at depths < 100m and known to have pelagic nonfeeding larvae, 19 species occur in **soA**. 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. 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, chitons, and some brachyuran crab families. 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 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.

Aquatic Ecotoxicology and Environmental Biology at RMIT University

Associate Professor Dayanthi Nugegoda and Dr Jeff Shimeta

RMIT University, School of Applied Sciences

The Ecotoxicology and Environmental Biology 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 and Dr Jeff Shimeta of the School of Applied Sciences with a number of Honours, postgraduate and postdoctoral researchers based at VMSC. The ecotoxicology component includes 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. The marine ecology and environmental science component investigates coastal processes involving invertebrates, microbes, and marsh plants, focusing on environmental issues. In 2007, the research group consisted of one postdoctoral fellow, six PhD, one Masters and one Honours student. In 2008, two new postdoctoral research fellows joined the group, one 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 ecotoxicology projects within the group include a study on the effects of environmental stressors on black bream (PhD 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; risk assessment from canobacterial toxins in seafood from the Gippsland

Lakes (post doctoral researcher Jackie Myers based at DPI) funded by the DHS and bioaccumulation of toxicants in little penguins in collaboration with Victoria University and Parks Victoria. For further details on ecotoxicology research activities contact dayanthi.nugegoda@rmit.edu.au. Marine ecology projects currently in progress include the influences of protozoa on bacterial denitrification rates in the sediments of Port Phillip Bay (funded by the Australian & Pacific Science Foundation, and in collaboration with the Monash University Water Studies Centre), and impacts of the invasive salt marsh grass, *Spartina anglica*, on infaunal communities in Corner Inlet and Anderson Inlet, Victoria. For further details contact jeff.shimeta@rmit.edu.au.

The evolution and development of Platyhelminthes or flatworms

Dr Kate Rawlinson

Smithsonian Marine Station, Fort Pierce, Florida

A survey of the local polyclad fauna and data collection was made over four weeks in April 2008. The research was in collaboration with Museum Victoria and conducted out of VMSC.

The Platyhelminthes are successful, speciose and are well known both as free-living Turbellaria/ Planaria and as parasitic Neodermata (including tapeworms and schistosomes). For most of the past hundred odd years their simplicity of organisation has led to flatworms being considered as a basal group of animals, a small step up from cnidarians and sponges. However, recent molecular phylogenetic studies infer that flatworms are no longer basally branching animals but are thought to be members of the protostomian clade of lophotrochozoans alongside phyla such as the annelids, molluscs and brachiopods. This knowledge has overturned the view of platyhelminth simplicity as being a primitive character and thus opens important questions over their evolution. The Polycladida possess a ciliated feeding larval stage which has similarities to trochophore larvae of annelids and molluscs.

To test whether these larvae are homologous to the larvae of annelids and molluscs, the developmental origins of larval structures using cell lineage tracing of species with indirect development, will be compared. Immunohistochemistry and confocal laser scanning microscopy will be used to describe the development of the musculature and nervous system.

A Victorian polyclad Echinoplana celeriima was gravid in April and develops directly into a juvenile worm, an embryonic time series was collected for this species and these data are being used to determine which mode of development is ancestral. The detailed developmental data plus the embryonic derivation of larval structures, when compared to that of other marine invertebrates, will increase our understanding on the evolutionary relationships of the platyhelminthes and the evolution of larval stages.

PhD

Aspects of genetics of blue mussels, Mytilus species in Australia

Emi Sherizan Ab Rahim

Deakin University / MAFFRI

Supervisors – Dr John Donald / Dr Brett Ingram

The mussel industry in Victoria has experienced significant decreases in availability of wild spat, which is reducing production, product quality and reliability of supply to markets. To improve competitiveness and market access, the industry requires the development of a hatchery-based breeding program, enhanced by controlled reproduction and selective breeding to reliably and cost-effectively mass-produce selected strains of quality-assured spat. Hatchery production of seedstock has the potential to overcome the problem, but international experience indicates that mortality of spat during nursery phases may be high and needs to be addressed. New capabilities in aquaculture genetics also provides the opportunity for concurrent development of selective breeding for hatchery production of elite strain spat designed to optimise development and adoption of complementary new production technologies. Selective breeding program for mussels is currently in development, including identification of species and stocks/populations, establishment of genetically diverse founder family lines, requisite holding infrastructure and identification of breeding program objectives in consultation with industry.Initially wild broodstock will be sourced from different locations and held at-sea until needed.

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 than 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.

Biodiversity of gelatinous zooplankton and their symbionts in eastern Australia

Joanna Browne

Griffith University / Museum of Victoria

Supervisors – Dr Kylie Pitt / Dr Mark Norman

My project involves the study of parasites of gelatinous zooplankton. Jellyfish are increasingly being recognised as an important part of the marine ecosystem. In regions around the world jellyfish are increasing in abundance and frequency of occurrence, however, their parasites are poorly studied. One part of my project is investigating the relationship between parasitic hyperiid amphipods and the blue blubber (*Catostylus mosaicus*) in Port Phillip Bay. I am studying temporal variation in abundances of the parasites, whether they are also found on other hosts in the Bay and will use stable isotopes to determine whether they feed directly on the blue blubber.

The other part of my project is studying digenean flukes (Platyhelminthes) parasitic on the upside-down jellyfish *Cassiopea* spp. I am studying the spatial variation of the flukes in Queensland, in *Cassiopea* as well as other jellyfish and comb jellies and have recently returned from collection trips on reefs off Townsville, Cairns and Lizard Island. Jellyfish act as intermediate hosts for the digeneans and this relationship has not been studied before in Australia. Using DNA analysis I will attempt to link the larval digeneans found in the jellyfish with the adult form found in vertebrates (most likely fish).

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.

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 various institutes: the Victorian Institute for Chemical Sciences (VICS); Professor Ann Lawrie (RMIT Bundoora); Associate Professor Jonathan White (The University of Melbourne); Dr Jonathan Burton (University of Cambridge, UK). Some marine collections have been made by the Victorian Marine Science Consortium (VMSC) at Queenscliff and Dr Brian Leonard (ex-RMIT, Bundoora) during the period of my candidature.

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 are an important and frequently abundant component of marine sessile communities associated with natural and artificial habitats. Many non-indigenous hydroids are known to exhibit ‘invasive’ behaviour and have the potential for economic impacts through extensive fouling of piles, pontoons, aquaculture facilities and vessel hulls. Unfortunately, they are often overlooked in ecological studies. My PhD research documents how the hydroid communities of Port Phillip Bay are composed and how these communities change temporally and spatially with regards to larval recruitment and the presence, absence, growth and fertility of adult colonies. It represents the first documented assessment of the hydroid fauna of this region. The study also examines hydroids as fouling species within local mussel culture operations, and the positive and negative role that non-indigenous hydroid species may play within farms in Port Phillip Bay.

In 2008 I began monitoring hydroid larval recruitment and the adult populations at several sites around the bay. I also determined the timing of recruitment of mussel and hydroid larvae at two mussel farms in the bay. In addition, I collected

hydroids for DNA analysis and ran a pilot study to examine the recruitment dynamics of mussel larvae onto morphologically distinct hydroid 'mimics'.

Meta population dynamics in temperate reef fish

John Ford

The University of Melbourne, Department of Zoology

Supervisor – Dr Stephen E Swearer

I commenced my candidature in late 2008 and am involved in a project identifying rocky reef habitats of high conservation value in Port Phillip Bay, Victoria. Principally I am investigating connectivity of reef fish populations, their productivity and the role of artificial reefs in increasing more persistent and biodiverse assemblages.

To understand productivity, I intend to survey population size, fish condition and fecundity in our target species the Southern Hulafish, *Trachinops caudimaculatus*, in numerous location around Port Phillip Bay. Like many reef fish this species has larvae which spend up to two months developing in the open waters of the Bay. To identify where these larvae go, and the level of exchange between different reefs, I will use natural elemental markers (otolith microchemistry) to trace the origin of newly settled fish. With knowledge of dispersal pathways and connectivity, I can identify important source populations, which are crucial to the survival of less productive populations. This will better enable managers to target productive source habitat of high conservation value.

My current experiments in the summer of 2008/09 involve the use of artificial reefs deployed off Altona in the northwest and Carrum in the east of Port Phillip Bay. I am investigating the factors driving mortality in juvenile *T. caudimaculatus* by manipulating reef size, reef location and density of fish on artificial reefs. Through this I hope to determine to what degree habitat size and quality, location of that habitat in a larger matrix, and fish density are determining either population persistence or extinction in *T. caudimaculatus*.

Capture-related stress physiology and post-release survival of sharks

Lorenz Frick

Monash University, School of Biological Sciences / MAFFRI

Supervisors – Dr Richard Reina and Mr Terry Walker

Only a few shark species are targeted by commercial fisheries in Australia, but many more are caught as by-catch, and subsequently discarded dead or alive. The fate of sharks released alive is an essential factor for the assessment of the impact of fisheries on shark populations, but is so far completely unknown.

A few studies have addressed the effects of capture on sharks caught in the wild. However, an unambiguous interpretation of results obtained in the wild can be difficult, because many factors, such as water temperature or dissolved oxygen, affect exercise-related physiological processes. To avoid these uncertainties, fisheries capture in this study is simulated in a controlled setting with captive sharks.

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 using longline, gill-nets and trawling.

Aside from providing insight into a poorly understood aspect of elasmobranch biology, the results will help 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 development and evolution of the branchial arch endoskeleton in chondrichthyans (sharks, skates and holocephalans)

Andrew Gillis

University of Chicago

My PhD research at the University of Chicago is addressing the evolution and development of the vertebrate branchial arches (jaws and gills), with a specific focus on the developmental genetic patterning and embryology of the branchial arch skeleton in chondrichthyans – sharks, skates, rays and holocephalans. In early 2008, I carried out a field project in collaboration with VMSC and MAFFRI to characterize the embryology and developmental genetic patterning of the branchial

arch skeleton in another poorly understood, yet phylogenetically important, chondrichthyan species: the elephant fish (*Callorhinchus milii*). The elephant fish belongs to the most basally branching group of extant chondrichthyans – the holocephalans – and data on the development and patterning of the gills in this species will allow me to better understand the evolution of branchial arch development within cartilaginous fishes. More specifically, data the from elephant shark will allow me to determine whether the patterns of gene expression that I have reported in the little skate are a derived condition of this taxon, or a more primitive feature shared by chondrichthyans (and perhaps jawed fishes) in general. With assistance from Justin Bell (VMSC / MAFFRI) and Dr. Kate Rawlinson (Smithsonian Marine Station, Florida, USA), and grant support from the University of Chicago, the American Museum of Natural History and the Australian Geographic Society, we have characterized the nursing grounds of the *C. milii* in Westernport Bay, Victoria, Australia, and collected a complete embryonic time series for this species. I have cloned several key developmental genes from these embryos, and currently examining the expression of these genes in a developmental series of *C. milii.* This is the first developmental genetic and descriptive embryological study of skeletal development in a holocephalan. A preliminary paper on the distribution of elephant fish eggs in Westernport Bay, Victoria, Australia is currently *in review* with the *Journal of Fish Biology* (Gillis, Bell and Rawlinson).

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 black bream, *Acanthopagrus butcheri*

Kathryn Hassell

RMIT University / MAFFRI / AIMS

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

During 2008 I continued sampling black bream from field sites around Victoria with different environmental conditions. Growth rates, size at first maturity and gonad condition were some of the variables that were measured, along with vitellogenin levels. Vitellogenin proteins were measured using the ELISA method that was developed in the lab, and there was a clear relationship between vitellogenin levels in blood plasma and gonad condition in females. It was only detected in females that had vitellogenic or maturing ovaries, indicating that the technique could be used as an alternative to cannulation or biopsy for assessing gonad condition. In addition, vitellogenin can be used as an indicator of exposure to endocrine disrupting chemicals if it is found in male blood plasma. No vitellogenin was detected in any of the males that were collected for the field study, indicating that the levels of such chemicals in the environment are low. Water samples are currently being tested for total estrogens to confirm the findings in fish, by Graeme and Mayumi Allinson of MAFFRI Ecotoxicology.

2008 also marked the end of my field sampling and laboratory work, leaving just the write up of my PhD thesis. Once that is completed I look forward to starting my post-doctoral fellowship at Melbourne University under the supervision of Dr Steve Swearer and Dr Vin Pettigrove.

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 third 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

The University of Melbourne, Department of Zoology

Supervisors - Dr Stephen E. Swearer and 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. 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 shows 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.

Thesis submitted March 2008.

Fish responses to seagrass habitat fragmentation

Peter Macreadie

The University of Melbourne, Department of Zoology / MAFFRI

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

Marine organisms that inhabit coastal waters increasingly have to deal with habitat fragmentation and concomitant increases in edge habitat. Effective conservation of coastal habitats requires an understanding of how and why organisms respond to these habitat changes. Seagrass is a critical marine habitat that is becoming increasingly fragmented. To understand how fish living in seagrass respond to fragmentation, I actively fragmented artificial seagrass habitats (single, continuous 9-m2 patches fragmented to 4 discrete 1-m2 patches) and evaluated changes in fish abundance. Fish abundance was unaffected by fragmentation, and this was consistent through time (1 day, 1 week, 1 month). If fish crowded into remnant seagrass fragments, then crowding effects may explain the lack of decline in fish abundance that would

otherwise be expected from seagrass habitat loss. Progressive removal of seagrass (16-m2 patches to 4-m2) showed that fish temporarily (≤1 day) crowd into remnant patches, but crowding effects could not explain the longer-term persistence of fish in fragmented seagrass. I then tested the hypothesis that fish are more abundant at seagrass edges than interiors (i.e., 'positive edge effects') and that the effects of seagrass habitat loss on fish abundance were offset by an increase (25%) in edge habitat in fragmented patches. I found that fish were 3 times more abundant at edges than interiors in continuous seagrass (single, 9-m2 patches), but in patchy seagrass (4 discrete 1-m2 patches) there was no difference, which is probably because pipefish perceived patchy seagrass as consisted entirely of 'edge' habitat. To test whether the observed edge effects in continuous seagrass were caused by increased availability of food at edges, I estimated the abundance of food across continuous seagrass patches. Food abundance peaked at seagrass edges and was 16% higher than samples taken from patch interiors. To separate causality from correlation, I supplemented interiors of continuous seagrass with food and found that edge effects ceased, which indicated that fish were moving from patch edges to interiors in response to food supplementation. This provided evidence that fish were more abundant at seagrass edges due to greater food availability.

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

Hintsa Mateos

Victoria University, School of Biomedical and Health Sciences / Deakin University, School of Medicine

Supervisors – Dr Xiao Su / Dr Paul Lewandowski

Abalone is a rich source of omega -3 long chain polyunsaturated fatty acids (n -3 LC PUFA). There is an increasing interest in these fatty acids because studies have shown that they can reduce the risk of cardiovascular 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 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.

The proposed research will investigate the effects of feed incorporated with fish oil on the lipid profiles of cultured adult hybrid abalone. The study also aims to examine the growth and development of cultured 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 associated with lipid metabolism in abalone will be investigated. The study will provide useful information for aquaculture and food industries as well as 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 – Professor John Beardall / Dr Leanne Gunthorpe and Dr Graeme Allinson

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.

Thesis submitted – May 2008.

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.

Thesis submitted – January 2008.

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

David Phillips

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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

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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 individuals and defining what distinguishes them 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 and movements of individuals of differing parental quality. 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. 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

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

The southern fiddler ray presents an interesting case study of myriad reproductive modes of chondrichthyans. My project is investigating what role the uterus plays in nutrient transfer, waste disposal and gas exchange during gestation, through histology, electron microscopy and analysis of uterine fluids. This will uncover 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 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 to understand the relative risk each species faces from a particular fishing activity.

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

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

Michael Sams

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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

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Supervisor – Dr Stephen E. Swearer

Most fish species possess complex life histories that involve the metamorphosis of a larval stage into a distinct juvenile stage. Variation in larval experience has been shown to affect the age, size and nutritional condition of larvae at metamorphosis .These factors can, in turn, affect juvenile growth survival and possibly fecundity.

Many fish populations show marked variability in the growth rate, size, age and condition of recruits within and between years. However, variation within larval cohorts explains much more of the variability in these traits than differences between cohorts sampled over time .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. Recently, however, researchers have begun to acknowledge that the effects of larval experience can carry over into the juvenile period. 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).

Thesis submitted – December 2008.

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

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Supervisors – Professor Michael J. Keough / Dr Greg P. Jenkins and Dr Jeremy Hindell / Dr Rod Connolly

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).

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

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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. There has been an 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. 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 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 and organochlorine pesticides on these hormones, as a possible explanation for the recruitment failure of *A. butcheri* in the Gippsland Lakes.

Reproductive biology of Urolophids (stingarees) found in south-eastern Australia

Fabian Trinnie

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

Studies of the reproductive attributes such as maturity, maternity and litter size 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 compare between each species for future fisheries stock assessments, ecological risk assessments and threatened species evaluations.

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

Megan Underwood

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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.

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

Joel Williams

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Supervisors – Dr Stephen E Swearer, Dr Greg P Jenkins and 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

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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). 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. A portion of hsp70 was successfully sequenced from *X. securis* and localized to both the gill and mantle.

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.

Life history and ecology of the spotted stingaree, *Urolophus gigas*, in south-eastern Australian waters

Lauren Dagley

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Supervisors – Dr Rob Day / Dr Matias Braccini

Many shark and ray species are at increasing risk of depletion as a result of the combination of their life history characteristics and anthropogenic impacts such as fishing, habitat fragmentation and degradation, and pollution. The life history traits of sharks and rays (e.g. low fecundity, slow growth, late maturation and long life span) results in low reproductive potential and low capacity for population increase in response to fishing exploitation. Most sharks and rays are incidentally taken in many fisheries. However, little is known about the life history of many species, particularly about coastal stingarees. This project aims to examine the reproductive biology, age and growth, feeding ecology, and movement of the endemic spotted stingaree, *Urolophus gigas*. This will be achieved by determining the age and growth rate of specimens (using band count on vertebrae), the age and size at maturity, the onset of reproduction and the reproductive output (by examination of the reproductive system). The study will also monitor habitat use and movement within a marine park

and surrounding areas, and analyse stomach contents to determine the feeding ecology of this species. The result of this study will provide much needed understanding of the life history and ecology of *Urolophus gigas* to improve the management and conservation of this species.

Evaluating management strategies for cetacean-based tourism: a case study of Port Phillip Bay, Victoria

Leia Howes

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Supervisor – Dr Carol Scarpaci

Since 1989, the southern end of Port Phillip Bay, Victoria (Australia) has become a venue for dolphin tourism in the form of swim-with-dolphin operations. This research assessed tour operator compliance to regulations stipulated within the Wildlife (Whales) Regulations, effectiveness of the Ticonderoga Bay Sanctuary Zone (TBSZ) as a refuge for dolphins from commercial tourism, and behaviour of dolphins according to vessel approach methods.

The research was conducted onboard a permitted dolphin-swim tour vessel with the vessel operator, and dolphin behaviour recorded using a combination of scans and continuous observations.

The results from this study have indicated that operators displayed unsatisfactory compliance to four of the seven regulations studied. Non-compliance by tour operators was not confined to generic conditions, with operators displaying non-compliant behaviour within the TBSZ despite its purpose to provide a dolphin refuge. Tour operators did not comply with the minimal distance regulation during the 57 vessel approaches that were documented within the TBSZ. Furthermore, operators did not exercise any significant caution around the dolphins while inside the prescribed sanctuary zone. These results illustrate that the mere designation of a location, or its significance alone, does not ensure operator compliance.

The management strategies studied in this thesis were implemented to: i) provide protection; and ii) encourage operator compliance.

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

Calvin Quick

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Supervisors – Dr Janine McBurnie / 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

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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.

Physiological stress associated with the capture, handling and captivity of the Australian swellshark (*Cephaloscyllium laticeps*), an abundant by-catch species in southern Australian fisheries

Jay Van Rijn

Monash University / MAFFRI

Supervisors – Dr Richard Reina / Dr Matias Braccini

The study of physiological stress and post-release mortality experienced by shark species caught as by-catch in fisheries is critical for the sustainable management of global fisheries and shark populations. In this study I examined on physiological stress induced by simulated capture and handling techniques that closely mimic standard fishing operations on an abundant by-catch species, the Australian swellshark *Cephaloscyllium laticeps*. I examined the stress and physical consequences induced by the ingestion of water and air. An ability unique to the swellshark family due to its expandable stomach. In this study I also examined the physiological stress experienced by these sharks, associated with long-term captivity. Physiological stress was determined using the physiological indicators of stress of plasma lactate and glucose concentration, plasma osmolarity, haematocrit, and the granulocyte to lymphocyte (G/L) ratio, which has not been previously tested on sharks. I found that plasma lactate and glucose concentrations, and the G/L ratio are useful indicators of physiological stress, whereas plasma osmolarity and haematocrit did not change enough to have any biologically detrimental effect on the shark. Of the capture and handling processes I simulated, 120 minutes of air exposure induced the highest measurable physiological stress, followed by gillnet capture gear, and peak physiological stress occurs several hours after release from capture gear. Overall, this study demonstrates that while *C. laticeps* is resilient to capture and handling stress experienced in fisheries, careful consideration must be taken when holding this species captive. Furthermore the granulocyte to lymphocyte ratio can be used as a physiological indicator of stress for this shark species.

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CONFERENCE AND OTHER PRESENTATIONS

Isla Fitridge
Seasonality, seduction and foul play: the hydroid fauna of Port Phillip Bay
Poster presentation : 46th Australian Marine Science Association (AMSA) Conference, Christchurch NZ, July 2008.

Lorenz Frick
What happens after we throw them back? The physiological response of sharks to capture stress
Oral presentation : American Society for Ichthyology and Herpetology (ASIH) / American Elasmobranch Society (AES) Meeting, Montreal Canada, July 2008

Effects of fisheries capture on the post-release condition of Port Jackson sharks and gummy sharks
Oral presentation : Oceania Chondrichthyan Society (OCS) Meeting, Sydney NSW, September 2008

Kathryn Hassell
Hassell K.L., Coutin P.C. and Nugegoda D.
The effects of environmental stressors on aspects of reproduction in black bream, (Acanthopagrus butcheri)
Oral presentation : 2008 Australian Society for Fish Biology (ASFB) Workshop & Conference, Bondi Beach NSW, September 2008

Hassell K.L., Pettigrove V. and Nugegoda D.
Black bream (Acanthopagrus butcheri) as a potential biomonitoring species for endocrine disrupting chemicals in estuaries of southern Australia
Oral presentation : Society for Ecotoxicology and Chemistry (SETAC) 5th World Congress, Sydney NSW, August 2008

Jodie Kemp

Kemp J., Swearer S.E., Robertson S. and Jenkins G.P.
The potential use of otolith shape and microchemistry to distinguish cod species (Genus Pseudophycis) in the diet of Australian Fur Seals
Oral presentation : 2008 Australian Society for Fish Biology (ASFB) Workshop & Conference, Bondi Beach NSW, September 2008

Peter Macreadie
Macreadie P.I., Hindell J.S., Jenkins G.P., Connolly R.M. and Keough M.J.
Fish responses to seagrass fragmentation
Oral presentation : 46th Australian Marine Science Association (AMSA) Conference, Christchurch NZ, July 2008
Oral presentation : 2008 Australian Society for Fish Biology (ASFB) Workshop & Conference, Bondi Beach NSW, September 2008
Oral presentation : CSIRO Wealth from Oceans Workshop, Hobart TAS.

Life on the edge of habitat fragments: the stomach rules the mind
Oral presentation : 33rd Ecological Society of Australia (ESA), University of Sydney NSW, December 2008
Oral presentation : Australian Marine Science Association (AMSA) Victoria Public Meeting, Zoology Department, University of Melbourne VIC.

Coastal habitat fragmentation
Oral presentation : 3rd Year Marine Ecology Lecture, University of Melbourne VIC.

Hintsa Mateos
Mateos H.T., Lewandowski P.L. and Su X.Q.
Seasonal variations of total lipid and n-3 polyunsaturated fatty acid contents in Jade Tiger hybrid abalone
Poster presentation : 32nd Nutritional Society of Australia (NSA) Annual Scientific meeting; Adelaide SA, December 2008

Dr Jeff Shimeta
Influence of flow speed on the functional response of a passive suspension feeder, the spionid polychaete (Polydora cornuta)
Oral presentation : 46th Australian Marine Science Association (AMSA) Conference, Christchurch NZ, July 2008

Tim Smith
Smith T.M., Hindell J.S., Jenkins G.P. and Connolly R.M.
Does predation cause edge effects in seagrass beds?
Oral presentation : 46th Australian Marine Science Association (AMSA) Conference, Christchurch NZ, July 2008

Edge effects in patchy seagrass habitats: using video to sample mobile species
Oral presentation : 2008 Australian Society for Fish Biology (ASFB) Workshop & Conference, Bondi Beach NSW, September 2008