

Queenscliff Marine Station

Annual Report

1997

Member Institutes and Representatives

Deakin University

Professor David M Stokes
Dean, Faculty of Science and Technology

Marine & Freshwater Resources Institute

Dr Garth Newman
Director

Monash University

Dr Gerald P Quinn
Department of Ecology and Evolutionary Biology

Royal Melbourne Institute of Technology

Professor Douglas A Holdway
Department of Applied Biology and Biotechnology

The University of Melbourne

Associate Professor Michael J Keough
Department of Zoology

Victoria University of Technology

Dr Trevor R Burridge
Department of Environmental Management

STAFF

Administrative Secretary

Elizabeth McGrath

Technical Officer

Roderick P Watson

Contents

	Page
Member Institutes and Representatives	4
Introduction	6
Chairman's Report	7
Operations	
Field courses	8
Research vessels	9
Diving.....	10
Aquarium	10
Researchers	10
Management.....	12
Services and Facilities	
Teaching facilities	13
Research facilities	13
Other	13
Finances	
Balance sheet as at 31.12.97	14
Operating statement from 1.1.97 to 31.12.97	15
Research Projects	16
Grants Received	32
Publications	34
Conference and Symposia Presentations	36

Introduction

The Queenscliff Marine Station was established in 1989 to provide a facility dedicated to marine research and tertiary education. The Station was initially planned and funded by a consortium comprising Monash University, the Royal Melbourne Institute of Technology (RMIT), The University of Melbourne and the Victorian Institute of Marine Sciences (Marine & Freshwater Resources Institute). Deakin University and the Victoria University of Technology have since joined the consortium.

The Station commenced operation in 1991 in two relocatable buildings transferred from The University of Melbourne. A new aquarium building was also completed at this stage. In 1992, \$635,000 was received from the Australian Research Council, following a cooperative proposal for research infrastructure funding. The proposal was to provide 'a flow-through seawater system supporting experimental facilities, emphasising ecotoxicology at the Queenscliff Marine Station'. Construction of the new facility began in August 1994 and was completed in January 1995.

Today, the Station is a unique facility catering for researchers, educators, undergraduate and postgraduate students. The Station provides an ideal environment for interaction amongst specialists with major interests in marine science.

The Station is located on the southern end of Port Phillip Bay on the Bellarine Peninsula, providing convenient access to a diverse range of marine habitats. Sandy beaches, intertidal and sub-tidal rocky reefs, seagrass meadows, mangroves, the protected waters of Port Phillip Bay and the open seas of Bass Strait are all within easy reach, making the Station an ideal centre for research and education.

The facility primarily serves the member institutes but is available to researchers and educators from Australia and overseas. The Station also offers industry, commerce and the public sector opportunities to conduct new and relevant research.

Chairman's Report

During 1997 the Station continued to operate smoothly and provide facilities for undergraduate, graduate and postgraduate studies by consortium members and thus make a major contribution to the promotion of marine science in Victoria.

There was a marked increase in the use of the Station and eight major new research projects were started during the year.

QMS is now well established in its new building and the increased pattern of usage and dependence of consortium members on the facility was such that a strategic review of the future of the station was required. This was undertaken during the year and desired future outcomes, and their associated actions, were established for QMS. These actions are to be periodically monitored by the Management Committee to ensure that the outcomes identified for the Station are achieved.

A major funding proposal was submitted to the ARC for a new vessel and upgrading of the aquarium facilities. This was unfortunately not successful but the application will resubmitted in 1998.

Representatives from QMS met with colleagues from South Australia and Tasmania to prepare a submission to the Marine Science and Technology Working Group entitled "Towards a national focus on Australia's Temperate Marine Ecosystems". The paper provided a collective view on how best to utilize and develop existing marine research capability.

I would like to thank the members of the Management Committee for their continued co-operation and input during the past year. This unique partnership between five universities and a major marine research institute provides worthwhile and cost effective facilities for research training which would probably be beyond the means of any one member of the Consortium.



Dr Garth Newman
Chairman

Operations

Field courses

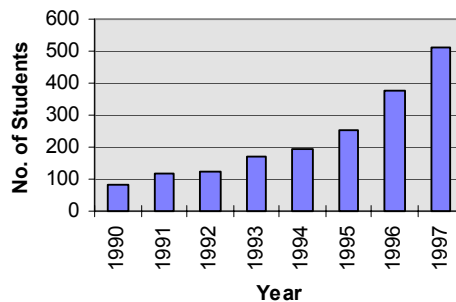
The following undergraduate courses were conducted at QMS during 1997:

1997	University	Course	Students
2-9 February	University of Melbourne	Invertebrate zoology	35
10-16 February	Uni. Melbourne and Monash	Marine ecology	56
24-28 February	Monash University	Botany	32
15 & 16 March	Deakin University	Marine biology	40
12 & 13 April	Deakin University	Marine biology	40
19 & 20 April	Victoria Uni of Technology	Marine biology	40
17 & 24 August	Deakin University	Maine biology	30
6 & 7 September	University of Melbourne	Marine ecology	35
13 September	Deakin University	Fish biology	40
20 & 21 September	University of Melbourne	Marine ecology	40
3 October	Deakin University	Marine biology	40
11 & 12 October	Deakin University	Marine biology	30
21-30 October	University of Melbourne	Botany	50

Total students	508
-----------------------	------------

Undergraduate student courses at the Station have increased significantly during the past seven years.

Undergraduate Students 1990-1997



Collaborative teaching during undergraduate courses came from the Museum of Victoria, Flinders University and the Universite Libre de Bruxelles. These cooperative links allow for high quality undergraduate teaching and also encourages research students to transfer between institutions for their PhD studies.

Two inaugural undergraduate courses were conducted by The University of Melbourne : marine invertebrate zoology and marine botany. Both courses were highly successful with positive feedback received from staff and students.

Research vessels

The Station's 6.5 metre research vessel, *Velella*, performed 150 tasks during 1997.

The boat was necessary for research into biodegradation of crude oil, the ecology of temperate reef fishes, oil spill ecotoxicology, dolphin research, gannet research, research into introduced species into Port Phillip Bay, including *Undaria pinnatifida*, *Corbula gibba* and *Sabella spallanzanii*.

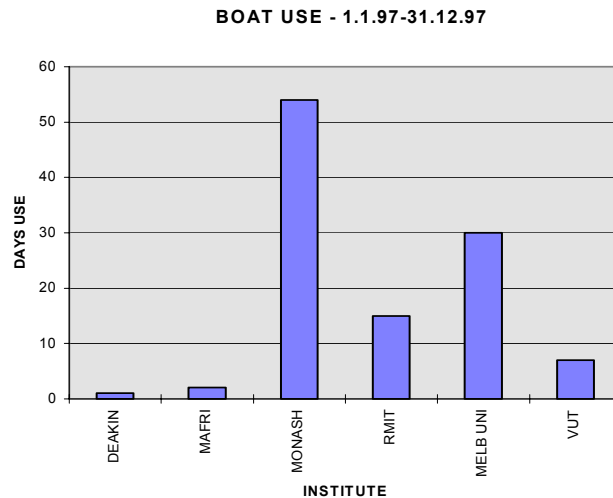
The major expenditure during the year was to replace the steering hydraulic cylinder, but otherwise general servicing was all that was required.

We have initiated a charge rate of \$10 per engine hour for students and \$20 per hour for researchers and student groups in order to regain some running costs, which rose significantly due to increased use.

The 4.1 metre punt was used as a netting boat for whiting research, for diving and fish trapping for reef fish research and as a diving vessel for biodegradation samplings.

The research vessel, *Korrong*, is owned by the Geomatics Department of The University of Melbourne and located at the Station. It is used by Geomatics Department for mapping and sensing work, and is also used by researchers at MAFRI.

The following graph shows vessel utilisation by each member.



Diving

During 1997, 150 dives were logged. Approximately 50% of these involved diving on reefs around the southern half of the Bay researching reef fish communities. Other regular activities included setting up and sampling biodegradation frames, collecting abalone, sea stars, sea urchins and octopus. Again this year, most of the dives occurred in depths of under 10 metres.

Aquarium

The aquarium was used extensively to hold animals prior to toxicology experiments. Tagging effects on fish were also conducted. Macroalgal recruitment experiments were continued as was the treatment of sharks for cancer research.

The aquarium uses around 0.6 ML of seawater per week.

Researchers

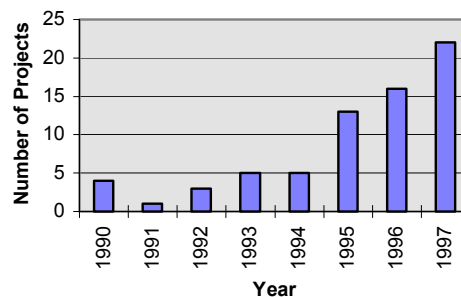
During 1997, the following projects were undertaken at the Station. A more detailed description of each project is contained under *Research*, p16.

Anderson, Tara	PhD	Larval dispersal and settlement patterns	Melb.
Bellgrove, Alecia	PhD	Macroalgal recruitment	Monash
Bite, Juanita	Masters	Ecological studies on Japanese kelp in Port Phillip Bay	VUT
Bunce, Ashley	PhD	Research on the Australasian Gannet	Melb.
Burton, Bronwyn	PhD	Feeding ecology of intertidal gastropods	Melb.
Cohen, Adam	PhD	Oil spill effects on Australian Bass	RMIT
Cummins, Scott	Honours	Bioassays of abalone egg-laying hormone	Deakin
Cutajar, Nadine	Honours	Feeding studies on abalone using Japanese kelp	VUT
Duda, Susan	PhD	Immunotoxic effects on native fish	RMIT
Gagnon, Monique	Post-doc	Oil spill toxicology	RMIT
Gomelyuk, Victor	Research	Reef fish	Melb.
Gorski, Jacqueline	Honours	Ecotoxicology studies on Japanese kelp	VUT
Gulec, Ismail	PhD	Oil spill toxicology	RMIT
Gwyther, Janet	PhD	Meiofauna ecology	Deakin
Hindell, Jeremy	PhD	Influence of predation on fish communities in seagrass habitats	Melb.
Jenkins, Dr Greg	Research	Whiting larval ecology and recruitment	Melb/ MAFRI
Jenkins, Dr Greg	Research	Sampling for post-settlement in <i>Pagrus auratus</i>	MAFRI
Karunajeewa, Nimal	PhD	Seastar ecology	Melb.
Karistianous, Melanie	Honours	Effect of primary and secondary effluent on the germination of <i>Ecklonia radiata</i>	VUT
Long, Sara	PhD	Oil spill effects on octopus	RMIT

Morris, Liz	PhD	Organic pollution and effects on invertebrates	Melb.
Porter, Chris	PhD	Temperate reef biodiversity	Deakin
Scarpaci, Carol	PhD	Dolphin research	VUT
Shir, Mary-Anne	PhD	Ecotoxicology studies on brown algal macrophytes	VUT
Syme, Anna	Honours	Food limitation in King George whiting	Melb.
Talman, Sonia	PhD	Biology of <i>Corbula gribba</i> , an introduced bi valve	Melb.
Teasdale, Caroline	Masters	Vitellogenun induction by dispersed oil in leatherjackets	RMIT
Temara, Ali	Post doc	Sea urchin reproduction	RMIT
Trivett, Melanie	PhD	Cancer research via sharks	Melb.
Walker-Smith, Genefer	PhD	Taxonomy of harpacticoid copepods	Melb./ Museum
Wheatley, Melissa	PhD	Temperate reef fish ecology	Monash

The following graph shows the growth of post graduate projects conducted at the Station during the past 7 years.

Total Postgrad Projects 1990-1997



In January, Professor Bruce Coull, from the School of Environment, University of British Columbia, USA, visited (by invitation from Deakin University) and worked with researchers at the Station.

Professor Kerry Black from the University of Waikato N.Z., visited on 2 occasions to collaborate with MAFRI researchers on the hydrodynamic modelling of spawning areas for King George whiting.

Other researchers from the EPA and the Museum of Victoria, also utilised the Station throughout the year.

Management

The Management Committee met on 5 occasions during 1997 - 14 February, 17 April, 29 May, 4 September and 30 October

The meeting on 4 September was convened specifically for development of a strategic plan. The strengths and weaknesses, opportunities and threats of current operations were analysed in detail. *A Strategy for the Queenscliff Marine Station* documents the future desired outcomes for the Station, which the Committee has undertaken to address during the next 5 years.

A funding application to the Australian Research Council to replace our ageing vessel and upgrade the aquarium system was unsuccessful; a similar application will be submitted in 1998.

The Committee decided to seek sponsorship from the corporate sector and will pursue this in 1998.

Services and Facilities

Teaching facilities

- A lecture room to accommodate 40.
- A general/teaching lab with bench space for approximately 25 students.
- Both rooms can be used separately or combined into one large area suitable for conducting presentations to in excess of 70 students.

Research facilities

- General/teaching lab bench space.
- A dedicated ecotoxicology lab offering bench space, benchtop aquaria, compressed air and 24 seawater taps servicing the benchtop aquaria.
- Two controlled light and temperature rooms supplied with seawater and compressed air.
- Large preparation room adjacent to the ecotoxicology lab.
- An aquarium equipped with a dissecting table, 6 double-tiered and 4 single aquarium stands. Seawater and compressed air is supplied to each stand.
- Seawater is supplied to all aquaria via a high quality flow-through system.
- The Station's 6.5 metre vessel *Velella* is available for field activities.
- Various other small craft can be made available by arrangement.
- A comprehensive range of scientific equipment is available for use.

Other

- Limited office space is available to visiting researchers and postgraduate students
- Access to computers, fax and photocopier is available.
- At the present time, no accommodation is provided at the Station, but can be found in Queenscliff and nearby Pt. Lonsdale.

Finances

Balance Sheet as at 31 December 1997

Current Assets	\$	\$
Cash held by Deakin University	39,388	
Sundry Debtors	197	39,585
Non Current Assets		
Equipment	72,134	
Less : Provn. Deprn.	-36,956	35,178
Motor Vehicles	24,407	
Less : Provn. Deprn.	-18,305	6,102
Furniture	1,056	
Less : Provn. Deprn.	-343	713
Land & Buildings	126,114	
Less : Provn. Deprn.	-26,484	99,631
Liabilities		
Sundry Creditors - Accruals		0
Provision for Annual Leave	-2,275	
Provision for LSL	<u>-3,732</u>	-6,007
Income in Advance		0
	NET ASSETS	175,201
		<hr/>
Represented by:		
Consortium Members funds		257,133
Profit & Loss Appropriation		(78,666)
Current Year Profit/(Loss)		(3,267)
	NET ASSETS	175,201
		<hr/>

Operating Statement for the period ended 31 December 1997

Income	
Consortium Contributions	91,632
Interest	<u>1,757</u>
Total Income	93,389
Less Expenditure	
Salaries	
Salaries	50,727
Payroll Tax	3,472
Superannuation	8,509
Workcover	140
Employee Entitlements	<u>(1,699)*</u>
Total Salary Expenditure	61,149
General	
Catering	36
Cleaning	2,122
Consultants	100
Consumables - Computer	216
Consumables - General	847
Depreciation	15,570*
Electricity	4,000
Minor Equipment	2,170
Photocopier & Stationery	521
Postage	188
Registration/Insurance-Boat & Trailers	769
Rent/Lease Expenditure	104
Repairs & Maintenance	3,706
Staff Training	177
Subscriptions & Memberships	60
Telephone, Fax	3,281
Travelling Expenses	177
Vehicle & Boat Fuel	<u>1,464</u>
Total General Expenditure	35,507
Total Expenditure	<u>96,655</u>
Net Operating Result	(3,266)

* No provisions were made in the 1997 budget for the non-cash items of depreciation and employee entitlements and the income received from consortium members falls short by these two amounts. This has led to the negative net operating result for the year \$3,266.

Research

Investigation on ageing black-lip abalone, *Haliotis rubra*

Victor Gomelyuk, The University of Melbourne/FRDC.

In August 1997, an experiment involving shell staining with manganese chloride on black lip abalone, *Haliotis rubra*, was carried out at Queenscliff Marine Station. Five hundred and three abalone were caught at Flinders Reef, transported to QMS and placed into the circular plastic tank with MnCl₂ solution (195 mg/L of sea water). Water in tank was aerated with air compressor and filtered using active carbon filter. After 48 hours all water volume was replaced with the fresh manganese solution. Staining lasted for 96 hours. After staining was completed, the manganese solution was replaced by circulating sea water. All abalone were measured, individually tagged with pore tags and then released back to the habitat. This experiment was a part of a FRDC funded project on ageing abalone. I thank Rod Watson for his assistance.

The role of meiofaunal food supplies in the recruitment of a temperate demersal fish

Dr Greg Jenkins, Marine & Freshwater Resources Institute.

This study seeks to understand the link between seagrasses and juveniles of an important fish species, the King George whiting. Traditionally, protection from predators provided by plant structure was thought to be the major factor. Preliminary studies on juveniles of the King George whiting, however, suggests that food, in the form of small invertebrates (meiofauna), may be the major benefit. This project has been underway for one year in which we completed a major field program. Sampling was aimed at testing the hypothesis that the relative use of seagrass and unvegetated habitats at a site would be a function of the relative distribution of meiofauna in the two habitats. We sampled both juvenile fish (including King George whiting) and meiofauna in seagrass and unvegetated habitats at nine sites repeated monthly over the recruitment season. The sites spanned a range of sediment characteristics from well sorted sand to fine mud. From each site we also sampled seagrass and sediment. Laboratory analysis is presently underway examining juvenile fish and meiofauna abundance and size distribution, diet and growth of juvenile KGW, and seagrass (biomass, density, length) and sediment (size distribution and organic content) characteristics. Field sampling was also undertaken for juvenile KGW every 3h over 24h periods to examine diurnal variation in feeding rate. In the laboratory we examined digestion rate and maximum feeding rate of juvenile KGW feeding on laboratory cultured harpacticoid copepods. An extensive sampling program was also undertaken for piscivorous fish at seagrass sites to assess the potential for predation to determine distributions of juvenile KGW between seagrass and unvegetated habitats. Laboratory analysis of piscivorous fish diets is presently underway.

Sampling of newly-settled snapper, *Pagrus auratus*, and identification of preferred habitats in Port Phillip Bay- a pilot study

Dr Greg Jenkins, P. A. Hamer and D. Welsford, Marine & Freshwater Resources Institute.

The ecology, including the distribution and preferred habitats of newly-settled snapper are largely unknown in Australian waters. Newly-settled snapper are fish of about 20-30 mm in length that have recently transformed from a larva living up in the water column to a bottom associated juvenile. This lack of information is primarily

due to a lack of success in capturing snapper at this stage of their life-cycle. The aims of this pilot study were to: 1) Determine if newly-settled snapper (10 - 30 mm) can be quantitatively sampled in Port Phillip Bay, Victoria, and 2) Determine the habitat requirements of newly-settled snapper and assess whether such habitats are under threat of degradation. For this study we designed a small beam trawl based on a design used to sample newly-settled snapper in Japan. The beam trawl was fished on the bottom and had mouth dimensions of approximately 2.5 m wide and 1.5 m deep when fishing. Floats and weights are used to open the net vertically and a 3m steel beam is used to open the net laterally. Sampling was conducted, both day and night, throughout Port Phillip Bay on a monthly basis during the settlement period from December 1996 through to April 1997. Overall, 110 sites were sampled, however, no newly-settled snapper were found, a small number of one year old snapper were captured. Abundances of juvenile snapper are known to show strong variability from year to year and we hypothesise that the failure to capture newly-settled snapper was due to very low or even failed recruitment of newly-settled snapper during the 1996-97 summer rather than inefficiency of the beam trawl. This hypothesis is supported by recent sampling with the small beam trawl in March 1998 where we captured significant numbers of newly-recruited snapper from 3 to 8 cm in length. Without data on newly-settled snapper, we could not determine their habitat requirements and assess the threats to these habitats. Another habitat which has received limited investigation as a habitat for newly-settled snapper in Victoria is estuarine habitat. Concurrent with the beam trawl sampling we also conducted sampling with a small beach seine net in four estuaries within Port Phillip Bay. No newly-settled snapper were captured in estuaries. The absence of newly-settled snapper from estuarine habitats within Port Phillip Bay, however, may not mean that they do not use these habitats. Their absence may have also been due to low or failed recruitment. We have since (March 1998) found small (3-7 cm in length) snapper at the mouth of the Yarra River, and they are known to be common in the Gippsland Lakes at certain times. The importance of estuarine habitats for newly-settled snapper requires further study in years of known high juvenile recruitment.

Biochemical Indicators of Exposure to Petroleum Compounds in Atlantic Salmon

M.M. Gagnon and D.A. Holdway, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

In Australia, Atlantic salmon (*Salmo salar*) are pen-reared at sea in areas where oil exploration, extraction and transport is a major industrial activity. In the event of an oil spill, environmental managers have to follow and evaluate exposure of farmed fish to petroleum compounds dissolved in the water. Exposure can be greatly enhanced by the use of chemical dispersants.

The project focuses on the alterations of biochemical markers of exposure to the water accommodated fraction of Bass Strait crude oil, and to chemically dispersed crude oil. Induction of the hepatic detoxication enzymes of the mixed function oxygenase (MFO) system are monitored in conjunction with production of metabolites excreted through the bile. Subacute effects on the cellular and subcellular respiratory system are investigated using two indicators of the aerobic capacity of a tissue, the cytochrome C oxidase and the citrate synthase. The anaerobic respiration is evaluated through the activity of lactate dehydrogenase.

Preliminary results indicate that at low exposure levels, both aerobic and anaerobic respiration are inhibited, lowering basal metabolism. At higher but subacute exposure concentrations, aerobic metabolism is inhibited through damages caused by petroleum hydrocarbons to the mitochondrial membrane, and development of anoxic condition is evidenced by a large increase in lactate dehydrogenase activity. MFO

system is highly induced, accompanied by excretion of petroleum compounds in the bile of the salmon.

DNA adducts formation after exposure to Bass Strait crude oil

M.M. Gagnon, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

Modulations of the integrity of DNA occur subsequent to exposure to genotoxic agents and is amenable to detection. Damage to DNA, such as strand break potentially leading to the formation of cancerous tumours, various malformations and lowered survival rate of offspring, is used in this project in assessing the genotoxic properties of Bass Strait crude oil.

Native fish sand flathead (*Platycephalus bassensis*) and bluelthroat wrasse (*Notalabrus tetricus*), as well as the positive control Atlantic salmon (*Salmo salar*) were i.p. injected with crude oil in order to study the potential of Bass Strait crude oil to induce the formation of DNA adducts (addition products) in the liver. Results will provide insights on the potential long term effects of oil spills involving Bass Strait oils on the biota.

Oil-induced disruption of the foraging behaviour of the asteroid keystone predator,

Ali Temara, Oil Spill Research Group, Department of Applied Biology and Biotechnology, RMIT.

By moderating competition among its prey species, asteroid keystone predators maintain a high biodiversity in coastal benthic communities. It is therefore likely that an impact of contaminants on such key-species would affect the whole community. The present study aims to assess the effects of oil-derived products on the biology of the asteroid keystone predator in Southern Australia, *Coscinasterias muricata*. Asteroids were exposed to dilutions of Water Accommodation Fraction (WAF) of Bass Strait stabilised crude oil (10 %, 2 %, control) for 4 days, and depuration followed for 20 days. A prey localization test was developed for the study and effects were quantified after exposure and depuration using circular statistics. Uniformity of the distributions was tested using the Kuiper test, the significance of difference between the calculated mean angle and the expected direction (direction towards the prey, *Mytilus edulis*) was calculated using a modified Rayleigh test. A dose-related response was observed. Control asteroids directed towards the mussels ($p < 0.0005$, mean angle: 343 degrees, angular dispersion: 69, $n=16$). A small proportion (3/16) of asteroids exposed to 2% WAF did locate the mussels, while asteroids exposed to 10 % WAF did not locate the mussels ($0.99 > p > 0.975$, $n=16$). After depuration, asteroids exposed to 10% WAF recovered their ability to locate the mussels (Mean angle: 0, angular dispersion: 70, $p < 0.001$, $n=16$).

It is concluded that (1) the test developed is adequate to assess the effects of contaminants on the foraging behaviour of asteroids that locate their preys through chemoreception, (2) exposure to oil-derived products disrupts the foraging behaviour of the keystone predator studied, and (3) the effect is reversible.

Consulting

Holdway, D.A., Oil Spill Research Group, Department of Applied Biology and Biotechnology, RMIT.

Ecotoxicological sub-consultant to CSIRO to undertake an assessment of the toxicity of Boags Rocks treated effluent to marine fish on behalf of Melbourne Water. June-November 1997.

PhD Research projects

Fish-Seagrass Association: A Spatially Explicit Approach.

Tara Anderson, The University of Melbourne; Supervisor: Dr M. Keough.

The intention of this project is to unite landscape ecology and scale linkages within a spatially explicit framework. Seagrass areas commonly consist of a mosaic of spatially discrete and recognisable patches of seagrass interspersed with unvegetated habitats, defined at a variety of spatial scales. The initial aims of this project are to identify and describe the spatial structure of seagrass beds and the associated fish assemblage; to identify the relative scales of the fish-seagrass association; and to identify whether there is a characteristic 'scale' of the system.

The second stage aims to establish correlative relationships of seagrass and fish assemblages with physical and biotic factors; and to experimentally identify the relative importance of these factors. I then plan to formulate hypotheses using path analyses to produce a species-environment response surface relationship.

The final stage would be to test these hypotheses against new and novel situations.

Factors affecting intertidal macroalgal recruitment on a wave-exposed rocky coast

Alecia Bellgrove, Monash University.

Recruitment into a population can be an important process in the structure and dynamics of adult assemblages. There have been many studies in the past few decades addressing questions about the patterns of recruitment processes and the stock-recruit relationship. However, these studies have largely focused on invertebrates and fish. The few studies that have examined macroalgal recruitment have focused on a single species at a time, usually kelps. There have been no previous studies of macroalgal recruitment on a community level.

My research has involved the development of artificial substrata suitable for studies of macroalgal recruitment, and their implementation in an investigation of the temporal and spatial patterns of intertidal macroalgal recruitment in the Point Nepean National Park. The focus of my research in 1997 has been finalising both field and laboratory experiments examining the impacts of various molluscan and crustacean herbivores on the recruitment of intertidal macroalgal, and entering the writing phase of my PhD.

The influence of age on reproductive success in Australasian gannets, *Morus serrator*

Ashley Bunce, The University of Melbourne.

Variations in age-specific reproductive success have been demonstrated, yet our knowledge of the proximate causes of this variation is limited. Two mechanisms have been proposed to explain such age-specific differences in reproductive performance. First, individual reproductive success may improve with age because of age-related improvements, such as in foraging efficiency, or because of accumulated experience. Second, reproductive success may change with age due to senescence, individuals may increase the amount of effort devoted to each reproductive event as the probability of surviving to reproduce in future reproductive events declines. One major hindrance to studies of age-specific reproductive success has been the paucity of long-term population studies that can provide sufficient numbers of known-aged individuals. This study aims to investigate whether reproductive success increases

with age in Australasian gannets, and the possible mechanisms causing this variation.

The reproductive success of known aged Australasian gannets breeding at Pope's eye Marine Reserve will be monitored over the next two breeding seasons. Dates of laying, hatching and chick growth and mortality rates will be collected. To identify possible factors affecting reproductive performance further investigations of breeding birds will be conducted. Including, experiments to test the effects of food availability on chick growth and survival, investigation of variations in foraging efficiency and food delivery rates to chicks with age and differences in foraging behaviour and diet of known individuals determined. Knowledge of the factors affecting breeding success in Australasian gannets will be an important tool for the management of a species which is restricted to just a few breeding sites in Australia.

Feeding ecology of intertidal gastropods: effects of species, population density, and individual size

Bron Burton, The University of Melbourne.

Rocky intertidal shores are frequently characterised by high density populations of animals with limited natural resources. Gastropods constitute a large percentage of the fauna inhabiting the intertidal zone. The impact of competition, both between and within gastropod species, is important in influencing the distributions and abundance of the animals and plants that inhabit these shores.

The objectives of my project are to investigate the mechanisms that allow two gastropod species to co-exist on exposed intertidal rocky shores. The limpets *Cellana tramoserica* and *Siphonaria diemenensis* are two of the most abundant mobile grazing gastropod species on rocky intertidal shores in South-Eastern Australia. Both species occur in high densities across the mid-littoral zone, with extensive overlap in vertical distribution. Individuals feed when submerged by scraping their chitinous radulae (feeding organs) across the rock, removing epilithic and endolithic microalgae. There is evidence that both species compete exploitatively for food sources, and this competition is both inter- and intra-specific in nature.

My work has involved establishing enclosures and monitoring densities of limpets on the intertidal rocky shores of Cheviot Beach, Point Nepean National Park. I have been investigating the effects of limpet species, population density and body size on aspects of feeding ecology. These include limpet growth rates, feeding rates, microalgal food abundance, bioerosion rates, and limpet mortality. Some of my primary results indicate that *C. tramoserica* is consistently dominant over *S. diemenensis*, although the size of *C. tramoserica* individuals appears to affect intra-specific competitive interactions.

The sublethal effects of oil spill remediation techniques on Australian Bass, *Macquaria novemaculeata*

Adam Cohen, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

The project investigates energy flow through the test species, from exposure to dispersed oil, oil and burnt oil. Total Protein, lipid and carbohydrate content has been investigated, as well as organism metabolism (respiration). Toxicant uptake and depuration has also been examined, as well as toxicant transport through the different routes of uptake (water and food web).

The immunotoxic effects of important environmental pollutants on Australian native fish species, freshwater and marine

Susan Duda, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

It is well documented that exposure to adverse environmental conditions can increase the susceptibility of fish to opportunistic pathogens and disease. Furthermore, it has been shown that this increased susceptibility is most likely a result of the effects of environmental stressors on the immune system. Unfortunately, immunotoxic effects are not obvious as repercussions of immunosuppression may only become apparent after a longer time period.

The study of fish immunotoxicology is in its infancy in Australia. Most of the work in fish has been conducted overseas, or on introduced species in Australia. Hence, there is currently a lack of available information pertaining to effects on Australian native species. Immune cells have the ability to rapidly proliferate and differentiate, thus they provide a potential biomonitoring system that is particularly sensitive to the toxic effects of environmental pollutants.

My project will examine the immunotoxic effects of important environmental pollutants on species of freshwater and marine fish, including native Australian species. Several assays will be used to assess non-specific and specific immune functions. Current techniques and methodologies in fish immunology will be optimised for the Australian native species.

Ecotoxicological effects of oil spill countermeasures on Australian marine organisms

Ismail Gulec, Department of Applied Biology & Biotechnology, Oil Spill Research Group, RMIT.

Crude oils are very complex mixtures and their composition varies widely. However, they can be divided into three groups of compounds, namely: light-weight components, medium-weight components and heavy-weight components. The physical and biological characteristics of those components vary, such as water solubility, evaporation, bioaccumulation and their acute and chronic toxicity. The acute and chronic toxicity of crude oil also varies between exposed species and can be affected by the life stage (egg, larva, juvenile, adult), habitat and food availability.

The ecotoxicological effects of crude oil on those marine organisms inhabiting Australian waters have not been examined to any significant extent. Extensive studies of toxic effects of crude oil have been conducted on marine organisms overseas. However, such information is not always applicable for Australian marine environments.

The object of this project is to investigate the ecotoxicity of crude oil, oil dispersants, dispersed oil and burned oil residue on Australian marine organisms (amphipod *Allorchestes compressa*, sand snail *Polinices conicus*, shrimp *Palaemon serenus* and fish larvae *Macquaria novemaculeata*) by employing both acute and chronic toxicity bioassays. A second objective of the project will be to determine the most suitable marine organisms for use in oil spill bioassays and to develop appropriate toxicity test protocols using these organisms.

Ecology of mangrove meiofauna in the Barwon river estuary

Janet Gwyther, Deakin University.

During 1997 my research into the ecology of meiofauna in the Barwon estuary was aimed towards characterising the abundance and composition of meiofauna from sedimentary and phytal habitats within the mangrove zone.

These studies have indicated that whereas nematode worms dominate the muddy habitat in both abundance and species diversity, the meiofaunal assemblage found on the surface of pneumatophores (air-breathing emergent roots of the mangrove trees) is dependent on the dominant macro-epibiont of the root surface. Pneumatophores which are encrusted with barnacles support a meiofaunal "island" dominated by mites; those roots bearing epiphytic algae are inhabited by an assemblage of meiofauna in which harpacticoid copepods are often the most numerous taxon.

Although the contribution of meiofaunal abundance from the pneumatophores towards total meiofaunal abundance in the mangrove zone of the estuary is small, the significance of emergent roots in providing a feeding surface for small nekton, particularly juvenile fish, is of interest. A related project commences in 1998 to assess the significance of this trophic link.

The role of piscivory in structuring fish communities within seagrass habitats

Jeremy Hindell, The University of Melbourne.

Predation is often considered to be one of the most important sources of mortality during the pre- and post-settlement phases of many marine organisms. However, a generalised theory explaining the role of predation in recruitment variability, differential growth and survival, modification of inter- and intraspecific interactions, and the subsequent population structure of marine animals, has proven as elusive as a northerly and a good wave during summer.

Seagrass beds are widely acknowledged as important nursery habitats for many invertebrates and vertebrates (primarily fish), in both tropical and temperate climates around the idyllic but often precarious coastline of Australia. The high structural complexity of seagrass provides inhabitants with refuge from predation and disturbance, and increased food availability.

While predation has been shown to influence the distribution and abundance of many invertebrates within seagrass habitats, little research has investigated how piscivory, predation upon fish, might structure the abundance, diversity and distribution of resident fish populations, the majority of which are recently settled larvae or juveniles which utilise seagrass beds temporarily. Of particular importance within seagrass habitats of Port Phillip Bay, is how piscivory influences the distribution and abundance of King George whiting (*Sillaginodes punctata*), and how predation compares with (the much favoured, indeed loved but somewhat esoteric) hydrodynamic and behavioural models in explaining patterns of larval/juvenile King George whiting distribution and abundance.

The first goal of this project will be to definitively survey the diurnal, tidal and spatial distribution, abundance, and diversity of potential fish predators and prey. Subsequently, manipulative experiments will be undertaken during the second and third field seasons to evaluate intricate hypotheses postulated from tremendous trends and exciting relationships arising from preliminary data.

The management of King George whiting within Port Phillip Bay will undoubtedly be improved by, indeed the survival of the species may depend upon, increasing our understanding of the myriad stochastic processes which influence population

structure, particularly predation, and subsequently the recreational and commercial fishing viability of these much sought after 'pussies' of the ocean.

Biomarkers of exposure to crude oil and dispersed crude oil in *Octopus pallidus*

Sara Long, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

There have not been many studies investigating the ecotoxicological effects of crude oil and oil spill remedial actions on Australian marine organisms. Such information is required when an oil spill occurs and the best remedial action needs to be determined. *Octopus pallidus* is a native Australian marine invertebrate, relatively abundant along the south-eastern coast of Australia. It is territorial in nature; making it a good species bioindicator of water quality from the area where it is caught. It is easily caught alive in large numbers in Port Phillip Bay using inexpensive, easily made traps.

Recent work has been undertaken to investigate the use of biomarkers (that is, the induction of a biological change in response to exposure to physical or chemical stressors) to analyse pollutant exposure in marine invertebrates. Biomarkers include behavioural and physiological changes, such as reproduction and feeding patterns, metabolic changes and alterations at the cellular and molecular level, such as stress protein synthesis and nucleic acid changes. Monitoring the molecular and cellular changes would provide a sensitive measure of effect since pollutants ultimately exert their effect at this level. The biomarkers I intend to look at are stress protein expression, respiratory enzymes and histopathological changes in tissues. Immature octopi will be exposed to sub-lethal concentrations of water-accommodated fraction (WAF) of crude and dispersed crude oil via the water column, in short term, acute tests, and via the sediment in long term, chronic tests; tissue samples will be taken for analysis.

The long term effect upon the endocrine system of octopi will be measured by observing histological changes in the gonads of male and female octopi exposed to crude and dispersed crude oil. In the UK, histological preparations of gonads of male fish exposed to pollutants showed the presence of primary oocytes.

My project will monitor growth and developmental of octopi from egg laying to maturity. When undertaking toxicity tests it is important to be confident that the test organism have not experienced any prior stress which could potentially bias the test results, therefore using laboratory reared octopi for tests will ensure this does not happen. This will be taken one step further by looking at growth and developmental changes as a result of exposure of one day post-hatch octopi to sub-lethal concentrations of WAF of crude oil. Measurements of growth, such as weight and length, will be taken every two weeks and compared to unexposed octopi. Any changes in behaviour will be observed and recorded.

Behavioural responses of adult infaunal invertebrates in response to experimentally applied doses of treated sewage effluent.

Liz Morris, The University of Melbourne.

It is generally accepted that pollution can change the composition of invertebrate animal assemblages in a soft sediment environment. Although there is a lot of information available that details pollution induced change in assemblage structure, we still have a limited understanding of the mechanisms that underly these observed changes. The animals that live in soft sediment environments are commonly used in

pollution monitoring and the greater our understanding of the way pollutants impact on these marine communities the more effective our monitoring is likely to be.

One aspect of my research is to investigate some of the behavioural traits of adult invertebrates subject to different doses of an organic pollutant, (secondarily treated sewage). A combination of field and laboratory experiments on animal communities from mudflats at Werribee are being undertaken to look at both vertical and lateral migration of different taxa as a response to varying doses of secondarily treated sewage effluent. This data will then be related back to monitoring observations of infaunal assemblage structure along a gradient of increasing distance from Lake Borrie outfall at the Western Treatment Plant, Werribee.

Temperate reef biodiversity

Chris Porter, Deakin University.

The purpose of this assessment is to assess how effective marine protected areas (mpas) in Victoria have been in achieving their conservation objectives. Biological diversity, impacts of use and user awareness of and compliance with regulations are the principle performance indicators used in this assessment.

A major case study of Pt. Lonsdale Marine Reserve, one of Victoria's first mpas, is near completion. A major case study of Victoria's newest mpa, Bunurong Marine Park is intended. The performance of these mpas will be compared with what is known about the performance of mpas in New Zealand and Queensland; places which have applied two very different strategies for marine protection (no-take marine reserves, multiple use parks, respectively). The results will be used to formulate a strategy for mpas establishment and management in Victoria.

I have written up the Point Lonsdale intertidal surveys and have found that conservation objectives for the intertidal component of the Marine Reserve are being achieved, despite lack of active management (such as signage, education, surveillance and enforcement) by the managing authority. Unfortunately, I was unable to proceed with investigating effects of reservation on the subtidal component of the reserve. I am currently analysing results of a questionnaire-based of managers of southern temperate marine protected areas, from which I will draw conclusions about efficacy of these mpas and factors influencing their success.

Distribution and population structure of the Bottlenose Dolphin, *Tursiops truncatus* in Port Phillip Bay, Victoria

Carol Scarpaci, Victoria University of Technology.

The study has monitored the dolphins behavioural patterns in the Port Phillip Heads region; their annual behavioural pattern will be completed in March. Dolphins have been constantly observed throughout the year in the region engaging in travel, feeding and social behaviour. Results on their behaviour, time budgets and ecological preferences will be available in the near future. The study is also currently monitoring dolphin swim tour operations on this population of dolphins. Previous research findings on the Bottlenose dolphin were presented in the Australian Progress Report on Cetacean Research at the International Whaling Commission in Monaco.

Sound recordings that have been transferred onto spectrograms have allowed certain individuals to be identified via their signature whistles, which is unique and distinctive for each individual dolphin. Links between sound production and behaviour are currently in progress to better understand the natural context and function of the signature whistle in a wild population of dolphins, by simultaneously recording behaviour and sound.

The effects of sewage effluent on germination and growth of three marine macroalgae

Mary-Anne Shir, Victoria University of Technology.

This study is investigating the effects of sewage effluent on three species of marine macrophytes. Marine organisms found in intertidal and nearshore habitats are particularly vulnerable to the effects of effluent discharge. Despite this, little research has been conducted on the effects of sewage effluent on aquatic plants and more specifically large brown algal species. Any research which has been conducted has shown that macrophytes can be successfully utilised as potential bioindicators of water pollution. This research is investigating the effects of sewage effluent on the macroalgal species *Phyllospora comosa* (Labillardiere) C. Agradh (Seirococcaceae, Phaeophyta), *Hormosira banksii* (Turner) Decaisne (Fucales) and *Macrocystis angustifolia* (Bory). Toxicity tests have been conducted investigating the effects of primary and secondary treated sewage effluent on germination and growth of the three species.

It is hoped that this research will provide a better understanding of the impact that sewage discharge may have on three dominant macroalgal species of the Victoria coastline. By understanding the effects of sewage effluent, the data collated may prove beneficial in future toxicity testing and used in conjunction with ongoing monitoring programs and for improvements in the management of our coastal areas.

The ecology of an exotic marine bivalve, *C. gibba*, in Port Phillip Bay, Victoria, Australia

Sonia Talman, The University of Melbourne.

Corbula gibba is a small bivalve mollusc which was introduced into Port Phillip Bay from the north Atlantic, presumably via ballast water. It was first found in Port Phillip Bay in 1987 but misidentified as a native species. It was correctly identified in a 1991 survey and this discovery became the first documented record of the species outside of its natural distribution. The potential exists for *Corbula gibba* to threaten the natural ecosystem of Port Phillip Bay as it is widespread and abundant in certain localities.

The project aims to investigate the ecology of *Corbula gibba* in Port Phillip Bay to allow comparisons between the native and the invaded environment. Aspects to be covered include:

- current distribution in Port Phillip Bay
- spatial and temporal patterns in abundance
- life history characteristics such as growth rate, annual production, life span, size-frequency distributions, settlement and recruitment patterns.

In addition, the project will aim to test the hypothesis that colonization by exotic species is possible or more successful in disturbed habitats. This will be done by comparing recruitment of *Corbula* into undisturbed and disturbed areas of the seafloor in the Geelong arm of Port Phillip Bay.

The project will also investigate interactions between *C. gibba* and co-occurring species through density manipulations in the field and/or laboratory. Historical data will be analysed to determine if the abundance of *C. gibba* is correlated with that of other species and, if so, such species may be targeted for interaction studies.

The mechanisms underlying such interactions may also be investigated. It is envisaged that work will be done on the feeding ecology of *C. gibba* (selection efficiency, cell size consumed) and compared with that of scallops and other co-occurring filter feeding species. The possibility of competition for space may also be examined using field and laboratory experiments.

What is parathyroid hormone-related protein and what's it doing in sharks?

Melanie Trivett, The University of Melbourne.

The major hypercalcemic factor found in all land dwelling vertebrates, parathyroid hormone (PTH) is produced in higher vertebrates by the parathyroid glands, glands which appear to be lacking in fish. The presence of a hypercalcemic factor in fish pituitary that shares homology with mammalian PTH had been proposed since the late 1970's and despite numerous attempts no such factor was isolated in the succeeding years. In the late 1980's a factor similar to PTH, now termed parathyroid hormone-related protein (PTHrP) was isolated from various types of cancers in humans, and it was implicated in causing elevations in plasma calcium levels in patients with certain types of malignancy. Further research showed that non-malignant tissues also produced PTHrP, such as the skin, kidney, and uterus, among many others. In mammals, PTHrP has roles in regulating local calcium fluxes, smooth muscle relaxation, growth and differentiation. The question arose as to whether PTHrP could be the PTH-like factor that had been proposed to exist in fish. Work by my supervisor and collaborators demonstrated that PTHrP existed in the sea bream, *Sparus aurata*, and in the dogfish, *Scyliorhinus canicula* both within tissues and the circulation. Localisation of PTHrP to sites such as pituitary and kidney and in the shark, rectal gland, raised the question of whether PTHrP had roles in ionoregulation, or perhaps calcium regulation.

My work with the gummy shark at Queenscliff has shown that PTHrP exists in high circulating levels in these animals, whereas in humans PTHrP is normally undetectable in the circulation. Sites of localisation again indicated that possible roles may lie in ionoregulation. To investigate environmental factors that may alter circulating levels of PTHrP and tissue distribution, we have used captive sharks at Queenscliff, with the assistance of Rod Watson, to examine the effects of decreased salinity and increased temperature on PTHrP in sharks. By exploring potential roles in fish of PTHrP we hope to gain insight in to the evolutionary relationship between PTHrP and PTH as well as expanding current knowledge of the physiological roles that PTHrP has in all vertebrates.

Harpacticoids from Port Phillip Bay: Seagrass Meiofauna - The ecology and systematics of southern Australian Harpacticoida (Copepoda) and their utilisation by juvenile fish

Genefer Walker-Smith; Jointly supervised by the University of Melbourne and the Museum of Victoria.

Harpacticoid copepods are abundant microcrustaceans found in virtually all marine environments and form a significant proportion of the meiofaunal biomass in seagrass systems. Past taxonomic work has identified 81 species in Australia, but only a few have been described from seagrass or sandy habitats. Only 2 species have been described from Victoria. In seagrass communities, harpacticoids are the major source of food for juvenile King George whiting and thus it has been suggested harpacticoids may play an important role in the recruitment dynamics and growth of these fish.

As part of my PhD project, field work was conducted from September to November 1997. Meiofaunal samples were collected every 2 weeks from 5 sites around Port Phillip Bay. This was the second sampling season for the project. Approximately 12 new species have been identified from material collected and these are currently being described. A paper discussing the systematics one species identified from Port Phillip Bay is currently in review : Preliminary investigations of the genital field of *Robertgurneya smithi* (Hamond) - its structure, function and evolutionary significance.

Variations in the species composition between sites and between habitats are being analysed, as is the data between field seasons (1996 & 1997).

A second aspect of this project was to investigate the diet of juvenile King George whiting. Gut analysis of juvenile whiting caught (by Dr Greg Jenkins and Paul Hamer) at the same time as the meiofauna samples were collected, is in progress, to determine if the proportion of species in the gut matches the proportion of the same species in the seagrass beds. Laboratory experiments were also undertaken in the constant temperature rooms at QMS to test if, given a choice, juvenile whiting eat one species of harpacticoid in preference to another. Results of these experiments are currently being analysed.

Ecology of temperate rocky reef fish of southeastern Australia, specifically the sixspine leatherjacket, *Meuschenia freycineti*

Melissa Wheatley, Department of Biological Sciences, Monash University.

Unlike many fields of marine ecology, where most effort has been concentrated in temperate waters, our knowledge of the processes structuring reef fish assemblages comes mainly from tropical coral reefs. Temperate reefs differ from coral reefs in a number of ways, the most obvious is that macroalgae forms a major source of structural habitat on temperate reefs. I have conducted visual transects on three reefs to record the spatial and temporal variation in the abundance and diversity of these fish assemblages. I now intend to increase the spatial scale of this sampling to determine whether any correlations exist between the species observed and algal type/cover or reef rugosity.

Fish traps are a popular method for sampling reef fish, however, catches from traps often differ substantially from visual transect counts. Comparisons will be made between the fish species caught and observed in traps and transects respectively. Although rarely recorded during visual surveys the most abundant species caught in fish traps during this study is *Meuschenia freycineti*, the sixspine leatherjacket. Despite becoming an increasingly popular recreational and commercial fishery little is known about the habitat requirements of *M. freycineti*. Knowledge of the local distribution, abundance and movement patterns will aid in the sustainable management of this species.

While many fish species undergo ontogenetic shifts in their habitat requirements, most studies focus on only one life-history stage. Consequently, a knowledge of the links between these different environments is unknown. *M. freycineti* recruits settle to inshore seagrass beds before moving to deeper offshore rocky reefs. I hope to increase our current understanding of both the habitat requirements, and the movement patterns of juvenile and adult *M. freycineti*. This involves tagging larger juveniles within seagrass beds to determine when, and potentially where, these individuals migrate. Tag/recapture studies are currently being conducted at three offshore reefs to assess the local movements of adult *M. freycineti*. Manipulative experiments using artificial reefs will assess the habitat requirements of *M. freycineti*. Factors such as crevice size/number, and algal type will be manipulated to determine the relative importance of these characteristics in explaining the distribution of *M. freycineti* in and around Port Phillip Bay.

Masters of Science

Ecology and demography of the introduced Japanese Macroalga *Undaria pinnatifida* (Harvey) Suringar in Port Phillip Bay

Juanita Bite, Victoria University of Technology.

Undaria pinnatifida (Harvey) Suringar (Phaeophyta: Laminariales, Alariaceae) is a temperate, brown, macroalgae endemic to coastlines of Korea, Japan and China. *Undaria* has become established in a number of locations outside of its native habitats in Asia and has been identified as an exotic pest species. *Undaria* is rapidly spreading in both the northern and southern hemispheres, including France, New Zealand, England, Italy, Argentina, Tasmania (Australia). It was most recently found in 1996 in Port Phillip Bay, Victoria, Australia. The primary vector for spread between sites of infestation is believed to be via ballast water and/or hull fouling of international shipping and other seaborne traffic.

Information on the impacts of introduction of and infestation by *Undaria pinnatifida* in Australasia is extremely limited and in most cases anecdotal only. The tendency of the plant sporophyte to form a dense forest during autumn to spring suggests that competition for space and light may lead to exclusion and displacement of native plants and animals.

There is also very little information available on the biology, fecundity and demography of *Undaria pinnatifida* in the Australasian context. This project is to gain an understanding of the potential impacts and spread of *Undaria* in Australia and therefore is aimed at investigating the biology and demography of the introduced population.

This includes:

- a) the general biology, growth and morphology of the *Undaria pinnatifida* population in Port Phillip Bay;
- b) recruitment strategies of the Port Phillip Bay *Undaria* population. This section will establish the nature of within season recruitment of *Undaria*, i.e. does recruitment of new sporophytes occur from spores released from the previous year (cohort) of growth, or from spores released from within the current years cohort of sporophyte plants;
- c) factors regulating spore germination and gametophyte maturation. The physical factors which may regulate spore germination and gametophyte maturation will be assessed experimentally in the laboratory;
- d) floristic changes in other macroalgae occurring in the *Undaria* population site;
- e) the differences in biology compared to current knowledge of biology elsewhere will be assessed and a literature review of these differences undertaken.

Oestrogenic effects of oil dispersants on flathead, *Platcephalus bassensis*

Caroline Teasdale, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

The purpose of this project is to develop an enzyme-linked immunosorbent assay (ELISA) for the detection of vitellogenin (Vg) to be used as a bioindicator of exposure to dispersed Bass Strait crude oil. Vg is a protein normally produced by females in response to oestrogen or oestrogen mimics. The test species is sand flathead, *Platcephalus bassensis*. The outcomes of the project will allow any oestrogenic

effects of crude oil and dispersed oil to be identified. To determine whether the dispersant is an oestrogen mimic or an oestrogen inducer, plasma oestrogen levels will be measured using a radioimmunoassay (RIA). As the immune system may also be affected by exposure to dispersed oil, the investigation will also include white blood cell differentiation to obtain white blood cell counts. Finally, as a separate measure of exposure, mixed function oxygenase (MFO) activity will be measured to assess the uptake of petroleum hydrocarbons in the fish. The use of realistic exposure concentrations will provide data that can be applied to an oil spill. Results from this study will help determine the suitability of Vg as a biomarker of crude oil or dispersed oil exposure, the mechanism of Vg induction by environmental oestrogens, and the effects of dispersed oil on the immune system.

Honours

Bioassays of abalone egg-laying hormone

Scott Cummins, School of Biological and Chemical Sciences, Deakin University.

Bioassays involved injecting abalone with hormone produced by bacteria in which the abalone egg-laying hormone had been placed using recombinant DNA techniques. Black lip abalone *Haliotis rubra* were injected with 100 microlitres of the hormone, but unfortunately the animals had previously spawned. Further bioassays are being carried out.

The effect of *Undaria pinnatifida* (Laminariales: Phaeophyta) on the feeding abalone species *Haliotis Rubra* (Leach, 1814)

Nadine Cutajar, Victoria University of Technology.

A preliminary investigation to determine whether the brown algae *Undaria pinnatifida* would be grazed in the absence and presence of other algae was conducted on the black-lip abalone *Haliotis rubra*. Two kinds of experiments were conducted. 'No choice' experiments were carried out where abalone were offered one species of algae. The algal species offered were *Ulva lactuca*, *Acrosorium uncinatum* and *Undaria pinnatifida*. 'Choice' experiments were also conducted where abalone were given a choice of two algal species. In the 'no choice' experiments, *Haliotis rubra* grazed on the algae, but the green alga *U.lactuca* was consumed at higher rates than the red alga *A.uncinatum* and the brown alga *U.pinnatifida*. When given a choice, *U.pinnatifida* was not grazed when in the presence of *U.lactuca* or *A.uncinatum*. A mixed diet of *U.lactuca* and *A.uncinatum* was preferred.

Undaria pinnatifida will only be grazed by the abalone *H.rubra* when no other algal species is available. It appears preference may be governed by the nutritional value of the food with factors such as chemical content and morphology of algae also having an influence.

The use of biocidal agents as a potential control mechanism for the exotic kelp species *Undaria pinnatifida*

Jacquelle Gorski, Victoria University of Technology.

To assess the potential use of chemical agents as a control mechanism for the marine macroalga *Undaria pinnatifida*, toxicity assays were conducted using five biocide/algicide agents. Three terrestrial herbicides, Diuron, Simazine and Glyphosate, a commercial antifoulant, Sea nine 211™ and a red algal extract, Furanone 281 were assayed for effect on zoospore germination and gametophyte mortality of *Undaria* and the closely related *Ecklonia radiata*. Germination inhibition and gametophyte mortality were employed as end points in screening bioassays and

concentrations determined at which complete inhibition of germination occurred. The biocides which proved most effective were then assayed for effect on gametophyte mortality. The results suggest relative insensitivity for both algae to the three herbicides and maximum sensitivity for the antifoulant. For both species complete inhibition of germination of zoospores and mortality of gametophytes was achieved for concentrations of Sea nine 211™ in excess of 1.6mgL⁻¹. For Furanone 281 complete inhibition of zoospores and gametophyte mortality occurred between 20mgL⁻¹ and 40 mgL⁻¹.

Use of native fish in environmental monitoring

B.J. Smith, Department of Applied Biology and Biotechnology, Oil Spill Research Group, RMIT.

The use of mixed function oxidases (MFOs) as a biomarker of pollution in Port Phillip Bay was investigated in three indigenous fish species, sand flathead (*Plathycephalus bassensis*), bluethroat wrasse (*Notalabrus tetricus*) and sixspine leatherjacket (*Meuschenia freycineti*). Investigation of the relative MFO induction potential was performed by intraperitoneally injecting each experimental fish species with 100 µg/kg of 3,3',4,4',5-pentachlorobiphenyl (PCB 126) using corn oil as a carrier. Induction was fluorimetrically measured by the activity of 7-ethoxyresorufin O-deethylase (EROD) determined in the livers of the fish 10 days post-injection.

Of the three species tested, the sand flathead was selected as the most suitable indicator species for its high MFO induction potential and desirable characteristics related to its population biology. Bluethroat wrasse appeared relatively uninducible by PCB 126, while sixspine leatherjacket demonstrated a medium induction potential but was unsuitable as a biomonitoring tool because of its scarcity and distribution limited to reef beds.

Food limitation in King George whiting

Anna Syme, The University of Melbourne.

The King George whiting, *Sillaginodes punctata*, is a valuable commercial fish in southern Australian waters. The aim of this Honours project is to determine whether post-settlement individuals of this species are food limited.

Post-settlement King George whiting are found in seagrass habitats around Port Phillip Bay. In the spring of 1997, sampling of the post-settlement whiting has been undertaken in two sites over four 24-hour periods. The stomach contents of these whiting will be analysed to give an indication of prey type and its variation with site, time of day, time of year and size of whiting. Daily ration will be estimated from prey volumes. This will be compared with lab-determined maximum feeding rates.

Food availability may be important in determining the location and success of recruitment. This research will be useful in understanding the recruitment dynamics of the King George whiting.

3rd year projects

A short-term study on the feeding behaviour of captive, post-parous female *Octopus Pallidus*

Britt Anderson, Deakin University.

The feeding behaviour of captive, post-parous octopods was studied in an eight week period using five local *Octopus pallidus* species. Individual feeding behaviours were observed in each octopod. Two octopods continued to feed throughout the duration

of the experiment, one octopod exhibiting weight gain and the other a steady decrease in weight. One octopus did not eat for the entire experiment and two octopods refused to feed after the first week in captivity. These octopods showed a gradual decline in weight during the eight weeks. The mean percentage weight loss was highly correlated between these three octopods and a notable deterioration in the skin occurred as hatching of their eggs neared. Food preference was exhibited by two octopods, eating only one species of crab (*Cyclograpsus audouinii*). Brooding *O.pallidus* spend very little time away from their eggs. They typically remain with their eggs, cleaning them with their suckers and ventilating them with their siphon.

Care of eggs by captive *Octopus Pallidus*

Lee Baumgartner, Deakin University.

Octopus pallidus is a small shallow water octopus which inhabits the waters of south-eastern Australia. Observations of aspects of the reproductive biology involving the care and identification of eggs were investigated and described. The females were observed from the time of egg production until the eggs had neared the completion of their development. The eggs produced were large (9-15mm long) and had a mean weight of 0.11 grams. Females were necessary for prevention of the fouling of eggs and in one case for the reattachment of eggs which had fallen from their anchorage. Deterioration of the females condition was recorded and was seen to be a factor affecting the ability to care and identify for the eggs. Observations over a 24 hour period were conducted and activity over that time period was recorded. The results showed a possibility for the identification of eggs but this could be better revealed with further study.

Grants received

- **Australian Research Council – Queen Elizabeth II Fellowship** \$365,000 (1996-2001). *Causes and consequences of recruitment variation in a seagrass associated fish.* **Dr G.P. Jenkins**, Marine & Freshwater Resources Institute.
- **Australian Research Council** \$13,500 (1998). *Health status of fish populations in Port Phillip Bay.* **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **Australian Research Council** \$130,000 (1997-1999). *The role of meiofaunal food supplies in the recruitment of a temperate demersal fish.* **Dr G.P. Jenkins**, Marine & Freshwater Resources Institute.
- **Department of Industry, Science and Tourism (DIST) Major Grant** \$27,000 (1997-1999). *Environmental assessment of the efficacy of oil spill remediation and restoration technologies.* **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **Fishing Industry Research Corporation** \$48,000 (1996-1997). *Sampling of newly-settled snapper, *Pagrus auratus* and identification of preferred habitats in Port Phillip Bay – a pilot study.* **Dr G.P. Jenkins**, Marine & Freshwater Resources Institute.
- **Fishing Industry Research Corporation** \$160,000 (1995-1997). *Determination of spawning areas for King George whiting in south eastern Australia using hydrodynamic modelling.* **Dr G.P. Jenkins**, Marine & Freshwater Resources Institute.
- **RMIT National Competitive Grant Scheme Support Program** \$51,500 (1996-1999). *Sub-lethal effects of oil spill remediation techniques on Australian Bass, *Macquaria novemaculeata** / includes PhD scholarship support - **Dr M. M. Gagnon and Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **RMIT National Competitive Grant Scheme Support Program Grant** \$10,000 (1997). *Endocrine disruptive effects of crude oil and dispersed oil on fish.* **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **RMIT National Competitive Grant Scheme Support Program Grant** \$20,000 (1997). *Monitoring the ecotoxicity of accidental release of crude oil and oil-spill remedial actions in Australian marine organisms.* **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **RMIT National Competitive Grant Scheme Support Program Grant** \$50,728 (1996-1998). *Use of Octopus as a bioindicator species of inshore marine pollution by oil spills: detoxication enzyme and larval bioassays.* (PhD Student Scholarship). **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.
- **RMIT Research & Development Grant** \$338,500 (1995-1998). *Oil Spill Research Program. Research assessing the toxicity of oil, dispersants, dispersed oil and burned oil residues to Australian marine species; quantitate oil tainting in fish and correlate with biomarkers of oil exposure.* **Professor D.A. Holdway**, Royal Melbourne Institute of Technology.

-
- **RMIT Research & Development Grant** \$8,930 (1997). *Use of mixed function oxidases in fish livers as indicators of environmental health.* **Dr M. M. Gagnon**, Royal Melbourne Institute of Technology.
 - **RMIT Research support during Fellowship** \$24,000 (1996-1999). *Biomarkers as indicators of tainting in fish.* **Dr M.M. Gagnon**, Royal Melbourne Institute of Technology.
 - **Urban Water Research Association of Australia** \$250,000 (1995-1997): Melbourne Water, Barwon Water and S.A. Water grant *Effects of coastal sewage discharges on ecosystem processes involving marine flora* - **Dr. T.R. Burridge**, Victoria University of Technology.

Publications

- Anderson T.J. (1997) Factors influencing habitat association and shelter use of *Octopus tetricus*. *Marine Ecology Progress Series* 150:137-148.
- Bellgrove A., M.N. Clayton, & G.P. Quinn (1997) The effects of secondarily treated sewage effluent on intertidal macroalgal recruitment processes. *Marine and Freshwater Research*. 48: 137 - 46.
- Brumley C.M., V.S. Haritos, J.T. Ahokas and D.A. Holdway (1997 - in press, accepted 01/12/97). Chlorosyringaldehyde metabolites in fish bile as biomarkers of bleached eucalypt pulp effluent exposure: the effects of exposure duration and feeding status. *Ecotoxicol. Environ. Safety*.
- Butty J.S. and D.A. Holdway (1997). Assessment of the octopus *Octopus pallidus* as a potential biomarker species: baseline studies. *Marine Pollution Bulletin*, 34:564-570.
- Gulec I. and D.A. Holdway (1997 in press). The toxicity of laboratory burned oil to amphipods and snails. *Australasian Journal of Ecotoxicology*.
- Gulec I. and D.A. Holdway. Toxicity of dispersant, oil and dispersed oil to two marine organisms. Improving Environmental Protection: Progress, Challenges, Responsibilities. *Proceedings of the 1997 International Oil Spill Conference*, Fort Lauderdale, Florida, USA ISSN No. 75-4161, API Publication no. 4651, pp.1010-1011, 7-10 April 1997.
- Gulec I., B. Leonard and D. A. Holdway (1997). Ecotoxicological assessment of oil, dispersants and dispersed oil combinations on the amphipod *Allorchestes compressa* and the gastropod *Polinices conicus*. *Spill Science & Technology Bulletin*, 4, January 1997.
- Hamer P.A. and G.P. Jenkins (1996). Larval supply and short-term recruitment of a temperate zone demersal fish, the King George whiting, *Sillaginodes punctata* Cuvier and Valenciennés, to an embayment in south-eastern Australia. *J. Exp. Mar. Biol. Ecol.* 208:197-214.
- Holdway D.A. (1997). Truth and validation in ecological risk assessment. Invited paper 'Ecological risk assessment: charlatan or sage?'. *Environmental Management*, 21(6):816-819.
- Jenkins G.P., H.M.A. May, M.J. Wheatley & M.G. Holloway (1997). Comparison of fish assemblages associated with seagrass and adjacent unvegetated habitats of Port Phillip Bay and Corner Inlet, Victoria, Australia, with emphasis on commercial species. *Estuarine, Coastal and Shelf Science*, 44:569-588.
- Jenkins G.P., K.P. Black, M.J. Wheatley & D.N. Hatton. (1997). Temporal and spatial variability in recruitment of a temperate, seagrass-associated fish is largely determined by physical processes in the pre- and post-settlement phases. *Marine Ecology Progress Series*, 148:23-35.
- Jenkins G.P., and C.R. Sutherland (1997). The influence of habitat structure on nearshore fish assemblages in a southern Australian embayment: colonisation and turn-over rate of fishes associated with artificial macrophyte beds of varying physical structure. *J. Exp. Mar. Biol. Ecol.* 218:103-125.
- Pollino C.A. and D.A. Holdway (1997 - *accepted with changes* 09/97). Acute and subchronic toxicity of 4-chlorophenol, cyanazine, endosulfan and copper to two species of hydra. *Australasian Journal of Ecotoxicology*.

-
- Temara, A., I. Gulec and D.A. Holdway (1997 - in press). Oil-induced disruption of the foraging behaviour of the asteroid keystone predator, *Cosinasterias muricata* (Echinodermata). Manuscript submitted to *Marine Biology*.
- Stauber J., L. Gunthorpe, I. Anderson, D.A. Holdway, I. Gulec and K. Kevokordes (1997). Toxicity testing of Melbourne Water's eastern treatment plant effluent - Progress Report. *Study conducted for CSIRO Environmental Project Office* July-November 1997.
- Van Dam R.A., M.J. Barry, J.T. Ahokas and D.A. Holdway (1997 - in press accepted 25/10/97). Effects of water-borne iron and calcium on the toxicity of diethylenetriamine pentaacetic acid (DTPA) to *Daphnia carinata*. *Aquatic Toxicology*,

Conference and Symposia Presentations

- Anderson T.J. and R.C. Babcock. A new means of tagging octopus. Oral presentation. *Australian Institute of Marine Science (AMSA) Conference*, Auckland, New Zealand, July 1997.
- Bellgrove A. Temporal variation in intertidal macroalgal recruitment processes. Poster presentation. *Fourth International Temperate Reefs Symposium*, Santiago, Chile, 21-25 July 1997.
- Bellgrove A. Temporal variation in intertidal macroalgal recruitment processes. Poster presentation. *Australian Society of Phycology and Aquatic Botany '97*, CSIRO Marine Laboratories, Hobart, January 1997.
- Bellgrove A. The effects of molluscan and crustacean herbivores on intertidal macroalgal recruitment. Oral presentation. *Sixth International Phycological Congress*, University of Leiden, The Netherlands, August 1997.
- Bellgrove A. The effects of molluscan and crustacean herbivores on intertidal macroalgal recruitment. Oral presentation. *Fourth International Temperate Reefs Symposium*, Pontificia Universidad Catolica de Chile, Santiago, Chile, 21-25 July 1997.
- Bidwell, J.R., K.W. Wheeler and T.R. Burridge. A short-term bioassay using zoospores of the marine macroalga, *Ecklonia radiata* (Phaeophyta: Laminariales). *Australian Society of Phycology and Aquatic Botany '97*, CSIRO Marine Laboratories, Hobart, January 1997.
- Bidwell, J.R., K.E. Ross and T.R. Burridge. Further development of a bioassay using zoospores of the marine macroalga, *Ecklonia radiata*. 18th Annual Meeting of SETAC - *Society for Environmental Toxicology and Chemistry*, November 1997.
- Burton B. Defence on the rocky platform: dominant grazers, algal deterrence, and an intertidal 'menage a trois'. Paper presentation. *Joint Meeting of Australian Marine Sciences Association and the New Zealand Marine Sciences Society*, The University of Auckland, NZ, July 1997.
- Burton B. Intertidal defence: abundant grazers, algal deterrence and a rocky platform triad. Poster presentation. *Annual meeting of the Ecological Society of Australia*, Charles Sturt University, Albury, NSW, September 1997.
- Burridge, T.R., S.J. Campbell and N. Young. The introduction of Japanese kelp *Undaria pinnatifida* (Harvey) Suringer into Port Phillip Bay, Victoria. *Australian Society of Phycology and Aquatic Botany '97*, CSIRO Marine Laboratories, Hobart, January 1997.
- Campbell, S.J. and T.R. Burridge. Productivity and nutrient uptake by the Japanese kelp *Undaria pinnatifida* in Port Phillip Bay. *Australian Society of Phycology and Aquatic Botany '97*, CSIRO Marine Laboratories, Hobart, January 1997.
- Cohen A.M., M.M. Gagnon and D.A. Holdway. Toxicodynamics of Oil Derived Products in an Australian Coastal Food Chain. *Fourth Annual Conference of the Australasian Society for Ecotoxicology*, Griffith University, Brisbane, 17-19 July 1997.
- Cohen A.M., M.M. Gagnon and D.A. Holdway. Toxicodynamics of oil derived products in an Australian coastal food chain. *Fourth Annual Conference of the Australasian Society for Ecotoxicology Proceedings*, Brisbane, Australia. pp. O6.1, 17-19 July 1997.

-
- Cohen A.M., Oil Spill Research Group, RMIT. The Toxicodynamics of Oil Derived Products in a Marine Coastal Food Chain. Paper presentation. *Fourth Annual Conference of the Australasian Society for Ecotoxicology*, Griffith University, Brisbane, 17-19 July 1997.
- Gagnon M.M. and D.A. Holdway. Biochemical tools as indicators of fish stock recovery following oil exposure. Improving Environmental Protection: Progress, Challenges, Responsibilities. *Proceedings of the 1997 International Oil Spill Conference*, Fort Lauderdale, Florida, USA ISSN No. 75-4161, API Publication no. 4651, pp.1023 (abstract missed deadline & only title published, poster paper handed out at conference), 7-10 April 1997.
- Gagnon M.M. and D.A. Holdway. Biochemical tools as indicators of fish stock recovery following oil exposure. *Fourth Annual Conference of the Australasian Society for Ecotoxicology Proceedings* pp.O2.2., Griffith University, Brisbane, Australia.17-19 July 1997.
- Gulec I. and D.A. Holdway. Toxicity of dispersant, oil and dispersed oil to two marine organisms. Improving Environmental Protection: Progress, Challenges, Responsibilities. *Proceedings of the 1997 International Oil Spill Conference*, Fort Lauderdale, Florida, USA ISSN No. 75-4161, API Publication no. 4651, pp.1010-1011, 7-10 April 1997.
- Gwyther J. Meiofauna of the Barwon Estuary, Poster presentation. *International Conference on Ecology of Estuaries and Soft-sediment Habitats*, Deakin University, Warrnambool, 4-7 February 1997. (Winner of poster award).
- Hamer P., G.P. Jenkins, K. Black and D. Hatton. Predicting King George whiting spawning areas using otolith ageing and hydrodynamic modelling. *Australian Society for Fish Biology*, Darwin, 15-19 July 1997.
- Jenkins G.P., M.J. Keough, and K.P. Black. Factors influencing recruitment of a demersal fish to seagrass beds in a temperate bay. *International Conference on Ecology of Estuaries and Soft-sediment Habitats*, Deakin University, Warrnambool, 4-7 February 1997.
- Jenkins G.P. Factors influencing recruitment of a demersal fish to seagrass beds in a temperate bay. Seminar presentation. *School of Fisheries and Ocean Sciences*, Juneau Centre, University of Alaska, June 1997.
- Jenkins G.P. Factors influencing recruitment of a demersal fish to seagrass beds in a temperate bay. *Twenty-first Annual Larval Fish Conference of the American Fisheries Society, Early Life History section*, Seattle, 26 June-3 July 1997.
- Jenkins G.P. Hydrodynamic numerical modelling studies of the larval input and recruitment of a seagrass associated fish in Southern Australia. *Fisheries Society of the British Isles, International symposium: Ichthyoplankton Ecology*, Galway, Ireland, 8-11 July 1997.
- Long S. Biomarkers of exposure of *Octopus pallidus* to crude and dispersed crude oil. *National Marine Fisheries Service, National Oceanographic and Atmospheric Administration (NOAA)*, Seattle, WA, USA, June 1997.
- Pollino C.A. and D.A. Holdway. Use of two Australian species of hydra for toxicity testing: The acute and chronic toxicity of 4-chlorophenol, endosulfan, cyanazine and copper. *Fourth Annual Conference of the Australasian Society for Ecotoxicology Proceedings*, pp. P.19, Brisbane, Australia. 17-19 July 1997.
- Shir, M. and T. Burrige. The effects of sewage effluent on germination and growth of brown marine macrophytes. *Australian Society of Phycology and Aquatic Botany '97*, CSIRO Marine Laboratories, Hobart, January 1997.

-
- Welsford D. The role of vertical migration in the larval transport and recruitment of *Sillaginodes punctata* in Port Phillip Bay. Oral presentation. *Australian Institute of Marine Science (AMSA) Conference*, Auckland, New Zealand, July 1997.
- Wheatley M.J. Movement patterns of the sixspine leatherjacket, *Meuschenia freycineti*, a temperate reef fish from southern Australia. Oral presentation. *Fourth International Temperate Reef Symposium*, Santiago, Chile, 21-25 July 1997.