

Coastal CRC Conference



Research for Coastal Management

Conference Program
and Abstracts

14 September 2005
Greenmount Beach Resort
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CRC for Coastal Zone
Estuary & Waterway Management



Editor

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Coastal CRC

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[†]Abstracts are listed alphabetically by presenting author.

WELCOME

This conference comes at a particularly important time for coastal management in Australia. The nation's population continues to grow with our coastal population increasing most rapidly. Consequently, impacts on the coast from development, tourism, transport, water consumption, waste disposal and recreation are greater than at any time in our history. However, despite the increases in these pressures there has been little recognition that the coast is a dynamic but fragile zone susceptible to natural and human-induced change.

The naturally dynamic nature of the coast added to the rapid increase in human-induced pressures mean that careful planning and management based on sound research and understanding are crucial. The importance of this informed planning and forward-thinking management is highlighted in the tragic human and environmental impacts of recent coastal disasters such as the Indian Ocean tsunami and Hurricane Katrina.

Most of our coastline has been relatively stable for the past 200, and probably the past 2000 years, but over geological time, and even over the period of Indigenous occupation of Australia, our coastline has changed dramatically. The current period of stability does not represent the long-term future of our coastline. This fact is being increasingly highlighted through predictions of coastal impacts from sea-level rise and climate change and even relatively small-scale events such as the loss of an 'Apostle' from one of our best known national parks.

However, there is a sea change ahead. The 'SeaChange' phenomenon itself is forcing a shift in how we view the coast and coastal management. Governments around Australia, community groups and NGOs are working towards improving management of our coastal assets. Research groups like the Coastal CRC and its Partners are focussing on understanding our coastal zone and the tools needed for better integrated coastal management.

One crucial problem has yet to be solved. This is the need for greater cooperation, integration and communication among the community and the many groups responsible for the coast. However, recent research, the current collaborative activities of coastal agencies around Australia and even the broad mix of stakeholders attending this small conference hint at advances even in this perennial problem area. As in all coastal matters, the weather ahead will not always be favourable. But we can be prepared by working cooperatively through ***research for coastal management***.

Dr Rob Fearon
CEO, Coastal CRC

Conference Organising Committee

Maria Vandergragt – Chair
David Scheltinga
Rachel Mackenzie
Don Alcock

AUSTRALIA'S COOPERATIVE RESEARCH CENTRE FOR COASTAL ZONE, ESTUARY AND WATERWAY MANAGEMENT

The Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management (Coastal CRC) provides tools, understanding and knowledge for managing and protecting Australia's coastal areas and waterways.

The Coastal CRC provides high quality social, economic and environmental research to our partners and stakeholders. Our multi-disciplinary research and development program is shaped by stakeholder needs and scientific understanding.

Research projects developed in partnership with state agencies, local government, research institutions, industry, regional bodies and other stakeholders address environmental pressures and social issues associated with coastal resource use, economics, ecosystem monitoring, habitat loss, beach erosion, water quality, estuarine processes, community governance and regional planning. The projects have resulted in substantial financial savings and economic returns to Coastal CRC partners and stakeholders, and in the long-term, provide significant environmental, social and economic benefits to Australia.

We provide knowledge to manage coastal resources, such as online guides to enhance community involvement in natural resource decision-making and databases to help local authorities manage estuaries. We offer decision-support systems and develop ecosystem health monitoring programs for local groups to protect their natural resources and make better decisions. We develop new technology for remote sensing and coastal water habitat mapping. We facilitate effective local, interstate and international collaboration between coastal scientists, managers, policy-makers, educators and stakeholder groups through joint projects, meetings, conferences, workshops and publications.

The Coastal CRC also supports many outstanding postgraduate researchers and delivers professional training for coastal managers.

CONFERENCE PROGRAM

8:00	<i>Registration</i>	
9:00	Rob Fearon	Welcome
9:05	Maria Vandergragt	Conference overview
<i>Keynote presentation</i>		
9:10	Nick Harvey	Relevance of Global Change for Coastal Management
10:00	<i>Morning tea</i>	

After morning tea the conference will be split into three separate streams. You are welcome to move between streams at anytime but please do this quietly and where possible during the presenter changeover period (a minute or two before the next presentation is due to start).

Stream 1 contains presentations under the themes of *Physical processes* and *Remote sensing* and is located in the ***Rainbow Bay Room***.

Stream 2 contains presentations under the themes of *Coastal management and planning* and *Biology and ecology* and is located in the ***Tweed River Room***.

Stream 3 contains presentations under the themes of *Marine mapping techniques and processes* and *Governance* and is located in the ***Mount Warning Room***.

Full programs for each stream can be found on the following pages.

Please note that the presentation abstracts are listed alphabetically by the presenting author.

Stream 1: *Rainbow Bay Room*

Physical processes		
<i>Chair – John Penrose</i>		
10:30	Ian Webster	The Fitzroy Contaminants Project – a Study of the Dynamics of an Australian Tropical Estuary
10:50	Phillip Ford	Biogeochemical Zonation in Keppel Bay in Relation to the Distribution and Nature of the Underlying Sediment: a Dry Season Perspective
11:10	Simon Costanzo	Antibiotics as Pollutants: Do they Pose a Risk to the Environment and Recycled Water?
11:35	Peter Pollard	Health Impacts of Sewage Overflows into a Tidal Urban Creek of Brisbane
11:55	David Rassam [†]	The Riparian Nitrogen Model: a Tool for Assessing the Role of Riparian Buffers in Catchments
12:15	<i>Lunch</i>	
Physical processes (continued)		
<i>Chair – Ron Johnstone</i>		
1:00	Russell Richards [†]	Modelling Copper Bioaccumulation in the Sydney Rock Oyster
1:20	Steve Arquitt	The Use of Simulation Modelling for Improved Understanding of <i>Lyngbya majuscula</i> Blooms
1:40	Roshan Singh	Seawater Intrusion into the Brisbane River and its Effect on Subsurface Groundwater Quality
2:05	Brad Angel	Investigation of Metal Sources In and Around Port Curtis, Queensland
2:25	Jacqueline Balston	Climate Impacts on the Barramundi and Banana Prawn Fisheries of Princess Charlotte Bay
2:45	Ian Halliday [†]	Estuarine Fisheries That Vary with Freshwater Flow and Implications for Management in the Fitzroy River
3:05	<i>Afternoon tea</i>	
Remote sensing		
<i>Chair – Rob Fearon</i>		
3:35	Stuart Phinn [†]	Remote Sensing for Coastal Ecosystem Indicator Assessment and Monitoring: Benthic Habitat Maps for Moreton Bay
3:55	Vittorio Brando	Simultaneously Mapping Depth, Substrate Type and Water Quality in Cockburn Sound Using Hyperion Satellite Data
4:15	Arnold Dekker	Water Quality Compliance Mapping in the Mossman-Daintree GBR Lagoonal Waters Using Remote Sensing – a Demonstration Project
4:35	Poster Session – Wine and cheese	
6:00	<i>Close</i>	

[†]Coastal CRC Award: short-listed nominee

[†]Coastal CRC Student presenter

Stream 2: Tweed River Room

Coastal management and planning		
<i>Chair – James Whelan</i>		
10:30	Piet Filet	Managing Health Threats to Community Activities in Brisbane Waterways: a Case Study on Program Design and Implementation Needs
10:50	Philip Haines[†]	Existing and Future Management of NSW Coastal Lagoons (ICOLLs)
11:10	Neil Lazarow	Gold Coast Shoreline Management Plan
11:35	Christine Madden	South-east Queensland Regional Coastal Management Planning
11:55	Boyd Blackwell	The Economic Value of Australia's Natural Coastal Assets: Some Preliminary Findings
12:15	<i>Lunch</i>	
Biology and ecology		
<i>Chair – Peter Gehrke</i>		
1:00	Nathan Waltham	Trophic Strategies of Nutrition for Fish in Canal Estates
1:20	Marcus Sheaves	The Road to Ecosystem Collapse
1:40	Ross Johnston[†]	Discrete Depth Distributions of Aquatic Fauna within Isolated Pools
2:05	Leonie Andersen	Antioxidant Enzymes as Biomarkers of Environmental Stress in Oysters in Port Curtis – Field and Laboratory Studies
2:25	Ron Baker[†]	Juvenile Fishes in Estuarine Nurseries: Refugees or Ravenous Predators?
2:45	Jon Knight[†]	Defining Mosquito Hydro-habitats in a Mangrove Forest System by Linking Tidal Hydrology to Substrate Structure
3:05	<i>Afternoon tea</i>	
Biology and ecology (continued)		
<i>Chair – Maria Vandergragt</i>		
3:35	James Seager	Underwater Photogrammetry: Advances with Three-Dimensional Modelling and Laser Projection Systems
3:55	Phillip Ford	Coastal Creeks of Keppel Bay: Uniformity and Diversity in Biogeochemical Performance
4:15	Janine Sheaves[†]	Broad Scale Spatial Changes in the Distribution of Macro-benthic Communities Along Freshwater Marine Gradients
4:35	Poster Session – Wine and cheese	
6:00	<i>Close</i>	

[†]Coastal CRC Student presenter

Stream 3: Mount Warning Room

Marine mapping techniques and processes		
<i>Chair – Bob Noble</i>		
10:30	Gary Kendrick [‡]	Predictive Mapping of Seafloor Substrate and Biota at Point Addis Marine Park, Victoria
10:50	Cass Castalanelli [‡]	Marmion Marine Park Habitat Mapping Systems Trials 2004
11:10	Anthony Boxshall	Using Science to Manage Coastal and Marine Environments – a Victorian Park Agency Perspective
11:35	Des Lord	Mapping Marine National Parks Along the Victorian Coast: the Coastal CRC/Parks Victoria Partnership
11:55	Iain Parnum [†]	The Application of Multibeam Sonar in Benthic Habitat Mapping
12:15	<i>Lunch</i>	
Governance		
<i>Chair – Rachel Mackenzie</i>		
1:00	Peter Oliver and James Whelan [‡]	Barriers and Bridges to Collaborative Natural Resource Management
1:20	Darryl Low Choy	Increasing the Bang For Your Buck: Opportunities for Incorporating Coastal and Waterways Science into Traditional Planning
1:40	Peter Hoppe [‡]	Empowered Participatory Governance: a Working Model
2:05	Stewart Lockie	Developing Meaningful Social Indicators for Coastal Resource Management: Validity, Significance and Democratisation
2:25	Lynne Turner	Environment Reporting Initiatives to Support Effective Coastal Management
2:45	Ian Ramsay	Improved Monitoring and Modelling Knowledge for Coastal Management
3:05	<i>Afternoon tea</i>	
Governance (continued)		
<i>Chair – Don Alcock</i>		
3:35	Roger Shaw	Ideas for Synthesising Knowledge to Minimise Unintended Outcomes
3:55	Lachlan Newham	An Integration Tool to Assist in the Management of Coastal Lake Catchments
4:15	Rachel Mackenzie	The National Water Quality Management Strategy Workshops. Building Water Management Capacity Around Australia
4:35	Poster Session – Wine and cheese	
6:00	<i>Close</i>	

[‡]Coastal CRC Award: short-listed nominee

[†]Coastal CRC Student presenter

LIST OF POSTERS

Acoustic Mapping of Estuarine Benthic Habitats: Results of a Trial in Wallis Lake, N.S.W., **David Ryan** and **Brendan Brooke**

Acoustic Mapping of the Great Barrier Reef Seascape, **Thomas Stieglitz**

Analysis and Development of a Marine Science Oriented Software Application for Benthic Sampling, **James Wise** and **James Seager**

Assessing the Impacts of Coastal Ecosystem Health on Human Well-being, **Melanie Cox**

Autotrophic and Heterotrophic Productivity, **Peter Pollard**

Beach State Classification Using Features from a Cross-shore Dissipation Profile, **Matthew Browne**, **Rodger Tomlinson** and **Darrell Strauss**

Brisbane River Water Quality – Automated Monitoring, **Regina Counihan** and **David Scheltinga**

Cost Effective Habitat Mapping from Small Vessels Using Sidescan Sonar and Video, **Andy Bickers**

Decision Support for Sustainable Management of Urban Stormwater, **Linda Cobiac**

Developing a Cost-effective Method of Classifying and Predicting Marine Habitats: an Integrated Approach Applied to the Recherche Archipelago, Western Australia, **Katrina Baxter**

Ecosystem Goods and Services Provided by Wetlands, **Jackie Robinson**, **Sean Ryan**, **Tara Cully** and **Jungho Suh**

Estimating Onshore Break Size from a Global Wind-wave Model Using Neural Networks, **Matthew Browne**, **Rodger Tomlinson** and **Darrell Strauss**

Gold Coast Oceanway – People Moving Along the Gold Coast, **Greg Stuart**

Historical Coastlines: Community Perspectives, **Coastal CRC HC1 Project**

How Vulnerable are the Coastal Lowlands of Native Dog Creek to Acidification?, **Julie Anorov**

Implementation of Genetic Programming Toward the Improvement of Acoustic Classification Performance for Different Seafloor Habitats, **Yao-Ting Tseng**, **Alexander Gavrilov**, **Alec Duncan**, **Michael Harwerth** and **Sara Silva**

Investigating the Role of Freshwater Flows in Sustaining Estuarine Fisheries Production, **Coastal CRC FH3 Project**

Metal Bioaccumulation Through Food Web Pathways in Port Curtis, **Leonie Andersen, Andy Revill and Andrew Storey**

Modelling the Accumulation of Copper in the Sydney Rock Oyster (*Saccostrea commercialis*), **Russell Richards**

Moreton Bay – Remote Sensing Phase 1 – Project Outcomes 2000-2003, **Arnold Dekker, Vittorio Brando, Alex Held, Janet Anstee, Alan Marks, Paul Daniel, Stuart Phinn, Chris Roelfsema and Peter Scarth**

Port Curtis Integrated Wetlands Mapping, **Karen Danaher**

Predicted Consequences of Increased Nutrient Inputs to Saint Georges Basin, NSW South Coast, **Emma Murray, David Heggie, Craig Smith and Ralf Haese**

Receiving Water Quality Modelling, **Coastal CRC SM Project**

Review of On-site Wastewater Management Practices in SEQ, **Cara Beal, Ted Gardiner, Col Christiansen and Peter Beavers**

Small Fish are Important Predators in Shallow Nursery Habitats, **Ron Baker**

South East Queensland's Sustainable Human Carrying Capacity, **Michelle Graymore**

The Effects of Fluctuating Copper Exposure on the Marine Algae *Phaeodactylum tricornutum*, **Brad Angel, Stuart Simpson, Simon Apte and Dianne Jolley**

The Quantification of Submarine Groundwater Discharge in the Coastal Zone Via Multiple Methods – a UNESCO/IAEA Initiative, **Thomas Stieglitz, William Burnett, Henry Bokuniewicz, Jaye Cable, Matt Charette, Evgeny Kontar, Steve Krupa, Willard Moore, June Oberdorfer, Pavel Povinec and Makoto Taniguchi**

The Trophic Implications of Life History Changes for the Function of Estuarine Fish Nursery Habitats, **Jane Wilson**

Trophic Structure of a Tropical Estuarine Fish Assemblage in an Intertidal Bay, **Jane Wilson, Ronnie Baker and Marcus Sheaves**

KEYNOTE SPEAKER PROFILE

Professor Nick Harvey

The University of Adelaide, Adelaide, SA

Professor Nick Harvey has 30 years of coastal research experience in locations such as the Great Barrier Reef, much of the South Australian coast and more recently a number of Pacific islands. In 1996 he was the convenor of the 2nd national coastal management conference 'Coast to Coast' and was also a member of the South Australian Coast Protection Board for 7 years from 1996 to 2002. He has written over 100 scientific papers and books, including many on coastal science and management. In 2003 Professor Harvey, with co-author Brian Caton, produced a comprehensive book called *Coastal Management in Australia* which was published by Oxford University Press.

Professor Harvey has extensive academic experience. He has held a number of senior positions at the University of Adelaide in South Australia, including Director of the Graduate Centre for Environmental Studies (1995-1998); Head of Geography and Environmental Studies (1998-2004); Executive Dean of the Faculty of Humanities and Social Sciences (short-term in 1999 and again in 2001-2002); Associate Dean (Research) of the Faculty of Humanities and Social Sciences (1999-2004). In addition he has 7 years of non-academic scientific experience when he was a full-time employee of the South Australian Government (1984-1991) in its Environmental Impact Assessment Branch.

Professor Harvey has a wide international experience in coastal science. He was Vice-Chair of the international scientific steering committee for LOICZ (Land-Ocean Interactions in the Coastal Zone) from 1997-2002. He is one of a number of lead authors who contributed to the LOICZ book *Coastal Fluxes in the Anthropocene*, published by Springer in 2005, outlining how world coasts respond to global change. He is currently Chair of the international START-Oceania committee dealing with global change research and is scientific leader for an APN (Asia-Pacific Network for Global Change Research) project into global change implications for coastal management in the Asia-Pacific region. Professor Harvey is also one of the 8 authors of the Australia and New Zealand chapter for the next IPCC (Intergovernmental Panel on Climate Change) assessment of the global impacts of climate change.

CONFERENCE ABSTRACTS

Antioxidant Enzymes as Biomarkers of Environmental Stress in Oysters in Port Curtis – Field and Laboratory Studies

Leonie Andersen¹, William H.L. Siu², Eric W.K. Ching², C.T. Kwok² and Paul K.S. Lam²

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¹Central Queensland University, Gladstone, QLD / Coastal CRC

²City University of Hong Kong, Hong Kong

Previous studies in Port Curtis have identified bioaccumulation of some metals in resident and transplanted oysters in the inner harbour area in comparison to outer harbour reference sites. The question arises as to whether there is a deleterious biological effect on the organisms from the contaminant exposure. Antioxidant enzyme responses of deployed oysters in the field and copper exposed oysters in the laboratory were investigated as biomarkers of oyster stress. The enzymes are produced by aerobic organisms to deal with oxidative stress often caused by exposure to pollutants.

In the field experiment Glutathione S-transferase (GST), Catalase (CAT), Lipid peroxidation (LPO) and Glutathione (GSH) were measured in the gill and hepatopancreas of oysters deployed at an impacted and reference site. Subsamples of oysters were collected on eight occasions over a four-week period and analysed for both enzymes and accumulated metals.

In the laboratory, experiment replicate oysters were exposed to five serial dilutions of copper up to the addition of 30 µg/L. Subsamples of oysters were collected on eight occasions over a four-week period and analysed for both enzymes and accumulated copper.

Preliminary results of correlations between oyster enzyme responses and oyster copper or metal accumulation will be presented and discussed.

Investigation of Metal Sources In and Around Port Curtis, Queensland

Brad Angel^{1,2}, Stuart Simpson¹, Simon Apte¹ and Dianne Jolley²

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¹CSIRO Energy Technology, Bangor, NSW / Coastal CRC

²The University of Wollongong, NSW

Port Curtis is a rapidly growing industrial harbour in central Queensland. Although a recent risk assessment of contaminants in Port Curtis did not identify dissolved metals as contaminants of concern, there was evidence of enrichment of some metals in some biota inhabiting the harbour. To investigate possible sources of metal contaminants, two water sampling surveys were undertaken in late 2004 and 2005. Sampling and analyses of trace metals in waters and suspended solids was undertaken along axial transects extending away from possible point sources within the harbour. Further sampling was undertaken within selected inlets and the Fitzroy River.

Metal concentrations in coastal waters adjacent to Port Curtis were observed to be low and were comparable to other uncontaminated coastal sites around Australia. Cadmium and lead were at low parts per trillion concentrations in all water samples. Dissolved zinc and copper concentrations ranged from <31 to 580 ng/L and <19 to 800 ng/L, respectively, and had concentration maxima in the harbour adjacent to the entrance to The Narrows. Dissolved nickel concentrations ranged from 110 to 900 ng/L and had a concentration maxima further up The Narrows near Ramsay's crossing.

The area where dissolved copper, nickel and zinc had maxima was also accompanied by maxima in suspended solid-bound aluminium and iron. This region also generally had a lower water pH and higher salinities.

The highest dissolved concentrations of nickel (1,760 ng/L) and copper (1,290 ng/L) occurred in the Fitzroy River, with copper being only slightly below the regulatory guideline trigger value. All metal concentrations detected were below ANZECC guidelines.

The Use of Simulation Modelling for Improved Understanding of *Lyngbya majuscula* Blooms

Steve Arquitt¹ and Ron Johnstone²

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The causes of environmental problems can be difficult to understand due to complex webs of feedback loops, stochastic effects and long delays between perceived causes and effects. Furthermore, it is often impracticable or unethical to conduct field experiments. If no hypothesis is generally accepted by stakeholders as a 'best current explanation' of problem behaviour, it is unlikely that an effective mitigative policy can be designed and implemented. Formal simulation modelling using the theories and methods of System Dynamics allows us to come to terms with feedback effects, information delays and other barriers to learning. The formal model articulates an explicit hypothesis of system behaviour, and provides a controlled environment in which virtual experiments can be performed to challenge and improve the hypothesis and to design mitigative policies. Stakeholder involvement in the modelling process can facilitate debate and consensus building.

We have developed a System Dynamics model to offer an explanation of harmful blooms of the blue green algae *Lyngbya majuscula*. The model embodies the hypothesis that *Lyngbya* is iron limited and that blooms are initiated and perpetuated in response to increased concentrations of bioavailable iron. Our prime objectives are to: (1) provide a forum for debate and discussion among stakeholders; and (2) provide a means for focussing and coordinating empirical investigations. To accomplish the first objective, input from stakeholders has been invited through a series of presentations and workshops. Also, we have attempted to make the model transparent and user-friendly. To accomplish the second objective, simulation is used to assess the sensitivity of the system to uncertain parametric and structural assumptions. Assumptions that are both uncertain and influential to the system behaviour are identified as candidates for further field or laboratory research. The model is then tested with updated estimates, and another round of sensitivity analyses based on a revised model is conducted in an iterative hypothesis-building cycle.

Juvenile Fishes in Estuarine Nurseries: Refugees or Ravenous Predators?

Ron Baker¹ and Marcus Sheaves

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James Cook University, Townsville, QLD / Coastal CRC (¹Student)

Shallow estuarine habitats around the world are considered as critical nurseries for a range of juvenile fishes of commercial, recreational and ecological importance. Reports of the presence of only low numbers of large predatory fishes occurring in these habitats have led to the widely held view that shallow water nurseries provide juvenile fishes with a refuge from predation. However, detailed examination of the dietary habits of a range of fishes sampled from shallow water nurseries has revealed a diverse and complex assemblage of predators that prey on juvenile fishes.

A range of small fishes that inhabit shallow estuarine nurseries, such as gobies, glass perch, and juveniles of common species including whiting, bream and flathead, normally include fish as only a small proportion of their diets. Consequently, these are often considered as unimportant or 'minor' predators. However, many of these species are capable of switching feeding behaviour to prey on new fish recruits entering the nursery. Periodically, a high proportion (up to 90%) of individuals from a variety of these species were found to be feeding on fish. At such times, the fish prey consumed were found to be primarily small new recruits, indicating a switch in the diet of these 'minor' predators in response to recruitment events.

Many of these 'minor' predators are highly abundant members of the shallow-water nursery assemblage, and combined, may inflict a large proportion of the predation pressure on new recruits. These previously overlooked small and occasional predators may play a significant role in shaping estuarine fish communities through their predation on new recruits within the shallow water nursery.

Climate Impacts on the Barramundi and Banana Prawn Fisheries of Princess Charlotte Bay

Jacqueline Balston

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Queensland Department of Primary Industries and Fisheries, Cairns, QLD / James Cook University, Cairns, QLD / Coastal CRC

Princess Charlotte Bay (PCB) lies approximately 340 km north of Cairns on the east coast of Cape York Peninsula and has a climate typical of a tropical, monsoonal area. The Bay is fed by a number of large rivers and countless smaller streams which join together during the wet season to form extensive wetland and swamp areas. The foreshore and estuaries are dominated by extensive saline flats which front dense mangrove forests and seagrass habitat in inshore areas of the bay. These habitats are ideal for barramundi and other estuarine and inshore species such as the banana prawn. The original vegetation and ecosystems have remained relatively undisturbed and the catchment as a whole is classified as near pristine / relatively undisturbed with little anthropogenic influences on the fishery.

Both barramundi (*Lates calcarifer*) and banana prawn (*Penaeus merguensis*) are important commercial fisheries in the bay, and exhibit dramatic inter-annual fluctuations in catch. This has been attributed by fishers, and some research from other regions, to variations in climate including freshwater flows, rainfall, temperature and wind. This study is aimed at quantifying the potential impact of natural climate variability on each of these fisheries in PCB through the application of correlation and regression modelling in conjunction with a conceptual model explaining the life history of each species. Local commercial catch data was adjusted for effort and analysed against a suite of climate parameters at the seasonal and annual scale including freshwater flow into the bay, maximum and minimum air temperature, sea surface temperatures in the bay, local averaged rainfall, U-wind (zonal) and V-wind (meridional) vectors, evaporation and climate indices for the Madden Julian Oscillation (MJO) and Southern Oscillation (SOI).

A forward stepwise ridge regression model for barramundi developed using only climate variables explained 67.6% of the variance in catch adjusted for effort (rainfall July-September⁻² (lagged by two years), annual evaporation⁻² and October-December SOI (no lag)). The second model using only climate forecasting indices explained 53.1% of the variance in catch adjusted for effort (October-December SOI (no lag), July-September SOI⁻² and MJO Phase 4⁻¹). However, each of these models required data collected in the year of catch and so did not allow time for a management response. A model using only variables lagged by two or more years (the time corresponding with the growth of the fish from spawning to commercial size), included rain July-September⁻², evaporation annual⁻² and sea surface temperature January-March⁻² and explained 62.7% of the variance in catch two years later ($p < 0.05$).

Correlation and regression analysis of banana prawn catch against seasonal and annual climate parameters in the year of catch failed to find any significant correlations ($p < 0.05$). A forward stepwise ridge regression model for banana prawns using average March-April zonal wind (east-west), rainfall July-September and rainfall October-December, explained 42.6% of the variance in catch adjusted for effort in the same year ($p < 0.1$). To improve the model, future work could focus at a monthly or even daily scale as these results suggest that either the impact from climate on banana prawns in PCB is not strong, or limitations in data (small commercial fishery) or analysis (annual and seasonal scale) are masking any stronger relationships.

The Economic Value of Australia's Natural Coastal Assets: Some Preliminary Findings

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Although most Australians hold the country's natural coastal assets in high regard, the total dollar value of goods and services provided by these assets remains relatively unknown for Australia. However, individual studies examining the value of particular ecosystem services provided by coastal natural resources have been conducted but not in an aggregated and nationally focused way for Australia.

An attempt to bridge this gap in knowledge is being undertaken by a Coastal CRC project. The project has approached the problem of placing an economic value on the 'ecoservices' of Australia's natural coastal assets from two fronts. First, by undertaking a preliminary macro-level assessment using values estimated by Costanza *et al.* (1997) on a per area basis and multiplying these by the area of Australia's various coastal biomes. Preliminary results from this first step suggest that, for some 'biomes' where the previous global assessments provide estimates (beaches are not included), estuaries appear to be the most valuable per square kilometre for their ecoservices, such as removing nutrients from waste water, providing for storm and flood protection, transportation and fisheries. On a total value basis, Australia's continental shelf appears the most valuable asset, due to its size, followed by open oceans, seagrass beds, estuaries, coral reefs and mangroves. Beach ecoservices and values are yet to be determined.

The next step of the project is to collect data for a micro-based economic assessment in order to eventually compare results with the initial macro-assessment.

A draft discussion brief is available.

Using Science to Manage Coastal and Marine Environments – a Victorian Park Agency Perspective

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Parks Victoria, Vic

Parks Victoria is responsible for the management of 18% of Victoria which includes an extremely diverse array of landscapes, ecosystems, cultural values and visitor opportunities and services. Close to 65% of coastal land is managed by Parks Victoria. Approximately 5% of the Victorian marine waters (out to 3 nm from the coast) are managed as a system of 24 Marine National Parks and Sanctuaries, which were declared in 2002. Parks Victoria recently became an associate member of the Coastal CRC.

This presentation will give some background on the approach that Parks Victoria takes to managing natural resources and how science and scientific information fits in. I will outline the broad framework that underlies the Parks Victoria approach to research and monitoring – one loosely based on Pressure-State-Response theory but treated as Threats-Condition-Management Action where threats are potential targets for management action and serve as a proxy for maintenance or improvement of 'condition'.

I intend to give a short overview on one of the main research delivery models used: the 'Research Partners Panel', a panel of university and other research providers engaged by Parks Victoria to work as partner organisations in research.

I will finish with three examples of marine and coastal research or monitoring programs highlighting how the objectives and outcomes fit into the management of coastal and marine areas. First is a state-wide reef monitoring program to build marine baseline monitoring. Second is a broad agency partnership to develop a decision-support system to support the artificial opening of estuaries. Finally, I will discuss the marine habitat mapping partnership with the Coastal CRC – specifically the Coastal Water Habitat Mapping section of the CRC.

Simultaneously Mapping Depth, Substrate Type and Water Quality in Cockburn Sound Using Hyperion Satellite Data

Vittorio E. Brando, Arnold G. Dekker and Janet Anstee

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CSIRO Land and Water, Canberra, ACT / Coastal CRC

A component of the Coastal CRC's Coastal Water Habitat Mapping (CWHM) project is to compare the results of acoustical and hyperspectral mapping data of substrate type and cover. We present here the results for the hyperspectral satellite-based mapping of Cockburn Sound (Western Australia) of depth, substratum and optical water quality indicators.

This presentation describes the data collection, processing, mapping and validation processes used to meet this goal. Satellite images of Cockburn Sound were collected separately from field sampling of benthic cover, depth and water optical properties. Field survey data were collected as part of the CWHM project that focussed more on the acoustic-based remote sensing of the substratum. The field data is a georeferenced set of measurements of depth, benthic cover type (to species level), seagrass biomass and the level of cover. Each image data set was subject to correction of its top of atmosphere (satellite) pixel values to remove atmospheric and air-water interface effects (sun glint) so that the information for the classification is based on the actual colour of the water body and substratum cover type.

Optimisation-inversion algorithms were applied to each pixel to simultaneously map seagrass species composition and cover, water depth and water column composition in terms of chlorophyll, total suspended matter and coloured dissolved organic matter. These maps will be used to make a comparison of hyperspectral satellite-based and *in situ* acoustic-based mapping methods in the near future.

Marmion Marine Park Habitat Mapping Systems Trials 2004

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Fugro Survey Pty Ltd, in partnership with the Coastal CRC, initiated a series of equipment trials and habitat assessment protocols within the Marmion Marine Park in Western Australia in November 2004, over an area of approximately one square kilometre. The area contains an array of habitats typical of the region including reef, sand, macroalgae and seagrass.

A systematic comparison was made of the main systems that are used internationally for habitat mapping, including the GeoAcoustics GeoSwath, Reson 8125, Reson 8101 Multibeam systems and the Klein 5500, Atlas C-Max and EG&G 260 Side Scan Sonar systems. Acquisition, processing and analysis of the data were all undertaken under closely controlled conditions, establishing the Marmion Marine Park as an important reference site for marine habitat mapping.

The assembling of leading edge technologies into a rigorous side-by-side field comparison, in a real world situation, provided a set of information as well as the experience from which robust decisions on cost-effective mapping of large areas of shallow marine habitats could be made. Importantly, multibeam backscatter information from these trials has enabled the development of procedures that further support the prospect of this replacing traditional sidescan sonar.

This project provided the base information and decision-making process for the equipment, survey design and data deliverables of the Hydro-Acoustic survey for Parks Victoria and additional habitat mapping off the Victorian coastline, as well as for further habitat assessment programmes that are now planned for the Ningaloo Marine Park (WA), and a large portion of the South-west Coast of Western Australia.

Antibiotics as Pollutants: Do They Pose a Risk to the Environment and Recycled Water?

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The high consumption rate of water per capita in Australia coupled with the lack of substantial water supplies has placed Australia in the precarious situation of facing sustained water shortages. Recent attention has been directed towards wastewater re-use in Australia to alleviate some of this water stress and improve water management practices. The presence of pharmaceuticals such as antibiotics is an issue in wastewater re-use that has received little attention in the past. Despite their widespread use as medicines and growth promoters (>700,000 kg/yr in Australia), these chemicals have also received comparatively little attention as pollutants in the aquatic environment. Current wastewater treatments are mostly ineffective in the complete removal of antibiotics and as a result, antibiotics have been identified in effluent waste and receiving waters all over the world. The presence of antibiotics in wastewater effluent and receiving waters are of concern for the following reasons: (1) contamination of water used for drinking, irrigation and recreation; (2) potential to accelerate widespread bacterial resistance to antibiotics; and (3) negative effect on important ecosystem bacteria (e.g. denitrifying bacteria).

In this study, concentrations of 26 antibiotics were assessed in recycled wastewaters and effluent discharged into aquatic environments from three Brisbane sewage treatment plants with different treatment technologies. Bacterial resistance to antibiotics was also assessed to provide information on potential ecosystem effects from these emissions. Results indicated that all treatment plants were efficient at removing antibiotics with an average removal rate of 83%. However, antibiotics were detected in all effluents in low concentrations ($\mu\text{g/L}$), including two plants designed for wastewater re-use. Antibiotic resistance in *Escherichia coli* and faecal *Enterococci* was also demonstrated within the sewage plants to a range of antibiotics.

This preliminary information regarding antibiotics in our waterways highlights the need for further investigations on sources, fates and management of wastes containing these and other pharmaceutical compounds.

Water Quality Compliance Mapping in the Mossman-Daintree GBR Lagoonal Waters Using Remote Sensing – a Demonstration Project

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Results are presented from a project undertaken for the Coastal Catchments Initiative in the Mossman-Daintree region to assess the utility of satellite remote-sensing for monitoring of chlorophyll and suspended sediment concentrations in the nearshore coastal waters of the Great Barrier Reef. The image data is provided by the two MODIS (MODerate resolution Imaging Spectroradiometer) sensors currently in operation. One objective of this project was to trial and demonstrate the feasibility, utility and accuracy of routine remotely-sensed measurement of suspended sediment and chlorophyll concentration covering the Cairns to Cape Tribulation coastal waters. The second objective was to develop a methodology and derived product(s) that can be used by environmental management agencies to measure compliance of coastal and estuarine waters with specified water quality objectives. Examples of a full year of MODIS Aqua data (approximately 300 scenes) for chlorophyll and total suspended matter will be presented in the form of daily, weekly, monthly and yearly images derived products, including water quality compliance maps.

Managing Health Threats to Community Activities in Brisbane Waterways: a Case Study on Program Design and Implementation Needs

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As urban centres grow, community use of their local creeks and waterways increases. As a duty of care for local government, there is need to ensure that any public health risks are managed in these locations.

Brisbane City Council has a range of existing water management roles, but how can it expand its responsibilities to consider health threats in local waterways? In this presentation, an approach is discussed. The initial elements of the approach rely on using local information and having an informed prioritisation process, with both embedded in sound-science principles.

Aim: facilitate safe community activities in and around local waterways.

Program elements include:

1. local information – provide baseline information on health issues and community activities from which the status and progress can be measured;
2. techniques to prioritise needs – utilise a suite of nested risk assessment techniques to deal with the variations in spatial extent and severity of impacts;
3. implementation – establish the function, roles and responsibilities of Council efforts to manage waterways and add targeted health protection and management tasks; and
4. evaluation – assess Council efforts on the management of health threats, at policy, program and practice levels, for their benefits to community activities in waterways.

For this program to work a number of science and information issues arise, namely:

- what are the local issues, in terms of hazard contaminants and disease consequences?;
- what are the current and future waterway use activities that may or may not be at risk?;
- how suitable are the various national and industry risk assessment and risk management frameworks?;
- what level of cross agency and regional collaboration is needed to avoid duplication?; and
- how do we know if risks are being adequately managed?

Coastal Creeks of Keppel Bay: Uniformity and Diversity in Biogeochemical Performance

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Four major coastal creeks connect to Keppel Bay in close proximity to the mouth of the Fitzroy River. Collectively, they have a volume and surface area comparable to the Fitzroy estuary. Unlike the Fitzroy estuary, where most of the large dissolved nutrient and sediment loads are sourced well upstream from the large catchment, these creeks all have very small catchments that contribute relatively small nutrient and sediment loads. Rather, the dominant source of sediments and particulate nutrients to these coastal creeks appears to be particulate material from the Fitzroy deposited by flood events at the mouth of the Fitzroy River. The flood delivered solid material is subsequently resuspended and delivered into the mouths of the coastal creeks.

The biogeochemical response to these inputs varies from creek to creek depending on the loading of material, the rate of breakdown of the particulate organic material to produce dissolved inorganic nutrients, and the capacity for *in situ* primary production within the creek governed by the light climate. These local factors, together with the differing hydrodynamics of the different creeks, interact to produce markedly different behaviour in the various creeks. Three creeks act as sources of dissolved nutrients to Keppel Bay, while one is clearly a sink for dissolved nutrients.

We use a simple model (Smith and Atkinson, 1983) to estimate the size of the nutrient fluxes either to, or from, the creeks. Finally, we comment on the ecological implications of the biogeochemical differences between these superficially similar systems and the implications for management.

Biogeochemical Zonation in Keppel Bay in Relation to the Distribution and Nature of the Underlying Sediment: a Dry Season Perspective

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The strategic rationale of the Coastal CRC's Fitzroy Contaminants project is to develop better systems understanding and predictive capability for the transport, transformation and impact of nutrients and sediments in the Fitzroy River estuary and Keppel Bay.

The Fitzroy River, together with the Burdekin River, are responsible for the largest inputs of sediment and nutrients to the lagoon of the Great Barrier Reef (GBR). Therefore, as we are examining the fate and impact of contaminants within the zone fringing the GBR, results from this study, together with those from other Coastal CRC projects in the Fitzroy region, will support the recently implemented Reef Water Quality Protection Plan (<http://www.deh.gov.au/coasts/pollution/reef/>).

This presentation will highlight some interesting biogeochemical results from two dry-season surveys of Keppel Bay undertaken in September 2003 and August 2004. These preliminary findings include evidence for: (1) a potentially important role for iron oxy-hydroxide reduction in the breakdown of organic matter; (2) the dynamic nature of organic nutrients in Keppel Bay (dissolved organic nitrogen and dissolved organic phosphorus); (3) the utilisation of nitrogen by (possibly) heterotrophic bacteria in the region of Keppel Bay underlain by Fitzroy River sediment; and (4) zones of dominant phytoplankton assemblages (pico-plankton-dominated, micro-phytoplankton dominated and mixed pico-plankton and micro-phytoplankton) that correlate best with the amount of phosphorus in organic forms.

Importantly, these findings illuminate the biogeochemical functioning of turbid, tide-dominated estuaries, which are poorly understood in Australia.

Existing and Future Management of NSW Coastal Lagoons (ICOLLs)

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Coastal lagoons are relatively common along the South-east Australian coastline, where they are technically known as Intermittently Closed and Open Lakes or Lagoons (ICOLLs). Most coastal lagoons in NSW are closed for the majority of the time, and environmental processes have evolved to accommodate the natural variability in water level that results from sustained entrance closure. ICOLLs within NSW contain a diverse range of physical, chemical and biological environments, which to a large degree, is a function of their entrance conditions.

Due to risks of inundation to a range of private and public assets and infrastructure around the foreshores, the ocean entrances of many ICOLLs are artificially opened when water levels get high, but still much lower than the maximum water levels that would be reached before natural entrance breakout. Truncation of the water level regime results in a series of hydrodynamic changes that permeate through the whole physical, chemical and biological spectra of ecosystem processes. Key changes include, exacerbated shoaling of the flood-tide delta, and 'terrestrialisation' of fringing wetland habitats.

The demand for future development along the NSW coast is likely to intensify the need for pragmatic and scientifically defensible management decisions to achieve ecological sustainability of these precious natural resources, including decisions regarding future entrance manipulation. In addition, ICOLLs are also susceptible to future climate change. Rising sea level will translate to an equivalent increase in typical ICOLL water levels, as these levels are controlled by coastal processes, which influence the entrance berm and channel morphology. Given the pressures of development and rising sea level, pressure on ICOLLs is being applied from both directions.

Future management of ICOLLs will need to address the need for perpetual entrance manipulation, appropriate setbacks of development from the waterway and sustainable usage of the environment, including both commercial and recreational demands (which can be highly seasonal).

Estuarine Fisheries That Vary with Freshwater Flow and Implications for Management in the Fitzroy River

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In central Queensland, the annual commercial catch of barramundi has fluctuated in a cyclical nature between 10 and 40 tonnes over the 6 decades for which data are available. The decadal scale fluctuations are significantly correlated to stream-flow and coastal rainfall within the region, with the highest catches being recorded 3 to 4 years after successive wet summers. These fluctuations have occurred despite extensive changes within the catchment that include land clearing for agriculture, construction of numerous dams and weirs and a tidal barrage that obstructed upstream fish passage and halved the area of the estuary, and the introduction of numerous fisheries regulations.

High coastal rainfall and high stream-flow in summer allows high survival (i.e. recruitment) of young-of-the-year barramundi producing a strong year-class that can be followed through the population over many years.

Greater knowledge of the role of freshwater in the lifecycles of estuarine fish and the effects of the flow duration, timing and volume is needed to assist in assessing risks to the sustainable management of fish in rivers with variable flow. The delivery of this information to water and fisheries managers has provided the detail needed to account for variability in the population and flow-related risk when setting targets and outcomes of water or fishery management scenarios.

The provision of information targeted to a wide range of stakeholders has allowed an informed public to become involved in these planning processes.

Relevance of Global Change for Coastal Management

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The Intergovernmental Panel on Climate Change (IPCC) is currently preparing its Fourth Assessment Report, due in September 2007, including a volume on Impacts, Adaptation and Vulnerability, which is of direct relevance for linking science and policy in areas such as coastal management. This presentation will first outline the IPCC climate change assessment process as a background for determining global change impacts on the coast.

The presentation will then examine the impact of global change on coastal management in the Asia-Pacific Region based on a review recently commissioned by The Asia-Pacific Network for Global Change Research (APN), comprising 21-member countries. The aims of the review included: an evaluation of previous APN-funded coastal projects; an assessment of current issues for Asia-Pacific coasts; and most importantly an identification of future global-change research directions relevant for coastal management in the region. A key finding from the review was the need to develop more effective science-policy interaction.

The APN review identifies global change issues for the Asia-Pacific region, the most important of which is global warming and accelerated sea-level rise. The potential impacts from this are compounded by current issues, such as unsustainable use of coastal resources, coastal impacts from poor catchment management, population increase and urbanisation pressure, and coastal resource and development pressure on rural coasts. Methods for tackling these issues, such as integrated coastal management, have few examples of best practice in the Asia-Pacific region. There is a need to recognise the diversity of coastal management practices in the region and to develop appropriate national and local policies. Similarly there is a need for this to be accompanied by appropriate education.

The presentation concludes by reflecting on the relevance of global change issues for Australian coastal management and illustrates this with selected examples. Finally a number of questions are raised about the need for prioritising applied research into global change impacts on our coast and consideration of the usefulness of research results for future policy development.

Empowered Participatory Governance: a Working Model

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Within the framework of the Coastal CRC subproject 'Natural Resource Governance and Partnerships' our team developed a multi-stakeholder engagement model, which originally emerged from our recent work in Switzerland. It is an empirical model developed from extensive research in Switzerland and Queensland. As a governance model it allocates limited power to local communities where local and state authorities act as referees rather than regulators. Confronted with social, cultural and political differences we revised the model to fit the Queensland context. The multi-stakeholder engagement model we are proposing is relatively autonomous and is based upon limited, project specific power sharing, which in turn is based upon relations of trust and benefaction. This does not mean a wholesale paradigm shift namely, from a conventional top down approach to full-scale decentralisation. Instead, we are suggesting a project specific participatory power shift, which ceases with the completion of the development in question.

Discrete Depth Distributions of Aquatic Fauna within Isolated Pools

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We examined the spatial distributions of aquatic fauna of isolated floodplain and intertidal pools in the Rockhampton and Townsville regions. Cast nets proved excellent for obtaining quantitative samples of mobile fauna from discrete areas/habitats within the pools. Tortoises and several species of fish had clear and consistent patterns of distribution. In freshwater pools tortoises (*Emydura krefftii*) and the fish, mouth almighty (*Glossamia aprion*) and barred grunter (*Amniataba percooides*) were mostly found in edge habitats less than 2.0 m deep. Barred grunter were particularly concentrated along shallow edges adjacent to the deeper areas of the pools, and around fallen timber. Fork-tailed catfish (*Arius graeffei*) were generally found at depths between 0.5 and 2.5 m. In contrast to the small (< 100 mm length) bony bream (*Nematolosa erebi*) which preferred depths between 1.5 and 2.5 m, the larger bony bream were mainly found in water deeper than 2.5 m. In shallow pools, with depths less than 2.5 m, large bony bream aggregated in the deepest water available. Those distribution patterns remained consistent over time and among pools.

Patterns of species distribution in intertidal pools were less clearly defined and somewhat less consistent. Barramundi (*Lates calcarifer*) and mangrove jack (*Lutjanus argentimaculatus*) were found in complex habitats along pool edges but other common species, such as whipfin silverbiddies (*Gerres filamentosus*) and green-backed mullet (*Liza subviridis*) showed no consistent habitat associations. Despite this, whipfin silverbiddies were mainly found in waters between 0.5 and 1.0 m deep.

Gaining a clear understanding of the way species are distributed within pools will enable better management through more reliable estimates of population parameters (e.g. size/age structure, relative abundance, species density) because knowledge of distributions allows more effective and representative sampling.

Predictive Mapping of Seafloor Substrate and Biota at Point Addiss Marine Park, Victoria

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The mapping of marine habitats involves a number of stages: (1) collecting and processing of raw data; (2) extensive secondary modelling on primary data, such as bathymetry, to develop spatial surfaces which are relevant to both the physical (e.g. substrate) and biotic (e.g. seagrass) aspects of a site; (3) integrating spatial surfaces and *in situ* information; (4) the development of predictive habitat models; and (5) the spatial extension of *in situ* data to unknown areas using predictive models. Each of these stages is essential to build realistic models of both the seafloor substrate and the organisms that live there. However, very few mapping projects, except those in shallow water, go beyond the prediction of seafloor substrate. This is very limiting in a management sense, as knowledge of the biota is often critical for management and protection. In this study, stages 2 to 5 (above) were employed at the Point Addis Marine Park. Predictive modelling methods are used to explore the data. Final predictions were developed using a novel approach of merging multiple habitat predictions. High accuracy maps of both seafloor substrate and biota were developed.

Defining Mosquito Hydro-habitats in a Mangrove Forest System by Linking Tidal Hydrology to Substrate Structure

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Mangroves play an important role providing habitat for marine organisms and this is recognised by their protected status under legislation such as the *Fisheries Act 1994* (Queensland). They can also provide conditions suitable for breeding of the disease vector mosquito *Ochlerotatus vigilax*. To manage mosquito populations it is necessary to understand the mosquito's breeding requirements within mangroves, particularly oviposition (egg-laying) and larval development stages. These requirements involve the interplay of hydrology, forest substrate structure and time at the microhabitat level. A prerequisite for identifying target mosquito microhabitats is to understand hydrologic conditions at the mangrove forest level, especially the role of tidal inundation.

Hydrology is one of the primary controlling forces in determining wetland morphology and ecology. It is generally believed that mangrove systems are flushed relatively regularly by tidal waters and usually would be inundated on the highest tides. Because of the complex nature of the wetland/watershed relationship, there is still a great deal of uncertainty over the hydrologic budgets and hydrologic functions of different types of wetlands. Most of the existing hydrologic studies of wetlands have been conducted in relatively simple systems, for which the components of hydrologic budgets can be estimated. However, lake-edge wetlands such as at Lake Coombabah in South-east Queensland, are inherently more difficult to study. This is in part because of the difficulty of accurately measuring sheet flow across the wetland surface in and out of the lake where water flow is impeded by varying densities of pneumatophores.

We undertook a study of tidal inundation of lake-edge mangroves at Lake Coombabah, monitoring water levels at seven locations during tides of various heights. As a result, we identified significant variations in tidal inundation pattern within the lake-edge mangroves. We also undertook detailed substrate surveys stratifying by substrate microhabitat type integrated with mosquito breeding requirements, to characterise each substrate type.

Three levels of tidal inundation were identified, ranging in extent from: 1) very infrequent with minor water level change; 2) occasional inundation with some water level change; to 3) frequently flooded with significant water level change. These corresponded to long-term tidal exceedence frequencies of around 5%, 20% and 50% of high tides, respectively. By linking inundation character with substrate microhabitat form, a schema of hydro-habitat was derived for describing mosquito breeding potential within the lake-edge mangroves at Lake Coombabah.

Gold Coast Shoreline Management Plan

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A large number of coastal engineering and management works have been undertaken on the Gold Coast. Most of the activity has occurred in the last 30 years since major storms devastated most beaches in 1967 and 1974.

A dedicated coastal data collection program was implemented that included physical properties such as hydrographic surveys, wave recording and current measurements. Some data has been collected on ecological characteristics such as fish species, submerged reef coverage and condition, rocky intertidal habitat and sandy beach meiofauna. Much of this investigation has been related to specific projects and has been on an *ad hoc* basis.

The Gold Coast Shoreline Management Plan (GCSMP) covers the area of coast from Pt Danger to Jumpinpin. This plan will provide a mechanism to review all available previous investigations, identify knowledge gaps, propose new research and identify priority areas for action.

The key focus is on the sandy beach environment. The GCSMP will concentrate on the littoral zone that is defined as the area from the rear dune fence or boulder wall alignment to the offshore zone where sand deposits for beach nourishment may be. This not only takes in the active zone of littoral transport but also those areas outside the active zone that may act as sediment sources.

A series of workshops with technical experts in the coastal management field have been held on the Gold Coast to guide further work on the GCSMP. To address the key issues in managing our coastline the study has been split into five major themes as outlined below:

1. Community Values and Involvement;
2. Physical Beach Processes;
3. Ecological Beach Processes;
4. Economic Value of Beaches; and
5. Beach Management.

A program of research leading to the preparation of management guidelines, decision-support systems and capital works programs has been developed. Funding has been requested from federal, state and local governments. So far only the Gold Coast City Council has committed to a financial involvement in this process.

A major focus of coastal research for many years has been focussed on estuarine and wetland areas at the expense of the littoral zone. The proposed GCSMP is seen as an opportunity to undertake important research into sandy beach processes that will lead to direct improvements in beach management. The Gold Coast will be used as the study area for lessons that will benefit many other coastal managers locally, nationally and internationally.

More information about this project is available online at:

www.griffith.edu.au/centre/gccm/gcsmp

Developing Meaningful Social Indicators for Coastal Resource Management: Validity, Significance and Democratisation

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This presentation discusses a number of theoretical and methodological issues surrounding the development of social indicators relevant to the management of natural resources in the Australian coastal zone. It identifies three desirable characteristics of indicator selection that frequently are ignored in social monitoring and reporting programs. These include: validity (the identification of clear relationships between changes in the state or management of natural resources and social outcomes); significance (ensuring that programs address those impacts that are most important to impacted communities); and democratisation (providing opportunities and resources for impacted communities to participate in data interpretation and strategy development).

Drawing on case studies of water flows and water quality in two Central Queensland catchments, the presentation explores how social indicators may be identified, validated and incorporated more adequately within the more traditional biophysical monitoring and reporting programs.

Mapping Marine National Parks Along the Victorian Coast: the Coastal CRC/Parks Victoria Partnership

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The mapping of shallow marine habitats of the Marine National Parks (MNPs) along the coast of Victoria (known as the Parks Victoria Mapping Project), is being undertaken as a partnership between the Coastal CRC and Parks Victoria, with a major contribution from Fugro Survey Pty Ltd, a prominent commercial partner in the Coastal CRC. The mapping includes six of the main MNPs in Victoria (Discovery Bay, Twelve Apostles, Point Addis, Wilson's Promontory, Point Hicks and Cape Howe) covering a total area of 252 km².

The mapping of such large areas of shallow marine seafloor with full coverage has not previously been undertaken in Australia. The selection of technology to be used was influenced by existing coastal water habitat mapping expertise, in particular from a series of trials that took place during November 2004 in the Marmion Marine Park (off the Western Australian coast), where a full range of hydroacoustic and camera systems were operated and compared under carefully controlled conditions.

The first stage of mapping of Victoria's MNPs took place in late summer 2005 and included Point Addis MNP (37 km²) and part of the Wilson's Promontory MNP (22 km²). Hydroacoustic surveys were conducted first, using a combination of a Reson 8101 multi-beam sonar system and a GeoAcoustics sidescan sonar; these were completed in under 10 days of operation. Subsequently, extensive camera surveys took place, with the acquisition of 55 km of towed video images. Importantly, very high positional accuracy was obtained for all instruments. Habitat maps were produced by combining all of the information using a range of interpretive procedures, including semi-automated classification techniques developed for this work. Of particular relevance is that backscatter obtained from the Reson multibeam is considered suitable for habitat texture analysis, indicating that sidescan sonar is not always required for this purpose.

The surveys have revealed geomorphic and biological features previously unknown along the Victorian coast. The approach and techniques that have been developed in Victoria, for the cost-effective mapping of large areas of shallow marine habitat, is of national importance and international relevance.

The shallow water habitat mapping has now been extended to include a number of additional areas along the Victorian coast. In 2005/2006, it is planned to undertake hydroacoustic surveys and prepare habitat maps for a total of approximately 700 km² of Victoria's coastal waters.

The success of this venture has been largely due to the very strong support, collaboration and interaction that has occurred among the members of a team that is spread across the country, and which possesses the wide range of diverse skills and experience needed to effectively implement this complex multi-disciplinary project, which has met (and largely exceeded) all expectations.

Increasing the Bang For Your Buck: Opportunities for Incorporating Coastal and Waterways Science into Traditional Planning

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The role of science in forming public policy is receiving increasing attention as that role becomes better understood. A number of commentators have argued that science can be the 'compass' which provides guidance and points to the direction for future management by applying the rigours of analysis, verification and correction to adopted public policies. They point out that the use of science in planning for sustainable management of the coastal zone can include better informed decision-making, an ability to respond to changing conditions by adaptive-based management and a greater probability of accomplishing the planning goals.

This presentation will draw on research of the Coastal CRC's Environmental Planning project which investigated the integration of science into the policy and planning processes used by state and local level agencies for the governance and management of the coastal zone and associated waterways. It explores the relationships between science and planning, especially the emergent performance-based planning approaches. In particular, it examines the challenges of integrating coastal and waterways science into traditional planning processes that are employed to manage environmentally sensitive areas at the land-water interface.

Bringing scientists and science into the planning process and identifying the appropriate tools to do it successfully is a priority challenge for environmental planning.

The National Water Quality Management Strategy Workshops. Building Water Management Capacity Around Australia

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The National Water Quality Management Strategy (NWQMS) provides nationally agreed policies, processes and a set of guidelines that form part of the Council of Australian Government's Water Reform Agenda. They provide the information and tools helping communities achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

While the NWQMS is a critical tool for water quality management, the breadth and complexity of the documents can make it difficult for planners to use. Regional organisations indicated to the Department of Agriculture, Fisheries and Forestry that they would benefit from regionally specific, face-to-face guidance on how to best use these documents to improve water quality in their region. The Coastal CRC was awarded the tender to develop and deliver seven workshops in regions around Australia.

The workshop process was based around Malouf's principles of adult learning, which are very learner oriented. There was a great deal of consultation with key regional people prior to the workshops to ensure that each workshop was tailored to meet the specific needs of the individual regions and the stakeholders within those regions. The workshops were designed to be highly participatory with attendees applying the components of the NWQMS water quality management framework to their local catchments.

Evaluation sheets were designed to enable continuous improvement throughout the workshop series. These evaluations also provided useful information about the success of the workshops and some ways to enhance future workshops. Additionally, there were some general observations made while conducting the workshops on how to improve uptake of the NWQMS at a regional level.

South-east Queensland Regional Coastal Management Planning

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In 1995 the Queensland Government commenced the *Coastal Protection and Management Act 1995 (Coastal Act)* which provided the legislative framework for achieving integrated coastal zone management in Queensland. A key component of the *Coastal Act* was the preparation of coastal management plans to provide policy direction on coastal management issues.

The State Coastal Management Plan – Queensland's Coastal Policy (State Coastal Plan) commenced in 2002 to guide decision making in Queensland's coastal zone (broadly defined as top of catchment through to state water limits). The State Coastal Plan guides the development of regional coastal management plans, which provide specific coastal management outcomes at a regional scale.

The SEQ Regional Coastal Management Plan (SEQ Coastal Plan) was released for public consultation by the Minister for Environment in late November 2004. Submissions closed on 28 February 2005 and the plan is scheduled to be finalised by the state government in early 2006.

The SEQ Coastal Plan's policies address key coastal management issues in South-east Queensland. These policies were developed through a consultative process involving groups and organisations that have responsibilities within the coastal zone including state and local government, industry, conservation, Traditional Owners, community, and commercial and recreational groups. The policies also rely on research carried out by the Environmental Protection Agency in areas that relate to the assessment of biodiversity values, wetland areas and shorebird habitat, and integrates information from other state agency research programs.

This presentation provides a brief overview of the policy framework for coastal management in Queensland and outlines the approach, development and implementation mechanisms for the SEQ Coastal Plan.

An Integration Tool to Assist in the Management of Coastal Lake Catchments

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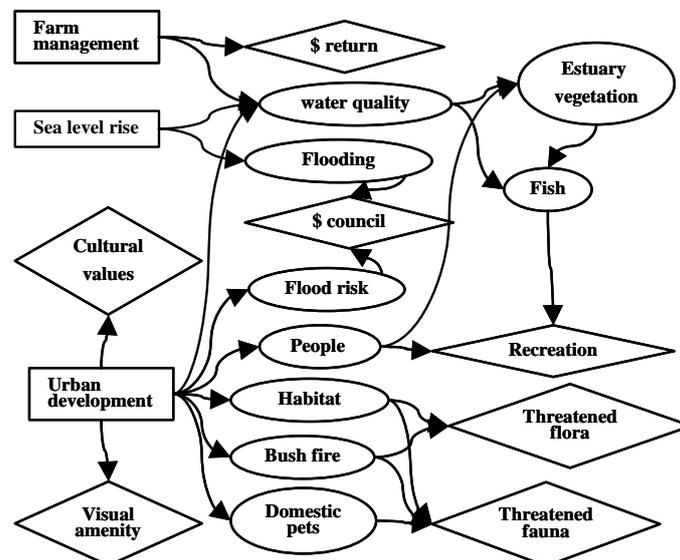
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The coastal zone provides important ecological, social and economic values to the Australian community. Coastal land and water resources are limited and are subject to conflicting pressures such as increasing urban development and intensity of agricultural production, as well as heightened pressure for environmental conservation. Therefore, those charged with managing the coastal zone of Australia have a very important and often controversial task in evaluating and prioritising catchment management issues.

This research presents a decision-support tool that integrates the key ecological, social and economic values for coastal lake catchments. It provides an estimate of the potential impacts of various management decisions on these values. A Bayesian Decision Network (BDN) approach is used and incorporated into an easy-to-use interface. The BDN approach represents the catchment system as a series of variables (model nodes) with causal links that represent the impact of one variable upon another. An example of a BDN framework is shown in Figure 1. The BDN approach enables the integration of quantitative results (including observed data and model simulation), as well as qualitative information, such as expert opinion. This allows for an effective account of the social, ecological and economic impacts using the best information available.

BDN tools have been developed and applied to eight lakes in NSW, which are Cudgen, Myall, Wollumboola, Narrawallee, Burrill, Coila, Merimbula and Back. The tools enable decision-makers to explore the potential impacts of pre-defined management decisions, such as urban development in different locations, riparian management and agricultural practice. Perhaps more importantly, they can explore cumulative impacts, for example, impacts of many separate urban developments within the same catchment. Thus the tool provides a means for managers to strategically approve or reject management options for the long-term sustainability of a catchment and its coastal lake.

Figure 1. Example of a Bayesian Decision Network framework representing a coastal lake catchment. Rectangle = scenario or management option, ellipse = interim variable, diamond = end variable.



Barriers and Bridges to Collaborative Natural Resource Management

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Managing natural resources in regional areas of Australia could be greatly improved if more effort went into strengthening relationships between community, government and industry groups. Australia currently has fifty-six regional bodies established by the Australian government under the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust II to develop and implement regional plans for natural resource management (NRM). These regional bodies are responsible for the delivery of over \$2.56 billion to fund a range of conservation and environmental projects, and are expected to administer this funding through collaborative and inclusive processes that support the active involvement of stakeholders including grassroots community organisations.

Environmental sociologists supported by the Coastal CRC have identified a range of constraints to the active involvement of grassroots groups in these regional NRM processes. Through comparative case studies of NRM groups in South-east Queensland, the research team have explored a number of weaknesses in such collaborations, highlighting: (1) 'turf wars' between grassroots NRM groups, mainly over differing expectations of the regionalisation process and a lack of resources; (2) power and responsibility inequities between government, the regional body and grassroots groups; and (3) in some areas, a culture of 'blame' caused by unresolved conflict over the regionalisation process and previous Natural Heritage Trust I activities.

The project has also identified several 'bridges' to improve collaboration among regional groups in planning, implementing, monitoring and evaluating their NRM plans that include:

- sharing realistic expectations of the process and to clearly define community and government roles and responsibilities;
- providing more resources for community groups to actively participate in regional NRM;
- working adaptively, reflecting on and learning from collaboration; and
- recognising, embracing and, where possible, resolving group conflict.

Download the full report at:

http://www.coastal.crc.org.au/pdf/Barriers_and_Bridges.pdf

The Application of Multibeam Sonar in Benthic Habitat Mapping

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Multibeam Sonar (MBS) can obtain high-resolution bathymetry and acoustic backscatter data of the seabed. These data can be used to help discriminate habitat boundaries and visualise the geomorphology of the seafloor. Coastal zone managers can therefore use this information for benthic habitat mapping. However, much of this work is still being developed, in particular the processing, production and analysis of MBS backscatter data require further work. This presentation explains the science behind MBS and highlights problems in developing methods to utilise MBS backscatter data for habitat mapping. Morinda Shoal (a patch coral reef system off Cape Bowling Green in Queensland) will be used as an example to show a potential approach to characterisation and segmentation of the seafloor based on topographic and acoustic properties obtained using MBS.

Remote Sensing for Coastal Ecosystem Indicator Assessment and Monitoring: Benthic Habitat Maps for Moreton Bay

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A major component of the Coastal CRC's 'Remote Sensing for Coastal Ecosystem Indicators' and 'Urban Benthic' projects is the production and verification of benthic substrate-type maps for sections of Moreton Bay using airborne and satellite image data sets. This presentation describes the data collection, processing, mapping and validation processes used to meet this goal.

A major multi-agency image and field data acquisition exercise was coordinated by the project team during July-August 2004 to collect airborne and satellite images of Moreton Bay in combination with coincident Bay-wide field sampling of benthic cover, depth and water optical properties. Two types of satellite image data were collected: (1) Quickbird-2 high spatial resolution multispectral (2.4 m pixels) covering the Eastern Banks region; and (2) Landsat 5 Thematic Mapper multispectral (30 m pixels) covering all of Moreton Bay. Airborne hyperspectral image data were acquired over the Eastern Banks and mouth of the Brisbane River from a CASI-2 sensor using a pixel size of 4 m.

Field survey data were collected as a combined effort with Environmental Protection Agency, Port of Brisbane Corporation, CSIRO and The University of Queensland. The primary field data is a georeferenced set of measurements of depth, benthic cover type (to species), seagrass biomass and the level of cover. Each image data set was subject to correction of its pixel values to remove atmospheric absorption and scattering effects, allowing representation of the amount of sunlight leaving the water surface.

Image mapping approaches were applied to each the three image data sets to evaluate their ability to map seagrass in terms of species composition, cover and biomass. Each image data set was used to derive three output maps which were validated against field survey data. Although preliminary, our results demonstrate that seagrass cover mapping is possible across all image types, whereas seagrass species composition and biomass requires high spatial and/or hyperspectral data.

Health Impacts of Sewage Overflows into a Tidal Urban Creek of Brisbane

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Across Australia sewerage systems are designed with emergency overflow structures to discharge untreated sewage into local waterways in case of system overload or breakdown. Our aim was to determine the impacts of sewage overflows and potential risks to the public and ecosystem health in the tidal waterways of the coastal suburb of Lota.

Expectations for improved sewerage system performance are driven by the belief that sewage overflows cause significant environmental harm. However, the research presented here shows that during a large wet weather event, stormwater, and not the overflow, was the dominant stressor of ecological health. Even during dry weather the impacts of overflow events were likely to be low and restricted to the mixing zone at the point of overflow. However, sewage overflows, in dry and wet weather, did pose an unacceptably high public health hazard to potential swimmers in Lota Creek until the overflow stopped and there was a complete tidal exchange with the estuary.

This Brisbane City Council/Brisbane Water and Coastal CRC project has provided a sound scientific basis for quantifying overflow impacts and prioritising management of overflows and stormwater. It has also identified the need to develop programs to educate and raise community awareness, assess waterway use and potential pathways that can pose a risk to human health from wet and dry weather overflows both locally and into Moreton Bay.

Improved Monitoring and Modelling Knowledge for Coastal Management

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Assessment of coastal systems is often difficult given the complex environmental issues, significant costs involved and the large range of techniques available. Nonetheless, environmental assessments usually involve a combination of monitoring and modelling, and can be undertaken prior to or during the construction or operation of a development. Each assessment can differ in scope and objectives depending on the locality and type of activity. For example, point source discharges (e.g. sewage treatment plants) might be assessed to determine environmental values and water quality objectives, the resilience of waterways, loads to waterways and initial mixing or performance during operation. The environmental assessment might focus on a current situation, a future design or a number of possible future designs. Only through understanding the nature of each activity and the specific management objective can an assessment approach be tailored to the decision maker's specific needs.

Even with this understanding, information on monitoring and modelling is dispersed and experts rarely cover both these fields. For this reason, information on monitoring and modelling for management has been compiled in a series of knowledge bases. Each knowledge base contains information covering issues relevant to coastal decision makers which has been sourced from the literature or elicited from experts. For example, the modelling knowledge base contains metadata on the types of approaches, typical uses, limitations, data requirements, examples and links to further information. The monitoring knowledge base contains a unique classification of monitoring approaches and metadata on key monitoring examples across the country. The information will be accessible through a stand-alone html based help system or through a decision-support system tailored to users' needs. These tools will enable the user to explore a recommended assessment approach or assess the suitability of a proposed water quality assessment, e.g. for development applications or licensing approvals. This presentation will briefly describe the knowledge bases, decision-support system and associated help system that have been developed.

The Riparian Nitrogen Model: a Tool for Assessing the Role of Riparian Buffers in Catchments

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Catchment-scale water-quality models are useful tools for predicting catchment behaviour under various climatic conditions and land-use scenarios. In this presentation, we discuss our Riparian Nitrate Model (RNM), which estimates the removal of nitrate as a result of denitrification. Denitrification is important as it is one of the major processes that leads to the permanent removal of nitrates from shallow groundwater during interaction with riparian soils.

The RNM is most suitably applied in riparian buffers belonging to low- and middle-order streams. Nitrate removal occurs mainly via three mechanisms, which are conceptualised as follows: Firstly, in floodplains belonging to ephemeral low-order streams where the potential for groundwater perching is identified – during flood events these areas fill but some surface water seeps through the soil and becomes groundwater, this water is denitrified during this movement, and may subsequently drain back into the surface water system. Secondly, in perennial middle-order streams, denitrification occurs as base flow intercepts the root zone. The hydrology of the floodplain plays an important role in determining the extent of denitrification. For example, a shallow water table and a high residence time promotes denitrification and flat floodplains with medium-conductivity soils are most conducive to denitrification. Thirdly, in perennial middle-order streams, denitrification may also occur when stream-water is temporarily stored in banks during flood events. The amount of water stored in the banks and its residence time will depend on the size of the flood event, the soil properties such as hydraulic conductivity and porosity and the geometry of the floodplain. The nitrate loads removed via each mechanism is estimated using 1st order decay kinetics.

The model is implemented in the Maroochy catchment. The modelling has shown that the optimum rooting depth is 2-3 m and that increasing the riparian buffer width beyond 10 m resulted in minimal benefits. For the denitrification rates used in this study, the riparian buffers have the capacity to remove up to 20% of the nitrate load in the Maroochy sub-catchments. Normalising the potential nitrate removal capacity in a sub-catchment with respect to total length of the stream network enables us to quantify the capacity of a unit length of riparian buffer to remove nitrate; this attribute can inform managers where optimal benefits from riparian restoration should likely occur and where the impacts of riparian land-clearing are likely to be the worst.

Modelling Copper Bioaccumulation in the Sydney Rock Oyster

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Oysters are acknowledged as excellent accumulators of copper, a toxic and ubiquitous metal occurring in marine ecosystems. This enables them to be used as bio-monitors of the health of coastal waterways. It is difficult, expensive and time consuming to measure copper directly from seawater and so oysters are a convenient and cheap alternative of measuring aqueous copper. However, copper accumulation in oysters is complex. The relationship between copper in the oyster, and copper in the water, has often been misinterpreted or oversimplified. This study seeks to better understand the processes causing copper to be accumulated by the oysters and thereby improve the way oysters are used as bio-monitors.

Experimental work carried out in this study focussed on determining the uptake and loss rates of copper specific to the Sydney rock oyster (*Saccostrea glomerata*). Sample oysters were placed at several locations across Moreton Bay for a period of up to one year. Each month, several oysters were collected from each location and analysed for copper. Water samples were also collected and these were analysed for aqueous copper, suspended sediment and chlorophyll *a*. This experimental data provided important spatial and temporal information for computer models used to simulate the bioaccumulation process.

A key outcome of the modelling was highlighting the dominant role that both living and dead phytoplankton plays in copper accumulation in Sydney rock oysters. Copper is easily adsorbed by phytoplankton, then transferred to the oysters when they feed on this phytoplankton. Copper stored in the sediment is likely to be a major source of the copper that ends up in the water column as the strong sorption properties of the phytoplankton draws it out.

The findings of this research has major implications for monitoring and controlling copper in our waterways. While this trace metal predominantly resides in sediments, algal blooms can liberate large amounts into the water column and therefore into oysters. Whether copper is naturally occurring or the result of human activities over the past 200 years, managing it in the food chain will involve controlling the conditions that cause algal blooms. If oysters, or any other marine organisms, are to be used to monitor trace metal contamination in waterways then we need to better understand the accumulation processes. My research provides a framework that can be used to achieve this goal.

Underwater Photogrammetry: Advances with Three-Dimensional Modelling and Laser Projection Systems

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Photogrammetry provides an accurate method for performing non-contact, non-destructive three-dimensional measurement of underwater objects *in situ*. This presentation explores some advances in automated three-dimensional modelling of volume and surface areas for complex objects, as well as camera system calibration using a laser projection system.

The photogrammetric measurement process provides a three-dimensional point cloud describing the surface of an object. In many biological applications it is useful to utilise the measured point cloud to estimate the volume and surface area of an object. Currently available techniques (commercial software) for generating volume and surface area models have proved slow and cumbersome on geometrically complex objects. This presentation describes a method capable of modelling complex objects with overhangs and concavities using multiple stereo camera locations. From the model, accurate estimates of volume and surface area can be made. The method has been validated by comparing estimated volume results with displaced water volume for models of varying size and complexity, as well as for real sponges. Estimated volumes for models are typically within 5% of the displaced volumes. Tests with real sponges are currently in progress and will also be presented.

The presentation also discusses the use of a laser projection system designed and built as part of the Coastal CRC project. The laser projection system was designed and constructed to provide a structured light source to enable automation of three-dimensional measurement from stereo imagery. Besides this primary use, mathematical models to allow calibration of stereo camera systems are currently under development. The laser projection system and its uses are described.

Ideas for Synthesising Knowledge to Minimise Unintended Outcomes

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Humans work best when focussed on specific subject areas. For complex issues encompassing social, economic and environmental aspects, it is very difficult to provide holistic and integrated views of the processes operating, comprehensive views of the decision options and the likely implications of various management actions. Integrated approaches are required to overcome the disadvantages of the fragmentation of society into segments of responsibility and of science into disciplines. This is of particular importance for the coastal zone.

A knowledge synthesis approach is outlined that allows the strengths of expert, experiential and historical knowledge to be synthesised to achieve an integrated view to allow the best long-term sustainable decision and actions possible in the circumstances.

The approach comprises six steps:

1. **Setting directions.** Scoping the issue, refining the brief, setting goals, agreeing on beliefs and method of interactions.
2. **Framing.** Framing the issue as 'what if' scenarios. This moves the focus to solutions for unknown futures, rather than disputes on processes, and provides a common basis for communication.
3. **Collages.** Experts and stakeholders provide collages of their understanding of processes and likely linkages, with the group developing and refining the linkages and their relative importance.
4. **Conceptual picture.** A refined, conceptual mental picture of the feedbacks and interactions, available decision and management options, and their possible consequences is developed from the synthesised knowledge.
5. **Prediction.** Each participant provides their probabilistic prediction of the most likely outcomes of selected and agreed 'what if' scenarios, based on their knowledge, intuition and the tools they use. A numerical process is used to capture the intuitive judgements of the participants. This often neglected aspect balances innate wisdom with scientific data and knowledge to contribute to the best possible outcome.
6. **Expected outcomes.** A synthesis of the most probable scenario outcomes including the range of responses, their uncertainty, implications, possible resilience and response times are identified.

The process used to locate the lost US submarine *Scorpion* is an exemplary approach for seeking the best decision to a complex issue where the information was limited.

The necessary principles for interaction, barriers to the synthesis approach and strategies to minimise their impact are considered.

Broad Scale Spatial Changes in the Distribution of Macro-benthic Communities Along Freshwater Marine Gradients

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Intertidal macro-benthic organisms are important members of the estuarine community. They are often used to detect environmental stress and change as they are easy to sample and abundant in areas where impacts are common. However, there is little basic understanding of the communities and how they change naturally over space and time or how they are influenced by the 'interplay' between marine and freshwater inputs.

Estuarine fauna are strongly influenced by marine water entering the mouth and freshwater entering the head of the estuary. This leads to distinct differences in the fauna between downstream and upstream sites. However, the balance between these forces changes over time (e.g. seasonally) and space (e.g. between the wet and dry tropic regions). To date there have been few investigation of the effect of these changes in different climatic regimes.

Sampling was conducted in the wet tropics (Cardwell to Hinchinbrook Island), dry tropics (Bluewater to Townsville) and dry south (Gladstone area). Three streams from each region were sampled. Samples were collected on four separate occasions. At each stream, samples were collected from the mouth, mid and upstream areas.

The fauna in one region differed from the fauna in other regions. Within each stream there were distinct differences in the upstream and downstream fauna. In general, the upstream community had few species, with many of these species occurring in very high abundances. The mouth sites typically had more species than the upstream sites, but the mouth fauna generally occurred in low abundances.

Within each region, the upstream fauna was very similar, and these communities remained stable if there was no significant rainfall. The mouth fauna tended to remain quite stable, even during high rainfall events, this is most likely due to the influence of the tide, with saltwater flowing into the estuaries twice daily.

The Road to Ecosystem Collapse

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We studied the trophic compositions of fish assemblages in ten estuarine floodplain wetland pools, to gain an understanding of their functional make-up and how that functionality changed over time. The sites ranged from permanently freshwater pools, through low-salinity brackish pools, to pools highly connected to the estuary that usually exhibited marine salinities, and on to hypersaline pools. They included both isolated pools and pools forming upstream series.

Despite expected clear differences in the identity of the species between pools of different salinity, all sites were dominated by detritus feeding fish, bony bream (*Nematalosa erebi*) and sea mullet (*Mugil cephalus*) in freshwater pools, and greenback mullet (*Liza subviridis*) and sea mullet in more saline pools. The species composition and trophic make-up of pools were distinct and maintained over time, with one exception. Early in 2005 the water level in one large freshwater pool, Woolwash Lagoon, reached very shallow levels, reducing the available habitat and making bony bream, the dominant detritus feeding fish, vulnerable to predation by large flocks of pelicans. The result was a catastrophic change in species composition and trophic structure. By May 2005 the vast majority of fish biomass remaining in Woolwash lagoon was comprised of one species, the large, omnivorous fork-tailed catfish (*Arius graeffei*). The levels of many species were so reduced that normal ecosystem function will probably not be restored until Woolwash lagoon reconnects with other freshwater systems.

The implications for the health and functioning of floodplain wetland pools, and associated ecosystems, are far reaching in the face of human induced change to the delivery of water to wetlands, and as we move into a regime of global warming and altered weather patterns.

Seawater Intrusion into the Brisbane River and its Effect on Subsurface Groundwater Quality

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Australia is presently undergoing rapid urban and agricultural development, with Queensland's coastal plains being one of the fastest developing regions. The large increase in the coastal population and extreme weather conditions predicted for the longer term may result in severe water resource problems for future generations. Water quality degradation may be attributed to a number of causes such as seawater intrusion. Salinity intrusion may be enhanced by the impulse effect of tidal exchanges, extraction of groundwater related to irrigation for agricultural activities, and sea level rise generally.

In this presentation, a 3D seawater intrusion model developed for the Brisbane River and the coastal aquifer is discussed. The model simulates the effects of changes to river salinity on the Brisbane River itself as well as the nearby subsurface aquifer. The GMS-FEMWATER finite element model was used to solve the related 3D density dependent flow and transport equations. The Brisbane River salinity data, groundwater related hydraulic and soil parameters along with the normal seaward boundary conditions are used to calibrate the model. Various salinity profiles are presented that show the combined effects of river salinity and seawater intrusion on groundwater quality. This study is the first phase of a major project to develop a large scale more complex fine discretised 3D model of seawater intrusion into the Brisbane River and Brisbane's subsurface groundwater.

Environmental Reporting Initiatives to Support Effective Coastal Management

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State of Environment Reporting is an internationally accepted process to report on the state of the environment, to evaluate the effectiveness of environmental policies and to provide environmental information to the public. The Queensland Environmental Protection Agency has undertaken a number of initiatives to streamline environmental reporting, including the creation of an Environmental Reporting function to coordinate environmental reporting activities across the Queensland Government and the development of SoEOnline to support more regular updates on a range of environmental indicators and statistics to support community, industry and government information needs and reporting obligations.

This presentation discusses some of the issues that arise in relation to effective reporting of the state of the coastal zone and the effectiveness of policies, programs and initiatives. These include exploring strategies for:

1. facilitating the integration of social and economic information;
2. providing information at the right scale, supporting regional reporting;
3. alignment between the Natural Resource Management National Monitoring and Evaluation Framework and updated ANZECC Core Environmental Indicators; and
4. ensuring effective peer review and access to the best available information.

The presentation will also highlight information sources such as the National Pollutant Inventory that may be useful inputs to support coastal and catchment models.

Trophic Strategies of Nutrition for Fish in Canal Estates

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Demand for residential developments with water frontage has resulted in natural wetland habitats being replaced by artificial waterways in several Australian cities. The same species of fish occur in natural and artificial habitats, even though aquatic macrophytes are absent from artificial waterways. We tested whether the source of nutrition supporting fisheries production differed between natural and artificial habitats, using stable isotope and stomach content analyses.

We collected garfish (*Arrhamphus sclerolepis*, family Hemiramphidae), a species harvested commercially, from artificial habitats and adjacent natural wetlands on the Gold Coast, Australia, over two years. In both years, the carbon isotope values of fish from natural habitat were enriched (mean -12‰) relative to those of fish from artificial habitat (-20‰). We inferred that garfish rely on an enriched autotrophic source, either seagrass or saltmarsh grass, in natural habitats, and in artificial habitats rely either on local microalgae or a mixture of enriched and depleted autotrophic sources (e.g. mangrove) arriving as particulate matter.

Stomach content analysis clearly showed that garfish in natural habitats consumed seagrass leaves during the day and night. The diet of fish from artificial habitats differed between day and night. At night, they consumed benthic algae, mostly unicellular taxa (e.g. *Enteromorpha* sp.). Whereas during the day, garfish ate terrestrial insects that presumably had been blown into the water from surrounding areas.

The isotope and stomach content analyses together confirm that seagrass is consumed directly and is the predominant source of nutrition in natural habitats. In the artificial habitat, garfish utilise local algal sources, not macrophyte material from adjacent natural wetlands. There is also a contribution of terrestrial material.

This study demonstrates that not only do garfish occur in both artificial and natural habitats, but they use the same trophic strategy of bulk herbivory with the inclusion of small amounts of animal prey in the two habitats. This understanding of how ecological processes support fisheries production in artificial habitat improves the overall understanding of the effects of urbanisation on coastal food webs.

The Fitzroy Contaminants Project – a Study of the Dynamics of an Australian Tropical Estuary

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After the Burdekin River, the Fitzroy River supplies the second largest load of sediment and nutrients to the lagoon of the Great Barrier Reef. With Coastal CRC funding, a multi-agency team has studied the hydrodynamics, fine-sediment dynamics and biogeochemistry of the Fitzroy River estuary and adjacent Keppel Bay over the last six years. The main aims of the project are to assess the impact that catchment loads have on the Fitzroy River estuary itself and the role that the estuary and Keppel Bay plays in mediating the delivery of material from the river to the GBR lagoon.

The discharge of the Fitzroy River is highly episodic – its discharge usually occurs as a series of high-flow events during the summer months with virtually no discharge occurring during the rest of the year. Inter-annual variability is also very high with total annual discharges varying by a factor of 100. In addition, the Fitzroy River estuary and Keppel Bay are subject to a large tidal range and the associated tidal currents are vigorous. Not only do water masses move large distances over the tidal cycle, but suspended sediment concentrations vary due to resuspension and settling over this time scale. The variability in the discharge and the tidal variation in water properties pose significant challenges for studies of the estuarine dynamics and we have chosen a combined measurement, remote sensing and modelling approach to address this issue.

In my presentation, I will focus on an overview of the project together with some results achieved so far.

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