New coastal science for the

Fitzroy estuary

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Coastal CRC
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Fitzroy estuary – Landsat TM imagery (1997) by the Australian Centre for Remote Sensing (ACRES) Australian Surveying and Land Information Group, Canberra

The Fitzroy Basin in central Queensland is a major study area for the Coastal CRC. Improved management of land, vegetation and water in the region is being driven by the need to reduce loads of sediments and nutrients delivered from this large agricultural catchment to the coastal zone, including the Great Barrier Reef lagoon.

Coastal CRC research conducted between 2000 and 2003 is providing new information on important estuarine and marine processes including sediment, nutrient and contaminant dynamics, the relationships between freshwater flows and fisheries production, aquatic ecosystem health and beach stability and rehabilitation. Studies of human interactions with the coastal environment have produced information on attitudes of stakeholders and historical analysis of coastal features, habitats and human development. This new information on the coastal zone has been incorporated, along with other extensive knowledge of the catchment, into a *Central Queensland Information Paper* to assist the Fitzroy Basin Association Incorporated, the peak stakeholder organisation in the region, to develop a regional natural resource management plan. A Healthy Waterways TV campaign has been effective in increasing public awareness of these coastal and catchment issues.

The Fitzroy Coastal CRC team – Bob Noble, Bob Packett, Peter Long and Fiona Mikkelsen

Sediment, nutrient and contamination dynamics in the Fitzroy estuary

Dr Phillip Ford CSIRO

Shallow banks near the mouth of the Fitzroy River have stabilised in the last 50 years into low islands with stands of mangroves

This project undertook collection of water-quality data in the Fitzroy estuary and characterisation of sediment delivery to the estuary from this large agriculturally based catchment.

In collaboration with the Queensland Environmental Protection Agency,13 sites from the river mouth to the Fitzroy Barrage were monitored monthly for a range of chemical and physical parameters. Fitzroy River Water supported sampling at six sites in the upper estuary.

Flows across the Barrage have been monitored to estimate catchment inputs. The Fitzroy estuary is characterised by significant summer flows of freshwater with extended periods of low flow. During this low flow period the main sources of freshwater are the three sewage treatment plants and the fish ladder at Rockhampton (approximately 35 ML/day).

The sediment dynamics of the estuary are strongly influenced by flood flows carrying the majority of sediment into Keppel Bay with incoming tides reintroducing sediments.

Measurements of estuary tidal heights identified that the incoming tide flows for a shorter period and has a higher velocity than the outgoing tide. Accordingly this tidal action induces ongoing re-suspension in the lower estuary creating a light-limited environment. Phytoplankton production is restricted as a result.

A nutrient budget model including primary productivity potential has been produced for the estuary. This allowed Fitzroy River Water to plan future upgrades for the sewage treatment plants. Finally it was established that crocodile eggs contained elevated levels of DDE a component of DDT, a formally used agricultural chemical.

Within the project it was quantified that the estuary took ten months to return to full saline conditions after a flood flow. After floods, sediment was found to floc out at 1.5 to 2.0 parts per thousand (normal seawater 35ppt).

Stakeholder analysis of the Fitzroy catchment

Assoc Prof Stewart Lockie CQU

A stakeholder analysis of the upper and lower Fitzroy catchment identified all stakeholder groups either involved in, or affected by, catchment management activities and mapped the values, aspirations and attitudes of those stakeholders to the coastal zone.

The survey of 800 CQ residents revealed that most highly valued water quality in local rivers and wetlands. Additionally most residents rated safe drinking water, swimming areas and environmental protection as priorities that should never be compromised for development. The research was used to develop a Central Queensland Healthy Waterways publicity campaign.

This activity will be used in the development of a conceptual model (both actual and preferred) of decision-making in the coastal zone and in the establishment of criteria for quantitative measurement of attitudes, knowledge, values and aspirations. This measurement will in turn be used to benchmark and monitor social change in relation to the coastal zone; to assess capacity building needs; and to promote interest and participation in decision-making activities.

Long Island Bend Environmental Reserve

Aquatic ecosystem health and water resource planning

Dr Satish Choy NRM&E

This project is designing and will implement a pilot study to identify and refine appropriate indicators for freshwater and estuarine areas, to be used in the development of a monitoring network design. The aim is to achieve a design suitable to assess the long-term effectiveness of the flow management strategies, stated within the Fitzroy Water Allocation and Management Plan, in meeting specified ecological outcomes. The study is also expected to fulfil the initial monitoring requirements within the Fitzroy ROP (Resource Operation Plan). The indicators and monitoring network design for on-going monitoring will be selected and implemented based on the outcomes of this study.

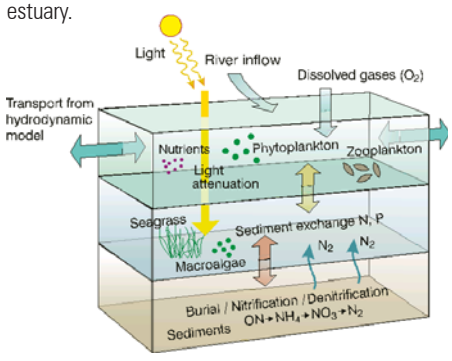
In the future, based on this analysis of the water quality results, the number of ambient monitoring sites below the Fitzroy Barrage could be reduced to seven: three in the upper estuary two in the lower estuary and two in the vicinity of the middle section.

Modelling of the Fitzroy

Dr Ian Webster CSIRO

Computer models of the hydrodynamics (water currents and mixing), fine sediment dynamics and biogeochemistry (nutrient dynamics and primary production) have been developed for the Fitzroy estuary. These models help us to understand the interrelationships between flow, sediment concentrations and primary production and predict how changes in the delivery of freshwater, sediments and nutrients from the catchment might impact on the ecological function of the estuarine system.

So far, the models have demonstrated how fine sediments are pumped up-estuary by the tidal motions during times of low river flow. Also, most primary productivity occurs in the landward half of the estuary where turbidity is relatively low due to smaller tidal currents, than in the seaward half of the estuary. The modelling will be extended to Keppel Bay in the ongoing CRC project in the Fitzroy estuary.



Estuary biogeochemical model

The role of environmental flows and estuarine habitats, fisheries and biodiversity

Dr Julie Robins DPI&F

Flows of freshwater play a fundamental role in the estuarine ecosystem affecting habitat distribution, allowing the connection of off-river habitats with the estuary, stimulating fisheries production and biodiversity, initiating migrations and supporting fish processes. Approximately 75% of Queensland's commercial and recreational fisheries are species that rely on estuaries for at least part of their life cycle.

There is a strong relationship between the commercial barramundi catch and flow 3-4 years previously. Strong year classes are present in the population from years with wet summers (i.e. 91, 92, 96 and 99). Coastal rainfall as well as summer flows are considered important for barramundi recruitment. However, after March, floods and coastal rainfall have little effect on the population. It was clearly identified that barramundi do not grow at uniform rates: for example, an 800mm (total length) barramundi can range in age from 2 to 6 years old, a 1000mm (total length) barramundi can range in age from 5 to 13 years old. The oldest barramundi sampled from the commercial catch in the Fitzroy River was 32 years old.

Project scientists survey the Fitzroy River

The project is also examining the banana prawn community and collecting a full range of juvenile and larval fish species. Prawns are highly valuable to commercial and recreational fishers and are short-lived with populations responding quickly to flows. Differences in prawn size-range were identified between sections of the river. The project recently identified six new fish species in the Fitzroy (making 103 in total). It was found that the majority of fish species breed before the arrival of summer flows.

Planning and management for natural variability of open coastlines

Assoc Prof Jurek Piorewicz CQU

The Capricorn Coast is vulnerable to severe erosion and requires sustainable restoration of beaches to improve their protection, safeness and attractiveness. Optimal solutions for two beaches, Keppel Sands and Yeppoon Main Beach, were investigated based on field data measurements, theoretical analyses and implementation of a numerical model (GENESIS) for prediction of shoreline changes.

Monitoring of the beach changes (2002-03) after extension of the groyne on the Keppel Sands beach showed progress in the beach restoration. The complex nearshore bathymetry significantly influences the final model prediction. Further monitoring and analysis is continuing. The Livingstone Shire Council provided financial support for this work.

Field measurements and analysis of Yeppoon Main Beach have been continued. The beach has not changed for the last 30 years since the rubble mound rockwall was implemented on the entire length of the beach. Suggested options for improvement of the beach include: a groyne, nourishment or beach drainage. The final option is not yet determined.

Historical analysis of coastal features and natural habitats

Dr Norm Duke UQ

Human development has increased dramatically in the coastal zone with alterations to coastal features to accommodate industry, trade and population. In the Fitzroy the impact has been a gain of 300ha (9.1%) of mangroves and a loss of 1150ha (40.9%) of saltmarsh between 1941 and 1999. The gains have been attributed to depositional gains possibly due to changes in sediment loads and river hydrology. A noteworthy event is the formation of large mangrove islands near the mouth of the Fitzroy River. In contrast, on Balaclava Island there was a loss of 4ha (4.8%) in mangroves and a gain of 7ha (3.3%) in saltmarsh detected from 1956 to 1999. The shift observed appeared to be related to climate change.

The major outcome of the project was the development of a practical classification system for the assessment of change in tidal wetlands of 12 main types. For each type, on-ground and remote sensing indicators are used.

Historical coastlines (community perspectives)

Assoc Prof Steve Mullins CQU

This project applied historical methodology to investigate the relationships between local communities and their coastal environments. Focussing on the Fitzroy River estuary and the Capricorn Coast it fostered awareness of the past states of local ecosystems, helped to develop a better understanding of intergenerational attitudes to environmental change and encouraged an appreciation that environmental management is an intergenerational concern.

Well preserved rock wall, Fitzroy River

Among other things, research was undertaken into Rockhampton's response to the great flood of 1918, the worst natural disaster inflicted on the city. Research results were published in a 134 page monograph, *Marooned: Rockhampton's Great Flood of 1918*.

A detailed investigation was also undertaken into the 'training' of the Fitzroy estuary from 1865 to 1965, a huge engineering effort to make Rockhampton a deep-water port. Some 30 kilometres of stone walls, dykes and revetments were constructed to straighten the river to make it scour sediment and maintain depth. Today the Fitzroy estuary is, to a considerable extent, an artefact of many years of human intervention.

The project has also collected over 600 images, and numerous manuscript and newspaper articles on the development of the Capricorn Coast and Fitzroy River. These can be viewed on the Coastal CRC web site, www.coastal.crc.org.au/envhist/index.html.

Yeppoon Main Beach circa 1920

Macrobenthic community structure

Dr Alistair Melzer, CQU

Macrobenthic community structure in the Fitzroy estuary was examined by collecting 74 sediment 'grabs' at a range of depths in November 2001. Sites included Fitzroy delta, Keppel Bay, Port Alma and the Narrows. Sediment samples were analysed for organisms and particle size. A total of 49 benthic species and 7449 individuals were identified. Principal groupings were polychaetes or worms (19 species), crustaceans (14 species) and molluscs (14 species). Bivalve molluscs account for the greatest abundance and some 80% of the animals were filter feeders.

Invertebrate organisms play a vital part in recycling nutrients. Consequently they play an important role in the maintenance of estuary water quality. In turn they are highly productive and critical to the maintenance of coastal bird-life and fisheries.

Small benthic fish Trypauchen microcephalus

Healthy Waterways campaign

Don Alcock Coastal CRC

A television campaign is showing how science and community action are helping to keep catchments and waterways healthy. The CQ Healthy Waterways campaign features the work of people in the Fitzroy Basin, Capricorn Coast and Port Curtis tackling natural resource management issues. Since 2002, twenty x 30 second television and radio segments have been broadcast weekly throughout the region on WIN TV, including topics about water quality monitoring, historical changes to coastal landscapes, weed removal in creeks, litter and pollution control, responsible fishing and scientific modelling.

The campaign highlights what landholders, environmental managers, scientists, students and residents can do to understand ecosystems and conserve creeks, rivers, estuaries, wetlands and beaches. It has been sponsored by the Coastal CRC, Catchment Hydrology CRC, Rockhampton City Council, Fitzroy Basin Association, Sunfish and WIN Television, and supported by local radio stations.

CQ Information Paper

Dr Paul Lawrence, NRM&E

The Coastal CRC undertook the task of preparing the Central Queensland Information Paper to provide technical information about current trends of biophysical, social and economic assets in the Fitzroy Basin. With the responsibilities for the development of the regional natural resource plan Fitzroy Basin Association contracted the Coastal CRC to prepare a comprehensive document. The purpose of the Paper was to provide information so the community could set targets for the Fitzroy Natural Resource Plan.

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Dynamics of tropical estuaries benthic fauna

Janine Sheaves PhD Student JCU

There are few studies of benthic animals (bottom dwelling) at the saltwater – freshwater interface (estuaries) in tropical regions. The Fitzroy is within the dry tropics. The project achieved a broad scale understanding of the variation in important communities. Findings from the seven estuaries studied identified distinct groups with those in downstream wet tropics being similar to dry tropics. However, changes occur across the seasons, driven by salinity and flows.

A reach scale classification for water management in coastal wetlands

Ross Johnston PhD Student JCU

The lower reaches of the Fitzroy estuary, with consistent higher levels of turbidity, contain low densities of plankton eating fish. In contrast the upper estuary contains higher levels of plankton eating fish. Small fish and crustaceans demonstrate clear responses to habitat variability. All habitats are utilised by small fish but some are preferred. In the Fitzroy species richness and numbers of fish were much higher on mud substrates rather than sand bottoms. The majority of small fish strongly favour channel edges rather than mid-stream habitats.

Ecosystem processes: Estuarine habitats, Fitzroy and Port Curtis

Ron Baker PhD Student JCU

Small and juvenile fish play an important role in the cycling of energy through tropical estuaries. The study identified that juvenile fish consume plankton (microcopic size). As they move into an estuary from coastal water they bring large amounts of carbon and energy obtained from feeding in coastal waters. The presence of juvenile fish recruitment was found to enhance the value of estuarine nurseries for juvenile predators.

The influence of altered river flow on trophic relationships of estuarine fish faunas

Jane Wilson PhD Student JCU

Seasonal changes in river flows influence dietary relationships of estuarine fish. Stream flow increases the numbers of plankton eating fish in the lower reaches of the Fitzroy. Bottom and plankton feeding fish are predominant in the mouth and upstream reaches. River flows bring about a change in estuarine food production which in turn favours different predator species although some species have the ability to switch prey. Additionally they may adopt a different foraging strategy. In summary, flows in estuaries favour different species to those present in non-flow periods.

The Coastal CRC runs a program to foster and support postgraduate students.This program builds a research culture linking formal education with the ethos and applied research of the CRC.

Partners and collaborators in the Fitzroy Coastal CRC Project

Central Queensland University (CQU) • CSIRO • Dept of Primary Industries and Fisheries Qld (DPI&F) • Fitzroy Basin Assn (FBA) • Fitzroy River Water • Griffith University (GU) • James Cook University (JCU) • Livingstone Shire Council • Natural Resources, Mines and Energy Qld (NRM&E) • Qld Environmental Protection Agency (EPA) • The University of Queensland (UQ) • Brisbane City Council • Geoscience Australia

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www.coastal.crc.org.au/fitzroy/index.html