Central Queensland
Information Paper

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to support regional natural resource management planning

Volume 3 Capricorn Coast Catchments

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Volume 3

Chapter 7 Capricorn Coast Catchments

Chapter 7 Capricorn Coastal Catchments

7.1 Introduction

This chapter provides context to the information on the Capricorn Coastal Catchment and its environs for the process of target setting. It assembles known information, research data, and local knowledge to inform catchment stakeholders. However, no information is ever complete, and there are gaps in our knowledge that occur at the catchment scale which also has impacts at the regional scale. Some of these deficiencies are listed, and it is expected that the process of catchment consultations to define targets will address some of these.

The Capricorn Coastal Catchments in Livingstone and Broadsound Shires contain a high diversity of species and ecosystems. Land clearing for agricultural development has been more localised than in other areas of Central Queensland and is concentrated in the Styx and Shoalwater Catchments. There is expanding urban development along the Capricorn Coast but there are extensive areas of remnant vegetation within the Shoalwater Bay and Byfiled areas. Mining is limited but there is potential for significant impacts.

7.2 How to use this chapter

The information brought together for the Capricorn Coastal Catchment in this chapter is divided into six clusters. These clusters are: land use and management; terrestrial biodiversity; inland aquatic ecosystems; estuarine and marine aquatic ecosystems; water quality and social and economic profile. Within each of these sections, information is supplied that addresses critical assets, condition and trend, information and knowledge gaps. Key points from these sections are provided in text boxes to help the reader to quickly gain an overview of the issues for the catchment. Finally, the section contains a listing of the recommended targets for resource condition and management actions for all clusters except for social and economic. Summary information of how the target was derived, indicators, monitoring and other details accompany the list of targets.

Where possible, maps and diagrams have been developed to summarise the information and improve the effectiveness of communicating the key messages. All appendices and references referred to in the text are combined into Chapter 14 at the end of this Information Paper.

It is important that the material contained in this chapter is read in conjunction with Chapter 5 so regional scale information can be integrated with the local catchment issues and information. This will ensure that the natural resource management plan developed meets the aspirations of all those who live and depend on the Central Queensland region.

7.3 Land use and management

The land resources of the Capricorn Coast area are shown as Land Resources Areas (LRAs) in Figure 7.1. The area is dominated by the Eucalypt duplex uplands and the alluvial plans. There are significant areas of marine plains areas near St Lawrence, while areas to the north and south of Yeppoon have coastal sand dune LRAs.

Critical land assets for the Capricorn Coastal Catchment:

- Productive grazing, forestry and sugar lands
- Water resource infrastructure for water supply and recreation
- Well established rural services, facilities and local manufacturing.
- High tourist and recreation use
- Primary, secondary learning institutions
- Reserved areas for military purposes

7.3.1 Critical assets

The Capricorn Coastal Catchment supports areas of extensive grazing, productive forestry, sugar cane principally in the north, as well as national parks, wetlands and conservation reserves for recreation and biodiversity (Fig. 7.2). The catchment is also recognised for its recreation for boating, fishing and the tourist trade.

7.3.2 Condition and trend

The Capricorn Coastal Catchment experiences many conditions that are conducive to soil erosion. Three factors that contribute to soil erosion include the rainfall intensity (R-factor), the erodibility of the soil (K-factor), and the slope of the land surface (S-factor). Representations of these three factors for the Capricorn Coastal Catchment are given in Figure 7.3. An analysis of the long term rainfall at St Lawrence is provided in Appendix A7.3.1

Pressures and threats for the Capricorn Coastal Catchment:

- High intensity storms
- Moderate-high soil erosion
- Areas of low fertility soils
- Locations of high salinity hazard
- Acid sulfate soils not currently mapped

The catchment experiences moderate to high rainfall intensity near the coastal areas, with the intensity reducing away from the coastline. The analysis shows high rainfall intensity at St Lawrence and in the southern part of the catchment. In terms of soil erodibility, most of the catchment has low to low-moderate ratings, however locations of moderate soil erodibility are shown to occur in the band running parallel to the coast. There are areas of steep slopes on the western fringe of the catchment, which influences the inland rainfall.

The information in Figure 7.3 relates to the potential for soil erosion to occur when bare ground coincides with high intensity storms. Rates of soil erosion are reduced when management practices retain cover on the surface and protect the bare soil from exposure to direct raindrop impact. Using information from remote sensing to determine cover levels, along with the factors shown in Figure 7.3, the Sednet model (Broner et al. 2001) developed in the National Land and Water Resources Audit (Prosser et al. 2001) is able to estimate long term average annual erosion within the landscape. An assessment of erosion and sediment movement (ie. total erosion) within the Capricorn Coastal Catchment is shown in Figure 7.4. The results indicate a broad range of erosion rates occur within the catchment. Most of the area is less

than 5 t/ha/yr, however areas of Softwood scrub LRAs can experience soil erosion rates of 5-10 t/ha/yr . Figure 7.4 also displays areas of extremely high erosion rates (up to 100 t/ha/yr), occurring on the Ranges LRAs, and these should be considered a priority when defining management actions.

Salinity hazard within the Capricorn Coastal Catchment is shown in Figure 7.5. The information to compile the salinity hazard rating for the catchment was derived from data of lower resolution (1:2.5million scale) than the datasets for the other catchments in the Fitzroy Basin, although the same methodology was employed. Most of the area in the catchment is of a low to moderate hazard rating, with very limited areas displaying high hazard ratings in the north and south. The moderate levels of salinity are closely associated with the Eucalypt duplex uplands and alluvial plains LRAs. The hazard map does however show small areas of high salinity hazard which must be recognised in the formulation of management actions. Areas of low salinity hazard seem to be associated with Range LRAs.

Acid sulfate soils in Central Queensland have been mapped from Iveragh to St Lawrence (Ross, 2002). The results show a high occurrence of these soils on the coastal plain along the Curtis and Capricorn coasts, Shoalwater Bay and at Broad Sound. These coastal plain contains a diversity of landforms in which acid sulfate soils are situated including tidal flats, older more elevated marine plains and beach ridges, and alluvial plains overlying estuarine sediments. In this study, Ross found that 78% of the soils are seasonally wet or saturated with a shallow watertable and most of these are acid sulfate soils. Soils associated with swamps and extratidal flats are strongly acid and contain an abundance of jarosite. Very high levels of oxidisable sulfur occur on supratidal flats or saltpans from Boyne Island to St Lawrence and may be unrelated to any particular catchment or sub-catchment. High levels of sulfur at shallow depth are associated with the mangrove species *Rhizophora*. Measured total actual acidity values are typically low throughout the study area. The upper limit of acid sulfate soil formation is recorded at 5m AHD in the Broadsound estuary, however some acid sulfate soils are situated at ground surface elevations higher than 5m AHD, in particular beach ridge plains and marine plains (Ross, 2002).

7.3.3 Knowledge, data and information gaps

The following are gaps in our understanding and knowledge for sustainable land management and use in the Capricorn Coastal Catchment:

- Statistics and data on sustainability indicators are not available at the property level, e.g. rainfall, paddock production, and ground cover. The data needs to be monitored, collated, interpreted and made accessible at the property level
- Baseline records of quality and quantity of surface and groundwater have only just commenced at the Neighbourhood Catchment (NC) scale. This information is highly valuable, and will provide a basis for better understanding of interacting processes and functions
- However, while this information is being collected, there is not a good understanding of the catchment interactions and systems scale models and tools to adequately test and evaluate management actions

- There is not a mature (shared) understanding of the paddock to ocean scale interactions, including the interactions with peri-urban land uses and impacts.
- Indicators that are appropriate at paddock, property and catchment scale, and which are responsive to management actions, need to be tested within the Neighbourhood Catchment projects
- An integrated information system and database for annual review of catchment responses to the management actions is required. This can be used by the community to report on outcomes and recommend refinements
- The integrated information system and database can provide information on the effectiveness of Property Management Plans and Sustainable Management Systems at property and Neighbourhood Catchment scales
- Areas of acid sulfate soils need to be mapped with high levels of accuracy. State guidelines and management actions for acid sulfate soils need to be incorporated into local government planning schemes. Workshops are required to raise awareness and education amongst property developers, industry and government planners

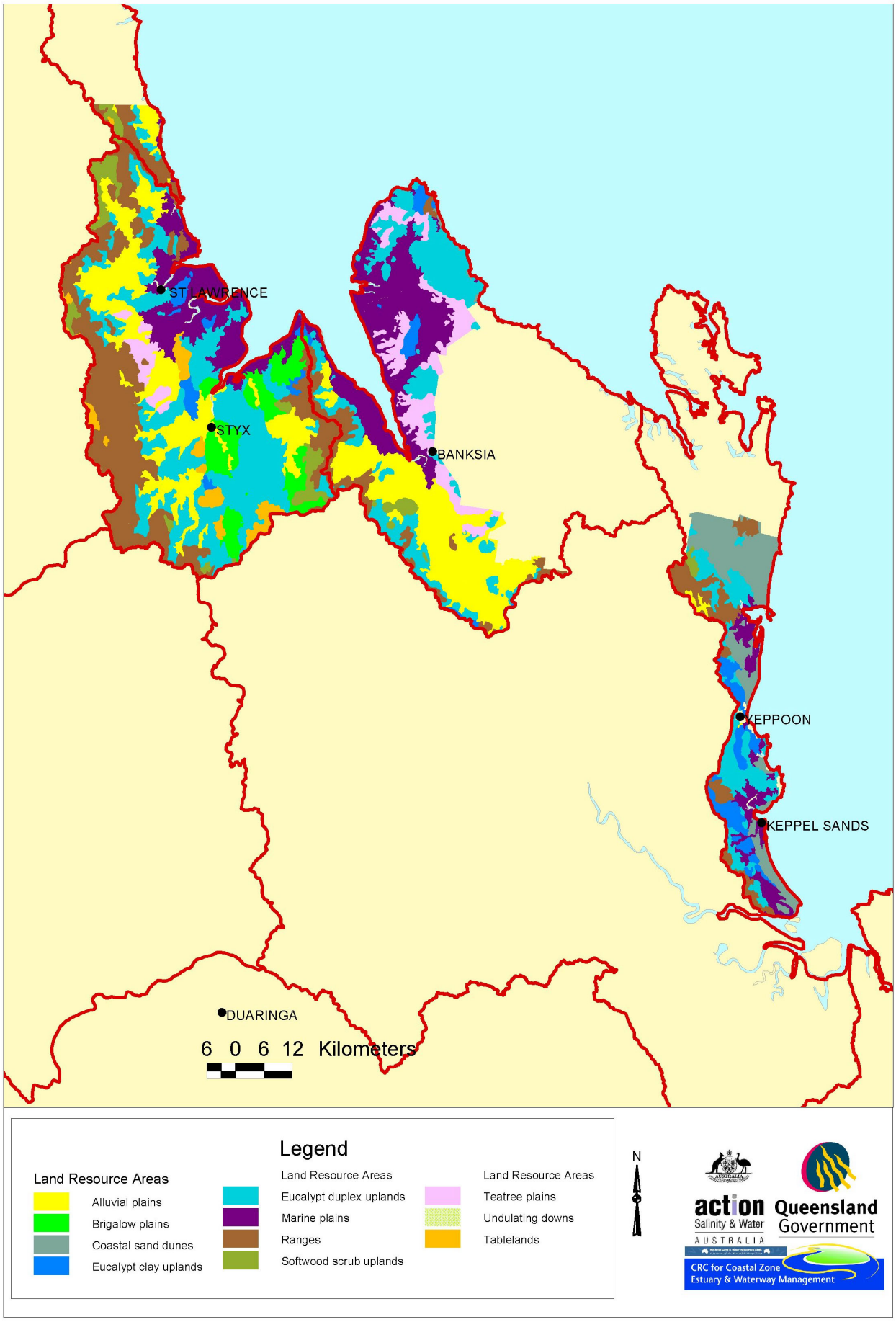


Figure 7.1 Land Resource Areas of the Capricorn Coastal Catchments

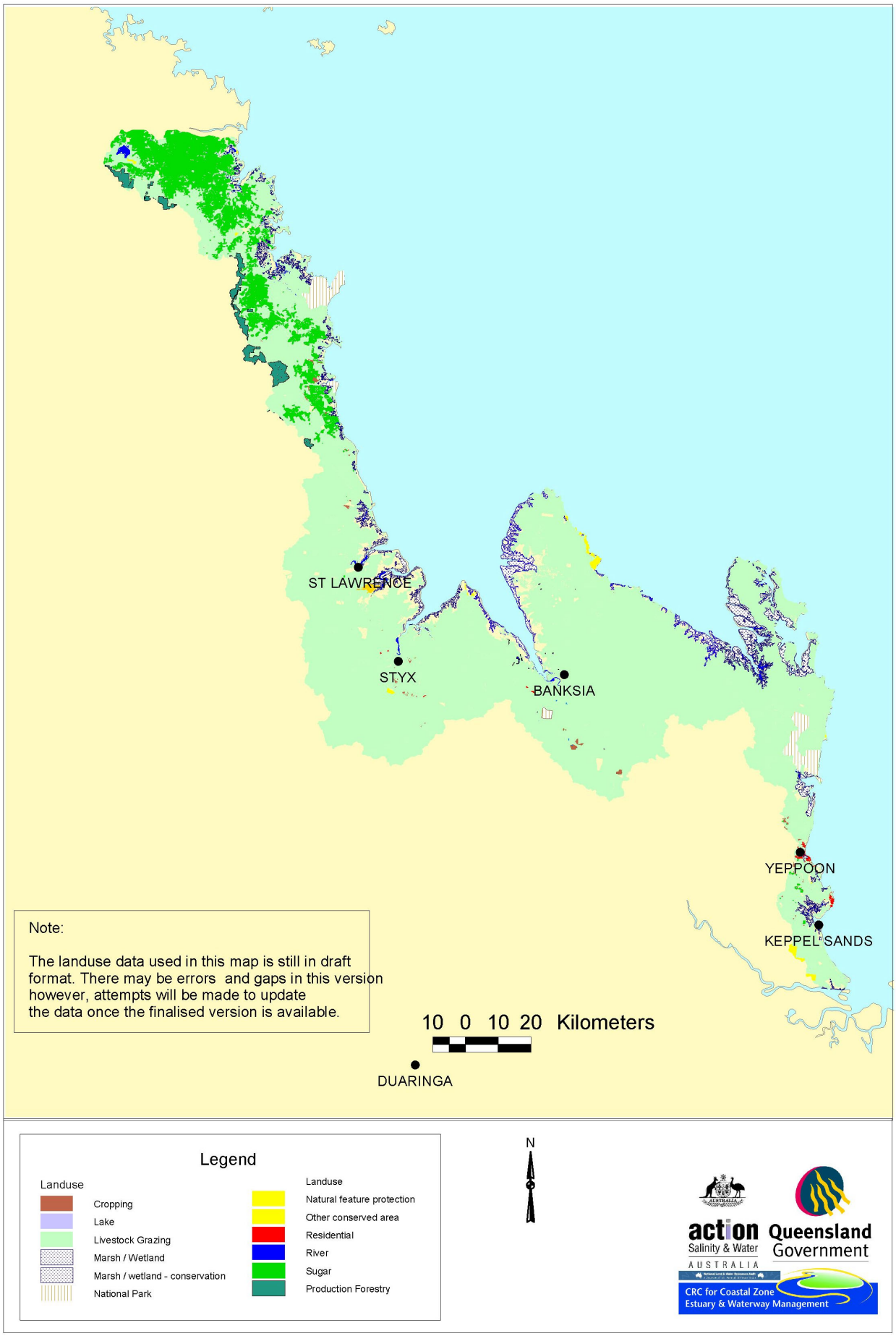


Figure 7.2 Land use within the Capricorn Coastal Catchments

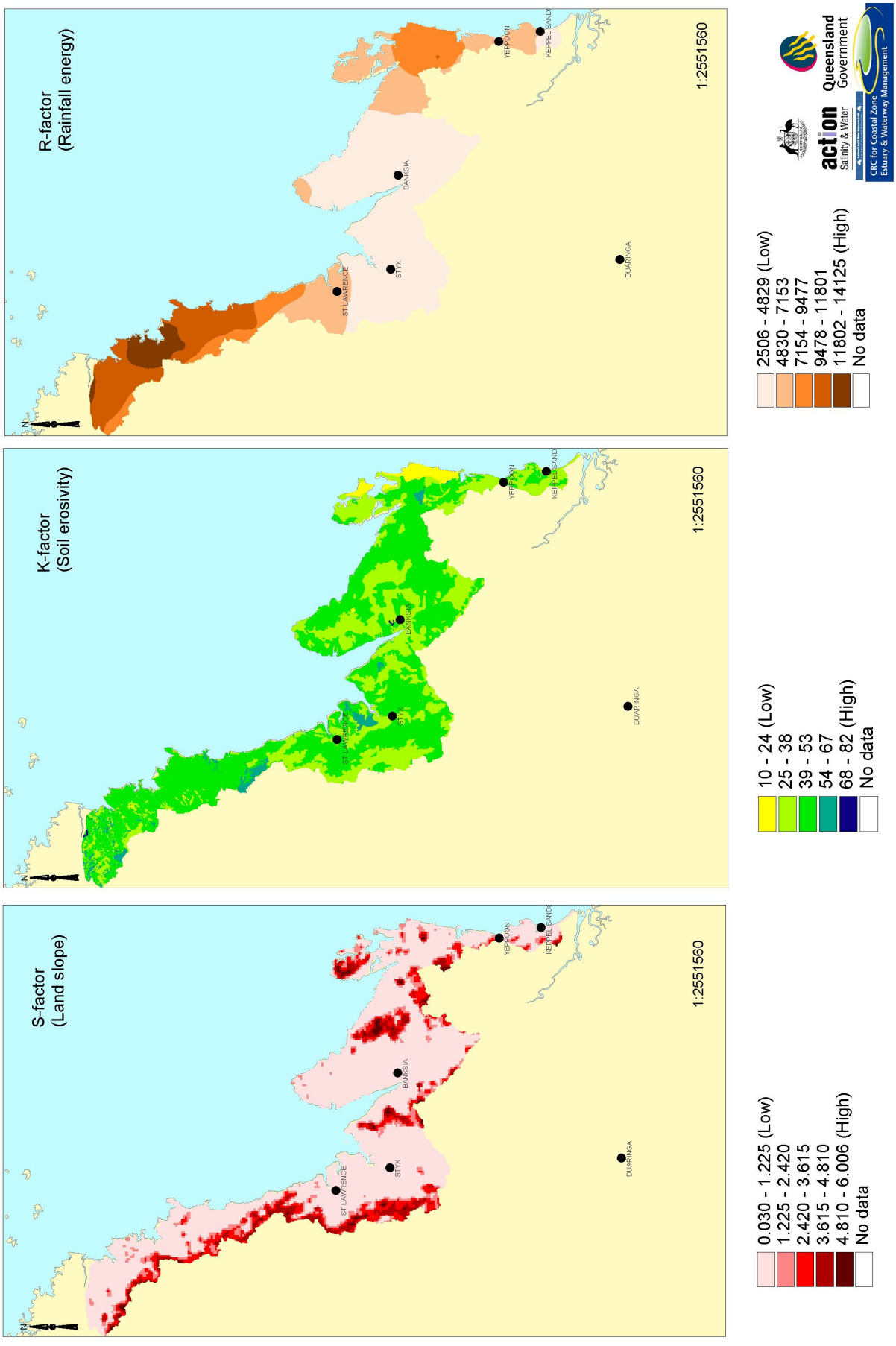


Figure 7.3 Distribution of factors contributing to soil erosion in the Capricorn Coastal Catchments. These are land slope (S-factor), the soil erodibility (K-factor) and the rainfall intensity (R-factor)

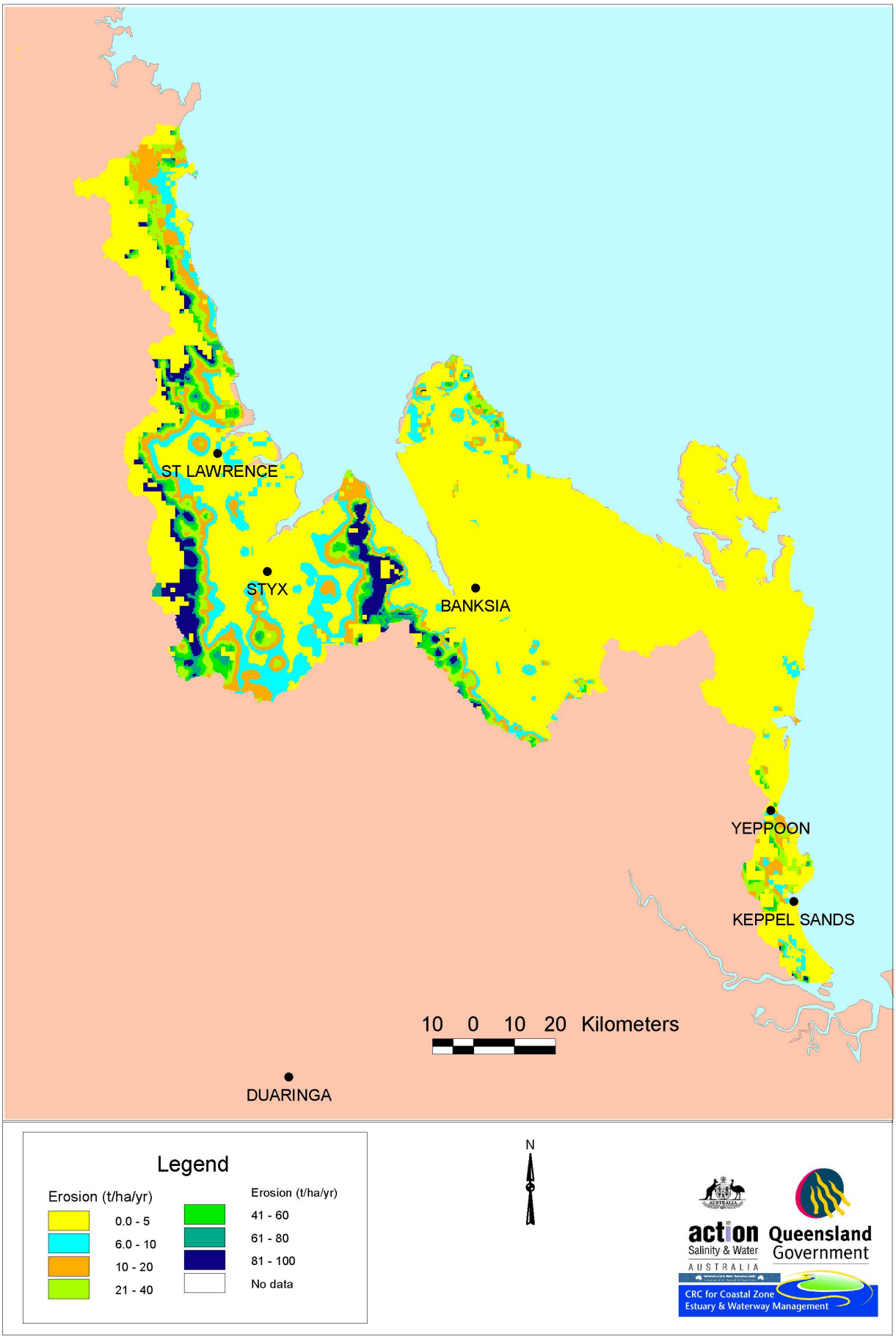


Figure 7.4 *Soil erosion calculated by the SedNet model for the Capricorn Coastal Catchments*

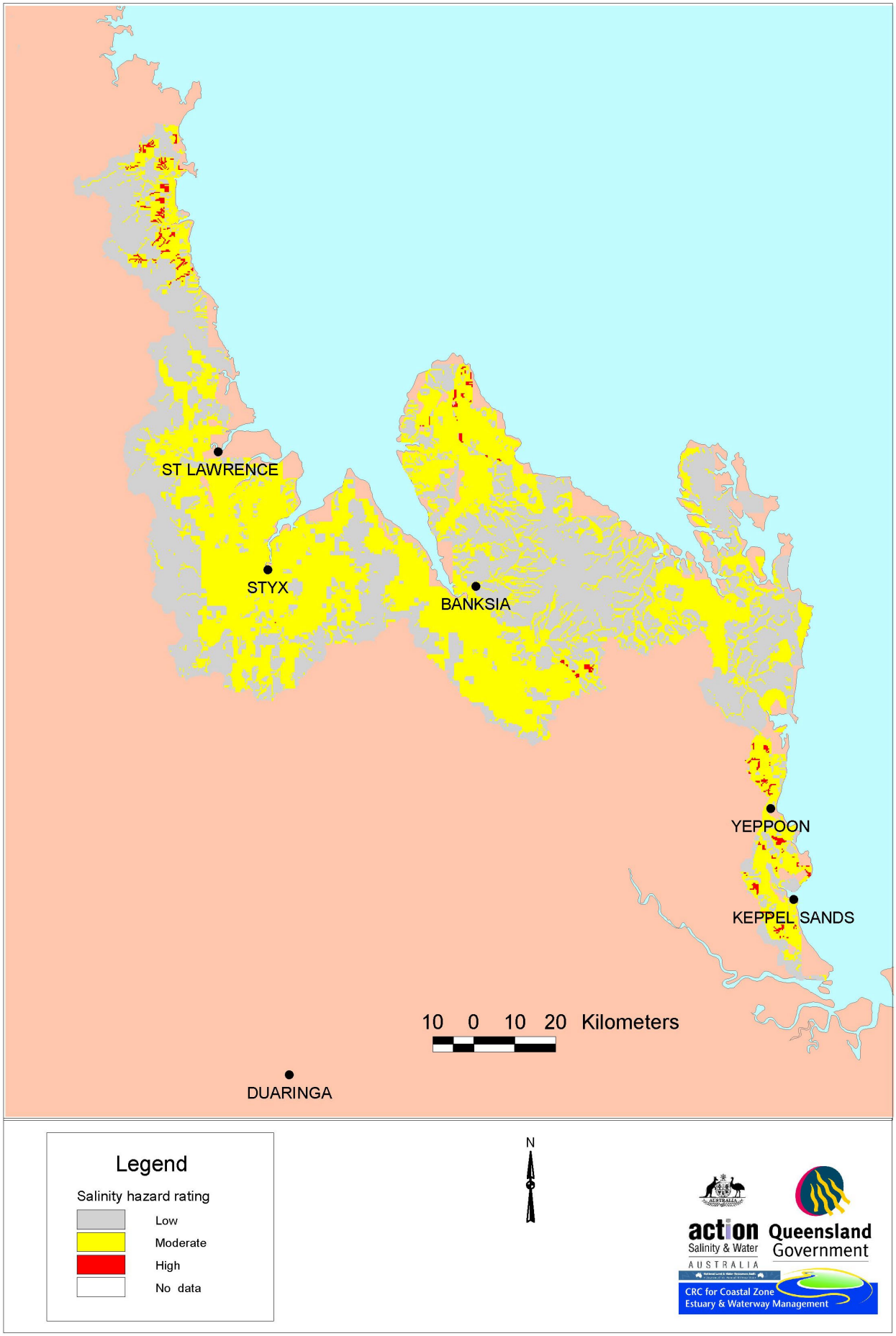


Figure 7.5 Salinity hazard map for the Capricorn Coastal Catchments

7.3.4 Targets

In developing targets for soil condition and salinity, it is important to consider the five guiding principles for sustainability:

- optimum resource management
- optimum production
- positive economics
- minimumal environmental impacts
- optimum social and cultural benefits

The perceived dilemma for agriculture has been that production and economic goals are in conflict with the resource management and environmental goals. This paper proposes directions that aim to achieve all five sustainability goals.

Considerations for sustainable production systems

Many of the targets provided for soil condition are designed to reduce runoff and soil erosion across grazing, dryland cropping and irrigation. Hillslope erosion can be controlled by:

- reducing runoff. (a) Cover levels greater than 30% will reduce runoff to about 10% of the bare soil equivalent by stopping raindrop impact which creates surface seals and increases runoff. (b) Wet soils runoff more than dry soils.
- (c) Restrictive layers in the profile (e.g. compaction) increase runoff. (d) Soils that are not trafficked, have high cover levels and are kept generally dry will produce 'natural' runoff amounts.
- managing runoff to limit concentration of flow. Pasture and woody plants tend to spread runoff across the slope (the natural condition) but mechanised agriculture directs flow in the direction of travel. With cross-slope working flow will concentrate in depressions and then drain downslope (these channels are called rills).
- reducing sediment concentration. Raindrop impact produces many of the small particles suspended in run-off water. Cover reduces sediment concentration by preventing rain from hitting the ground directly and creating these small particles. Wheel and animal traffic also break down the surface aggregates producing suspension-sized particles. During a flood, these fine sediments can travel large distances in flows to the river mouth. Additionally, fine particles carry higher levels of contaminants.

Therefore, sustainable production systems must include runoff minimisation and runoff management strategies at the paddock, farm and catchment scales. In cropping lands, the development of holistic strategies such as controlled traffic farming (CTF - Yule *et al.*, 2000, Cannon *et al.*, 2000, Loadsman *et al.*, 2001) have reduced soil erosion rilling in intense storms, prevented problems of silt fans blocking contour channels, increased production, and reduced environmental impacts.

In irrigation systems, Waters *et al.* (1999) developed an irrigated cotton/cereal double-crop system in Emerald to reduce runoff and contaminant movement during winter and to provide stubble cover during spring to reduce erosion and pesticide movement. The cotton/wheat double crop system is a good 'mimic of nature' and produces secondary benefits from reduced insect attack. Runoff was reduced by

40%, erosion by 70% and endosulphan transport by 70%. Some of the reduction in endosulphan movement was due to fewer sprays because cotton seedlings in stubble were less attractive to insects. The system was practical and effective on sloping land but resulted in some problems on low slope land. Further participatory action research is needed to make the system widely applicable.

Considerations for management actions in salinity

It is well recognised now that dryland salinity is a groundwater management problem requiring understanding of scale and process issues. The management options selected need to account for the time taken for groundwater response. In order to make decisions on how to manage dryland salinity appropriately, it is necessary to assess the effects of land use on the water balance and on groundwater. These are referred to as 'risk assessments' and are a crucial component of planning in any salinity management strategy.

Salinity management at catchment and regional scales requires:

- knowledge of groundwater flow systems, and the location and rates of recharge and discharge areas in the catchment
- groundwater level and trend data including non-alluvial areas
- elevation, regolith and soils data to support terrain analysis and the interactions between climate, land management and water balance to assess the salinity risk at the catchment scale
- a monitoring and evaluation framework to allow land management responses to be evaluated over time

Soil Condition Targets 1 – Land System Diversity Asset

Recommendation on resource condition target	
• No further loss of Land Systems Diversity in the catchment	RC

Recommendations on management action targets to meet resource condition	
• 100% implementation and integration of Water Resource Plan, Regional Vegetation Management Plan, Local Government Planning Schemes, and catchment strategies within the catchment	MA

Target explanation	Draft resource management plans need to be integrated and combined with proposed natural resource management plans to ensure no further loss of land systems diversity. The integration of plans needs to be linked with a program of integrated monitoring and recording, from the paddock scale to catchment scale. The full value of each plan and strategy is achieved through integration.
How target was derived	Plans have been developed on the basis of implementation to achieve sustainable use of natural resources, so full and immediate actions to implement and monitor the effectiveness of the existing plans needs to occur.
Indicators	Improved quality of soil, water and vegetation resources. See later targets and indicators on approaches to achieve these goals.
Monitoring methods	Implementation of resource plans, strategies in conjunction with assessment of plans by local government, catchment coordinators, agency staff.

Soil Condition Target 2 – Grazing Land Asset

Recommendation on resource condition target
• Retain a minimum of 30% surface cover on grazing land in the catchment within 5 years

RC

Recommendations on management action targets to meet resource condition
• Develop Sustainable Grazing Systems (SGS) in association with Priority Action Projects within 12 months • 10% of catchment area have Property Management Plans developed and SGS implemented within 2 years • Total of 40% of catchment area have Property Management Plans developed and SGS implemented within 5 years • Remaining 50% of area have Property Management Plans developed and SGS implemented within 5-10 years

MA

Target explanation	Sustainable grazing systems need to maintain at least 30% cover throughout the year. Much of this cover will be actively growing plants ensuring higher growth rates of animals, less weed competition and adequate fuel supplies if burning is required. Production from these systems will increase with better economic performance. Erosion will be reduced due to high cover and dry soils, and salinity risk will reduce due to higher transpiration. Many systems will include adequate trees to further dry the subsoils and produce timber. Grazing land will contribute to biodiversity and connectivity and provide wide community benefits.
How target was derived	30% surface cover is now accepted as the minimum amount to influence soil erosion. The higher the amount of grass cover, the greater the chance of reducing the potential of soil being eroded into gullies and streams. Experimental grazing and runoff sites and modelling studies by DPI and NR&M, as well as CSIRO investigations support the 30% cover target as an absolute minimum with higher levels recommended, particularly during the summer months when high intensity storms occur. The region's grazing industries are largely reliant on native pastures as well as improved (predominantly buffel). Sustainable management of these resources is dependent on management practices that maintain or enhance long term productivity. Condition assessments of the *Aristida – Bothriocloa* woodlands (Eucalypt Clays, Eucalypt Duplex, Plateaus and Ranges) have concluded that about 30% is good, 30 –60% fair and 10 – 30% is in poor pasture condition (Weston *et al*. 1981; Tothill and Gillies, 1992, Silcock 1996). Brigalow pastures (Alluvial Plains, Brigalow Plains and Softwood Scrubs) had 30% good, 35% fair and 35% poor condition, and Queensland Bluegrass pastures (Open Downs) had 10% good, 30% fair and 60% poor condition. Condition is defined as – fair or deteriorating - a state reversible with appropriate management and normal rainfall; poor condition is - degraded - probably irreversible within the bounds of economic management. Potential for improving condition is identified in these studies. However, not only must the management practices improve, but all land managers need to be aware of the early warning signs that indicate undesirable change is about to occur. There is a need for a planned, deliberate approach to ecologically based grazing land management which includes grazing ecology and the existing extension/initiatives. Accurate predictions of safe carrying capacity and development of the Grazing Land Management Education package are high priorities.
Current resource	Good condition 30%.

condition	Fair condition 30 – 60%. Poor condition 10-30% (Tothill and Gillies 1992, Silcock 1996).
Indicators	Surface cover, land condition, animal and timber production.
Monitoring methods	Paddock level by property owners.
Other comments	Training necessary. DPI developing monitoring package (STOCKTAKE program).
References	Tothill, J.C. and Gillies, C. 1992. The pasture lands of northern Australia: their condition, productivity and stability. Tropical Grassland Society of Australia, Occasional Publication No. 5. Silcock, R. G. 1996 Enhancing pasture stability and profitability for producers in *Aristida Botriochloa* woodlands. DAQ090. Final Report. MRC QDPI. The Ecograze Project – developing guidelines to better manage grazing country. Ash, A, Corfield, J and Ksiksi, T.

Soil Condition Target 3 – Dryland Cropping Land Asset

Recommendation on resource condition target
• Retain a minimum of 30% surface cover on paddocks throughout the year in 50% of the catchment within 5 years • Retain a minimum of 30% surface cover on paddocks throughout the year in the remaining 50% of the catchment within 10 years • 80% of suitable cropping lands achieve 3 t/ha/yr grain yield within 5 years

RC

Recommendations on management action targets to meet resource condition
• Develop Sustainable Cropping Systems in association with Priority Action Projects in 12 months • Implement Sustainable Cropping Systems (e.g. Controlled Traffic Farming, incorporating Reduced Tillage Systems) in 30% of cropping areas within 5 years • Implement Sustainable Cropping Systems in remaining 70% of cropping areas within 10 years • Ensure all Sustainable Cropping Systems consider economics, business planning and enterprise planning within 3 years • Develop an integrated information system and database that collates and summarises information on sustainability indicators at the paddock and property level. Information needs to aggregate from the paddock and property level to catchment scale and support state of the region reporting • Develop a shared understanding of the interactions between surface and groundwater flow systems, between water quantity and water quality at the Neighbourhood Catchment scale. Tools that support this understanding include catchment models, the Human Effects on Landscape Processes model, integrated interpretation of experimental data from research projects within the catchment. Outcomes can identify critical indicators that then need to be monitored at the property level

MA

INFO GAP

Target explanation

High cover increases infiltration and crop production, and reduces runoff and erosion. High cover can be achieved through opportunity cropping to increase annual production and maintain dry soils (less runoff and deep drainage), and zero tillage to improve soil health and reduce energy inputs. Controlled traffic farming (CTF) helps to manage soil compaction, supports zero tillage, increases farm efficiencies, ensures access and timeliness, and reduces erosion. Soil erosion causes loss of production, loss of nutrients and may restrict machinery access across the property. Erosion is a major contributor to turbidity and decreased water quality, as well as resulting in a loss of organic matter, nutrients, water- holding capacity, and the productive use of the soils. This target recognises that sustainable cropping systems will reduce soil erosion by retaining surface cover, and provide benefits of productivity, imporved water quality downstream and in the Great Barrier Reef..
Sustainable cropping systems need to consider climate, the water balance, capability of land resource areas, increasing yields, reducing inputs and approaches towards farm enterprise. The essential components for Sustainable Cropping Systems commence with the Neighbourhood Catchment program to develop ‘best bet’ systems and adoption strategies. It is recommended that a staged approach be undertaken with incentives to encourage early adoption and focus groups to identify challenges and capacity for chance.

How target was derived

30% surface cover is now accepted as the minimum amount to influence soil erosion. The higher the amount of cover, the greater the chance of reducing the susceptibility of soil being detached and transported into gullies and downstream into waterways. Experimental sites and modelling studies support the 30% cover target as an absolute minimum with higher levels recommended, particularly during the summer months when high intensity storms occur.
CTF has been adopted on about 10% of the cropping area as a system that produces improved soil resources, high productivity, positive economics, reduced environmental impacts and social benefits. CTF was developed in

	Central Queensland and a large resource of skilled and experienced farmers can support further adoption. The yield target is based on an annual rainfall of 600mm, crop water use of 300mm and a water use efficiency of 10kg/ha/mm. This is a conservative target that will stretch available infrastructure and justify modernisation. This target has also been exceeded by many CTF growers during recent dry years.
Current resource condition	Hillslope soil erosion is at moderate to high levels, while gully erosion is at a low–moderate level within the catchment due to the low levels of surface cover. There is currently no property level measure of surface cover within the catchment that can be used as a baseline. Annual production is not recorded but average crop yields are 1.5 to 2 t/ha at cropping frequencies less than one crop per year.
Indicators	Surface cover that includes crop and stubble residue cover. Grain protein and yields measured at the paddock scale. % of Property Management Plans and Sustainable Cropping Systems developed and adopted.
Monitoring methods	Monitoring of land cover is best done at the paddock level by property owners. Records should include the date, paddock, land management practice and visual inspection of the % cover to compare to a photo-standard. Grain yield monitored at the paddock scale. Grain protein level recorded at the paddock scale
Other comments	Training may be required to implement monitoring and recording methods.
References	Department of Natural Resources. 1999. Natural resource monitoring guide: a practical guide for detecting changes occurring at the property and catchment level. Report DNRQ990050.

Soil Condition Target 4 – Irrigated Land Asset

Recommendation on resource condition target

- Retain a minimum of 30% surface cover throughout the year in 60% of irrigated blocks within 3 years
-

RC

Recommendations on management action targets to meet resource condition

- Develop Sustainable Irrigation Systems (SIS) for horticulture, citrus, grapes, vegetables in association with Priority Action Projects in 12 months
- 40% of irrigated lands implement Land and Water Management Plans and SIS within 3 years
- 60% of irrigated lands implement Land and Water Management Plans and SIS within 5 years

MA

Target explanation	Soil erosion causes loss of production, loss of nutrients, chemical transport and downstream impacts on waterways in irrigation areas. The most severe events are caused by a storm occurring after the soil has been wet up by irrigation. This target recognises that sustainable irrigation systems will reduce soil erosion by retaining surface cover, reduce off-site runoff and provide benefits of productivity, imporved water quality downstream and in the Great Barrier Reef.. Sustainable irrigation systems need to consider climate, the water balance, capability of land resource areas, increasing yields, reducing chemical, pesticide and fertiliser inputs and approaches towards farm enterprise. It is recommended that a staged approach be undertaken with incentives to encourage early adoption and focus groups to identify challenges and capacity for change. Average yield targets to be set by

	growers at the highest achievable level.
How target was derived	A minimum of 30% surface cover is now accepted as being necessary to reduce soil erosion from cropping lands.
Indicators	Surface cover that includes crop and stubble residue cover. Yield measured, preferably with yield monitor. Water use efficiency.
Monitoring methods	Monitoring of land cover is best done at the paddock level by property owners. Records should include the date, paddock, land management practice and visual inspection of the % cover to compare to a photo-standard. Yields monitored at the paddock scale Water use monitored at the paddock scale.
Other comments	Farms are undertaking best management practices, and greater adoption of industry standards is occurring.
References	Noble, R.M., Duivenvoorden, L.J., Rummenie, S.K, Long, P.E., and Fabbro, L.D. 1996. Downstream effects of land use in the Fitzroy catchment. Department of Natural Resources Report DNRQ97001. 97pp.

Soil Condition Target 5 – Forest Land Asset

Recommendation on resource condition target	
• Retain a minimum of 30% surface cover throughout the year in all State and private Forest Lands within 5 years • Grazing Production Resource Target to be defined • Timber Production Resource Target to be defined	RC

Recommendations on management action targets to meet resource condition	
• Develop Sustainable Grazing Systems in Forest Lands in association with Priority Action Projects within 12 months • Develop Sustainable Timber Management Systems in Forest Lands in association with Priority Action Projects within 12 months • 50% of catchment area have Property Management Plans developed and implemented within 3 years • Remaining 50% of catchment area have Property Management Plans developed within 5 years	MA

Soil Condition Target 6 – Mining Land Asset

Recommendation on resource condition target	
• Retain a minimum of 50% surface cover throughout the year on all mining rehabilitated land within 3 years	RC

Recommendations on management action targets to meet resource condition	
• Mining industry audit Mine Rehabilitation Operational Plans in accordance with mine Environmental Management Overview Strategy (EMOS) • 100% implementation of Environmental Management Overview Strategy (EMOS) conditions within 5 years • Consider off-site impacts of mining industry in context to local and larger catchments	MA

Target explanation	Erosion is a major contributor to turbidity and decreased water quality, as

	well as resulting in a loss of organic matter, nutrients, water holding capacity, and the potential success of mine rehabilitation. This target recognises that successful mine rehabilitation will reduce soil and spoil erosion by retaining surface cover, and will prevent surface crusting, increase infiltration and hence successful establishment and vegetative growth.
How target was derived	A minimum of 50% surface cover is recommended on mine rehabilitated lands to reduce soil and spoil erosion. The higher amount of cover than recommended for agricultural lands is due to the higher slope gradients often formed following rehabilitation. Long-term experimental sites under natural rainfall (6 years), rainfall simulator and modelling studies conducted by NR&M and University of Queensland support the 50% cover target as an absolute minimum with higher levels recommended on steeper slopes, particularly during the summer months when high intensity storms occur.
Current resource condition	Overburden material has typical slopes of 75%, following reshaping slopes can range from 10% to 20%. Hill-slope erosion without surface cover can be very high > 200 t/ha/year with extensive rill and gully erosion. The coalmine industry is required to produce an Environmental Management Overview Strategy (EMOS), and Operational Plan to meet environmental targets, with regular audits of the plan.
Indicators	Surface vegetative cover, and water quality.
Monitoring methods	Record annual percentage surface cover on mine rehabilitated landforms. Water quality entering and leaving mine lease.
Other comments	Mining companies have monitoring programs already existing as part of their EMOS.
References	Carroll, C., Merton, L., and Burger, P. 2000. Impact of vegetative cover and slope on runoff, erosion and water quality for field plots on a range of soil and spoil materials on central Queensland coalmines. Australian Journal of Soil Research 38: 3131-327. Loch, R.J. 2000. Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mines, Tarong, Queensland. Australian Journal of Soil research 38: 299-312. Sheridan, G.J., So, H.B., Loch, R.J., and Walker, C.M. 2000. Estimation of erosion model erodibility parameters from media properties. Australian Journal of Soil Research 38: 265-284.

Soil Condition Target 7 – Conservation and Recreation Land Asset

Recommendation on resource condition target
• Retain a minimum of 80% surface cover throughout the year on all conservation and recreation land within 3 years

RC

Recommendations on management action targets to meet resource condition
• Develop and implement Vegetation Management Plans that provide high levels of surface cover within 3 years

MA

Soil Condition Target 8 — Urban and Infrastructure Land Asset

Recommendation on resource condition target
• All local councils complete and submit Planning Schemes within 2 years • All local councils develop point source pollution / sewage overflow abatement plans within 3 years

RC

Recommendations on management action targets to meet resource condition
• 75% implementation of Local Government Planning Schemes in 5 years • 60% compliance of Urban Stormwater Management Plans within 5 years • 25% reduction in the amount of pesticide and fertiliser applied in urban and town areas within 3 years

MA

Target explanation	The *Integrated Planning Act 1997* (IPA) establishes a uniform system for making, assessing and deciding development applications. Local government authorities are required to complete planning schemes under the IPA by June 30, 2004. The schemes indicate the location and nature of major infrastructure proposed to be provided, areas or places that constrain the use of land due to their environmental value or their adverse effects on development. Measures to address point and non-point sources of pollution and urban stormwater design should also be considered in the planning scheme.
How target was derived	The development of a local government planning scheme is a statutory requirement under the IPA. The deadline for compliance has recently been extended from until June 30, 2004.
Current resource condition	All shires in CQ region have comemnced, with most at stage 3 (planning scheme under preparation) or stage 4 (first state interests check).
Indicators	Approval of local government authority planning schemes and progressive implementation.
Monitoring methods	Department of Local Government and Planning scheme approval register.
Other comments	The rate base of local shires to fund and maintain infrastructure is a concern. Most shires are resource constrained.

Soil Condition Target 9 – People, Knowledge and Experience Asset

Recommendation on resource condition target
• 100% of communities and properties remain viable

RC

Recommendations on management action targets to meet resource condition
• Implementation of Property Management Plans as targets will increase capacity, knowledge, social capital and willingness to change by all catchment stakeholders within 5–10 years • Appropriate indicators and methods for measuring change in capacity and knowledge are difficult to define. It is recommended that indicators of change be defined for property and catchment levels, and that these also consider attitudes to action learning and adaptive management.

MA

Target explanation	Workshops to develop Property Management Plans will provide additional skills and capacity to landholders to support and encourage the implementation of the plans. Dialogue between landholders, industry representatives and government advisors will improve relationships, and

	progress towards healthier arrangements at the property and regional level. The difficulty is that measuring and monitoring change is difficult, and it is not clear how this can, or should, be done. Recent work in the National Land and Water Resources Audit found no statistical connection between proposed indicators of 'capacity for change' and the adoption of natural resource management practices by farmers. Landholders, their families and the towns in which they live and depend on, must remain viable in the region.
Current resource condition	There is insufficient information or relationships between indicators and monitoring to provide an indication of the current "condition" of social capacity of landholders in the region.
Indicators	Meaningful indicators that reflect social dimensions of change in an economic and ecological environment need to be developed.
Monitoring methods	Monitoring methods need to be determined
References	Lockie, S., Lawrence, G., Dale, A. and Taylor, B. 'Capacity for change': testing a model for the inclusion of social indicators in Australia's National Land and Water Resources Audit. Journal of Environmental Planning and Management (submitted).

Soil Salinity Target 1 – All Land Assets

Recommendation on resource condition target

- Reduce deep drainage and return groundwater levels to natural levels by improved management of the water balance using Sustainable Production Systems at paddock and Neighbourhood Catchment scales on 50% of each Land Asset in the Basin within 10 years
- Reduce deep drainage and return groundwater levels to natural levels on a further 30% of each Land Asset in the Basin within 15 years

RC

Recommendations on management action targets to meet resource condition

- Prepare Property Management Plans for 50% of each Land Asset within 4 years, as described in Resource Condition Targets. Include water balance management at paddock scale and groundwater flow management at Neighbourhood Catchment scale in PMP training
- Prepare Property Management Plans for a further 30% of each Land Asset within 8 years, as described in Resource Condition Targets
- Develop Sustainable Production Systems for each industry through the PAP within 12 months. Ensure SPSs target deep drainage and groundwater management at property scale and NC scales
- Implement Sustainable Production Systems on 75 properties and 7 Neighbourhood Catchments including examples of all Land Assets through the PAP within 1 year. Include at least one NC specifically for salinity management, presumably from the Salinity Hazard map.
- Implement Sustainable Production Systems at property and Neighbourhood Catchment scales on 50% of each Land Asset within 5 years
- Implement Sustainable Production Systems on a further 30% of each Land Asset within 10 years

MA

- Use the integrated information system and database (from Resource Condition Targets) for annual review of catchment responses to Management Actions, the effectiveness of PMP and SPS processes at property and NC scales in terms of the Salinity and Soil Condition Targets, report to community and recommend refinements.

INFO GAP

- Link these Management Actions to the Statewide Investment Program aimed at better understanding groundwater systems, salinity processes, risk assessment and modelling of salinity and water quality interactions, developing a monitoring and evaluation framework, and at salinity assessment in representative catchments (i.e. NC) to evaluate applicability of approaches annually, to report to community and to recommend refinements.

Target explanation	By comparison with the Murray–Darling, the Fitzroy Basin is steep, and slope within a catchment provides major opportunities for drainage (natural or built) of groundwater to disposal points (probably streams). This slope has little impact on the processes leading to dryland salinity but will limit the extent, and allows a greater range of management options. One small example is the development of salinity in the Emerald Irrigation Area and its management by sub-surface drains. It is generally accepted that dryland salinity is the result of changes in the water balance brought about by replacement of the natural vegetation with agricultural systems that use much less water. The extra recharge to groundwater systems results in increased discharge and salt movement to the land surface and to streams. In landscapes prone to dryland salinity, the time frames and the extent of degradation depend upon the interaction of four key factors: c*limat*e, *land u*se, *salt store*s and *hydro-geology*. Of the four key factors, land use is the only one that can be managed feasibly. **Gap**: Collation and capture of biophysical data to underpin analyses of risk assessment, including groundwater, salinity surveys, geological structures and soils and regolith characteristics. These are institutional responsibilities but careful consideration of what data are useful and associated costs are necessary to establish priorities. **Gap**: Development of a groundwater flow system map for Queensland at a scale of 1:250 000. The current hazard map for Queensland was based on a groundwater flow system map derived from 1:2 500 000 scale data. This was useful as an initial attempt at hazard assessment at the national scale, but is not suitable for management support at the catchment scale or for definition of priority activities State wide. **Gap**: More detailed salinity risk assessments on representative catchments using the best information available on groundwater and regolith characteristics (Webb, 2002). By considering the Basin as a whole, land managers need to be engaged as partners in the process and to start from a 'best bet' position based on current knowledge and to continuously improve it.
How target was derived	These targets are based on the assessment of salinity risk in Queensland by A.A. Webb (2002), and developed in conjunction with the recently released Salinity Hazard Map for the Fitzroy
Current resource condition	Many parts of the region have been identified as being at moderate and high level of salinity hazard.
Indicators	Quality (salinity) of groundwater and surface water, depth to groundwater, rate of rise in groundwater, quality of groundwater, permanent wet areas, presence of salt or salt crystals on surface, soil pH, changes in vegetation, dying of trees and grasses, reduced yields.
Monitoring methods	Direct and routine (3-4 times per year) measurements, photographic records, use of electrical conductivity meter, water samples analysed by laboratory.
Other comments	Salinity is a disruption in the water balance of the landscape. Methods to control and minimise salinity need to reduce runoff and deep drainage, and maximise transpiration of soil water by plants.
References	Webb, A.A. 2002. Dryland salinity risk assessment in Queensland. Consortium for Integrated Resource Management (CIRM), Department of Natural Resources and Mines Report QNRM02007: 46pp Department of Natural Resources. 1999. Natural resource monitoring guide: a practical guide for detecting changes occurring at the property and catchment level. Report DNRQ990050.

Acid Sulfate Soils Target 1 – All Land Assets Within 5m AHD

Recommendation on resource condition target RC

- Within 5m AHD, minimise drainage and maintain groundwater levels to natural levels by improved management of the water balance using Sustainable Production Systems on 50% of each Land Asset at paddock and Neighbourhood Catchment scales within 5 years
- Within 5m AHD minimise drainage and return groundwater levels to natural levels on a further 40% of each Land Asset within 10 years

Recommendations on management action targets to meet resource condition MA

- Identify all areas of hazard and risk from acid sulfate soils in the catchment within 3 years
- Conduct at least 3 awareness, training and education workshops that engage industry, community and urban stakeholders within 2 years. These workshops must include guielines for ponded pastures, irrigation, aquaculture and urban development.
- Rehabilitate 70% of areas already identified as seriously acidified or where acid sulfate areas are causing serious off-site effects within 3 years.
- Implement acceptable management practices involving sustainable cropping systems and sustainable grazing production systems where acid sulfate soils have been disturbed with 5 years.

Target explanation	Acid sulfate soils (ASS) is the common name given to soils and sediments containing iron sulfides, the most common being pyrite (FeS_2). When exposed to air due to drainage or disturbance these soils produce sulfuric acid (battery acid), often releasing toxic quantities of iron, aluminium and heavy metals. This cocktail of acid, iron, aluminium and heavy metals can cause significant damage to the environment, engineering structures and even human health. Acid sulfate soils are formed when seawater or sulfate-rich water mixes with land sediments (containing iron oxides) and organic matter under waterlogged anaerobic (oxygen free) conditions. Exposure with air may be caused by construction of dams, ponds, drains, ditches or building sites and tree clearing.
How target was derived	Discussions with Queensland Acid Sulfate Soils Investigation Team (QASSIT).
Current resource condition	Areas of high acid sulfate soil hazard have been mapped in the Keppel Sands – Yeppoon area. Further areas to be done.
Indicators	Vegetation, rust coloured iron stains, fish kills, low pH of water, water quality, drains and ditches, sulfide odours, shells, destruction of infrastructure.
Monitoring methods	Field pH peroxide test procedure, field pH test procedure (see Hey, 2002).
Other comments	John Ross, DNR&M, currently completing further work on mapping and identifying acid sulfate soils in coastal areas.
References	Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR. 2002. Soil Management Guidelines. This document defines risk-based management strategies for ASS and provides guidance on how to achieve best practice environmental management of ASS. Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998. Powell B and Ahern CR. 1999. QASSMAC Acid Sulfate Soils Management Strategy for Queensland**.** QASSMAC and Queensland Department of Natural Resources, Indooroopilly, Queensland. Ahern CR, Hey KM, Watling KM and Eldershaw VJ (eds). 2000. Acid Sulfate Soils: Environmental Issues, Assessment and Management, Technical Papers, Brisbane, 20–22 June, 2000. Department of Natural Resources, Indooroopilly, Queensland, Australia.

7.4 Terrestrial biodiversity

7.4.1 Critical assets

The Capricorn Coastal Catchment contains 6 sub regions of the Brigalow Belt and Central Queensland Coast Bioregions. The catchments retain much of their natural values and clearing of native vegetation for pasture production and urban development covers <40% of the area. The average rate of clearing is between 0.25% and 0.50% of the catchments annually.

Assessments that determine the relative significance of remnant vegetation or habitat for biodiversity conservation have been completed by the Environmental Protection Agency (Fig. 7.6). At a landscape scale the remaining significant wildlife refuges and wildlife corridors have been identified. The Shoalwater Bay and Byfield areas are recognised for their national significance as a wildlife refuge. The adjacent wetlands have international importance. The remnant vegetation along the Ranges within Broadsound Shire is a significant north-south wildlife corridor critical to conservation of biodiversity.

7.4.2 Condition and trend

Overview of sub regions in the Capricorn Coastal Catchments

Sub region	% of sub region mapped as remnant vegetation	Extent of remnant vegetation in Catchments by sub region (Interim)	Extent of remnant vegetation of state significance for biodiversity conservation	NLWR Audit landscape health stress rating - 6 is the highest stress rating	Vegetation clearing rates 1997-1999 % of catchments cleared annually	Extent of remnant vegetation within protected areas by sub region
Marlborough Plains	45%	225,483ha	118,226ha	1	0.29%	16,967ha
Nebo-Connors Ranges	64%	41,820ha	4,253ha	3	1.09%	2,080ha
Byfield	93%	82,543ha	Not available	1	0.22%	2,757ha
Manifold	88%	60,715ha	Not available	1	0%	6,911ha
Clarke-Connors Ranges	87%	82,044ha	Not available	1	0.08%	58,989ha
Proserpine-Sarina Lowlands	34%	20,066ha	Not available	3	0.35%	18,067ha

Note: In general sub regions under the greatest stress and which are least conserved in protected areas have the greatest need of management to maintain biodiversity.

Vegetation

The loss and degradation of wildlife habitat associated with broad scale vegetation clearing is the main threat to biodiversity in the area north of Shoalwater Bay. There is some fragmentation of remnant vegetation in the alluvial and clay downs land zones. Local extinctions of fauna may occur if remnant vegetation in the Coastal floodplain continues to be cleared. The vegetation in the Shoalwater Bay and Byfield

area remains largely intact. Clearing for urban development is fragmenting vegetation along the Capricorn Coast.

Desired National Outcome: Biodiversity and the extent, diversity and condition of native ecosystems are maintained or rehabilitated	
	Capricorn Coastal Catchments Condition Statement
1	60% remnant vegetation in the catchments
2	Clearing rates are high
3	Habitat is well connected
4	Urban development is expanding
5	Lack of consistent systematic monitoring

The extent of future clearing will be limited through a range of strategies. Legislative initiatives by the Queensland Government have led to the preparation of draft regional vegetation management plans (RVMP), including the Capricorn Dawson RVMP, Nebo Broadsound RVMP and the Central Queensland Coast RVMP that cover the Capricorn Coastal Catchments. These plans still permit clearing in the region so strategies that encourage landholder cooperation with biodiversity conservation initiatives are required.

The other major issues for maintenance of the key terrestrial biodiversity assets of the catchments are:

- The implementation of grazing land management practices that restore and maintain ground cover in remnant vegetation
- The regulation of clearing for mining and urban development of 'at risk' regional ecosystems and critical habitat for 'at risk' species
- Control of invasive species where these represent a threat to biodiversity and conservation of remnant vegetation

Regional ecosystems 'at risk'

Using the biodiversity status of regional ecosystems, 64 regional ecosystems are 'at risk' within the Capricorn Coastal Catchments.

There are 17 regional ecosystems classified as 'endangered' and 47 regional ecosystems with an 'of concern' biodiversity status. There are a number of regional ecosystems endemic to the Shoalwater Bay and Byfield areas.

To facilitate setting targets for biodiversity conservation a rapid assessment to define areas with high priority for management actions has been undertaken by reviewing the biodiversity planning assessment for the catchments in relation to the major threatening processes. The key remnant units having a high priority for management actions are presented in Appendix A7.4.1 and Figure 7.7.

The *Vegetation Management Act 1999* provides protection from further broad scale clearing for agriculture for 'endangered' regional ecosystems on freehold and leasehold land and 'of concern' regional ecosystems on leasehold land. The assessment codes in the draft RVMPs also provide adequate protection from clearing for 'of concern' regional ecosystems on freehold land. Some of the significant areas of 'not of concern' regional ecosystems that contain special biodiversity values are not protected by the draft RVMPs.

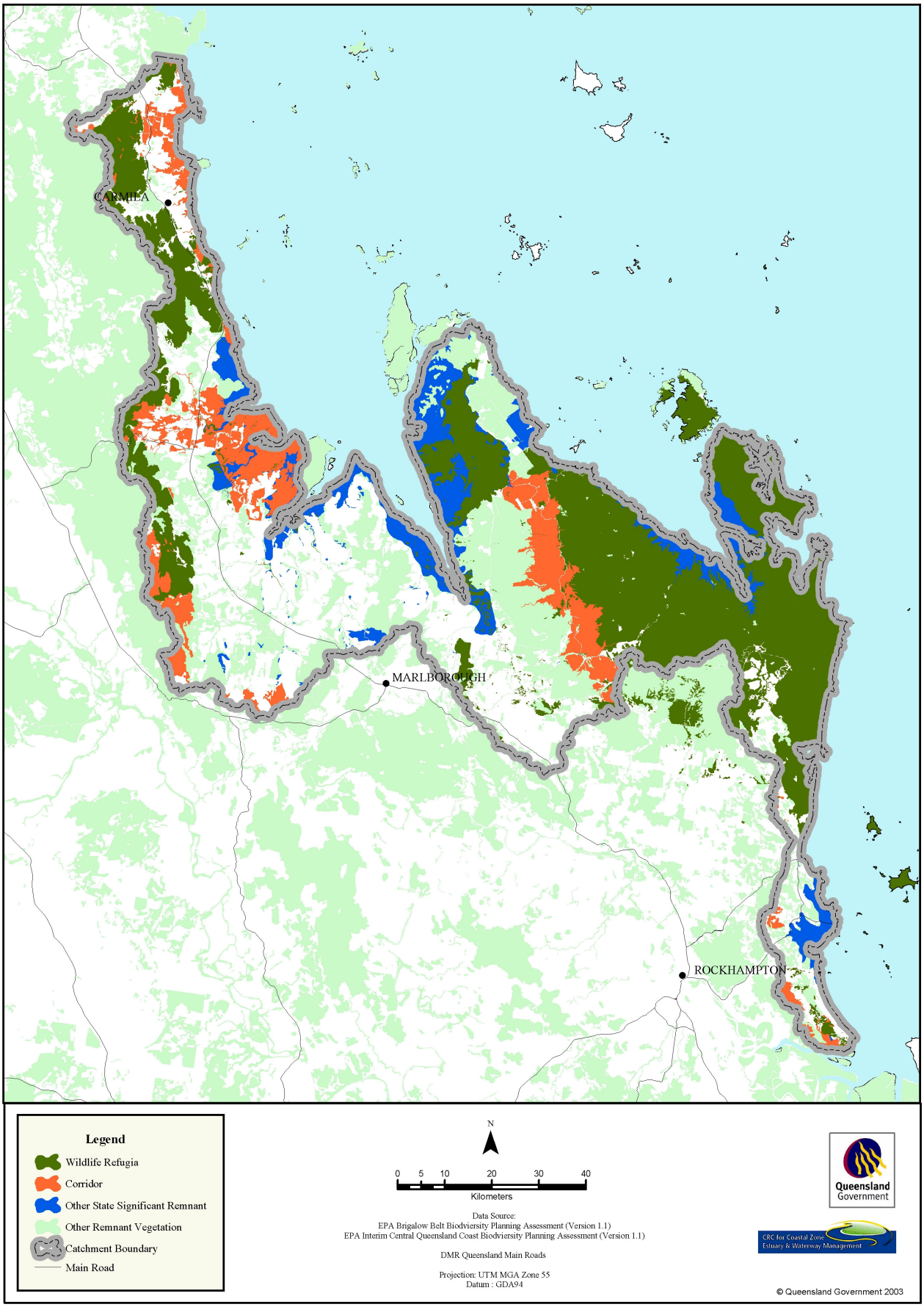


Figure 7.6 *Wildlife refuges, wildlife corridors and other remnant vegetation of state significance for biodiversity conservation in the Capricorn Coastal Catchments*

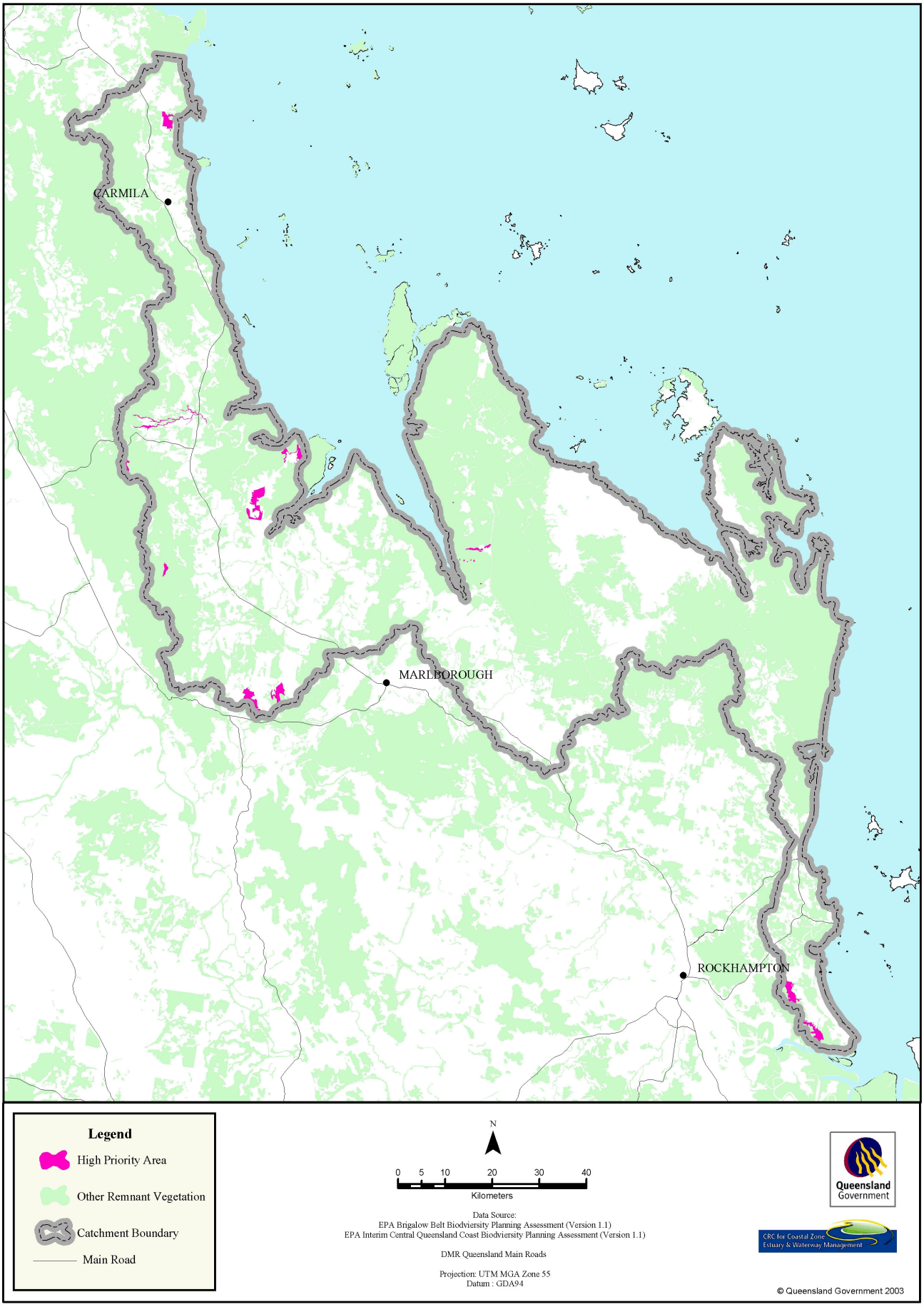


Figure 7.7 Areas of high priority for management actions to conserve biodiversity in the Capricorn Coastal Catchments

The other significant threats to these ecosystems are alterations to the ground layer from grazing by cattle, invasion by exotic pasture grasses and browse species, clearing for mining and urban development or inappropriate fire management. The impacts of these processes vary across the catchments.

Processes that threaten terrestrial biodiversity:

- Broad scale tree clearing
- Urban and industrial development
- Mining
- Overgrazing
- Alterations to wetlands
- Introduced species
- Unsustainable timber harvesting
- Altered fire regimes
- Environmental weeds
- Invasive native species
- Pest animals

There has been no systematic assessment of the condition of key remnants and this is a priority action so that an accurate level of threat to biodiversity can be determined.

A total of 13,361ha (2% of the remnant vegetation) of the Capricorn Coastal Catchments is managed for conservation within protected areas under the *Nature Conservation Act 1992*. Actions are being taken to manage the key threats identified above within protected areas. The species and ecosystems protected within these areas do not adequately represent the diversity and richness of wildlife that occurs within the catchments. However, the species and ecosystems of the Byfield and Manifold sub regions are well protected because the Shoalwater Bay Military Training Area is managed to protect its biodiversity values.

In addition 27,438ha (4% of the remnant vegetation) are in State Forests or other reserves. These areas are protected from vegetation clearing for agricultural production but are threatened by unsustainable grazing and localised vegetation clearing for mining. Mining poses a significant threat to some critical areas of 'endangered' regional ecosystems.

The acquisition of land for protected area or the protection of remnant areas through voluntary partnerships with landholders is a high priority to ensure adequate representation of the diversity and richness of the regions wildlife in areas managed for conservation. Two voluntary nature conservation covenants (Nature Refuges) have been established in the Capricorn Coastal Catchments. Voluntary conservation agreements are also available to encourage and assist landholders to protect habitat for wildlife. Devolved grant programs have also been operating which provide funding to enhance nature conservation on properties.

Targeted extension with landholders of key conservation sites has been identified as the primary management action leading to improved conservation management of these areas.

Species of conservation concern

Some parts of the catchment are significant as habitat for rare and threatened plant and animal species, and for other species of conservation concern. Site records are available, but surveys have not been systematic and critical habitat for the conservation of these species in the catchment has not been identified.

The Central Queensland Strategy for Sustainability recognises species loss as an important focus of community concern. The level of fragmentation of habitat that has occurred will mean some species will continue to decline over time.

Overview of species of conservation concern in the Capricorn Coastal Catchments

Species Group	Total No. Species	Extinct	Endangered	Vulnerable	Rare	Other Significance
Plants	1,892	0	4	12	17	0
Mammals	48	0	0	3	1	0
Birds	356	0	4	7	13	0
Reptiles	60	0	1	1	2	0
Frogs	25	0	0	0	0	0

Source: 'WildNet' (EPA, 2002)

Plants

Thirty three (33) 'endangered', 'vulnerable' and 'rare' ('at risk') plant species listed under the *Queensland Nature Conservation* (*Wildlife*) *Regulation 1994* are known to occur in the Capricorn Coastal Catchments. The threat to habitats of 'at risk' species from clearing for pasture production is not high. However, potential mining and rural residential development of serpentinite areas are a threat to the 11 'at risk' species associated with the serpentinite communities. Retaining all serpentinite areas as rural land is a high priority.

Desired National Outcome: Populations of significant species and ecological communities are maintained

	Capricorn Coastal Catchment Condition Statement
1	33 plant species of conservation concern
2	34 vertebrate animal species of conservation concern
3	No recovery plans for 'at risk' flora species
4	No recovery plan for 'at risk' fauna species
5	'At risk' regional ecosystems protected from broadscale vegetation clearing
6	Clearing for urban development and mining a continuing threat

The main threat to the 'rare' *Macropteranthes fitzalanii* is habitat clearance for urban development. The species is restricted to the coastal vine thicket communities between Rockhampton and Proserpine and is considered a medium priority for management action. Preventing the destruction of habitat is seen as a key management action.

Animals

A total of 491 vertebrate species have been identified from the Capricorn Coastal Catchments. Of these thirty-four (34) are considered to be 'at risk' according to the *Queensland Nature Conservation* (*Wildlife*) *Regulation 1994*. Two (2) species are considered locally extinct. Three (3) birds are considered to be a high priority for management action.

Species that are presumed locally extinct in the area:

- Coxen's fig-parrot (*Cyclopsitta diophthalma*)
- Yellow chat (*Epthianura crocea*)

The 'endangered' little tern (*Sterna albifrons*) has been recorded at several locations along the Capricorn Coast. Human disturbance, black rats (*Rattus rattus*), silver gulls (*Larus novaehollandiae*) and crows (*Corvus* spp.) are threats to this species. The species breeds at Sandy Point (Corio Bay) and protecting this area will have a

positive impact on the population (Garnett and Crowley, 2000). Support for the management actions listed in the '*Action Plan for Australian Birds 2000*' (Garnett and Crowley, 2000) is a high priority.

Animals considered to have a high priority for management action:

- Little tern (*Sterna albifrons*)
- Red goshawk (*Erythrotriorchis radiatus*)
- Crimson finch (*Neochmia phaeton*)

Red goshawk populations have declined by as much as 30% over the last few years (Garnett and Crowley, 2000). It is estimated that there may be fewer than 1000 birds remaining. The last official sighting from the Capricorn Coast area was 1971 but the extent of remnant vegetation along the coast means it may still persist in the region. Home range estimates are 120km^2 for females and 200km^2 for males. Fragmentation of native vegetation, the reduction of prey species through the drainage of wetlands (especially melaleuca swamps), loss of suitable nest trees in logged forests, and the inappropriate use of fire, are thought to be key threatening processes. Support for the management actions listed in the '*Action Plan for Australian Birds 2000*' (Garnett and Crowley, 2000) is a high priority.

Animals considered to have a low to medium priority for management action:

- Black-breasted button-quail (*Turnix melanogaster*)
- Glossy black cockatoo (*Calyptorhynchus lathami*)
- Powerful owls (*Ninox strenua*)
- Rusty monitor (*Varanus semiremex*)
- False water rats (*Xeromys myoides*)

The 'vulnerable' crimson finch (*Neochmia phaeton iredalei*) has been recorded in the Styx River Catchment. The last official sighting of this population was in 1997. Unlike finch populations in far north Queensland, crimson finches have declined in Central Queensland. The destruction and degradation of the finch's habitat and illegal trapping are believed to be the species main threats. Fire may also pose a significant threat. The species is considered to be a high priority for management action. Key management outcomes would include improving our understanding of the species conservation needs and status in the area and working with landholders to retain long grass in some riparian areas.

The population of black-breasted button-quail (*Turnix melanogaster*) in the Shoalwater Bay area is recognised as the northern limit for the species. It is estimated that less than 2000 birds remain (Garnett and Crowley, 2000). The species is considered a medium priority for management action. Support for the management actions listed in the '*Action Plan for Australian Birds 2000*' (Garnett and Crowley, 2000) is a priority.

Glossy black cockatoos (*Calyptorhynchus lathami*) and powerful owls (*Ninox strenua*) are both listed as 'vulnerable' under the *Queensland Nature Conservation* (*Wildlife*) *Regulation 1994*. The main threats to these species are coastal development and land clearance for agriculture (Garnett and Crowley, 2000). In the Capricorn Coast area a significant amount of suitable habitat occurs on private lands. Therefore, improving community awareness of these two birds particularly in relation to their environmental significance and their conservation requirements would be a key management action.

The biology of the rusty monitor (*Varanus semiremex*) is poorly known. Only a few scattered populations have been found in the tidal estuarine mangroves and melaleuca swamps north of Gladstone (Hines, 2003). Population trends for this species are unknown, it may be naturally rare. Alterations to lowland wetland communities and the toxic effect of cane toads are threatening processes (Burnett 1997). Improved understanding on the distribution of this species in Central Queensland is a priority management action.

Ecologically Significant Invasive Species

The focus of this section is on invasive species that have the potential to have a significant impact on ecosystem function or cause a reduction in native species richness and abundance (see Section 5.4.3).

Pest species that are considered to be ecologically significant and a priority for management action:

- Giant rats tail (*Sporobolus pyramidalis*)
- Cat's claw creeper (*Macfadyena unguis-cati*)
- Cabomba (*Cabomba caroliniana*)
- Rubber vine (*Cryptostegia grandiflora*)

The information available on the distribution and status of weeds in the Capricorn Coastal Catchments is not at a scale relevant to developing strategic weed management plans although anecdotal evidence suggests weeds are not a major threat to biodiversity. The partial distribution of some weeds including giant rats tail (*Sporobolus pyramidalis*), parthenium (*Parthenium hysterophorus*), prickly acacia (*Acacia nilotica*) rubber vine (*Cryptostegia grandiflora*), parkinsonia (*Parkinsonia aculeata*), and badhara bush (*Gmelina asiatica*) has been collated using 'PestInfo'.

Giant rats tail has the potential to significantly impact upon primary productivity. The weed copes remarkably well with disturbance and is often a symptom of poor land management. Maintaining the integrity of the landscape, and preventing the spread of weed seeds are crucial for the control of Giant rats tail grass. The eradication of small infestations and control in larger areas is a priority for landholders.

Cat's claw creeper (*Macfadyena unguis-cati*) is a major environmental weed that is often difficult to control. It is capable of smothering and destroying the canopy. Controlling small outbreaks in the coastal catchments with the aim of eradication is a priority.

The aquatic Cabomba (Cabomba caroliniana) is a weed of national significance and is present in the catchment. The control of this weed is extremely difficult and is a high priority while the problem is still small.

Control programs for rubber vine (*Cryptostigia grandiflora*) have been attempted in protected areas and in other areas of remnant vegetation in these catchments with limited success. It is a major problem to primary production and biodiversity in general. Improving community awareness and promoting the spread of the rubber vine rust, which is known to reduce the vigour of the plant and allow other native species to compete, is a priority.

7.4.3 Knowledge, data and information gaps

- Currency of vegetation mapping information
- Native vegetation condition relating to trends and changes in structure and composition including weed invasion.
- Location of critical habitat for 'at risk' species and certain vegetation types with specific management requirements that may require finer scale data.
- The threats and reasons for the decline of many 'at risk' species.
- Lack of biodiversity survey and monitoring information for all land tenures but particularly private land.
- Guidelines for the sustainable management of regional ecosystems in relation to grazing and fire

7.4.4 Targets

Terrestrial Biodiversity Target 1

Recommendation on resource condition target RC

- Retain a minimum % of native vegetation coverage in each catchment in patches of sufficient size to maintain ecological processes and ecosystems within 3 years

Catchment	Current (1999) resource condition (%)	% retention of remnant vegetation	Size of patches (ha) or greater
Broadsound Coast	47	40–44	100
Styx	57	50–54	500
Shoalwater	78	74–76	500
Capricorn Coast	83	77–80	100

Recommendation on management action targets to meet resource condition MA

- Make submissions as part of the public comment processes for each Regional Vegetation Management Plan in Central Queensland within a year
- Adequately represent the diversity and richness of the region's wildlife by protecting 5,000ha of remnant vegetation from clearing (through acquisition of land for protected area, or through voluntary covenants with landholders) within 7 years
- Encourage and assist land-holders to provide habitat for wildlife under the 'Land for Wildlife' program by having a co-ordinated program for each catchment within a year
- Implement incentive programs for biodiversity conservation and vegetation management within 3 years
- Co-ordinate community extension so that activities focus on land-holders responsible for areas that are considered of State significance for biodiversity conservation and are threatened by clearing within a year
- Revegetate non-remnant areas (primarily through the management of regrowth) on State Forests and other reserves. >90% of non-remnant areas (on State Forests and reserves) under active regeneration programs within 7 years
- Seek offset agreements with industry leaders and major infrastructure providers to protect remnant vegetation within a year

Target explanation This target recognises that the retention of remnant vegetation in large patches is a high priority. The amount of remnant native vegetation and its condition are used as partial surrogates for terrestrial biodiversity, especially for more common and abundant taxa. The recommendations for patch size in the regional target percentages are aimed at ensuring that remnants created by clearing and fragmentation are viable in the longer term. The selection of areas to be retained, in addition to those automatically protected under legislation, can be

	guided by reference to: • intrinsic biodiversity values (described and mapped in EPA Biodiversity Planning Assessments) • nature conservation values in addition to biodiversity • threats to biodiversity values.
How target was derived	The community has been involved in vegetation management planning in the catchment and draft plans have been prepared. The maintenance of biodiversity through the retention of remnant vegetation is a key outcome for the plans. In general, the areas available for future clearing are the least productive, due to constraints such as soil depth and fertility or slope. 30% minimum retention at a property level is emerging as an appropriate minimum target for the most highly fragmented and disturbed landscapes in Australia based on loss of species over time for different levels of clearing and fragmentation.
Current resource condition	In 1999, all Central Queensland catchments were mapped by the Queensland Herbarium, the % of remnant vegetation within the Capricorn Coastal Catchment ranged from 47% to 83%.
Indicators	% of catchment that are remnant vegetation in patches greater than the minimum size defined.
Monitoring methods	Queensland Herbarium remnant vegetation maps are updated every 2–3 years enabling updating of statistics for bioregions, subregions and other planning regions.
Other comments	Regrowth patches of Regional Ecosystems could be used as a basis for increasing the remnant area in the future, in particular by increasing the size and viability of remnant patches.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. • 1999 Queensland Herbarium vegetation mapping • EPA Biodiversity Planning Assessments

Terrestrial Biodiversity Target 2

Recommendation on resource condition target

- No loss (<1% of 1999 extent) of each Regional Ecosystem with an ‘endangered’ biodiversity status within 7 years

RC

Recommendation on management action targets to meet resource condition

- Negotiate with mining companies with interests in Central Queensland to ensure environmental management plans for mining leases and exploration activities adequately protect ‘endangered’ regional ecosystems and restore biodiversity values within 3 years
- Identify the potential areas of loss of ‘endangered’ and ‘of concern’ regional ecosystems due to mining and seek compensatory protection of remnant or regrowth (disturbed) regional ecosystems through agreement within 3 years
- Seek offset agreements with industry leaders and major infrastructure providers to protect remnant vegetation within a year
- Implement incentive programs for biodiversity conservation and vegetation management, including the regeneration of ‘endangered’ regional ecosystems within 3 years
- Ensure policy, plans and strategies for biodiversity conservation are reflected in local government planning schemes to the extent that positive outcomes can be practically achieved through management of development by the scheme. In particular, make submissions to all Local Governments in Central Queensland to seek support that ‘endangered’ regional ecosystems will be excluded from future zoning as urban or rural residential land in shire schemes and that code provisions protect ‘endangered’ regional ecosystems from development impacts within a year

MA

Recommendation on management action targets to meet resource condition
• Revegetate non-remnant areas (primarily through the management of regrowth) to increase the extent of 'endangered' regional ecosystems, particularly where there is future loss to mine development or where the extent of the regional ecosystem in the catchment is <10% of the original extent by co-ordinating community extension activities within a year • Revegetate non-remnant areas (primarily through the management of regrowth) on State Forests and other reserves. >90% of non-remnant areas (on State Forests and reserves) under active regeneration programs within 7 years • Define appropriate methods for the regeneration of 'endangered' and 'of concern' regional ecosystems, including the management of fire and grazing

Target explanation	An 'endangered' biodiversity status indicates that the species that comprise a regional ecosystem and the interactions between these species and the environment have been extensively depleted and modified.
How target was derived	Endangered regional ecosystems need to be protected and expanded to maintain biodiversity. The target indicates parts of the landscape subject to restrictions to clearing and modification under legislation and which will contribute to regional target percentages established under Target 1.
Current resource condition	'Endangered' regional ecosystems occupy <5% of the Capricorn Coastal Catchments.
Indicators	Location of remnants and total area (ha) for each 'Endangered' regional ecosystem
Monitoring methods	Remnant vegetation maps are updated every 2–3 years enabling updating of maps and area statistics
Other comments	Clearing for mining is a threat to some 'endangered' regional ecosystems. Regrowth patches of 'endangered' regional ecosystems could be used as basis for increasing the remnant area in the future.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. • 1999 Queensland Herbarium mapping. • Biodiversity Planning Assessments (provide an additional spatial context as they indicate the location of 'endangered' regional ecosystems relative to the location of other biodiversity values in the landscape).

Terrestrial Biodiversity Target 3

Recommendation on resource condition target		
• % loss of 1999 extent on freehold land and % loss on leasehold land of each Regional Ecosystem with an 'of concern' biodiversity status within 7 years		
Catchment	Freehold land	Leasehold land
Broadsound Coast	<2.5% loss	<1% loss (no loss)
Styx	<2.5% loss	<1% loss (no loss)
Shoalwater	<2.5% loss	<1% loss (no loss)
Capricorn Coast	<2.5% loss	<1% loss (no loss)

Recommendation on management action targets to meet resource condition
• Make submissions as part of the public comment processes for each Regional Vegetation Management Plan in Central Queensland within a year • Negotiate with mining companies with interests in Central Queensland to ensure environmental

Recommendation on management action targets to meet resource condition

management plans for mining leases and exploration activities adequately protect 'of concern' regional ecosystems and restore biodiversity values within 3 years

- Seek offset agreements with industry leaders and major infrastructure providers to protect remnant vegetation within a year
- Implement incentive programs for biodiversity conservation and vegetation management, including the protection of 'of concern' regional ecosystems within 3 years
- Ensure policy, plans and strategies for biodiversity conservation are reflected in local government planning schemes to the extent that positive outcomes can be practically achieved through management of development by the scheme. In particular, make submissions to all Local Governments in Central Queensland to seek support that 'of concern' regional ecosystems will be excluded from future zoning as urban or rural residential land in shire schemes within a year
- Revegetate non-remnant areas (primarily through the management of regrowth) to increase the extent of 'of concern' regional ecosystems, particularly where there is future loss to mine development or to improve connectivity in key wildlife corridors and buffering of wetlands by co-ordinating community extension activities within a year
- Revegetate non-remnant areas (primarily through the management of regrowth) on State Forests and other reserves. >90% of non-remnant areas (on State Forests and reserves) under active regeneration programs within 7 years

- Define appropriate methods for the regeneration of 'endangered' and 'of concern' regional ecosystems, including the management of fire and grazing within a year

Target explanation	An 'of concern' biodiversity status indicates that the species that comprise a Regional Ecosystem and the interactions between these species and the environment have been depleted and modified.
How target was derived	'Of concern' regional ecosystems are subject to some statutory controls and which will contribute to regional target percentages established under Resource Condition Target 1.
Current resource condition	The extent of each regional ecosystem by tenure and catchment are available (Queensland Herbarium, 2001).
Indicators	Location of remnants and total area (ha) for each 'of concern' regional ecosystem on freehold and leasehold land
Monitoring methods	Remnant vegetation maps are updated every 2–3 years enabling updating of maps and area statistics
Other comments	Regrowth patches of 'of concern' regional ecosystems could be used as basis for increasing the remnant area in the future. Clearing for mining is a threat to some 'endangered' regional ecosystems.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. • 1999 Queensland Herbarium mapping. • Biodiversity Planning Assessments (provide an additional spatial context as they indicate the location of 'of concern' regional ecosystems relative to the location of other biodiversity values in the landscape).

Terrestrial Biodiversity Target 4

Recommendation on resource condition target

- >95% of state significant remnant vegetation protected from habitat loss in all sub-catchments within 7 years

RC

Recommendation on management action targets to meet resource condition

- Make submissions as part of the public comment processes for each Regional Vegetation Management Plan in Central Queensland to ensure high nature conservation value areas are protected within a year
- Adequately represent the diversity and richness of the regions wildlife by protecting 5,000ha of remnant vegetation from clearing in areas managed for conservation through acquisition of land for protected area or through voluntary partnerships with land-holders within 7 years
- Encourage and assist land-holders to provide habitat for wildlife under the Land for Wildlife program by having a co-ordinated program for each catchment within 3 years
- Implement incentive programs for biodiversity conservation and vegetation management within 3 years
- Co-ordinate community extension so that activities focus on land-holders responsible for areas that are considered of State significance for biodiversity conservation and are threatened by clearing within a year
- Seek adoption of sustainable practices for timber harvesting from remnant vegetation on all lands
- Remap existing state significant vegetation every 2 years based on best available knowledge

MA

Target explanation	Clearing of remnant vegetation remains a threat to biodiversity in the catchment, particularly within ecosystems with the highest biodiversity values. The Biodiversity Planning Assessment for the catchment has identified areas of state significance for biodiversity conservation.
How target was derived	Clearing of remnant vegetation for agricultural development, mining and urban development will continue but the retention of areas of state significance is a high priority.
Current resource condition	Brigalow Belt Biodiversity Planning Assessment Version 1.1. Southeast Queensland Biodiversity Planning Assessment Version 1.1
Indicators	Location of key remnants and total area (ha) for each remnant unit retained
Monitoring methods	Remnant vegetation maps are updated every 2–3 years enabling updating of maps and area statistics.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. Brigalow Belt Biodiversity Planning Assessment Version 1.1. Southeast Queensland Biodiversity Planning Assessment Version 1.1. • 1999 Queensland Herbarium mapping. • Biodiversity Planning Assessments.

Terrestrial Biodiversity Target 5

Recommendation on resource condition target

- Conserve the ground layer in a % of remnant vegetation where loss of ground cover threatens biodiversity conservation within 7 years

RC

Catchment	% of remnant vegetation where ground layer is conserved
Broadsound Coast	20–50
Styx	20–50
Shoalwater	>75
Capricorn Coast	>50

Recommendation on management action targets to meet resource condition

MA

- Develop and implement incentive programs to achieve minimum ground layer standards within 3 years, including a trial of a market based tender process within a year
- Improve grazing land management in remnant vegetation to ensure that the natural species and cover in the ground layer is retained by co-ordinating community extension activities, including integration with Property Management Planning and rural land management improvement programs within a year
- Define grazing systems that protect biodiversity and improve economic returns. These systems need to cover the diversity of grazed remnant ecosystems for the catchment within a year
- Seek adoption of suitable grazing systems in all State Forests and Reserves by undertaking catchment-wide reviews of lease and permit conditions and monitoring programs in conjunction with relevant government agencies within 2 years
- Adequately represent the diversity and richness of the regions wildlife by protecting 5,000ha of remnant vegetation from clearing in areas managed for conservation through acquisition of land for protected area or through voluntary partnerships with landholders within 7 years
- Encourage and assist landholders to provide habitat for wildlife under the Land for Wildlife program by having a co-ordinated program for each catchment within 3 years
- Implement incentive programs for biodiversity conservation and vegetation management within 3 years
- Seek offset agreements with industry leaders and major infrastructure providers to improve the management of the ground layer in remnant vegetation within a year

INFO GAP

- Improve knowledge and define best practice management of ground cover for the conservation of all ‘at risk’ regional ecosystems to ensure the maintenance of habitat and species diversity within 7 years
- Develop a catchment-wide monitoring system for the ground layer in remnant vegetation within 2 years

Target explanation

Loss of ground cover is seen as a threat to biodiversity in the catchment, particularly within ecosystems with the highest biodiversity values. Remnant regional ecosystems having highest priority for management actions to conserve biodiversity need to be determined. The selection of areas can be guided by reference to:

- intrinsic biodiversity values (described and mapped in EPA Biodiversity Planning Assessments)
- nature conservation values in addition to biodiversity
- threats to biodiversity values.

How target was derived

The target is based on the DPI recommendation for grazing land managed in good condition with an addition component to ensure the predominance of native species in the ground layer. *The consultant’s recommendation is to have 70% of the ground layer as native species including legumes* (*or 70% of the grass layer as palatable and perennial native species*) *with a minimum ground cover* (*live or dead organic material*) *of 50% at the end of the growing season*.

Current resource condition

Level of adoption of current recommended practice for grazing management in key areas of remnant vegetation.

Indicators	Location of key remnants and total area (ha) for each remnant unit meeting ground cover requirements.
Monitoring methods	On ground monitoring required
Other comments	This target links with neighbourhood catchment projects and other grazing extension focused on water quality.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. Brigalow Belt Biodiversity Planning Assessment Version 1.1. Southeast Queensland Biodiversity Planning Assessment Version 1.1. • 1999 Queensland Herbarium mapping. • Biodiversity Planning Assessments.

Terrestrial Biodiversity Target 6

Recommendation on resource condition target

- Fragmentation of key wildlife corridors, particularly riparian areas, is reduced by regenerating wildlife habitat within 7 years

RC

Catchment	Area regenerated to reduce fragmentation (ha)
Broadsound Coast	100–500
Styx	500–2,000
Shoalwater	Nil
Capricorn Coast	100–500

Recommendation on management action targets to meet resource condition

MA

- Revegetate non-remnant areas (primarily through the management of regrowth) to improve connectivity in key wildlife corridors by co-ordinating community extension activities within a year
- Implement programs for the management of riparian areas along the significant wildlife corridors within a year
- Encourage and assist land-holders to provide habitat for wildlife under the Land for Wildlife program by having a co-ordinated program for each catchment within 3 years
- Make submissions as part of the public comment processes for each Regional Vegetation Management Plan in Central Queensland to ensure the implementation of controls on clearing that provide for strategic retention of remnant and non-remnant vegetation to reduce fragmentation of remnant vegetation
- Implement incentive programs for the regeneration of wildlife corridors within 3 years
- Seek offset agreements with industry leaders and major infrastructure providers to improve connectivity in key wildlife corridors within a year

INFO GAP

- Define appropriate methods for the regeneration of ‘endangered’ and ‘of concern’ regional ecosystems, including the management of fire and grazing within a year

Target explanation	Fragmentation of remnant vegetation, particularly on the alluvial and clay downs land zones, is a major threat to biodiversity conservation in the catchment. Revegetation of non-remnant areas (primarily through the management of regrowth) is the most effective way to improve connectivity. The catchment targets are based on the size of the catchment and the current level of fragmentation.
How target was derived	State significant wildlife corridors have been identified in Biodiversity Planning Assessments. Other key corridors at a regional scale will need to be identified. The retention of regrowth in riparian areas on leasehold land is

	required by legislation. The catchment targets are based on the size of the catchment, the extent of leasehold land and the current level of fragmentation.
Current resource condition	Biodiversity planning assessments identify key habitats and some major corridors, particularly the main rivers within Central Queensland. Vegetation that has been cleared but is regenerating has been mapped by the Herbarium.
Indicators	Linkage between key remnants and total area reverting to remnant status in identified wildlife corridors.
Monitoring methods	Remnant vegetation maps are updated every 2–3 years enabling updating of maps and area statistics.
References	Queensland Herbarium. 2001. Regional Ecosystem Description Database (REDD) A database maintained by Queensland Herbarium. Environmental Protection Agency, Brisbane. Brigalow Belt Biodiversity Planning Assessment Version 1.1. Southeast Queensland Biodiversity Planning Assessment Version 1.1. • 1999 Queensland Herbarium mapping. • Biodiversity Planning Assessments.

Terrestrial Biodiversity Target 7

Recommendation on resource condition target

- Prevent further loss of biodiversity at a species scale within 7 years

RC

Recommendation on management action targets to meet resource condition

- Develop recovery plans/management plans for 10 species of conservation concern
- Improve community involvement in ‘at risk’ species management and strengthen partnerships between organisation by co-ordinating community extension activities within a year
- Adequately represent the diversity and richness of the regions wildlife by protecting 5,000ha of remnant vegetation from clearing in areas managed for conservation through acquisition of land for protected area or through voluntary partnerships with landholders within 7 years
- Encourage and assist land-holders to provide habitat for wildlife under the Land for Wildlife program by having a co-ordinated program for each catchment within 3 years
- Implement incentive programs for biodiversity conservation and vegetation management within 3 years
- Negotiate with mining companies with interests in Central Queensland to ensure environmental management plans for mining leases and exploration activities adequately protect ‘at risk’ species within 3 years
- Develop partnerships with industry for the recovery of species of conservation concern within 3 years

MA

- Identify the distribution, critical habitats and threats for 10 poorly known ‘at risk’ species not covered by a recovery plan within 7 years

INFO GAP

Target explanation	Species of conservation concern are those species listed in State and Commonwealth legislation as being of conservation concern (endangered, vulnerable, rare, or covered by international convention), locally significant species, species under threat due to human activities, and species at the edge of their range. These various categories of significant species are recognised through the Biodiversity Planning Assessments. The target recognises that species under the greatest threat in the catchment due to the impacts of human activities have the highest priority for management actions. Monitoring management actions is assumed to be a surrogate for monitoring species abundance and distribution.
How target was	Consistent with the objectives of Queensland natural resource management

derived	legislation including the *Nature Conservation Act 1992*, *Environmental Protection Act 1994*, *Forestry Act 1959*, *Vegetation Management Act 1999*, and the *Land Act 1994*. Also consistent with Commonwealth and international conservation objectives.
Current resource condition	Varies regionally for each of the listed species.
Indicators	• Identification of species of conservation concern at a catchment level • Knowledge of the threats to significant species at a catchment level • Knowledge of the distribution and abundance of high priority species of conservation concern • Loss of identified significant species
Monitoring methods	• Mapping of significant species • Reporting on loss or decrease in significant species
References	• Queensland Herbarium • Queensland Museum • Biodiversity Planning Assessments • *Wildnet* • Local knowledge

Weeds and Pest Animals Target 1

Recommendation on resource condition target	
• The environmental impact of existing widespread weeds and pest animals is stabilised in key areas of remnant vegetation or where they impact on 'at risk' species	RC

Recommendation on management action targets to meet resource condition	
• All local governments have weed and pest management plans that incorporate all class 3 environmental weeds within 2 years • All properties that contain class 3 weeds be consulted and assisted with the development of property management plans incorporating pest management within 7 years • All protected areas, state forests and reserves be surveyed for the presence of class 3 weeds and agencies to develop park or reserve management plans incorporating pest management within 7 years • All utility service providers to have weed management plans within 3 years • Develop a weed management action plan or strategy for 5 'at risk' species that are directly affected by weeds within 3 years	MA
• Expand weed mapping to include environmental weed populations that affect key remnants and promote the use of Pestinfo	INFO GAP

Target explanation	The major challenge is acquiring accurate information on the distribution and abundance of weeds and pest animals and their environmental impact within each catchment.
How target was derived	The target is based on the objectives for weed management in the Central Queensland Strategy for Sustainability.
Current resource condition	Mapping information generated using PestInfo is available for weeds, including: • parkinsonia (*Parkinsonia aculeata*) • parthenium weed (*Parthenium hysterophorous*) • rubber vine (*Cryptostegia grandiflora*) • bellyache bush (*Jatropha gossypifolia*) • harissia cactus (*Eriocereus martini*)

- water hyacinth (*Eichhornia azurea*)
- giant rats tail (*Sporobolus pyramidalis*)
- hymenachne (*Hymenachne amplexicaulis*)
- sengal tea plant (*Gymnocornnis spilanthoides*)
- badhara bush (*Gmelina asiatica*)
- prickly acacia (*Acacia nilotica* spp. *indica*)

Indicators The degree of implementation of management actions.

References Pestinfo database.
Central Queensland Strategy for Sustainability.

Weeds and Pest Animals Target 2

Recommendation on resource condition target

- No new outbreaks of environmentally significant pests (weeds and animals) beyond the regions capacity for full control

RC

Recommendation on management action targets to meet resource condition

- A management action plan be drafted that identifies potential new weed and pest incursions and outlines strategies to cope with them (should they be introduced to the region) within a year
- Interpretive material that can assist the community and all key stakeholders identify potential new weeds and pests be produced within 2 years
- Another 10 major towns to have a suitable wash-down facility available for public use within 7 years
- Have widespread adoption by transport companies, government departments and service providers of the use of vendor declaration forms within a year

MA

Target explanation The major challenge is identifying potential weeds and pest animals. The intent is to prevent potential weeds and pest animals from becoming a significant environmental issue. The Department of Natural Resources and Mines has already outlined ways to prevent the spread of weeds through the 'Queensland weed seed spread project July 2000'. Guidelines for the construction of a wash-down facility are included in this document.

How target was derived The target is based on the objectives for weed management in the Central Queensland Strategy for Sustainability.

Indicators The degree of implementation of management actions.

Other comments Promote reporting on the location and extent of populations.

References Central Queensland Strategy for Sustainability.
Pestinfo database.

7.5 Inland aquatic ecosystem integrity

7.5.1 Critical assets

These relatively small catchments usually have freshwater wetlands at their sources (Fig. 7.8). The wetlands provide important nursery grounds for aquatic species such as barramundi and tarpon that move between fresh and saltwaters as well as providing important bird habitat.

Critical inland aquatic assets of the Capricorn Coastal Catchments:

- Few artificial barriers
- Unique sand filtered water feeding Water Park Creek
- Significant animal and plant species

Water Park Creek has particular biodiversity importance as the largest near perennial stream of this catchment area. This stream is unique in that its water is sourced from a large sand deposit near Shoalwater Bay. It is home to several species of biodiversity interest including the jungle perch (*Kuhlia rupestrus*). Saltwater crocodiles have been recorded from wetlands and freshwaters of this area.

Threatening processes related to inland aquatic biodiversity and stream integrity in the Capricorn Coastal Catchment:

- Artificial barriers
- Floodplain and riparian habitat modification
- Chemical contamination/water chemistry
- Managed water flows
- Algal blooms
- Invasive species

7.5.2 Condition and trend

The presence of jungle perch in a stream is regarded as indicative of very good water quality and ready access between salt and freshwaters.

Water Park Creek has no major barriers although extraction of water for coastal communities may in the future become a significant pressure on the stream.

The major influence on the aquatic biodiversity of these coastal freshwaters is a range of barriers such as levees constructed as ponded pasture development. Ponded pastures have increased the area of floodplain wetland available to some species, but have also introduced barriers to organisms moving to and from saltwaters.

In some circumstances the freshwater wetlands of the coastal zone have been altered by coastal development. The importance of the wetlands to freshwater and estuarine biodiversity should be recognised as significant.

Pest and weed species important to inland aquatic ecosystems of the Capricorn Coastal Catchments:

- *Salvinia molesta*
- Water hyacinth (*Eichhornia crassipes*)
- Water lettuce (*Pistia stratiotes*)
- *Hymenachne amplexicaulis*
- Para grass (*Brachiaria mutica*)
- Mosquito fish (*Gambusia affinis*)

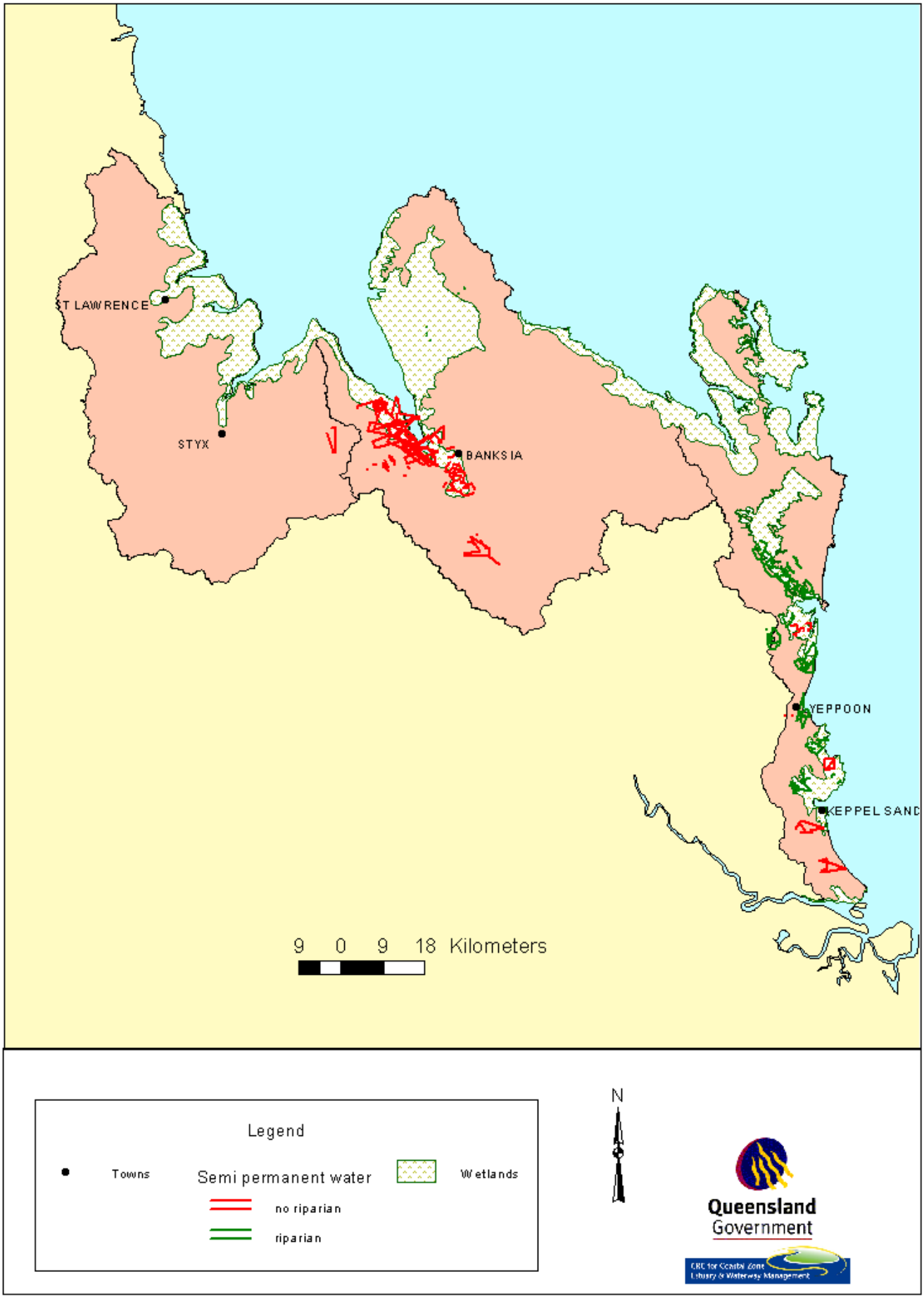


Figure 7.8 Aquatic features of the Capricorn Coast Catchments

7.5.3 Knowledge, data and information gaps

At present knowledge of aquatic species is very limited both spatially and temporally.

Detailed knowledge at the neighbourhood catchment scale is unavailable for:

- Areas with good habitat supporting the significant species
- Spawning sites for native fish
- Extent, condition and connectivity of offstream wetlands
- Artificial barriers to migration
- Presence of invasive species
- Riparian condition

7.5.4 Targets

Similar resource condition targets for inland aquatic ecosystem integrity are provided across the region as a guideline for developing localised targets for each inland catchment.

The resource condition targets for aquatic ecosystem integrity are intended to:

- Indicate the ***types*** of resource condition and management action targets that will support aquatic ecosystems and biodiversity across much of the region.
- Provide ***flexibility*** in order to allow identification of management actions most applicable at the local scale for future priority actions (different catchments will require different actions).
- Provide a ***stimulus for discussion*** on the ***degree*** to which particular targets should be applied in each sub-catchment. That is, it may be appropriate to provide management actions in 70% of riparian zones in some catchments while in others only 20% may require management actions. This matter needs to be considered at the catchment scale.

Inland Aquatic Ecosystem Integrity Target 1

Recommendation on resource condition target
• Minimise the number of new artificial instream barriers created • Improve fish passage through artificial barriers to aquatic organism movement at low flows by 10% within 7 years • Provision of appropriate freshwater flows to maintain inland systems within 7 years

Recommendation on management action targets to meet resource condition target

• Educate local community on the impacts of stream barriers within 2 years
• Remove unnecessary barriers within 7 years
• Reengineer stream crossings, levees etc. to cater for movement of aquatic species to achieve RC target within 7 years
• Install fishways on dams and weirs where practicable within 7 years
  • Ensure new barriers include fish passages and use best practice design and construction
  • Release of environmental flows, including base flows, in line with Water Resource Plan requirements
 	
• Identify artificial barriers to migration at the neighbourhood catchment scale within 2 years

Target explanation	Artificial barriers in streams prevent migrations to breeding sites, genetic mixing and dispersal of organisms. Where barriers are present, environmental flow releases can mitigate some of the impacts of such barriers.
How target was derived	Satellite imagery and State of the Rivers assessments used to identify artificial barriers.
Current resource condition	Refer to Appendix A.5.5.2.
Source of condition data	Satellite imagery and State of the Rivers assessments used to identify artificial barriers.
Indicators	Movement of aquatic organisms. Evidence of successful reproduction in selected species.
Monitoring methods	Visual assessment of artificial structures. Fish tag and recapture data.
References	Cotterell E. Jackson P., 1999. A catchment approach to fish passage:A preliminary biological and technical assessment for the lower Fitzroy-Dawson. Berghuis and Long 1999. Freshwater Fishes of the Fitzroy Catchment, Central Queensland. State of the Rivers, Department of Natural Resources and Mines.

Inland Aquatic Ecosystem Integrity Target 2

Recommendation on resource condition target RC

- Increase the length of functional riparian habitat by 20% within 7 years

Recommendation on management action targets to meet resource condition target

MA

- Protection of all identified remnant good quality, functional riparian habitat from tree clearing within 2 years
- Apply appropriate improved management actions such as sustainable grazing and cropping systems in riparian zones, reestablishment of native riparian species and control of invasive species to 20% of riparian areas within 7 years (links to Soil Condition Targets 2,3,4 and 5)
- Apply strategies for managing invasive species as needed within 7 years

INFO GAP

- Identify locations with good functional riparian habitat within 2 years
- Determine most effective dimensions and appropriate actions to improve riparian function within 2 years
- Develop appropriate strategies for managing invasive species within 2 years.

Target explanation	Riparian zones provide to aquatic ecosystems • instream habitat such as snags and large woody debris • food sources such as fruits and insects • shading of pools (improved dissolved oxygen) • reduce erosion of stream beds and banks
How target was derived	Satellite imagery and State of the Rivers assessments used to identify locations with riparian vegetation present.
Current resource condition	Refer to Appendix A.5.5.2.
Source of condition data	Satellite imagery and State of the Rivers assessments used to identify locations with riparian vegetation present.
Indicators	Riparian width.

	Riparian structure.
Monitoring methods	Analysis of aerial photographs and satellite imagery. Visual assessment of riparian zones.
Milestones	No reduction in riparian zone functionality. Increased application of appropriate land use practices in the riparian zone.
Other comments	Riparian management needs to be assessed at the neighbourhood catchment and property scale.
References	State of the Rivers Department of Natural Resources and Mines.

Inland Aquatic Ecosystem Integrity Target 3

Recommendation on resource condition target

- Reduce the number of reported fish kills by 10% within 7 years

Recommendation on management action targets to meet resource condition target

- Improving water chemistry to levels proposed in WQ condition targets
- Improved management of water infrastructure (irrigation channels, dams and weirs) within 4 years
- Management of invasive species such as *Salvinia molesta* in all major outbreaks

- Investigate the cause of most fish kills reported

Target explanation	Fish kills have been reported from the Fitzroy region. These may be associated with natural processes such as low dissolved oxygen associated with low water levels in summer, but have also been recorded associated with the first storms of summer releasing poor quality water from surrounding lands. Fish kills have also been associated with adverse impacts of introduced plant species such as *Salvinia molesta*.
How target was derived	Analysis of fish kills recorded by the Environmental Protection Agency.
Current resource condition	Refer Appendix A.5.5.2.
Source of condition data	Analysis of fish kills recorded by the Environmental Protection Agency.
Indicators	Fish kills observed in rivers and other wetlands.
Monitoring methods	Analysis of fish kills recorded by the Environmental Protection Agency.
Other comments	Some fish kills have natural causes, however improved water chemistry and other management actions would be expected to reduce the incidence of fish kills.

Inland Aquatic Ecosystems Integrity Target 4 - Wetlands

Recommendation on resource condition target
• Provide protection and restoration of wetlands and their riparian zones within 7 years. (There is insufficient available information to meaningfully establish resource condition targets for wetlands in most catchments)

RC

Recommendation on management action targets to meet resource condition target
• Protection of identified functional wetlands within 2 years • Maintain or restore connectivity of 70% of wetlands within 7 years • Maintain or restore 20% of riparian zones of wetlands within 7 years • Assess wetland extent and historical loss of wetland extent within a year • Assess wetland connectivity within a year • Assess wetland condition and values including water quality and ecological, cultural and biodiversity values within a year

MA

INFO GAP

Target explanation	Wetlands are vitally important to the integrity of aquatic ecosystems. Evidence suggests Fitzroy wetlands may have been extensively modified over time but insufficient detail is available to set targets for wetland protection.
How target was derived	There is an urgent need to assess: • Wetland extent and historical loss of wetland extent • Wetland connectivity • Wetland condition and values including water quality and ecological, cultural and biodiversity values • This is required before meaningful targets could be set.
Current resource condition	Refer to Appendix A.5.5.2 for the little data that is available.
Source of condition data	No adequate data available.
Indicators	• Wetland extent • Wetland connectivity • Wetland condition and values including water quality and ecological, cultural and biodiversity values
Monitoring methods	Analysis of satellite imagery, aerial photography.
Milestones	•Identification of wetland remnant extent •Identification of wetland condition
References	Venz, M.; Mathieson, M.; Schulz, M. 2002. Fauna of the Dawson River Floodplain. Environmental Protection Agency - Queensland Parks and Wildlife Service.

Inland Aquatic Ecosystems Integrity Target 5 - Rivers

Recommendation on resource condition target	
• Retain current habitat variability and condition of reaches with high ecological value in each catchment	RC

Recommendation on management action targets to meet resource condition target	
• Maintain pool/shallow water habitat balance in important reaches with good aquatic habitat variability and connectivity • Carryout awareness program to raise awareness of invasive aquatic species within 2 years • Survey aquatic ecosystems to map and develop a database of invasive aquatic species in the catchment within 2 years • Implement appropriate strategies for managing invasive aquatic species within 2 years	MA
• Define important aquatic habitat reaches within 2 years • Develop appropriate strategies for managing invasive aquatic species within 2 years	INFO GAP

Target explanation	The balance between weir pool and natural habitat is important in supporting native aquatic species. To maintain natural biodiversity a variety of habitat types are important. Invasive aquatic species can compromise the habitat values of aquatic systems. This target proposes to support natural biodiversity values through maintaining habitat variability and managing invasive species in locations with high aquatic habitat value.
How target was derived	Reaches with natural pool /shallow water habitat and good connectivity (few artificial barriers) were identified from satellite imagery.
Current resource condition	Refer to Appendix A.5.5.2.
Source of condition data	Satellite Imagery, State of the Rivers assessments.
Indicators	Balance between weir pool and natural habitat.
Monitoring methods	Satellite Imagery, aerial photography, ground assessment.
Milestones	No loss of habitat variability in important reaches.
References	Houston, W.A. and Duivenvoorden L.J. 2002. Replacement of littoral native vegetation with the ponded pasture grass *Hymenachne amplexicaulis*: effect on plant, macroinvertebrate and fish biodiversity of backwaters in the Fitzroy River, Central Queensland, Australia. Marine and Freshwater Research 53: 1235-1244.

Significant Native Species and Ecological Communities Target 1

Recommendation on resource condition target	
• Maintain or improve the conservation status and geographic distribution of aquatic species listed as rare, vulnerable or endangered within 7 years	RC

Recommendation on management action targets to meet resource condition target	
• Maintain habitat requirements of the Fitzroy River turtle (*Rheodytes leukops)* through instream habitat, population connectivity and nesting sites at locations identified as important to the species within 4 years • Reduce threatening processes to the Fitzroy River turtle (poor water quality, loss of habitat diversity through drowning by dams and weirs, hot or cold water release from weirs, artificial barriers to migration, loss of nesting sites through land and water use impacts)	MA

Recommendation on management action targets to meet resource condition target

- Establish the geographic distribution of the Fitzroy River turtle in each catchment within 2 years
- Determine locations supporting healthy populations of the within 3 years
- Determine locations important to the nesting of the turtle within 3 years.

INFO GAP

Target explanation	One aquatic species (the Fitzroy River turtle, *Rheodytes leukops*) is currently listed as vulnerable under state and federal legislation. Its distribution is recorded at the catchment scale but not at the neighbourhood catchment scale.
How target was derived	Recorded sightings of the turtle, habitat requirements of the turtle.
Current resource condition	Refer Appendix A.5.5.2.
Source of condition data	Recorded sightings of the turtle.
Indicators	Turtle sightings, condition of instream and nesting habitat.
Monitoring methods	• Monitoring of: • Geographic range, • selected nesting locations and • important habitat requirements
Milestones	• Development of monitoring program for *Rheodytes leukops* • Establishment of programs to manage threats to *Rheodytes leukops*
Other comments	Monitoring actions should complement those being developed within the Resource Operations Plan associated with the Water Resource Plan (Fitzroy Basin).
References	A.D. Tucker, C.J. Limpus, T.E. Priest, J. Cay, C. Glen and E. Guarino. 2001. Home ranges of Fitzroy River turtles (*Rheodytes leukops*) overlap riffle zones: potential concerns related to river regulation. Biological Conservation 102: 171–181. Venz, M., Mathieson, M., and Schulz, M. 2002. Fauna of the Dawson River Floodplain. Environmental Protection Agency - Queensland Parks and Wildlife Service.

7.6 Estuarine and marine aquatic ecosystem integrity

7.6.1 Critical assets

Critical estuarine and marine aquatic assets of the Capricorn Coastal Catchments:

- Significant habitats
- Significant animal and plant species
- Significant commercial and recreational fisheries

The Capricorn Coastal region (for the purposes of the Information Paper) covers the area from the mouth of Raglan Creek to the Shoalwater Bay region. It has extensive mudflats, salt marshes, shallow embayments, rocky headlands, sand beaches, wetlands and significant mangrove forests. Diverse reef communities, including coral cays, planar, outer, fringing and rocky reefs, hard and soft coral communities (including Keppel Bay Islands) and other parts of the region are included in the Great Barrier Reef Marine Park zone and therefore World Heritage Listed. Significant commercial and recreational fisheries are present. Diverse habitats, some which are recognised as close to pristine condition and of high ecological and biodiversity value (e.g. Shoalwater Bay), occur within the catchment. Many of the communities within the catchment contain plant and animal species that have protection status. The lower parts of the Capricorn Coast region are shown in

Figure 7.9.

Figure 7.9 *The lower sections of the Capricorn coastal area* (source, modified from Landsat image [acquired by Coastal CRC 2001])

7.6.2 Condition and trend

Threatening processes relating to estuarine and marine biodiversity and integrity:

- Boat strikes
- Non-target net captures
- Increased sediment and nutrient inputs
- Effects of acid sulfate soils leaching
- Artificial barriers
- Algal blooms
- Planned industrial development
- Increasing coastal urbanisation
- Cattle feedlot (5000 head) planned for Fitzroy River flood plain near Rockhampton

The coastal strip is undergoing rapid urban expansion in some areas (e.g. Yeppoon) and significant expansion in industrial infrastructure (e.g. Rockhampton/Stanwell). Other less impacted areas such as Shoalwater Bay and Corio Bay have not had any recent development. There is a significant commercial fishery in the region for fish, prawn and crab species. Catch records indicate declines in some species (e.g. mackerel and barramundi).

Water quality can vary depending on flood flows from the catchments with the Fitzroy River being the major influence on Keppel Bay. Corio Bay and the Shoalwater area have high quality fresh waters entering the systems with flow rates variable depending on local rains and water harvesting for urban use (e.g. Sandy and Water Park Creeks).

Significant species include:

- Six marine turtle species (one 'endangered' and one endemic)
- Half (7) of the seagrass species found in Queensland
- 15 species of mangroves
- 26 species of seabirds and 79 species of shore/waterbirds
- Four dolphin species (2 'rare')
- Three whale species
- Dugong (*Dugong dugon*)
- Saltwater crocodile (*Crocodilus porosus*)
- Hard and soft corals
- 148 fish species identified to date
- Significant commercial species including fish, crabs and prawns
- Benthic invertebrates (e.g. crustaceans and molluscs)

The Great Barrier Reef Marine Park Authority has conducted chlorophyll monitoring for a number of years in the region and results suggest that Keppel Bay and the Bunker lagoon can have high algal concentrations for significant periods as compared to other (northern) inshore reef areas. There is concern for the future of a number of marine species in the area with boat strikes, non target net deaths and water quality issues considered as some of the threatening issues for the area.

The region is considered to be in reasonable overall condition, however, trends are difficult to measure owing to lack of comprehensive long term information. In general it is thought that there has been an overall decrease in condition in recent years (post 1950s)

Significant invasive species

Pest and weed species important to estuarine ecosystems of the Capricorn Coastal Catchment:

- Para grass (*Brachiaria mutica*)
- Cats' claw creeper (*Macfadyena unguis-cati*)
- Rubber vine (*Cryptostegia grandiflora*)
- Pigs (*Sus scrofa*)
- Foxes (*Vulpes vulpes*)

There has been limited research into invasive species for the Capricorn Coast region, however the recent project to detect invasive species in the Gladstone port area detected very few and insignificant types possibly originating

from ship ballast water releases. There are no reported major invasions of foreign species for the marine environment to date.

Invasion of Para grass into wetland areas, particularly those associated with ponded pasture systems and grazing areas near brackish wetlands, is of particular concern. Cats' claw and rubber vine infestations occur in river and creek riparian areas and are wide spread on the banks of the Fitzroy River and creek systems. Feral animals such as pigs and foxes can affect shoreline populations (e.g. crocodile and bird nests) due to predation and habitat destruction.

7.6.3 Knowledge, data and information gaps

There are significant gaps in knowledge for the Capricorn Coast systems and habitats. Current research projects (Coastal CRC, DPI etc) will bridge some of these gaps.
Major gaps to be addressed include:

- Detailed mapping of habitat types to enhance known mangrove community information
- Audit of species types and groups for estuarine, coastal and marine areas on a seasonal and geographical basis
- Extent and effects on invasive species on riparian areas
- Importance and frequency of connectivity between river and wetlands areas during upper catchment and local floods/flows
- Types and amounts of contaminant inputs from local/urban storm runoff
- Long term trends in fishery (eg crabs) catch rates and viability under current take conditions
- Effects on species and ecosystems of contaminants from flood flows from the catchment at an acute and chronic perspective (i.e. short high concentrations or low long term concentrations)
- Mechanisms involved in primary productivity for Keppel Bay and Capricorn Bunker Lagoons
- Lack of data for a number of significant species such as two rare dolphins
- No reliable data on long term algal bloom incidence and trend.

7.6.4 Targets

Estuarine, Coastal and Marine Habitats Integrity - Target 1

Recommendation on resource condition target	
• Provision of appropriate freshwater flows to maintain estuarine systems within 7 years • Restoration of base flows to Fitzroy River estuary within 7 years	RC

Recommendation on management action targets to meet resource condition target	
• Release of environmental flows, including base flows, in line with Water Resource Plan requirements • Design of further infrastructure accounting for provision of natural overland flows through wetlands and maintenance of groundwater levels	MA

Recommendation on management action targets to meet resource condition target
• Research to determine the effects of restricted freshwater flows on wetland function, structure and resilience, start within 2 years

Target explanation	Barriers to overland, sub-surface and instream freshwater flows resulting in structural changes to the intertidal wetlands and fisheries arise from infrastructure such as barrages, roads, power supply infrastructure, water supply impoundment and port facility development. The *Inland Aquatic Ecosystem Integrity Target 1* addresses the issue of these barriers to flow. This target aims to increase awareness of this issue and address the associated issue of releases of environmental flows from such barriers to meet the needs of estuarine, coastal and marine habitats and species.
How target was derived	Consistent with requirements of State Coastal Plan policy 2.4.1 and the EPP(Water) that recognise the impacts of changed hydrology and water quality to coastal wetlands. The Draft Curtis Coast Regional Coastal Management Plan adopts these principles. The target is also consistent with the recommendations in Long and McKinnon (2002).
Current resource condition	Hydrological barriers are increasing with the growth in industry and urban developments in the coastal zone leading to micro and macro-scale flow reductions and the potential for significant changes to wetland hydrology and consequent structure.
Source of condition data	GAWB EDCM, CQU/GPA mangrove monitoring program reports.
Indicators	Maintenance of function and structure within wetland communities adjacent to and downstream from these barriers.
Monitoring methods	Monitoring of riparian and wetland systems in terms of structural characteristics and function through remote sensing and field validation.
Milestones	Implementation of engineering designs for new developments accounting for provision of freshwater flows.
References	Draft Curtis Coast Regional Coastal Management Plan. *Environmental Protection* (*Water*) *Policy 1997* Part 7 Division 3. Long, P.E. and McKinnon, S.G. 2002. Habitats and fisheries resources of the Fitzroy River estuary (Central Queensland). Department of Primary Industries, Brisbane.

Estuarine, Coastal and Marine Habitats Integrity - Target 2

Recommendation on resource condition target
• Structure, richness and function of remnant intertidal wetlands are maintained by sustainable management within 7 years • Restoration of present ponded pasture area (i.e. removal of) by 50% within 7 years

Recommendation on management action targets to meet resource condition target
• Sustainable design of infilling (reclamation) for industrial or urban development (where no other feasible and practical alternatives exist) • Buffer between wetland and future activity maintained • Minimisation of modification and impacts to wetlands • Implementation of Soil Condition Management Actions to reduce erosion and sedimentation • Management and regulation of waste discharge into wetlands • Maintenance of natural hydrological and hydrodynamic flows through wetlands • Research on the importance of saltmarsh and saltpans to general wetland function and integrity

Recommendation on management action targets to meet resource condition target
and as fish habitat within 2 years • Continued research into effects of various threatening processes to wetland function, structure and resilience, including ponded pasture mapping and restoration plans

Target explanation	The value of coastal wetlands is immense as are the threats. These habitats have been extensively exploited and the remaining areas need to be appropriately preserved and sustainably managed to maintain their integrity as functioning ecosystems.
How target was derived	The State Coastal Plan policy 2.8.2 recognises that further loss or degradation of coastal wetlands must be avoided.
Current resource condition	The current resource condition is based on Port Curtis. Indications are that 17% of mangroves and 24% of salt marshes in the Port Curtis area have been lost with 90% of this loss due to industry and urban development. Attempts at artificially establishing mangroves have so far failed though natural colonization of mangroves on bundwalls is occurring.
Source of condition data	Curtis Coast Study, GPA. Highland (2002).
Indicators	Continued functioning of coastal wetlands as determined by ongoing monitoring.
Monitoring methods	Continuation of the reviewed Port Curtis mangrove and seagrass monitoring programs in conjunction with remote sensing techniques.
References	Highland, S.J. 2002. An investigation of the impacts of ponded pastures on barramundi and other fish populations in tropical coastal wetlands. Final report – FRDC Project 07/201, DPI and FRDC. Long, P.E. and McKinnon, S.G. 2002. Habitats and fisheries resources of the Fitzroy River estuary (Central Queensland). Department of Primary Industries, Brisbane.

Estuarine, Coastal and Marine Habitats Integrity - Target 3

Recommendation on resource condition target
• Turtle nesting habitats are maintained and enhanced within 7 years

RC

Recommendation on management action targets to meet resource condition target
• Maintain vegetated buffer between significant nesting areas and settlement • Exclude recreational vehicles from dunes and minimize public access impacts during nesting season within 2 years • Minimise lighting impacts from nearby developments within 2 years • Feral & domestic animal control program within 2 years • Turtle awareness and education programs are implemented within a year

MA

Target explanation	The increased use of beaches for recreation makes the beach and dune systems prone to degradation and disturbance. Management of this resource to prevent excessive disturbance is important to ensure the sustainability of the area as a turtle rookery in the future.
How target was derived	Available information from regional management plans and resource reports highlight the vulnerability of the area but provide a positive basis for management and education. The target date is arbitrary and it is hoped that from year to year turtle numbers would be sustained.
Current resource	Turtles are known to nest on beaches along the Central Queensland coast

condition	though data is limited regarding numbers and condition for the region and is restricted to specific sites along the central coast.
Indicators	Minimal disturbance to beach and dunes from human sources; continued use of the beaches by turtles for nesting.
Monitoring methods	Voluntary turtle monitoring during nesting season by community in association with QPWS.
References	*Coastal Protection and Management Act 1995*, State Coastal Management Plan – Queensland's Coastal policy (State Coastal Plan). Draft Curtis Coast Regional Coastal Management Plan 2002.

Estuarine, Coastal and Marine Habitats Integrity - Target 4

Recommendation on resource condition target
• Important habitats for migratory bird species are preserved within 7 years

Recommendation on management action targets to meet resource condition target
• Key shorebird habitats are identified within planning documents within a year • Shorebird feeding, roosting and breeding sites are protected from disturbance within a year • Impacts to shorebirds from public access is managed within a year • Local governments promote adoption of shorebird network sites within 2 years • Shorebird public awareness and education programs are implemented within a year
• Community-based program implemented to monitor annual migrations of shorebirds to Port Curtis within 2 years

Target explanation	The importance of the Capricorn Coast as a destination for several JAMBA and CAMBA listed migratory wader species as well as other shorebird species requires targeted action to protect the feeding and roosting habitats that encourage them to the area.
How target was derived	This target is consistent with the requirements of the *Environmental Protection and Biodiversity Conservation Act 1999* and the State Coastal Plan. Threats to the local shorebird habitats are documented in the Curtis Coast Study and Draft Curtis Coast Regional Coastal Management Plan.
Current resource condition	Extensive areas of exposed mudflats are available for feeding but there are limited, convenient high-tide roosting sites in Port Curtis.
Source of condition data	Draft Curtis Coast Regional Coastal Management Plan.
Indicators	Presence of listed and usual wader species observed seasonally.
Monitoring methods	Community-based monitoring programs and annual audits.
References	Curtis Coast Study Resource Report. Houston, W and McCabe, J. 1996. Waterbirds and Waterbird Habitats of the Freshwater Wetlands of the Lower Fitzroy River, Report to Queensland Department of Environment and Australian Heritage Commission, Capricorn Conservation Council, Rockhampton. Houston, W and Mitchell, A. 1997. A fifteen month survey of wader and tern numbers from Corio Bay, Central Queensland, Australia. Stilt 30: 16-22.

Estuarine, Coastal and Marine Habitats Integrity - Target 5

Recommendation on resource condition target
• Maintain existing coral colonies and reef habitats within 2 years

RC

Recommendation on management action targets to meet resource condition target
• Management of tourism and fishing activity in the Capricorn bunker group and inshore reef areas • Maintenance of water quality (as per other WQ management actions) • Careful management of dredging activities • Tighter controls on greenhouse gas emissions within 7 years

MA

• Study inshore rocky reef habitats to assess diversity and importance within a year • Study effects of dredging-related activities on inshore reef values within a year

INFO GAP

Target explanation	Maintenance of fringing and planar coral reefs is important for the conservation and management of biodiversity in the Curtis Coast region. The Capricorn Bunker Group of the Great Barrier Reef Marine Park is part of the GBR World Heritage Area and its values must be maintained.
How target was derived	This target is consistent with the requirements of the *Environmental Protection and Biodiversity Conservation Act 1999*, the *Nature Conservation Act 1997* and the State Coastal Plan.
Current resource condition	There are large gaps in knowledge of the inshore reef habitats, their diversity and condition. The Great Barrier Reef has been impacted by sediment and nutrient inputs from coastal rivers, increased tourism, recreational and commercial fishing, COTS and water temperature increases.
Monitoring methods	Intertidal and subtidal reef audits using divers. Community-based research using divers.
Milestones	Species list for inshore reef systems.
References	Draft Curtis Coast Regional Coastal Management Plan.

Estuarine, Coastal and Marine Habitats Integrity - Target 6

Recommendation on resource condition target
• Maintenance of tidal flows through estuarine systems within 7 years

RC

Recommendation on management action targets to meet resource condition target
• Design of river, creek and port structures with allowance for provision of natural hydrological and hydrodynamic processes to intertidal ecosystems

MA

• Research into effects of hydrodynamic changes to estuarine wetlands, start within 2 years • Study into the effects of reducing freshwater flows into estuaries via small barrages (e.g. Sandy Creek proposal – on Corio Bay ecosystem)

INFO GAP

Target explanation	Barriers to natural estuarine hydrodynamic processes such as wave action and tidal currents resulting in structural changes to the intertidal wetlands and fisheries arise from port facility development and wetland reclamation. Maintenance of these flows is important for habitat integrity, and access to nursery and feeding areas for significant species.
How target was derived	The State Coastal Plan policy 2.4.1 recognises that changes to hydrology and hydrodynamics adversely impact water quality and consequent coastal resources. The Draft Curtis Coast Regional Coastal Management Plan adopts

	these principles.
Current resource condition	Barriers are increasing as further industry develops and infrastructure requirements increase.
Source of condition data	Port Curtis Mangrove Monitoring Programme. Long and McKinnon (2002). Highland (2002).
Indicators	Maintenance of function and structure within coastal wetland communities over time.
Monitoring methods	Monitoring of wetland systems using remote sensing with field validation.
Milestones	Drafting of engineering designs for new developments accounting for provision of tidal flows through wetlands.
References	Draft Curtis Coast Regional Management Plan. Highland, S.J. 2002. An investigation of the impacts of ponded pastures on barramundi and other fish populations in tropical coastal wetlands. Final report – FRDC Project 07/201, DPI and FRDC. Long, P.E. and McKinnon, S.G. 2002. Habitats and fisheries resources of the Fitzroy River estuary (Central Queensland). Department of Primary Industries, Brisbane.

Significant Native Species and Ecological Communities - Target 1

Recommendation on resource condition target

- Maintain long-term populations of commercial and recreationally important fish and crustaceans within 2 years

Recommendation on management action targets to meet resource condition target

- Management of fishing permits, size and bag limits
- Exclusion of important nursery areas from fishing within 2 years
- Protection of important fish habitat within 2 years
- Increased presence of enforcement agencies within 2 years
- Increased penalties for infringement within 2 years
- Minimise bycatch and habitat degradation in fishing operations within a year

- Research impacts on habitats from trawling operations within 2 years
- Food web studies to determine principle dietary requirements and sources of significant species within a year
- Study the success of exclusion zones and FHA's within 7 years
- Monitor commercial catch within 2 years

Target explanation	Competing demands on fisheries resources has resulted in their depletion. As coastal resources come under increasing pressure from commercial and recreational fishing, and from industrial and urban expansion through the coastal zone, long-term sustainability becomes increasingly difficult to preserve.
How target was derived	In response to supposed threats to fisheries and fish habitats of the Central Queensland coast due to importance of commercial and recreational fisheries to the region.
Current resource condition	No accurate available data at the moment. Some catch records available.
Indicators	Fish catch according to effort.
Monitoring	Surveys of habitats; commercial and recreational fish catch records.

methods

References Long, P.E. and McKinnon, S.G. 2002. Habitats and fisheries resources of the Fitzroy River estuary (Central Queensland). Department of Primary Industries, Brisbane.

Ecologically Significant Invasive Species - Target 1

Recommendation on resource condition target
• No new outbreaks of pests of aquatic environmental significance spread beyond the region's capacity for full control within 7 years

Recommendation on management action targets to meet resource condition target
• Continued management of ballast water treatment and discharge • Implement education programs within 2 years
• Comprehensive base line assessment for introduced marine species in Port Alma and other ports within 2 years • A ballast water risk assessment establishing which species could potentially be introduced, and establish, in Curtis Coast waters, based on their current native and introduced range (Port Curtis, Port Alma).

Target explanation	Port Alma and Port Curtis are destinations for international shipping and boating with risks associated with importing exotic species, some of which may be potential pests both ecologically and commercially, through hull fouling and ballast water. Approximately 10 species are likely to have been introduced to Port Curtis and further introductions are possible without adequate control measures. No surveys have been undertaken elsewhere in the region.
How target was derived	State Coastal Plan policy 2.8.5 Pest species management supported by the Curtis Coast Regional Plan; matter for target of invasive species.
Current resource condition	Ten species are possibly introduced in Port Curtis. There is no baseline data available for other ports or harbours in Central Queensland.
Source of data	CRIMP/ Coastal CRC audit report.
Indicators	Identification of new, exotic species through monitoring.
Monitoring methods	Dedicated diving surveys and incidental sampling.
Milestones	Comprehensive baseline inventory of existing species in region. Implementation of an action plan for incidents.
References	Lewis, S., Hewitt, C. and Melzer, A. 2001. Port Survey for Introduced Marine Species – Port Curtis. Report to the Gladstone port Authority by the Centre for Environmental Management, CQU. Long, P.E. and McKinnon, S.G. 2002. Habitats and fisheries resources of the Fitzroy River estuary (Central Queensland). Department of Primary Industries, Brisbane.

7.7 Water quality

Assessments of water quality indicators for the Capricorn Coastal Catchments are summarised below and include implications for the aquatic ecosystem as well as human uses. Assessments are based on default trigger values (TV) as per the National Water Quality Guidelines (ANZECC/ARMCANZ, 2000) and Drinking Water Guidelines (NHMRC, 1996) (Section 5.7).

7.7.1 Turbidity/suspended particulate matter

Elevated turbidity levels (25-65 NTU) were recorded at most of the 13 freshwater sites monitored at the Shoalwater Bay Training Area (SWBTA) during the 1999 wet season. These levels are attributed to feral animals (cattle, horses and pigs).

Water Park Creek has good water quality.

Elevated levels of suspended particulate matter are carried in flood plumes from the Fitzroy River into the area with an estimated 2,635,482 tonnes of sediment exported per year (estimates will be further refined by advanced modelling (GBRMPA water quality action plan).

Of four estuarine sites monitored in the Shoalwater Bay training area, turbidity levels of between 15 and 45 NTU were observed during the 1999 wet season which is generally higher than the TV for estuarine ecosystem health.

No studies on other estuarine/coastal areas of the Capricorn coast have been performed.
(Sources: Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program; NR&M Water Quality Database)

Implications of elevated TSS levels	
Health of aquatic ecosystems:	• Decrease in ability of filter-feeders and fish to feed (including important commercial fish species) • Decrease in fish reproduction rates • Impairs aquatic plant growth • Affects species composition and decreases biodiversity • Siltation and shading has detrimental impact on reefs around Great Keppel and further offshore, as well as impacting on the small extent of seagrass beds that occur in Keppel Bay
Aquatic areas for recreation and aesthetics:	• Impaired visual clarity and colour • Sands of Capricorn Beaches coloured by mud and silt of the Fitzroy estuary
Water for drinking:	• Increased treatment costs

7.7.2 Nutrients in aquatic systems

Elevated nutrients were recorded at many of the 13 freshwater sites monitored in the Shoalwater Bay Training Area during the 1999 wet season. Important points:

- Levels of total nitrogen (TN) were between 0.18 and 2.6 mg/L
- Levels of total phosphorus (TP) were between <0.05 and 0.21 mg/L

- Levels of ammonia were between <0.005 and 0.14 mg/L
- These levels of nutrients in the aquatic system were attributed to feral animals (cattle, horses and pigs); human waste disposal and use of munitions

Water Park Creek has good water quality.

Elevated levels of nutrients are carried in flood plumes from the Fitzroy River to the area. An estimated 6579 tonnes of TN and 1440 tonnes of TP are exported per year (estimates will be further refined by advanced modelling (GBRMPA water quality action plan).

Along the Great Barrier Reef, chlorophyll-*a* levels were highest at Capricorn Bunkers/Keppels during 1993-1999 (refer to graph of Reef Research Chlorophyll *a* in Section 5.7).

High levels of TN, TP and ammonia were recorded from the estuarine creeks around Yeppoon. Further testing is being carried out.

High levels of nutrients were recorded at estuarine sites in the Shoalwater Bay Training Area during the 1999 wet season. Important points:

- Levels of TN were between 0.32 and 1.1 mg/L
- Levels of TP were between <0.05 and 0.08 mg/L
- Levels of ammonia were between 0.01 and 0.17 mg/L

No other monitoring information is available for the estuarine/coastal areas of Capricorn coast.
(Sources: Livingstone Shire Council; Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program; NR&M Water Quality Database)

Implications of elevated nutrient levels	
Health of aquatic ecosystems:	• Increased growth of nuisance plants including blue-green algae • Potential for increased eutrophication causing shading, reduced oxygen levels and subsequently a decline in biodiversity • Some evidence of increased algal blooms offshore (Brodie and Mitchell, 1992) • Potential for population changes in valued marine species through changes in species composition in lower trophic levels
Water for primary industries:	• TP levels generally exceed long term trigger values (LTV) in irrigation water – may cause bioclogging of irrigation equipment over time
Aquatic areas for recreation and aesthetics:	• Problems are growth of nuisance plants including blue-green algae • Potential for algal blooms of *Trichodesmium* and *Lyngbya* offshore and in inshore areas – produce skin, eye and respiratory irritations and a distinct malodour • Ammonia in creeks tested around Yeppoon at levels above that specified for swimming
Water for drinking:	• Problems are growth of nuisance plants including blue-green algae

7.7.3 Nuisance algal blooms

Algal blooms were reported in some ponds of the Shoalwater Bay Training Area. Information for the remainder of the catchment is not available.
(Source: Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program)

7.7.4 Surface Water Salinity

Of the13 freshwater sites monitored in the Shoalwater Bay Training Area, elevated salinity was recorded at Halfway Creek (~5000µS/cm), a site 600m outside the training area. These levels are above the default trigger values for aquatic ecosystems health and were attributed to concentrations of ions from surrounding soils as the water bodies dried up.

Waterpark Creek has good water quality.
(Sources: Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program; NR&M Water Quality Database)

7.7.5 Pesticides in aquatic systems

No pesticide contaminants have been detected in waters or sediments within the Shoalwater Bay Training Area or in estuarine/coastal areas of the Capricorn coast.
(Source: Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program)

7.7.6 Metals in aquatic systems

Monitoring in the Shoalwater Bay Training Area revealed that:

- Arsenic levels (0.07 mg/L) were high at Halfway Creek (site outside of training area boundary) compared to the TVs for protection of aquatic ecosystems
- Copper levels were high at one site (0.002 mg/L) compared to the TV for protection of aquatic ecosystems. This site was downstream of high impact military activity.
- Metal levels in sediments were not above the water quality guidelines.

Preliminary investigations of estuarine creeks around Yeppoon have recorded high aluminium, iron and manganese levels compared to guidelines for recreational purposes. Further testing is being carried out.

Metal levels were not of concern in estuarine sites monitored in the Shoalwater Bay Training Area.

A study of metals in sediments of Keppel Bay is in progress (Dr V. Vicente-Beckett, CQU).

With increasing development of the coastal region between Farnborough and Zilzie, the potential for release of metals from acid sulfate soils in these areas needs further consideration.
(Sources: Livingstone Shire Council; Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program)

Implications of elevated metals	
Health of aquatic ecosystems:	• Arsenic in aquatic systems is toxic to phytoplankton
Aquatic areas for recreation and aesthetics:	• Arsenic levels at Halfway Creek site are above those for swimming • Potentially harmful through ingestion of arsenic • Aluminium, iron and manganese recorded at levels higher than guidelines for recreational purposes at creeks around Yeppoon
Water for drinking:	• Raw water at the Halfway Creek site unsuitable due to arsenic levels

7.7.7 Knowledge, data and information gaps

- The natural levels of turbidity/suspended particulate matter and nutrients compared to levels brought about by human activities.
    - needed to set local water quality targets as levels in the catchment and estuaries are elevated compared to National guidelines
- Trends in water quality, especially for turbidity/suspended particulate matter, nutrients and nuisance algal growths. Sufficient information, which includes data over a lengthy period and knowledge of natural factors, is required.
    - needed to monitor the effects of land use over time
- Arsenic levels in waterways
    - arsenic was historically used in cattle dipping and could be in high levels throughout the catchment
- Pesticides in catchments surrounding Yeppoon
    - pineapple farming was once an important primary industry, especially along Tanby Road, north of Yeppoon and near Emu Park. Mango and other small crops are currently grown around the Yeppoon area. Pesticide residues could be present.
- Water quality in the Corio Bay, the Causeway Lake and Coorooman Creek
    - these ecosystems are important habitats for the success of many aquatic species and currently there is no water quality data available.

7.7.8 Targets

Water Quality (Freshwater) Target 1 – Nutrients: Nitrogen and Phosphorus

Instructions: Tick those assets you want to protect, working from top to bottom. The last row ticked should give your recommended target value (see target setting process and example). Enter the target date against your recommended target values.

Recommendation on resource condition target						
Tick	Asset to be protected	WQ Target				Target date:
		Nitrogen (mg/L)		Phosphorus (mg/L)		
	Water for livestock	Nitrate: Nitrite:	400.00 30.00	-		
	Water for irrigation	TN:	5.00	TP	0.05	
	Drinking water	Nitrate: Nitrite:	50.00 3.00	-		
	Water for recreational use (swimming)	Ammonia: (as N) Nitrate: Nitrite:	0.01 44.30 3.28	-		
	Water for aquatic ecosystems	TN:	0.50	TP:	0.05	

RC

Recommendation on management action targets to meet resource condition target
• Aim to reduce point and diffuse (catchment) inputs of nitrogen and phosphorus by x% and y% respectively, within ? years
• Collect total nitrogen and total phosphorus data set for reference site to allow local reference guidelines to be developed within 2 years

MA

INFO GAP

Target explanation

The target levels of total nitrogen and total phosphorus will protect the critical assets chosen by the community, with due consideration of social and economic impacts of the management actions to achieve the targets.

How target is derived

Using the process shown in Figure 5.7.7.
The critical assets chosen by the community are ticked above.
Because the targets are more stringent as you move down the table, the target value in the last row ticked is the most stringent and will protect all the assets above it. Then, when considering social and economic impacts of the management actions to achieve the target, decide if the choice of critical assets (and hence the target value) needs to be reviewed.

Current resource condition

Nutrient issues for the inland waters of the Capricorn Coast Catchments are noted in Section 7.7.2.

Source of condition data

Queensland Natural Resources and Mines (NR&M Water Quality Database).
Shoalwater Bay Training Area (SWBTA) Water Quality and Sediment Monitoring Program for Shoalwater Bay area. Consultants GHD were commissioned by the Department of Defence to undertake monitoring in the SWBTA in the wet season of 2002.

Indicators

Total nitrogen, nitrite nitrogen, nitrate nitrogen, ammonia, total phosphorus

Monitoring methods

The Department of Natural Resources and Mines assesses and monitors streams in each of the drainage divisions that cover Queensland. Timing of sampling varies.
The Department of Defence monitors water and sediment quality in the

	SWBTA, with standard monitoring procedures undertaken by consultants.
Milestones	Water quality information available in the Capricorn Coastal Catchments was collated.
Other comments	The management action targets will be linked to recommendations by GHD and management plans of the Department of Defence in relation to feral animals, waste disposal and munitions in the SWBTA. In setting targets, there is a need to consider the variability driven by factors linked to the unpredictable and variable climatic patterns of this region. Local reference guidelines may need to be a range of values.
References	Queensland Department of Natural Resources and Mines. 2000. Hydsys - Water Sample Database. A database maintained by NR&M. Gutteridge, Haskins & Davey Pty Ltd (GHD). 2002. Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program. Report on 2002 Wet Season Survey to the Department of Defence.

Water Quality (Freshwater) Target 2 – Surface Water Salinity

Instructions: Tick those assets you want to protect, working from top to bottom. The last row ticked should give your recommended target value (see target setting process and example). Enter the target date against your recommended target values.

Recommendation on resource condition target

Tick	Asset to be protected	WQ Target		Target date:
	Water for livestock	EC (µS/cm)	>6,000	
	Water for irrigation	EC (µS/cm)	Varies with soil and crop, refer to National Guidelines	
	Water for aquatic ecosystems	EC (µS/cm)	125-2,200	
	Water for recreational use (swimming)	TDS (mg/L)	1,000	
	Drinking water	TDS (mg/L)	500	

RC

Recommendation on management action targets to meet resource condition target

- Protection by rehabilitating (e.g. by planting of deep-rooted trees) and/or maintaining cover on land areas associated with potential salinity problems within ? years
- Develop local reference guidelines for Halfway Creek to assist with future monitoring within ? years

MA

- Identify land areas from Salinity Hazard map (See Fig. 7.6) that require rehabilitation (e.g. planting of deep-rooted trees to restore natural water balance) and/or protection to alleviate any future salinity problem within 2 years (link to Salinity Management Actions).

INFO GAP

Target explanation	The target levels of surface water salinity will protect the critical assets chosen by the community, with due consideration of social and economic impacts of the management actions to achieve the targets.
How target is derived	Using the process shown in Figure 5.7.7. The critical assets chosen by the community are ticked above. Because the targets are more stringent as you move down the table, the target value in the last row ticked is the most stringent and will protect all the assets above it. Then, when considering social and economic impacts of the management actions to achieve the target, decide if the choice of critical assets (and hence the target value) needs to be reviewed.

Current resource condition	Surface water salinity issues (assessed as elevated electrical conductivity) for the inland waters of the Capricorn Coast Catchments are noted in Section 7.7.4.
Source of condition data	Queensland Natural Resources and Mines (NR&M Water Quality Database) for Water Park Creek. Shoalwater Bay Training Area (SWBTA) Water Quality and Sediment Monitoring Program for Shoalwater Bay area. Consultants GHD were commissioned by the Department of Defence to undertake monitoring in the SWBTA in the wet season of 2002.
Indicators	Electrical conductivity (EC) and total dissolved solids (TDS). Note: TDS in mg/L is about 2/3-3/4 of the EC measured in µS/cm.
Monitoring methods	The Department of Natural Resources and Mines assesses and monitors streams in each of the drainage divisions that cover Queensland. Timing of sampling varies. The Department of Defence monitors water and sediment quality in the SWBTA, with standard monitoring procedures undertaken by consultants.
Milestones	Water quality information available in the Capricorn Coastal Catchments was collated
Other comments	The first management action target will link to vegetation management plans and land and water management plans.
References	Queensland Department of Natural Resources and Mines. 2000. Hydsys - Water Sample Database. A database maintained by NR&M. Gutteridge, Haskins & Davey Pty Ltd (GHD). 2002. Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program. Report on 2002 Wet Season Survey to the Department of Defence.

Water Quality (Freshwater) Target 3 – Turbidity/suspended particulate matter

Instructions: Tick those assets you want to protect, working from top to bottom. The last row ticked should give your recommended target value (see target setting process and example). Enter the target date against your recommended target values.

Recommendation on resource condition target				
Tick	Asset to be protected	WQ Target		Target date:
	Water for livestock	-		
	Water for irrigation	-		
	Water for recreational use (swimming)	Secchi disk	>1.6 m	
	Water for aquatic ecosystems	NTU	6-50	
	Drinking water	NTU	5	

RC

Recommendation on management action targets to meet resource condition target

- Aim to reduce point and diffuse (catchment) inputs of suspended particulate matter by x% within ? years

MA

- Collect turbidity (NTU or total suspended solids) data set for reference site or neighbourhood catchment to allow local reference guidelines to be developed within 2 years (Links to Soil Condition targets 2,3,4,5,6,and 7).

INFO GAP

Target explanation	The target levels of turbidity/suspended particulate matter will protect the critical assets chosen by the community, with due consideration of social and economic impacts of the management actions to achieve the targets.
How target is	Using the process shown in Figure 5.7.7.

derived	The critical assets chosen by the community are ticked above. Because the targets are more stringent as you move down the table, the target value in the last row ticked is the most stringent and will protect all the assets above it. Then, when considering social and economic impacts of the management actions to achieve the target, decide if the choice of critical assets (and hence the target value) needs to be reviewed.
Current resource condition	Turbidity issues for the inland waters of the Capricorn Coast Catchments are noted in Section 7.7.1.
Source of condition data	Queensland Natural Resources and Mines (NR&M Water Quality Database). Shoalwater Bay Training Area (SWBTA) Water Quality and Sediment Monitoring Program for Shoalwater Bay area. Consultants GHD were commissioned by the Department of Defence to undertake monitoring in the SWBTA in the wet season of 2002.
Indicators	Total suspended solids, NTU and secchi disk measurements
Monitoring methods	The Department of Natural Resources and Mines assesses and monitors streams in each of the drainage divisions that cover Queensland. Timing of sampling varies. The Department of Defence monitors water and sediment quality in the SWBTA, with standard monitoring procedures undertaken by consultants.
Milestones	Water quality information available in the Capricorn Coastal Catchments was collated
Other comments	The management action target will be linked to recommendations by GHD and management plans of the Department of Defence in relation to feral animals, which were identified as the cause of elevated sediments in the SWBTA. In setting targets, there is a need to consider the variability driven by factors linked to the unpredictable and variable climatic patterns of this region. Local reference guidelines may need to be a range of values.
References	Queensland Department of Natural Resources and Mines. 2000. Hydsys - Water Sample Database. A database maintained by NR&M. Gutteridge, Haskins & Davey Pty Ltd (GHD). 2002. Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program. Report on 2002 Wet Season Survey to the Department of Defence.

Water Quality (Estuarine Waters) Target 4 – Nutrients: Nitrogen and Phosphorus

Instructions: Tick those assets you want to protect, working from top to bottom. The last row ticked should give your recommended target value (see target setting process and example). Enter the target date against your recommended target values.

Recommendation on resource condition target						
Tick	Asset to be protected	WQ Target				Target date:
		Nitrogen (mg/L)		Phosphorus (mg/L)		
	Water for aquatic ecosystems	TN: estuarine Ammonia: estuarine	0.30 0.15	TP: estuarine	0.03	
	Water for recreational use (swimming)	Ammonia: (as N) Nitrate: Nitrite:	0.01 44.30 3.28	-		

RC

Recommendation on management action targets to meet resource condition target
• Aim to reduce point and diffuse (catchment) inputs of nitrogen and phosphorus by x% and y% respectively, within ? years • Collect total nitrogen and total phosphorus data set for reference site to allow local reference guidelines to be developed within 2 years

Target explanation	The target levels of total nitrogen and total phosphorus will protect the critical assets chosen by the community, with due consideration of social and economic impacts of the management actions to achieve the targets.
How target is derived	Using the process shown in Figure 5.7.7. The critical assets chosen by the community are ticked above. Because the targets are more stringent as you move down the table, the target value in the last row ticked is the most stringent and will protect all the assets above it. Then, when considering social and economic impacts of the management actions to achieve the target, decide if the choice of critical assets (and hence the target value) needs to be reviewed.
Current resource condition	Nutrient issues for the estuarine waters of the Capricorn Coast Catchments are noted in Section 7.7.2.
Source of condition data	Shoalwater Bay Training Area (SWBTA) Water Quality and Sediment Monitoring Program for Shoalwater Bay area. Consultants GHD were commissioned by the Department of Defence to undertake monitoring in the SWBTA in the wet season of 2002. Livingstone Shire Council (LSC) preliminary study of tidal creeks around Yeppoon
Indicators	Total nitrogen, nitrite nitrogen, nitrate nitrogen, ammonia, total phosphorus
Monitoring methods	The Department of Defence monitors water and sediment quality in the SWBTA, with standard monitoring procedures undertaken by consultants. Standard methods used by LSC.
Milestones	Water quality information available in the Capricorn Coastal Catchments was collated
Other comments	The management action targets will be linked to recommendations by GHD and management plans of the Department of Defence in relation to feral animals, waste disposal and munitions in the SWBTA. And, linked to management and monitoring activities relating to urban development along the coastal strip from Farnborough to Zilzie. In setting targets, there is a need to consider the variability driven by factors linked to the unpredictable and variable climatic patterns of this region. Local reference guidelines may need to be a range of values.
References	Gutteridge, Haskins & Davey Pty Ltd (GHD). 2002. Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program. Report on 2002 Wet Season Survey to the Department of Defence. Belinda Davies, Environmental Officer of LSC, Feb 2003, pers. comm.

Water Quality (Estuarine Waters) Target 5 – Turbidity/suspended particulate matter

Instructions: Tick those assets you want to protect, working from top to bottom. The last row ticked should give your recommended target value (see target setting process and example). Enter the target date against your recommended target values.

Recommendation on resource condition target				
Tick	Asset to be protected	WQ Target		Target date:
	Water for recreational use (swimming)	Secchi disk	>1.6 m	
	Water for aquatic ecosystems	NTU	0.5-10	

RC

Recommendation on management action targets to meet resource condition target
• Aim to reduce point and diffuse (catchment) inputs of suspended particulate matter by x% within ? years • Collect turbidity (NTU or total suspended solids) data set for reference site to allow local reference guidelines to be developed within 2 years

MA

INFO GAP

Target explanation	The target levels of turbidity/suspended particulate matter will protect the critical assets chosen by the community, with due consideration of social and economic impacts of the management actions to achieve the targets.
How target is derived	Using the process shown in Figure 5.7.7. The critical assets chosen by the community are ticked above. Because the targets are more stringent as you move down the table, the target value in the last row ticked is the most stringent and will protect all the assets above it. Then, when considering social and economic impacts of the management actions to achieve the target, decide if the choice of critical assets (and hence the target value) needs to be reviewed.
Current resource condition	Turbidity issues for the estuarine waters of the Capricorn Coast are noted in Section 7.7.1.
Source of condition data	Shoalwater Bay Training Area (SWBTA) Water Quality and Sediment Monitoring Program for Shoalwater Bay area. Consultants GHD were commissioned by the Department of Defence to undertake monitoring in the SWBTA in the wet season of 2002.
Indicators	Total suspended solids, NTU and secchi disk measurements
Monitoring methods	The Department of Defence monitors water and sediment quality in the SWBTA, with standard monitoring procedures undertaken by consultants.
Milestones	Water quality information available in the Capricorn Coastal Catchments was collated.
Other comments	The management action target will be linked to recommendations by GHD and management plans of the Department of Defence in relation to feral animals, which were identified as the cause of elevated sediments in the SWBTA. In setting targets, there is a need to consider the variability driven by factors linked to the unpredictable and variable climatic patterns of this region. Local reference guidelines may need to be a range of values.
References	Gutteridge, Haskins & Davey Pty Ltd (GHD). 2002. Shoalwater Bay Training Area Water Quality and Sediment Monitoring Program. Report on 2002 Wet Season Survey to the Department of Defence.

7.8 Social and economic profile

The socio-economic profiles provided in this information paper provide information about the current economic and social structure of the local government areas (LGAs) that make up the Central Queensland region. The Capricorn Coastal Catchment is sewed by the Broadsound and Livingston LGA. The objective of the profiles is to establish the economic and social context for setting natural resource management targets; providing information about the resilience of the local economy to absorb changes in resource use to meet the targets as well as to provide information about the capacity of the local community to take up natural resource management. Information about farm performance, an important consideration for determining the capacity of communities to take up resource management, is not available for the LGAs that comprise the Central Queensland region. This information has been provided in the regional overview. It is recommended that the FBA undertake more detailed survey work to identify the financial viability, including the structure of farm debt, of communities dependent on industries that are likely to be vulnerable to changed economic circumstances as resource management actions are implemented. These communities are likely to require financial support and economic incentives to take up resource management.

LGAs are described firstly in terms of major land and water uses and the value of production from each land use. More detailed information is then provided about current agricultural land use and management. Employment in the major resource use industries in each LGA over the last 10 years is then discussed highlighting the economic diversity of the area and dependencies on specific industries which may be subject to changed resource use to meet natural resource management targets.

The National Land and Water Resources Audit identified a conceptual model for appraising the capacity for change. One component of this was the availability of information and community networks A number of aspects of social capital, interpreted for this paper as the capacity of the community to take up changed resource use is then described by examining the population, its age structure and projected growth. Special mention is made about youth and indigenous persons resident in individual LGAs. Median income, access to housing, health and educational institutions provide an indication of community well being and of the propensity of the population to remain long-term in the area and to take up resource management. Access to computer technology, Landcare groups and the capacity of local government in the area all throw some light on the ability of the community to access information and to be involved in community organisations working towards resource management. Where possible this information has been provided. However, it is recommended that the FBA undertake an extensive audit and assessment of the availability and capacity of individual community organisations to identify those most in need of support to implement resource management.

7.8.1 Broadsound Local Government Area (18546.2 sq. km)

Resilience of the economy to respond to changed natural resource management

Land use

Table 7.1 Land use and gross value of production - Broadsound LGA, 2001

Major land user	Area (ha)	Value of production ($)	Proportion of industry in Central Qld (%)
Agriculture			
Irrigated cropping	2,588	na	na
Crop/Pasture rotation	16,929	na	na
Permanent cropping	53,840	15.5m	5.6
Grazing	1,660,199	47m	5.54
Total	1,733,556	75m	5.67
State forests[2]	8,592	na	na
National park	-	-	-
Managed protected areas (MPA)[3]	85,406	na	na
Mining	8,297	333m	5.8
Urban/industry	9,268	na	na

Notes: 1. Source: National Land and Water Resources Audit (NLWRA), 1997 (draft).
2. The area under forestry includes only State forests
3. MPA includes areas that fall within permanent cropping and crop/pasture areas not actually part of the dominant landuse classification e.g. riparian vegetation or a rocky outcrop that would be impossible or at least very difficult to utilise. The Draft NLWRA information includes land categorisation "conservation" which has been included in MPA.

Mining is by far the largest contributor to the local economy in Broadsound in 2001 ($333m). Coal is the major mining activity in the area. There are two coalmines operating in the area, Norwich Park and Foxleigh. In 2000-2001, the Norwich Park mine exported approximately 3.5 million tonnes of coal, primarily to Japan, France and the United Kingdom (Qld Government, Queensland Coal Industry Review, 2000-2001). The Foxleigh mine exported just over 2 million tonnes of coal in 2000-2001. A substantial quantity of this coal was exported to Japan, Korea and Spain. Coal from both mines was exported from Dalrymple Bay and Hay Point.

Agricultural production is dominated by grazing, contributing $47m to the economy.

Agricultural Land Use and Management

The total area of agricultural holdings in the Broadsound LGA in 2001 was 1,733,556ha. The area devoted to major agricultural commodities is given in Table 7.2. Grazing occupied 95% of agricultural land in the area and contributed 61% to the value of agriculture from the area. However, total agriculture from the Broadsound LGA contributed only 5.67% to the total value of agriculture in the region. Production of sugar cane in the area was valued at $7m, while cotton and fruit/vegetables provided similar production values in 2001.

Irrigation

Of the total land holdings in the Broadsound LGA only 0.17% (2,261.32ha) of land is irrigated. Of the total irrigated land, 132ha is pasture (native or sown) and 830ha is irrigated cotton.

Table 7.2 Agricultural production - Selected commodities - Broadsound LGA, 2001

Type	Area (ha)	Broadsound as a percentage of the region	Production	Estimated value ($) of production	Broadsound as a percentage of the region
Fruit/Vegetables[a]	49	1.35	-	2.1m	6.45
Cereal crops for grain[b]	36,389	6.59	86,952 (t)	15.5m	6.55
Cotton	1,304	3.43	1,272,487 (Kg) (lint) 3,304,838(Kg) (seed)	2.5m	2.69
Beef cattle	987,533	10.28	234,277 head	47m	5.54

Source: ABS, Agricultural Census, 2003.
Notes: [a] Fruit and vegetables includes all vegetables, fruit (including grapes) and nuts.
[b] Cereal crops for grain includes cereals for grain, which includes wheat, sorghum, oats, barley, maize, millet and triticale.

Cultivation techniques

Seventy-two percent of land in the Broadsound LGA is cultivated using zero or minimal till, which is similar to the regional average. Farmers using zero or minimal till for cultivation are expected to be minimising erosion and nutrient runoff. The different cultivation techniques across the LGA are given in Table 7.3. There is still room for improvement with over 27% of land in the LGA cultivated using conventional cultivation practices.

Table 7.3 Cultivation techniques - Broadsound LGA, 2001

Land Preparation Technique	Proportion of land prepared - Broadsound	Proportion of land prepared - Region
No cultivation or zero till (apart from actual sowing operation)	28.5%	34.45%
Minimal till, One or two cultivations only (immediately prior to sowing)	44%	38.32%
Conventional cultivation, land prepared with other cultivation	27.5%	27.07%
Total area prepared (ha)	9,609	620,676

Source: ABS, Agricultural Census, 2001

Fertiliser use

Fertiliser in the Broadsound LGA is applied at a rate (tonnes/ha) approximately one and two-fifths times greater than the average regional application rate. More specifically, the application of urea is approximately one and a half times greater than the regional average, while anhydrous ammonia is applied at twice the regional rate of application and mono ammonium phosphate is applied approximately one and two-thirds times higher than the regional average. This fertilizer usage possibly reflects the cultivation of cereal grains, fruit and vegetables as well as cotton in the area, and the use of urea as a feed supplement for cattle.

Tree planting

Tree planting is one activity regarded by the ABS as making a positive contribution to resource management. It is stressed however, that rehabilitation of areas to encourage regeneration of natural vegetation is likely to be more widespread amongst land managers. In the 2001 Agricultural Census (ABS, 2001) it was reported that 113.51ha of land was planted with seedlings for natural resource management purposes across the Broadsound LGA. This is the largest area across all

the LGAs in the region, and accounts for approximately 32% of the 360ha of land planted with seedlings for natural resource management purposes.

Protective fencing
In 2001, 84.08ha of agricultural land in the Broadsound LGA was reported to be fenced off to protect the land (See Table 7.4). This accounts for approximately 0.14% of the 61,377ha of land fenced off regionally for land protection. Protective fencing in the Broadsound LGA used to protect other degraded areas and all other areas, is substantially higher than the regional average. Of potential concern is the absence of fencing to protect planted trees and shrubs, creeks and remnant vegetation. Insufficient detail about "all other areas" is provided by the ABS statistics to comment about the use of fencing for this purpose.

Table 7.4 Land fenced off for resource management - Broadsound LGA, 2001

Land Protected	Percentage of total land fenced off - Broadsound	Percentage of total land fenced off - Region
Saline Areas	0%	1.26%
Other degraded areas	15.49%	5.9%
Planted trees and shrubs	0%	0.2%
Creeks and rivers	0%	37.5%
Remnant native vegetation	0%	11.7%
All other areas	84.50%	42.1%
Total area protected (ha)	84.08	61,377

Source: ABS, Agricultural Census, 2001

Salinity management
There are approximately 207 agricultural establishments in the Broadsound LGA. Approximately 5.8% of these (12) indicated that they had some area of their land affected by salinity compared with 3% of establishments (114) affected regionally. In addition, approximately 5.8% of all establishments (12) in the Broadsound LGA reported that they were using salinity management practices. This is lower than the proportion of establishments regionally (8%) that employ these management practices. This is a matter of concern, as only those who have identified saline areas on their properties would appear to be practicing salinity management.

Employment
Table 7.5 details employment by industry in the LGA and shows changes in employment in these industries since 1991.

In 2001, mining, agriculture and trade made the greatest direct contribution to employment in the Broadsound LGA (34.68%, 15.59% and 15.23% respectively) (ABS, 2001, cat. no. 2001.0). The Census demonstrates an absolute decline in the number of people employed in mining and community services since 1991. This is a matter of concern as mining makes the greatest contribution in terms of value of output to the economy of the area, while community services are necessary for the on going functioning of the community. Substantial increases in employment were in agriculture, forestry and fishing, trade and building construction.

In the 1996 Census, there were more people employed by private industry in the Broadsound LGA than for the State or Commonwealth governments. The number of persons employed by private industry in the local economy (85.7%) was higher than

for those employed in Queensland (79%). The Commonwealth government employed 0.7% of the population in Broadsound compared with 4% in Queensland (OESR, ABS, 1996 Population Census, unpublished). This situation suggests a greater reliance on the financial viability of private enterprise in the LGA than would be the case if a greater proportion of those employed were dependent on State or Commonwealth governments.

Table 7.5 Employment by industry - Broadsound LGA, 1991 to 2001

Industry	Census 1991		Census 1996		Census 2001	
	Number	Percent	Number	Percent	Number	Percent
Agriculture, forestry and fishing	441	11.9	467	13.3	526	15.59
Mining	1,731	46.7	1688	48.0	1,170	34.68
Manufacturing	42	1.1	37	1.1	74	2.19
Electricity, water and gas	15	0.4	8	0.2	24	0.71
Construction	138	3.7	94	2.7	265	7.85
Trade (wholesale and retail)	252	6.8	409	11.7	514	15.23
Transport, storage and communication	122	3.3	108	3	123	3.65
Finance	84	2.3	110	3.1	184	5.45
Public administration and defence	97	2.6	80	2.3	70	2.07
Community services (incl. education and health)	353	9.5	358	10.2	294	8.71
Recreational services	190	5.1	8	0.2	12	0.36
Personal and other services			51	1.4	53	1.57
Non-classifiable economic units and not stated	244	6.6	101	2.9	65	1.93
Total	3,709		3,519		3,374	

Source: ABS Population Censes, 1991, 1996 and 2001.

Of persons employed in 2001 in the Broadsound LGA, 22.1% were in part-time employment. The participation rate of the workforce at the 2001 Census was 67.8%, which is significantly better than that for the State (59.3%). (ABS, 2001, cat. no. 2001.0). The participation rate and proportion of the workforce in full-time employment for 15 to 25 year olds is also lower in the Broadsound LGA than for Queensland.

The median weekly individual income for 15 to 25 year olds in Broadsound has been lower than that of the State since the 1996 Census. At the 1996 Census, median weekly income was $180 compared to $192 for the State as a whole (ABS, 1996, cat. no. 4123.3). The median weekly individual income for people aged 15 years and over at the 2001 Census was $500-$599 which was considerably higher than that for the region and the State ($300-$399). The median weekly family income was $1,200-$1,499 in 2001, which was also higher than the State average income of $800-$899. The relatively high individual income is likely to be a reflection of the high income earned by those in the mining industry.

There is a net outflow of youth from the area, which together with the employment profile of youth in the area is likely to be a reflection of the structure of employment in the mining industry. This industry attracts young graduates who are resident in the region only for the duration of their employment contract.

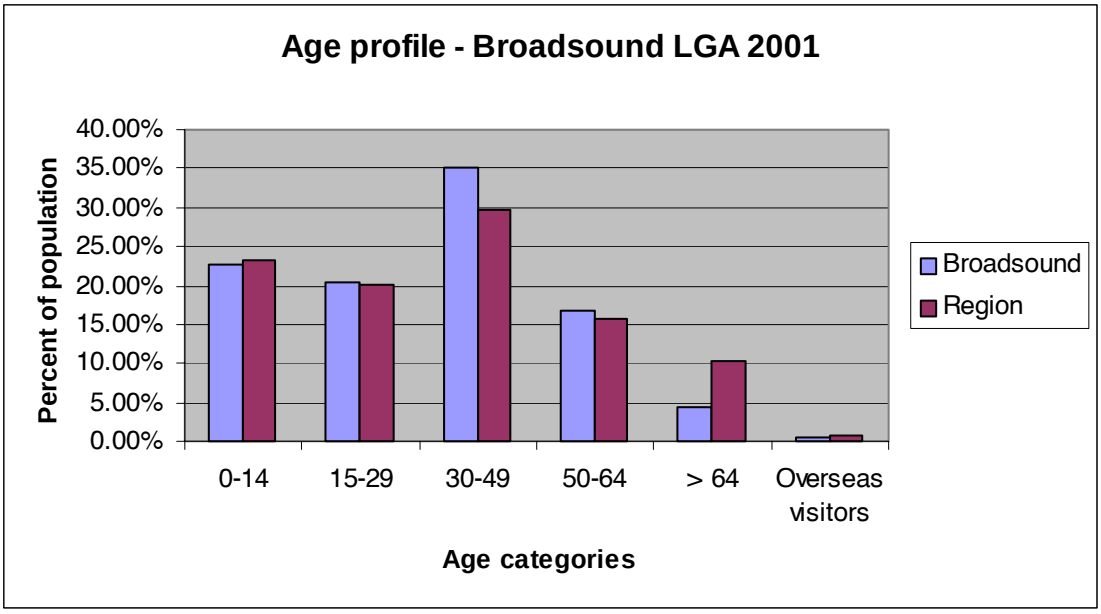
Although Broadsound has an unemployment rate of 2.8% it should be noted that the rate of unemployment, or conversely employment, is not particularly meaningful at this scale as people who are unemployed tend to migrate to regional centres where employment opportunities and rental accommodation are more readily available. The unemployment rate for indigenous persons was 0%. It is difficult to draw a meaningful conclusion from this given that the overall population of indigenous persons in the labour force is small in the Broadsound LGA (52)(ABS, 2001, cat. no.2002.0).

Capacity of society to respond to natural resource management

Assessing the capacity of the individual and the community to respond to change is highly complex. Access to services including public housing, health services and education is likely to provide a sense of community well-being and a sense of place, both of which would motivate the community to reside long-term in a local area and to support natural resource management. The stated field of study (of those no longer undertaking education) is important for resource management. It would be expected that persons trained in natural resource science and environmental management in an area would be a source of intellectual capital and who might be expected to participate in resource management programs. In addition, the ability for farmers to access information from both local Landcare groups and other extension activities both personally and through the use of the internet provides some indication of the transfer of information and technology which would influence the capacity of individuals to change their management of natural resources. Some information is available about the stated financial capacity of local government to initiate and support environmental protection; where available this is provided.

Population and age structure

The population in Broadsound LGA has declined over the last 10 years. It is projected to continue to decline and is ageing. The population of Broadsound accounts for 3.22% of the population for the total region and is 0.2% of the population of Queensland (ABS, 2001, cat. no. 2001.0). In 2001, the population of the Broadsound LGA was 6,950 persons. Between 1996 and 2001 the Broadsound population declined by 1.6% each year since the 1996 Census (DLGP, 2001). This one of the highest rates of decline in the Central Queensland region.



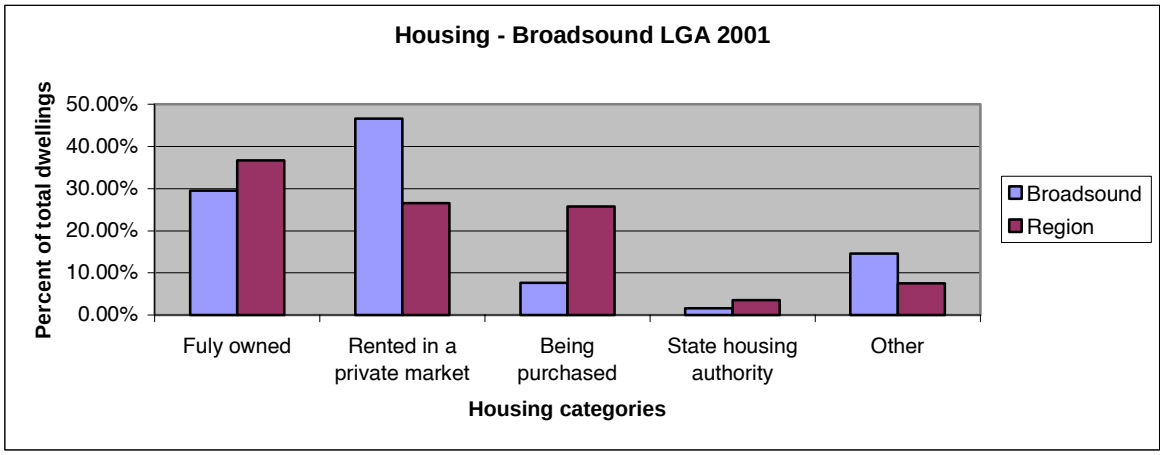
Young people (12 to 25 years) in the Broadsound LGA accounted for 17.95% of the population in Broadsound compared to 19.3% for the region and 19% for Queensland (ABS, 2001, cat. no. 2001.0). Although the indigenous population in the area accounts for only 2.8% of the population, the age structure was significantly younger than for the whole population of the Broadsound LGA. The median age of people in the Broadsound LGA in the 2001 Census was 34 years, compared with 31 years in the 1996 Census and 27 years in the 1991 Census (ABS, 2001, cat. no. 2001.0).

The index of relative disadvantage

According to the index of relative socio-economic disadvantage calculated in 1996, Broadsound received a score of 999, higher than the Mackay statistical division and Queensland as a whole, which were scored at 984 and 983 respectively. The index of relative socio-economic disadvantage is a measure of the relative disadvantage between geographic locations. Scores falling above 1000 are considered relatively advantaged. The index scores are derived from attributes including low-income levels, level of educational attainment, high unemployment and jobs in relatively unskilled occupations (McLennan 1998).

Housing

The total stock of dwellings in the Broadsound LGA was 2,262 dwellings in 2001. The availability of dwellings and ownership suggests the likelihood of the local community to remain in the area over the longer term. The availability of rental and State housing dwellings provides an indication of the propensity of those without employment to continue to reside in the area. The low number of people who fully own their homes and the high number of people renting compared to the region suggests that the population in the Broadsound LGA is transient, a reflection of the nature of employment in the mining industry.



Health

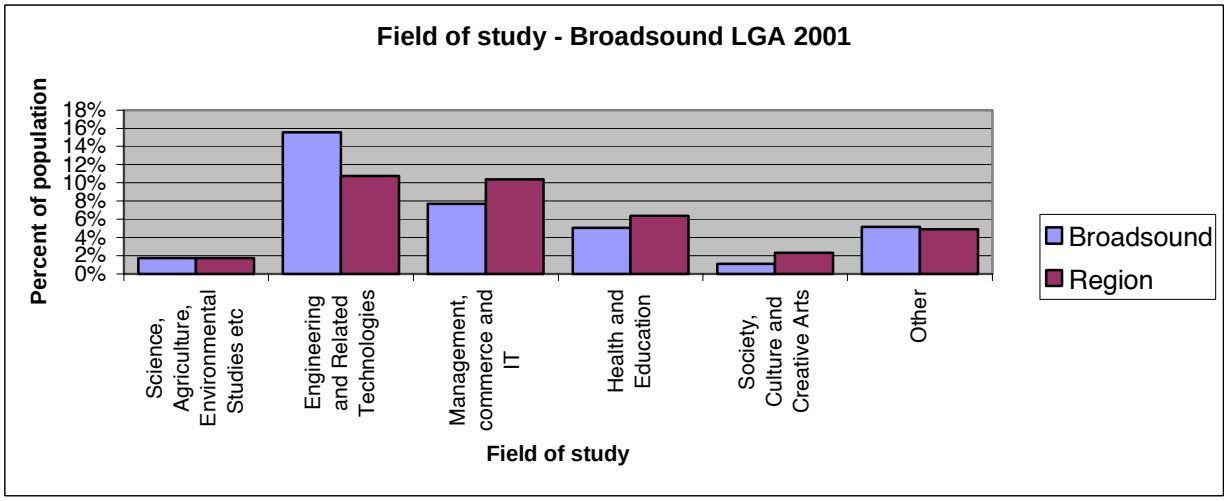
Provision of health facilities for the population in the Broadsound LGA in 1996/97 was generally lower than for the State. This situation could worsen as the population declines further and the government rationalises its service provision.

Education

Broadsound has a total of 9 education establishments representing 5.6% of the total for the Central Queensland region. Approximately 20.11% of the population in Broadsound are attending an educational establishment, which compares with 21.7% regionally. There are no significant differences in the numbers of people in the LGA holding qualifications and those of the region.

Field of study

There are a number of notable differences in the field of study of those no longer attending educational establishments. Approximately 31% of the population at the 2001 Census cited their field of study. In particular, the percent of the population in the Broadsound LGA citing science, agriculture and environmental studies or engineering and related studies as their field of interest is higher that those in the region. This is likely to be due to the number of people in the LGA working in agriculture or in mining related industries. This situation is an asset to the region for promoting improved resource management.



Access to computers
Access to computers, but more particularly the internet, is important for policy makers as it indicates the usefulness of internet services as a communication and information sourcing tool. Access to computers and use of the internet by Broadsound residents was not significantly different from estimates for the Central Queensland region. Nearly 40% of residents in Broadsound reported that they used a computer at home in the week prior to Census night, 2001. The internet was used by 29.3% of persons (with 18.6% of persons having access to the internet at home) in the week prior to Census night, 2001.

Local government capacity
The capacity of local government to take up conservation and environmental protection was investigated by the Local Government Association of Qld. It was determined that the Broadsound local authority did not have broad community support for expenditure on conservation and environmental protection. There was limited supporting legislation and a lack of financial incentives for authorities and landowners to take up conservation and environmental protection. In addition, local authorities cited lack of guidance on the cost effectiveness of management actions and lack of State extension services to assist resource management.

Conclusions
There has been a substantial decline in the population of the Broadsound LGA since the 1991 population Census which is reflected in the decrease in employment in the mining industry in the area.

No access to irrigation supplies has limited agricultural production to largely broad-acre cropping.

Economic assets	Threats
Agricultural production	
Large grazing and cereal grain production in the area, valued at $62.5m in 2001.	Dependence on world commodity prices. Limited access to irrigation supplies has limited the diversity of agricultural production.

Economic assets	Threats
Mining 2 coalmines located in the area. Production valued at $333m in 2001with 1,170 persons employed.	Mines have a limited life. Sale of coal is dependent on world commodity prices. Employment is declining and transient.
Value-adding for agricultural production	Limited access to value-adding for agricultural production could increase the vulnerability of industry to world economic conditions.
Road and rail transport Availability of a regional network of roads and rail.	Closure of grain silos across the region could lead to increased transport costs for producers.
Access to sea transport Coalmines have access to bulk coal-loading facilities at Dalrymple Bay and Hay Point.	

Social assets	Threats
Population	The population is ageing and declining. There is a net loss of youth from the area.
Employment	Highest numbers of employed are in agriculture and mining. Both of these industries are dependent on world markets. Employment is concentrated in industries that attract itinerate workers.

7.8.2 Livingstone Local Government Area (11,774.6 sq. km)

Resilience of the economy to respond to changed natural resource management

Land use

Table 7.6 Land use and gross value of production - Livingstone LGA, 2001

Major land user	Area (ha)	Value of production ($)	Proportion of industry in Central Qld (%)
Agriculture[1]			
Irrigated cropping	3,010	na	na
Crop/Pasture rotation	3,419	na	na
Permanent cropping	8,356	669,773	0.29
Grazing	441,833	41m	4.89
Total	2,368,503	$58m	4.38
State forests[2]	17,378	na	na
National park	3,268	na	na
Managed protected areas[3]	376,055	na	na
Mining	114	$18.4m	0.32
Urban/industry	46,137	na	na

Notes: 1. Source: National Land and Water Resources Audit (NLWRA), 1997 (draft); ABS, 2003, Agricultural Census.
2. The area under forestry includes only State forests
3. MPA includes areas that fall within permanent cropping and crop/pasture areas not actually part of the dominant land use classification e.g. riparian vegetation or a rocky outcrop that would be impossible or at least very difficult to utilise. The NLWRA (draft) includes a land use categorised as "conservation". This has been included with MPA.

The major mining activities in the region are in limestone, magnesium and ornamental gem stone mining. Grazing is the dominant agricultural land use to the economy of the shire, contributing 70% of the total value of production.

Agricultural Land Use and Management

The total area of agricultural holdings in the Livingstone LGA in 2001 was 693,021ha. The area devoted to major agricultural commodities is given in Table 10.7.

Table 7.7 Agricultural production - Selected commodities - Livingstone LGA, 2001

Type	Area (ha)	Livingstone as a percentage of the region	Production	Estimated value ($) of production	Livingstone as a percentage of the region
Fruit/Vegetables[a]	1,395	38.38	14,416 (t)	11.3m	41.79
Cereal crops for grain[b]	1,364	0.25	3,786 (t)	18,827	0.02
Cotton	-	-	-	-	-
Beef cattle	441,834	4.60	155,139 head	41m	4.89

Source: ABS, Agricultural Census, 2003.
Notes: [a] Fruit and vegetables includes all vegetables, fruit (including grapes) and nuts.
[b] Cereal crops for grain includes cereals for grain, which includes wheat, sorghum, oats, barley, maize, millet and triticale.

Grazing occupies 63% of agricultural land use in the LGA and contributes 50% to the total value of agricultural production in the LGA. Interestingly, fruit and vegetable production, which occupies less than 1% of agricultural land in the LGA,

accounts for 38% of land under fruit and vegetable production in the region and contributes 41% of the total value of fruit and vegetables produced in the region.

Irrigation
Of the total land holdings in the Livingstone LGA approximately 1% (2,102ha) of land is irrigated. Of the total irrigated land 820.5ha is pasture (native or sown).

Cultivation techniques
The percentage of land cultivated using zero is unknown because the area is minimal. However, the proportion of farmers using minimal tillage is approximately equivalent to the regional average. The different cultivation techniques across the LGA are given in Table 10.8. Over 59% of land cultivated is prepared using conventional cultivation techniques which is a matter of concern and is more than twice the regional average. The use of conventional tillage is known to impact on soil erosion and downstream sedimentation. Although the area of cropping is not large in the Fitzroy LGA, the high percentage of farmers continuing to use cultivation practices is a concern.

Table 7.8 Cultivation techniques - Livingstone LGA, 2001

Land Preparation Technique	Proportion of land prepared - Livingstone	Proportion of land prepared - Region
No cultivation or zero till (apart from actual sowing operation)	np	34.45%
Minimal till, One or two cultivations only (immediately prior to sowing)	39.56%	38.32%
Conventional cultivation, land prepared with other cultivation	59.57%	27.07%
Total area prepared (ha)	3,114	620,676

Source: ABS, Agricultural Census, 2001
Note: np = Information withheld by ABS.

Fertiliser use
Fertiliser application rate (tonnes/ha) in the Livingstone LGA is approximately one-fifth higher than the average for the region. More specifically, the application of urea is approximately two-fifths higher than the regional application rate, and mono ammonium phosphate is applied at a rate approximately one-third higher than the regional average. The high usage is likely to be indicative of fertilizer for fruit and vegetable production.

Tree planting
Tree planting is one activity regarded by the ABS as making a positive contribution to resource management. It is stressed however, that rehabilitation of areas to encourage regeneration of natural vegetation is likely to be more widespread amongst land managers. In the 2001 Agricultural Census (ABS, 2001) it was reported that 18.35ha of land was planted with seedlings for natural resource management purposes across the Livingstone LGA by agricultural producers. This accounts for approximately 5.1% of the 360ha of land planted with seedlings for natural resource management purposes within the region.

Protective fencing

In 2001, 505ha of agricultural land in the Livingstone LGA were reported to be fenced off to protect the land. This accounts for approximately 0.8% of the 61,377ha of land fenced off regionally for land protection. Protective fencing in the Livingstone LGA used to protect saline areas, planted trees and shrubs, and remnant vegetation is substantially higher than that in the region. This is detailed in Table 10.9.

Table 7.9 Land fenced off for resource management - Livingstone LGA, 2001

Land Protected	Percentage of total land fenced off - Livingstone	Percentage of total land fenced off - Region
Saline Areas	10.11%	1.26%
Other degraded areas	0%	5.90%
Planted trees and shrubs	8.66%	0.21%
Creeks and rivers	np	37.52%
Remnant native vegetation	29.86%	11.70%
All other areas	50.83%	42.11%
Total area protected (ha)	505.04	61,377

Source: ABS, Agricultural Census, 2001
Note: np = Information withheld by ABS.

Salinity management
There are approximately 362 agricultural establishments in the Livingstone LGA. Approximately 9% of these (33) indicated that they had some area of their land affected by salinity compared with 3% of establishments (114) affected regionally. In addition, approximately 12% of all establishments (44) in the Livingstone LGA reported that they were using salinity management practices. This is higher than the proportion of establishments regionally (8%). This is promising as it indicates that preventative measures for salinity management are being undertaken by establishments. However, the Fitzroy catchment has a high proportion rated as moderate/high to high salinity hazard (Fig.10.6), particularly in the floodplain. Subsequently, awareness of the potential hazard and management actions to address salinity must increase.

Employment
Table 10.10 details employment by industry in the LGA and shows changes in employment in these industries since 1991.

Employment in the area increased by nearly 3,000 persons between 1991 and 2001. In 2001, the trade, community services and finance sectors made the greatest direct contribution to employment in the Livingstone LGA (26.36%, 20.69% and 9.11% respectively) (ABS, 2001, cat. no. 2001.0). Whilst there has been an absolute increase in employment in all sectors since 1991, the 2001 Census demonstrates a slight decline in the percentage of total employment in agriculture and construction since 1996. The structure of employment in this area suggests an economy that is relatively diverse, that is, not dependent on the fortunes of any one industry.

In the 1996 Census, there were more people employed by private industry in the Livingstone LGA than for the State or Commonwealth governments. The number of persons employed by private industry in the local economy (76.5%) was lower than for those employed in Queensland (79%). Only 2.9% of employed persons were employed by the Commonwealth government in the Livingstone LGA compared to

4% in Queensland (OESR, ABS, 1996 Population Census, unpublished). This situation suggests a greater reliance on the financial viability of private enterprise in the LGA than would be the case if a greater proportion of those employed were dependent on State or Commonwealth governments.

Table 7.10 Employment by industry - Livingstone LGA, 1991 to 2001

Industry	Census 1991		Census 1996		Census 2001	
	Number	Percent	Number	Percent	Number	Percent
Agriculture, forestry and fishing	695	9.5	671	7.8	714	7.00
Mining	101	1.4	109	1.3	198	1.94
Manufacturing	604	8.3	698	8.1	832	8.15
Electricity, water and gas	51	0.7	97	1.1	141	1.38
Construction	593	8.1	686	8.0	808	7.92
Trade (wholesale and retail)	1,083	14.8	2,260	26.3	2,690	26.36
Transport, storage and communication	337	4.6	450	5.3	550	5.39
Finance	471	6.5	782	9.1	930	9.11
Public administration and defence	638	8.7	362	4.2	432	4.23
Community services (incl. education and health)	1,356	18.6	1,759	20.5	2,111	20.69
Recreational services	802	11.0	134	1.6	199	1.95
Personal and other services			296	3.5	358	3.51
Non-definable economic units and other	569	7.8	268	3.1	240	2.35
Total	7,300		8,572		10,203	

Source: ABS Population Censes, 1991, 1996 and 2001.

Of persons employed in 2001 in the Livingstone LGA, 35.4% were in part-time employment. The participation rate of the workforce at the 2001 Census was 52.56%, which is lower than that for the State (59.3%). (ABS, 2001, cat. no. 2001.0). The participation rate for 15 to 25 year olds was lower in the Livingstone LGA compared to the State however, the rate of full-time employment for the same age group was higher for the Livingstone LGA compared to the State. This is a matter of concern as it suggests that employment opportunities for 15 to 25 year olds might not be available in the area.

The median weekly individual income for 15 to 25 year olds in Livingstone has been lower than that of the State since the 1996 Census. At the 1996 Census, the median weekly income was $150 compared to $192 for the State as a whole (ABS, 1996, cat. no. 4123.3). The median weekly individual income for people aged 15 years and over at the 2001 Census was $300-$399, which was the same as that for the region and the State $300-$399. The median weekly family income was $700- $799 in 2001 which was also lower than the State average.

There is a net inflow of youth aged 15-19 years into the area. This is possibly a reflection of the diversity of employment sectors in the shire and is a positive indication that young workers are taking up residence in the area.

Although Livingstone LGA has an unemployment rate of 8.6% it should be noted that the rate of employment, or conversely unemployment, is not particularly meaningful at this scale as people who are unemployed tend to migrate to regional

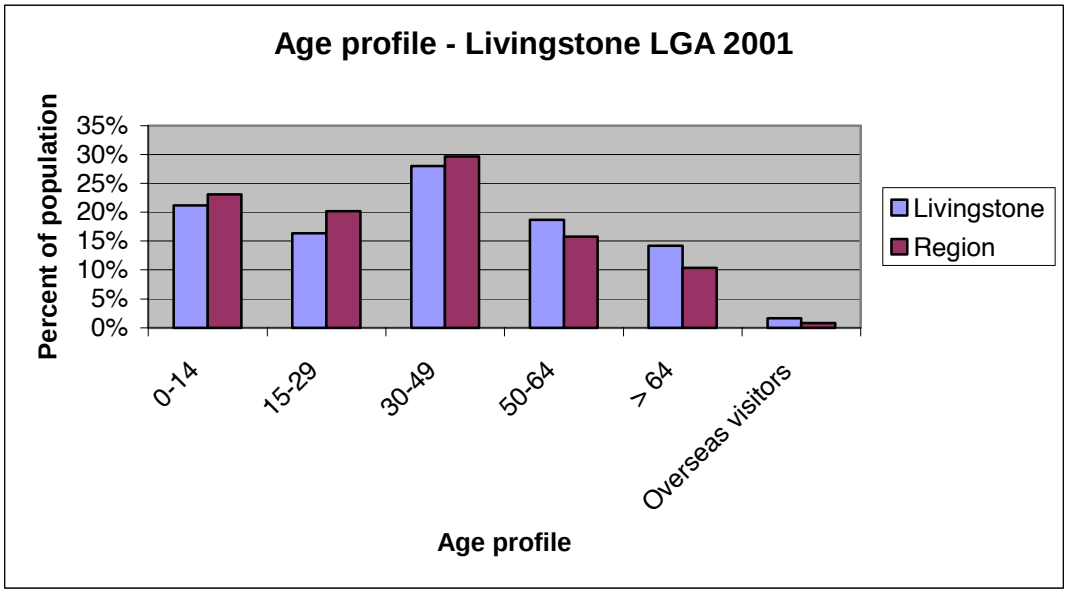
centres where employment opportunities and rental accommodation are more readily available. As this LGA is a coastal LGA it is likely that the unemployed have migrated into the area from inland catchments. The unemployment rate for indigenous persons (29.6%), although considerably higher than the rate for the workforce as a whole at the 2001 Census, was comparable with the unemployment rate for indigenous persons throughout the Central Queensland region (ABS, 2001, cat. no.2002.0).

Capacity of society to respond to natural resource management

Assessing the capacity of the individual and the community to respond to change is highly complex. Access to services including public housing, health services and education is likely to provide a sense of community well-being and a sense of place, both of which would motivate the community to reside long-term in a local area and to support natural resource management. The stated field of study (of those no longer undertaking education) is important for resource management. It would be expected that persons trained in natural resource science and environmental management in an area would be a source of intellectual capital and who might be expected to participate in resource management programs. In addition, the ability for farmers to access information from both local Landcare groups and other extension activities both personally and through the use of the internet provides some indication of the transfer of information and technology which would influence the capacity of individuals to change their management of natural resources. Where available, information is provided about the stated financial capacity of local government to initiate and support environmental protection.

Population and age structure

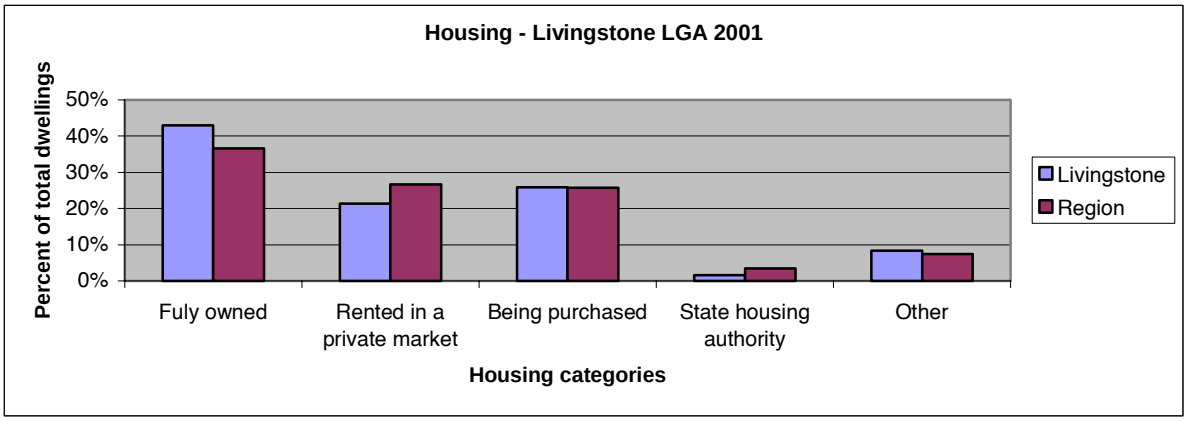
The population in Livingstone LGA has increased over the last 10 years and is projected to continue to increase. The population of Livingstone accounts for 13.19% of the population for the total region and is 0.74% of the population of Queensland (ABS, 2001, cat. no. 2001.0). In 2001, the population of the Livingstone LGA was 26,492 persons. Since the 1996 Census, the population has been growing at a rate of 2.5% each year, well above the State average annual growth rate for the same period. This is the highest growth rate in the Central Queensland region.



Young people (12 to 25 years) in the Livingstone LGA accounted for 17.45% of the population in Livingstone compared to 19.3% for the region and 19% for Queensland (ABS, 2001, cat. no. 2001.0). Although the indigenous population in the area accounts for only 2.9% of the population, the age structure was significantly younger than for the whole population of the Livingstone LGA. The median age of people in the Livingstone LGA in the 2001 Census was 38 years, compared with 35 years in the 1996 Census and 33 years in the 1991 Census (ABS, 2001, cat. no. 2001.0).

The index of relative disadvantage
According to the index of relative socio-economic disadvantage calculated in 1996, Livingstone received a score of 979, higher than the score for the Fitzroy statistical division (972) and but slightly lower than the score for Queensland (983). The index of relative socio-economic disadvantage is a measure of the relative disadvantage between geographic locations. Scores falling above 1000 are considered relatively advantaged. The index scores are derived from attributes including low-income levels, level of educational attainment, high unemployment and jobs in relatively unskilled occupations (McLennan 1998).

Housing
The total stock of dwellings in the Livingstone LGA was 9,759 dwellings in 2001. The availability of dwellings and ownership suggests the likelihood of the local community to remain in the area over the longer term. The availability of rental and State housing dwellings provides an indication of the propensity of those without employment to continue to reside in the area. In the Livingstone LGA, although the proportion of dwellings fully owned is higher than for the region, some concern surrounds the lower number of dwellings available for rent or currently being purchased. The main concern, not demonstrated in these statistics, is the limited availability of suitable accommodation for persons wanting to reside in the area. The relatively lower than region proportion of dwellings rent could reflect the shortage of supply of rental accommodation rather than poor demand.



Health

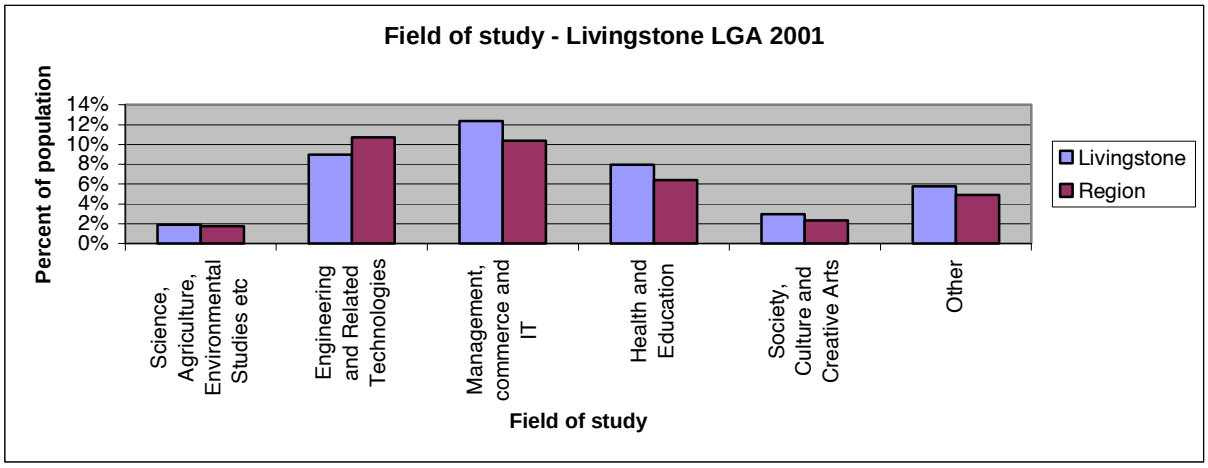
Provision of health facilities for the population in the Livingstone LGA in 1996/97 was generally lower than for the State. This situation is a matter of concern as the population is growing, putting increasing pressure on the existing facilities. Due to its close proximity to the regional centre (Rockhampton), it is possible that authorities are anticipating those wishing to access health facilities will travel to Rockhampton.

Education

Livingstone has a total of 18 education establishments representing 11.25% of the total for the Central Queensland region. Approximately 24.16% of persons in Livingstone are attending an educational establishment compared with 21.71% for the region. There are no significant differences in the numbers of people in the LGA holding qualifications and those of the region.

Field of study

There are a number of notable differences in the field of study of those no longer attending educational establishments. Approximately 40% of the population at the 2001 Census cited their field of study. In particular, the percent of the population in the Livingstone LGA citing management, commerce and IT, and health and education, as their field of interest is higher that those in the region. This is a reflection of the nature of the economy of the area which is dominated by employment in the trade sector (primarily accommodation and restaurants) and is indicative of the increased tourist activity in the area since the 1991 Census.



Access to computers

Access to computers, but more particularly the internet, is important for policy makers as it indicates the usefulness of internet services as a communication and information sourcing tool. Access to computers and use of the internet by Livingstone residents was not significantly different from estimates for the Central Queensland region. Nearly 38.5% of residents in Livingstone reported that they used a computer at home in the week prior to Census night, 2001. The internet was used by approximately 31.8% of persons (with 16.6% of persons having access to the internet at home) in the week prior to Census night, 2001.

Capacity of local government

The Capacity of local government to take up conservation and environmental protection was investigated by the Local Government Association of Qld. It was determined that the Livingstone local authority did not have the broad support of the community for expenditure on conservation and environmental protection. Impediments were not identified.

Conclusions

Although the economy of this area would appear to be in a position to absorb changes required for natural resource management, the growing population in the area has brought its own pressures on local authorities. In particular, service provision, including urban water supply and sewerage, are under increasing pressure in the area.

The development of a strong tourist industry in this area over the past 10 years requires consideration of the impact of tourists on natural resources and the development of appropriate infrastructure to minimise the impact. There is a danger that urban expansion will encroach on highly productive agricultural land in the future and compete for valuable water supplies.

Economic assets	Threats
Agricultural production Relatively diverse agriculture. The area has one of the most productive fruit and vegetable growing areas in the region (33.69% of the value of fruit and vegetables in the region). Value of agricultural production in 2001 is estimated at $58m.	Limited access to irrigation supplies. As the population increases, urban water demands may result in a redistribution of water from lower valued agriculture to urban water supply.
Mining Deposits of magnesium are valuable for the region. The ore is not refined in the area.	
Road and rail transport Extensive road and rail network throughout the area.	Need to upgrade the local road network to service the growing local population
Access to sea transport Close proximity to Gladstone Port.	

Social assets	Threats
Population High population growth (2.5% per annum). Net inflow of young people.	Need for service provision by local authorities. Tourists represent an immediate increase in people living in the area who are accessing locally provided services. These persons tend not to contribute significantly to the rate base.
Employment Diverse employment opportunities. Substantial employment in the trade sector (2,690 persons in 2001) dominated by employment in tourist related industries.	Dependence on the continued influx of tourists.