Submission to the Productivity Commission

Industries in the Great Barrier Reef Catchment and Measures to Address Declining Water Quality

Issues Paper
August 2002

This submission is prepared by the Dawson Catchment Coordinating Association Inc. It includes the views and comments of the Callide Valley Landcare Group and is intended to also raise issues on behalf of the community groups represented by the Dawson Catchment Coordinating Association Inc.

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1. ***What is the nature and extent of research and monitoring activities relating to land and water uses, water quality and GBR health? What are the main areas of scientific agreement and disagreement on these relationships?***

Research has been conducted documenting the health of the Dawson Catchment relating to condition and trends. Land degradation and soil loss has occurred as a result of grazing and agriculture, this has lead to declined water quality from the introduction of excess sediments, nutrients and pesticide and other chemicals. The research is from a variety of sources being the Queensland Departments of Natural Resources and Mines, and Primary Industries as well as the Central Queensland University and community and private organisations.

It should be noted that there has been no quantification of how much soil loss is occurring from any given industry as a point source throughout the catchment.

The following publications also relate to ***Question 2***.

- **The Dawson Catchment Coordinating Association website documents the majority of water quality research and sampling taking place or historic references. This is the first recommended point of reference, the following reference material is mostly referred on the website.**
  www.dawsoninfo.org/catch/water/

- Dawson Catchment Water Quality Forum Proceedings, 2000 and 2001, cd of 2002 proceedings. A forum hosted by the Dawson Catchment Coordinating Association and Theodore District Chemical Liaison Group to bring together stakeholders to discuss and share information about water quality initiatives in the Dawson Catchment.
  Proceedings Attached via Mail. Also visit www.dawsoninfo.org/catch/water/

- Sediment Watch – Contact: Catherine Collins, Department of Natural Resources and Mines, LMB 1, BILOELA Qld 4715, Ph: 07 4992 9124, catherine.collins@nrm.qld.gov.au

- *River Health in the Fitzroy Catchment – Community Ownership*, R.M. Noble, Queensland Department of Natural Resources, Rockhampton Qld 4700, January 1997 – December 1999.
  Contact: Bob Noble, DNRM, Ph: 07 4938 4017, bob.noble@nrm.qld.gov.au
  Copy Attached via Mail.

- *Downstream Effects of Land Use in the Fitzroy Catchment*, December 1996, R.M. Noble, L.J. Duivenvoorden, S.K. Rummenie, P.E. Long, L.D. Fabbro, Department of Natural Resources, Primary Industries and National Landcare Program.
  Contact: Bob Noble, DNRM, Ph: 07 4938 4017, bob.noble@nrm.qld.gov.au
  Copy Attached via Mail.

- *Technical Report 3 Theme 7 – Catchment health, Fitzroy Implementation Project Queensland*, National Land and Water Resources Audit, Mary-Anne Jones, Department of Natural Resources, Central Queensland University.
  Contact: National Land and Water Resources Audit. www.nlwra.gov.au
  Copy Attached via Mail.

- *State of the Rivers, Dawson River and Major Tributaries, An Ecological and Physical Assessment of the Condition of Streams in the Dawson River Catchment*, Department of Primary Industries, Damon Telfer, October 1995.
  Contact: DPI Resource Management PO Box 2454, Brisbane 4001
  Ph: 07 32247613 www.dawsoninfo.org/catch/water/comm/comm.html#soriv

- *Dawson Implementation of Strategies*, Dawson Catchment Coordination Association, 2002. Outlines actions again identified issues in the Dawson River Catchment Strategy. Some references attached.
  Attached on email.

4. Should the Commission undertake a more detailed investigation of a few regions or catchments as part of its study to highlight important regional and local issues? If so, which areas are suggested and for what reasons?

The Fitzroy region is particularly significant due to its area, industry contribution and suspected environmental impacts on the GBR. Targets set for this region being a 50% reduction in Sediment has instigated much debate given how little is known about the nature of sediment movement throughout the catchment and how this target is going to be achieved.

Given the size of the Fitzroy Basin, the major industries and the widespread population throughout the Basin, it is important that the impact and contribution of each of the local areas is identified clearly. Whilst data is available for the region as a whole and sub-catchment basis, only isolated studies determine the contribution of sediments and other point sources of impact at a local level. This information will be critical in implementing policy and solutions and gain cooperation of land users in addressing problems and reaching targets.

Atrazine has been detected throughout the Dawson River reported from the Sediment Watch project (Department of Natural Resources and Mines) where regular water samples are collected from the River and Creek systems. This monitoring however does not address the issue of where the Atrazine is coming from given the widespread detection. Also not known is the nature of Atrazine movement in the water and if it has been sourced from recent applications or contributed from long term residues, complicated by the significant decrease in Atrazine use in recent years. Given the complexity, we therefore have been not targeted a response to reducing Atrazine runoff due to lack of point source information.

In the Dawson Catchment and throughout the Fitzroy Basin grazing is a major land use with cultivation and irrigation only comprising a comparatively small area of land use. However the sediment contribution distinguishing between land uses, especially in a given area has not been determined. This information will be vital in implementing actions to reduce sediment.

These are a few examples of why the Fitzroy region should be given particular attention to ensuring detailed information is available to land managers to address the impacts on the GBR.

15. What are the principal activities of the main industries that have the potential to change water quality in the GBR lagoon, and how do these industries currently manage these?

Beef Industry

See attached email

- DCCA – Impacts of Stock on Water Quality
- DCCA Vegetation Management Practice Booklet
- DCCA Vegetation Project Overview

- *Dawson Riparian & Remnant Vegetation Management Project Overview*

There are 34 vegetation projects throughout the Dawson catchment area. Over 245 km of vegetation has been fenced, with the total conservation area being over 5776 ha. 39 watering systems and 91 troughs have been installed.

Cotton Industry

Potential impacts from the introduction of sediment and chemical pollutants into the Dawson River system. This in the past has caused localised fish kills. Measures are being taken to limit the impact of this industry to include 90% BMP in the Theodore area, use of boom sprays instead of aerial application, precision chemical application, modified cotton, integrated pest management, and constructions to retain the initial runoff in a rainfall event that contains the majority of chemical pollutants. Contact: Liz Alexander, Grower Manager, Cotton Australia, Emerald. Ph: 0407 404454.

Irrigation

Potential salinisation of groundwater and depletion of groundwater resources. Limits available environmental flows. Rural Water Use Efficiency Programs and Farmer Groups, Irrigators Associations and other initiatives.

Mining

Acid mine drainage sourced from the closed Mount Morgan mine site is contributing disproportionately to water quality pollution and widespread contamination of the Dee River. Whilst mining has ceased the problem of acid mine drainage from the site has caused several major fish kills in the Dee River. The tailings pit has the potential to overflow 1:2 years. The extent of impact from this polluted water source entering the Dee River and downstream impacts to the Dawson River and Duaringa town water supplies and indeed Rockhampton's water supply, has not been determined. Currently the Department of Natural Resources and Mines is working toward a rehabilitation and management plan for the site. The Wowan Dululu Landcare Group have been instigators of action in addressing this problem, however to date no significant amounts of money have been spent to implement the much needed measures. Measured pH in the Dee River is consistently as low as 2.

Callide Valley Landcare Response: Question 15 & 17

Beef Industry

Overstocking and tree clearing have the potential to change water quality in the GBR Lagoon.

Overstocking

- The Beef Industry Code of Practice for the Region is currently being updated by the Beef Research Group (Tropical Beef Centre) in Rockhampton.

- It should be noted that the relative contribution of sediments from stream bank erosion, overland flow, gully erosion and natural erosive processes is still unknown.

Tree Clearing leading to erosion and Salinity
Queensland Tree Clearing Guidelines

Cotton Industry

Adoption of Best Management Practice Guidelines
90% of properties in the Theodore area are accredited
70% of properties in the Emerald area are accredited

Aspects of the Code of Practice include
- returning of tail water and initial flows to on farm storage
- use of ground rigs rather than aerial spraying
- Use of soft and targeted chemicals rather than broad spectrum and endosulfins

Grain Industry and Dryland Cropping
- There has been a 70 % adoption of contour banks
- 30 % uptake of minimum till & sustainable farming systems in the Fitzroy region

The DNRM Field Estimates Report of 1983 for the Dawson/ Callide stated that well maintained and designed contour banks can halve the soil loss of unprotected country. John Mullins estimated this soil loss in unprotected sloping Brigalow country at 60 tons per hectare. The Field Estimates report puts soil loss in contoured and minimum till country at 5 tons per ha.

- An ABS estimate of the dryland cropping area in the Fitzroy is 500 000 ha. This figure may need updating from the latest ABS.

16. To what extent are management approaches like precision fertiliser application or revegetation being used to limit reductions in water quality, and what are the key incentives behind their use/non-use? Are there significant regional variations in the adoption of such practices?

See Question 15 response to management approaches. The DCCA *Dawson Implementation of Strategies* **(Attached email)** documents the responses of industry, community and government to the identified issues in the Dawson Catchment. The Natural Heritage Trust has been paramount in providing incentives and enabling better natural resource management practices to be adopted and implemented; there is a wealth of knowledge and experience to be gained from those involved in these projects and the outcomes documented.

See attached email
- DCCA – Impacts of Stock on Water Quality
- DCCA Vegetation Management Practice Booklet
- DCCA Vegetation Project Overview

- *Dawson Riparian & Remnant Vegetation Management Project Overview*

There are 34 vegetation projects throughout the Dawson catchment area. Over 245 km of vegetation has been fenced, with the total conservation area being over 5776 ha. 39 watering systems and 91 troughs have been installed.

Again the localised efforts need to be considered, for example all but one cotton grower in the Theodore area is BMP accredited and will soon be 100%. Recommendations from a study into the containment of tail water from the irrigation area is being developed into a project and already partly implemented by growers to prevent chemical runoff from the initial flows in a rainfall event. Whilst incentives are being sought to assist growers construct the containment storages, it is a grower initiated project and they should be recognised for the measures that are being taken to prevent environmental damage.

Revegetation in the Brigalow belt is unique in that there are relatively productive seed banks still stored in the soils even after degradation or denuding of vegetation. Natural revegetation occurs relatively quickly after resting of an area and careful management. Incentive programs have been designed to assist graziers fence off remnant and riparian vegetation and provide stock watering so critical areas of vegetation can be managed more appropriately with controlled grazing. Often in the degraded country even after only a very short period, revegetation of grass cover and regeneration of trees occurs quickly. Due consideration to local methods of revegetation should be given, ie. Tree planting is neither practical nor successful in most areas in the catchment; natural revegetation from resting is often adequate to obtain cover and regeneration.

Callide Valley Landcare Response: Question 16

Significant Regional Variations

Two useful references here are:

- *State of the Rivers Report* , Dawson River, 1995 , Damon Teller , DPI
- *Downstream Effects of Land Use in the Fitzroy Catchment* , December 1996, Bob Noble, NRM
- Variations in rainfall pattern include reasonable winter rainfall in some areas to heavy early summer rainfall with a dry winter. This significantly affects the erosive patterns.
- It should be noted that rapid regrowth and self-regeneration of vegetation is a significant factor in all areas, so revegetation practices are not used as extensively as in Southern States. I t also appears that the seedbed is still existing and fallow land or protected land will regenerate itself.
- The Fitzroy Catchment is characterised by fragile, dispersible soils with high clay content and marine sediments.
- Regional variations are intensified by the contrast between the small, high impact coastal catchments and the two large, inland catchments.
- The Isaacs River has a higher fall and flow than other rivers of the Fitzroy Catchment. Rainfall at the head is the highest for the Fitzroy Catchment and also broad acre clearing is high.

Key Incentives for improved Practices

In recent years NHT funding for riparian and remnant fencing has helped to improve grazing management practices for these areas. There appears to be little regional variation in the take up of these practices across the Fitzroy.

17. What industry codes of practices and other voluntary measures have been developed that would influence water quality in the GBR lagoon? Are these effective in terms of their adoption rates and their contribution to improved water quality outcomes?

- The DCCA *Dawson Implementation of Strategies* **(Attached email)** documents the responses of industry, community and government to the identified issues in the Dawson Catchment.

- Cotton Industry Theodore Irrigation Area study into the containment of tail water runoff.

See Response to Question 15 above.

The Natural Heritage Trust projects and initiatives document the extensive success in achieving improved natural resource management and conditions. Please ensure you refer to these projects for further specific information. These report findings are filed at the Department of Natural Resources and Mines, Rockhampton C/- Catrina Gibson, Natural Heritage Trust, Ph: 07 4927 3079.

18. Are there policy options which should be given priority for analysis by the Commission? If so, why are the nominated policy options of particular interest?

The current development of regional resource management business plans will address the nrm issues identified in the regions. Targets, management options and monitoring changes in natural resource conditions underpin these plans. It would be preferable given the years of established planning and activities, and the enormous amount of research and combined effort going into these plans, that they be given consideration as voluntary measures to address issues.

Due credit should be given to groups and departments where initiatives and practices have been implemented based on voluntary participation with successful outcomes. The impact of policy should be investigated to ensure it will not deter from the enormous amount of effort already being expended to address nrm issues.

Given the large area of the Fitzroy Basin and the lack of information about the nature of sediment loads, their point source, movement characteristics and contribution from each industry and area, policy should not be implemented without firm and accurate information. Policy options should take into consideration these determined characteristics based on each catchment.

The Fitzroy is characteristically different from the smaller coastal catchments adjacent the GBR, policy options should give due consideration to this variation and not be blanketed to fit all where clearly it will have impact on the social and economic wellbeing of local industries.

It is difficult for regional communities to affiliate themselves and their activities to the coast and manage on the basis of minimizing impact to the GBR. A soft approach to improving industry practices with incentives is optimal.

Callide Valley Landcare Response: Question 18

Policy Options

- Should be based on Regional Resource Management Business Plans where available as these are based on years of observation and experience
- Studies in silt loads and their sources should be done to take into account our specific soil types and river styles to target priority catchments
- The adoption and development of Best Management Practices in Grain, Beef and Horticulture and other industries should be a part of the Policy.

19. To what extent will the assessment of policy options need to take into account of variations between and within catchments?

Note should be taken of the regional differences between the large, inland Fitzroy and Burdekin catchments and the coastal catchments.

There are also significant differences between the sub-catchments of the Fitzroy Basin including soil, vegetation, climate and river characteristic variations. Future developments such as the Nathan Dam and other new industries need to be considered, especially in the Dawson Catchment where developments like the weirs are already having impact on health status and the Dee River disproportionately impacting on water quality.

21. Could institutional arrangements for managing water quality in the GBR lagoon be improved? If so, how?

It is apparent that communication between existing arrangements needs improvement. Eg, The regions responsible for achieving commonwealth targets were not given the opportunity to input into the process or targets. The nature of the Fitzroy region (size and area under different industries), makes it different to the smaller coastal catchments. Land management on farm is not visibly, socially or locally connected to the coast or GBR. Therefore institutional arrangements for management the GBR should give consideration to the regions and have strong connections to local people managing natural resources (eg catchment and Landcare coordinators) to provide regional links and significance to implementation and with cooperation.

Institutional arrangements could be improved by the GBR identifying all the Natural Resource managers in the regions and establishing contact with local and grass roots organisations. These should include local Landcare Groups and Department of Natural Resources and Mines Centres which are the repositories of a great deal of historical and current Natural Resource Management information.

In due course, the DCCA would be the appropriate contact for the Dawson Catchment and to Landcare and land managers.

Dawson River

Catchment Strategy

Endorsed February 2000

OVERVIEW OF IMPLENTATION ON PRIORITY STRATEGIES 2001

Dawson Catchment Coordinating Association Incorporated

1. Water Quality

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Develop and implement action plans to achieve agreed water quality targets, with priority on areas contributing disproportionately to water quality problems. (High)	WREP (Water Resources Environmental Planning)	EPA	WREP – EPA
	WAMP (Water Allocation and Mgt Plan)	DNR&M	
	Rural Water Use Efficiency Initiative Grains & Cotton	DPI	
	Development of LWRRDC	CQU	LWRRDC
	Downstream effects of Landuse in the Fitzroy Basin	DNR&M, CQU, DPI, LC	NHT Project
	Dee River Research Project	Wowan Dululu Landcare	NHT Report
	Dee River Community Action & Development Program	Wowan Dululu Landcare	NHT Report
	Dee River Water Management Plan	Wowan Dululu Landcare	NHT Report
	Cleaning-up Acid Mine Drainage in the Dee River	Wowan Dululu Landcare	NHT Report
	Mount Morgan Rehabilitation Plan	DNR&M	Draft
	Cotton Best Management Practices	DV Cotton Growers	
	Theodore Irrigators Containment Strategy	DV Cotton Growers	DVIA Report
	Grains Best Management Practices	Agforce, Graingrowers	
	Riparian Zone Management	DCCA, FBA, Landcare	NHT Reports
	Community Education, Waterwatch, Sediment Watch, Water Quality Monitoring with Action Plans – Callide Water Forum Group, Landcare, Fish Stocking, Chemical Liaison, Catchment and other Groups for Water Quality	DCCA, FBA, Landcare, DNR&M, EPA, community	
B. Ensure that Water Entitlement holders have Land and Water Management Plans in accordance with the requirements of the Fitzroy Basin Water Allocation and Management Plan (WAMP) and current legislation, and link to Best Management Practices where relevant. (High)	Land & Water Management Plans	DNR&M	Bill Wilkinson
	Cotton Best Management Practices	DV Cotton Growers	
	Grains Best Management Practices	Agforce, Graingrowers	
	WAMP		
C. Implement industry based Best Management Practices where gaps exist. (High)	Cotton Best Management Practices	DV Cotton Growers	QCotton
	Grains Best Management Practices – Minimum till, Control Traffic Farming, laser contouring, conservation farming, Sustainable Farming Systems	Agforce, Graingrowers	
	Neighbourhood Catchments	DNR&M, FBA	Scott Stevens, FBA
	Brigalow Catchment Study	DNR&M	Bruce Cowie
D. Facilitate community involvement in Waterwatch and Sedimentwatch and integrate with Action Plans, Best Management Practices, and Grasscheck, especially where gaps exist. (Medium)	"Fitzroy Catchment Trailer"	FBA	
	Sediment Watch Project – targeting gaps	DNR&M, Community	NHT Report
	Waterwatch – targeting gaps	FBA, DCCA, Landcare	NHT Report
	Grasscheck – included with DCCA monitoring	DPI, Landcare	
	Baralaba Recreation & Fish Stocking Group – Action Plan	With DNR&M	Action Plan
E. Maintain Environmental Management Overview Strategy for mines and make available to community essential information on water quality impacts. (Medium)	Cracow Mine, Moura Mine - Environmental Management Overview Strategy	Cracow Joint Venture	Klondyke EMOS
	Mt Morgan Mine Rehabilitation Plan	DNR&M	

2. Water Allocation, Equity and Use

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Develop and implement mechanisms for on-going community involvement and opportunity for input into water management issues that are of concern. (High)	Land & Water Management Plans Callide-Kroombit Catchment Project Callide/Kroombit Groundwater Initiative	DNR&M Callide Valley Landcare Callide Valley Landcare	
B. Develop and implement range of mechanisms and action plans to achieve a high quality groundwater resource and related resources (land, vegetation) in the Callide Valley taking a whole of catchment and whole of community approach. (High)	DNR&M poly of water harvesting thresholds WAMP and ROMP Water Act 2000 Land & Water Management Plans Fitzroy Food and Fibre Biloela Basin Water Forum Group – Action Plan Callide Valley Landcare – Action Plan Callide-Kroombit Catchment Project Callide/Kroombit Groundwater Initiative	DNR&M DNR&M DNR&M Callide Valley Landcare Callide Valley Landcare Callide Valley Landcare	
C. Coordinate the delivery of knowledge in relation to on-farm water management in terms of Land and Water Management Plans and research, development and extension of water use efficiency technologies and cropping alternatives. (High)	Land and Water Management Plans Rural Water Use Efficiency Program Conservative Farming and Grazing Systems Industry BMP	DNR&M DPI Industry Industry	
D. Refer to: Issue 1. Water Quality, Strategy B (Medium)	Fitzroy Basin Water Allocation & Management Planning	DRN&M	WAMP Fitzroy Basin WAMP Technical Reports

3. Land Use and Management

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Develop and implement mechanisms to overcome barriers to the adoption of proven land management practices and systems that improve both economic viability and land sustainability. (High)	Central Region Strategic Plan CQSS CQ-A New Millennium project CHRUPP Neighbourhood Catchments Rural Property Designs Land and Water Management Plans Environmental Management Systems Property Management Planning Best Management Practices Theodore District Chemical Liaison Group Actions Landcare Projects & Movement	DNR&M FBA CQ-ROC CSIRO DNR&M, FBA Rural Property Design DNR&M DNR&M, DPI, DNR&M, DPI, Futureprofit Industry – Cotton, grains All community sectors Landcare	
B. Explore opportunities to improve catchment management via Local Government Planning Schemes and Environmental Systems checklist. (High)	DCCA Liaising with Council RE: Local Government Planning Schemes	DCCA, Local Council	
C. Collate and make available current knowledge on dryland salinity risk and develop coordinated on-ground measures to control. (High)	Salinity Hazard Mapping, Fitzroy Basin Individual Site Inspections Preventative Measures through planning & BMP Salinity Information Project Brigalow Research Station Project National Action Plan for Salinity & Water Quality – science & targets	DNR&M DNR&M, FBA, Landcare DNR&M, Landcare, Industry Theodore Landcare DNR&M DNR&M	
D. Ensure community involvement in the development of Environmental Management Overview Strategy agreements for mine sites. (Low)	Consultation with community sectors by Mines	Cracow Joint Venture	
F. Determine extent and risks of contaminated lands and rail corridors and take appropriate action to limit risks. (Low)	Site contamination investigation Environmental Assessment Health and Environmental Risk Assessment	Qld Dept Main Roads Qld Dept Main Roads Qld Dept Main Roads	

4. Habitat and Riparian Zone Management

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Identify landholder management issues and explore range of management options to achieve more effective outcome in the context of catchment wide information on regional ecosystem types etc. (High)	Land for Wildlife Projects	EPA	
	Dawson River and Riparian Zone Management Project	DCCA, Landcare	NHT Reports
	Greening Australia Projects	Greening Australia	
	Flora and Fauna Surveys	CQU	
	Native Seed Bank Database for Central Queensland	Duaringa Shire Council	
	Community participation in Rehabilitation & restoration	Landcare & Council	
	Habitat Protection Bridal Nailtail Wallaby	Landcare & Council	
	Native Ecosystem Regeneration	DCCA, community	NHT Reports
	Dawson Fish Habitat Project – education & awareness	Callide Valley Landcare	
	Callide-Kroombit Catchment Project	Mimosa Landcare	
	Vegetation Management Mimosa Creek Catchment		
	Voluntary Nature Conservation Agreements		
	Landcare Projects & Awareness		
	See Land Management Strategies & Projects		
B. Develop the most appropriate means of community involvement in the implementation of a scientifically rigorous research and monitoring program for the Fitzroy Basin Water Allocation Management Plan, particularly how it relates to broader catchment management. (High)	Steering Committee – WAMP	DNR&M	
	Fitzroy Food & Fibre		
	Vegetation & Water Quality Monitoring	DCCA, FBA, DNR&M, Landcare	
C. Consider fire management issues in conjunction with Strategy 4A (above). (Medium)	Fuel Management in National Parks	QPWS	
	Fire permits		
D. Identify opportunities for improvements in current infrastructure construction and maintenance practices in Dawson River catchment, including strategically fixing problem spots and potential for coordination of infrastructure development. (Medium)	Impact Assessment Studies		
	Local Government practices to limit disturbance	Council	
	Improved construction techniques	Council, Main Roads	
E. Monitor effectiveness of Management Plans and explore options for community involvement in Park Management. (Low)	National Park Management Plans	QPWS	

5. Fisheries Management

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Use Dawson native fisheries as an avenue for improving broad scale catchment management practices and link with other projects and action plans to improve catchment wide fish habitat management. (High)	A catchment approach to fish passages	QDPI	
	Dawson River Operations Management Plan	DNR&M	
	Dawson Fish Habitat Project – Education & awareness	DCCA, DPI, community	
	Fish stocking groups		
	Dawson Fish Taggers Group – Action Plan	Community, DCCA, DPI	
	Queensland Fisheries Management Authority regulation	QDPI	
	Exotic Fish Road Signs	Glebe Weir Fish Stocking	NHT Reporting
	A Century in the Life of the Dawson River Waters	DCCA	
B. Determine extent of fish habitat change, identify critical fish nursery areas, and increase knowledge fish migration behavior in the Dawson. (High)	Dawson Fish Habitat Project	DCCA, Community	NHT Reports
	Water Resources Environmental Planning	EPA	
	DCCA Strategy Implementation project	DCCA	NHT Reports
	Fish Stocking Groups	Community, DPI	NHT Reports
	Dawson Fish Taggers	DCCA, DPI	NHT Reports
	A Century in the Life of the Dawson River Waters	DCCA	Sandy McCubbin
	Dawson Water Quality Forum		Proceedings
	Downstream effects of Land use in Fitzroy Basin	DNR&M	NHT Reports
	Dawson Fish Trailer		
C. Provide Dawson fisheries information to influence decision making on Dawson River Operations Management Plan, construction of cost effective fish passage on Baralaba Weir, riparian zone and floodplain management, and industry Best Management Practices. (High)	Dawson Fish Habitat Project	DCCA, DPI	NHT Reports
	Dawson Catchment Information Network	DCCA	Dawsoninfo.org
	A Century in the Life of the Dawson River Waters	DCCA	Sandy McCubbin
	Dawson Remnant and Riparian Zone Management	DCCA	NHT Reports
	Industry BMP – Cotton, Grains, Grazing	Industry	
	Dawson Water Quality Forums	DCCA	Proceedings
D. Provide alternative access to weirs for recreational fishers especially for fishing during critical migration periods. (Medium)	Queensland Fisheries Management Authority	DPI	
E. Identify potential sources of exotic fish species and implement public awareness campaign on threats of translocation of exotic fish species into the Fitzroy Basin. (Medium)	Exotic Fish Road Signs – Glebe Weir Fish Stocking	Fish Stocking Group	NHT Reports
	Dawson Fish Habitat – Education & Awareness	DCCA	NHT Reports
	A Century in the Life of the Dawson River Waters	DCCA	
	Dawson Fish Trailer	DCCA	

6. Forestry Management

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Balance controls on forestry management on leasehold and freehold, public and private land with incentives for sustainable management. (High)	EPA management responsibilities Review Cypress Pine Management on Leasehold Code of Practices for Cypress Pine Code of Practices for Native Timber Forest Production Western Hardwood Resource Review SE Qld Forest Agreement Area & other Regional Arrangements Grazing leases Dawson Agroforestry Group – range activities	EPA EPA, DPI EPA, DPI EPA, DPI SEQ RFA EPA, Landholders DAG, Landholders, Community	
B. Develop more effective partnerships for the multiple use of forests taking into consideration the economic and social benefits to the community of non-forestry industries. (High)	Dawson Agroforestry Group – plots, research, waste product utilization, National Training Program (High Schools, Woorabinda and Community Group placed trainees) EPA custodians of Forestry areas – arrangements with DPI and landholders. Multi use forests – recreation, grazing, timber, etc.	Dawson Agroforestry EPA, DPI, Landholders EPA, DPI, Landholders	
C. Identify and better manage conflicts where different land uses or land tenures adjoin State Forests. (Medium)	EPA liaison with interest groups. Codes of Practice Forest Agreement Areas		
D. Develop Agroforestry industry in the Dawson River catchment through a cautious program of research and development and feasibility studies. (Medium)	Dawson Agroforestry Group – trail plots, research, National Training Program (High School, Woorabinda, Community Group Traineeships throughout Dawson), utilizing waste products and effluent water for forest production, Landholder Agroforestry development.	Dawson Agroforestry, Community	
E. Develop Regional Forest Agreements to cover rest of forests in the Dawson River Catchment with community involvement. (Medium)	Western Hardwood Resource Review Will lead to further Regional Forest Arrangements		
F. Identify and trial potential cost-benefits of linking Agroforestry with range of objectives including controlling land, water, and vegetation degradation, carbon credits, and timber production. (Medium)	Dawson Agroforestry Group – trail plots, research, National Training Program (High School, Woorabinda, Community Group Traineeships throughout Dawson), utilizing industry waste products and effluent water for forest production, Landholder Agroforestry development. Research – land management & carbon sequestration	Dawson Agroforestry	

7. Pest Management

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Collate relevant literature and community knowledge on pests in the Dawson catchment and put in place processes to coordinate activities and increase and make better use of resources across jurisdictional and individual responsibilities. (High)	National Weeds Strategy; National Weeds Program	CPMG, DNR&M	NHT Report
	Capricorn Pest Management Group – Strategy	CPMG, Local Council	Strategy
	Local Government Pest Management Plans	Local Council	PMP
	Landcare Group – Awareness & management	Landcare	
	Green Corp & SWEEP crews		
	Neighbourhood Catchments	FBA, DNR&M,	NHT Reports
	Riparian & Remnant Riparian Zone Management	DCCA	NHT Reports
	BMP Manuals	CPMG, DNR&M, PAG	
	Conservative Sustainable Grazing Systems	Landcare, DNR&M, DPI	
	Industry Codes of Practice	Industry	
	Property Pest Management Plans	DNR&M, Futureprofit	
	Parthenium Action Group	PAG	
	Pest Facts and Pest Info	DNR&M	
B. Ensure the "causes" of weed and animal pest problems are being addressed in addition to being strategic about the use of resources for control and eradication. (High)	National Weeds Strategy; National Weeds Program	CPMG, DNR&M	NHT Report
	Capricorn Pest Management Group – Strategy	CPMG, Local Council	Strategy
	Local Government Pest Management Plans	Local Council	PMP
	Landcare Group – Awareness & management	Landcare	
	Green Corp & SWEEP crews		
	Neighbourhood Catchments	FBA, DNR&M,	NHT Reports
	Riparian & Remnant Riparian Zone Management	DCCA	NHT Reports
	BMP Manuals	CPMG, DNR&M, PAG	
	Conservative Sustainable Grazing Systems	Landcare, DNR&M, DPI	
	Industry Codes of Practice	Industry	
	Property Pest Management Plans	DNR&M, Futureprofit	
	Parthenium Action Group	PAG	
	Pest Facts and Pest Info	DNR&M	
C. Maintain public and industry awareness of movement vectors of pests, especially Parthenium, and seek out partnerships with industry in doing so. (High)	As above		
	Vendor Declarations	DNR&M	
	PAG		
	Site inspections, spraying roadsides, (Council and Landcare), wash down bays.	Council, Landcare, PAG	
D. Maintain weed pest awareness activities and expand into environmental weeds and potential weed pests from gardening and agricultural grazing. (Medium)	As Above		
	Landcare Field Days, awareness & education		
	Weed busters Week		

8. Rural Enterprise Viability

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Maintain Futureprofit and other training programs at limited cost and continue to adapt on a needs basis. (High)	Futureprofit	Futureprofit, DPI	
	Aussie GRASS Project	DPI	
	Sustainable Farming Systems	DNR&M, Landcare	
	Queensland Rural Adjustment Authority		
	Landcare Extension & Activities	Landcare	
	Neighbourhood Catchments	DNR&M, FBA	
	Grazing Management Systems	Landcare, DPI, DNR&M	
	Dawson Water Quality Forum	DCCA	
B. Provide a concise information package on Futureprofit, Queensland Rural Adjustment Authority and other programs so rural enterprises can target the program that meets their needs. (Medium)	Futureprofit	DPI	
	Queensland Rural Adjustment Authority		
	Neighbourhood Catchments	DNR&M, FBA	
	Landcare Extension	Landcare	
	Rural Water Use Efficiency Program	DPI	
	Farming Systems Institute Strategic Plan	DPI	
C. Identify and promote success stories of how rural enterprises manage industry changes. (Medium)	Landcare Extension		
	Neighbourhood Catchments		
	Healthy Waterways Program		
	Dawson Water Quality Forum		
D. Develop and implement mechanisms to ensure Queensland Rural Adjustment Authority financial assistance leads to sustainable rural enterprises in terms of economic viability and natural resource management, with consider given to the status of rural enterprises within growing districts. (Medium)			
E. Develop community natural resource management policy document addressing range of issues (regulation, codes of practice, financial practices, etc) for negotiation with institutions (Government, financial, research) that impact on rural enterprise viability. (Low)			

9. Social and Economic Development

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Develop and implement mechanisms to assist people experiencing industry change to identify alternative economic opportunities within the catchment. (High)	CQ – A New Millennium Surat Basin/Dawson Valley Economic & Infrastructure Study Dawson Valley Strategic Plan Networking the Nation	CQ ROC CQ ANM DVDA	
B. Complete Supporting Infrastructure Planning Project as a priority in conjunction with Surat/Dawson Private Infrastructure Development Project investigations. (High)	CQ – A New Millennium Surat Basin/Dawson Valley Economic & Infrastructure Study Dawson Valley Strategic Plan WAMP	CQ ROC CQ ANM DVDA	
C. Through the development of State of Region Reporting incorporate information relating to the economic and social services provided by environmental "infrastructure" to the community. (Medium)			
D. Adequately resource community based organisations and identify opportunities to create more effective partnerships in the management of social and economic change. (Medium)	NHT projects for NRM National Action Plan for Salinity and Water Quality DCCA – Action Planning with community groups		
E. Undertake consultation process with Murri groups to identify issues and opportunities for involvement in broader catchment management and social and economic planning. (Medium)	Dawson Agroforestry Group – Woorabinda Traineeships & plots Neighbourhood Catchments	Dawson Agroforestry FBA	

10. Information, Research and Extension

Strategy Implementation Overview

Strategy	Project/ Action Plan/ Activity	Lead Groups	References
A. Implement Integrated Information Management System for Catchment Managers as a collaborative joint venture and in the context of information and extension services already present. (High)	Dawson Fish Habitat Project – Education & Awareness	DCCA	NHT Reports
	Dawson Catchment Information Network – with Landcare web pages	DCCA	Dawsoninfo.org
	Dawson River Catchment Strategy Accelerated Implementation Project – On-ground change and information exchange.	DCCA	NHT Reports
	Around the Ridges Newsletter	DCCA	
	Landcare Extension	Landcare	NHT Reports
	Networking the Nation Project		
	Dawson Sharing the Workload Group	DCCA, Landcare, Govt	
	Dawson Catchment Water Quality Forum	DCCA	Proceedings
	Dawson Catchment NRM Strategy & regional Plan	DCCA	Strategy
B. Reduce duplication and make most effective use of human resources by coordinating activities and sharing information across Dawson River catchment. (High)	Dawson River Catchment Strategy Accelerated Implementation Project – On-ground change and information exchange.	DCCA	NHT Reports
	Dawson River Catchment: Targeting Sustainability through community participation, coordination & integration.	DCCA	NHT Reports
	Dawson Catchment NRM Plan	DCCA	Strategy
	Dawson Water Quality Monitoring Framework	DCCA, Chem Liaison	
	DNR&M Regional Strategic Plan	DNR&M	
C. Reduce institutional and financial barriers to information access with priority on community access to Geographic Information Systems information. (High)	Dawson Catchment Information Network	DCCA	Dawsoninfo.org
	Round the Ridges Newsletter	DCCA	
	Dawson Sharing the Workload Group		
	CQ Geographic Information System Users Group		
	CQ Regional Information System	FBA, CQANM, govt	
D. Fill knowledge gaps identified throughout the *Dawson River Catchment Strategy* (refer Adequate Information column) that are inhibiting action on issues. (Medium)	Dawson Catchment Information Network	DCCA	Dawsoninfo.org
	Sharing the Workload		
	Sustainable Farming Systems	Landcare, DNR&M	
	Neighbourhood Catchments – extension services	DNR&M, FBA	
	Dawson River Catchment Strategy Accelerated Implementation Project – On-ground change and information exchange.	DCCA	NHT Reports
	Dawson River Catchment: Targeting Sustainability through community participation, coordination & integration. – Action Planning	DCCA	NHT Reports
	Around the Ridges Newsletter	DCCA	NHT Reports
	Landcare Extension	Landcare	NHT Reports
	CQ Regional Information System	FBA, CQANM	
	Networking the Nation Project		
	Dawson Sharing the Workload Group		
	Dawson Catchment Water Quality Forum	DCCA	Proceedings
	Dawson Catchment NRM Strategy & regional Plan	DCCA	NHT Reports
E. Develop and implement mechanisms to reduce information collation and coordination problems caused by jurisdictional boundaries. (Medium)	Dawson River Catchment Strategy Accelerated Implementation Project – On-ground change and information exchange.	DCCA	NHT Reports
	Dawson River Catchment: Targeting Sustainability through community participation, coordination & integration.	DCCA	NHT Reports
	Around the Ridges Newsletter	DCCA	
	Landcare Extension	Landcare	NHT Reports
	Networking the Nation Project		
	CQ Regional Information System	FBA, CQANM	
	Dawson Sharing the Workload Group		
	Dawson Catchment Water Quality Forum	DCCA	
	Dawson Catchment NRM Strategy & regional Plan	DCCA	NHT Reports
	Information Database – DNR&M	DNR&M	

Impacts of stock on water quality

The impact of stock on water quality

Livestock grazing can affect both the shape and quality of the water column. Changes in water quality associated with uncontrolled access by stock include:

- Increased water temperatures and light through loss of shade;
- An increase in sediments and nutrients resulting from erosion and from the loss of the filtering capacity of the vegetation;
- Increased bacterial counts from faecal contamination;
- Increased sediments entering streams as upland and riparian areas subjected to erosion caused by stock;
- Increased water turbidity, which affects the habitat of aquatic plants and animals;
- Increased input to streams of contaminants flowing down tracks created by stock;
- Increased input of phosphorus and nitrogen form stock urine and faeces.

Livestock wastes may contaminate streams, while the faecal organisms contained in the waste can lead to health problems for humans. Streams contaminated with faecal material can be the source of a range of diseases, such as giardiasis, salmonellosis, gastroenteritis, typhoid fever, hepatitis A, amebiasis and viral gastroenteritis. The use of riparian buffers and the exclusion of stock from the riparian zone can reduce faecal inputs by up to 90%.

Stock not only affect water quality but are also affected by it. Work in Canada has demonstrated that gains in stock performance of up to 25% can be achieved through the provision of managed watering systems such as troughs. In Australia, this may have important implications for streams which have reduced seasonal flows and which are freely accessed by stock. Lovett & Price (eds) 1999:A140

Unlimited access of stock to streams can cause increased erosion and declines in water quality in rivers and wetlands. (Fairweather & Napier 1998:43)

The loss of vegetation cover from land due to clearing for agricultural and grazing purposes can have adverse impacts on nearby waterways. Water and wind erosion of exposed soils can add significantly to the sediment load of surface waters, leading to changes in the diversity, distribution and abundance of native plants and animals. Increases in runoff volume and flow rates through vegetation loss can cause hydrological changes that can lead to additional erosion of river and stream banks and beds. (Environmental Protection Agency 1999:4.12)

Farmers can help improve the state of their natural watercourses and the health of their stock by restricting animals' direct access to natural water sources.

Evidence shows allowing stock direct access to watercourses causes considerable damage to the surrounding environment and water quality. The damage is caused by direct trampling of the stream bank and contamination of the water and banks with manure and urine. This results in bank erosion, stream sedimentation and water pollution. For these reasons, which are important to landholders and towns downstream, it is best to control direct access by stock to creeks, rivers and lakes.

Animal manure deposited directly in the stream or on the bank increases the water nutrient load, causing toxic algal blooms and may spread bacteria which can have a harmful effect on animal health.

(Land and Water Resources – Research and Development Corporation, June 1996)

The natural consequences of watering points
The natural consequences of watering points are the excessive grazing of vegetation in the immediate vicinity, and excessive disturbance of the soil caused by cattle trailing in and out for water or camping nearby.

The disturbance is accentuated by drought conditions, so that the country surrounding permanent watering points such as bores and dams is more exposed to serious damage than that around surface water supplies. Consequently it is expected that watering points must be surrounded by a sacrifice area.

Badly eroded and extensive sacrifice areas do occur on those soils which are highly susceptible to erosion. This causes a serious shortage of feed for 1-2 km around the watering point. Sometimes it causes standing of silting up of the facilities around the bore.

If the watering point is a surface tank or dam, erosion of the surrounding area can result in the tank being quickly rendered unless by siltation.

Whether a watering point will develop a sacrifice area will depend on the susceptibility of the soil to wind or water erosion, and the degree of protection which may be afforded by tree cover. For this reason it is desirable to locate watering points, other things being equal, in suitable situations.

Water supply options
After deciding to fence off a natural water source, there are four basic options available.

1. Limited access to the bank at designated points.
2. Carting water to stock from another source.
3. Piping water from an existing supply.
4. Pumping water from the water source into tanks or dams.

The decision of which method to use depends on a wide range of factors, such as the number of stock requiring water, the remoteness of the location and the available funds.

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Fairweather, P.G. & Napier, G.M. 1998, *Environmental indicators for national state of the environment reporting – Inland waters*, Department of the Environment, Canberra.

Environmental Protection Agency. 1999, State Of The Environment Queensland 1999, Environmental Protection Agency, Brisbane.

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Best Management Practice Booklet

General

Agricultural activities, whether grazing, cropping or more intensive activities, can adversely affect inland waters in two major ways: increasing erosion and sedimentation and introducing agricultural chemicals into the water body. Soil erosion products and the pollutants they might contain can alter the quality of water. Intensive grazing can destroy riparian vegetation that provides a natural filtering and trapping mechanism for sediments and associated contaminants. The removal of riparian vegetation also reduces shading of streams, leading to increased sunlight for macrophyte growth. (Environmental Protection Agency 1999:4.12)

Grazing management appeared to influence the extent of riparian vegetation disturbance. (Environmental Protection Agency 1999:4.18)

Introduced grazing animals eat and trample vegetation and degrade soil structure, leading to changes in vegetation cover. Through the removal and trampling of vegetation, grazing can lead to alteration and degradation of habitat for ground-dwelling animals. (Environmental Protection Agency 1999:7.22)

RIPARIAN VEGETATION

Riparian land is important because it is usually the most fertile and productive part of the landscape, in terms of both primary production and ecosystems. It often has better quality soils than the surrounding hill slopes and, because of its position lower in the landscape, often retains moisture over a longer period.

Riparian land often supports a higher diversity of plants and animals than does non-riparian land. This is a result of its wide range of habitats and food types, its proximity to water, its microclimate and its ability to provide refuge. Many native plants are found only, or primarily, in riparian areas, and these areas are also essential to many animals for all or part of their lifecycle. Riparian land provides a refuge for native plants and animals in times of stress, such as drought or fire.

From an aquatic perspective, vegetation on riparian land regulates in-stream primary production through shading; supplies energy and nutrients (in the form of litter, fruits, terrestrial arthropods and other organic matter) essential to aquatic organisms; and provides essential aquatic habitat by way of large woody debris.

In addition to being productive, riparian land is often vulnerable part of the landscape – being at risk of damage from cultivation and from natural events such as floods.

The combination of productivity and vulnerability means that careful management of riparian lands is a vital for conservation of both Australia's unique biodiversity and economic productivity. Lovett & Price (eds) 1999:A3

Riparian ecosystems fringing watercourses are important energy and nutrient sources for stream ecosystems. They provide food, habitat and shade for both terrestrial and aquatic organisms. They are important for stream bank stability, guarding against excessive erosion and protecting water bodies from pollutants travelling overland in runoff. Riparian zones provide refuge for plants and animals in times of environmental stress. They are important wildlife corridors. (Environmental Protection Agency 1999:7.42)

Degraded riparian zones have led to extensive weed invasions. (Environmental Protection Agency 1999:7.42)

Characteristics of riparian vegetation
- Flora diversity
- Nutrient enrichment
- Water and moisture
- Food and productivity
- Shade and shelter. Lovett & Price (eds) 1999:A98

The contribution of healthy, natural riparian vegetation
- Biological diversity
- Water quality
- Bank stability
- Food supply
- Climate moderation
- Farm productivity. Lovett & Price (eds) 1999:A100

REMNANT VEGETATION

A common definition of remnant vegetation is "native vegetation occurring within fragmented landscapes", with the ultimate remnant described as an individual tree. [LWRRDC (1999b), *Exploring the Future Requirements for Managing Australia's Remnant Vegetation*. Occasional paper 02/99. Land and Water Resources Research and Development Corporation, Canberra.] Remnants are mostly associated with patches of woodland of limited size, but they can also include other native ecosystems such as grasslands and wetlands. These patches of vegetation are surrounded by crops or sown pastures and are often viewed as relatively discrete and readily definable. (Williams 2000:14)

Another way of viewing remnant vegetation is as a product of existing land uses and management practices. This view places remnant vegetation in a historical and economic context. In many cases, it is useful to recall that a remnant exists only because of decisions made by the landholder. Often remnants occur on land that is unproductive for agriculture or is held by a landholder with a strong commitment to conservation. Indeed remnant vegetation might be thought of as a stand of native vegetation that reflects current past management practices and opportunities. For this reason, good quality remnants are often associated with capable and sympathetic landholders. This is an important factor for developing policies for engaging landholders in the conservation and management of remnant vegetation. (Williams 2000:15)

Are small patches of native vegetation worth the effort?

Research supports the common belief that all native vegetation has some value. Landholders should not underestimate (and there is evidence that they do) the value of fencing and careful management of small remnants. We know that even small remnants can provide the base for revegetation: information of species composition and a seed supply for restoration work. They may also be of a significant vegetation type, or serve aesthetic or spiritual needs. Even individual trees provide habitat or resources for some fauna (Mortlock & Williams 2002).

It is clear from the research that 'what we're got is all we've got'. Once the original vegetation disappears form a site, then it is very difficult to create the same system. Active management at the site, region and landscape scale may be required for many remnants to remain viable (Mortlock & Williams 2002).

Australians strongly identify with the bush, but many parts of the rural landscape will lose their native vegetation if better management approaches are not developed and adopted. Native vegetation provides many benefits and services to agriculture, helps maintain the health of the country's land and water, and provides a home for Australia's unique biodiversity. Given the integral role of native vegetation in sustainable land management, it is important to understand the ecological, social and economic factors that affect the conservation and management of this increasingly scare resource. (Williams 2000:P13)

The major goal of the Program is to assist government agencies, community groups and landholders to better manage and protect remnant native vegetation, through the application of improved knowledge and understanding gained from research, with a strong emphasis on practical outcomes (Williams 2000:13).

Retention of rnv can be regarded as a duty of care. (Lockwood, Walpole & Miles 2000:52)

Vegetation degradation/threats

The societal processes that threaten remnant vegetation require as much attention as the ecological threats. For example, remnants can be placed at great risk from land-use change when markets shift, new technologies emerge or land ownership changes and new economic opportunities are revealed. Williams 2000:21

The broad-scale clearing of native vegetation and its replacement with shallow-rooted crops and pastures has contributed significantly to rising water tables, mobilization of salt, and other hydrological changes. Thus, vegetation clearance has led to landscape salinisation, increased sediment, nutrient and salt loads in rivers and streams, loss of habitat and a decline in biodiversity. The associated costs have been substantial for agricultural production, infrastructure, local communities and the environment. Consequently, a number of ecological and societal processes threaten the native vegetation remaining in highly cleared rural landscapes. Multiple threats can occur at the one site, making management even more complex. (Williams 2000:21)

ECOLOGICAL

Current ecological processes threatening remnant vegetation in rural areas of Australia

- Continued vegetation clearance and fragmentation
- 'Tidying up'
- Poorly managed grazing
- Dieback
- Lack of regeneration, especially of trees
- Invasive plants and animals, resulting in predation, competition and habitat loss
- Altered disturbance regimes including the frequency, intensity, season and type (e.g. fire, floods, grazing by native animals)
- Disease e.g. Mundulla yellow, Phytophthora
- Salinity
- Waterlogging
- Climate change
- Movement of nutrients, water and energy from adjacent lands to the bush
- Disruption of food webs (loss of native predators)
- Rubbish dumping
- Firewood collection – a more detailed example of a threatening process. Williams 2000:23

Degradation of riparian land

Because riparian land is a particularly dynamic part of the landscape, it can change markedly – even under natural conditions. Fires, unusually severe frosts, cyclones, and

major floods, can all have huge impacts on riparian land and result in major changes to channel position, shape and surrounding vegetation. Lovett & Price (eds) 1999:A4

SOCIAL/HUMAN

Current societal processes threatening remnant vegetation in rural areas of Australia

- Limited financial and human resources for the scale of the task
- Lack of management experience and confidence
- Information delivery of limited effectiveness, little person-to-person communication or interpretation
- Lack of institutional reform and political will to tackle the issues over the required time scale
- Pressure on landholders to maximize production and recognize returns. (Williams 2000:23)

Grazing

Riparian land is typically more fertile and more moist than adjacent lands and consequently supports higher quality and more diverse forage than does upland areas. In the hotter seasons, stock are attracted to cooler microclimates and may spend extended periods loafing in the shade or standing in the water. It is the combination of microclimate, forage, shelter and moisture that makes riparian land an area favoured by stock.

Overgrazing of riparian land generally results from unrestricted access by stock, usually arising from lack of, or damaged, fencing. When stock graze they preferentially select the more palatable species, either removing them from a site or reducing them to compact, low tussocks, coppices or rosettes. This prevents particular species from developing into fully grown trees, shrubs or tussocks and reduces the structural diversity of the site. Loss of species and absence of structural diversity within natural riparian vegetation leads to a loss of biodiversity, increased potential for weed invasion, and loss of habitat and wildlife values.

Trampling of riparian land during prolonged access by livestock results in soil compaction and physical damage to plants. Ground cover species, such as herbs, tufted grasses and tussock species, which slow overland flow and trap sediments, can all be damaged through trampling and excessive grazing. Soil compaction reduces the macrospore space in soil, reducing infiltration, root growth and overall plant production. The presence of a range of different plants influences the nature of the root zone and the depths to which roots penetrate. This in turn influences nutrient cycling and uptake, soil aeration, soil structure and levels of microbial activity.

Overgrazing by livestock opens up patches of bare soil which can then erode. Stock movement along the water edge disturbs and pugs the soil at the toe of the bank, making it prone to being washed away when rain increases the stream flow. The disturbance created by livestock through grazing of plants and opening up of bare ground, together with increased nutrient levels from animal faeces and urine, creates an ideal situation for the establishment of weeds. Weeds may also be spread directly by the animals, either through attachment to hair or skin through their faeces. Damaging weeds can spread from riparian lands onto adjacent farmland. Lovett & Price (eds) 1999:A110

The impact of stock on vegetation

Livestock have a variety of impacts on vegetation. The most obvious impact is associated with the direct grazing of ground covers and shrubs. Undisturbed vegetation often contains a diverse range of species, including trees and shrubs of various ages, height and form, as well as ground covers (including grasses, sedges and herbs). This contributes not only to the site's biodiversity but also to its structural diversity. When stock graze they preferentially select the more palatable species, either removing them from a site or reducing them to compact, low tussocks, coppices or rosettes.

Trampling by stock damages the vegetation and leads to soil compaction. The loss of ground covers leads to an increase in the amount of bare ground and a consequent increase in erosion and runoff of sediments and nutrients. Soil compaction reduces the

macropore space in soil and this reduces infiltration, root growth and overall plant production. The presence of a range of different plants influences the nature of the root zone and the depths to which roots penetrate and this, in turn, affects the water table in stream banks. Plant diversity influences nutrient cycling and uptake, soil aeration, soil structure and levels of microbial activity.

The response of vegetation to grazing is likely to vary according to the length of the growing season. For example, in warm climates with long growing seasons the amount of foliage may actually increase despite grazing, whereas in cooler, temperate climates, which have shorter growing seasons, it may decrease. Plants with different life forms respond to grazing in different ways. Grazing may favour sedges and grasses (which are able to survive, albeit with reduced vigour) over other life forms.

Shrub and tree species may be unaffected in the short term but damaged over time. The absence of a tree or shrub canopy may then favour the development or expansion of ground covers which further restrict germination of woody species. The loss of important species or functional groups affects the diversity at a particular site and can thereby result in changes in microclimate, nutrient cycling and soil structure. These changes can lead to disruption of ecosystem function and degeneration of the system which cannot be easily reversed.

Over time, heavy grazing can result in the development of even-aged stands of vegetation or a reduction in species diversity, or both. Overgrazing restricts the recruitment of most riparian plants, particularly that of overstorey plants, and so prevents the replacement of plants as they mature and senesce. This occurs because new seedlings are grazed or because trampling leads to changes in the soil structure which prevent germination. Species composition may shift, changing the patterns of dominance to favour species which can tolerate grazing. The lack of regeneration of tree and shrub species may result in a reduction in canopy cover and, consequently, an increase in the levels of light and temperature reaching streams.

In combination with fire, grazing can further restrict native perennial species and promote the establishment of ruderal species, which in turn prevent fire.

Livestock can also promote invasion of weeds (usually annual, ruderal species), which can bring about changes in vegetation structure. The creation of open sites by grazing or trampling provides a perfect opportunity for weed species to become established. Weeds are also spread by the movement of stock (in their faeces or by attachment to the animal). Stock faeces and urine also contribute nutrients to the soil, which further encourages the growth and spread of weeds. Lovett & Price (eds) 1999:A140

Degradation of riparian land

Human impact since European settlement has resulted in widespread and large-scale degradation of these vulnerable areas. In southern Australia this degradation has resulted largely from the wide-scale removal of riparian vegetation, whereas in northern Australia the cane and beef industries and feral animals and plants have had a major impact on riparian areas. A:4

Some impacts of human activity on riparian land: Summary

- Human use of riparian land can often lead to such land becoming degraded; grazing, in particular, can cause problems.
- When allowed uncontrolled access to riparian land, stock can contribute to the degradation of riparian vegetation by grazing and trampling as well as to consequent increases in rates of erosion, to changes in floral communities by way of preferential grazing and the differing responses of species to grazing, to invasion by exotic weeds, to increased stream turbidity, and to increased input of nutrients and bacteria into the stream. Such disturbance of the stream can have deleterious effects on aquatic ecosystems and downstream users.
- Control of stock access to riparian land, by means of fences, can allow riparian vegetation and riparian habitats to recover, although a return to pre-disturbance

conditions does not always occur. The process of regeneration depends on past and current land use, availability of propagules, and the composition and regeneration characteristics of the vegetation.
- Human-induced changes in fire regimes can have major impacts on the health of riparian vegetation. Lovett & Price (eds) 1999:A137

The impact of stock on stream-bank stability

The degree to which stock contribute to stream-bank erosion and soil degradation depends on:
- Soil type;
- Soil moisture content;
- Size of stream;
- Regional climate;
- Intensity and duration of grazing;
- Type of stock;
- Grazing history;
- Condition and type of vegetation.

Grazing by stock removes or inhibits vegetation which helps bind the stream-bank soils. Trampling opens up bare ground, creating focal points for erosion. Stock create tracks through riparian vegetation and these become pathways for sediments and nutrients to enter stream banks. Tracks created along the edges of stream banks crack, and may eventually slump into the stream.

The impact of stock is greatest when soil moisture levels are greater than 10%. At such moisture levels, any reduction in stock numbers is likely to have little effect. Fewer stock will mean that damage to localized sections of the stream bank is limited, but it will still occur. Grazed stream banks may erode three to six times faster than ungrazed stream banks. This erosion originates from ramps cattle create in accessing streams and can result in losses of about 40 m3 a year.

Stream size has an important bearing on the degree to which stock affect stream banks. Stock have a greater impact on small streams than they do on large streams. Small streams have low stream banks and shallower water, allowing easier stock access at many points. Larger streams have steeper banks, which limit stock access. Here, much of the erosion occurs as undercutting. A:140

The impact of stock on water quality

Livestock grazing can affect both the shape and quality of the water column. Changes in water quality associated with uncontrolled access by stock include:
- Increased water temperatures and light through loss of shade;
- An increase in sediments and nutrients resulting from erosion and from the loss of the filtering capacity of the vegetation;
- Increased bacterial counts from faecal contamination;
- Increased sediments entering streams as upland and riparian areas subjected to erosion caused by stock;
- Increased water turbidity, which affects the habitat of aquatic plants and animals;
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The nature of the problem

The degradation of riparian land, especially in southern Australia, is often associated with the removal of vegetation. The major impacts of this are summarised below.

- Removal of riparian trees increases the amount of light and heat reaching waterways. This favours the growth of nuisance algae and weeds.
- Under natural conditions, trees would occasionally fall into the river, creating woody debris – an important habitat for aquatic organisms. Removal of this debris and of the source of large branches and trunks disrupts aquatic ecosystems.
- Continuation of agriculture to the top of stream banks increases the delivery of sediments and nutrients to streams. Large volumes of fine-grained sediment smother aquatic habitat, while increased nutrients stimulate weed and algal growth. Increased nutrient load also affects estuarine and marine life beyond the river mouth.
- Removal of riparian vegetation destabilizes stream banks, often resulting in massive increases in channel width, channel incision and gully erosion. This erosion of the channels often delivers more sediment to streams than does human activity on the surrounding land.
- Removal of vegetation along channels, and of large woody debris in channels, can allow water to travel downstream at a faster rate, sometimes contributing to increased flooding and erosion of lowlands.
- Removal of vegetation throughout the catchment can lead (and has led) to raised water tables and salinisation of land which, as salt-saturated water drains into rivers and streams, ultimately results in saline waterways.

However, removal of vegetation is not the only human land use that adversely affects riparian land.

- Alteration of water regimes (through the imposition of dams, weirs and pumps) can severely affect aquatic populations and the capacity of the waterways to carry flow.
- Sand and gravel removal and channel straightening can result in channel incision and head cutting, which in turn can influence bank height and shape and lead to increased erosion rates.
- Uncontrolled access of stock can lead to grazing and trampling of vegetation, breakdown of soil structure and contamination of the water with nutrient-rich urine and faeces.
- Altered fire regimes and invasion by exotic weeds can further degrade riparian land.

It is important to recognize that the impacts of these disturbances are not just cumulative; they actually exacerbate each other. For example, clearing riparian vegetation from upland streams multiplies, many times, the impact of increased nutrients. This is because clearing also provides the light and higher temperature conditions needed to enable nuisance weeds and algae to flourish and dominate the aquatic ecosystem. Lovett & Price (eds) 1999:A5

Landholder attitudes

It is important to acknowledge that many farmers recognize problems associated with the loss of biodiversity and increased land degradation. However, the ways in which landholders are responding to changing expectations from politicians, the media and others are not easy to determine. While the ultimate benchmark is the state of the environment itself, tracking how farmers are responding is important in order to identify the relative effectiveness of different ways of bringing about change. P14

There is a sequence of responses. An initial one might be learning about a problem. This may or may not lead to attitude change. Whether behaviour then alters depends on a host of factors. Even when behaviour changes, land management and biodiversity may not change and may even continue to deteriorate. P14

There has been a significant public shift away from a production orientation towards one of sustainable development. (Crosthwaite & Malcom 2000:14)

A change in culture is also required, such that providing a supply of high quality nature conservation, aesthetic and land protection benefits to the community is widely recognized and accepted as a legitimate component of rural productivity. Private landholders need to be recognized for, and themselves come to accept, their significance as suppliers of nature conservation values. Such a cultural change can be fostered through, among other things, the ongoing communication and education efforts by all those rural institutions involved in rnv conservation – government agencies, greening Australia, Landcare groups and others etc. Some landholders may also act as important role models in this regard. (Lockwood, Walpole & Miles 2000:56)

Benefits of fencing vegetation

Fencing stock and providing alternative sources of drinking water can lessen the environmental impacts of stock. Despite considerable farmer resistance to limiting stock access, there is growing evidence from a number of small studies across the country that fencing waterways also makes good sense (in part because the capacity of the land to support grazing is less concentrated and so extended beyond proximity to natural water sources). (Fairweather & Napier 1998:44)

- **Increased groundcover**

Vegetation cover, extent, and condition are of critical importance in erosion control, nutrient cycling, habitat for biodiversity and maintenance of hydrological balance, and in providing the basis for our primary industries such as agriculture, forestry and horticulture. In addition, vegetation cover has a modifying influence on surface temperatures and local climates, as well as deep aesthetic appeal and value to tourism. Indicators that track all aspects of vegetative cover are central to the long-term sustainability of terrestrial ecosystems in Australia. Hamblin 1998:3

Measures to increase perennial vegetation:

1. removal of grazing animals from target areas; 2. fencing to exclude animals; 3. tree planting and reafforestation; 4. use of tree plantations; 5. replacing annual with perennial pastures; and 6. rabbit control. Hamblin 1998:62

Perennial vegetation may be promoted by a wide range of different measures. While tree planting is often the first that comes to mind, the most effective large-scale actions are:

1. removal of grazing stock and vertebrate pests from target areas – by capping unused bores, large animal culling and destocking;
2. fencing to exclude grazing animals from waterways and areas of remnant vegetation.
3. re-afforestation as part of best forest practice and tree-planting for aesthetic, wind-break and water control reasons;
4. development of tree plantations;
5. sowing perennial pastures in place of annuals;
6. control of rabbits. Hamblin 1998:62

- **Decreased erosion**

Accelerated erosion, loss of surface soil:

- Over grazing and ground-cover loss (Hamblin 1998:25)

Unlimited access of stock to streams can cause increased erosion and declines in water quality in rivers and wetlands. (Fairweather & Napier 1998:43)

- **Better water quality**

Riparian vegetation protects waterbodies from pollutants travelling overland in runoff (i.e. acts as a buffer strip), and strengthens banks against erosion from water flow. Riparian vegetation is also an important energy source (through litterfall) for the aquatic ecosystems within the stream. (Fairweather & Napier 1998:41)

Unlimited access of stock to streams can cause increased erosion and declines in water quality in rivers and wetlands. (Fairweather & Napier 1998:43)

The loss of vegetation cover from land due to clearing for agricultural and grazing purposes can have adverse impacts on nearby waterways. Water and wind erosion of exposed soils can add significantly to the sediment load of surface waters, leading to changes in the diversity, distribution and abundance of native plants and animals. Increases in runoff volume and flow rates through vegetation loss can cause hydrological changes that can lead to additional erosion of river and stream banks and beds. (Environmental Protection Agency 1999:4.12)

Benefits of off-stream watering

- **Produces healthier stock** – gain more weight etc. see paper.

Watering stock from natural water sources

Farmers can help improve the state of their natural watercourses and the health of their stock by restricting animals' direct access to natural water sources.

Evidence shows allowing stock direct access to watercourses causes considerable damage to the surrounding environment and water quality. The damage is caused by direct trampling of the stream bank and contamination of the water and banks with manure and urine. This results in bank erosion, stream sedimentation and water pollution. For these reasons, which are important to landholders and towns downstream, it is best to control direct access by stock to creeks, rivers and lakes.

Animal manure deposited directly in the stream or on the bank increases the water nutrient load, causing toxic algal blooms and may spread bacteria which can have a harmful effect on animal health.

- **No cattle pads, erosion caused by stock watering from creek/river**

The importance of watering points

Water is the most important item on a property. Where water is scarce or watering points badly distributed, pasture utilisation is poor. Those opportunities can have droughts while there is still plenty of feed at the opposite end of the paddock to the water.

Fencing and water point location are inextricably linked. Most fencing layouts in the past have been governed by access to water rather than the principles put forward in the fencing paper. Today, the availability of polypipe, fittings, concrete tanks and troughs etc. means that water reticulation can now be sensibly planned to suit the fencing layout and not vice versa. It is not cheap to reticulate water. However, the up front costs of water reticulation have to be balanced by the long term benefits of better utilisation, less erosion associated with poor siting of fences and tanks and sustained productivity.

The natural consequences of watering points
The natural consequences of watering points are the excessive grazing of vegetation in the immediate vicinity, and excessive disturbance of the soil caused by cattle trailing in and out for water or camping nearby.

The disturbance is accentuated by drought conditions, so that the country surrounding permanent watering points such as bores and dams is more exposed to serious damage than that around surface water supplies. Consequently it is expected that watering points must be surrounded by a sacrifice area.

Badly eroded and extensive sacrifice areas do occur on those soils which are highly susceptible to erosion. This causes a serious shortage of feed for 1-2 km around the watering point. Sometimes it causes standing of silting up of the facilities around the bore.

If the watering point is a surface tank or dam, erosion of the surrounding area can result in the tank being quickly rendered unless by siltation.

Whether a watering point will develop a sacrifice area will depend on the susceptibility of the soil to wind or water erosion, and the degree of protection which may be afforded by tree cover. For this reason it is desirable to locate watering points, other things being equal, in suitable situations.

Location of watering points
A sufficient number of watering points should be available to allow stock to graze all pasture areas without walling long distances. This helps to reduce concentrations of stock around each watering point and thus, reduce overgrazing and soil erosion.
Field, D. (ed). 1998:

Water supply options
After deciding to fence off a natural water source, there are four basic options available.

1. Limited access to the bank at designated points.
2. Carting water to stock from another source.
3. Piping water from an existing supply.
4. Pumping water from the water source into tanks or dams.

The decision of which method to use depends on a wide range of factors, such as the number of stock requiring water, the remoteness of the location and the available funds.

General Benefits

ECOLOGICAL
Many of the benefits associated with native vegetation relate to medium to larger patches, although all native vegetation plays some role in the landscape. For example, individual trees provide shade for stock, nesting and foraging sites for wildlife, cycle nutrients, act as a source of seeds and may help to reduce groundwater recharge and to recycle cations from depth. In addition to the conservation of biodiversity, native vegetation provides many benefits and free services to agriculture and is invaluable in maintaining the health of land and water. Sustainable agricultural production is dependent on farms being part of

a healthy functioning environment, and it is becoming increasingly clear that native vegetation plays a crucial role in maintaining landscape function and productivity. (Williams 2000:19)

In recent years, in recognition of the many potential benefits that can be achieved, many landholders, community groups and government agencies have become actively involved in improving riparian management. They have recognized the capacity of riparian land to

- Trap sediment, nutrients and other contaminants before they reach the waterways;
- Reduce rates of bank erosion and loss of valuable land;
- Control nuisance aquatic plants;
- Help ensure healthy stream ecosystems;
- Provide a source of food and habitat for stream animals;
- Provide an important location for conservation and movement of wildlife;
- Help to maintain agricultural productivity;
- Provide recreation and deliver aesthetically pleasing landscapes.

Many of these benefits can be achieved through careful riparian management. Lovett & Price (eds) 1999:A4

SOCIAL

Benefits associated with remnant vegetation in rural areas of Australia

- Aesthetics/heritage and cultural values
- Personal well being (existence value)
- Biodiversity conservation
- Recreation (especially riparian zones)
- Nutrient and water cycling for landscape health
- Soil conservation (protection from water and wind erosion)
- Shelter for stock from wind and sun
- Windbreaks for crops and pastures
- Pest control by native birds and animals
- Wood production for poles, posts and sawn timber
- Source of firewood
- Source of honey, flowers, specialty timbers, foliage and oils
- Genetic resources for a wide range of potential products
- Sources of seed for revegetation. (Williams 2000:19)

Benefits of nature conservation

It's all well and good to talk about nature conversation but at the end of the day, if your land is not making money then the property may be at financial risk. If we are to conserve nature, there needs to be some benefit or gain to justify it.

Incorporating native vegetation into your property plan can have a number of benefits from both a production and sustainability view point. Some of the benefits may include:

- Corridors for stock shade and shelter.
- Wind breaks, reduced physical stress on plants and less water loss through evaporation.
- Provide a fodder source in times of drought.
- Cycle nutrients from deep in the soil profile.
- Produce timber, nectar and other tree products.
- Habitat for birds and bees, birds help control insects and bees help with pollination.
- If incorporated into a plan correctly, can help with cattle movement and control (depends on community type).
- Erosion control.
- Water pumps, reducing occurrence of salinity.
- Visually pleasing, scenic amenity.
- Education and recreation areas.
- Ecotourism potential. Field (ed) 1998:31

ECONOMIC

Remnant native vegetation [rnv] can contribute to on-farm productivity through provision of unimproved grazing, timber products and stock shelter. It can impose an opportunity cost if the forested land could otherwise be cleared and used as improved pasture, pine plantations, or for some other enterprise. There are also costs to landholders associated with weed control, pest control, fence maintenance, and fire management. Rnv may provide benefits to downstream rural and urban populations through amelioration of land degradation associated with salinity, water quality decline and soil erosion. Salinity in particular imposes cost associated with decline in agricultural productivity and damage to infrastructure. Since rnv acts as a carbon storage, preventing clearing is beneficial in terms of reducing carbon emissions to the atmosphere (with the consequent mitigation of global warming). The Australian community also places economic value on attributes of rnv such as scenic amenity and contribution to biodiversity conservation. P15

The most important economic benefits from Rnv under current management regimes were productivity effects associated with prevention of land degradation, firewood production and, for the New South Wales study area, stock and crop shelter. The most significant cost was for weed management. P24

The largest benefit, land degradation mitigation, was a measure of how much productivity would be lost without the rnv. A large portion of the benefit is not a direct contribution to landholder's income. (Lockwood, Walpole & Miles 2000:24)

General Losses/Costs/Problems

SOCIAL

Perceived problems with remnant vegetation in rural areas of Australia

- Haven for feral animals, weeds and diseases
- Increases fire risk to crops, plantations and pastures
- Takes up land that could be used for productive purposes
- Difficulty in mustering stock
- Cost of fencing and maintenance to control stock access. (Williams 2000:19)

Impediments to remnant native vegetation conservation include resistance from some social and political institutions, economic costs, inconvenience, incompatibility with the landholder's style of land management, and a lack of social acceptability among some rural subcultures. (Lockwood, Walpole & Miles 2000:12)

ECOLOGICAL

Dryland salinity and soil erosion are the two main forms of degradation that might be exacerbated by continuing Rnv decline, and might have an impact on downstream rural and urban populations. (Lockwood, Walpole & Miles 2000:25)

Management

Stock management

- Uncontrolled stock access to streams has negative impacts because they input massive nutrient into the stream through their urine and dung; they trample and pug streambanks which leads to increased scour and erosion; they overgraze riparian vegetation leading to weed invasion and loss of bank stability; and they allow the passage of disease organisms through to other stock.
- It is possible, through strategic management of stock and grazing pressure, to both improve productivity and recoup fencing and watering costs while improving environmental management.

- Improved stock management can lead to natural recruitment of native vegetation. Guidelines are now available that show replanting is possible using cost-effective approaches, that can be integrated into whole of farm planting. RipRap Edition 22 2002:4

Grazing impacts and the role of fencing

The main aim of fencing remnant vegetation is to exclude large grazing animals, although rabbits can also be a problem. Inappropriate levels of grazing can cause compaction of the soil, increase the amount of nutrients at a site, introduce weed propagules, reduce invertebrate biodiversity and adversely affect particular plant species that are selectively grazed. Project CWE10 also found that heavy livestock grazing in salmon gum woodlands in Western Australia was associated with a decline in native perennial cover, an increase in exotic annual cover, reduced litter cover, reduced soil cryptogam cover, loss of surface soil microtopography, increased erosion, changes in the concentration of soil nutrients, degradation of surface soil structure, reduced soil water infiltration rates and changes in near ground and soil microclimate. Driver *et.al* (2000) also reported that 24 of 26 overstorey species showed regeneration after the removal of stock from remnant vegetation in the Riverina. P38

[Driver M, Proce L, Naimo J and Davidson I (2000), *Deposit for the Future: supporting remnant vegetation management through community cost sharing*. A report on the Murray Catchment Fencing Incentives program. Greening Australia – Riverina.

It is now relatively widely accepted that certain grazing regimes can be detrimental to both the conservation and production values of native vegetation, particularly continuous heavy grazing in riparian areas (Askey-Doran 1999).

[Askey-Doran M (1999), Managing stock in the riparian zone. In Price P and Lovett S (eds) Riparian Land Management Technical Guidelines, Volume 2: On-ground management tools and techniques. Pp. 65-82. LWRRDC, Canberra]

However, under certain circumstances these impacts can be managed so that grazing animals do not have to be totally excluded from native vegetation. It has been suggested that even riparian vegetation can be used as an emergency store of feed as long as the frequency of use and stocking rates are adjusted to suit the sensitive nature of the land. And in some instances the presence of grazing has been associated with the maintenance of high conservation values at a site. The key point is that *fencing allows total grazing pressure to be controlled*. It can also facilitate improved and differentiated management by zoning land both conceptually and physically. The physical power of erecting a fence to change management should not be underestimated. P39

The occasional use of remnant vegetation for grazing or stock shelter may alleviate some of the concerns of some land managers that fencing off remnants reduces the utility of the native vegetation. In the past the focus has been on the adverse environmental impacts of grazing, but there is growing interest in the strategic use of grazing to develop conservation outcomes. (Williams 2000:39)

If grazing has been part of the management of a site and the site is assessed to be in good condition, then the advice points to maintaining those practices but also to trying to determine what elements of the grazing regime are important. Grazing management that maintains appropriate levels of groundcover, provides breaks based on seasonal conditions and allows for seed set, germination and establishment should help ensure the protection of both the resource for stock and the remnant vegetation that sustains them. P40

While fencing is often the first crucial step, better management of native vegetation is not always as simple as excluding all grazing animals. This is being increasingly recognized in fencing schemes where it is being noted that some fenced sites will require weed management, either by physical, chemical or grazing manipulations. Where appropriate,

the use of controlled grazing in native vegetation may mean putting gates in the fences that are constructed around remnants, and providing alternative watering sources if fences exclude stock from streams. This may seem a small price to pay if it means greater acceptance of fencing as a management tool, but the practical implications of isolating remnants from grazing need to be considered. P41

Fencing is unlikely on its own to maintain remnants in the long-term because of the many processes that continue to threaten the vegetation, such as environmental weeds and changes to the patterns of disturbance by fire and native grazing animals. In some instances, the total exclusion of grazing by fencing out areas could lead to detrimental changes in the vegetation and its associated fauna. Therefore, the controlled use of grazing can be both useful for maintaining conservation and production values and can be used alongside other forms of management such as the control of pest plants and animals. The trick is knowing when and where grazing is an option, which can only be determined by a process of adaptive management. (Williams 2000:41)

Ecology

- Vegetation along rivers and creeks provides critical habitat and needs special management attention.
- Small and isolated remnants can make an important contribution to biodiversity conservation.
- Identifying appropriate disturbance regimes for native vegetation, such as fire, flood and grazing, is critical for its long-term maintenance.
- Successful regeneration/restoration is highly dependent on water availability, and management must meet this need. P10

Management

- Management is needed at the site, region and landscape scale.
- Management goals need to be clearly stated, so that progress can be measured.
- Adaptive management allows the effects of particular practices to be evaluated – monitoring is the key to 'knowing if you're winning'.
- If it ain't broke, don't fix it – in other words, don't change current management practices unless there is an obvious reason to do so.
- Fencing is only the first step in a management program for native vegetation.
- Strategic and controlled grazing of native vegetation is possible, and sometimes even essential.
- Caution must be taken when transferring results – what works in one place, might not in another.
- Obtain and use local knowledge wherever possible. P11

Socio-economic

- The future of native vegetation is tied up with the future of the farm itself.
- Cost-sharing incentives are a critical component of improved vegetation management on private land – but a mix of incentives is needed, including legal instruments.
- Partnerships that include all interested stakeholders are needed at the regional level.
- Understanding the value systems and perceptions of different stakeholders can lead to more targeted and effective approaches to management and education.
- Written materials on their own are not sufficient to change attitudes and behaviour.
- The 'personal approach' to extension services – face-to-face communication and discussion – is the most effective. P11 (Williams 2000)

Larger and more intact patches of native vegetation, or in some cases small, degraded patches, may be the only remaining examples of particular ecosystems and serve as a reference point for revegetation activities and ecosystem function. Once the original

vegetation disappears from a site, then it is difficult, if not impossible, to recreate it. And while revegetation projects are becoming increasingly sophisticated, it will take decades to develop the characteristics of the original vegetation (i.e. being self-sustaining), especially those provided by large trees. This means that what we've got is all we've got. Consequently, there is general agreement that the first step to sustainable management is to retain existing native vegetation where possible. The next steps are to protect and manage that vegetation and then, where appropriate, to revegetate cleared areas. (Williams 2000:19)

Active management of remnant vegetation is required to manage degrading processes such as weed invasion, rising groundwater, modified fire regimes, and changed site conditions leading to lack of recruitment and regeneration. It has also been noted that there is a need to increase the extent of existing areas of native vegetation to meet biodiversity conservation and other objectives such as combating salinity, waterlogging or erosion, and to provide sinks for carbon to meet the country's greenhouse commitments. (Williams 2000:35)

Guidelines for the management of native vegetation communities can help identify priority issues. Several of these have included landholder involvement to ensure that their content and language meets the needs of the primary audience. Rather than being prescriptive about managing remnant woodlands, an adaptive management approach is encouraged where ongoing monitoring is a key factor. And when it comes to specific management guidelines, nothing can match local knowledge about the systems involved. While technical knowledge about ecological patterns and processes varies among individual landholders, this source of information has often been overlooked. (Williams 2000:38)

The final decisions about managing natural resources on farms will depend on factors associated with the farm business. P15

Biodiversity conservation outcomes, and to a lesser extent problems of unsustainable land management, depend on the specific circumstances of each farm. These issues thus revolve around the uniqueness of the natural resources, how they are integrated into the farm business, and how the business changes over time. (Crosthwaite & Malcom 2000:16)

Management plans should include measurable objectives, and indicate the actions required to achieve these objectives. Ideally, the rnv management plan should be a sub-plan of a whole-plan. Rnv management needs to become a standard part of farm planning. The plan should also be consistent with higher level plans such as the regional vegetation management plans and regional biodiversity strategy in New South Wales, and the regional catchment management strategy and vegetation management plan in Victoria. P55

Management interventions are regarded as a series of successive and continuous adaptations rather than a set of rigid prescriptions. The approach emphasizes flexibility, requires willingness to learn through experience, and may require sacrificing present or short term gains for longer term objectives. The emphasis is on learning how the system works through management interventions that are both issue orientated and experimental. Adaptive planning recognizes that there is often considerable uncertainty about the outcomes of any particular action. This uncertainty is built into plans so that information about the actual results of actions is used to inform and, where necessary, modify management practices. It is a process of learning by experience. P55

Each property will have specific management needs depending on local environmental characteristics (broad vegetation type, landform, climate and land use) and other factors such as past uses of the rnv. While the general structure and format of plans can be

standardized, specific objectives and actions will probably need to be developed for each property. The planning effort will be considerable and will require the commitment of, and effective working relationships between, the landholders, Rnv officers and agency staff. P55

Specific matters that would need to be addressed in most rnv management plans include:
- Weed control, and where possible eradication;
- Feral animal control;
- Grazing regimes, if any, including stocking rates and times;
- Extraction of forest products such as poles, posts and firewood, if any, including quantities to be taken; and
- Fire management. P55

Effective rnv management requires that landholders feel they are being rewarded for sympathetic management (encouragement) and not have rigid management regimes imposed on them (hindrance). Although the emphasis in the proposed policy is on providing incentives rather than controls, some mechanisms are required to:
- Ensure appropriate expenditure of the funds provided;
- Evaluate whether the objectives of the management plans are being achieved; and
- Review the effectiveness of the program. P56

Funds allocated according to management agreements should be provided to landholders on a contractual basis, with the rnv officers responsible for determining that the terms of the contract are honoured. Monitoring of performance against the management plan objectives would also be the responsibility of the rnv officer. The approach in dealing with any deficiencies in plan implementation should be the provision of information, technical advice and encouragement, rather than sanctions. (Lockwood, Walpole, Miles 2000:56)

Many landholders in Australia are now implementing improved management techniques. Fencing and other methods used to control and manage the access of stock to riparian areas are a high priority in many parts of the country. Landholders are reporting that the cost of fencing and off-stream watering can be more than recouped over time because, for example, fenced riparian land can be used for growing higher value crops or because the health and productivity of animals grazed there is improved. In recognition of the fact that improved riparian management provides public as well as private benefits, there are now many forms of community and government support available to help defray the high cost of durable fencing. Lovett & Price (eds) 1999:A7

Some action has been taken by individual landholders, but in many cases it is more effective for neighbours to work together, in collaboration with local and State governments, to achieve improved management along a waterway reach that may be 10 to 30 km long. Lovett & Price (eds) 1999:A7

It is important to recognize that sound riparian management is not a substitute for good land management elsewhere in the catchment. Rather, it should be seen as one part, albeit a very important part, of sound management throughout the property or catchment. Even the best management of riparian lands will not overcome management practices elsewhere that lead to excessive soil erosion, loss of nutrients or contamination. Lovett & Price (eds) 1999:A8

The role of vegetation in riparian management – Summary
- Riparian land is often more diverse in flora and fauna and more productive than other parts of the landscape. Riparian vegetation is generally more dense, often contains a greater number of zones, and can be taller than nearby non-riparian vegetation.
- The high primary productivity of riparian lands is the result of soils which are richer in nutrients that those further upslope as well as a greater availability of water, shade and

shelter. The composition and structure of riparian vegetation vary both locally and along the length of the river.

- Vegetation abutting waterways protects water quality; it filters water moving across the soil surface, via underground systems, and in the air. Fine leaves, twigs, coarser branches and trunks provide a source of both food and habitat for aquatic plants and animals. Removing or disturbing riparian vegetation can alter the physical and chemical properties of the adjacent water body, adversely affecting aquatic organisms. It can also cause the scouring and collapse of stream banks.
- Well-managed riparian zones can provide windbreaks, slowing the wind that would dry out pastures and crops and remove valuable topsoil. Riparian vegetation can further contribute to agricultural productivity and business profits by way of agroforestry, apiculture, forage production and storage, stock shelter, land value and ecotourism.
- Riparian environments are prone to both natural and human-induced disturbance. Significant natural and human-induced disturbances are associated with flooding, water regulation, fire, vegetation clearance and fragmentation, the introduction of plant species and livestock, and rising groundwater and salinity. Lovett & Price (eds) 1999:A97

When stock are excluded from riparian land

In environments that have a long history of grazing and where the vegetation has adapted to this form of disturbance, the exclusion of livestock may result in changes to the vegetation structure, such as the invasion of woody plants and a reduction in species diversity. Experiments with grazing exclusion in riparian vegetation have shown a reduction in species richness and an increase in plant cover. These studies advocate management which excludes grazing for some period of the year (or in particular years) so that vegetation can recover and recruitment can take place.

In the winter rainfall areas of Australia exclusion of grazing for the summer period (when most damage to the vegetation and the stream bank is done) may be enough to prevent further degradation. However, successful recruitment of many species may be episodic, relying on the coincidence of several factors (such as winter flooding, early receding of floodwaters corresponding with seedfall, and some summer rainfall). Recruitment requiring particular environmental conditions has been documented in some plant communities, and intermittent grazing may interfere with any such 'window of opportunity' for recruitment. Predicting which particular species are most affected by livestock grazing and which species are likely to return after stock exclusion is important for the rehabilitation of degraded riparian areas. This may depend on particular traits of individual species – such as life form, ability to resprout after defoliation, seed production, seed dispersal techniques, seed dormancy and the ability to form a seed bank.

Fencing out stock can lead to a variety of outcomes. Past land-use history, present practices, availability of propagules (seed bank and proximity to native vegetation), regeneration characteristics of the vegetation, and the composition of the vegetation (introduced versus native) will all influence the path of regeneration. Lovett & Price (eds) 1999:A141

Managing and rehabilitating riparian vegetation

Management objective: To manage intact and degraded riparian vegetation in such a way as to obtain the multiple benefits offered by that vegetation. Lovett & Price (eds) 1999:65

Critical factors

- Stock management
- Weeds
- Fire
- Feral animals
- Nutrients
- Land use
- Monitoring. Lovett & Price (eds) 1999:68

1. Guidelines for managing largely intact riparian vegetation

- Stock management
- Weeds
  - Limit the opportunity for weeds to invade
- Fire
  - Understand the fire response of a particular vegetation community or species
- Site monitoring
  - Monitor the riparian zone regularly to reduce the risk of problems developing or becoming more serious

2. Guidelines for rehabilitating degraded riparian vegetation

- Assess the condition of the area to be rehabilitated
- Conduct a local catchment survey
- Collect other environmental information relevant to the rehabilitation of riparian vegetation
- Consult government agencies with an interest in land management
- Ascertain the appropriate approach. In doing this, ask

i. Are there any native species at the rehabilitation site?
ii. Are there intact stands of riparian vegetation nearby?
iii. Is uncontrolled grazing a problem?
iv. What problems other than vegetation-related ones need resolution?

- Aim to mirror natural systems appropriate to the region.
- Select species that suit the particular situation.
- Work from the stream out. Lovett & Price (eds) 1999:72

If the decision is made to revegetate, consider the most appropriate technique for the site and resources.

- Timing is important
- Minimise disturbance during revegetation work
- Monitor systematically, using a methodology that is consistent over time

Implement a weed management strategy. Lovett & Price (eds)1999:76.

Managing stock in the riparian zone

Management objective: To manage stock in such a way as to avoid degradation of riparian land and to sustain ecosystems. Lovett & Price (eds) 1999:99

Critical factors

- Timing, intensity and frequency of grazing
- Grazing systems
- Fencing
- Stock watering
- Stock behaviour. Lovett & Price (eds) 1999:102

Guidelines

- Timing, intensity and frequency of grazing
  - If riparian land is to be grazed, it should be grazed only when the bulk of the vegetation is dormant and when soil moisture levels are low

Generally, native plant species are dormant during winter, although it must be remembered that species go into, and come out of dormancy at different times. In addition, some native species such as wallaby grass and plume grass can be active in winter. The length of the dormancy period also varies from year to year and from region to region, according to weather patterns. Stock should be excluded from riparian areas if soil moisture levels are high and there is a risk of plugging and compaction. Lovett & Price (eds) 1999:102

- Avoid grazing riparian land in the growing and flowering season, which generally means spring and summer, and when germination is occurring

Continuous grazing when plants are putting on new growth will reduce the plants' vigour and lead to poorly developed root systems. Healthy root systems are important not

only for binding the soil, but also for ensuring access to moisture in dry periods and for nutrient cycling. Continuous grazing during flowering will also limit the ability of palatable species to set seed.

Germination can occur seasonally – in spring, for example – or in response to a particular triggering even such as flooding or fire. Grazing in the riparian zone after flooding or a fire can greatly reduce the chance of seedlings surviving and result in even-aged stands of vegetation. Seedlings can be destroyed by both grazing and trampling.

When planting a grazing regime, it is important to understand the life-cycle characteristics of riparian plant species, especially those of important functional groups and endangered species. Lovett & Price (eds) 1999:103

- If it is necessary to graze riparian land adjust both the stocking rates and the frequency of use to suit the sensitive nature of the land

This will mean low stocking rates for short periods and long rest periods. The riparian zone should be seen as an emergency store of feed that is available for controlled use during times of shortage elsewhere on the property. Lovett & Price (eds) 1999:103

- Grazing systems
- Riparian land as part of a whole farm management

Riparian land should be treated as a component of the property's entire pasture system. In this way it should be seen as an integral component of the whole farm, and managed as a sensitive area with special management requirements, rather than a piece of land at the bottom of a paddock. Lovett & Price (eds) 1999:103

- Exclude stock when and where damage is likely to occur

Depending on the type of riparian land being managed, it will be necessary either to exclude stock totally, or to use spatial and temporal controls when the land is grazed. Stock should be totally excluded if the stream banks or channel are likely to be damaged or if the quality of the vegetation or water is of paramount concern.

Three grazing strategies used in Australia, that are similar to those detailed in the table, are summarised in the following paragraphs.

1. Continuous grazing (set stocking)

Continuous grazing means there are no controls on stock access to land. Paddocks are stocked at a fixed rate for all or part of the year. This management strategy is not suitable for riparian land because it has a high level of impact on stream banks and vegetation.

2. Rotational grazing

In a rotational grazing system, stock are rotated through a number of paddocks in an organised manner. This may be done over a full year or for part of a year. Stock are held in each paddock for a fixed period (perhaps for as little as a week) before being moved on to the next paddock. Rotational grazing paddocks can include 'bush runs', which are used for supplementary feed. The number of paddocks being used in the rotation will determine how long each paddock is rested.

There are a number of disadvantages associated with rotational grazing

- Rotational grazing can fail to take into account variability between paddocks and changes in pasture growth rates;
- Pasture is rested for shorter periods than with cell grazing;
- Paddocks may be under, or over-grazed at different times of the year;
- The system is fairly inflexible.

Research shows that rotational grazing offers little benefit over continuous grazing.

3. Cell grazing (time-controlled grazing)

Cell grazing involves a combination of grazing periods and rest periods and provides a means of controlling stock access to riparian land. Decisions about the grazing and rest periods for each paddock are based on pasture growth rates. The preferred method is to use a cell design that treats riparian land as a separate paddock, running parallel to the stream. The paddock's low level of use within the cell system can then be determined on the basis of individual condition and the amount of feed available in other paddocks in the cell. Lovett & Price (eds) 1999:104

Table 1 outlines grazing methods that have been used on riparian land in the western United States and that are regarded as suitable for maintaining instream habitat values. Each of the methods needs to be considered in the light of the riparian land's condition and the overall farm-management strategy.

Table 1 Grazing methods for riparian land in the western United States

	Corridor fencing	Rest rotation with seasonal preferences	Rest
Definition	Entire riparian corridor (or required portion of) fenced for complete rest of for the application of desired grazing strategy.	One pasture completely rested for at least 1 year during the grazing cycle. Rest period rotated among several pastures. Grazing occurs when impact likely to be the least.	Selected areas rested until aquatic and terrestrial habitats recovered.
Problems	Extensive fencing required. Reduces the availability of riparian land for occasional forage use.	Moving stock between cells to meet seasonal requirements is labour intensive.	Exclusion of stock or limitations on use by stock to allow for recovery. Weed infestations can be a problem.
Benefits	Allows riparian land to be rehabilitated whilst providing a simpler grazing system for upland paddocks. Total exclusion avoids the risk of animals drowning.	Gives plants and stream banks time to recover from past damage. Riparian land can be grazed with optimal timing an intensity.	Riparian land begins to recover quickly with benefits to instream environments. Degraded pastures and riparian land can be returned to productive states, ready for a more suitable grazing strategy.
Compatibility	More likely to provide quality aquatic and terrestrial wildlife habitat. Can provide shelter and forage during dry periods.	High. Grazing can be programmed to meet the needs of both riparian and upland habitats.	Allows both aquatic and terrestrial habitat recovery. Following recovery, stock can be excluded or allowed to graze on a rotational basis.

Lovett & Price (eds) 1999:105

- Fencing

➢ Install fences suited to the flood regime

Fencing in riparian areas needs to be able to cope with flooding but still be strong enough to keep stock out. The most suitable fence design will depend on the stock being excluded, the nature of the land, and which portion of the stream is to be fenced. Generally, the fence should be above the annual peak flood level, in a position that avoids not only high flows but also debris. Fencing design and early warning of floods can reduce the risk of flood damage to the fences. No fencing is totally immune to flood damage, and all fencing requires a continuous program of maintenance. Some fence types are, however, better than others and require less attention. Lovett & Price (eds) 1999:106

➢ Install fencing suited to the land use

Placement of fences will be influenced by a range of factors – the purpose of the fencing, the topography of the area, the flow regime of the river, and so on. If the fencing is being done to improve the natural values of riparian land, and to provide habitat for wildlife, minimum of 30m (preferably 50m) from the stream banks is recommended. For many farmers, though, this will represent a sizeable portion of land removed from productive use. Lovett & Price (eds) 1999:106

- Fencing parallel to the stream and floodplain areas

Drop fences

These fences drop automatically as pressure from water and debris builds up behind them. Once the flood has receded they can simply be pulled back up: tension is automatically retained and the fence is re-tied ready for the next flood. These fences are suitable for both stream banks and floodplains. Two designs are in use:

(a) Grooved wooden droppers (not driven into the ground) are permanently attached at their base to the bottom of each star picket by a loop of high-tensile wire that acts as a hinge. The top of the dropper is attached to the star picket with a loop of low-tensile wire (less than 1 mm diameter). When flood pressure is exerted on the fence the top wire breaks, the fence lies flat, and any debris is released. Four or five wires are recommended for cattle and sheep.

(b) A design recently patented in Tasmania is currently being trialled. This fence pivots at ground level during a flood and lies flat on the ground. It consists of intermediate spring-loaded steel posts (which replace the star pickets) and triangular end assemblies, which also pivot at ground level. A special release wire runs the length of the fence and triggers when a flood passes through. Tension in the wires is maintained at all times and the whole fence can be easily re-erected after the flood. The fence can also serve as an emergency 'long gate' for access to paddocks or riparian land. Lovett & Price (eds) 1999:107

Lay-down fences

Lay-down fences are similar in design to drop fences but are laid down manually before a flood. This means that their effective use depends on good flood forecasting. The fences are hinged at the assembly end, allowing easy release and re-attachment. Once the flood has passed through, the fences are pulled upright again and the tension is retained. These fences are effective on broad floodplains where access to the fences poses no difficulties. Lovett & Price (eds) 1999:108

Electric fences

Electric fences allow more flexibility and are cheaper than traditional fences: they require fewer posts and droppers and less wire, and the gates are cheaper. They also offer greater flexibility in terms of location because they can more easily follow the meandering pattern of streams. Electric fences can be either temporary structures using tape, or permanent structures using plain wires.

Two or three wire electric fences work well for cattle, sheep and fat lambs. It is important that there is a good earth between the animal and the ground; this limits the effectiveness of electric fences in dry conditions.

In particular areas or at particular times, portable electric fences which can be put up are an inexpensive option for managing stock along streams. Lovett & Price (eds) 1999:108

- Fences crossing streams

Suspended crossing streams

Suspended fences hang across the stream to prevent stock from entering riparian land during times of low flow.

The fence relies on good strainer posts on either side of the stream. These posts can be made of railway iron, treated timber or even a tree or large stump: whatever is used must have a firm footing in the ground and be able to take the strain of the suspended fence. This may mean placing a pair of straining wires at 45 degrees to the strainer post. A cable is hung between the two strainer posts to support the hanging fence. Lovett & Price (eds) 1999:109

Non-electric suspended fence

The hanging panels can be made from a range of materials, such as galvanised iron ring-lock attached to a frame or vertically hanging narrow lengths of timber. The panels are attached to the suspended cable and move independently of each other. When the river level rises or there are floods, the fence rides up with the water. Lovett & Price (eds) 1999:110

Electric floodgates

Electric floodgates overcome the maintenance problems associated with panels or cables, which can be damaged by large floods.

All electric floodgates should incorporate a controller unit that limits voltage loss to the entire fencing system when flooding occurs. A cut-out switch can be used in the event of prolonged flooding.

Flotation devices at the base of the panels help the floodgates ride over debris. The gates can be permanent or semi-permanent, and the panels can be made of hinged lightweight mesh or chain (2.5 mm) or single-strand wire. If the floodgate is a continuation of an existing electric fence system, additional electrified wires should be run above the floodgate so that power is not lost if the floodgate is damaged. Lovett & Price (eds) 1999:111

Permanent electric fences across streams

Fences of this kind are suitable for deep, narrow crossings. Lightweight chain or hinged mesh is suspended from steel cable (for example, 8mm) that has been strained and firmly secured at both ends. The spreader wire between each chain can also be the wire that is electrified. Lovett & Price (eds) 1999:111

Semi-permanent electric fences across streams

Fences of this kind are suited to wide, flat crossings, including fords. Hinged and separated galvanised mesh panels are hung across the river from steel cable. A positive, electrified connection is made to the top of the panels; the moist bank and green grass act as the earth. Lovett & Price (eds) 1999:111

Semi-permanent fences with disposable sections

Fences of this kind are suited to uneven crossings. Using single-strand wire, individual sections or groups of sections are constructed separately. Star pickets are used for each section, and the joins between each section act as the breakaway point. A positive, electrified connection is made to the top wire of the sections, and one of the lower wires acts as the return. Lovett & Price (eds) 1999:112

Mesh floodgates

Mesh floodgates can be electric or non-electric. As with other hanging fences, steel cable is strained across the waterway and reinforced matting or strips of large open mesh are hung to just above normal water level. Lovett & Price (eds) 1999:112

Electronic fencing

Electronic fencing uses audio stimulation to control the movement of cattle. Developed in the United States, the system consists of special ear tags worn by stock and one or more transmitters strategically located to form an electronic boundary. Fencing of this kink can be used to separate riparian land from adjacent paddocks. Each transmitter emits a signal that defines the area from which stock are to be excluded. The ear tags consist of a receiver, an audio warning emitter, and a device that provides a small electrical stimulus to the animal's ear. An 'unlock' transmitter is placed at feeding or watering points the animal is likely to visit often and, after unlocking, the activation sequence can be repeated. This technique is also being developed in Australia and is know as 'Virtual Fencing'. Lovett & Price (eds) 1999:112

- Stock watering

➢ If fences exclude stock from the stream, provide alternative watering sources.
If streams are to be fenced off it is important to provide alternative watering sources for stock. Some of the more innovative watering system designs are

– Nose pumps. These small pumps, operated by cattle, can water between 30 and 50 beasts. The pump is a single unit consisting of a trough and a lever and diaphragm unit. The cattle push the lever aside to get at the water and, in so doing, pump more water into the trough.

- Solar-powered pumps. Solar power is a cost-effective means of operating pumps in remote locations. The outfit consists of a solar panel, a controller and the pump. The panels can be either fixed or designed to track the sun. Pumping performance varies with both latitude and season, and the volume pumped in summer exceeds the winter volume – demand for water is greatest in summer, so the system is quite efficient.

Other watering systems can also be incorporated in cell grazing designs. For example, it is common to have a wagon-wheel layout of cells with a trough as the central hub. Water for the trough is gravity fed from a dame upslope. If there is sufficient pressure, the dam may also feed other troughs on the property. Stock can be rotated through the cells and always have access to water.

There will probably be times when it is not practical to install an alternative watering system and use of the stream is the only option. In these situations it is important to restrict stock to designated watering points along the stream to minimize disturbance.

When choosing an access point, keep the following in mind.

- The site should be relatively flat, with a maximum slope of 1:6, to reduce erosion and to make it easier for stock to get to the stream edge.
- The site should be located on the inside of a bend, where water movement is slower and the banks are less prone to erosion. The outer bend of streams is the eroding point and is thus more sensitive to trampling.
- To prevent erosion, harden the surface of the access point with gravel. A hardened surface will also provide a better footing for stock.
- To minimize problems associated with stock camping or loafing around the watering point, make sure the site is not well sheltered.
- Angle the access point in a downstream direction, so that stock enter the stream in the direction of water flow. This allows the stream to flow past the access point during peak flows, rather than into it, which can cause further erosion.
- Fencing for the access point will be part of the corridor fencing. The corridor can be broken at selected places and two parallel fences run either from one side of the stream to the other or to the low-water mark in the stream. The important thing is to ensure that stock cannot get into the riparian corridor from the stream channel. Depending on the grazing system in operation, the fence may be permanent or temporary.
- The width of the access point will depend on the number of available access points and the number of stock to be watered. The suggested range is 2 to 20 m. Lovett & Price (eds) 1999:113

- Stock behaviour

Stock tend to use paddocks unevenly, and this affects the condition of both the paddocks and the riparian land. Problems associated with uneven use can be overcome by improving the paddock environment, so that it is used more uniformly. When designing paddocks, keep the following in mind.

- Locate watering points and salt, protein and mineral blocks away from the riparian margin. This will deter stock from camping around watering points and using paddocks unevenly.
- Ensure that there is adequate shade in the paddock: this will reduce the likelihood of stock camping on riparian land.

Ensure that the gates are located away from riparian land and that the paddock design does not channel stock towards riparian land. Lovett & Price (eds) 1999:115

In Australia, poor management, or lack of management, has led to the substantial degradation of riparian lands. The removal, fragmentation and drastic alteration of vegetation cover, combined with changed flow regimes, has increased the incidence of bank erosion, resulting in a loss of agricultural land during floods, changes to the functioning of river systems and decreased water quality. RipRap Edition 22 2002:3

The economic costs of the poor management of riparian lands are significant. Ten per cent of the $450 million spent each year on water quality treatment for human use may be attributed to the degradation of riparian lands. Remedial works, such as protective infrastructure and flood mitigation measures designed to prevent or reverse riparian degradation, represent a substantial cost to landholders, communities and governments, and is estimated at costing $100 million per year. These estimates take no account of production losses, nor the environmental services provided by riparian lands and healthy riparian vegetation. RipRap Edition 22 2002:3

Agreements

If substantial economic incentives are offered, the majority of landholders are likely to at least consider entering into binding agreements. (Lockwood, Walpole & Miles 2000:48)

Binding agreements, because of their restrictive nature, tend to be less accepted by landholders. Concerns have been raised by landholders about losing rights or management control over their land. In the longer term, this may change as such agreements become more commonplace, and if greater trust develops between landholders and the institutions involved in rnv conservation. There is therefore an urgent need to further develop constructive relationships between agencies and landholders. The effort must be maintained and strengthened through ongoing communication, partnership development and education. P49

In the short term, it is likely that non-binding agreements will continue to be more popular with landholders. In the longer term, an attempt should be made to tip the balance more towards binding agreements. The balance between binding and non-binding agreements will, in the end, be decided by landholders choices. Those responsible for managing the agreements need to have appropriate marketing and education programs in place to ensure that landholders make these choices in an informed way, and in a climate conducive to acceptance of an agreement. To be successful, management agreements must engage strong landholder support and commitment. Such agreements need to be seen as partnerships between the landholder and the contracting organisation. P49

Suggested that agreements should be for 5 years. This period should be sufficient to achieve short-term management objectives, while providing a limit on the duration of government support. Renewal of agreements should be based on satisfactory performance as measured against the objectives of a management plan. (Lockwood, Walpole & Miles 2000:49)

Monitoring

(- the different types and what information each type yields)

- **Photo points**

Photos provide a very good visual indication of the condition of your site. They can accurately and rapidly document vegetation changes. In order to take photos that are consistent you will need to establish permanent photo points. Such photo points allow you to take photos from specific points within your site area, rather that just taking random photos. This makes it easier to determine if changes have taken place over time, as you can compare photos taken from the same point at different stages (eg initially, after 6 months, 12 months and so on).

- **GRASS Check**

Changes in pasture and soil condition often occur very gradually, but may be extremely difficult to reverse. By careful monitoring, change can be detected and management can be adjusted where necessary.

Rainwater infiltration into the soil is increased with greater ground cover (herbage, grass, mulch), resulting in additional grass growth. The soil is protected from erosion and seeds present in the topsoil awaiting germination under favourable environmental conditions are also protected.

Pasture composition refers to the percentage of various plant species present in the grazing area. Measuring the composition will help you accurately assess the condition of your pasture.

GRASS Check (Grazier Rangeland Assessment for Self-Sustainability) can be used to monitor a number of different things, such as ground cover and pasture composition, soil condition, standing feed and stocking rates.

GRASS Check becomes more useful as a management tool when information is collected over a number of years. Results show the percentage of ground cover protected by plant material. When cover reduces to 30-40%, runoff increases dramatically and the soil is more prone to erosion. Pasture composition results indicate changes in the proportions of desirable, intermediate and less desirable plants. The desirable species are usually productive, palatable perennial grasses. An increase in the desirable species and/or a decrease in the less desirable species may indicate an improvement in pasture composition. Your management should aim to increase the chance of survival and reproduction of the desirable species.

- **Water sampling**

Water quality provides an excellent indication of overall catchment health. It can therefore be very useful to take water samples and have them tested for various attributes, such as pH, conductivity and turbidity. By keeping a close eye on your waterways you can gain an understanding of what is ‘normal’ for them.

It is important to remember to understand that although changes occur, the system as a whole should remain in balance. Monitoring will assist you to recognize when the system is in balance and detect early warning signs of things going ‘off the rails’.

When the riparian and in-stream habitats are healthy and biologically diverse, this is an indication that the natural system is in balance, is coping, or has found a new balance. When changes are apparent you may want to trace the source of the problem/s so that this balance stays intact.

- **Species lists – flora and fauna**

It is useful to compile a list of plant species which have been found within your transect (although it may be useful to extend this to cover your whole project site or property) so that comparisons can be made to determine what species are present and those returning due to altered stock management. This knowledge will allow you to manage your site and/or your property more effectively.

- **Habitat assessment and vegetation survey**

The habitat assessment is designed to determine the general condition of your site. The information recorded can be compared to future survey sheets to help determine any changes that may be occurring over time due to your changed management.

Monitoring is designed to gather information that will allow you to detect and assess change taking place over time. This information has the potential to improve future decisions and actions. Recent, or past management, natural occurrences, or land-use practices may cause these changes.

Monitoring allows one to determine what is really happening within a specific area, as well as help to establish best management practices for individual site or whole of property areas. The effectiveness of land management practices being applied to the land can also be determined by monitoring.

The aim of monitoring is to develop a long-term record of changes within a specific area, or on a whole of property scale. It should be simple or as complex as the individual wishes it to be.

Monitoring is important for two specific reasons:

1. It is a valuable tool for improving management practices; and
2. It allows us to know whether resource conditions are stable, improving or declining.

Monitoring is an important management tool that can play an integral role in improving one's understanding of the land and your property management.

Possible indicators of change

- Proportions of trees, grasses, shrubs etc.
- Increase/decrease in weeds/exotics.
- Increase/decrease in species diversity.
- Increase/decrease in erosion.
- Increase/decrease in leaf litter.
- Evidence of cattle pads.

How do you go about assessing the condition of remnants?

Remnant condition can relate to measures such as tree health, understorey diversity, structural diversity, the number of tree hollows, and weediness.

Plainly, remnants in good condition should be a high priority for conservation. But what of those that are not? In Tasmania, research showed that remnant condition is not linked to the occurrences of rare or threatened species, which were generally found in poorer-quality remnants (in terms of exotic species cover and species richness).

Research showed that animal species responded differently to landscape fragmentation and remnant characteristics. Consequently, no single species or group of species was thought to be a good indicator for the response of others, even closely related ones. Assessment of some characteristics of the remnant itself, rather than using a particular 'indicator' species (such as birds or mammals) appears to be the most effective approach to assessing their condition. For example, in the box-ironbark woodlands, the most useful measures included the level of disturbance to habitat resources such as ground cover and shelter, logs and woody debris, and large trees for hollows and nectar production.

Across the research, plant regeneration was found to be important for the long-term maintenance of native vegetation and critical for providing fauna habitat in the longer term. In addition, characteristics like the presence of feral predators and the amount of fertilizer drift can influence remnant quality (Mortlock & Williams 2002).

Particular management practices must be monitored and evaluated, and management adapted accordingly. Caution must be taken when transferring results – what works in one place, might not in another. We emphasise that fencing is only the first step in an active management program for native vegetation. Strategic and controlled grazing of

native vegetation is, for example, often possible, and sometimes even essential (Mortlock & Williams 2002).

Evaluation

The program should be subject to an initial evaluation after three years. This evaluation should avoid targeting individual properties, though assessments will need to be made of a sample of properties, but rather aim to form an overall view on the success of the program for achieving both property specific and catchment wide objectives for rnv management. Note that spending more money does not necessarily equate to better biodiversity conservation outcomes. The program evaluation should attempt to measure the program's value for money. The continuation of the program should be dependent on a positive evaluation report. The evaluation should be conducted by an independent consultant to the managing agency as determined under the cooperative agreement. (Lockwood, Walpole & Miles 2000:56)

To evaluate a stream rehabilitation project, you must set a time over which you expect to see results. The time frame must be long enough for natural recovery, but short enough to keep people interested. Stream CD

Three tasks in the evaluation procedure:
Task 1: Define the type of objectives
Task 1: Select the level of evaluation needed
Task 3: Design the evaluation. Stream CD

When it comes to evaluation, clear and measurable objectives are critical to measuring success. Without them, how will you know what to measure?

Objective type:
1. Execution outputs
2. Survival outputs
3. Aesthetic outcomes
4. Physical/structural outcomes
5. Ecological outcomes. Stream CD

A feasible objective has 3 characteristics. Firstly, it's affordable – the cost of the project is less than the money and resources available. Secondly, its legal - with permits you're allowed to complete the works required. Finally, and most importantly, the project is practical – the benefits far outweigh the negative side effects.

These tasks will help you define the feasibility of your objectives:
Task 1: Can you afford it?
Task 2: Are there legal constraints?
Task 3: Is there a net benefit?
Task 4: How confident are you of success?
Task 5: Weigh the feasibility. Stream CD

How do you decide which level of evaluation to use? The answer depends on three factors:

- What would you consider a success?
- Who do you want to convince?
- Do you have the resources to sustain the evaluation? Stream CD

What should you measure?
As a minimum, the evaluation needs to indicate if you have met the objectives of the project.

A good evaluation not only measures the objectives, but tells why they have succeeded of failed.

How frequently should you measure?
By sampling at regular intervals, you're able to monitor trends and variation in the data.
Stream CD

Case studies

➢ Wilga Vale

Project description
This project will erect fencing and provide a secure off-stream watering source to manage stock access to the banks of Back Creek. This will reduce the impacts of erosion from livestock and vehicle access on the banks (especially the high banks) of the watercourses and allow for better weed control and enhanced stock handling especially when mustering around watercourses.

Nature conservation values
Alluvial RE 11.3.2 and 11.3.3 (Of concern) – The riparian area of the Dawson River has excellent conservation qualities, there is diverse, mature vegetation (canopy, midstory and ground cover), and very few exotics. The dominant vegetation consists of silver leafed iron bark, and Coolibah. The anabranch is slightly degraded, it has mature and medium aged trees with sparse ground cover in some areas.

Natural resource management objectives
Off-stream watering and fencing will prevent further erosion from cattle pads and vehicle access to the riparian zones and will allow for the revegetation and management of ground cover. There are also water quality and wildlife conservation objectives due to the excellent habitat conditions.

➢ Hummocks

Project description
This project will erect fencing along the Dawson River and provide a secure off-stream watering source to manage stock access to river bank. This will help manage problems caused by cattle access such as degradation of the river bank and stock getting bogged, especially when water levels are drawn down.

Nature conservation values
Of Concern Regional Ecosystem 11.3.25 – mainly eucalyptus dominated riparian zone along Dawson River.

Natural resource management objectives
Reduce any damage caused by stock accessing the river, particularly stock pad erosion and river bank slumping.
Improved water quality in river by reducing the contamination caused by stock.

➢ Kelly's Creek

Project description
Cattle access water from a stock and domestic bore at the yards and the semi-permanent water in the lagoon. The lagoon is located at the bottom of the softwood scrub country and is part of the Kelly's Creek drainage system. This project will augment fence along western side of lagoon with fence along the eastern side between boundary fence and internal fence.

Nature conservation values
RE 11.3.25 (Of concern) – Originally a mixture of brigalow scrub on scrub soils and Eucalyptus tereticornis black soil flats, now cleared and improved pasture. Creek vegetation remains uncleared with two distinct vegetation types existing. In the drier flatter exist pure Eucalyptus tereticornis stands, in areas of permanent/semi-permanent water tea tree is dominant with a scattered blue gum overstorey.

Natural resource management objectives
Allowing the lagoon to dry before giving cattle access will reduce stock damage to soil and vegetation during wet periods. Improved grass and vegetation will slow water flow and increase soil water infiltration that will improve groundwater recharge. The property is located at the edge of the Argoon aquifer and groundwater levels are diminishing.

➢ Macander

Project description
This project constructed 1.75km of riparian fencing along the Dawson River and provided a secure off-stream watering source (with solar pump, tank and trough on a division fence, watering two paddocks) to manage stock access to the river bank. This was to manage problems caused by cattle access such as degradation of the river bank and stock getting bogged especially when water levels are down or fluctuating.

Nature conservation values
Alluvial RE 11.3.25 (Of concern) – Dawson River riparian zone, mainly dominated by Eucalyptus (Coolibah and Box) woodland, no major weeds identified in understorey.

Natural Resource Management Objectives
De-stocking the riparian zone will allow grasses to revegetate and stabilize banks and gullies leading to the river, preventing further erosion. The riparian vegetation forms a wildlife corridor for the entire length of the property and is approximately 150m wide, this vegetation also connects to other corridors located throughout the property. This stretch of the river is a high use recreational area and with constant changes of the river height due to varying demands on the water (by industry, town and irrigation) a number of social and natural resource problems exist with stock on the river banks (getting bogged, water quality). Reduced pressure on the river banks will meet natural resource objectives including soil conservation, biodiversity protection, water quality and fish habitat protection and meet social objectives.

➢ Baalgammon

Project description
Riparian fencing on the Dee River has been on a “give-and-take” system allowing neighbouring properties access to water holes for stock watering purposes. In 1998, a temporary/trial watering point and associated fencing was erected to exclude stock from a section of the Dee River. This has proven successful in terms of re-establishing grasses and ground cover in areas of high stock traffic, controlling noxious weeds and reducing erosion. This paddock has been more easily managed due to ease of stock mustering and no stock illnesses from noxious plants have been evident in that time. This project will therefore accelerate plans to provide fencing and off-stream watering facilities of a more permanent status to completely exclude all stock from the river system. To this end, each section to be fenced was analysed and the level of fencing and provision of watering facilities designed accordingly.

Nature conservation values
Of Concern Regional Ecosystem 11.3.25 – mainly eucalyptus dominated riparian zone along Dee River.

Natural resource management objectives
Prevent any damage caused by stock accessing the Dee River for water.
Management of noxious weeds through increased grass competition and strategic use of fire.
Improved water quality in river by reducing the contamination caused by stock.

Photos of case studies

Story telling/questions and answers from landholders relating to each case study

Background to project

The project established an Incentive Grant Scheme for the provision of fencing and off-stream watering systems. The scheme provided:

- Up to $600 per kilometre of fencing
- $3200 per off-stream watering system.

The actual amount of the grant was influenced by the type and cost of the fencing and off-stream watering system and the land/vegetation area to benefit from the project.

Implementation of the scheme

The basic steps outlined below show how the scheme was administered:

1. Landholder contacted the DCCA to register an expression of interest.
2. Property visit arranged to discuss scheme and potential project, inspect site and take photographs. (form: Landholder Expression of Interest and Property Visit Assessment)
3. A project application is developed between landholder and DCCA. (form: DCCA Survey and Incentive Scheme Application Form)
4. The DCCA Vegetation Project subcommittee assesses application.

5. The DCCA and the landholder negotiate a Voluntary Agreement that outlines the project including budget, implementation, communication, maintenance and monitoring.

- **When it started**

- **How it was advertised**

Around the ridges newsletter – article explaining the scheme, as **well as what is available**?; and **how to get involved**?

Letter to all Landcare groups in the Dawson Catchment.

- **Application and selection process**

- **How projects have progressed**

Involvement
All sectors of the community are engaging in a high and increasing level of activity in riparian restoration. Catchment management groups in Queensland have identified riverine degradation as a key coordinated action at State, regional and local levels. Riparian restoration features in many current Natural Heritage Trust projects. (Environmental Protection Agency 1999:7.42)

Recommended practices and why you should use them

- Fence off remnant and riparian vegetation
- Install off-stream watering

. See benefits above

Guidelines about how to go about it.

- Fence off as much area as landholder can 'sacrifice'

By using this manual, cotton farmers will be developing practical farm plans which minimize any impacts of cotton farming on the environment, as well as demonstrating their commitment to responsible resource management. Cotton BMP Manual P3

This Manual seeks to provide cotton farmers with a framework whereby they can identify (using self-assessment worksheets, hazard analysis) the critical components of their farming operation from an environmental perspective, and then plan and manage how they are going to manage those components. Cotton BMP Manual P3

The Manual seeks to be a *flexible* framework. It is recognized that cotton farming takes place under a wide range of environmental, commercial and social conditions. These varying conditions may place differing constraints on a cotton farmer. By using a planning framework, cotton farmers are able to identify any particular constraints that they may be operating under, and then plan the most appropriate method *for them* of overcoming that constraint. Cotton BMP Manual P3

Due Diligence
The principles of responsible agricultural practices centre around an understanding of the term "due diligence". Due diligence refers to the community's legal and moral expectation of you as a farmer, operator, manager, owner or director to:

- Act responsibly in all your activities and decision making processes;
- Know or be aware of information and issues associated with your activities and decisions that you ought reasonably to know or be advised on;
- Approach and consider any activity or decision in an industrious and persistent manner paying special attention to foreseeable events or situations; and
- Test all assumptions before undertaking an activity or when making a decision. Cotton BMP Manual P5

Commitment
Success with the BMP manual is most likely to be achieved if there is a firm commitment to convert plans and strategies into on-going, effective action plans. This commitment comes from the planner who has a vision of what is required and is driven by appropriate values and an understanding of the issues facing both their own farming operation, and the cotton industry (and farming in general) as a whole. Cotton BMP Manual P6

Cotton farmers' credibility within the community as responsible stewards of the land will grow with commitment, planning and attention to due diligence. Cotton BMP Manual P6

Different types of grazing

- Does this need to be included? Does this influence success of project?

Farmers perspectives on management, why they got involved with the project, their general thoughts

- Some have already done fencing
- If they can get funding that is a bonus
- Funding really doesn't go a long way, so the farmer really has to want to do it
- Often have other reasons for fencing off, not just conservation

Benchmarks

– improvements that should be seen.

The Characteristics of a Successful Implementation Pathway

There are three major arms to a good implementation model. They are:

- The quality of the Best Practice manual.
- The effectiveness of the compliance auditing system.
- The driving forces of the contingent rewards and sanctions. Doak 1998:18

Each of these aspects are now discussed.

The Best Practice Manual

Irrespective of the size or scope of a manual there are some factors which must be present if it is to be part of a successful implementation pathway.

- It should be based on widely collected information so that it represents the whole range of available knowledge.
- It should have been reviewed by a wide range of stakeholders to ensure its acceptability to the broader community.
- It must have a mechanism to keep it up to date and relevant.
- It must be a controlled document. That is, its distribution and receipt should be registered. This should also apply to updates.
- It should be endorsed by relevant interested parties (e.g. Environmental Protection Authority, Murray-Darling Basin Commission). The imprimatur of licensing and support groups adds greatly to the legitimacy of the document for the wider society. Doak 1998:18

The Auditing Mechanism

Many possibilities exist for auditing operators to check their compliance with Best Practice. An industry or individual can choose the ISO path which has the advantages of being a standard approach with wide recognition. Alternatively, an 'in-house' mechanism can be developed where this is more appropriate, or where wide recognition is not thought to be important. There are some essential requirements whichever path is chosen.

- The audit must encompass not only the compliance with Best Practice, but also the management system which assures compliance. ISO Quality Assurance Systems provide the model for this requirement.
- The audit must include, as a minimum, the requirements of the Best Practice endorsing entities.
- The audit system must be clearly defined and have measurable outcomes.
- Audits must take place at intervals which are reasonable and acceptable to interested parties.

- Auditors should be disinterested (third party) and should be acceptable to interested parties.
- A successful audit should produce an unequivocal accreditation marker so that complying operators are clearly distinguished from those who fail to comply or choose to operate outside the system.
- Accreditation arising from an audit must be consistent with the outcome of the audit. This is best achieved when the disinterested auditing entity awards the accreditation. P18

The Driving Forces

The efficiency of the driving forces of the system is a more difficult one to discuss due to the diversity of situations across agriculture. It must be stressed however, that a system of such forces needs to be identified and understood in order to provide the necessary energy to encourage participation and compliance. Some important attributes can be recognized.

- Wherever possible external driving forces should be used and enhanced. Thus an industry can make use of market forces, supply dynamics, public image and regulatory pressures to encourage participation in Best Practice. Where a concomitant partnership model is being used, this approach should be highly effective.
- An industry may need to look for drivers within its own structure to supplement external forces where they are not sufficiently effective. For example industries not subjected to customer pressure for environmental quality assurance may decide to use their own powers to provide rewards and sanctions. Discrimination and restraint of trade issues will need careful consideration.
- Rewards and sanctions must be applied strictly in accordance with compliance to Best Practice, lest the thrust of these drivers be diminished. P19

Indicators

- of change

Indicators – can be used by land managers to determine the status of riparian zones in terms of level of degradation and potential for recovery with changed management practices. RipRap Edition 22 2002:23

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PROJECT REPORT

"Dawson Remnant Vegetation and Riparian Zone Management Project"

In 1999 the Dawson Catchment Coordinating Association commenced a remnant and riparian vegetation management project. In 2002, additional funding was received to continue the project for another year.

Aim: The main aim of the project is to establish a Dawson River Riparian and Remnant Vegetation Incentive Scheme for the provision of fencing and off-stream watering system grants to improve the management of a representative network of riparian and remnant vegetation in the Dawson River catchment to achieve positive biodiversity, water quality and productivity outcomes.

Project summary: The Dawson Remnant Vegetation and Riparian Zone Management Project has established an Incentive Scheme for the provision of fencing and off-stream water system grants. The Incentive Scheme has encouraged landholders to consider alternative management practices for key riparian and remnant vegetation in the Dawson River Catchment. Project sites now exist throughout the whole catchment, increasing access at organised field days. Changes in practices are leading to positive biodiversity, water quality and productivity outcomes.

Short-term objectives:

- From Dawson River Catchment: Targeting sustainability through community participation, coordination and integration.
- Conduct community training to increase community skills and establish a monitoring program that to assess changes in remnant and riparian vegetation where management practices have altered as a result of the DCCA Incentive Scheme.
- Develop a booklet and case studies containing best management practices for at least ten different remnant and riparian vegetation sites and promote these practices throughout the Dawson Catchment and Fitzroy Basin.

Short-term objectives:

- From Dawson Remnant Vegetation and Riparian Management Project.
- Prepare guidelines for operation of Incentive Scheme and allocation of funds and operate Incentive Scheme in fair transparent manner.
- Broad public/landholder awareness of Incentive Scheme.
- Obtain baseline data on landholder remnant vegetation and riparian zone management practices in catchment for project planning and evaluation and monitoring purposes.
- Access best available riparian zone management and biodiversity information to provide objective criteria for Incentive Scheme assessment process.
- Ensure conservation (biodiversity, weed control, water quality) and productivity outcomes (stock water quality improvement, soil conservation, pasture and stock management) are achieved on a project by a project basis.
- Ensure a monitoring program is established for each site.
- Coordinate on a whole of catchment basis via Landcare groups, especially field days/bus trip and other extension/communication activities.

The Incentive Scheme

The project established an Incentive Grant Scheme for the provision of fencing and off-stream watering systems. The scheme provided:

- Up to $600 per kilometre of fencing
- $3200 per off-stream watering system.

The actual amount of the grant was influenced by the type and cost of the fencing and off-stream watering system and the land/vegetation area to benefit from the project.

Implementation of the scheme

The basic steps outlined below show how the scheme was administered:

1. Landholder contacted the DCCA to register an expression of interest.
2. Property visit arranged to discuss scheme and potential project, inspect site and take photographs. (form: Landholder Expression of Interest and Property Visit Assessment)
3. A project application is developed between landholder and DCCA. (form: DCCA Survey and Incentive Scheme Application Form)
4. The DCCA Vegetation Project subcommittee assesses application.
5. The DCCA and the landholder negotiate a Voluntary Agreement that outlines the project including budget, implementation, communication, maintenance and monitoring.

DCCA Remnant Vegetation and Riparian Zone Management NHT Project

Project Output Summary

Name	Address	Parish & Portion no.	Length Fencing	Length of Piping & Watering	Area/type Remnant vegetation	Bushcare Grant (inc GST)	Total Project Cost
Alec & Annette Reid	"Newlands" DUARINGA Q 4702 Ph: 07 4935 7237	Gainsford 276	1.7 km	0.15 km pipe 1 system 1 trough	13 ha 11.3.25	A – $ 3 729	$12 522
Peter & Susan Sparkes	"Hornet Bank" TAROOM Q 4420 Ph: 07 4627 0380	Hornet Bank L10/RP880092	2.4 km	0.75 km pipe 1 system 1 trough	40ha 11.3.25	B – $ 4 700	$22 586
Owen & Hazel Anderson	"Woodleigh" PO Box 76 THEODORE Q 4719 Ph: 07 4997 4147	Woolthorpe Lot 1, 20, 21, 22, 23	1 km	4 km pipe 2 systems 5+ troughs	 11.3.25 11.3.1	A – $ 6 400 B – $ 660	$50 770
Richard & Helen Golden	"Potter's Flat" YULEBA Q 4427 Ph: 4623 5228		2.5 km 12 km non project	4.5 km pipe 1 ½ systems 6 troughs 18 km managed	750ha 11.3.24, 11.3.25 11.3.4 11.3.2	A – $ 4 800 B – $ 1 500	$46 518
Raymond & Rinna Rider	"Weel Ne-er" MS 914 MOURA Q 4718 Ph: 07 4997 1782	Ghinghindi Lot 1 on LE32	4 km	½ system 2 troughs	77 ha 11.3.4 11.3.27	A – $ 2 000	$8 895
Bruce & Glenda Gill	13 Denby Street Portion 5, Alberta Rd BARALBA Q 4702 Ph: 07 4998 1196	Wright Potion 5	0.7 km	½ system 1 trough	3.5 ha 11.3.25	A – $ 2 020	$10 339
Les & Lois Peacock	"Baalgammon" DULULU Q 4702 Ph: 07 4937 1182	Bunerba L11 Rag 4083 L2 Rag 4070 L1 Rag 4068	2.7 km	1 system 3 troughs	46 ha 11.3.25	A – $ 4 820	$24 018
Keith Glasgow	Valentine Plains Rd PO Box 806 BILOELA Q 4715 Ph: 07 4992 3270	Callide 19 & 20		4.25 km 1 system 6 troughs	10 ha 11.3.25	A – $ 3 200	$63 216
John Creed	"Cecilwood" RAGLAN Q 4697					A – $ 7 040	

Barry Hoare	"Springhill" DUARINGA Q 4702 Ph: 07 4935 0123	Waratah 1TL2115557/68 1GHPL35/9703/5	21.5 km (6km DCCA)	2 km 2 systems 4 troughs	200 ha	A – $ 3 520 B – $ 3 960 C – $ 3 520	$66 427
Bill Zahnleiter	"Durak" DUARINGA Q 4702 Ph: 07 4998 1256	Olinda Lot 12	1 km	0.5 km ¾ system 1 trough	15 ha 11.3.25	A – $ 3 520	$10 478
Sam & Leesa Rathbone	"Kelsall" WANDOAN Q 4419 Ph: 07 4627 4972	Juliet Portion 19	4.5 km	2.6 km 1 system 2 troughs	45 ha 11.3.25	A – $ 3 520 B – $ 2 970	$22 094
Lindsay Berry	"Pleasant Valley" 366 Mt Molar Rd MS 223 NOBBY Q 4360 Ph: 07 4696 3220	Simmie, Westgrove L10/WT16 L11/WT292	7.5 km	3 systems 3 troughs	204 ha 11.3.25 11.9.4 11.10.11 11.3.2	A – $11 223	$52 359
Stephen & Ann Press	"Mimosa Park" DUARINGA Q 4702 Ph: 07 4935 0143	Nulalbin GHFL35/9778 Lot 5 on KM218 SL35/32375 Lot 7 on KM 175	6 km 7.5 km 22 km + 104 km = 140 km	42.75 km 5 systems 23 troughs	145 ha & 2 300 ha mgt 11.3.25 11.5.3 11.3.7, 11.3.2	A – $ 7 040 B – $ 3 520 2nd agreem't A – $ 5 280 B – $14 520	$271 600
Glen & Betty Bailey & sons	"Glen Lomond" BARALABA Q 4702 Ph: 07 4998 1262	Granville Lot 42	7 km	3.5 km 3 systems 6 troughs	360 ha 11.3.25	A – $ 4 510 B – $ 6 160 C – $ 4 510	$57 250
Vaughan Bennett	"Macander" PO Box 144 MOURA Q 4718 Ph: 07 4997 1214	Roundstone Lot 4, Plan Bh48		0.3 km 1 system 1 trough	27 ha 11.3.25	A – $ 4 455	$20 340
Rodney Reithmuller	"Oombabeer" site "Allambee" ROLLESTON Q 4702 Ph: 07 4984 4521	Pegunny L10	6.4 km	11 km 4 systems 11 troughs	550 ha 1221 ha mgt 11.3.25 11.3.1, 11.3.3 11.4.3, 11.4.8 11.9.1, 11.9.5	A – $ 7 040 B – $ 7 040	$50 614
Grant Austin	"Coominglah" BARALABA, 4702 Ph: 07 4998 1002	Alberta 13. 14. 15 SL R29	1.5 km		30 ha 11.3.11 11.3.25	A – $ 990	$ 5 478
John & Ann Macrae	"Kilmory" MOURA, 4718 Ph: 07 4996 3123	Pegunny 11	1.9 km	0.8 km 1 ½ system 2 troughs	68 ha 11.9.1	A – $ 4 534	$25 618
Rodney & Catherine Collins	PO Box 99 BILOELA, 4715 Ph: 07 4992 9124	Spier Lot 52, RN 349	0.75 km	1 km 1 system 1 trough	3.75 ha 11.3.25	A – $ 3 520 B – $ 440	$12 945

Alec Breckenridge	"Otway" THEODORE Q 4719 Ph: 07 4993 1641	Country Southend Labouchere 26		2.5 km 1 system 2 troughs	10 ha 11.3.25	A – $ 3 520	$18 864
David Curran	"Two-up" TAROOM Q 4420 Ph: 4627 3379	Carraba L8/FT12 113/103			11.3.3	A – $ 3 520	
John Phipps	Ramyard TAROOM Q 4420 Ph: 07 4627 3217	Norham Lot 19 on Survey Plan 109522	1.1 km			A – $ 3 520 B – $ 660	
Peter Mundell	92 Currans Lane TAROOM Q 4420 Ph: 07 4628 6245	Taroom Lot 120/ FT52		1 system	10 ha 11.3.25 11.3.3	A – $ 3520	$13 590
Ken & Claudia Stephenson	"Wilga Vale" MOURA Q 4718 Ph: 07 4997 1430	Lot 19 on FN 2001	2.6 km	1 system 2 troughs	32 ha 11.3.25 11.3.3	A – $ 3 520 B – $ 1 650	$20 908
Alan Austin	"Harcourt" BARALABA Q 4702 Ph: 07 49981326	Fairview 12	3.5 km	2.5 km pipe 1 system 2 troughs	35 ha 11.3.25 11.3.11	A – $ 2 915	$12 710
Doug, Barbara & Lester Maclean	"Denby" BARALABA Q 4702 Ph: 07 49971762	Perch L7 AF9533	1 km	0.2 km pipe 1 system 1 trough	60 ha 11.3.2 11.3.11	A – $ 3 960	$15 101
Bob Strachan	"Lochinvar" MS 351 BARALABA Q 4702 Ph: 07 4998 1308	Barnard L8 KM277	6 km		60 ha 11.3.25 11.3.11 11.4.8	A – $ 3 960	$15 101
Paul & Karen Woods	"Riverview" DUARINGA Q 4712 Ph: 07 4935 7321	Gamaford L38 PN276 PLS8226	2 km		20 ha 11.3.25 11.3.1 11.3.4	A – $ 1 320	$8 704
Owen Kelso	"Mostowie" BARALABA Q 4702 Ph: 07 4998 1385	Perch L5 RM86	4.3 km	1.3 km pipe ½ system 1 trough	86 ha 11.3.25 11.3.11 11.3.2	A – $ 4 598	$17 678
Doug & Lexie Howard	"Bindaree" MOURA Q 4718 Ph: 07 4997 3044	Fairview L2	1 km		10 ha 11.3.3 11.3.2	A – $ 660	$ 6 960
Paul & Bronwyn McLellan	"Alberta Vale" BARALABA Q 4702 Ph: 07 4998 1371	Wright L5/ RP856821 30641163	1.8 km	1 system 1 trough	35 ha 11.3.3 11.3.1 11.3.11	A – $ 4 708	$23 602
Alan & Sharyn	"Shandon"	Duaringa East	0.5 km	3 km pipe	5 ha	A – $ 4 730	$37 879

Buchanan	DUARINGA Q 4712 Ph: 07 4935 7002	L2/CP847222 GHFL/35/9006 Easement: L20/CP847222		1 ¼ system 3 troughs			
		TOTALS	**243.4 km**	**87.60 km pipe** **39 systems** **91 troughs**	**5776.25 ha**	**$193 422**	**$1 025 163**

Bank: $82 642
Grants unpaid: $62 735
In-kind: $831 741

Riparian and remnant vegetation

What is remnant vegetation?

“Many parts of Queensland’s forests, woodlands, grasslands, wetlands and heath lands have been changed significantly. The natural landscape of continuous native vegetation has been cleared to allow pasture, plantation forestry, cultivated crops and urban and commercial development. This has greatly influenced many natural ecological systems.

Although some regional ecosystems have remained intact, many areas have changes to the plants and animals present, and to the vegetation structure. Today, many areas of native vegetation exist as remnant systems.

These remnant areas are patches of native vegetation, varying in size and shape, and lying as fragments within cleared and human-modified land” (Field ed. 1998:25).

Bushland remnants are areas of native vegetation that have not been cleared for agriculture, grazing and land uses such as urban development. In many cases these areas have significant conservation value because they are representative of a once widely spread form of vegetation. These areas merit special management attention to limit impacts from fire, grazing and weeds.

What is riparian vegetation?

Riparian land is any land that adjoins or directly influences a body of water. It includes land alongside small creeks and rivers, including the riverbank itself, gullies and dips which sometimes run surface water, areas surrounding lakes and lagoons on river floodplains that interact with the river in times of flood. Riparian areas merit special management attention because of their value in providing good quality water, wildlife habitat and other values.

“Riparian lands are that part of the landscape adjacent to streams which exert a direct influence on streams or lake margins and on the water and aquatic ecosystems contained within them. Riparian land includes both the stream banks and a variable sized belt of land along side the banks” (Karssies & Prosser 1999:3).

Functions of riparian land?

- “Stabilise banks against erosion
- Reduce sediment delivery to streams
- Modify water quality by filtering nutrients and other pollutants
- Control plant growth in streams
- Maintain in-stream habitat
- Provide food for aquatic ecosystems
- Provide terrestrial habitat and wildlife corridors
- Provide aesthetic value and recreation
- Provide economic value” (Karssies & Prosser 1999:4).

Managing vegetation

“Management may involve fencing, regeneration, replanting, controlling external influences, weed control, altering grazing levels and burning practices” (Field ed. 1998:28).

Monitoring

Monitoring is designed to gather information that will allow you to detect and assess change taking place over time. This information has the potential to improve future decisions and actions. Recent, or past management, natural occurrences, or land-use practices may cause these changes.

Monitoring allows one to determine what is really happening within a specific area, as well as help to establish best management practices for individual site or whole of property areas. The effectiveness of land management practices being applied to the land can also be determined by monitoring.

The aim of monitoring is to develop a long-term record of changes within a specific area, or on a whole of property scale. It should be simple or as complex as the individual wishes it to be.

Monitoring is important for two specific reasons:

1. It is a valuable tool for improving management practices; and
2. It allows us to know whether resource conditions are stable, improving or declining.

Monitoring is an important management tool that can play an integral role in improving one's understanding of the land and your property management.

To effectively monitor your project or site in question, it helps to assess:

- Your aims (what is it you would really like to achieve?);
- What was there before you started?;
- Your work methods (how you organised your monitoring);
- The outcomes of your work (how things changed due to your efforts). What was there after you completed your project?
- How you measured your achievements?

The monitoring process can be broken down into the following parts:

- Identifying issues
- Identifying sites
- Photographing sites
- Recording results
- Interpreting results

Examples of what can be monitored

- Ground cover and composition
- Water quality
- Ecosystem and vegetation health
- Flora and fauna present
- Erosion.

Possible indicators of change

- Proportions of trees, grasses, shrubs etc.
- Increase/decrease in weeds/exotics.
- Increase/decrease in species diversity.
- Increase/decrease in erosion.
- Increase/decrease in leaf litter.
- Evidence of cattle pads.

Some suggested criteria for selecting monitoring techniques:

- Easy to use

- Accuracy
- Practical
- Cost effective
- Useful
- Results can be easily interpreted

General site information that may be needed:
- Area of site (including area of vegetation and area of benefit)
- Length of fencing (if fencing was part of project)
- Regional ecosystem type
- Presumed natural or original condition of vegetation
- Information about cattle and grazing (e.g. number of head in an area, how often they are rotated)
- Information about watering system (e.g. where it is located in relation to the project site).

Monitoring workshops

In order to show landholders a variety of monitoring techniques workshops were held in three major locations within the Catchment, these being Baralaba, Moura and Biloela. Each workshop was held on a property that had been involved in the Incentive Scheme. The workshops involved a number of Project Officers with different fields of expertise, these coming from Greening Australia, Fitzroy Basin Association, Taroom Shire Landcare and the Department of Natural Resources and Mines.

Workshops focused on: water sampling; photo points; ground cover; and general vegetation and site assessment. Photo points were promoted as the minimum standard of monitoring. Monitoring kits were given to all landholders who participated in the Incentive Scheme. The kits consisted of a monitoring booklet and recording sheets; bucket, rope and sample bottles for water sampling; disposable camera; and quadrat.

Benefits of monitoring for purpose of project:
- Inform governments/land managers of the impact of our efforts on natural resources; and
- Demonstrate the worth of project/group/organisation.

Monitoring information can include:
- The number of outputs (i.e. services, activities, products)
- Recorded changes (eg. resource condition or behaviour).

Regional ecosystems

“Regional ecosystems are an integrated entity derived from landscape pattern, geology and landform, and vegetation, so as to provide a robust classification for biodiversity planning that incorporates ecological processes at the landscape scale. Regional ecosystems of Queensland are often the primary basis for planning the conservation of biodiversity. They are defined within a hierarchical framework commencing with the classification of Queensland into bioregions” (pvii Sattler, P.S. & Williams, R.D. (eds) 1999, *The Conservation Status of Queensland’s Bioregional Ecosystems*, Environmental Protection Agency, Brisbane).

A regional ecosystem is a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil. This description is in accord with the definition of an ecosystem provided by the Endangered Species Scientific Subcommittee (1995):

> The concept of an ecological community is that species form groupings that occur in the wild as distinct geographic entities. Ecological communities are aggregations of species that interact with each other and their abiotic surrounding. With their abiotic surrounding, ecological communities form ecosystems. (p1/7)

Bioregions represent the primary level of biodiversity classification in Queensland at a scale of approximately 1:1 000 000 – 1: 2 500 000. (p1/4)

These regions are based on broad landscape patterns that reflect the major structural geologies and climate as well as major changes in floristic and faunistic assemblages. (p1/4)

Regional ecosystems have been derived for each bioregion in a number of ways, depending on the availability of mapped and descriptive information. In bioregions where the major source of information available is land system mapping, similar land units or land facets have been grouped within provinces into land types, and similar land types have been amalgamated across the bioregion to form regional ecosystems. Where the land system coverage is incomplete, geological maps and other information sources have been used to extrapolate existing information. In bioregions where comprehensive vegetation mapping is the dominant source of information, similar floristic associations within the same land zones have been grouped into regional ecosystems.

Numbering
The regional ecosystems have a three-part number:

- The first number is the bioregion;
- The second number is the geomorphic category or land zone that the ecosystem falls within (e.g. all regional ecosystems occurring on basalts are grouped);
- The third number is the ecosystem number, and relates to the dominant vegetation.

Brigalow Belt
The brigalow belt bioregion has 36 provinces.

Land zones
Twelve land zones are recognized in Queensland. Each represents a significant difference in geology and in the associated landforms, soils and physical processes that gave rise to distinctive landforms or continue to shape them. Generally speaking, the land zones correspond to broad geological categories, or groupings of these. (p1/7)

Land zone 3
Cainozoic alluvial plains and piedmont fans. Includes terraces, levees, swamps and channels of Quaternary alluvium and palaeo-estuarine deposits, and older floodplain complexes and piedmont fans with palaeo-stream channels. Also includes inland freshwater lakes and associated dune systems. Does not include talus slopes. Soils include deep cracking clays, loams, earths, and poorly developed alluvial soils.

Land zone 4
Cainozoic clay deposits, usually forming gently undulating plains with poorly developed drainage systems. Deep cracking clays of moderate to high fertility, often with gilgai microrelief, and texture contrast soils. Excludes clay plains and downs formed on older bedrock.

Land zone 5
Cainozoic sand deposits, usually forming extensive, uniform near-level or gently undulating plains. Includes slightly dissected surfaces and small remnants of these

surfaces. Soils are usually sands, earths or texture contrast and often overlie laterite profiles. Includes extensive sand plains of uncertain origin overlying weathered or unweathered bedrock. Excludes alluvial deposits (land zone 3), exposed duricrust (land zone 7) and shallow soils derived from underlying bedrock.

Land zone 9
Cainozoic to Proterozoic consolidated, fine-grained sediments with little or no deformation. Siltstones, mudstones, shales, calcareous sediments and lithic sandstones are typical rock types although minor interbedded volcanics may occur. Usually undulating landscapes with fine-textured soils of moderate to high fertility. Excludes areas of duricrust (land zone 7).

Land zone 10
Cainozoic to Proterozoic consolidated, medium to coarse-grained sediments with little or no deformation. Includes siliceous sandstones and conglomerates forming ranges, plateaus and scarps with shallow soils of low fertility. Minor interbedded volcanics may occur. Excludes overlying Cainozoic sand deposits (land zone 5), but includes in situ earths and texture contrast soils. Also includes springs associated with these sediments.

Provinces
The bioregions usually contain a number of distinctive subregions or provinces. These provinces delineate significant differences within the bioregion in landscape pattern usually associated with geology and geomorphology or finer climatic differences. The provinces therefore have a characteristic pattern of landform and vegetation, and generally indicate major differences in land processes and energy budgets, and species distributions and patterns of movements. Provinces may be defined by a suite of land systems that are largely restricted to that province.

Provinces provide a framework for the future description of detailed land types nested within regional ecosystems at a scale of 1:50 000 – 1:100 000.

Province 3, Cape River Hills, consists of Devonian and Carboniferous sediments and volcanics, obscured in many places by duricrusts. The landforms include linear hills and mesas and breakways. Soils are predominantly shallow loams, sands and duplex soils. The vegetation comprises lancewood and bendee Acacia *shirleyi/catenulate* scrubs, *Eucalyptus persistens* low woodlands and small areas of brigalow *Acacia harpophylla* and/or blackwood, *A. argyrodendron* low open forest.

Province 4, Beucazon Hills, consists of fine-grained Devonian sediments and metasediments which form undulating to mountainous country. There are also areas of igneous rocks. Soils are mostly duplex shallow and rocky. The vegetation includes narrow-leaved ironbark *Eucalyptus crebra* woodlands and lancewood *Acacia shirleyi* low open forest with *E. persistens*, poplar box *E. populnea*, mountain Coolibah *E. orgadophila* and silverleaved ironbark *E. melanphloia* on lower slopes, and forest red gum *E. tereticornis* and Coolibah *E.coolabah* along watercourses.

Province 5, Wyarra Hills, comprises predominantly upper Carboniferous volcanics, mantled in places by Tertiary duricrust. The topography includes a fringing core of low hills with duplex soils and lateritic mesa tops and breakaways with shallow rocky soils. Vegetation comprises silver-leaved ironbark *Eucalyptus melanophloia* woodland with bloodwoods *Corymbia* spp. and lancewood *Acacia shirleyi* and/or bendee. *A. catenulate* on scarps and mesas, and *Eucalyptus persistens*, poplar box *E. populnea* on lower slopes. There are also scattered small patches of blackwood *Acacia argyrodendron*.

Province 9, Anakie Inlier, has two distinct parts – a northern rugged area of Cambrian-Ordovician finegrained metamorphic rocks, and a southern undulating area of Devonian

granites that have intruded into them. On the metamorphics the steeper areas have lancewood *Acacia shirleyi* or bendee *A. catenulate* scrub, or narrow-leaved ironbark *Eucalyptus crebra* woodlands. The woodlands may have a dense understorey of rosewood *Acacia rhodoxylon*. The granites have a silver-leaved ironbark *Eucalyptus melanophloia* woodland, usually with red bloodwood *Corymbia erythrophloia*.

Province 10, Basalt Downs, is formed almost entirely on Tertiary basalts. It occurs as two separate parts: a northern section, which is dominantly undulating and contains areas of lower catena Tertiary sediments; and a southern section which is predominantly hilly and contains areas of outcrop of Permian sediments. The more undulating the areas carry a bluegrass *Dichanthium sericeum* grassland with mountal Coolibah *Eucalyptus orgadophila* on hillier areas, often with silver-leaved ironbark *E. melanphloia* and red bloodwood *Corymbia erythrophloia*. Coolibah *Eucalyptus coolabah* occurs on floodplains. In the north, on Tertiary weathered basalts, gidgee *Acacia cambagei* scrub and brigalow *A. harpophylla* scrub are common, belah *Casuarina cristata* often occurring with the latter. Narrow-leaved ironbark *E. melanophloia* and red bloodwood *C. erythrophloia* on rugged basalt areas. On the Permian sediments, narrow-leaved ironbark or poplar box *Eucalytus populnea* form open or shrubby woodlands.

Description
The geology, landform, soil and vegetation that characterise each regional ecosystem are briefly described. This description is not intended to be exclusive, but is the typical expression of the ecosystem based on the best available knowledge. Variation on a theme is to be expected, particularly in the relative dominance of characteristic plant species.

Extent reserved
The extent of regional ecosystems within protected areas is classified as:

- High >10% of original extent
- Medium 4-10%
- Low <4%

The high category, >10%, is based on IUCN (1994) guideline within the Caracas Declaration, which identified that 10% of each biome should be preserved. The medium category, 4-10%, merely reflects that this level would proportionally exceed the total area that is currently reserved in the protected area estate in Queensland (3.8%). The low category, <4%, reflects that representation is proportionally less than the total park area in the State and is low indeed. Where data are available the area of each regional ecosystem in protected areas is given.

Conservation status
Estimated extent
The extent to which a regional ecosystem remains at present has been largely determined by comparing remnant vegetation mapping and Landsat images with pre-European vegetation mapping.

Some regional ecosystems, although superficially intact, have undergone marked alternations in terms of species composition and structure. This especially applies where there has been significant soil loss or deterioration that would influence the recovery of the natural vegetation. Where the biodiversity of the regional ecosystem has been greatly comprised, although the tree layer may be largely intact, the estimated extent remaining in an intact condition (i.e. naturalness) is reduced to reflect the degree of change. This often applies to riparian ecosystems, where a long history of concentrated grazing pressure or weed invasion has had a lasting impact on natural values and the capacity to recover. Assessment of condition has drawn upon historical records such as botanical descriptions,

geological surveys, surveyors' records, explorers' and settlers' reports and assessments of pasture condition and trend.

Where status of a regional ecosystem is defined primarily by condition, this relates to the current remaining area in its natural condition, not the previously degraded areas of that regional ecosystem.

Criteria
The conservation status of regional ecosystems is based on their remaining extent in the bioregion together with their condition and the presence of threatening processes.

The conservation status of individual regional ecosystems has been assessed in terms of three classes, defined as endangered, of concern and no concern at present.

Endangered: less than 10% of pre-European extent remains in an intact condition across the bioregion, or its distribution has contracted to less than 10% of its former range.

Regional ecosystems classed as endangered because of condition are those in which severe degradation has occurred over an extensive area. They include bioregions where floristic diversity is greatly reduced and is unlikely to naturally recover in the medium to long term and/or the soil surface is severely degraded, including for example, loss of the A horizon.

Of concern: 10-30% pre-European extent remains in an intact condition in the bioregion.

Regional ecosystems classed as of concern because of condition are those in which moderate degradation has occurred. They include bioregions where floristic diversity is greatly reduced but may recover with the removal of threatening processes, and/or where the soil surface is moderately degraded.

Some regional ecosystems of high biodiversity value that have significantly contracted in extent and are now highly fragmented have been classed as of concern; for example, semi-evergreen vine thickets of the Brigalow Belt.

No concern at present: over 30% of pre-European extent remains in an intact condition in the bioregion.

Regional ecosystems considered to be of no concern at present are those in which little to no degradation has occurred. These include areas where floristic diversity is largely intact over most of the regional ecosystems and/or little to no soil degradation has occurred.

The **endangered** class is based upon the category established for plant species, namely a species at serious risk of disappearing from the wild within 10-20 years if present land use and other casual factors continue to operate. This category also correlates with the definition of an endangered ecological community under the *Commonwealth Endangered Species Act 1994*.

The **of concern** class indicates that a significant reduction in the distribution or condition of a regional ecosystem has occurred and that a particular management response is needed to ensure that it does not become endangered. The of concern category corresponds with the definition of a vulnerable ecosystem defined for forests.

The **no concern at present** class indicates that the ecosystem is relatively widespread.

Regional ecosystems that have a conservation status of endangered or of concern are considered collectively, as threatened.

Some regional ecosystems have a naturally limited extent. That is, their original occurrence across a bioregion was or is not extensive. In certain circumstances these types are relatively secure and not subject to any particular threat.

However, in the event of a threatening process occurring, the potentially rapid change to the status of these regional ecosystems necessitates that specific criteria be developed to define their conservation status.

Two categories are used to define ecosystems having a naturally limited extent: **rare** and **naturally** restricted.

A rare ecosystem is defined as having an original extent of less than 1000 ha, or patch sizes generally less than 100 ha which in total occur only over a limited extent across the bioregion, or the total range of the regional ecosystem is less than 10 000 ha. This chiefly relates to areas where 1:100 000 mapping is available, such as Southeast Queensland and the Wet Tropics.

A rare regional ecosystem subject to a threatening process is regarded as **endangered**. This reflects that such types would easily be lost where threatening processes occur. This definition also relates to the definition used in the guidelines for the *Endangered Species Act 1992*, though the nomenclature for rare is different. A rare regional ecosystem not subject to a threatening process is regarded as **of concern**.

For most of Queensland mapping is available only at a scale of 1:250 000 rather than 1:100 000. It is therefore appropriate to recognize regional ecosystems that are naturally restricted at a broader scale, as these may contain rare land types and become of concern or endangered relatively quickly.

A **naturally restricted** ecosystem is defined as having an original extent of less than 10 000 ha. If a naturally restricted type has been reduced to between 10 and 30% of its natural distribution it is considered **endangered**. If it is subject to a threatening process, a naturally restricted type is considered to be **of concern**.

Threats to biodiversity
The major threats to biodiversity are continued tree clearing, high total grazing pressure and the proliferation of exotic species. Major water infrastructure development and the expansion of intensive agriculture are emerging issues. While tree clearing in much of the bioregion occurred in the past, clearing of remnants and regrowth is now occurring as part of improving farm productivity. Furthermore, the focus of tree clearing is shifting from the essentially cleared acacia ecosystems on fertile soils to the eucalypt woodlands on poorer soils. Broadscale clearing is also continuing in the drier north-western part of the bioregion, where moderate areas of some ‘at risk’ regional ecosystems remain. Clearing has been accompanied by the introduction and spread of non-native pasture species such as buffel grass *Cenchrus ciliaris* which invades some intact natural regional ecosystems.

Regional ecosystem 11.3.1
Description: Open forest of *Acacia harpophylla* and/or *Casuarina cristata* with low trees *Geijera parviflora*, *Eremophila mitchelii* + - emergent *Eucalyptus* spp. e.g. *E. coolabah*, *E. populnea*, *E. pilligaensis* on Cainozoic alluvial plains. Cracking clay soils.
Extent reserved: Low.
Comments: Extensively cleared for cropping and pasture. Sometimes occurs as low open forest or woodland. Invades adjacent eucalypt woodland e.g. *Eucalyptus populnea* woodland.
Estimated extent: About 15% remains of an estimated preclearing area of 463 000 ha.
Conservation status: Endangered.

Regional ecosystem 11.3.2
Description: Woodland to open woodland of *Eucalyptus populnea* on Cainozoic alluvial plains. Understorey grassy but low trees and shrubs may be present. Scattered low trees sometimes present e.g.*Acacia salicina*, *Lysiphyllum* spp., *Cassia brewsteri* and *Eremophila mitchellii*. *Acacia aneura* in south-west of bioregion. Texture contrast, deep uniform clays and sometimes cracking clay soils.
Extent reserved: Low.
Comments: Extensively cleared or modified by grazing. Scattered patches of low *Acacia harpophylla* associated with this type in some areas.
Estimated extent: About 30% remains of an estimated preclearing area of 1 460 000 ha.
Conservation status:Of concern.

Regional ecosystem 11.3.3
Description: Grassy woodland to open woodland of *Eucalyptus coolabah* on Cainozoic alluvial plains. Sometimes as a grassland (e.g. *Astrebla lappacea*)with emergent *Eucalyptus coolabah*. Other tree species may be present e.g. *Melaleuca bracteata* and *Acacia pendula*.
Extent reserved: Low
Comments: Understorey of remnants tends to be extensively modified by grazing.
Estimated extent: About 35% remains of an estimated preclearing area of 743 000 ha.
Conservation status: Of concern.

Regional ecosystem 11.3.4
Description: Tall woodland or open forest of *Eucalyptus tereticornis* or *E. camaldulensis* on Cainozoic alluvial plains. Other species that may be present include *Corymbia tessellaris*, *Eucalyptus coolabah*, *C. clarksoniana*, *E. populnea* or *E. brownii*, *E. melanophoia*, *E. platphylla*, *Angophora floribunda*, *Lophostemon suaveolens*.
Extent reserved: Low. While this regional ecosystem is contained within a number of protected areas, the total area reserved is small.
Comments: Occurs on alluvial and terraces, as opposed to RE 11.3.25 which is restricted to stream banks. Regional ecosystem includes a wide range of vegetation associated with present day watercourses. Much remains uncleared, though remnants are generally degraded by grazing, dieback and associated lack of natural regeneration and weed invasion.
Estimated extent: 10-30% remains in intact condition.
Conservation status: Of concern.

Regional ecosystem 11.3.7
Description: Tall woodland of *Corymbia clarksoniana*, *C. tessellaris* and *C. dallachiana* on Cainozoic alluvial plains. Sandy soils.
Extent reserved: Low.
Comments: Subject to total grazing pressure and invasion by buffel grass.
Estimated extent: <30% remains in an intact condition.
Conservation status: Of concern

Regional ecosystem 11.3.11
Description: Semi-evergreen vine thicket and semi-deciduous notophyll rainforest on Cainozoic alluvial plains.
Extent reserved: Low.
Comments: Regional ecosystem includes small areas of notophyll vine forest in coastal parts of bioregion. Extensively cleared for cropping and grazing. Remnants subject to weed invasion and trampling by livestock.
Estimated extent: 10-30% remains of a naturally restricted type.
Conservation status: Endangered.

Regional ecosystem 11.3.24
Description: *Themeda avenacea* grassland on Cainozoic alluvial plains. *Themeda avenacea* tends to grow on hummocks and *Eleocharis pallens* in hollows.
Extent reserved:
Comments: Utilised for intensive cropping.
Estimated extent: <10% remains of a naturally restricted type.
Conservation status: Endangered.

Regional ecosystem 11.3.25
Description: Fringing woodland of *Eucalyptus tereticornis* or *E. camaldulensis*, generally with *Casusrina cunninghamiana*, *Callistemon viminalis* and *Angophora floribunda* on Cainozoic alluvial plains. Fringing forest and woodland. Stream channels especially in eastern parts of bioregion.
Extent reserved: Low.
Comments: Often associated with RE's 11.3.2 and 11.3.4 where it fringes larger watercourses. In cleared country, a narrow fringe of riparian vegetation is often the only surviving woody vegetation. Impact by total grazing pressure.
Estimated extent: 10-30% remains in an intact condition.
Conservation status: Of concern.

Regional ecosystem 11.3.27
Description: Freshwater wetlands with aquatic vegetation (lagoons) associated with Cainozoic alluvial plains.
Extent reserved: Low.
Comments:
Estimated extent: >30% remains but subject to modification as a consequence of total grazing pressure and competition for water from irrigation.
Conservation status: Of concern.

Regional ecosystem 11.4.3
Description: *Acacia harpophylla* and/or *Casuarina cristata* + - scattered eucalypts (e.g. *Eucalyptus pilligaensis*, *E. populnea*, *E. cambageana*, *E. thozetina* and *E. largiflorens*) + - *Brachychiton rupestris*, open forest usually with *Geijera parviflora* and *Eremophila mitchellii* in understorey on Cainozoic clay plains. Cracking clays often gilgaied. *Melaleuca bracteata* often present in low lying areas.
Extent reserved: Low.
Comments: Extensively cleared for cropping and pasture.
Estimated extent: About 60% remains of an estimated preclearing area of 2 250 000 ha.
Conservation status: Endangered.

Regional ecosystem 11.4.8
Description: *Eucalyptus cambagena*, *Acacia harpophylla* and/or *A. argyrodendron* woodland on Cainozoic clay plains.
Extent reserved: Low.
Comments: Extensively cleared for pasture.
Estimated extent: About 21% remains of an estimated preclearing area of 606 000 ha.
Conservation status: Of concern.

Regional ecosystem 11.5.3
Description: Shrubby woodland with Eucalyptus populnea and/or E. melanophloia + - Corymbia clarksoniana + - C. dallachiana on Cainozoic sand plains. Lowlands. Deep red earths. Understorey includes Eremophila mitchellii, Geijera parviflora and Ventilago viminalis.
Extent reserved: Low.

Comments: Extensively cleared for pasture or modified by total grazing pressure.
Estimated extent: About 52% remains of an estimated preclearing area of 450 00 ha.
Conservation status: No concern at present.

Regional ecosystem 11.9.1
Description: *Eucalyptus cambageana* or *E. thozetina*, *Acacia harpophylla* shrubby open forest on Cainozoic to Proterozoic consolidated, fine-grained sediments. Understorey includes *Eremophila mitchellii*, *Carissa ovata* and rarely *Terminalia oblongata*.
Extent reserved: Low.
Comments: Extensively cleared for cropping and pasture.
Estimated extent: About 16% remains of an estimated preclearing area of 117 000 ha.
Conservation status: Of concern.

Regional ecosystem 11.9.4
Description: Semi-evergreen vine thicket on Cainozoic to Proterozoic consolidated, fine-grained sediments. Emergents may be present including *Acacia harpophylla*, *Eucalyptus populnea*, *Casuarina cristata*, *Cadellia pentaqstylis* and *Brachychiton* spp.
Extent reserved: Medium.
Comments: Distinguished from RE 11.9.8 by absence of *Macropteranthes leichardtii*. In places the vine thicket is associated with areas that have been subject to basalt enrichment. Extensively cleared for cropping and pasture.
Estimated extent: About 24% remains of an estimated preclearing area of 226 000 ha.
Conservation status: Of concern.

Regional ecosystem 11.9.5
Description: *Acacia harpophylla* + - *Casuarina cristata* shrubby open forest on Cainozoic to Proterozoic consolidated, fine-grained sediments. Lowlands. Deep texture-contrast soils and cracking clays, often gilgaied. *Geijera parviflora* and *Eremophila mitchellii* in understorey. Understorey can also include semi-evergreen vine thicket species. *Melaleuca bracteata* often present along watercourses.
Extent reserved: Low.
Comments: Extensively cleared for cropping and pasture.
Estimated extent: About 11% remains of an estimated preclearing area of 2 200 000 ha.
Conservation status: Endangered.

Regional ecosystem 11.10.11
Description: *Eucalyptus melanophloia* + - *Callitris glaucophylla* shrubby woodland on Cainozoic to proterozoic consolidated, medium to coarse-grained sediments. Other species that may be present include *Acacia* spp., *A. excelsa*, *Angophora leiocarpa*, *Allocasuarina luehmannii*, *Eucalyptus chloroclada*, *E. populnea*, *Corymbia trachyphloia* and *E. creba*.
Extent reserved: Low.
Estimated extent: >30% remains.
Conservation status: No concern at present.

Watering Points

The importance of water points

Water is the most important item on a property. Where water is scarce or watering points badly distributed, pasture utilization is poor. Those opportunities can have droughts while there is still plenty of feed at the opposite end of the paddock to the water (Field ed.1998).

Fencing and water point location are inextricably linked. Most fencing layouts in the past have been governed by access to water. Today, the availability of polypipe, fittings,

concrete tanks and troughs etc means that water reticulation can now be sensibly planned to suit the fencing layout and not vice versa. It is not cheap to reticulate water. However, the upfront costs of water reticulation have to be balanced by the long term benefits of better utilization, less erosion associated with poor siting of fences and tanks and sustained productivity (Field ed.1998).

The natural consequences of watering points

The natural consequences of watering points are the excessive grazing of vegetation in the immediate vicinity and excessive disturbance of the soil caused by cattle trailing in and out for water or camping nearby (Field ed.1998).

The disturbance is accentuated by drought conditions, so that the country surrounding permanent watering points such as bores and dams is more exposed to serious damage than that around surface water supplies. Consequently it is expected that watering points must be surrounded by a sacrifice area (Field ed.1998).

Badly eroded and extensive sacrifice areas do occur on those soils that are highly susceptible to erosion. This causes a serious shortage of feed for 1-2 km around the watering point. Sometimes it causes standing of silting around the bore (Field ed.1998).

If the watering point is a surface tank or dam, erosion of the surrounding can result in the tank being quickly rendered useless by siltation (Field ed.1998).

Whether a watering point will develop a sacrifice area will depend on the susceptibility of the soil to wind or water erosion and the degree of protection that may be afforded by tree cover. For this reason it is desirable to locate watering points, other things being equal, in suitable situations (Field ed.1998).

Location of watering points

A sufficient number of watering points should be available to allow stock to graze all pasture areas without walking long distances. This helps to reduce concentrations of stock around each watering point and thus reduce overgrazing and soil erosion (Field ed.1998).

Watering stock from natural water sources

Farmers can help improve the state of their natural watercourses and the health of their stock by restricting animals' direct access to natural water sources.

Evidence shows allowing stock direct access to watercourses causes considerable damage to the surrounding environment and water quality. The damage is caused by direct trampling of the stream bank and contamination of the water and banks with manure and urine. This results in bank erosion, stream sedimentation and water pollution. For these reasons, which are important to landholders and towns downstream, it is best to control direct access by stock to creeks, rivers and lakes.

Animal manure deposited directly in the stream or on the bank increases the water nutrient load, causing toxic algal blooms and may spread bacteria which can have a harmful effect on animal health.

Riparian zones
The areas most affected by erosion, stream sedimentation and water pollution are the riparian zones. These are defined as the regions bordering either side of a creek or areas

that are regularly inundated during flooding. Riparian zones are often called buffer zones because they protect the watercourse from the outside influences of the adjacent land.

It is important that the riparian or buffer zone is healthy because of the role it plays in the health of the stream. Trees and plants growing close to the banks hold the soil together with their roots, protecting them from erosion. Rushes and reeds growing in the water slow the velocity of the water near the banks, reducing erosion and trapping some of the sediment present in the water. They also dampen the erosive effect of waves that occur on larger bodies of water such as dams and lakes.

The riparian zone acts as a natural filter by trapping pollutants such as sediments, nutrients and pesticides from surface runoff that flows into the stream. Vegetation on the banks also provides an ideal environment for aquatic creatures and creates a wildlife corridor.

Mud flats

During periods of low flow or supply, mud flats may become exposed forcing stock to cross them in order to drink. Apart from bogging up this area and causing further damages, there is the chance that the animals can become stuck and die. Excluding the financial loss of the animal, the remains if not discovered and removed further contaminate the stream.

A solution to this problem is to manage stock access to the water source. This is usually done by running a fence 20-30m from either side of the creek.

Fencing the land adjacent to creeks and streams can be used to improve grazing management. Some farmers use the feed growing within these areas for livestock grazing before the autumn break or during periods when feed is limited.

After stock are excluded by fencing a stream or creek, they need to be supplied with an alternative source of water. Erecting fences along creeks and investing in alternative watering methods is a cost which most farmers will be hesitant to pay given the lack of tangible benefits that result from protecting the creeks.

It is important that landholders assess the full costs and benefits of controlling stock access to riparian zones. Environmental benefits are often substantial, but hard to quantify in dollar terms.

Increased capital value of a well managed river frontage, as well as costs, can be saved by preventing bank erosion, flood outs and soil loss, and loss of infrastructure such as creek crossings. Maintaining wildlife habitat, healthy rivers and the diversity of land and water plants and animals are important to many farmers. The careful use of riparian grazing can add significant returns to dairy and beef enterprises. Timber production from the more productive riparian soils is a profitable additional enterprise for some.

Water supply options

After deciding to fence off a natural water source, there are four basic options available.

1. Limited access to the bank at designated points.
2. Carting water to stock from another source.
3. Piping water from an existing supply.
4. Pumping water from the water source into tanks or dams.

The decision of which method to use depends on a wide range of factors, such as the number of stock requiring water, the remoteness of the location and the available funds.

Pumping water
Water can be pumped from the source and reticulated directly to a trough or tank in the paddock. This method eliminates the damage to the vegetation and the soil caused by the stock and greatly reduces the amount of nutrient that flows into the creek from the surrounding land.

Because there is usually only limited financial gain from fencing off the creek or water hole, the system needs to be inexpensive to install and run, and easy to maintain while still being reliable.

It is often recommended that watering points and feed pads should be located at least 50m from a watercourse.

Funding
Funds are often available to assist farmers to support local riparian restoration projects. These funds are available under a wide range of guidelines. Fencing off degraded land or remnant vegetation can also be claimed as a tax deduction.

(Land and Water Resources – Research and Development Corporation, June 1996)

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Community driven delivery of the Neighbourhood Catchment's concept and future involvement of key players

Tony Nunan, Fitzroy Basin Association (FBA) Moura; Cameron Dougall, Department of Natural Resources and Mines, Emerald; Scott Stevens, Department of Natural Resources and Mines, Biloela.

In 1999 the Department of Natural Resources and Mines initiated the Neighbourhood Catchments project to look at improved NRM in the Fitzroy Basin. As a result of the success the Fitzroy Basin Association (FBA) adopted the concept as its preferred method of extension and community development. The approach allows the FBA to more efficiently direct funding to achieve on-ground outcomes. The FBA was able to gain funding from the Natural Heritage Trust to deliver a regionally based project that aimed at using neighbourhood catchments framework to implement current best management practices for sustainable land management. To date the project has delivered more than $700,000 to landholders in the form of devolved grants for management of riparian areas, strategic weed and erosion control.

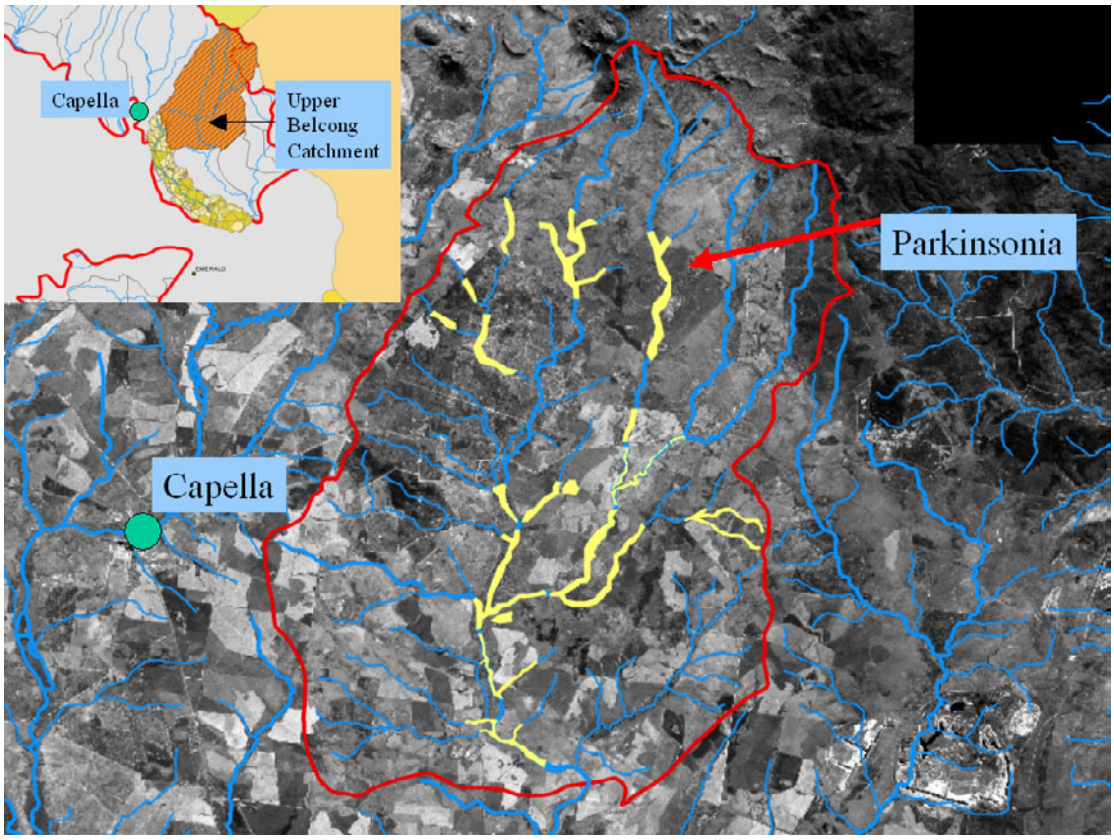

Figure 1: "Upper Belcong Catchment" devolved grant parkinsonian works (2002)

By using the neighbourhood catchments concept, the FBA and local Landcare and NRM groups were able to form a number of geographically defined catchment groups. Upon formation, these groups identified natural resource management issues that were important to their catchment and then attained funding to resolve them.

As a result of the increasing awareness of natural resource management issues within these groups, landholders are looking to incorporate all aspects of their enterprise into a property plan that will enable them to increase profitability while sustaining and improving their natural resource base.

With landholders signalling the need for a more “systems” orientated approach to natural resource management, both the FBA and the Department of Natural Resources and Mines, through its focus catchments at Bauhinia and Capella, will use scientific information and technical experience to develop a more integrated natural resource system for both grazing and farming systems.

The Future

Neighbourhood Catchment's concept highlights that research and extension are critical initiatives in bringing about change to the management imposed on our landscape by property owners. Without research, many crucial questions would remain unanswered due to the inherent complexities of our environment. However, where we have tended to fall down with research in the past is that we typically strive to address problems and issues irrelevant to the common community.

Neighbourhood Catchment's is addressing this by redirecting our focus to everyday issues that many property owners relate to across Central Queensland. It is our understanding that assistance in local relevant issues will result in a greater comprehension and emphasis on the importance of sustaining our natural resources.

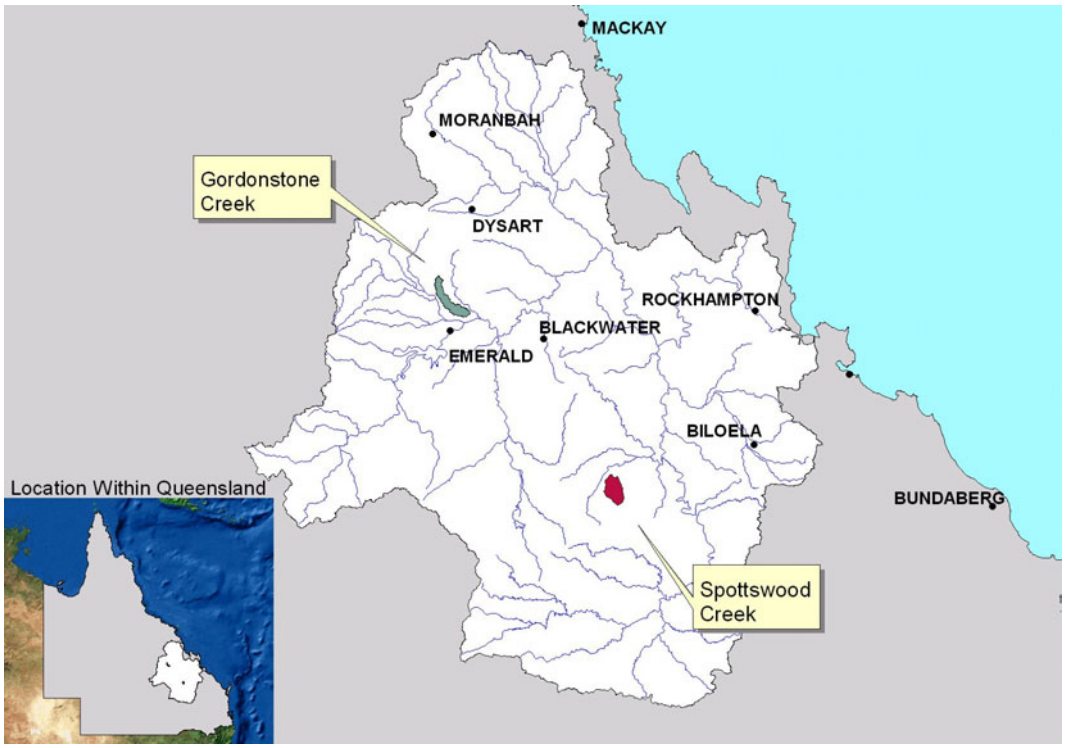

Figure 2: “Focus” Neighbourhood Catchment locations within the Fitzroy Catchment

Property Planning/Mapping

Most property owners have purchased or are in possession of a map of their property. However, how many owners utilise their maps to assist them with management decisions that could increase their productivity while improving their natural resources? Little emphasis has been placed on working with such people to improve their understanding of the economic benefits gained from such an exercise.

Previously, courses in property planning have been run by FutureProfit, an excellent initiative of the DPI. Neighbourhood Catchment's are offering a similar workshop with additional information and data collected from the 'focus' catchments of the current project. Additional topics covered will include soils, land types, vegetation, 'systems approach' to cropping and grazing best management, and the Neighbourhood Catchment's concept.

Monitoring

Monitoring is essential when assessing the impact of imposed management not only on the landscape but financial as well. It allows landowners to assess the viability of their current management relevant to land type and current and long-term seasonal conditions.

Neighbourhood Catchment's is developing, in partnership with local community groups, a monitoring workshop investigating techniques developed for grazing enterprises. This workshop will cover topics such as establishing landscape monitoring transects and photo points, pasture, soil, vegetation and water quality monitoring and cattle recording techniques.

Supporting Community Groups

Community groups are progressively influencing the strategic management of natural resources within their defined social boundaries. With a greater emphasis on targeting large-scale natural resources issues, community groups are consequently adopting a catchment approach to managing such issues.

Neighbourhood Catchment's are strategically placed to assist with catchment scale natural resource management issues. We are endeavouring to work closely with all community groups to pass on valuable knowledge learned from our two 'focus' catchments and extension activities.

With NHT2 and NAP just 'around the corner', Neighbourhood Catchment's are well positioned to assist with community groups wishing to establish 'target levels' on sediment and nutrient movement. It is our belief that forming closer partnerships with community will result in a more efficient and effective understanding and management of our natural resources.

For further enquiries regarding Neighbourhood Catchment's, contact Tony Nunan (4997 1103), Cameron Dougall (4987 9304) or Scott Stevens (4992 9104).