



Australian Government

Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility (MTSRF) December 2008 Milestone Report

Project 4.9.6 – Strategic Natural Resource Management and Land Use Planning

Project Leader: *Dr Cathy Robinson, CSIRO Sustainable Ecosystem.*

Summary

Including three activities – namely

1. Strategic NRM planning for Water Quality Improvement led by Dr. Cathy Robinson;
2. Biodiversity and local area planning, lead by Dr. Ro Hill, and,
3. Implementing ecosystem goods and services, lead by Anthea Coggan

For reference: Milestone extracted from Project Schedule

Date: December 2008

Report submission

- a) Progress report on key regional and Reef-wide water quality partnership and knowledge integration issues. Focus will be on priority wetland restoration and sustainable agricultural activities
- b) Report with attribution of MTSRF funding on the spatial and other prioritisation processes for targets of the Mission Beach Habitat Network Action Plan
- c) Progress report on activities to refine offset MBI for Mission Beach. Progress report on integration activities with working groups

Pathway to Impact Report for End-user relevance

Project Results

Description of the results achieved for this milestone

To date, this project is running well on track. Several key outputs have successfully been achieved. These include:

Activity A

Research undertaken as part of this Activity reflect the work done in the Tully-Murray case-study work and the comparative work that has focused on the Great Barrier Reef (GBR) scale and which comprises the second case-study of this research.

The effort to understand the cause of the state of complex and conflicting water quality and environmental governance issues has prompted researchers in the team to explore the patterns, practices and promise of institutional collaboration to resolve these issues (See list of publications achieved to date, **Attachment 1**). Institutional collaboration is used here to refer to 'the pooling of appreciations and/or tangible resources, e.g., information, money, labour, etc., by two or more stakeholders to solve a set of problems which neither can solve individually" (Gray 1989). A SMART approach to such collaborative efforts has advocated adaptive and consensus-building principles to underlie such arrangements in pursuit of a shared value or set of values (see Robinson et al., in press). As Lane and Robinson (in review) have argued, one of the greatest obstacles to improved environmental management is the decreasing potential for coordinated action by multiple actors across a landscape. As such a SMART approach to collaboration emerges as an approach to governance that has much to offer.

The application of SMART partnerships to GBR-wide institutional considerations has built on international experiences and research alliances to provide the foundations for this work (Robinson et al., in review). It has encouraged research alliances to be forged to consider knowledge integration and adaptive management strategy issues as part of this work (ie Eberhard et al., in review; Kroon et al., in review, for details see **Appendix A1**). The team look forward to aligning MTSRF work with developing CSIRO's strategic research directions.

This work has assisted us in our efforts to critically analyse and communicate the institutional support required to deliver sustainable agricultural and wetland restoration activities (see reports by Bruce Taylor (**Attachment 2**) and Leonie Pearson and Cathy Robinson (**Attachment 3**).

This research will continue to be consolidated to inform the development of a SMART partnership reporting framework that is the focus of the June 2009 milestone reporting requirement.

In Summary the Attachments included for Activity A are at end of this document and include:

Attachment A1 –

List of MTSRF Project 4.9.6 publications and abstracts underpinning SMART partnership research

Attachment A2 –

Water quality partnership and knowledge integration issues for priority wetland restoration and sustainable agricultural activities

(Bruce Taylor). Improving nutrient management in intensive agriculture land uses at catchment scale: a synthesis of management action, partnership and monitoring considerations.

This document provides a synthesis of the analysis of management responses designed to address diffuse water quality impacts from intensive agricultural land uses in the Tully Catchment, and Reef catchment more broadly. Specifically it considers agricultural industry perspectives on the design of management actions, including necessary partnership arrangements. In doing so it explores some of the dynamics between different catchment sectors and scales of planning activity that may influence industry cooperation in nutrient management to improve water quality outcomes.

Attachment 2 –

(Leonie Pearson, Cathy Robinson and Ben Harman) Weed activities and partnerships for wetland restoration: A case-study from the Tully- Murray catchment.

This document provides an analysis that focuses on broad costs, benefits and multiple outcomes that affect collaborator's commitment and effort to deliver *restoration* management practices identified to improve Tully-Murray water quality targets. The study focuses on the *Hymenachne* weed in and around significant wetlands.

Activity B Biodiversity values in regional and local area planning

b) Biodiversity values in regional and local area planning

Attachments

B1- Hill, R, K.J. Williams, P.L. Pert, S. Jenkins, R. Grace and T. O'Malley. 2008. Draft Mission Beach Habitat Network Action Plan. Terrain NRM and CSIRO, Cairns (separate document)

B2- Mission Beach Expert Panel documents (at end of this summary report)

The project team for task (b) continues to concentrate efforts on local area planning at Mission Beach, whilst preparing for second-tier case study in the context of the Cassowary Habitat Network Action Proposal under development.

Significant co-research and development has occurred since the last milestone on planning tools for the latter stages of the adaptive planning cycle. The prioritization processes involving application of multi-criteria analysis (MCA) and the development of an interactive mapping platform are described in 3, 4 and 6 of the attached Draft Action Plan (Attachment B1).

Summary of Multi Criteria Analysis Application: A collaborative process of development of projects together with partners who are able to deliver the agreed strategies resulted in the identification of 17 projects. Multi-criteria analysis was undertaken by a technical working group of the Mission Beach Habitat Network Action Committee to prioritise among these projects. The process of pair-wise comparison of potential criteria generated considerable discussion about the complex value-laden social, political, economic and other dimensions of habitat management at Mission Beach. However, the technical working group concluded that the MCA approach does not allow the projects to be considered in a manner consistent with the collaborative methodology, which is based on recognition and respect for multiple values and communicative rationality. As a result, the project projects are being pursued through an integrated approach that seeks investment in all projects from a range of potential investors—in effect a market-based prioritization.

Summary of interactive mapping package: A number of options were investigated for the delivery of spatial data interactively by a mapping tool for stakeholders. CSIRO Tropical Landscape Program has a long and established partnership with ESRI Australia, with many facets of the Geographic Information of the organisation currently stored and managed using ESRI Inc. GIS technology. We therefore requested a proposal from ESRI on their latest product "Dekho" (see attachment). This proposal was discussed but rejected based on the cost and infrastructure required. Further options were investigated through discussion with consultants "Spatial Vision". An eConference was held with Spatial Vision's Senior Analyst Milos Pelikan, Rosemary Hill, Tony O'Malley and Petina Pert on 17th October 2008. Milos indicated that as a general rule to undertake any kind of full interactive and dynamic web-based application we would need a budget of \$70,000-100,000 (not including hardware and software requirements). Milos provided cheaper non-dynamic alternative options including a web-based solution using Google Maps but after a team discussion these were also rejected based on the lack of functionality they offered. Dr Ken Lyons of Spatial Information Services

Pty Ltd was then invited to discuss his use of another tool “CommunityViz” in an Australian context.

After initial discussions it was decided that CommunityViz will provide an adequate cost-efficient solution. Scott Lieske from the University of Wyoming and Dr Ken Lyons then provided CommunityViz training and worked through the data and requirements of the project.

This interactive biodiversity mapping platform utilising ArcGIS with the CommunityViz extension is currently under development and refinement, both to display biodiversity spatial data, and to identify priority areas for habitat protection and restoration. This computer based mapping and geodatabase facilitates analysis and interpretation of complex inter-related biodiversity, threat, condition, protection and opportunity attributes across the study region. It has practical value for planning through interpretation of options under different future threats and can be used to monitor change in habitat and biodiversity values over time. The geodatabase is already functional and is being developed to ensure it will be available in perpetuity and continually updated with new information. A draft output of a map of biological sensitivity is shown below based on the significant biodiversity attributes identified by Chenoweth (2008). The map includes the significance settings from the CommunityViz assumptions window (Figure 1).

Mission Beach
Biodiversity Sensitivity based upon
Significance

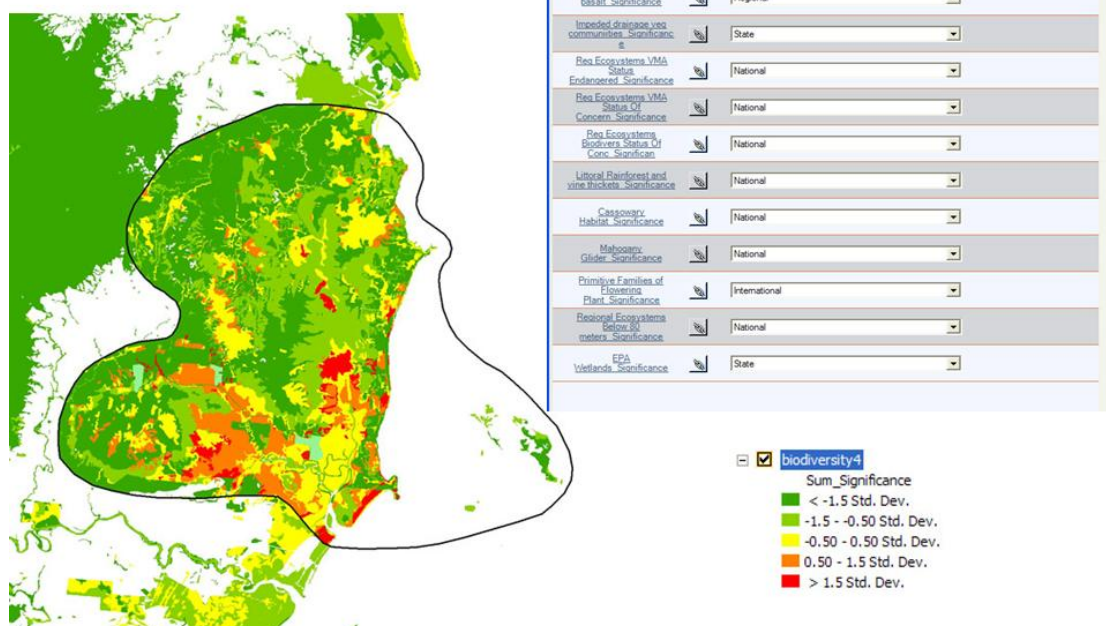


Figure 1: CommunityViz output of summed Biodiversity Significance

A Mission Beach Expert Panel workshop being held on 12 December will further refine inputs and usage of the platform (see Attachment B2 at end of this document).

We are also developing a pilot for public display of our work which involves incorporating some of our terrestrial GIS layers into the Reef Resilience and Risk Atlas. The Reef Atlas is a new collaborative project supported by MTSRF that provides easy access to data, maps

and information on topics relevant to the GBR and its catchments to management authorities, researchers, reef-based industries and community (Figure 2).

A meeting was held on 21st October to get a further understanding of the Reef Atlas' background and capabilities. Terrestrial data will now be uploaded into the Reef Atlas for public display pending metadata and data agreements. A demonstration site can be accessed via <http://demo.reefatlas.org.au/geoserver/www/map.html> and a draft display of Cassowary Habitat in the Reef Atlas user interface environment is shown below.

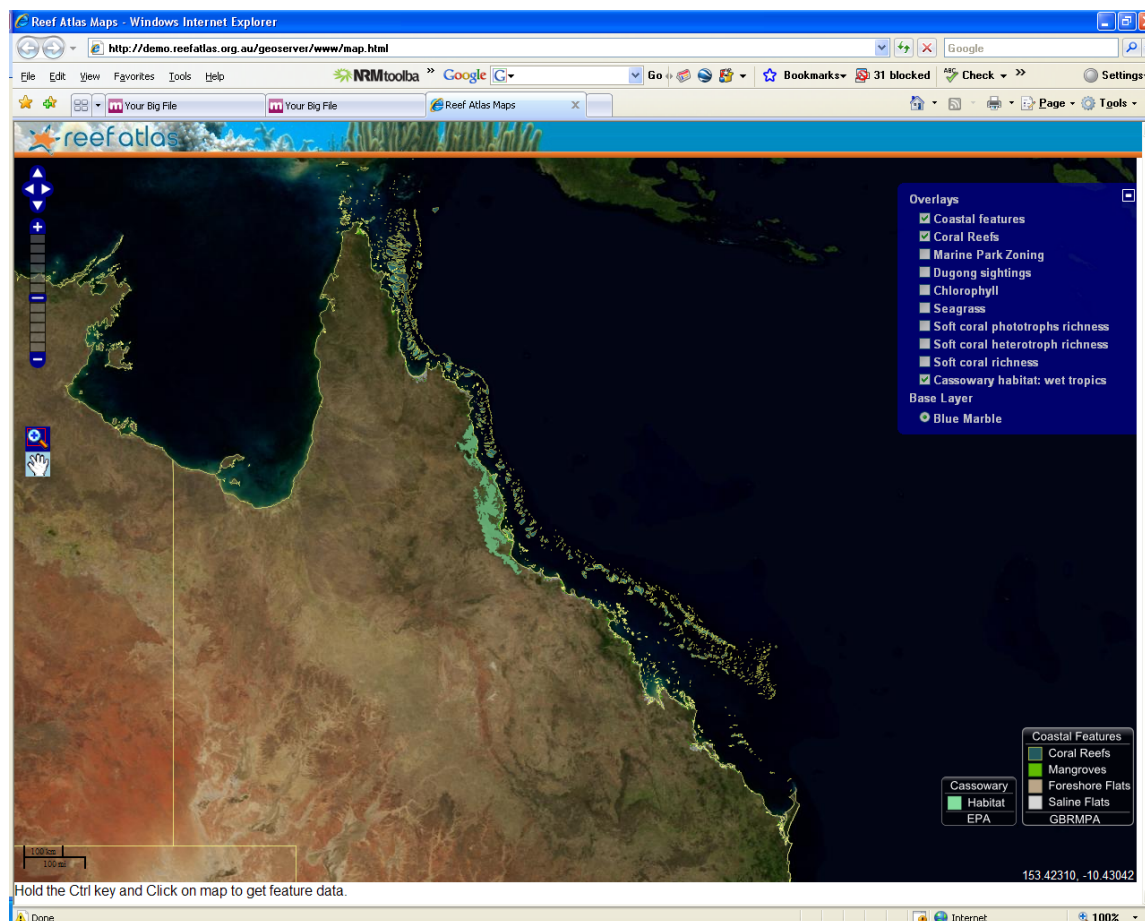


Figure 2: Reef Atlas user interface

Exploring the use of Incentives for Landscape Restoration: A final report on the LWA project which linked to the MTRSF work in Mission Beach is available on the web (<http://cms.csiro.au/science/landscapetenders.html>). The CSIRO project developed an approach to apply competitive tenders for environmental projects beyond individual properties (Reeson et al. 2008¹, Windle et al. 2008²).

¹ Reeson, R., Rodriguez, L., Whitten, S., Williams, K.J., Nolles, K., Windle, J. & Rolfe, J. 2008. Applying Competitive Tenders for the Provision of Ecosystem Services at the Landscape Scale. Paper presented at the 10th Annual BIOECON Conference on "The Effectiveness and Efficiency of Biodiversity Conservation Instruments", 28-30 September 2008, Cambridge UK. <http://www.bioecon.ucl.ac.uk/10papers10.htm>

² Windle, J., Reeson, A., Whitten, S. and Rolfe, J. 2008. Interactive experimental workshops: A tool for the design and communication of MBIs with stakeholders. In, A. Reeson et al, CSE45 Achieving coordinated landscape scale outcomes with auction mechanisms. Final Report for Land & Water Australia. CSIRO Sustainable Ecosystems, Canberra.

The case study for Mission Beach integrates the market based instrument and landscape modelling of habitat networks and complementarity (Reeson & Williams 2008³; Williams et al., 2008a⁴).

This work has been continuing through the MTSRF project. Michael Drielsma and Jamie Love (NSW Department of Environment and Climate Change) recently completed the development of a tool to analyse landscape condition, connectivity and complementarity in an auction setting. The results of the beta-testing workshop held at Mission Beach in April 2008 were delayed until computation issues could be resolved through specialised programming and software development. The draft report by Love and Drielsma (2008)⁵ will be integrated into a revised manuscript describing the method and outcomes Williams et al., 2008a⁶ into the manuscript over the next few months. A recent bid to LWA to continue the development and testing of market based instruments for NRM practice, with a possible Mission Beach or wet tropics case study, was successful⁶. This proposal included a letter of support from Terrain NRM, among other NRM and CMA bodies around Australia.

Other research: Some other outcomes from the ongoing research and development have been synthesized into a "Draft Mission Beach Habitat Network Action Package". Section 1 of the document presents the action plan; section 2 summarizes the tools and approaches from both biodiversity and planning systems science that underpin the outcomes in the plan. Part 5 presents progress with biodiversity assessment and conservation planning tools in relation to modeling finer scale variation in biodiversity, fragmentation and connectivity, and unique and complementary areas for biodiversity protection. Further development of this document will occur over the next few months prior to public release in early 2009. Continuing development of the planning tools will depend on additional funding support, potentially through investment consistent with the Mission Beach Habitat Network Action Plan, and other avenues, such as the Caring for Country program.

Several conference presentations about the project and a large number of meetings have been held (see Table 1 below) since the last milestone. Key outputs for this milestone period include:

- Policy briefing "Cassowary Habitat Network Action Package Proposal: enhancing resilience against climate change in the wet tropics."⁷
- Presentations at the Qld Spatial Science Conference⁸, the GBRMPA Seminar Series⁹, the CERF Annual Conference¹⁰ and the Ecological Society of Australia Conference¹¹.

³ Reeson, A., Williams, K. 2008. (Unpublished) Mission Beach Case Study – Interactive workshops with stakeholders. In, A. Reeson et al, *CSE45 Achieving coordinated landscape scale outcomes with auction mechanisms*. Final Report for Land & Water Australia. CSIRO Sustainable Ecosystems, Canberra.

⁴ Williams, K.J., Drielsma, M., Reeson, A., Love, J., and Pert, P. 2008a. (Unpublished) Ecological metrics for evaluating landscape scale outcomes in conservation auctions. In, A. Reeson et al, *CSE45 Achieving coordinated landscape scale outcomes with auction mechanisms*. Final Report for Land & Water Australia. CSIRO Sustainable Ecosystems, Canberra.

⁵ Love, J. and Drielsma, M. 2008. Optimising the metric based selection of incentive funding bids. Report to CSIRO, November 2008. NSW Department of Environment and Climate Change, Armidale.

⁶ Whitten, S. and Gorddard, R. 2008. *Measuring investments – principles and protocols for best-practice MBI metrics in NRM*. A proposal submitted in the Second Round 2009 Innovation Call, Land and Water Australia. CSIRO Sustainable Ecosystems, Canberra.

⁷ WTMA and Terrain NRM. 2008. *Cassowary Habitat Network Action Package Proposal: enhancing resilience against climate change in the wet tropics. Preliminary Policy Briefing Draft. August*. Cairns: Wet Tropics Management Authority and Terrain NRM.

⁸ Pert, P.L., K.J. Williams, and R. Hill. 2008. Spatial Analysis Techniques Prove Useful in Projecting Biodiversity Impacts on the Southern Cassowary in Mission Beach. Paper at *Queensland Spatial Conference 2008 – 17-19 July 2008 Global Warming: What's Happening In Paradise?* Gold Coast.

⁹ Hill, R, KJ Williams, P Pert, and E. Harding. 2008. Adaptive, collaborative planning at Mission Beach. Lessons for other conservation initiatives. Paper at *Great Barrier Reef Marine Park Authority Seminar Series*, 19 August, Townsville.

- Preparation of a paper for submission to the Australian Geographer Using Spatially Explicit Scenarios to Project Biodiversity Impacts in Mission Beach”
- Report “Mission Beach Habitat Network Action Plan First Draft” attached to this Milestone as Attachment B1, which includes **reports on the spatial and other prioritisation processes for targets with attribution of MTSRF funding**
- Agenda and biodiversity mapping recommendations to the Mission Beach Expert Panel Workshop, attached to this Milestone as Attachment B2
- Reports “Draft Projects – Mission Beach Habitat Network Action Plan” and “Project Costing and Prioritization – Mission Beach Habitat Network Action Plan” presented to the MBHN Action Committee

Activity C - Best practice framework for implementation options for cassowary conservation

This project is running on track. Key activities since June 2008 are outlined below.

In September and October 2008, Anthea spent time in FNQ conducting data for offset policy testing platform actions (as discussed in detail in June 2008 progress report). This data collection involved review of Terrain’s recently produced offset policy and discussion of this policy and current offsetting activities for Mission Beach with key Terrain staff. The purpose of this discussion was to ensure that offset policy testing was aligned to Terrains offset policy knowledge needs. In addition to confirming current data availability and gaps, a key outcome of these discussions was a greater understanding of current offsetting that is occurring in Mission Beach for the management of development on the cassowary. It was decided that any offset policy platform should seek to refine what is currently occurring. A key issue for current offset arrangements and therefore the focus of current policy refinement is an understanding of the drivers, extent and distribution of transaction costs. Refinement of the offset policy should seek to reduce the extent of these transaction costs.

The focus on work between June and December 2008 has been reviewing literature on transaction costs. Components of this literature review was presented as a paper (with co authors Stuart Whitten, Leonie Pearson and Jeff Bennett (ANU) to the joint North American and Canadian Agricultural Economics Association Conference in July 2008 (Activity C - Attachment 1 below). Anthea has also provided input into transaction cost analysis of weeds management which is occurring as a part of MTSRF project 4.9.6a.

Surveying of key players about transaction costs in current Mission Beach offsets is proposed for early 2009.

Anthea continues to engage with offset policy development in Mission Beach and surrounds. A broad researcher offset working group was held as a part of the MTSRF researchers’ conference in April 2008. The next official offset working group is scheduled for February 2009.

¹⁰ Hill, R, KJ Williams, and P Pert. 2008. EPBC Act at Mission Beach Biodiversity planning systems science for cross-scale integration. Paper to *Commonwealth Environmental Research Facilities Annual Conference*. Canberra, 15-16 September 2008.

¹¹ Pert, P.L., R. Hill, and K.J. Williams. 2008. Use of new graph-based landscape connectivity indices: towards prioritisation of habitat patches and corridors for southern cassowary conservation. Paper to *Ecological Society of Australia Annual Conference*. 1-5 December 2008, Sydney

Communications, major activities or events

During milestone reporting period

Table 1 below summarises the liaison activities undertaken to date, including contributions to Project Activities achieved from those activities.

Table 1. Activities undertaken during (June – December 2008) milestone reporting period and contribution to project outcomes

Activity	Date	Outcome
Activity (Task A)	Date (2008)	Outcome
Interviews undertaken with local and regional and cross-regional stakeholders on wetland restoration programs	July - August	Completion of data collection and analysis to assess partnerships for ecologically significant wetlands
Interviews undertaken with local and peak industry groups on best management practices for intensive agriculture	July - December	Completion of data collection and analysis to assess partnerships for industry management practices to achieve water quality targets
MTSRF project team updates & meetings	ongoing	Ongoing project planning, monitoring and review
Interviews undertaken with regional, state and federal stakeholders on wetland restoration programs in the GBR and Tully-Murray catchment	July - August	Completion of transaction analysis of weed control partnerships for ecologically significant wetlands
Conducted 10 interviews with Reef Rescue package participants including representatives of Canegrowers, Growcom, GBRMPA and Regional Bodies;	Sept-Nov	Contribute to industry partnership analysis for improving the delivery of nutrient management outcomes
Attended and recorded discussions on institutional measures of success between participants at Reef Focus summit for analysis	October 24 th	Contribute to Institutional measures of success as part of adaptive management reporting system to support SMART Partnerships application
Attended two meetings of Terrain NRMs Industry Advisory Group in Tully and Innisfail	September 25 th and December 4 th	Briefed group on research and secured permission to attend and observe that group as regional scale partnership forum
Preparing a conference paper for The Australian Sociological Association Conference in Melbourne in December	December 2 nd	Scientific and research profile of RRRC and the project specifically improved. Peer reviewed publication also results.

Activity	Date	Outcome
MTSRF project team updates & meetings	ongoing	Ongoing project planning, monitoring and review
Activity (Task B)	Date	Outcome
Activity (Task B)	Date	Outcome
MTSRF project team planning meeting	27 June	Clear delineation of roles, responsibilities and outputs of each of the team members
Implementation partnership meetings	2 July to 10 July	Eleven separate meetings were held with potential implementation partners for the plan including WTMA, EPA, C4, CCRC, DIP, MRD, DEWHA, and others resulting in 17 project proposals to deliver the strategy
Queensland Spatial Conference 2008 Global Warning: What's Happening In Paradise? Presentation on <i>Spatial Analysis Techniques Prove Useful in Projecting Biodiversity Impacts on the Southern Cassowary in Mission Beach</i>	17-19 July 2008	Interest expressed by several conference attendees in the approach; information about potential software applications suitable for the "interactive biodiversity mapping platform" gathered
Mission Beach Habitat Network (MBHN) Action Committee meeting No. 7	22 July	Meeting considered draft projects developed through meetings with implementation partners, Wongaling Corridors neighbourhood habitat network plan, biodiversity mapping and FNQ 2025. Valuable advice was provided on all aspects.
Terrain/CSIRO (Ro Hill, Petina Pert, Tony O'Malley) interactive biodiversity mapping platform planning	4 August	Process for expert workshop as part of the interactive mapping platform development
MBHN technical project prioritisation working group (Terrain, CSIRO, CCRC)	13 August	Multi-criteria analysis was reviewed and rejected as an approach to project prioritisation; alternative approach was to maintain package as a whole and seek investors for various elements.
Seminar to GBRMPA on <i>Adaptive, collaborative planning at Mission Beach: lessons for other conservation efforts</i>	19 August	Interest was expressed by GBRMPA in the integrated local area planning approach
Policy briefings on Cassowary Habitat Network Action Package with State and Federal Environment Ministers/policy advisors	2 September, 16 September	Qld Minister for Environment and policy staff indicated interest in further development of proposal; Federal Minister for Environment policy staff also indicated ongoing interest
Cassowary Habitat Network Action	18 August, 22 September and	CSIRO, WTMA, Terrain ongoing development of integrated package

Activity	Date	Outcome
Proposal Working Group	6 November	including second tier case study on the Atherton Tableland
CERF Conference presentation <i>EPBC Act at Mission Beach: national standards, locally-based resilient biodiversity planning science systems</i>	16 September	Increased level of awareness of the Cassowary Habitat Network conservation issue at Mission Beach with DEWHA
Mission Beach Habitat Network (MBHN) Action Committee meeting No. 8	30 September	Meeting considered Wongaling Corridors Fauna Crossings report and Conservation incentives proposal; report from project priorities working groups, and the Cassowary Habitat Network Action Proposal and provided valuable advice to all
Abstract submitted for ESA Conference	2 October	Petina Pert submitted an abstract to internal reviewers, theme and program leader for approval. Abstract entitled "Use of new graph-based landscape connectivity indices: towards prioritisation of habitat patches and corridors for southern cassowary conservation at Mission Beach" then submitted online for ESA conference
eConference with Spatial Vision's senior analyst Milos Pelikan	17 th October	Milos demonstrated three possible solutions for an interactive mapping platform and provided advice on costs and applications.
Terrain/CSIRO (Ro Hill and Rowena Grace) meeting re MERI framework	23 October	Draft MERI framework for Cassowary Habitat Network Action Package
CSIRO/Spatial Information Services workshop/training development of Community Viz as platform for interactive mapping package	7 November, 11-14 November	Draft biodiversity sensitivity analysis incorporating significant biodiversity attribute layers
EPBC Cassowary strategic policy workshop convened by DEWHA	10 th November	Input to a relevant policy under development by DEWHA
Meeting with Ro Hill, Petina Pert, Tony O'Malley and Milos Pelikan (Spatial Vision) to discuss various interactive mapping options available and to view previous project demonstrations	17 th November	After viewing the capabilities and products that Spatial Vision demonstrated it was decided it was too expensive to use them as consultants for an interactive mapping program.
Mission Beach Habitat Network (MBHN) Action Committee meeting No. 9	25 th November	Meeting considering Draft Mission Beach Habitat Network Action plan, including communication strategy; FNQ2025 consultation report, JCU's cassowary road management study; Wongaling Corridors Fauna Crossings implementation; National Environmental Significance project funding; Littoral Rainforest EPBC listing; Biodiversity

Activity	Date	Outcome
		Mapping project.
ESA Conference, Sydney	1-5 th December 2008	Presentation by Petina Pert "Use of new graph-based landscape connectivity indices: towards prioritisation of habitat patches and corridors for southern cassowary conservation at Mission Beach."
Activity (Task C)	Date	Outcome
NAREA and CAEA Conference	July 2008	Paper presented. Productive discussions held with leading researchers on policy transaction costs
Data gathering discussions – Terrain, Mission Beach local area coordinator, CSIRO	Sept/Oct 2008	Understanding of current offset policies and on ground implementation. Initial understanding of Mission Beach offsetting and drivers of transaction costs

During next milestone reporting period

Table 2 below summarises the liaison activities that will be undertaken during the next milestone reporting period, including expected outcomes from those activities.

Table 2. Proposed meetings and future activities during next milestone reporting period

Activity	Date	Expected Outcome
Activity (Task A)	Date	Outcome
Continue development of cross-regional framework to monitor and evaluate institutional capabilities and support for selected priority water quality management responses in the GBR	Jan – Mar 2009	Reporting framework that has been tested and assessed by key GBR stakeholders
CSIRO project team meetings	Ongoing	Development of milestones and setting of guidelines for future maps and work.
Research summary article requested for CANEGROWERS magazine to be prepared – Draft article will be sent to RRRC for approval	Jan-Feb 2009	Communication of research findings through industry stakeholder media – improved impact of research
Attend and report progress to Terrain NRM Industry Advisory Group Meeting in March 2009	March/April 2009	Communication of research findings through enduser partnership forums – improved impact of research
Undertake communication strategies as outlined in Impact Report for Enduser relevance	Ongoing	Ensure stakeholder collaborators and endusers endorse and are provided the communication tools to consider and use this work

Activity (Task B)	Date	Outcome
Interactive biodiversity mapping platform expert workshop	12 December 2008	Review and refinement of the biodiversity attribute mapping and the modelling of priorities for investment in protection and restoration.
CSIRO project team meeting	Early 2008	Revised project plan and outputs
Formal Working Group for CfoC Large Project Bid	Early 2008	Bid for the large project "Securing the Species of the Wet Tropics" submitted to the Australian Govt.
Terrain NRM Biodiversity Team (including Ro Hill as CSIRO partner)	6 weekly	Major activity will be finalisation of the application for Federal funding of the Cassowary Habitat Network Action Package
Mission Beach Habitat Network Action Committee	bi-monthly	Community governance of Action Plan
Activity (Task C)	Date	Outcome
CSIRO project team meeting	Early 2008	Revised project plan and outputs
Offsets workshop	February 2009	Alignment with current policy development
Extensive transaction costs data collection - transaction cost of current and alternate offset design. Meetings to be planned with developers, offset coordinators (Terrain), legislators (local council, state and federal government)	March – May 2009	Understanding of drivers of transaction cost of current offset approach and hypothetical alternative approaches. Input into alternative approach simulation

Forecast variations to planned milestones

Slight adjustments to research team members are expected for 2009. MTSRF will be notified as soon as this has been negotiated. This will not change budget allocations or milestones.

The introduction of state regulation as part of the response to the Reef Rescue Plan adds some important changes and complications to the MTSRF Project A research activities. Every effort will be made to ensure the management action monitoring and reporting framework responds to these institutional and policy changes as they unfold.

Attachments - Activity A

Attachment 1

This Attachment provides summaries of academic publications delivered to date that relate to project objectives to construct a rigorous SMART partnership framework to evaluate alternative environmental management strategies for water quality improvement in North Queensland including their environmental, social and economic performance. The focus to date has been on selected priority sustainable agriculture and wetland restoration activities that have been investigated at catchment and regional scales.

1. *The SMART partnership framework*

Robinson, Cathy J, Taylor, Bruce M, Pearson, Leonie, O'Donohue, Mark, and Harman, Ben. in press - A SMART Assessment of Water Quality Partnership Needs in Great Barrier Reef Catchments, *Australasian Journal of Environmental Planning and Management*

Summary

There has been considerable effort to set SMART (specific, measurable, achievable, realistic and timed) targets to halt the decline in the quality of water entering the Great Barrier Reef from diffuse sources. Less attention has been paid to assessing collaborative delivery options needed to meet these targets with industry and catchment communities. Conventional evaluations of collaboration often focus on consensus-building processes rather than whether and how such arrangements achieve outcomes. This paper adapts the SMART criteria to assess partnership needs to help deliver proposed water quality management programs. The criteria were used to guide agricultural industry and local government sector focus group discussions to assess partnership implications of Queensland's Tully-Murray Water Quality Improvement Plan (WQIP). This formative assessment enabled these sectors to: determine if and how existing collaborative arrangements adequately considered the *specific* place and purpose of proposed water quality management activities. It exposed if *measures* of delivery and partnerships success were compatible among relevant collaborators and highlighted if there was a fair distribution of delivery cost and responsibilities among partners to ensure proposed water quality management practices are *achievable*. The assessment also highlighted if proposed water quality activities were aligned with partner agendas and capabilities to ensure activities are understood and *relevant* to partners, and considered how delivery through partnerships could be *timed* to maximise benefits of proposed actions. We suggest that the framework can be helpful for practioners and researchers interested in systematically assessing whether partnerships can adaptively 'fit' the purpose of what is required to deliver collaborative water quality management plans.

2. Case-Study: The Tully Water Quality Planning Process: Knowledge integration issues

Kroon, Frederieke J, Robinson Cathy, J, Dale, Allan, *in review*, The integration of knowledge to inform water quality planning in the Tully Basin, Australia, *Marine and Freshwater Research*

Summary

Decentralised approaches to water planning are becoming common in water management. Yet there remain many challenges in the implementation of such approaches in practice. In the Tully catchment of North-east Australia, non-statutory regional natural resource management (NRM) bodies and other stakeholders are coordinating efforts to assess water quality condition and set management priorities for improving the quality of water entering the Great Barrier Reef World Heritage coastal lagoon. Regional NRM bodies, in particular, are also seeking to align longer term implementation efforts and monitor progress. This paper focuses on a key albeit contentious component of this planning and management process – the integration and translation of different knowledge used to inform objective setting and action strategy development for water quality programs. The analysis of the kinds of knowledge and mechanisms of translation involved highlights the tensions between the uncertainty and bias in different types of knowledge brought to the planning table; the timing of knowledge contributions that affects if and how knowledge contributions can be considered, critiqued and integrated; and the capabilities of decentralised planning structures and processes to translate and integrate knowledge to inform priority management activities.

3. Institutional Collaboration for effective water quality management: Scaling up and working across scales

Lane, Marcus B and Robinson, Cathy J. *in review*. Institutional complexity and environmental management: the challenge of integration and the promise of extra-regional collaboration, *Australasian Journal of Environmental Management*.

Summary

Integration has become something of a byword for those concerned with environmental planning and management in Australia in recent years. Yet efforts to collaborate with non-state actors in policy development and implementation, and co-ordinate local, state and federal government policies and activities suggests that integration can become an amorphous and often ambiguous goal. This paper draws on recent collaborative and co-ordination efforts to address water quality issues facing Queensland's Great Barrier Reef to highlight some of these challenges. A preliminary assessment shows how a Reef-wide collaborative water quality partnership has risen to the challenge of integration. To date this extra-regional collaboration has focused on co-ordinating a defensible knowledge-base to guide water quality management responses and developing an adaptive management strategy to test this knowledge through management experience and monitoring feedbacks. An initial evaluation of these efforts suggests the value of extra-regional collaboration to facilitate integrated environmental management. There is no "hard-wired" or structural solution to the problem on integration; instead, this experience shows that the development of collaborative partnerships holds great promise. Such partnerships need to be carefully fitted to the particular management contexts in which integration is being pursued.

Robinson, Cathy J, Margerum, Richard, D, Koontz, Tomas, M, Moseley, C, and Lurie, Sue in review, Large-scale collaboration for effective environmental management: Lessons and challenges from Australia and the United States, Society and Natural Resources.

Summary

Collaborative approaches to natural resources management have been playing an increasing role in addressing complex environmental policy problems. Much of what is known about collaboration is drawn from processes and structures operating at the local scale. Research has focused on the institutional support needed for these groups, the processes that make these groups effective and the local context in which these efforts emerge. At the same time, there have been efforts to develop collaborative approaches to address larger regions, government programs and priorities, and policy conflicts. Yet little is known about how these large-scale collaboration differ from the more community-based efforts that dominate the literature. This paper draws on examples of large-scale collaboratives in Australia and the United States to contrast large-scale with small-scale collaboratives and suggest a research agenda for moving forward. In particular, we highlight differences in partnership formation, institutional arrangements, resources, and focus.

Activity A - Attachment 2A

Improving nutrient management in intensive agricultural land uses: adopting a multi-scalar perspective to enhance water quality partnerships

Bruce Taylor and Cathy Robinson, CSIRO Sustainable Ecosystems

Introduction

This research examines partnerships between intensive agriculture stakeholders, governments and regional natural resource management bodies to reduce the off-farm impact of nutrients on environmental water quality in the Great Barrier Reef (GBR) lagoon. Earlier assessments conducted under this project applied a suite of 'SMART partnership' criteria at the catchment scale to inform water quality planning (see Robinson et. al, 2007).

This current phase of the project expands that initial analysis by identifying the multi-scalar imperatives for successful action at the catchment scale. It then articulates some opportunities for improving stakeholder involvement, deliberation and planning between these scales. The analysis focuses on three factors which influence improved water quality outcomes, specifically nutrient management, from this multi-scalar perspective, namely:

1. the contribution of **knowledge** to policy goals and planning objectives;
2. how this knowledge influences implementation strategies generally, and **management practice design** specifically; and,
3. the **interactions** between government, industry and other sectors that are most likely to enhance progress towards targets.

The third factor, interactions, can be horizontal, that is within scales of activity such as a region or catchment, and vertical, occurring between scales of activity. These interactions between diverse actors can be viewed as networks of deliberation that influence water quality outcomes.

By way of background we provide a brief overview of multi-scalar networks in environmental management. We then present the analysis of catchment level actions identified by cane industry stakeholders before discussing the multi-scalar and networked implications of these actions.

Multi-scalar networks as partnerships for environmental management

The nature of diffuse water quality impacts from land-based industries on coastal and marine environments adds additional layers of complexity to the management task. These layers can include management geographies that do not match easily with jurisdictional or socio-cultural boundaries. Other imperatives involve designing local management actions that meaningfully nest within Reef-wide objectives. Further, with the broadening of the suite of players involved in governing water quality, there is a broadening of the values being contested within the process of planning and implementation. The implications of this complex setting for governance are two-fold. First, farm scale interventions must be nested within broader, whole-of-Reef and whole-of-sector responsibilities; and second, many of those responsibilities are likely to be reconfigured through the process of 'managing by networks'. Ferreyra and others describe these phenomena as particularly significant in questions of implementing environmental policy:

...multifaceted environmental policy issues such as freshwater resources management...cannot be reduced to the activation and empowerment of governance processes at one particular scale...what is required is a more sophisticated understanding of (1) the way scales are socially (re)constructed in a particular locale by stakeholders from different levels and sectors of society and (2) the way socially constructed scales can be linked to enable meaningful and effective processes of environmental governance across multiple levels and sectors (*Ferreyra, de Loë and Kreutzwiser 2008:317*)

Research in the Wet Tropics reveals that hybrid, networked forms of environmental governance have emerged over time in that region through repeated interactions between stakeholders (Morrison 2007). This work points to the socio-political character of managing by networks at the regional scale, Morrison's analysis suggest actors tend to "privilege the priorities of their [own] network rather than the priorities of the region" (2007:231). This compliments findings on factors influencing the adoption of more sustainable management practices by different agricultural industries in the Fitzroy region (Lockie, Lawrence, Dale and Taylor, 2002). This work showed that different industries (e.g. grazing, cotton, grain), use different networks for information and political support. These different industries are also more or less likely to operate collectively or independently, and show differential levels of access and interest in working with external service providers. Morrison does not however consider these types of conditions to be terminal for good environmental governance. What is required however to break these interest-oriented networks she contends is the alignment of "local and extra-regional resources and opportunities" (2007:232). That is when vertical networks come into play, entrenched horizontal networks can be catalysed or coopted to act collectively.

The assertion that networks linking actors and resources, vertically through multiple spatial scales are important to effective planning and governance is not limited to environmental management.

This thinking has also been employed in metropolitan planning contexts where “understanding the way [a] multi-scalar large institutional network evolves and learns is central to understanding how it functions and malfunctions, how it creates, decides on, and executes policies and plans, and how it exerts power and influence to obtain outcomes” (Neuman 2007:337).

From this discussion then the connection between substantive, practical environmental improvements, such as halting water quality decline in the Reef, are indeed influenced by these multi-layered, multi-party arrangements. In the following section we analyse industry dialogue on management practices to improve water quality at the catchment scale which then sets the platform to describe the multi-scalar imperatives and implications for successful catchment level action.

Nutrient management in agriculture and Reef water quality

Intensive agricultural production of sugar cane and horticultural cropping, grazing or commercial forestry comprises a significant proportion of the production landscapes within the catchment of the Great Barrier Reef. These production landscapes are recognised and valued as an important regional asset under regional and catchment level natural resource management plans (Armour, 2004; Kroon, 2007). The management and use of this asset in regions such as the Wet Tropics however is now known to pose a threat to the condition of other regional assets such as freshwater and marine ecosystems and the many values they hold (Productivity Commission, 2003). One of these threats is that of nutrients such as nitrogen and phosphorus (in their various forms) exported from production landscapes into local water ways and then transported to coastal and marine environments. These nutrients, highly valued as fertiliser additives contributing to plant health and productivity in production landscapes, can become unwanted pollutants in the aquatic environment.

Taking nitrate in the Tully-Murray catchment as an example, recent modelling estimates that 84% of the Dissolved Inorganic Nitrogen at the end of the catchment is sourced from sugarcane (76%) and bananas (8%). Monitoring also shows a strong relationship between nitrate concentrations with the proportion of intensive (fertilised) land use. For example, sub-catchments with 95% cropping land demonstrated concentrations 35 times higher than those without agriculture (Mitchell et al. cited by Eberhard et al. 2007)

Peak representative organisations of agricultural industries recognise that improved nutrient management is becoming an important factor in securing long term community and government support to farm in wet tropical environments or adjacent to World Heritage status assets (QFF, 2005; Anon, 2007). Further, there is also recognition that improved nutrient management may result in efficiencies and cost savings in the farm operation as well as benefits to water quality. Both the cane and horticultural industries have promoted and participated in initiatives to improve nutrient management on-farm on a voluntary or incentive basis and are participating in catchment and regional level planning initiatives such as *Water Quality Improvement Planning*. Additionally, the suites of management practices that are likely to result in improved water quality are generally well known and accepted by industries (e.g. Roebeling et al. 2007). What has been contested until very recently however, is who leads the water quality ‘improvement’ agenda in catchments, and, who pays if public benefits result in private costs on-farm?

Nitrate has been identified as the highest priority water quality issue in catchments such as the Tully-Murray through the Water Quality Improvement Planning process. A case study prepared to inform adaptive management of the plan's implementation (Eberhard, 2007) developed a ‘basic conceptual model’ showing the instrumental logic behind the relationship between on-farm fertiliser use and ecological impacts on reef ecosystems.

To this, or from this model, the case study identifies the hierarchy of management objectives embedded in the WQIP. These are presented in Figure 1 below.

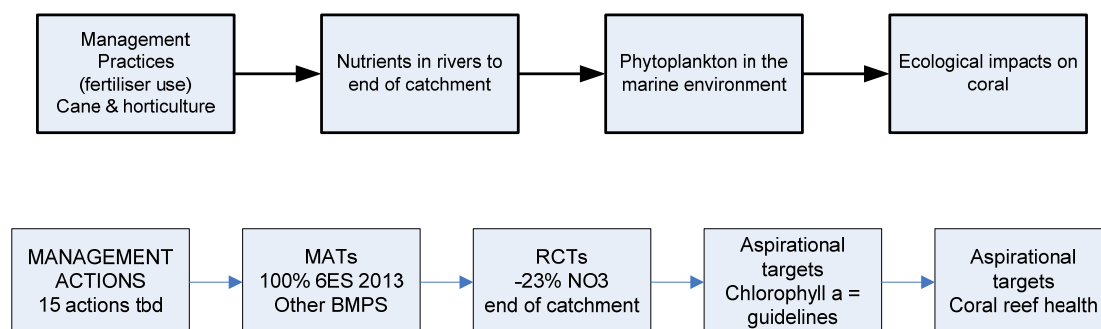


Figure 1 Conceptual framework of the Tully WQIP. Source: Eberhard, 2007

Box 1 below presents a sample of targets and related actions proposed under the Tully Water Quality Improvement Plan within the Wet Tropics Region.

Box 1: Example of nutrient management targets specified in the Tully-Murray WQIP

Resource Condition Target SI1: Reduce nutrient losses by 50% from contributing land uses by 2013

Management Action Target: Coordinated nutrient management strategies implemented in all four main land uses by 2013

Project / Action: Uptake of Six Easy Steps (6ES), including nutrient management plans, by 90% of canefarmers by 2013

Responsibility: BSES, Canegrowers, TCPS

Interpreting industry dialogue to analyse partnership needs

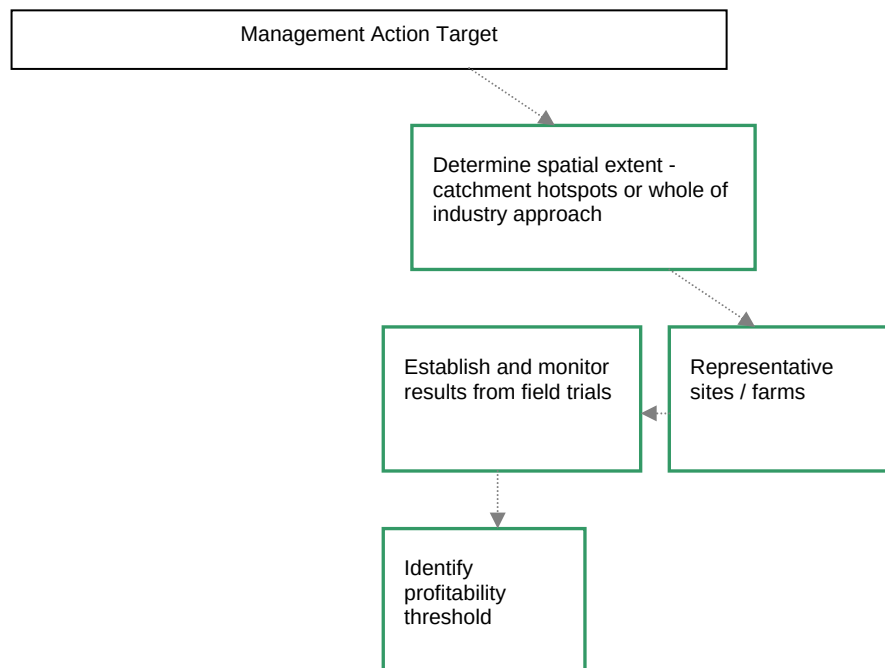
Deliberations amongst cane industry stakeholders (e.g. Canegrowers and Bureau of Sugar Experimentation Services) as part of the WQIP planning process, identified a 'suite' of actions involved in achieving targets of the kind presented in Box 1 above. Achieving "90% adoption of Six Easy Steps (6ES) by canefarmers by 2013" for example requires a complex set of political, social, knowledge-based and institutional interactions and preconditions to be met. An abstracted example of these interactions and conditions is presented below in Figure 2 to illustrate the multiple actions implicit within a catchment scale target.

Table 1 Examples of partnership arenas at different scales affecting nutrient management implementation for Wet Tropics region stakeholders

Scale	Examples of formal partnership arenas in which research team engaged
Reef	<i>Reef Water Quality Partnership</i> (including Regional Implementation Group; Science Panel; Management Committee) <i>Reef Alliance – consisting of Reef regional bodies, industry peak organisations and WWF</i>
Region	Industry Advisory Group, Terrain NRM Ltd
Catchment / local	Cardwell (Tully-Murray) Floodplain Steering Committee Production Action Team

Subset 1: Knowledge based actions and networks

The figure to the right (Figure 3) shows the subset of actions associated with design of specific and measurable nutrient management practices. The knowledge needs expressed here were considered by cane industry stakeholders as prerequisites to practice selection. These include sets of actions to identify the likely spatial extent of implementation, benchmark current practice, establish trials and assess the impacts of altered management regimes on resource condition and enterprise profitability if fertiliser use was modified. The imperative here for local or catchment level actors was to ensure the efficacy of practices and limit the economic risk to enterprises.

**Figure 3:** Knowledge-based actions

The intent of industry actors here is to first identify then reduce Nitrogen application rates to a critical profitability threshold rather than a predetermined 20 or 30kg/ha. This requires detailed knowledge on whether productivity will be impacted in the short term as well as projected long term sustainability of yield. Commitment to funding long-term trials (approximately seven years) on application rates was viewed as necessary to evaluate impact effectively. These concerns were particularly acute given the gaps in scientific knowledge evident during the catchment-level planning process.

These gaps included where nutrient goes, how much is available and how much is lost in the system, even at paddock to sub-catchment scale.

Local industry actors claimed the lack of demonstrable understanding of these issues at locally relevant scales reduced grower commitment. There was also some perception at the time that this lack of clear instrumental understanding made government regulation unlikely or at least highly problematic. This was considered by industry to provide a rationale to argue for a cooperative and incentive-based approach to improved nutrient management.

Subset 2: Practice-based actions and networks

The figure to the right (Figure 4) shows the subset of actions associated with improved practice design noted in the catchment level dialogue of industry actors. Cane industry actors' interpretation of the science implications is the expectation of reducing current application rates of urea-based (nitrogen) fertiliser in the Tully area from 160kg/ha to 110kg/ha¹². BSES officers believed "the bulk" of current application was sub-surface, which is in line with current recommended practice. Canegrowers suggested that taking 20-50kg/ha out of production "may well be a good thing if productivity and profitability are not impacted" by this reduction.

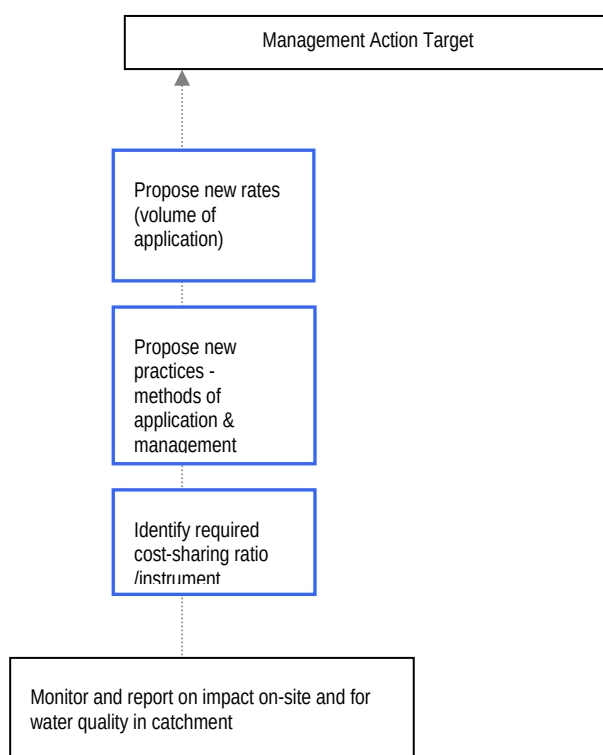


Figure 4: Practice-based actions

The group noted that soil testing as part of nutrient management is not currently common amongst growers, and that currently available tests have a low reliability. Implementing Six Easy Steps (6ES) would offer a considerable improvement in helping growers adjust rates based on mineralising capacity of different soil types. In the interim a need was identified to start implementing and measuring uptake of 6ES.

¹² on ratoon crops

Ideally, this would link to delivery of a revised Productivity Plan for the local district and the possibility of targeting areas of coarser textured soils where the “biggest gains” are most likely.

The group reported that “not too many” growers currently have fertiliser management plans and that rates used are largely based on fertiliser company soil analysis, for which growers can get best rates for different blocks. Other sources of advice included resellers, sales agronomists and independent consultants. BSES indicated they meet regularly with resellers to ensure accurate advice on rates was being provided. It was also noted that most independent consultants have come largely from the banana industry and moved into mixed cane/banana enterprises more recently. Farming styles of individual growers was also noted influencing fertiliser application with some growers taking a risk management approach and applying generous amounts of nitrogen to reduce the risk of crop failure, others using nitrogen-based fertilisers as a cure-all for symptoms often associated with other problems (e.g. zinc levels). Market drivers were also seen to influence advice seeking behaviour i.e. when cane prices are low and / or fertiliser prices are high, growers tend to look for quick fixes from consultants. These market conditions can therefore create a window of opportunity for advice on better practices.

A further requirement identified by the group is a clear commitment (from government and regional investors) to provide adequate funding for implementation, prior to industry sign-up. Failure to “put the dollars on the table” would “see the industry walk away” from catchment level planning and delivery processes. This position had also been articulated by industry representatives in the higher level policy dialogue, occurring at the whole-of-reef scale.

Subset 3: Actions and networks for institutional coordination

It became increasingly evident within the industry dialogue and in other fora that successful delivery would require cooperation between actors within the broader cane production sector, that is, other participants in the value chain beyond simply farmers and their representative organisations. It was similarly noted that it would require improved coordination between public, private and civic actors. Three main tasks of institutional coordination identified in Figure 5, right, are briefly described below.



Figure 5: Actions for institutional coordination

Commercial and public sector advisors and technicians

The need to engage or recruit other participants in the supply chain particularly advisors from commercial 'production services' sector was seen as critical. This involved seeking support from the processing sector (e.g. milling interests) and manufacturing and retail companies associated with fertiliser and application technologies. This was seen as essential in order to get a "common message to growers" on acceptable fertiliser practices. Government and quasi-government technical and science service providers (e.g. BSES and CSIRO) were also to be enlisted to promote a consistent culture of practice. This included drawing on locally-based state agency extension officers and industry development staff who were considered essential to identify critical locations (or growers) in the landscape that contributed disproportionately to nutrient export. Promoting new practice technologies that might also be seen by some growers as innovative or risky would require broad-based and coordinated advice provision.

Administering incentives and on-ground works

Given the 'public good' focus of the proposed incentive-based approach, government agencies may traditionally have positioned themselves to administer the investment directly to farmers. Industry stakeholders however, raised concerns over the inability of State Government agencies in the region to undertake this function in the context of perceived difficulties in meeting their existing statutory monitoring and compliance roles. This was reinforced by a perception that largely state agencies to "deliver their promises" under the Reef Water Quality Protection Plan. In this environment Regional NRM Bodies and their agents were discussed as an appropriate entity to undertake this program delivery function. Regional bodies were seen as having something of a comparative advantage with their capacity to facilitate and broker NRM outcomes and history of administered devolved grants through decentralised arrangements. Terrain, as the regional body in the Wet Tropics, had also positioned itself, through its planning facilitation role in the catchments, as an intermediary between industry and community stakeholders and government agencies.

Working with mixed enterprises and across commodities

The difficulties presented to adopting a purely commodity or industry specific implementation strategy for improving nutrient management practices were recognised by industry stakeholders as two fold. First, many agricultural enterprises in the Wet Tropics region produced multiple commodities. Second, investment needed to target priority locations that consisted of adjacent enterprises growing different commodities. In order to ensure the best chance of contiguous uptake of improved practices in these locations, cooperation between industry organisations representing different commodity types was needed. Beyond pragmatism however, adopting a multi-commodity approach had an ethical dimension, particularly for cane industry stakeholders at catchment-level who felt it necessary that other industries in the catchment area "need to share the burden and responsibility for clean up". Achieving this commitment to shared responsibility was a significant factor in cane industry buy-in to the planning process at the catchment scale.

Discussion: Multi-scalar implications for partnership-based delivery of nutrient management objectives in catchments

The above analysis identifies some of the catchment scale considerations discussed by sugarcane industry representatives and their networking implications. In the following discussion recent changes in governance arrangements at the Reef-wide scale are considered highlighting how they connect with, and affect action at other scales.

The recent formation of the Reef Alliance as a reef-wide partnership arrangement between, predominantly, regional natural resource management bodies and agricultural peak industry organisations has created space for improvements in governing reef water quality. In particular this new partnership has established shared principles of cooperation and cohesive investment strategies which begin to address spatial coordination between regions in the GBR and the agri-industry interests that represent land users in those regions. In doing so it appears to have provided several benefits. These benefits include improving coordinated action across several industry types in a given region; improving the capacity to engage with mixed enterprises; and the capacity to classify and standardise measures of practice adoption across diverse enterprises and physical environments. Each of these was a specific concern raised by catchment level actors during their planning activities. The Reef Alliance appears to provide a cohesive, if perhaps temporary and somewhat vulnerable, governing network at the whole of reef scale.

This Alliance which developed between two existing horizontal networks of 1) regional NRM bodies and 2) peak agri-industry organisations has provided a collective policy and investment platform. Its benefits however, extend beyond the reef-wide arena. It is the fusion of these two sector-based networks that has enabled the flow of financial and political resources of the Australian Government to actors working at catchment scales to encourage practice improvement¹³. This appears to be an institutional response to overcoming some peak industry associations' capacity to deliver programs of this nature at catchment scale. In addition, it has also provided the overarching framework to extend the influence of regional body investment by accessing industry-based grower networks, communication resources and the legitimising effect of 'industry backing'.

Interestingly, whilst the alliance was brokered at reef-wide scale by CEOs of regional bodies and peak-industry group leaders, the impetus was generated some months earlier by cooperation amongst regional body officers seeking a coordinated approach to WQIP implementation. At the same time, industry officers agitated for a more inclusive and consistent policy delivery mechanism. This dialogue occurred largely, but not solely, through the Regional Implementation Group of the Reef Water Quality Partnership. So in this instance catchment and regional-level cooperation has contributed to catalysing policy and investment-based cooperation at Reef-level. Whilst at the same time the reef-wide collaboration has provided the political and financial capital to actors at 'lower' scales to achieve policy goals.

What this suggests is the parallel but co-dependant development of horizontal networks at multiple spatial scales. Further, the vertical networks that link reef-wide with catchment-level deliberations and actions are also present. These vertical networks take two forms. First, these are sectoral, hierarchical networks of government agency and industry self-organisation.

¹³ There had in fact been precedents for peak-industry group alliances to seek political commitment and cooperation with the Queensland State Government on farm sustainability initiatives, including the Rural Water Use Efficiency program, and the Farm Management Systems Memorandum of Understanding in 2005.

The second form of these vertical networks embodies complementary but discrete functions that enable implementation at catchment-level. These functions include the production and testing of knowledge; the design and selection of farm management practices and, the coordination of institutions.

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Activity A - Attachment 2B

Sustaining Multi-Scalar Natural Resource Management Networks to Rehabilitate Significant Wetlands: A case-study from the Tully- Murray Catchment

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This progress report focuses on multi-scalar governance issues associated with wetland rehabilitation through weed management activities in Far North Queensland. The analysis refines the SMART (Specific, Measurable, Achievable, Realistic and Timely) partnerships framework to consider the transaction costs and benefits associated with building and maintaining the collaborative networks that influence the efficacy of wetland management activities. This requires understanding the different natural resource management (NRM) networks that exist at multiple scales (local, regional extra-regional) around wetland management in the Northern Australian region of the Tully-Murray catchment. It also requires analysing how the nature of transaction costs and benefits involved in building and sustaining these NRM networks affect stakeholder motivations and capacity to implement effective programs of weed management action. The focus of this analysis has been on activities and collaborations that have responded to the threatening process of weed (*Hymenachne*) infestation in and around Kyambul wetlands (Tully-Murray catchment).

This research responds to an unprecedented round of water planning, reform and implementation that is now occurring within Northern Queensland and across Australia. Major policy and program initiatives driving this activity include the National Water Initiative, the Reef Water Quality Protection Plan ('Reef Plan') and regional NRM initiatives negotiated under the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust (Hussey and Dovers 2007). In Queensland, regional NRM bodies are involved in the development of water quality improvement plans (WQIPs) to address 'hot spot' catchments believed to be contributing disproportionate quantities of sediment, nutrients and pesticides to the Great Barrier Reef (GBR) lagoon (Natural Resource Management Ministerial Council 2006).

In the Tully-Murray catchment, wetland rehabilitation has been identified as a significant issue, which is reflected in the Terrain regional NRM plan and current draft Tully WQP. The main threatening process to wetlands management is weeds, which threatens a range of ecological, cultural and recreational values within floodplains and drainage systems. This has been a critical driver behind a multi-scalar effort to mobilise local, regional and extra-regional networks to restore and protect significant wetlands and riparian areas from the impacts caused by *Hymenachne* infestations. Significantly, different institutions and actors have been identified for implementation of the Tully WQIP weed management, yet alignment of resources to these actors and networks is un-specified

The paper proceeds as follows: First the context of wetland management in the Tully-Murray Catchment and Great Barrier Reef is summarised. The methods used to apply and refine the SMART partnership framework are then outlined. Results from the multi-scalar partnership analysis are then described based on desktop review and interviews with numerous networks.

We conclude by highlighting key transaction issues that influence the effectiveness of institutional collaboration for wetland rehabilitation activities in this Northern Queensland region.

This progress report initiates work into collaborative networks of WQIP and solidifies current research around SMART criteria and transaction analysis. Further research will focus on testing ideas and issues raised in this report in the field and..

Context – Wetland Management in the Tully Murray Catchment and Far North Queensland Region

Wetland ecosystems are widely recognised as hot spots of biodiversity that have been subjected to significant human impact across the globe. As Wohl et al. (2005) note, the key limitations to effective river and wetland rehabilitation efforts are a lack of scientific knowledge of catchment-scale processes, dynamics and linkages, as well as poorly designed institutional arrangements needed to manage such complex environments. From a review of riparian and wetland management programs across the world, Wohl et al (2005) argue that effective rehabilitation relies on the following key components:

- Strategic and participatory mechanisms that translate and integrate knowledge and learning across (biophysical and social) sciences and management expertise;
- Management flexibility through adoption of adaptive management principles; and
- Stakeholder inclusiveness through ownership of local and context-rich information and community participation in the rehabilitation process.

Such knowledge and institutional needs also exist in Northern Queensland. There are significant scientific knowledge gaps in the role of wetlands to sustain a healthy environment (QEPA 2004). However, there is now growing recognition that wetlands play an important role in the provision of many ecosystem goods and services (Environment Australia 2001). Perhaps some of the most pertinent ecosystem goods and services provided by wetlands in coastal areas include water retention and filtration and regulation of flood waters (Environment Australia 2001). In the Far North Queensland Region, for example, there are a number of wetlands that are now officially protected for a range of national and international values (see Table 1)

Table 1 - Significant wetlands in Far North Queensland NRM Region

Type of wetland in FNQ	Number
World Heritage Area	2
Internationally important	0
Nationally important	31
Protected areas	127
Fish habitat areas	14
Wild Rivers	1

Source: EPA 2007

Despite these protections, over 50% of Australia's wetlands have been significantly altered since European settlement (DEH 2004). Perhaps the most destructive influences have come from urban development and agricultural practises causing loss of wetlands through drainage and infilling (Environment Australia 2001; EPA 2004). While it is difficult to quantify, the degradation of wetlands through extensive land clearing and drainage has allowed increasing levels of sediment and nutrients to enter the GBR lagoon (GBRMPA undated; Productivity Commission 2003; Brodie et al. 2001). The conservation and management of wetlands is important for protecting the GBR environment and its \$4.3 billion tourism industry and \$359 million fishing industry (Productivity Commission 2003).

As the Tully WQIP outlines in some detail, the invasion and dominance by exotic pasture species is a critical issue for wetland health in the Tully-Murray catchment. The introduction and invasion of exotic pasture species such as *Hymenachne* and *Para Grass* are severely altering hydrological patterns and biodiversity values of the floodplain. The resultant impacts on wetland ecology identified in the Tully WQIP include: the smothering and eventual replacement of native submerged and emergent macrophytes (these are important feeding and breeding resources for waterfowl and fish); organic loading and oxygen depletion in shallow water bodies; the creation of physical and water quality barriers to fish passage; trapping of sediment and siltation of floodplain flow paths and waterholes and the prevention of native vegetation recruitment surrounding water bodies.

The fact that weed problems cross jurisdictional boundaries and impact on all levels of actors signifies the importance of strategic partnership arrangements to reduce the impacts on natural ecosystems, agricultural landscapes, waterways and coastal waters (Natural Resource Management Ministerial Council 2006; Department of Natural Resources and Mines 2002). In the Tully-Murray context, this has largely been done through regional NRM planning facilitated through the regional NRM body; Terrain Inc. This regional NRM approach reflects a growing support for decentralised approaches to environmental decisions and management solutions. This flexibility means institutional arrangements and relationships need to be 'fit for purpose' to reflect the specific environmental management issue in question, the dynamic relationships amongst collaborators and affected communities, the agendas of collaborators involved, and types of policy intervention instruments and mixes available (Gunningham and Sinclair 2005, Ostrom 2005). Studies that have compared the 'fit' of different collaborative NRM arrangements highlight important differences in the purpose and design of governance arrangements across the spectrum of policy, organisational and action levels of collaboration and in response to different pressures and opportunities (such as self-interest or mutual benefit) (Oliver 2004).

The Tully WQIP has been negotiated to align with the Far North Queensland regional NRM plan that includes a suite of NRM strategies to achieve wetland rehabilitation objectives (see Box 1). The regional NRM body Terrain Inc, has focused considerable energy in building the collaborative capacity of various actors, institutions and networks in the region. This includes partnerships with local government and Aboriginal Corporations to undertake a suite of weed management programs, placing a priority on areas that contain Weeds Of National Significance (WONS), and protection of important ecological and cultural areas against threats caused by these invasive species. As outlined in more detail below, the Cardwell Shire area in the Tully-Murray catchment is currently a key focus of a number of activities relating to water quality and catchment health.

Box 1. Wetland rehabilitation; weed related targets identified in the Far North Queensland NRM plan (FNQ)

The Wet Tropics regional NRM plan identifies a number of weed-related targets:

- Resource condition targets:
 - RCT B4. No new deliberate introductions of ecologically invasive species that threaten terrestrial ecosystems after 2006
 - RCT B5. Eradication of Category 1 pests under the FNQROC Regional Pest Management Plan and strategic eradication or containment of other ecologically invasive species that threaten terrestrial ecosystems by 2014
 - RCT L6. 100% control of outbreaks of new agricultural pest plants and animals from 2004 and impact of agricultural pests contained by 2009 and reduced by 2014.
- Related Management action targets:
 - B4.1 Establish protocols that stop the introduction of ecologically invasive species by 2005.
 - B5.1 Recommended priority actions from FNQROC Regional Pest Management Plan are implemented by 2006.
 - B5.2 Control of weeds, pests and diseases contributing to an improving trend in the condition of terrestrial ecosystems, especially 'regional management priorities', by 2014.
 - B5.3 The negative impact of weeds and pests on Aboriginal cultural values and assets are reduced and the cultural values of weeds and pests are recognised in policy, planning and management by 2009.
 - L6.1 Strategic control of pest plants and animal outbreaks from 2004.
 - L6.2 Coordinated weed control in all shires using shire pest management plans and involving all stakeholders is implemented with targeted information available for property managers including best practice weed management covering machinery and stock crate movement by 2005.

Source: www.Terrain.org.au

Collaborative activities and arrangements in the Tully-Murray catchment and broader FNQ region are funded through a range of programs. This includes the Queensland Wetlands Programme (QWP) which has the goal to support projects and programmes that result in long-term benefits to the sustainable use, conservation and protection of Queensland wetlands. This is supported through two sub-programmes of the National Heritage Trust (now Caring for Our Country) and the Great Barrier Reef Coastal Wetlands Protection Plan (GBRCWPP). Most of the effort to date has been focused on developing wetland maps, improving agricultural systems and recording Traditional Owner wetland values. Through the GBRCWPP, a range of projects have been undertaken including a consortium of volunteer projects led by Conservation Volunteers Australia including; adoption of incentives, rehabilitation guidelines and wetlands education products.

The accompanying Aboriginal Cultural and Natural Resource Management Plan for the Wet Tropic NRM region also recognises that that weeds cause significant impacts on cultural, economic and livelihood values in the region, that are associated with river and coastal ecosystems (www.terrain.org.au) .

Transaction Analysis and the refinement of the SMART Partnership Assessment Framework

The analysis presented in this paper draws on the broader MTSRF project work that has developed the SMART (Specific, Measureable, Achievable, Realistic and Timely) criteria which can be used by collaborators to systematically test and assess partnership needs associated with proposed water quality management activities (summarised in Robinson et al, in press; Appendix 1). This includes the need for partnerships to facilitate actions that provide spatially *specific* tasks for collaborators which incorporate the right mix of coercive and incentive based approaches.

Measures of performance need to be negotiated to enable judgements of partnership and management; effectiveness, efficiency and appropriateness to be captured. Delivery commitments under SMART partnerships also need to take into account sectoral perspectives of the broad range of costs and benefits that inform *achievable* practice change associated with delivery options. Complementary, conflicting, and potentially different outcomes desired by each partner affect *relevant* attributes of partnerships that can be negotiated under existing institutional arrangements and relationships. Finally, *timed* attributes of collaborative partnerships take into account how long activities need to be implemented, when they ought to be initiated, and what is the best sequencing of actions for effective delivery to ensure effective organisational links throughout the planning, implementation and review phases.

The results presented in this report apply a transaction cost and benefit analysis to focus on the achievability dimensions of the SMART partnership framework which is analysed as a system of multiple institutional scales.

We draw on Holmes (2006) findings that many environmental management programs in Northern Australia are influenced by a complex hybrid style of networked governance that involves a range of 'horizontal' (between stakeholders at a given scale) and 'vertical' (across scale) interactions (see also Lane and Robinson, Appendix 1).

As a result, effective management activities and collaborations for wetlands in FNQ need to consider a confluence of interactions and relations that exist around wetland areas that often contain significant cultural, economic and environmental values. As such, stakeholders involved in wetland rehabilitation activities will often be engaged in a range of other collaborative networks that have formed to build consensus, integrate knowledge and reach agreement on related issues. Therefore, in achieving wetland management a variety of networks are involved at varying scales; local (eg. specific agricultural industry activities, local government, traditional owners); regional (eg. WQIP, regional NRM network) and extra-regional (eg. Conservation NGO, etc.) although most networks can operate at a variety of scales and hence are termed multi-scalar (Figure 1).

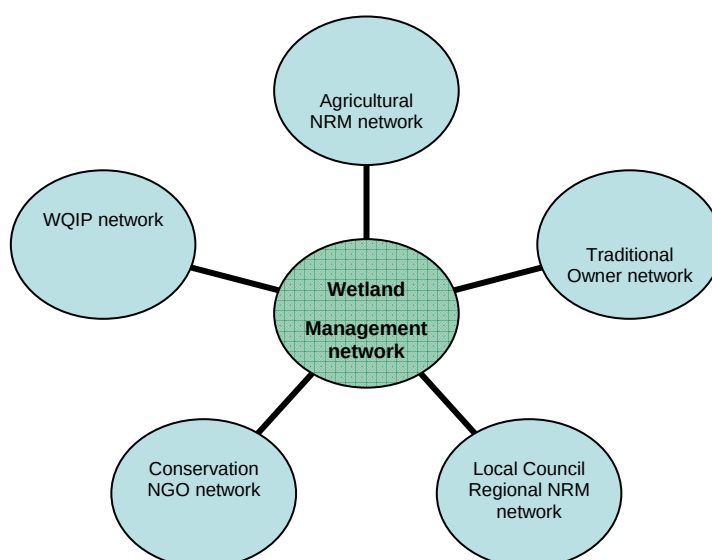


Figure 1: A stylised confluence of Collaborative networks involved in wetland management, Far North Queensland. Nodes (circles) represent the networks involved and spokes (lines) show the direct link to wetland management activities.

Economic analyses of the transactions involved in negotiating and delivering wetland management activities add critical insights to the costs and benefits associated with building and maintaining such networks to negotiate and deliver wetland management programs. Traditional approaches to transaction analysis only consider costs born by government agencies to deliver environmental management goals. The multi-scalar and collaborative dimensions of the SMART partnership framework require our approach to consider and compare the costs and benefits to actors involved in wetland program negotiation and implementation (Kumm and Drake 1998, Falconer and Whitby 1999). This enables the assessment to consider a range of broad social, economic, engagement and institutional costs and benefits that are generated from the establishment and facilitation of collaborative networks and activities (Edwards et al. 2001, McDonald et al. 2005, Robinson et al, 2005).

Consideration of the broader costs and benefits associated with implementation can influence assessments of institutional capacity to integrate (such as adequate funding and the ability to deliver mutually beneficial objectives). This opens up challenging questions about whether the transaction costs involved in partnerships exceed the benefits that are delivered (Alexander 1995, Gunningham and Sinclair 2002). Few NRM partnership studies have provided any form of estimates of what are the delivery net benefits or net costs to partners involved in collaborations. Falconer and Whitby (1999) note however that costs borne by either private or public partners shift between different delivery mechanisms (voluntary agreements, market or policy driven) (Falconer and Whitby 1999, cf. Kumm and Drake 1998).

Some assessments on the significance of transaction costs to policy implementation are provided. McCann et. al. (2005) for example note that transaction costs made up 38% of the total costs of the United States program of technical assistance for agriculture and 8% of the water purchase cost for the California Water Bank (Howitt, 1994). Colby (1990) in her study of water transfers identified transaction costs to include: attorneys' fees, engineering and hydrological studies, court costs, and fees paid to the state agencies. The results indicated that on average \$91 per acre-foot of water transferred was transaction costs. Measured another way the time spent waiting for state agency approval (time delays) was 29 months in Colorado, 4.3 months in New Mexico, and 5 months in Utah. Buitelaar (2004) notes that the consultation process involved in developing public private partnerships for infrastructure projects makes up a significant component of the cost of such a policy.

Thompson (1989) shows that these transactions are ongoing throughout the policy cycle, from early policy discussions, through to delivery of environmental programs. Whitten et. al. (2003), Whitten and Bennett (2005) and McCann et. al. (2005) all highlight that these costs are incurred by the agency developing and implementing the policy (public costs) and by policy stakeholder that have to learn about and engage with the policy at some stage in the future (private costs). Importantly economic analysis of transaction highlights that these costs can be born by any of the stakeholders involved in the transaction; state agency, local landholder, industry groups and community actors. These costs are usually measured in personal time, resources and financial expense associated with participating in collaboration. These costs can be grouped into 'fixed' (i.e. not varying throughout the policy cycle) or 'variable' (i.e. changing throughout the policy cycle).

Transaction analyses of NRM networks involved in Kyambul Wetland rehabilitation activities



Tully-Murray Kyambul Wetlands (anon, 2005)

The research aimed to assess multi-scalar partnership needs for rehabilitation in the Tully-Murray catchment and focused on wetland activities (particularly weed management) activities and collaborations in the Tully-Murray Kyambul floodplain. This area was chosen as it is currently the focus of a number of activities relating to water quality and catchment health in the Far North Queensland NRM region.

These activities are broadly designed to meet the ambitious resource condition target to enable the 'quality and extent of terrestrial and riparian ecosystems to be maintained and improved by 2013'. Activities and partnerships that achieve the strategic control of invasive weeds and pests in priority areas by 2013 are a key management action target to achieve this objective (see Box 2).

Box 2: Supported weed management activities in Tully-Murray catchment of Far North Queensland NRM Region.

Strategic control of *Hymenachne* in priority areas as identified by Control Plan. (800Ha Total Estimate of 14000 ha Catchment)

1. Lagoons and Creeks of Murray Upper Wetland area. 200 Ha @ \$300 /Ha
2. Tully River and Davidson Creek 100Ha @ \$ 300 /Ha
3. Meunga/Kennedy Catchment 10Ha @\$300Ha
4. Banyan Catchment 10 Ha @ 300Ha

A number of wetland rehabilitation and weed management networks have been formed and supported through this regional NRM and WQIP planning process. These networks are both scale dependent (ie. local, regional and extra-regional) and scale independent (ie. multi-scalar). The networks include:

- Local and Regional NRM network: A cooperative network between Terrain Regional NRM and Local Councils to achieve strategic and coordinated response to weed management. Example include far North Queensland Regional Organisation of Councils Pest and Animal Committee (FNQ ROC PAC)

- Extra-Regional Conservation NGO Network: Coordinated through Australian Conservation Volunteers and includes Kyambul as key site of wetland protection activities.
- Multi-Scalar Agricultural NRM Network: Adjoining landholders adjacent to Kyambul floodplain that have funds to undertake a range of wetland and riparian work on their properties in collaboration with programs such as Queensland Wetlands Programme Farm Management Systems. Examples include Agri-Industry Representative Groups such as CANEGROWERS and GROWCOM.
- Multi-scalar Traditional Owner Network: A network coordinated through Giringun Aboriginal Corporation who are contracted to protect a range of ecological and cultural value protection work on Cardwell Shire Council land including weed control activities.
- Multi-scalar WQIP Network: A network coordinated through Cardwell Shire Floodplain Steering Committee and focused on water quality improvement and wetland health issues.

The complex actors and agendas inherent in these networks highlight the significant issues associated with transactions that are required to ensure weed management and wetland rehabilitation work is both effective and collaborative. To interrogate this further we have undertaken a desktop analysis of weed management activities and collaborations that have focused on the Kyambul wetland. We are augmenting this by interviewing key stakeholders involved in these networks to describe the costs and benefits involved in establishing and sustaining partnerships needed to negotiate and deliver weed management activities. Primarily data collection is continuing and to date has been via face to face semi-structured interviews with key stakeholders. When interviews are completed they will cover the variety of networks involved in wetland management, including local farmers, Traditional Owners, local government, the Terrain regional NRM body and government agency representatives. Each interview lasts about 40 minutes, the interview schedule is provided in Appendix B and interviews conducted to date have been held between March and December 2008.

Results

The results are organised as follows: First we draw on the SMART partnership framework to outline the transactions required to achieve collaborative management of *Hymenachne* through existing networks associated with this wetland rehabilitation activity. We then summarise and compare the key transaction costs and benefits for participating stakeholders. Finally, the net position of transactions required to establish and maintain the multiple networks needed to deliver wetland rehabilitation activities is outlined.

A SMART assessment of Weed Management & Wetland Rehabilitation Partnerships

The transaction analysis interrogated the weed Management Action Targets for the Tully-Murray catchment against SMART partnership attributes. *Hymenachne* (a wetland based grass) needs specific management practices to control its spread and eradicate its existence (see their specific control plans DNRM&W, 2006 and DNRM&W 2006a). In the Tully catchment the weed management is an issue throughout, spread from the upper catchment (Murray wetlands) to peri-urban spaces (Meunga/ Kennedy Catchment) across protected areas (e.g. Lagoons and Wetlands of Upper Murray area) and the agricultural production landscape (e.g. Brick and Davidson Creek Catchments). A SMART partnership assessment of the *Hymenachne* MAs is provided in Table 2.

Table 2. Summary of critical SMART Actions and Networks to deliver Hymenachne Weed Management in Tully WQIP

	Action	Actors and Networks
Specific	Eradicate Hymenachne in Lagoons and Creeks of Murray Upper Wetland area. 200 ha – upper catchment. Control Hymenachne in: Tully River and Davidson Creek 100 ha @ \$300/ha Meunga/Kennedy Catchment 10 ha @ \$300/ha Banyan Catchment 10 ha @ \$300/ha	Establish partnerships to eradicate Hymenachne in priority areas identified by control plan (involves multiple networks involving CSFP SC, Landholders, TERRAIN, EPA, CSIRO, TOs, CSC, QPWS, CSCRIT, DNRM&W). Partnerships exist on both public and private land. Establish partnerships to control Hymenachne in priority areas (Landholders, TERRAIN, CSC, DNRM&W). Partnerships on private land.
Measurable	Informed by next report	Informed by next report
Achievable	Current financial resources are adequate to start eradication and control measures – part of core business for CSC & TERRAIN, Current status of insurance limitations and contracts with CSC ensures that no water based management can be undertaken, therefore can't achieve MA,	Central partnerships around private/ public land (i.e. in the Murray Upper Wetlands) management are established (e.g. between CSC, TERRAIN, Landholders, TOs and CSIRO), however new entrants are required for integrated management (e.g. EPA, QPWS, DNRM&W). Each specific catchment identified needs to establish one-on-one partnerships with private landholders and CSC/ TERRAIN to achieve MA – this is time consuming and potentially prohibitive. Each different stakeholder involved has specific values, perspectives, benefits and costs these needs alignment for implementation.
Relevant	How can we ensure weed management strategies can protect the values that Tully community and Reef plan collaborators wish to protect?	How weed partnerships can balance and reflect collaborator roles and agendas in improving water quality and ecosystems. What are the broad costs and benefits associated with current weed management partnership priorities and resources.
Timed	All control and eradication management strategies for Hymenachne occur pre- and post-wet season for maximum effectiveness (i.e. mid Nov and March). Combine land and water based activities are best coordinated simultaneously.	Partnerships are stretched at particular times to achieve a lot of work (pre and post wet season) and then resources are allocated elsewhere. Landholders undertake control on private lands whilst public agencies (i.e. Cardwell Shire Council & TERRAIN) undertake activities on public lands (e.g. in water channels) and in hard to access places (i.e. remote or mass infestations).

Table 2 outlines a number of issues affecting implementation partnerships. A critical issue affecting these networks for weed management and wetland rehabilitation in the Tully-Murray catchment is land tenure, that is:

- The network of partnerships that deal with weed management on private lands (e.g. directly on farmer's land) and
- The network of partnerships that deal with weed management on the interface between private and public land (e.g. land in and around wetlands).

A basic overview of the key partners, their scale of operation and basic indication of their input (either information or application focused) is found in Figure 2.

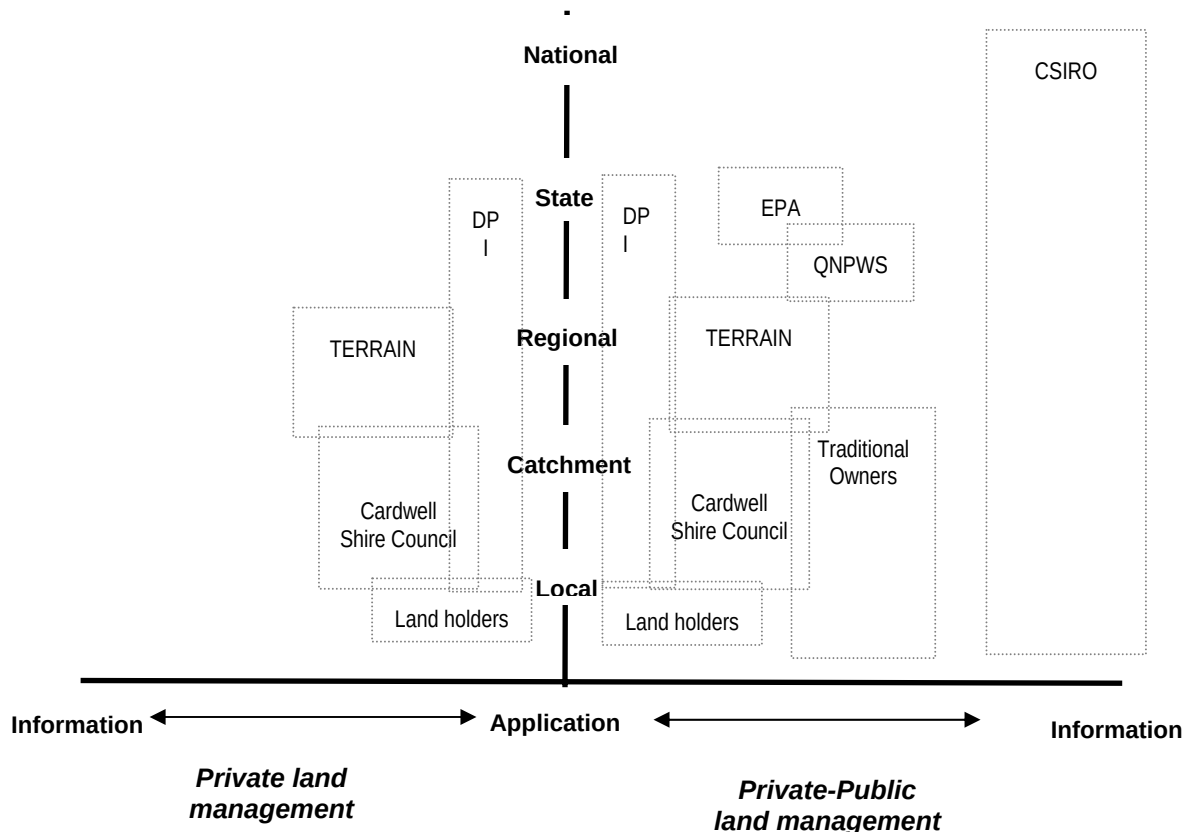


Figure 2. Institutional analysis of weed management activities categorised across local, regional and extra-regional scales; focus of input (i.e. information or application focus) and tenure (i.e. private or private-public)

The key weed management issues occurring on private-public land interface are found around the Upper Murray wetlands (e.g. Kyambul) which require significantly different partnerships and actions than when weed management occurs on private land. However, the majority of weed management in the Tully occurs on private land and so both issues are explored below.

The majority of weed management in scope, resources and partnerships in the Tully is directed towards private land, a number of selected catchments for priority management were named in the Tully WQIP. The management activities for these areas are relatively small and are generally focused on preventative or controlling actions.

Even so, there are some characteristics of transactions with landholders that were noted as critical to ensure that collaborations through government incentive programs were successful.

Interestingly, knowledge networks that were assessed by landholders to have a net benefit were not local community based but rather a mix of regional and extra-regional agri-industry, regional NRM and extra-regional scientific and individual business relationships. The transactions associated with weed control activity networks surrounding landholder capacity are related to their ability to manage strategically for long-term outcomes. This is challenged by the lack of next-generation family members to benefit from such benefits, and the benefit of informal organisations rather than government programs to ensure management programs reflected the local context in which they were being delivered.

However, there are different management actions that appear dependant on whether there is a positive net benefit of weed control to the individual farmer or whether there is no net benefit to the landholder. A positive net benefit could include an overall increase in land productivity due to undertaking weed control actions. Whilst no net benefit to the farmer may result because the land is un-productive (i.e. weeds too dense, topography inappropriate for crops, etc.) or the costs for involvement in weed control are too onerous.

Networks of weed management compliance were also noted and rely heavily on socially-enforced sanctions and relationships, rather than the power of enforcement through regulation. Council officers and agency staff who could rely on formal enforcement powers emphasised the value of engaging with social networks, learning and community pressure as a more effective and less costly than enforcement through non-collaborative means. While, landholders agreed with this approach, interviewees conveyed that collaborative networks for compliance purposes need to be strong and require constant management in order to be effective. There appears to be some variability in perspectives about whether the time it takes to maintain healthy networks is too costly for the short and long-term outcomes that are obtained. This will continue to be analysed as interview material gets collected and analysed.

Thus far, multi-scalar analysis has explored the effects of costs and benefits borne by each collaborator to sustain the networks involved in collaborative efforts associated with wetland planning and management. This research suggests that:

- The costs can be broken down into those associated with planning activities, costs associated with undertaking on-ground activities (i.e. actually spraying of weed) and finally the costs associated with delaying on-ground activities. Delayed action emerged as a critical issue because of the aggressive nature and impact of *Hymenachne* as an invasive weed (Table A – Appendix A).
- The benefits of collaboration can be identified and include; appropriate delivery pathways achieved through the coordination of multiple networks through weed planning and management activities, achievement of more environmental, livelihood and cultural outcomes through multiple network coordination; enhance timely response that prevents risk of delayed and non-strategic weed management response (Table B- Appendix A)

After interrogation of separate cost and benefits a desired overall net position was asked of the respondents. This was to flesh out if they perceived that costs outweighed the benefits (or vice versa) in weed management activities. This net position was derived by specifically asking 'on a scale of 1 to 5 (1 being negative and 5 being positive) how do you perceive you net position (benefit or cost) of weed management activities (including information collections and sharing experiences)'. Interestingly many of the respondents identified that there were multiple outcomes that occurred due to weed management such as increased

farm economic viability, enhanced ecosystem functionality, however these all occurred later in time (ie. number of years) after weed management activities are undertaken. Due to the temporal influence confounded with the multiple beneficial outcomes, the results will be divided as the net position now (i.e. current day) compared with the future time. The results are preliminary and will continue to be refined as more interviews are completed and analysed (Table 2).

Table 2 : Net position of transactions involved in the wetland rehabilitation and weed management networks for Kyambul wetland rehabilitation, Far North Queensland

	Net position now	Net position in future
Agricultural NRM network		
Key Issues	Multiple outcomes need to be delivered to overcome the transaction and resource costs of current weed management activities. Individual capabilities to bear costs when farming viability threatened (i.e. fluctuating sugar market) key driver to sustain weed control effort after initial control work.	Landholders and industry groups view themselves as broad NRM managers who are networked into the catchment community – imposes a moral obligation for long-term strategies, Challenges remain to ensure incentive program funding coincide weed management that is both effective and realistic to fit into existing farm management activities.
Net position	Cost - neutral	Benefit
Local Council and Regional NRM network		
Key Issues	Weed management is core business for most intra-catchment actors as such they perceive no costs: “always positive”	Weed management is just one area of NRM that intra-catchment actors are implementing: “Greater gains into the future, all relationship building for the better.”
Net position	Benefit	Large benefit
Traditional Owner network		
Key Issues	Need to ensure Indigenous institutions are supported to enable and sustain Indigenous CNRM activities required to deliver efficient weed management and effective management of Indigenous livelihood and cultural values.	Sustainable Indigenous institutions and networks will enable appropriate and targeted activities to occur ‘that benefit everyone in the community because [multiple] values will be protected from Ranger work’.
Net position	Weak benefit	Large benefit
WQIP network		
Key Issues	Tensions remain to ensure that programs under the WQIP also protect water quality / wetland values that Tully catchment NRM networks wish to protect. Capacity of landholders and agencies in agricultural NRM network to bear short term costs for long term gains variable in the landscape and between industries.	Healthy and dynamic collaborations between multiple NRM and WQ networks key to adapt to new knowledge and ensure delivery programs achieve healthy outcomes for Tully catchment / GBR coastal lagoon. Motivations to protect multiple outcomes associated with wetland rehabilitation, weed management and healthy waterholes remain strong.
Net position	Weak cost	Benefit
Conservation NGO network		
Key issues	Yet to be interviewed or reviewed	

Discussion

The preliminary analysis will continue to be explored as part of the investigation as to how to inform management actions, partnerships and opportunities that enhance investment in the Tully-Murray catchment. The analysis to date has highlighted a number of issues regarding restorative weed management practices to meet Tully catchment natural resource management targets. There are four specific areas of results as outlined below.

1. An understanding of the 'net benefit' position of each of the partners involved in the MATs to determine how cost and benefits align between the multiple networks that are formed to negotiate and deliver the actions that need to be undertaken:
 - Landholders in the agricultural NRM network see benefits of weed management as long term, but the resources for implementation are a much greater short term cost.
 - While short term benefits associated with measurable outputs for program reporting and Traditional Owner employment and CNRM activities are recognised, it is the long term benefits of healthy wetlands that are key motivations behind strategic and sustained management of Hymenachne in the Tully.
2. An understanding of the capability of institutions and actors in each network to collaborate with other networks to enable the alignment of activities and knowledge needed to deliver multiple outcomes. This also raises issues of partnership design for different tenure (private vs the interface between private and public land) and management objectives (i.e. water quality for GBR coastal lagoon vs healthy wetlands; delivery for multiple outcomes vs single outcomes):
 - There are competing motivations and perceptions of what constitutes the most effective delivery pathway and collaborative network to achieve 'strategic' weed management to protect and rehabilitate wetlands. Multiple weed management pathways through landholder incentive programs, local council NRM activities, volunteer activities, and Indigenous Ranger activities need to be better coordinated to ensure effective management of significant wetlands such as Kyambul.
 - Collaboration between wetland and weed management networks are easier when support is provided to all institutions involved in these activities. There is general agreement that the costs of weed infested wetlands to local communities, Traditional Owners, and nationally significant species is significant. The costs of sustaining knowledge networks, weed control activity networks and networks to ensure weed management compliance to local landholders is also significant and requires networks to be supported if these activities are to be sustained.
3. Clarification of the points at which 'crises' or tipping points occur where fragmentation between weed management and wetland rehabilitation networks occur. For example:
 - A sensitive and low weed infestation threshold that affects individual landholders' motivations to respond and collaborate. Provides a critical indicator used by partners to measure efficacy of collaborative activities and networks.
 - Type, extent and delay of management activity threshold that affects tolerance for multiple weed management pathways to co-exist (i.e. the patchwork of weed spraying and tree planting undertaken by volunteers, Council officers, landholders and Indigenous Rangers).

4. Discerning if there is any timing or spatial implications of existing patterns of institutional collaboration and the actions involved:

- There is currently a distinctive mismatch between timing of benefits and costs imposed for different collaborators. Minimal investment in institutions required to govern collaboration between the multiple networks threatens strategic and sustained weed management for wetlands.

Some Key References:

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APPENDIX A - Table A A summary of key transaction costs of *Hymenachne* management for wetlands in the Tully

Planning	Undertaking on-ground activities	Delaying on-ground activities
Cost to change current activities - partnership 'cost' for landholder to meet people; to gain knowledge; risk of new changes; partnership cost of regional / extra regional actor relationships (i.e. volunteers coming to property; CSC arriving to discuss weeds, etc) Cost to reform others activities – 'cost' of NRM conflict; knowledge uptake lags; and revising prevailing assumptions about the power of social networks (i.e. leaders getting GPS) to local Councils and regional NRM bodies Costs associated with equity of funding; for example lack of transparency about who gets funding, if it aligns with farming timing or program timeframes and where such incentives are concentrated in the landscape, i.e. Next to council reserve where ecological and cultural impact of weeds are high or where landholders are willing to commit time and effort Cost of effort when scientific, practical or government program logic information is wrong, misdirected that affects the motivations and sustainability of maintaining appropriate wetland networks	Opportunity cost of own activities; needing to align this with farming practices – i.e. hard to weed during dry season when so many other jobs need doing. For government agency collaborators this includes the costs to align local weed management priorities with broader policy directions and budget allocations Efficacy of some collaborative networks while high to protect some values (i.e. NGO tree planting activities for tourism and broad social capital benefits) do impose transaction costs to landholders who worry about open gates and activities on their land. Environmental impacts of such activities are critical if the nexus between local landholder network and volunteers network critical if this is to be sustained. Discussion The preliminary results analysis will continue to be explored as part of the investigation as to how to inform weed management actions, partnerships and opportunities that enhance investment decisions wetland management in the Tully-Murray catchment. The analysis has highlighted a number of issues regarding restorative weed management practices to meet Tully catchment natural resource management targets. There are four specific areas of results. An understanding of the 'net benefit' position of each of the partners involved in the MATs to determine how cost and benefits align for each partner and the actions that they need to undertake: Primarily farming landholders see benefits of weed management as long term, but the resources for implementation are a much greater short term cost	Costs associated with time delays to wait for partner readiness (landholder; Council weed management officer, or government program investor) to ensure weed management can be co-delivered and 'co-regulated' in an effective and informal way Costs of weed impact feedback – i.e. control of small <i>Hymenachne</i> plant less costly to control than huge infestation Cost of behavioral reform i.e. shifting response from the narrow view that landholders have a narrow role of farm management to base collaboration to landholders as broader NRM managers and partners; Costs associated with not all the catchment (social networks) changing land management practices, weeds spread and all neighbors need to be aligned for control and eradication plans Financial cost is enormous for an infestation of weeds, as opposed to a small cost for control and maintenance of small number of plants A cost is effort is born if action is delayed, as the weeds will spread and become

Planning	Undertaking on-ground activities	Delaying on-ground activities
	Overall all stakeholders believe that there are only benefits to the control of <i>Hymenachne</i> in the Tully over the long term An understanding of the capacity of partners to fulfill their action and partnerships for implementation (involving understanding the various resources available to partners for both private and private-public land management); There are competing drivers for the weed implementation: good farm practice versus ecological values of regenerating wetlands by the different stakeholders Intra-catchment bodies (i.e. government) have explicit funds to undertake weed management (i.e. core business) whilst private landholders do not have the same resources, particularly farmers that are struggling financially (e.g. those in sugarcane farming) Clarification of the points at which 'crises' or tipping points occur where partners will change their involvement based on particular issues; There was an ecologically threshold identified by some farming landholders around the infestation of <i>Hymenachne</i> – if we can stay on-top of it then it won't overtake the whole farm There was also a management threshold identified, whereby is every landholder sprayed or eradicated the weed intensely over a period in a coordinated way, then there should be much less regrowth as it is primarily spread form within the catchment (through waterways and birds) Discerning if there are any timing or spatial implications of the partnerships and the actions involved;	entrenched in water systems and the whole catchment

Planning	Undertaking on-ground activities	Delaying on-ground activities
	A distinctive mismatch between timing of benefits and costs for the predominantly farming landholders Primarily farming landholders see benefits of weed management as long term, but the resources for implementation are a much greater short term cost Further work needs to be undertaken to address many weed implementation issues raised including: What are the social benefits of weed management and do they outweigh the private benefits of individuals on farm management techniques? – particularly those farmers that do not undertake any on-farm weed management. Are there alternate partnership strategies or ideas that need to be considered in weed management. Issues of collective action were raised as well paid contractors to keep the 'majority' of the infestation down to a manageable level. Do these partnerships need to consider the tipping points raised earlier? Should alternate partnerships and actions be delivered when an 'infestation' of <i>Hymenachne</i> is apparent as opposed to the general on-going maintenance requirements? Costs to multiple networks to mediate "inherited damage" caused from misguided or poor farming practices, lack of access to protect cultural values in an appropriate way, or gaps in funding to sustain weed management efforts Cost in time and resources for all networks to negotiate and to monitor effectiveness of activities Financial cost for sprays	

Planning	Undertaking on-ground activities	Delaying on-ground activities
	Opportunity cost in effort, particularly when it is at a time with competing jobs related more directly to production improvements Cost to upgrade other infrastructure, e.g. road maintenance so that inaccessible areas can be more accessible (i.e. upgrading roads 'open the gate' for volunteers at Kyambul wetlands) Cost of effort and to finances particularly felt during hard times (i.e. canegrowers and current markets) The cost of an infections weed that spread from others properties: "the minute I relax it will beat me, but it doesn't involve much cost to control it as part of my day to day activities"	
Devolution of effort is only in priority areas (i.e. identified wetlands with small infestations and priority wetlands) and in non-priority areas they "play with the willing". Costs in terms of time and effort are required to develop the depth and strength of partnerships necessary with all partners: ROC, Terrain, Main Roads, CSC Engineering, canegrowers and Sugar Mill, tourist industry and DPI for information, QPWS but many intra-catchment partners have poor relations with landholders.	Costs of activities include resources and time "but in budget" (i.e. no perceived opportunity cost for landholder liaisons etc.)	Hymenachne is a major fish barrier, traps then remobilizes nutrient and dams wetlands. It is also 'pervasive' and with large spreading downstream. Most collaborators within the catchment consider that continued management has sustained the size of infestation but agree that the density is less around wetlands and key riparian managed areas

APPENDIX A - Table B Summary of key transaction benefits of *Hymenachne* management for wetlands in the Tully

Planning	Current on-ground activities	Long term outcomes	Delaying action
The alignment of NRM networks for wetland management can provide enhanced benefit to multiple outcomes – such as the protection of wetland’s cultural and ecological values; Cross fertilization of learning between learning provides important opportunities for more timely and alternative more effective delivery pathways to be explored (i.e. informal ‘co-regulation’ achieved through social networks and trust built between council officers and local landholders) Developing trust to ensure relationships are maintained that allows opportunities for knowledge integration to occur (i.e. trusted scientists informing landholder practices; growing recognition of Indigenous values in key wetland areas) Government agencies rely on regional NRM body to maintain good relationships with local landholders (‘we value them because we don’t have our own extension officers any more’). The costs to much to maintain good relationships is not deemed high by stakeholders in the region given the benefits of more context relevant and socially acceptable delivery pathways that can be negotiated. Yet it does require constant and conservative effort to initiate change.	@ local scale – primary driver is increased farm productivity (aiming for increasing productivity even if increases costs) others more focused on balancing costs and benefits (i.e. cost of clearing drains calculated as input / output of drain rather than the whole farm system – Angelo remodeling drains; Weeds themselves critical driver – i.e. very satisfying seeing tree grow, not much excitement about stopping weeds to grow; <i>Hymenachne</i> described by all collaborators involved in Tully wetland management as “scary”, “wild”, “uncontrollable”, “aggressive”, “explodes” onto the landscape” very context specific and very minimal. Landholders with high capabilities and capacity could see long term benefits and had short term capabilities to weed manage for that; others (i.e. cane) fine economic margins (farm profitability) did not have that flexibility to undertake strategic activities	Increased opportunity for productivity – high cost to revegetate but long term gain to get weeds under control Future generations see the benefits of our current work “important to keep land in good condition, it takes a long time to get it back” [threshold issue here] “cost to me is small, compared to the potential loss in productivity” Government collaborators see the value of “healthy ecosystem to get rid of weeds” but are also aware of the need to ‘report on tangible short term outputs to highlight funding program success’. The delivery of multiple outcomes are achieved in the long-term and require the delivery of short-term outcomes that align with different motivations held by each NRM network (livelihood agendas; immediate access to important waterholes; aesthetic benefits etc)	Decreased risk – could see others success and failures (threshold); not perceived to be near ecological threshold of no return

Alternatively a lack or loss of relationships costs a lot (if conflict gets too high; if lack of transparency about delays in government funding occur; local DPIF extension officer leaves; if landholder sells farm and new “westy” comes in who is ignorant of social networks and tropical landscape context needs. State / regional NRM limited benefits Collaboration also enables motivations and knowledge to be shared and key areas of conflict or non-collaboration to be exposed. This has been a dynamic cost-benefit relationship as funds, knowledge and feedbacks from the Tully-Murray WQIP process have ebbed and flowed. This has been affected by the growing exposure of community and Traditional Owner values that require protection, the variable and shifting interest in wetlands for end-of-valley water quality targets for WQIP program managers, and the emerging science of limits of wetlands as a nitrogen ‘filter’ in this Northern Queensland hydrological context. Engaging with the landholders critical to almost all programs so this provides one that they are interested in for their profitability – it ‘open’s the door’ for discussion about other programs. Terrain Regional NRM is seen as a critical broker for industry – program delivery networks for WQIP issues. Industry peak bodies are valued for brokering political response, and relevant knowledge to inform best weed management practices.	For broader catchment (water quality, decreased land erosion, positive outlook for catchment, economic viability – Which types of activities will lead to a weeds and or other outcome/ benefit not necessarily same (e.g. “grazing is an acceptable practice for controlling <i>Hymenachne</i>”, “Cattle clean the country”, tree planting or spray gun) “good business plan to control weeds” Alignment of management efforts and purpose between each of the wetland NRM networks critical to manage the impact and spread of a such invasive wide-spread weed. As one government agency officer put it, ‘the effort is different but needs to be coordinated to really ensure the best bang of the wetland buck’.		
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Appendix B Semi-structured interview schedule

Interview Schedule for Weeds Collaboration investigation

This interview is part of an independent MTSRF research project run by CSIRO Sustainable Ecosystems that involves Cathy Robinson and Leonie Pearson. The project is gathering a range of different views about collaborative weed management strategies near Kyambul wetlands that are occurring on land in the Tully Murray Catchment. We are particularly interested in strategies around *Hymenachne*.

In a practical sense some of the information from this project will be used to inform the Tully WQIP and efforts to improve water quality outcomes in Far North Queensland. However, the analysis is being conducted independent of both those processes. The research team is also happy to make the analysis available to you as a participant. If you have any questions contact Cathy Robinson (Catherine.Robinson@csiro.au ph: 07 3214 2329) or Leonie Pearson (Leonie.Pearson@csiro.au) ph: 03 9252 6092

The interview should take no more than 40 mins. It covers two areas:

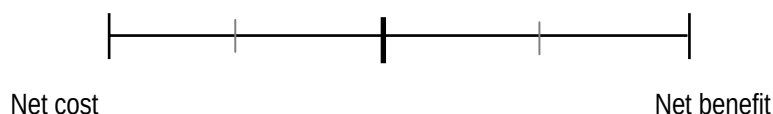
- Understanding how beneficial (or not!) collaboration for weed spraying is for delivering weed outcomes and any other outcomes.
- Net benefit or cost of collaboration with neighbours, others within the catchment and those outside of the catchment for weed and other outcomes

Have you got any questions or concerns before we start?

Part 1: Net benefit of weed collaboration

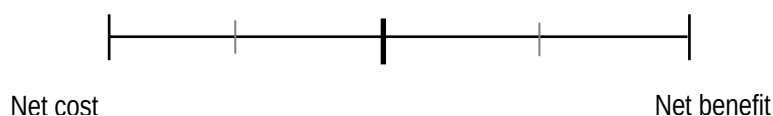
Collaboration requires you to work with others to achieve weed management of *Hymenachne*. We're keen to understand what 'transactions' are required to achieve this and if on balance they are a cost or benefit to you.

Focusing only on your delivery of the weed management (i.e. spraying on the ground):
Net benefit of collaboration for the **weed outcome**:



Do you receive any **other outcomes** and what are they? E.g. social relations, knowledge etc.

Again on balance would you consider that the collaboration for weeds has a net benefit or cost for delivering all those other outcomes?



We're keen to look at collaboration at different levels:

With neighbours

Weeds outcome

Other outcomes

Within the catchment (e.g. people upstream and downstream)

Weeds outcome

Other outcomes

Outside of the catchment (e.g. state agencies, regional bodies, CSIRO and scientists)

Weeds outcome

Other outcomes

Part 2. Demographics

Type of stakeholder: state, non-state, farmer

What type of tasks do you undertake for collaboration in delivering weed control, i.e. research, information collection, meetings, etc.

Weed Management tasks		Inter or intra catchment collaboration required
Information	Surveying of the designated area	
	Designation of area	
	Designing management options	
	Iteration of management mechanisms	
	Re-design of mechanisms	
Contracting	Negotiation between organisation and farmer	
	Administration of contract	
	Payment making	
Implementation	Promotion of scheme to farmers	
	Purchase and maintenance of equipment & chemicals	
	Weed eradication process (spraying or cutting)	
Enforcement	Environmental monitoring	
	Mechanism evaluation	
	Policy evaluation	
	Farmer compliance	

Attachments for Project 4.9.6 - Activity B

**Attachment B1 – Draft Mission Beach Habitat Network Action Plan.
In separate attachment**

Attachment B2 - Mission Beach Expert Panel Workshop

AGENDA

Friday 12th December 2008

James Cook University, ATFI (E2) Building, McGregor Rd, Smithfield E2.113A

9.00 Welcome

9.05 Ro Hill – Aims of the day

9.10 Tony O'Malley – Background

9.15 David Francis (Chenoweth) – Biodiversity significance attributes – methodology

9.45 Ro Hill – Introducing Working Groups

WORKING GROUP SESSION 1 – Biodiversity significance attributes session

1. Vegetation/Geology/Corridors/Relative Size/Vegetation integrity

2. Scheduled Species and communities

3. World Heritage Values/Wetlands/Climate

10.15 – 10.30 Report back from working groups

10.30 – 10.50 Morning Tea

10.50 Petina Pert – Datasets used, maps

11.00 Petina Pert – Introducing Working Groups

WORKING GROUP SESSION 2 - Mapping of biodiversity significance attributes session

12.00 Report back from working groups

12.15 – 1.00 Lunch

1.00 Ro Hill – Introducing - Mapping condition and status

Presentations

1.10 Miriam Goosem – Assessing the habitat quality of remnant and riparian vegetation

1.20 Dan Metcalfe – weeds

1.30 Dave Westcott – invasives

1.40 Petina Pert – Connectivity Indices and VAST

1.50 Questions

2.00 – Ro Hill – Introducing Working Groups
WORKING GROUP SESSION 3 - Condition and status session

2.20 – Report back from working groups

2.30 – 2.50 – Afternoon tea

2.50 Ro Hill – Conservation Investment platform, Reef Atlas (platform for public display)

3.00 Petina Pert – CommunityViz demo (platform for investment decision makers)

3.20 Comments from the floor

3.40 David Francis (Chenoweth) – response to workshop feedback

3.50 Ro Hill - Where to from here?

4.00 Close

Biodiversity Significance Attributes List

The following list of Biodiversity Significance Attributes was prepared by Chenoweth (2008) utilising the Criteria outlined in the “Biodiversity Significance of Mission Beach” report (CEPLA, 2007). Where Geographical Information System (GIS) data is known to be readily available specific mapping considerations have been identified. In some instances where ‘off the shelf’ data is unavailable; it is likely that information can be prepared by manipulating existing data sources. CSIRO/terrain together have compiled and prepared maps from existing data to address Chenoweth’s mapping recommendations.

CHENOWETH				CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
1	Geological diversity	Specific geological variations and diversity are good indicators of habitat diversity and ecosystem micro-variation. Mission Beach includes land systems that contribute to high biodiversity or individual species of significance.	Rocky versus sandy shores to identify the overlapping areas around Mission Beach; Basalt in coastal fringing areas; and Diversity of land zone. This could possibility be mapped by utilising Simpson's Diversity Index for mapped land zones in the Wet Tropics. High rankings in the Mission Beach area may indicate significance relative to other areas.	1.1 1.2 1.3	1.1 Scenic coastal landscapes including areas of state significance (EPA) 1.1 Coastal waterways geomorphic habitat mapping 1.2 Geology – Basalts (100K) Not completed – awaiting data.	Further investigation is required to ascertain existing data availability Dan Metcalfe's new RE's in Basalt headland (Metcalfe et al. 2008) Further investigation into Stuart Kinnimonth's marine mapping of shorelines. AIMS, GBRMPA zones data? CSIRO only has 100K geology Geology attribute found in Stanton mapping Regional ecosystems - the geology, landform, soil and vegetation that characterises each regional ecosystem are briefly described by the attribute 'landzone'.
2	Significant Vegetation Communities	The rarity of some vegetation communities contributes to their conservation value. Frequently rarity	This might be represented through a series of maps given vegetation has been mapped separately by Stanton and Stanton (2005) and the Queensland Herbarium (EPA, 2005). The following might be considered in mapping: Mapping the relative extent of vegetation communities known to be rare in the region	2.1 2.1.2 2.1.3 2.1.4 2.2 2.3 2.4	2.1.1 Regional ecosystems and geology (100k) – Basalt 2.1.1 Stanton and Stanton Vegetation Mapping –	Other datasets - SLATS FPC

CHENOWETH				CSIRO/terrain		
Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments	
	has been driven by human activities, but sometimes it is a result of unique geological and climatic conditions prevailing in a specific location. Integral patches of rare vegetation communities are regarded of significance.	such as rainforest on coastal basalt, mesophyll rainforest on sand, Licuala Fan palm forests or headland occurrences of native grassland on basalt of Mission Beach to that across the region, the Wet Tropics and North Queensland. It has been reported that Mission Beach has the highest diversity of impeded drainage vegetation communities in North Queensland (Small, 1995). This attribute might be mapped by mapping selected vegetation communities / regional ecosystems across the region, the Wet Tropics and North Queensland and assessing diversity per a given unit of area. A Regional Ecosystem map illustrating conservation status under the <i>Vegetation Management Act 1999</i>. This gives a relative significance of vegetation communities primarily based on the extent remaining in the landscape following European settlement. A Regional Ecosystem map illustrating Biodiversity Status. Biodiversity Status (based on an assessment of the condition of, and threats to, remnant vegetation in addition to the pre-clearing and remnant		Geology 2.1.2 Mesophyll rainforest on beach sands – RE 7.2.1. 2.1.3 <i>Licuala ramsayi</i> – Regional ecosystems 2.1.4 Native grassland on basalt – RE 7.8.7b 2.2 Impeded drainage vegetation communities RE 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.3.8 and 7.3.9 2.3 Regional Ecosystems Vegetation Management Status 2.3 Regional		

CHENOWETH				CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
			extent of a regional ecosystem) provides another measure of significance.		Ecosystems VMA Status 2.4 Regional Ecosystems EPA Biodiversity Status 2.5 Areas of High Ecological Significance (FNQ2025) 2.6 Areas of General Ecological Significance (FNQ2025)	
3	Relative Size of Vegetation Communities	A measure of the area of each remnant, relative to other remnants of similar ecosystem, indicates whether a remnant area is likely to be a 'good'	This can be measured for all vegetation communities and/or regional ecosystems for the area relative to those throughout the wet tropics or targeted to specific communities where a difference is already known (e.g. Licuala Palm Forests). The EPA's Biodiversity Assessment and Mapping Methodology (EPA, 2002) ranks the relative size of individual regional ecosystems according to the following: A patch will be regarded as of Very High Significance if a patch is >75% of the size of	3.1	'As above'	Using software tools calculations can be derived on the size, area, length of RE's (or patches). Area of each vegetation patch (RE) Percent vegetation cover, ground cover, woody, canopy density from other datasets (NCAS AGO). Comparison to RE's found in region (outside study area) - % remaining. Use of other Remote Sensing data LiDAR Use of LiDAR (Light Detection and

CHENOWETH				CSIRO/terrain		
Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments	
	representative sample of its type, and whether it is likely to represent a significant proportion of its type remaining in the region. A patch which includes a relatively high proportion of the remaining ecosystem has high conservation significance.	the 'largest example' of the regional ecosystem in the bioregion. (NB The 'largest example' is calculated utilising the average of the three largest patches in the bioregion); A patch will be regarded as of High Significance if a patch is 50-75% of the size of the 'largest example'; A patch will be regarded as of Medium Significance if a patch is 25-50% of the size of the 'largest example'; and A patch will be regarded as of Low Significance if a patch is <25% of the size of the 'largest example'. This technique can be applied at the local and bioregional scale. However, this technique relies on the relative size of specific vegetation communities and does not take into account habitat types – for instance, Rainforest would be made up of a number of different vegetation community types. On this basis there may also be benefit in grouping vegetation types when considering this attribute. For example, the importance of Mission Beach to lowland rainforest may simply be demonstrated by grouping rainforest types below the 80m			Ranging) could provide a rich platform for detecting structural elements of native vegetation. Cheaper alternatives - SPOT5 and Landsat TM.	

CHENOWETH				CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
			contour and illustrating that Mission Beach supports the largest lowland rainforest patch.			
4	Diversity of Ecosystems	The number of different ecosystems present in an area is a broad indication of its habitat diversity, ecotones (boundaries) and ecological processes which contribute to biodiversity.	Ecosystem diversity must be considered both within each remnant unit and within its 'neighbourhood' of abutting and nearby ecosystems. This requires a neighbourhood buffer around each remnant unit to 'capture' adjacent ecosystems. Ecosystem diversity is commonly classified using concepts of 'Richness' (number of different ecosystems) and 'Evenness' (relative abundance of the different ecosystems). Simpson's Diversity Index (SDI) is a commonly used index that incorporates both concepts, by calculating the probability that two sample sites selected at random from a defined area will have different ecosystem characteristics. The application of Simpson's Diversity Index to the vegetation communities and/or regional ecosystems of the Wet Tropics will provide a relative basis from which to compare Mission Beach's value in the local area, bioregion, north Queensland or the State.	4.1	4.1 Vegetation Stanton and Stanton	To classify Ecosystem Diversity a buffer is placed around the focus Remnant Unit reflecting its shape. The width of the buffer is derived using the modal (most frequently occurring) area of all Remnant Units within the bioregion (rounded to the nearest 50m). An Ecosystem Diversity for the focus Remnant Unit is calculated within the total buffered area.

	CHENOWETH			CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
5	Scheduled Species	Scheduled species are those listed as Endangered, Rare or Vulnerable under the <i>Nature Conservation (Wildlife) Regulation 2006</i> or Endangered or Vulnerable under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> . Species that are regarded as Extinct might be considered in some circumstances ¹⁴ .	Point records attained by GPS represent the most reliable information. Some point records in databases (e.g. HerbreCs, Wildnet, Queensland Museum) have low precisions and can therefore not be accurately assigned to a specific location. Lack of survey effort limits the capacity to identify all known locations of threatened species. A further complicating factor is that it is difficult to assign a point location to a highly mobile animal that depends on a wide habitat range. Habitat modelling can therefore provide valuable information to capture the habitat needs of a particular species or compensate for lack of survey effort in an area. A recent report (Metcalf, Ford, & Lawson, 2008) prepared for the Commonwealth Department of the Environment, Water, Heritage and the Arts would provide a valuable tool to identify actual and likely species' habitat for nationally listed flora and fauna.	5.1 5.2 5.3	5.1 EPBC species and RE's VMA Status 5.1 Regional Ecosystems – Littoral rainforest and vine thickets 5.1 Significant species 5.2 Modelled distributions of species – Steve Williams 5.2 <i>Myrmecodia beccarii</i> – Ant Plant 5.2 <i>Arenga australasica</i> – Australian arenga palm	A recent report (Metcalf, Ford, & Lawson, 2008) prepared for the Commonwealth Department of the Environment, Water, Heritage and the Arts would provide a valuable tool to identify actual and likely species' habitat for nationally listed flora and fauna.

¹⁴ The latest State of the Environment Report 2007 (EPA, 2008) recorded that two species of plant thought to be presumed extinct were rediscovered. Given this, there may be some circumstances where presumed extinct species may be considered.

CHENOWETH				CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
		Recorded locations of 'At Risk' species of flora and fauna indicative of essential remaining habitat, are of very high nature conservation significance for the maintenance of biological diversity.	Icon scheduled species, such as Cassowaries and Mahogany Gliders, may need to be considered through separate mapping.		5.3 <i>Litoria rheocola</i> – Common Mistfrog 5.3 Cassowary Habitat 5.3 Cassowary habitat and proposed landscape linkages in Mission Beach 5.3 Cassowary and Mahogany Glider habitat	
6	Nationally Important Wetlands	By definition its very definition areas mapped under this attribute are regarded as of National Significance.	Nationally Important Wetlands of the Mission Beach area are mapped by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWR, 2007).	6.1 6.2	6.1 Directory of Important Wetlands 6.2 Queensland Wetlands	Data available

	CHENOWETH			CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
7	Wet Tropics World Heritage Values	By definition these areas are regarded of global importance	World Heritage areas can be readily mapped and accordingly attributed with a significance ranking. However, Wet Tropics World Heritage values are frequently not confined to these cadastrally defined areas. Additional areas support some of the key values of World Heritage Area. For instance, the Southern Cassowary is an important contributor to World Heritage values as both a species and through its role in the dispersal of rainforest plants. As a species with a wide home range it is not confined to protected estate. Intervening habitat areas between mapped World Heritage Properties are therefore important in maintaining World Heritage Values. World Heritage Values outside of nominated estates might be mapped through identification of key habitat attributes/surrogates such as cassowary habitat.	7.1 7.2	7.1 Regional Ecosystems 7.3.10 – Primitive families of flowering plants 7.2 Locality maps of special faunal species endemic to Wet Tropics (87 species) 7.2 Locality maps of special faunal species endemic to Wet Tropics (? species) – Steve Williams or wildnet	Mapping of World Heritage values Location of ancient plant taxa and other plant relicts. Relict fauna species as listed in WHA values Endemics Other values which contain unique, rare or superlative natural phenomena, formations or features of exceptional natural beauty could be visualised via 3D visualisation (e.g. Google Earth) of the coastal scenery, rainforest and reefs.

	CHENOWETH			CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
8	Diversity in Climate	Mission Beach has a diverse rainfall pattern when compared to the balance of the Wet Tropics (Goosem, 1992). This is an important driver for the biodiversity values of Mission Beach.	Climatic gradients can be mapped illustrating an important driver of biodiversity at Mission Beach relative to the region.	8.1	8.1 Annual Mean Temperature	
9	Corridors	The connectivity of vegetation frequently underpins its viability within a landscape and biodiversity significance.	The Far North Queensland Draft Regional Plan 2025 (QDIP, 2008) identifies State and Regional Conservation Corridors that should be considered. Additionally, corridors identified in local planning instruments and in the Biodiversity Significance of Mission Beach study (CEPLA, 2008) (particularly the Mission Beach to Tablelands Rainforest Corridor) and the Wongaling Corridors study (Biotropica, 2008) should also be considered. The significance level assigned to each corridor will need to be established as part of the mapping project. The input of expert advice may determine	9.1 9.2 9.3	9.1 Local, State and Regional Conservation Corridors 9.2 Natural Areas Plan – Johnstone Shire 9.3 Mission Beach to Tablelands Rainforest Corridor (aerial photo) 9.4 Wongaling	Use of Conefor Sensinode, Habitat Priority Planner software tools to identify corridors etc. Biotropica ARF Recommendations Connected Remnant Units are more representative of biodiversity, contribute more to a habitat network and have greater resilience to the effects of disturbance than small isolated Remnant Units. In BioCondition there are four broad categories that describe the connectivity

CHENOWETH				CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
			that additional corridors should be mapped for species or groups of species. For instance, although it is recognised that the Mission Beach foreshore and offshore islands (EPA/QPWS, 2005) provide habitat and corridor values for shorebirds, it is likely that these habitat areas have not been sufficiently mapped to date.		Creek Habitat Linkages 9.5 Shorebird corridor and habitat values – Not mapped	of the patch of vegetation within the zone of assessment (Table 15 and see Figure 10). http://www.epa.qld.gov.au/publications/p02603aa.pdf/BioCondition_a_terrestrial_vegetation_condition_assessment_tool_for_biodiversity_in_Queensland_field_assessment_manual_Version_16.pdf
10	Relative Size of Tracts of Vegetation	The size of any area of natural vegetation is a major indicator of ecological significance, diversity, and is also strongly correlated with viability. Larger remnants are less susceptible to ecological edge effects, and as a	This attribute will need to consider tracts of vegetation. The EPA's Biodiversity Assessment and Mapping Methodology (EPA, 2002) ranks tract size according to a normalised distribution ¹⁵ of vegetation polygons occurring in a bioregion. Significance is attributed as Very High, High, Medium or Low according to whether a tract falls within the 4 th , 3 rd , 2 nd or 1 st percentile of the normalised distribution respectively. It may be necessary to undertake a similar exercise for the Wet Tropics to demonstrate that tracts of vegetation of Mission Beach are relatively significant.	10.1	To do	

¹⁵ Normalised, because there are very few very large patches and many very small patches

	CHENOWETH			CSIRO/terrain		
	Biodiversity Attribute	Rationale	Mapping considerations	Map No.	Map Title	Recommendation/Comments
		consequence are more likely to be able to sustain viable populations of native flora and fauna.				
11	Vegetation Integrity	Although portions of the forests of Mission Beach have historically been logged, much of the area is mapped as Remnant Vegetation. The presence of lowland vegetation communities is significant in largely cleared landscape.	The mapping of remnant regional ecosystems below the 80m contour will provide a visual aid to demonstrate the importance of the lowland vegetation communities of Mission Beach relative to the balance of the region and Wet Tropics. This might be quantified by establishing remnant regional ecosystem cover for a grid over lowland areas of the Wet Tropics or by calculating percent cover for catchments.	11.1 11.2	11.1 Regional Ecosystems – below 80m 11.2 VAST Class 11.2 VAST – Habitat Condition 11.2 VAST – Land Use Intensity Index	Further detailed mapping for lowland vegetation. Investigate further Miriam's mapping. Use of LiDAR ? Comparison with catchments – Caroline's analysis for MTSRF Status and Trends - % cover for each catchment.
12	Threats		To be developed			
13	Protection		To be developed			

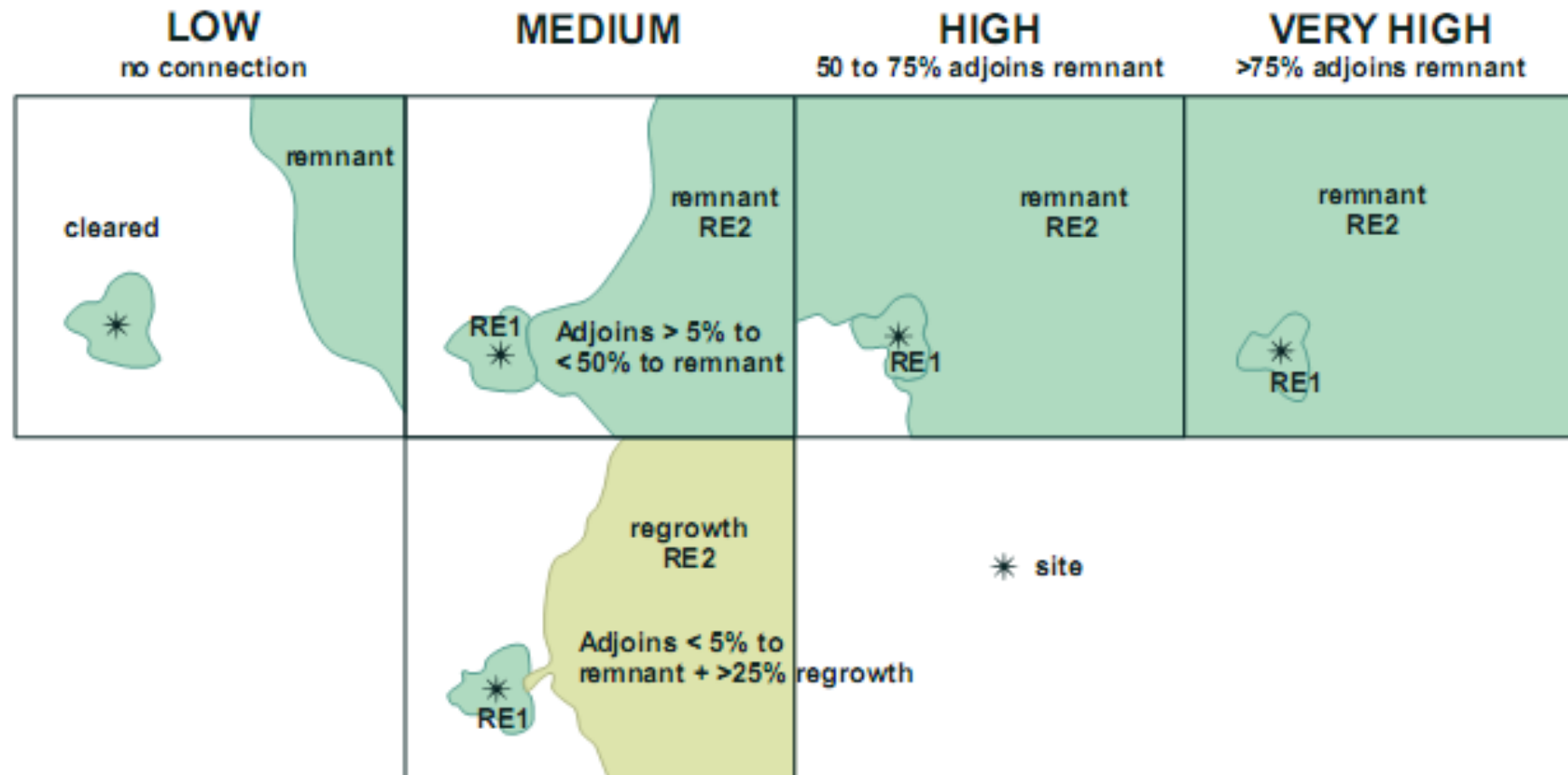


Figure 10: Examples of Landscape Connectivity scores (RE – Regional ecosystem)

Table 15. Description and scores for connectivity. The description is relevant to the patch of vegetation the assessment site is contained within.

Category	Description	Score
Low	The patch is not connected using any of the below descriptions	0
Medium	The patch;– • adjoins with adjacent remnant vegetation along >5% to < 50% of its perimeter OR • adjoins with adjacent remnant vegetation along <5% of its perimeter AND • adjoins with adjacent non-remnant native vegetation > 25% of its perimeter	2
High	The patch;– • adjoins with adjacent remnant vegetation along 50% to 75% of its perimeter	4
Very High	The patch;– • adjoins with adjacent remnant vegetation along > 75% of its perimeter	5

Attachments for Project 4.9.6 - Activity C

Costing the bathwater along with the baby: Thinking about transaction costs in environmental policy decision making.

Paper presented at the joint annual conference of the North American Agricultural and Resource Economics Society and the Canadian Agricultural Economics Association. Quebec City July 2008.

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Abstract

Intervention for the supply of an environmental good can occur through one or a combination of policy types. These are most often regulatory, market based or partnership based instruments. Each instrument or package provides a different level, mix and distribution of benefits and costs which occur over varying spatial and temporal scales. The caveat on any form of intervention is that it is efficient. That is, that the benefits outweigh the costs. Transaction cost economics highlights the importance of including the policy creation, use and closure costs incurred by public and private stakeholders in any *ex ante* policy decision making. The purpose of this paper is to inform this process by highlighting the key drivers of transaction costs in environmental policies. We note that transaction costs are affected by the biophysical characteristics significant to the policy investment, the social and organisational capacity and the institutional setting. We also note the importance of thinking beyond short term transaction cost minimisation in policy decision making. We highlight the factors affecting policy transaction costs using a Australian based policy decision context.

Key words: transaction costs, environmental policy, biophysical, capacity, path dependence, *ex ante*.

1. Introduction

Land use decisions by individual landholders occur in response to incentives (Wills 1997). Markets are the most widely used mechanism for signalling incentives to individuals in western society. Landholders are rewarded for land uses that have marketable production outputs but not for the other valued but non-marketable products such as the maintenance, in general, or enhancement of natural resources. When the market fails to supply a good to the level that is socially desirable, market failure is said to have occurred. It is at this point that intervention by government or non government organisations for the supply of this good may be justified (Murtough *et. al.* 2003). Intervention could be through the establishment of a number of alternative instruments: market based, regulatory, or a combination which also draws on partnerships and social networks. Each individual or package of instruments provides a different level, mix and distribution of benefits and costs which occur over varying spatial and temporal scales.

The caveat on any form of intervention is that it is *efficient*. Measures of efficiency include both the outcome that is achieved and the process for achieving this (Buitelaar, 2007). An efficient intervention is the one that achieves the greatest net benefit, the largest benefit at the least cost. There is increasing evidence of the size of transaction costs, the non production costs of decisions (Lai, 1997; Nilsson and Sundqvist, 2007) in calculations of cost and efficiency. McCann *et. al.* (2005) reports that transaction costs made up 38% of the total costs of the United States program of technical assistance for agriculture and 8% of the water purchase cost for the California Water Bank (Howitt, 1994). Colby (1990) in her study of water transfers identifies transaction costs to include: attorneys' fees, engineering and hydrological studies, court costs, and fees paid to the state agencies. The results indicated that on average \$91 per acre-foot of water transferred was transaction costs, or measured another way the time spent waiting for state agency approval (time delays): 29 months in Colorado, 4.3 months in New Mexico, and 5 months in Utah. Buitelaar (2004) notes that the consultation process involved in developing public private partnerships for infrastructure projects makes up a significant component of cost of such a policy.

But transaction costs are usually measured in ex poste evaluation of policy

But how does a policy maker for environmental goods make *ex ante* decisions that include transaction costs? In this paper we seek to inform this question by exploring the key drivers of policy transaction costs for environmental goods. We demonstrate how considering the key drivers of transaction costs *ex ante* could influence policy choice with an example of a practical environmental policy decision.

This paper is structured as follows. In the next section we provide some background to environmental policy, why intervention is needed and the forms that this intervention could take. In section three we present the conceptual framework of transaction costs, providing discussion on the components of policy transaction costs. We discussed the drivers behind policy transaction costs in section 4. In section 5 we demonstrate how thinking about transaction costs and their drivers can be included in *ex ante* policy decisions by working through a policy decision for a real world environmental problem. Section 6 provides some final discussion and conclusions and also highlights some future work that has been identified as a part of this paper.

2. Background

Environmental goods are undersupplied because the market fails to send signals to agents who are either having a detrimental impact on the environment or able to provide a demanded level of environmental service (Van Bueren, 2001). One of the key reasons for market failure is the lack of fully defined property rights (Bromley 1991). Well defined property rights provide access security, defensibility of ownership and transferability of access and use. For many private goods such as a car or a house these characteristics are present and therefore exchange can occur, but this is often not the case for goods such as environmental services.

To date, the most common form of intervention to bring about an environmental good is regulation. This involves setting minimum performance standards or supply targets for private individuals or internalising the production of the good, for example, through government purchase of private land and ongoing supply through a structure such as a national park.

Alternate to a regulation is using the market to coordinate the provision of the environmental good. A pure market operates where there are many buyers and sellers with a significant number of commodities, and full information available for those commodities (fully defined property rights and low transaction costs). The price governs the way people transact and the self motivated actions by operators in the market leads to patterns of production and consumption that are efficient (Weimer and Vining, 1992; Levacic, 1991). This level of production is the place where it is not possible to make one person better off without making another worse off (Weimer and Vining, 1992). Markets are the most widely used mechanism for signalling incentives and coordinating exchange in western society. Market based instruments (MBIs) are policy tools that are **based** on the positive qualities of the pure market and seek to encourage targeted behaviours through market signals rather than through explicit directives such as those used in a more regulatory approach (Stavins, 2000). By rectifying uncertainties associated with property rights and thereby reducing transaction costs of exchange, MBIs 'harness market forces' to redefine the agenda of firms and individuals such that improved environmental outcomes are in their own best interest. There is growing interest in MBIs as they can often deliver equivalent outcomes to regulatory approaches at lower cost to landholders and government.

Hybrid instruments lie between the purely command and control approach of the regulatory model and the pure market approach (Richards, 2000). Buitelaar (2007) describes the hybrid instruments as those that are not wholly reliant on the pricing mechanism for exchange. Coordination mechanisms in this category include informal instruments such as moral suasion through to instruments that combine the use of prices, contracts and relationships in a transaction. Many of the instruments and instrument mixes currently used for native vegetation conservation are hybrid governance structures. Voluntary programs generate change through building relationships with landholders and influencing actions through the provision of information and support. Some of these relationship based instruments secure change over time through long term contracting. Conservation covenants are an example of this. The market based instrument approach to generating improved provision of environmental goods can also be described as a hybrid approach. For example, conservation auctions, with government acting as the sole buyer, motivate initial landholder engagement and change using prices but secure ongoing conservation actions with long term contracting. Long term and relationship based contracts are also being used to secure change across land boundaries (see Pankhurst *et. al.* 2002; Pankhurst and Shogren 2004).

It was observed by Pannell (2006) that more often than not, the variety of instruments available coupled with the short timeframes for policy decision making within the regional body results in an unsophisticated approach to selection, design and implementation of instruments. Choices tend to occur based on personal experience of individual policy makers and immediate reporting or program needs rather than a systematic consideration of the instrument benefit and costs. There is a high risk that this unsophisticated approach will lead to policy failure, or at best, inefficient outcomes Coggan *et.al.* (forthcoming).

The purpose of this paper is to provide some insight into the drivers of transaction costs such that this can be included to better inform environmental policy decision making.

3. Conceptual framework - Transaction costs

3.1 What are Transaction Costs ?

A transaction occurs when the property rights over a good or service are transferred (Williamson, 1996). Commons (1931) uses the word 'control' to describe a transaction, indicating that a transaction is an exchange in control rather than always the exchange in a physical thing (Buitelaar, 2007). Transaction costs are the non -production costs incurred in a transaction (Lai, 1997; Nilsson and Sundqvist, 2007). Transaction costs occur due to information uncertainty whereby transactors incur costs in finding contract partners, gaining knowledge of materials and production, negotiating and concluding contracts and monitoring and enforcing non fulfilment of contracts (Kasper, 1998). Human interaction of any form leads to transaction costs. High transaction costs reduce the quantity and quality of interactions: very high transaction costs can reduce exchanges to zero.

The application of transaction cost theory to understanding decisions on coordination emerged from organisational economics, when theorists moved from considering the organisation of a firm as a neoclassical production unit to that of a governance structure. Transaction cost minimisation was used to understand how a firm coordinated the transactions of production (Coase, 1960; Williamson, 1998; McCann *et. al.*, 2005; Williamson, 1993). The aim of production is to transform inputs (eg. human, natural, and built, capital) into outputs desirable for consumption by society (Arrow, 1973). Most of these inputs are considered to be 'costs of production' (flour, water, yeast in bread making for example) and are not considered further in this paper. Costs are also incurred in the coordination of production (eg the cost of time and effort in finding and negotiating with the flour miller, yeast supplier etc as described by Kasper (1998) above). Organisational theory puts forward that the best mechanism to coordinate production is that which optimises the outcome for the least production and transaction cost.

3.2 What are the transaction costs of environmental policy decisions?

Government policy also incurs transaction costs. These are the costs to create, implement, use and close the policy (McCann *et. al.* 2005; Buitelaar, 2003, 2004 and 2007; North, 1990; Challen, 2000). Whitten *et. al.* (2003), Whitten and Bennett (2005) and McCann *et. al.* (2005) all highlight that these costs are incurred by the agency developing and implementing the policy (public costs) and by policy stakeholder that have to learn about and engage with the policy at some stage in the future (private costs).

It should be noted that policy transaction costs sit within a nested hierarchy of costs associated with implementing government business. 'Higher' levels of costs, for example those associated with 'sovereign' risk, social norms change and institutional structure are not included in this paper.

3.2.1 Transaction costs in policy creation

Whitten *et al.* (2003) refers to the 'set up' transaction costs as institutional transaction costs. These transaction costs are associated with defining exchange frameworks, institutions or rules for the policy and are incurred through the actions of research, information gathering and analysis to define the problem and recognise the need for action; enactment of any enabling legislation including lobbying, cost of public participation, costs of changing laws etc and design (such as defining and allocating property rights).

3.2.2 Transaction costs in policy use

Transaction costs will also be incurred in the 'use' of the policy, these costs are those associated with the setting up of structures to manage and monitor the market exchange. The cost to implement the policy will occur through implementation costs (which also include the cost of hiring staff and consultation) and the ongoing costs of running and administering the policy including the cost of monitoring and review and the costs involved in adjusting the policy according to evaluation findings (McCann *et al.*, 2005).

Private individuals also have transaction costs associated with their involvement in policy implementation. They occur during information collection, data collation, relationship management with policy agencies, monitoring and enforcement of the policy. Some of these costs are associated with "production" as such should not be included any further, however many are not and this is dependant on the type of policy instrument implemented.

4. What affects policy transaction costs and how does this occur?

The transaction costs of environmental policy are broadly affected by the context in which the policy is to be applied. This can be further dissected into: the biophysical characteristics of the policy objective; the organisational and social capacities of the implementing agent and the potential transactors; and the institutional setting. All of these costs are affected by past policy decisions. Similarly, decisions today affect the transaction costs and therefore efficiency of future policy choices. A summary of the policy transaction costs and the factors that affect these transaction costs is presented in Figure 1.

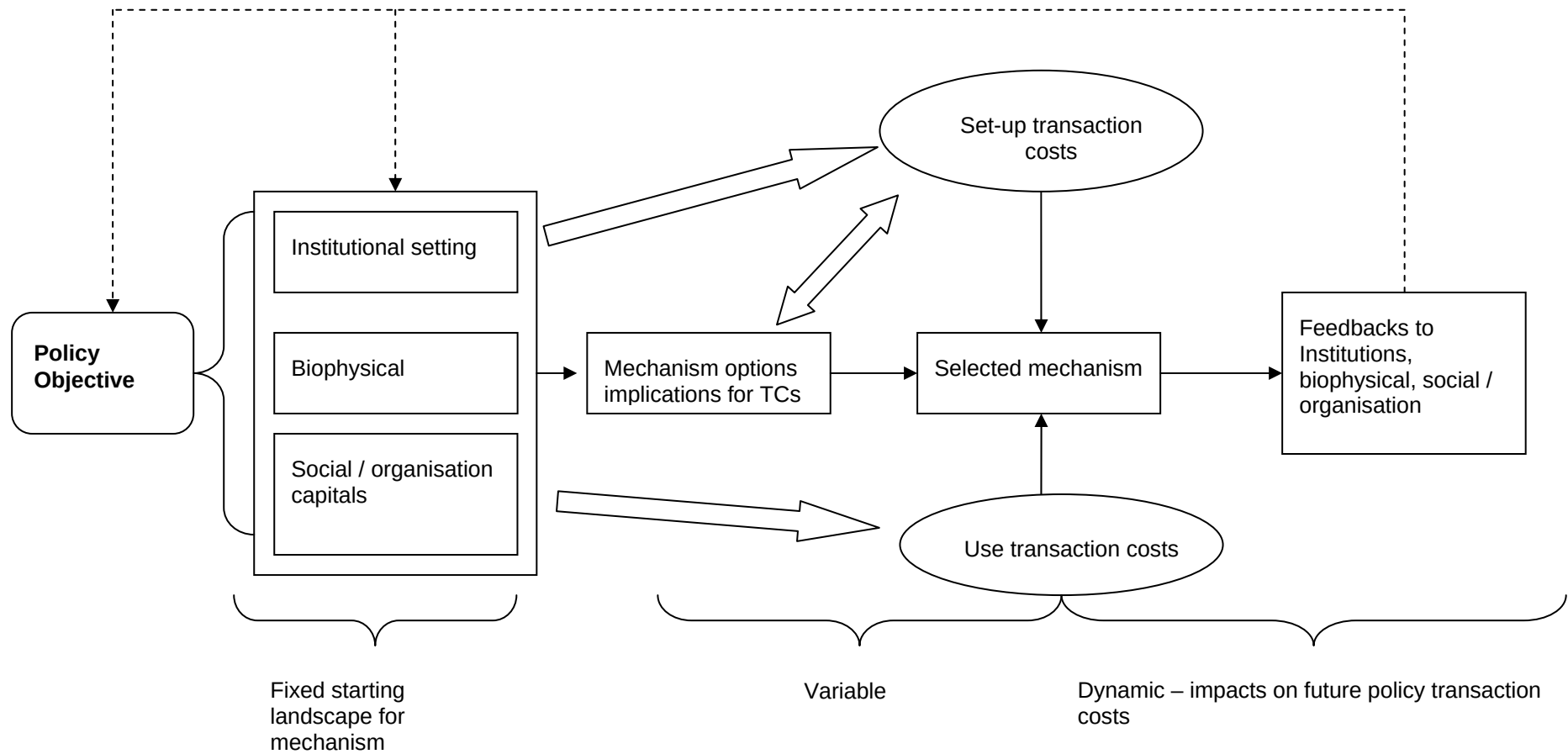


Figure 1: Thinking about policy transaction costs

4.1 The biophysical characteristics of the investment

The level of transaction cost is closely related to the level of precision that is required to achieve the objectives of the policy (Vatn, 2001). The level of precision will depend on the objective and the configuration of investment required to meet that objective. New Institutional Economists discuss this concept in terms of asset specificity (Buitelaar, 2007; Williamson, 1981).

Asset specificity can be related to the site of production (location of the asset is important to the outcome), be physically specific (the inputs or actions are significant to the outcome) or be related to the labour (the knowledge in the labour is significant to the outcome) (Williamson, 1981). Falconer (2002) further disaggregates site and physical asset specificity by exploring the degree of separability in the supply of the specific asset. A good or service of low separability is one that requires coordinated actions to achieve the desired outcome. Goods of this nature act as compliments rather than substitutes to one another.

The level of specialised investment could also be related to the timing of the investment. Timing may mean that the value of a good is related to the timing of its supply in the production process or that the value of the investment is affected by the length of the investment over time, that the investment needs to be ongoing or recurring (Buitelaar, 2007; Alexander, 2001).

Environmental policy objectives tend to vary in their asset specificity requirements. An objective such as a broad increase in vegetation cover is not specific any form. However, this type of environmental policy objective tends to be the exception rather than the norm. Investments in environmental goods tend to be highly specific in terms of their type (eg species), action (for example land management for a salinity or water quality outcome) and location (eg the value of investment in vegetation for habitat is dependant on the location). Often, investment in environmental goods have multiple levels of specificity, for example, habitat has requirements on type, management actions and location (both in discrete value and in relation to other areas of vegetation conservation).

The more specialised and precise an investment is to meet an objective, the higher the transaction costs tend to be. The extent of the transaction costs is closely related to information available and the social and organisational capacity which is discussed next.

4.2 Social and organisational setting: Level of information and the nature of transactors

Transaction costs of any policy approach are also affected by the social and organisational setting for the transaction. Specifically this relates to the level of information and knowledge held by the agents that will be engaged in the transaction. When there is low information about an asset, or information is held asymmetrically, transaction costs will be incurred through actions such as finding exchange partners, specifying the good and monitoring and enforcing the exchange etc (Table 1).

Table 1: Affects on transaction costs of high uncertainty

Nature of information uncertainty	Affect on transaction cost
High information costs - asymmetric information	Whilst the information regarding the social benefits and private costs of environmental good exist there is high cost of exchange partners transferring this information (High search cost for the exchange partners).
High information costs – scientific uncertainty	Uncertainty remains about the impacts of changed land management. The costs to determine the cause and effect relationship is high which requires costly contracts or monitoring and enforcement
High information costs – monitoring impacts over time	Success of management actions and changes can only be measured <i>ex poste</i> but management costs of management changes are incurred up front. High cost of monitoring over time makes contracts or monitoring costly

Source: Adopted from Whitten and Shelton 2005 and OECD 1999:21

If the asset is highly specific, the costs to define, monitor and enforce the specific provision of that good may outweigh the benefits. Vatn (2001) suggests that transaction costs associated with high uncertainty could be reduced through the use of proxy measures (for example, using area of vegetation or species number as a proxy for habitat goals etc). Decisions will be based on the acceptable trade off between the level of precision in asset investment and the transaction costs of this precision.

The impact of high uncertainty on policy transaction costs also depends on the behaviour of the transactors. According to Williamson (1975) there are two 'elementary attributes of human decision makers' that result in transaction costs – decision makers are limited in their ability to acquire and process all information and so are, at best, boundedly rational; and, they tend to make decisions opportunistically, with high levels of "self interest with guile" (Williamson 1981, p. 554).

When there is a high level of information uncertainty surrounding the exchange of goods, there is potential for opportunistic behaviour by transactors which needs to be offset by some level of observation, the ability to observe that the good that has been paid for and is delivered. The long time lag between action and outcome related to environmental goods means that observability of outcomes tends to be low. This can result in increased transaction costs of exchange in either the drawing up of complex contracts or to monitor and enforce the delivery of the good. Once again, proxy measures could be used to reduce these policy transaction costs.

Vatn (2001) notes that for many environmental policies, the transactors (landholders) often have a personal connection to the good that is the policy objective that is they get some private benefit from the provision of this good. When this is the case, policy transaction costs can be significantly lowered by opting for policies of information dissemination and cooperation rather than policies that rely on strong control to generate outcomes. A cooperation based instrument may result in reduced communication costs, can optimise precision through common understanding, can reduce what is perceived as a cost in exchange (landholder may realise the private benefit of provision) and optimises on the creativity of individuals in supplying a good.

4.3 Institutional setting.

Policy is rarely implemented in a vacuum, there are often existing institutions and structures that influence the way an environmental good is provided or how policies can operate in a region. These current institutions can create or reduce policy transaction costs. The creation of transaction costs can occur if current institutions impose an additional layer of administration on the policy stakeholders, such as reporting.

Transaction costs of policy to public and private stakeholders can be influenced by how aligned the policy instrument is with current institutions. With clear alignment to current institutions (rules and governance structures and processes) there are potential differences in start up transaction costs, for example political acceptance and stakeholder learning and variable costs throughout implementation of the policy Coggan *et. al.* (2005).

The institutional setting can also have an influence on the type of policies that can be considered for an environmental good. For example, in Australia a regional body does not have the institutional power to create legislation to achieve policy objectives. This eliminates any regulatory policy from the realm of policy possibilities under consideration.

4.4 Path dependency

Path dependence is “a property of contingent, non reversible, dynamic processes, including a wide array of processes that can properly be described as ‘evolutionary’” (David, 2007). Path dependency means that the path chosen now will affect the efficiency of future paths. Choices today will affect the knowledge and capacity drawn upon for future policies (and therefore future policy transaction costs). Choices today will also affect future transaction costs by creating institutions and structures that may be costly to deconstruct (Challen, 2000).

Due to path dependency, policies chosen today are affected by past decisions. For example if past policies have resulted in high organisational capital (ie. understanding of context, institutions, on-ground activities, knowledge sharing, organisation learning and education from past policies) (Black and Lynch, 2005) and high social capital (ie. trust, bridging and bonding the institution to the local social networks and power brokers) (Hatfield-Dodds and Pearson, 2005) associated with the objective, it is likely that the institutional and bureaucratic transaction costs of policy design, development and implementation will be lower. This is because less research and development is required within the implementing agency and less learning about the policy is required by the stakeholder. This past policy may also have left a legacy of institutions (rule and norms surrounding interaction and coordination) and social networks that are beneficial to the policy instrument under consideration.

Path dependence is usually discussed in relation to how it affects transaction costs of policies now. Noting that many organisations implement multiple not single objectives they may also wish to implement a policy that develops the institutions that are aligned with known future policy objectives, invest in future options. If future objectives are dependant on community capacity, ownership, cooperation, then the better policy response now may be the one that sets up the ability for this future coordination. This may not be the most outcome or process efficient in the short term! For example, Pearson *et.al.* (forthcoming) has outlined that weed management by local council is achieved in northern Queensland through farmer engagement on multiple outcomes. Importantly farmers are interested in feral pig management, not weed management per se, as such a combined strategy of pig trapping and weed spraying is the outcome objective and the process for achieving this are very different to a single weed focused approach.

A summary of all of these transaction costs, who incurs them and what may affect the extent of them is provided in Table 2. The information contained in Table 2 is heavily based on McCann et. al.'s (2005) paper. There are two points of difference however. First, following an adaptive management approach, we include public consultation earlier on in the policy development process. That is, rather than placing it with the early implementation of a policy we include public consultation in instrument selection, ie before a policy instrument is chosen and implemented. Second, we include recognition of path dependency.

Table 1: Policy transaction costs, who incurs them and what affects them

Policy stage	Policy activity	Performed by	Type of policy transaction costs	Factors that will affect this cost
Start up	Research and information	NRM body	Consultancies (engaging and managing), Costs of developing an understanding of the problem, staff time, staff hiring, data collection,	Previous policies, number and capacity of staff
		Private individuals	Costs of lobbying to highlight need for policy intervention.	Previous policies, extent of change in policy from current, level of participation in policy development
Development and enactment	Research and information; enactment and litigation	NRM body and internal or external decision makers	Resources and staff time in lobbying and providing information to decision makers, public consultation, cost of staff time to review and make policy decisions	Relationships with decision makers and stakeholders
	Research and information	Private individuals	Cost of time to engage in public consultation and policy piloting	Design/organisation of public consultation, travel distance etc.
	Establishing structures and protocols	NRM body	Cost of staff time, cost of resources (software) to test objectives with different structures and protocols, cost of engaging expert assistance	Previous policy, nature of the good, behaviour of actors, length of engagement, social networks and trust
	Design	NRM body	Cost of staff time, cost of resources (software) to test policy configurations according to the objective, cost of engaging expert assistance (metric development etc)	The nature of this policy in relation to past policies. Current organisational capital
Implementation	Implement and administer	NRM body	Staff hiring for implementation, cost of staff time to respond to queries, litigation and disputes. Time and resources involved in implementation such as advertising policy, assessing the value of offers, time and resource costs of contracting.	Capacity of agency, social networks and relationships built previously and as a result of this policy development process. The nature of the policy – eg if on ground assessment is required or if policy can be run desk based.
	Engage and administer	Private individuals	Cost of understanding means of engagement with policy (beyond compliance), eg time and opportunity cost of training. Time and opportunity cost of engaging with the policy, determining bid price, placing a bid negotiating contracts etc	Capacity of actor, nature of the policy, nature of the action (change from present)
Monitor and enforce	Monitoring	NRM body and private individuals	Physical cost to do on ground checks - staff time and resources for the NRM body	Contracting arrangements, social networks
	Enforcement	NRM body	Cost to initiate enforcement processes (staff time and resources)	Contingencies in policy
		Private individuals	Cost of time and resources to comply with enforcement actions	Contingencies in policy
		legislature	Cost to process enforcement action (staff time and resources)	Contingencies in policy

Adapted from McCann *et. al.* (2005) and Whitten and Bennett (2005)

5. Case study of thinking through transaction costs: Cassowary habitat on private land

The Southern Cassowary (*Casuarius casuarius johnsonii* or cassowary) is a large flightless bird and a significant key stone species to the rainforest of the wet tropics of Far North Queensland, Australia (Figures 2 and 3). The cassowary is a major and often sole disperser of seeds for over 100 species of rainforest trees and vines in the World Heritage listed wet Tropics (BioTropica Australia, 2005). Without the cassowary, rainforest maintenance and regeneration is likely to be significantly compromised. The population of cassowaries is in decline, this is particularly the case in cassowary population hotspots such as Mission Beach, Far North Queensland (FNQ) (Moore, 2007). One key reason for the decline in the cassowary population is the removal or less than optimal management of cassowary habitat on private land.

The policy objective for our case study is for an increase in the management (and therefore quantity and quality) of cassowary habitat by private landholders on private land. In this case study we are considering the policy decision from the perspective of the local regional body, a non statutory body with an organisational objective of improved natural resource management.

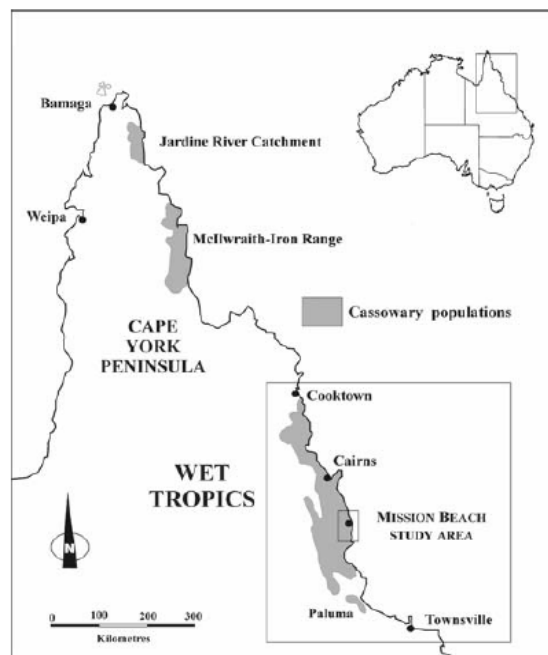


Figure 2: Cassowary population location in Far North Queensland, Australia.
Source: Moore 2007



Figure 3: The endangered Southern Cassowary
Source: www.gondwanaguides.com.au

4.2 What will affect transaction costs?

The extent of benefit from the management of cassowary habitat on private land is highly dependant on the configuration of the investment. To achieve the objective, investment needs to occur with specificity around actions, vegetation species, location, and timing. For example, policy should be aimed at conserving (BioTropica Australia, 2005):

- A high diversity of native fruiting trees to provide a year-round supply of food in the form of fleshy fruits;
- With habitat located close by to drinking water and that enables cassowaries to maintain territory and be nomadic in their home range – large areas of habitat that are connected;
- Is adequately removed or buffered from the impacts of day to day human life; and
- Is protected over a long period of time and, at best, into perpetuity.

There are a range of policy instruments that could be applied to gain assets of this level of specificity. With this mix of investment configuration required to achieve the objective it is likely that a range of policies will be appropriate. The choice of policy mix will depend on the potential benefits assessed against the transaction costs of creating and using the policy. Transaction costs are affected by:

Current institutions and structures

Institutional limitations: The lack of statutory powers of the regional body will mean that the regional body will incur significant policy transaction costs if they were to pursue objectives with regulation. The extent of these transaction costs are likely to outweigh any potential policy benefit.

Current institutions: At present there are a range of formal institutions currently in place to manage habitat on private land. These range from regulation to prevent or reduce losses from actions such as development through to government and non government organisation (NGO) engagement with landholders to provide information and support to encourage voluntary management (this is sometimes supported into perpetuity with voluntary covenants). There are no known institutions or structures that will generate additional transaction costs to a regional body policy.

Policy choice may be affected by the ability to reduce transaction costs through nesting whole or parts of policies with groups that already have a relationship with landholders. For example, the start up and running costs of a policy with an extension component could be reduced by working with other policies already applied in the region.

Current organisational capacity:

The regional body already has a high level of information capacity surrounding the policy objective. For example, the regional body has geographic information of areas of high habitat value and strong proxies to relate actions to outcomes. High transaction costs may be incurred in monitoring and enforcing actions due to staff shortages and the remoteness and number of stakeholders.

Current social capacity

There is currently low levels of social capacity related to cassowary habitat management on private land. Landholders have low understanding of management actions and cassowary habitat outcomes, landholder knowledge of regional body programs and means of engagement is also low. This indicates the potential for high start up transaction costs of any habitat policy incurred by both the regional body and the landholders. There may be some potential to reduce these transaction costs by nesting with current policies and institutions.

Future policy directions and multiple objectives

While not affecting the transaction costs of this policy decision, choices made now will affect the transaction costs of future policy decisions. Therefore the transaction costs of policy choice now should be weighed against future objectives. The regional body operates on a tight budget, this is likely to continue into the future. One factor that could reduce future policy transaction costs is the social capacity and relationships that are formed now (see Vatn, 2001). The benefit of this in the future needs to be considered against the transaction cost of this now.

5. Discussion and Conclusions

Government intervention for the supply of an environmental product is not necessarily 'good'. The policy instrument or mix needs to be efficient both in terms of the outcome and the costs to generate this outcome. Numerous policy evaluations demonstrate that the policy transaction costs, the costs to create, use and close the policy can be significant to the policy cost. Accordingly, an understanding of these costs needs to be a part of *ex ante* policy decision making. Recognising the difficulty of this, the purpose of this paper was to identify the drivers for transaction costs in environmental policy creation and use. We do this from the perspective of a regional level policy maker and provide an environmental decision making problem as an example.

We note that the transaction costs of policy are heavily dependant on the nature of the good that is central to the policy, the social and organisational capacity (including extent and access to information) of those engaged in the policy and the institutional setting. We created a framework which outlines the drivers for transaction costs and where and how these drivers will influence the policy mechanism design and implementation process. This framework was applied to a case study in Northern Queensland, Australia regarding habitat conservation of the Cassowary.

Just as policies should not be chosen without consideration of the cost of creating and using them, we note that policies should not always be chosen according to transaction cost minimisation alone. The cost of process must be evaluated in terms of the distribution of the cost as well as how costs compare with the extent and distribution of the benefit. These benefits may be related to the biophysical objective (eg multiple benefits of a biophysical outcome) or could be related to broader objectives such as optimising on path dependence or achievement of political, equity or justice related goals (McCann *et.al.* 2005; Buitelaar, 2004). The most transaction cost minimising policy, such as one with fully defined, allocated and exchangeable property rights, will not be considered 'best' if this outcome is not consistent with the broader policy aims.

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