FINAL REPORT

PROJECT REFERENCE NUMBER: CSE7

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PROJECT TITLE:

Landscape design principles for native vegetation management: addressing multiple scales.

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CONTENTS

PROJECT CSE7: LANDSCAPE DESIGN PRINCIPLES FOR NATIVE VEGETATION MANAGEMENT: ADDRESSING MULTIPLE SCALES.

ABSTRACT

Previous research (NRVMP project CTC9) has advanced vegetation design principles and thresholds, for sustainable management of grazed landscapes, especially the grassy woodlands. These principles and thresholds, which have attracted national and international interest, were targeted at the paddock and broader property scales. The effectiveness of their application at the local landscape scale has not previously been empirically explored. Moreover, their applicability to larger scales (e.g. catchments) was inferred, but not formally tested. CTC9 also identified significant barriers to adoption of the principles by landholders trying to achieve successful conservation outcomes on their properties. The present project sought to validate the design principles and thresholds in the field at both the single property and larger micro-catchment scales (e.g. clusters of properties), and to identify the importance of spatial arrangements of vegetation within landscapes at these scales. It also sought to extend the principles/thresholds to other vegetation communities (e.g. scrublands); and to explore the scope for collective action to achieve better economic outcomes than appeared likely for landholders acting alone. The work was conducted in 30 small catchments within the Emu Creek Catchment (a major tributary of the Brisbane River) in partnership with the Emu Creek Catchment Landcare Group. The general finding is that many of the observations that were reported concerning the resource health of the 4 case properties from CTC9 were also reflected in the wider sample of catchments in the Emu Creek catchment. In particular, observed balances and imbalances in land use and vegetation patterns (especially the size and spatial distribution of remnants, and access of grazing to riparian land) were similar between the 4 case properties from CTC9 and the 30 catchments that were sampled. Consistent relationships between a good many of the indicators employed to measure catchment condition and the resource attributes that are consistent with the principles and thresholds were not identified by either single or multivariate regression analyses. Health and rehabilitation `hotspots' that might be amenable to economic forms of collective action were not identified. The range of technical, attitudinal and institutional barriers to adoption that were identified in CTC9, were also seen to continue to be relevant.

INTRODUCTION

This Final Report follows 4 Milestone Reports that covered research methods, activities and preliminary results. The sections that follow summarise the project objectives; results achieved against those objectives; communication and adoption activities; project publications and contact details. A detailed technical report is included in 2 parts as Attachment A. Part 1 details field methods, measures of landscape design/management and indicators of catchment condition; and Part 2 includes findings from the catchment sampling and the statistical analyses of potential relationships between the various measures and indicators. The project communication plan is included as Attachment B. A detailed statement on the approach and methods to be employed at the time of project initiation (July 2001) are presented in Attachment C.

PROJECT OBJECTIVES

Using Emu Creek catchment as a case study to:

1. Validate and refine landscape design principles for agricultural use of grassy woodlands at a range of scales (e.g. paddock to micro-catchment);
2. Explore the importance of spatial arrangements of vegetation, at those scales, for achieving conservation outcomes;
3. Explore the relevance of the design principles to other vegetation communities in the region; and
4. Explore the likelihood that collective action will achieve better economic outcomes, than if landholders act alone.

SUMMARY OF METHODS AND MODIFICATIONS

As originally proposed, the project was to take a case approach - using 2 catchments of the Brisbane River system (Emu Creek and Crows Nest Creek) and working with an established partnership of stakeholders (state agencies, Greening Aust, Landcare and local landholder networks - notably ECCLCG, CNCLCG) – to explore the validity of existing landscape design principles and thresholds. That is, whether the largely theoretical/heuristic-derived thresholds did yield sound resource outcomes where they are observed to apply within an agricultural landscape. Moreover, it would confirm whether vegetation thresholds relevant at the landscape scale context shift between properties to larger aggregations such as micro-catchments (e.g. 5-10 properties) - also whether the spatial arrangement of the vegetation has a direct bearing on the outcomes of landscape design. Alternative approaches to case studies (e.g. experimental approaches and modelling) were seen to be infeasible in terms of costs, time, data and logistics for the scales under review and also had limited scope for positively engaging the interests of local stakeholders. Approximately, 20 local catchments were to be selected and a combination of aerial photographs, ground truthing, and field data used to describe the vegetation and management (e.g. woodland cover, level of intensive development, stream buffers), including the spatial distribution. Sustainability measures (e.g. tree health, stream condition/water quality, habitat diversity) would be derived and related to the vegetation and management values using multi-variate techniques. A technical panel was formed to support this work. The relationships were to be tested for stability across scales and key areas for rehabilitation identified. Cost-benefit analyses would determine whether collective action by landholders in parts of the catchments is more cost-effective than individual action at the property scale. Results would then be contrasted to economic analyses for the two CTC9 case study properties that were located in the Emu Creek Catchment.

A communication plan developed early in the project established the principal communication targets, strategies, communication media, personnel/agency responsibilities and approximate timing. A copy of the plan is presented as Attachment B.

Major modifications to the methods included:

(a) Reducing the project focus to one catchment – Emu Creek Catchment. It became evident early in the of the project that the Crows Nest Creek Catchment Landcare Group was relatively inactive making it difficult to usefully engage with this group. Moreover, the two catchments are adjacent to each other and Crows Nest Creek Catchment is geographically smaller than the Emu Creek Catchment. Given the highly fragmented nature of land ownership in the region, where many holdings are made up of regionally dispersed land parcels, the Crows Nest Creek Landcare Group also shared a significantly overlapping membership with the Emu Creek Catchment Landcare Group. Field and communication activities located in one catchment easily reached the constituents of the other.

(b) An increase in the number of catchments to 30 with a reduction in the scale of the individual catchments - (1) increasing the number of catchments was to obtain a good spread across the full geographic range of Emu Creek Catchment, including hilly land in the interior of the catchment. It also allowed a more complete coverage of soils and vegetation types, as well as tree cover ranging from closed forest through to the near totally-cleared landscapes that are typical of the more intensively run dairy enterprises in the basaltic lands of the western part of the catchment. (2) reducing the size of individual catchments was closely related to the first issue, and centred on getting discrete catchments that had the desired soil and vegetation attributes for testing. Selection of catchments of the order of 1000-1500ha, as originally proposed, made getting catchments with high levels of tree cover particularly difficult.

(c) Fewer formal field communication activities due to (1) delays in meeting some project tasks – catchment mapping and resource assessments, and (2) seasonal conditions preventing proposed exercises meeting their intended objectives.

(d) Less emphasis on economic analyses than was originally foreseen. The significant role placed on economic analyses in the objectives of CSE7 was predicated on finding ecological `hot spots' whose address might be economically approached through collective action. Project CTC9 had identified economic issues as substantial barriers to individual landholders taking action alone to address landscape problems. In the event, the project found little evidence of the existence of such `hot spots' with most landscape health problems being spread fairly evenly across the catchment.

These changes were detailed in correspondence with the Program Manager, at Program review meetings, and in various Milestone Reports (1 to 4) that were submitted during the life of the project.

RESULTS AGAINST OBJECTIVES

Objective 1: ***Validate and refine landscape design principles for agricultural use of grassy woodlands at a range of scales (e.g. paddock to micro-catchment);***

From project CTC9, McIntyre *et al.* (2002) outlined principles and thresholds for designing and managing grassy eucalypt woodlands to achieve ecological sustainability (Attachment D). The principal objective of CSE7 was to validate these design principles by empirical field-testing. The final approach adopted (previous section cf. Attachment C) was to select 30 small catchments (each of approximately 500ha in area) in the Emu Creek region near Crows Nest in South-east Queensland (27.3^{o}S; 152.1^{o}E) that varied for the characteristics identified in the principles (e.g. woodland cover, amount of intensive development, level of ground cover, presence/absence of vegetation buffers, uncontrolled grazing access), and to make assessments of these and also of the ecological condition of the catchments. Scale issues are addressed by examining aggregations of sub-sets of catchments with common boundaries. The results are presented in detail in a technical report (Attachment A) – Part 1 has 4 sections - a description of the selection of the 30 small catchments, a description of the methods used in the field, a discussion of the measures of landscape design/management, and a description of indicators of catchment condition (as measures of ecological sustainability). The measures of landscape design/management were used in the statistical analyses as input variables and related to the estimates of condition (output variables) to seek to identify any relationships, and particularly any thresholds. In all cases, the variable values applied to the whole of the small catchment. Part 2 outlines the results, which includes an assessment of the condition of each catchment against the principles-based criteria from the catchment sampling and the statistical analyses of potential relationships between the various attribute and indicator variables. A summary of these results follows:

Measures of landscape design/management: The landscape design/management measures varied widely between catchments – an exception was stock access to watercourses (only 1 property within 1 catchment excluded livestock through fencing) and dedicated conservation reserves (nil).
Catchment condition indicators: There were generally high values (indices > 80, scale 0-100) for soil surface condition, litter, soil erosion, pasture health, riparian tree health, riparian weeds and bank stability; intermediate values (indices 51 - 80) for upland tree health and upland weeds; and low values (indices <50) for bed stability, wildlife diggings and scats, and representative remnant vegetation. No catchments were consistently low or high for all indicators and the results revealed no catchment that could be considered a 'hot spot' (i.e. in generally poor condition and in need of urgent rehabilitation, or that might be economically treated by collective action - Objective 4). For the 14 indicators (Attachment A, Part 2, Sect 3), all 30 catchments had 5 or more indicators with values exceeding 80, and all catchments had at least 1 indicator below 50.
Relationships between measures and indicators: Each of the measures of landscape design/management was initially related to each of the catchment condition indicators by linear regression and correlation coefficients estimated for each relationship (Attachment A, Part 2, Sect 4). Of the 196 individual correlation co-efficients (Attachment A, Part 2, Table 3), only 66 were significant (P<0.05), many explaining only a small part of the variance; while 13 did explain more than 40% of the variance (Attachment A, Part 2, Sect 4.1). Multiple regressions, involving 2-4 variables, failed to explain much

more of the variance and were not pursued further. Failure to establish strong relationships between the variables is likely to be due to many factors influencing each indicator (including many not directly studied), and no single variable dominating all the others. In some cases, the increased value of a variable *a priori* viewed to likely promote an adverse outcome (e.g. % intensive land use) had an apparently benign effect on an indicator (e.g. soil surface index). In other cases, the relationship was consistent with prior expectation (e.g. marsupial scats and standing and fallen dead timber as measures of habitat quality).

Scale: The effect of scale on the relationships between the catchment condition indicators and measures of landscape design/management was explored by aggregating data from some contiguous catchments. From the original 30 catchments, it was possible to select 12 that could be grouped into 6 larger units (approx. 1000ha) by aggregating 2 adjacent catchments. These were further expanded to 3 large catchments (2000ha), which comprised 4 each of the original catchments that were in close proximity. The impacts of these changes in scale were explored for 5 measures of landscape design/management – % intensive use, % woodland cover, riparian buffers, % soil cover, % tussocks (Attachment A, Part 2, Sect 5) and 5 catchment condition indicators – soil erosion, upland shrubs, stream bed stability, marsupial scats, and wildlife diggings. The relationships between them were also examined. Generally the minimum values increased, maximum values decreased and correlation co-efficients increased as the average catchment size increased between 500ha to 2000ha (Attachment A, Part 2 Table 4, Figure 37).

Objective 2: ***Explore the importance of spatial arrangements of vegetation, at those scales, for achieving conservation outcomes***.

The issue of the importance of the spatial arrangement of vegetation at various scales is largely centred on woodland cover and other critical components of the vegetation matrix (e.g. riparian vegetation presence/condition). As indicated above (Objective 1), there was little correlation between the measures of landscape design/management and the catchment condition indicators, in particular, woodland cover. The lack of correlation could be due to the spatial arrangement of woodlands, creek channels or the distribution of steep land within the catchment. However, examination of the woodland location (e.g. lower creek, mid slope, hill top) on a subset of indicators judged most likely to be affected showed no effect of the woodland spatial arrangement. Similarly, neither the density of main creek channels nor the prevalence of steep land showed any effect. It is possible that the woodland location could be important with regards to salinity but, as no saline areas were observed in any of the 30 catchments, this could not be tested. It is important to note that our assessment of a limited salinity presence (as opposed to hazard) is consistent with similar assessments of a limited salinity problem within the Emu Creek Catchment by state resource conservation agency staff (e.g. E. Heijnen – former QDNRM Oakey soil conservationist *personal comm*.). Nevertheless, there is a considerable discourse in the theoretical literature at least on the importance of spatial patterns of vegetation for landscape health (e.g. McIntyre *et al.* 2002). The practical validity of this discourse may well be evident at scales that are larger than those that were studied here. For the present study, we found no localised effect of vegetation patterns on resource health (e.g. salinity could be important in other regions or at scales larger than 500ha). Nevertheless, appropriate scale may be important for other landscape health issues such as species conservation, especially at the larger regional scale for species with large habitat needs or subject to seasonal migration etc. What is a relevant scale necessarily varies between species (e.g. sedentary plants cf. eagles), and these issues could not be addressed under the scale/techniques applied to this study.

Objective 3: ***Explore the relevance of the design principles to other vegetation communities in the region.***

The CTC9 landscape design principles and thresholds were essentially directed at the extensive grassy eucalypt woodlands of eastern Australia. While the Emu Creek Catchment study region has a high percentage of this particular woodland vegetation type, there are other non-woodland vegetation communities within the region. These communities are also of interest for landscape management, as they co-exist with eucalypt woodlands on many properties in the catchment. Moreover, associated with the wide scale national interest in the CTC9 design principles has been the question of how well they might apply outside the grassy woodlands context. Vegetation types were defined according to 6 different `land units' which are derived from the Queensland Regional Ecosystems (Sattler and Williams 1999 - Attachment A), and are based on 24 potential combinations of 4 soil types and 6 vegetation types. Of these, 5 are eucalypt woodlands (viz. narrow-leaved ironbark, mixed ironbark, blue gum, spotted gum and other woodland). The sixth vegetation type has been defined as `rainforest/vine thicket' and covers the following Regional Ecosystems – R.E. 12.8.13, 12.8.21, and 12.9/10.15. The original vegetation for these Regional Ecosystems includes a broad range of microphyll and microphyll/notophyll rainforest species and/or semi-evergreen vine thicket species and are typically located on basalt, laterised basalt, sandstone or alluvial soils. The land units are generally associated with relatively fertile soils (sandstone apart) and originally had almost nil grass content, which essentially eliminated their value for grazing in an unaltered state. They have been extensively cleared and sown to pastures, and/or crops; and remaining (relictual) shrub and tree stands are typically of minor extent and are located on ridgetops or in rough gullies that were not amenable to pasture establishment. Apart from the principles relating to tussock grass cover, all of the landscape principles and thresholds should be applicable to these land units. However, due to the historical development pattern, the catchments with a high proportion of these land units failed to meet many of the principles and thresholds (Attachment A, Part 1 Table 1); especially woodland cover, minimum viable stand size of trees, dedicated conservation areas, vegetation buffers and controlled access for grazing. They did, nevertheless, have generally high levels of pasture ground cover and limited areas of bare ground – largely due to the sown pastures and their management at the time of sampling. These land types may possibly carry higher levels of some wildlife species (e.g. macropods) than the original scrubland vegetation communities might have allowed.

Objective 4: ***Explore the likelihood that collective action will achieve better economic outcomes, than if landholders act alone.***

As was the case with project CTC9, the majority of landholders with whom the present project interacted appeared to be sincerely committed to managing their resources responsibly; and were generally willing to discuss opportunities for incorporating new insights into their management. However, as was also the case with CTC9, the project continued to encounter formidable economic, technical and attitudinal constraints facing landholders who might otherwise be willing to adopt the landscape management principles. These constraints were revealed during many meetings with the Executive Committee of the Landcare group, and with landholders at field meetings or during visits to their holdings when the 30 catchments were being surveyed. Even with will, however, achieving collective action across whole catchments will always be difficult due to the number of landholders, and their attitudinal differences, within each catchment. For example, there was an average of 4.1 landholders over the 30 500ha catchments surveyed. Over the 12 catchments that could be aggregated, the average was 5.8 landholders per catchment, 9.0 landholders over each pair (1000ha), and 16.3 over sets of 4 (2000ha). The only significant form of collective action for landscape conservation observed within the catchment has been a concerted attempt by the Landcare group to control lantana (a major weed species in the region) on both private holdings and along roadsides and public reserves. To this end, substantive funding has been drawn from several sources (e.g. NHT grants, community gaming funds etc) and a good many landholders and the local Council have been involved. This activity has occurred largely independent of either CTC9 or the present project and could be argued to have captured the conservation agenda in the region to the detriment of other conservation investments. For example, issues relating to progress and the logistics of a catchment-wide spraying campaign dominated most Landcare committee meetings. The majority of applications for NHT-supported conservation grants administered by the Landcare group were for chemicals and operating costs of spraying equipment – very little for tree planting or habitat enhancement.

One area that has shown serious promise in terms of collective action to responding to insights directly attributed to both CTC9 and the present project relates to fencing out small `riparian conservation reserves'. A suggestion from CTC9 to break a serious deadlock on fencing out watercourses and riparian areas was to consider a `pareto' solution, involving establishment of small riparian reserves around permanent waterholes. Based on about 5-10ha of fenced out reserves with off-stream watering points, these were seen to meet multiple objectives of creating viable woodland patches, protecting the remaining water bodies in the dry season, drought refuges, and dedicated conservation reserves. They would also provide an opportunity for landholders to experiment with the technical management of reserves, and to gain confidence that they are effective. This may lead to a spatially more extensive commitment to limited stock access to riparian areas. Finally if linked across the landscape in a network, by establishment of many such sites, these mini-reserves might contribute positively to regional wildlife and biodiversity goals. This was raised at several meetings, including a project-sponsored landholder forum at Anduramba and field days held at Emu Creek in March and November 2003 (Attachment B). In late 2003, the Landcare group initiated a NLP project with $65,000 of seeding monies to initially sponsor the establishment of 10 riparian conservation areas. The project team provided the group with guidelines for selecting these sites and will help the group to monitor their performance (Attachment E).

With respect to the original objective of applying economic analyses to the collective rehabilitation of catchment `hot spots', as noted before, little action was undertaken, as these `hot spots' were largely undetected. Where landscape health problems were identified, they were largely spread across the catchment impacting on all landholders in much the same way and/or generally localised to individual holdings with little apparent off-site impact that would attract neighbours to the idea of collectively addressing the problems. Nevertheless, early in the life of the project an evaluation framework was developed to assess the economic impact of collective action and template models constructed to complete the analyses, if and when the `hot spots' were identified by the field surveys and subsequent statistical analyses. This framework was discussed with the Executive Committee of the Landcare Group at two meetings in March and June 2003. The structure of this evaluation framework is presented schematically in Attachment E.

ADOPTION, COMMUNICATION AND TECHNOLOGY TRANSFER

The project sought to work closely with the Emu Creek Catchment Landcare group executive committee to explore the economic and ecological scope of group adoption options. There was little direct adoption of the design principles observed on individual holdings in the catchment, although some NLP funding has been secured by the Landcare group to trial the co-ordinated establishment of off-stream waters and fenced off micro-riparian reserves (previous section). Communication activities have followed a communication plan laid down in the first year of the project (Attachment B). The plan was centred on 3 main areas of activity:

1. *Reporting to Emu Creek Catchment Landcare Group Committee meetings (approximately bi-monthly)* – the principal investigator attended approximately each second meeting of the committee and gave both formal (e.g. Powerpoint, written report) and informal updates (15 minute oral presentation) on project progress and/or sought endorsement of its activities within the catchment.

2. *Participating as significant contributors to open field days and/or other Landcare group field activities* – During the life of the project, the project team organised 2 open field days in the catchment (June 2002, June 2003), and also another in an adjoining region (Albert and Logan Rivers Catchments Association, Laravale) in June 2004. The team also presented materials and results from both CTC9 and CSE7 to a landholder meeting at Anduramba (November 2003).

3. *Reporting to general meetings of landholders and other stakeholders* - At the completion of the field sampling activities in each of the 30 catchments, summary reports of the overall assessment of the catchments' condition were forwarded the landholders whose properties were included in the catchments (Attachment G). An offer was made to address any queries that the landholders might have about the assessment technique or summary reports. In November 2003, the team convened a field meeting at Emu Creek that canvassed the assessment methods and results. The project was represented in a CSIRO-sponsored workshop on landscape design (Thredbo, November 2003), a joint Australia-NZ ecological economics forum (Auckland, October 2003), and the ESA annual conference

(Armidale, December 2003). Materials from the project were presented in posters to the Australian Rangeland Congress in Kalgoorlie (July 2002), International Rangeland Congress in Durban (August 2003), and also submitted for the International Grassland Congress to be held in Dublin (July 2005).

An important observation is that land uses within the Emu Creek Catchment are undergoing a continual transition from dominance by commercial agriculture to a mixed usage best designated as `amenity' landscape use (Barr 2002). This may have some important implications for the communication and outreach activities of future projects seeking to promote sustainable use of landscape resources. This issue may be productively canvassed under the next round of R&D being considered as part of the proposed Native Vegetation and Biodiversity R&D Program.

ACKNOWLEDGEMENTS

The project team is extremely grateful to the many stakeholders whose continued interest in the project and the landscape management guidelines is encouraging. Particular acknowledgement is given to the Executive Committee of the Emu Creek Catchment Landcare Group, the members of the Technical Panel, Jann Williams and Jason Alexandra (LWA Program Managers), and Rick Galbraith and David Manning (Crows Nest Shire Council) for the time they willingly committed to the project. The Queensland Department of Natural Resources and Mines assisted through provision of satellite and resource maps of the Emu Creek Catchment. Land and Water Australia funded the work under the Native Vegetation R&D Program.

COMMERCIAL POTENTIAL

While there remains considerable interest in the research and extension domain to explore the application of the original landscape management guidelines (CTC9) within Australia, and CSE7 has maintained the momentum of that interest, there seems to be little commercial potential for the material. The information from the project rightly belongs in the public domain.

PUBLICATIONS (CSE7 Project team)

MacLeod, N.D. & McIvor, J.G. (2003). Evaluating Landscape Design Principles for Optimising Biodiversity in Grazed Savannas. *In.* (N. Allsop *et al.)* Proc 7th Int. Range. Cong., Durban, Aug. pp.1961-63.

MacLeod, N.D & McIvor J.G. (2003). Reconciling Economic and Ecological Conflicts for Sustained Management of Grazing Lands. *Proc. Ecol-Econ. Think Tank*, Nov., Auckland. ANZ Soc. Ecol. Econ. pp PM2.1:1-14.

McIvor, J.G., McDonald, C.K., MacLeod, N.D. & Hodgkinson, J.J. (2005). Agricultural intensification: have sown pastures damaged the environment? *Proc. IGC Dublin*, in press.

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Sattler, P. & Williams, R. (Eds.) (1999) *The Conservation Status of Queenslands Bioregional Ecosystems.* Environmental Protection Agency: Brisbane.

FURTHER INFORMATION

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