CHARLES STURT
UNIVERSITY

Report No. 160

Providing the knowledge base for landscape change in the Ovens Catchment

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June 2002
Albury, NSW

Research commissioned by:
North East Catchment Management Authority
Department of Natural Resources and Environment
Natural Heritage Trust

NORTH EAST CATCHMENT MANAGEMENT AUTHORITY

State Government Victoria Department of Natural Resources and Environment

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

Johnstone Centre, Albury, NSW

Cataloguing in Publication provided by Johnstone Centre, Charles Sturt University

Curtis, Allan. Graham, Megan, Byron, Ian, Lockwood, Michael. And Simon McDonald
A project in conjunction with the North East Catchment Management Authority, the Department of Natural Resources and Environment and the Natural Heritage Trust / by A. Curtis, M. Graham, I. Byron, M. Lockwood, and S. McDonald / Johnstone Centre, Charles Sturt University, Albury, NSW 2000.
1v., - (Report / Johnstone Centre, No. 160)

ISBN 1 86467 105 X.

1. Conservation of natural resources – Victoria – Ovens River Valley. 2. Landscape changes – Victoria – Ovens River Valley. I. Curtis, Allan 1953-. II. Charles Sturt University. Johnstone Centre for research in Natural Resources and Society.

ACKNOWLEDGEMENTS

Project funds and in-kind contributions were made by the Natural Heritage Trust (NHT) through the *Heartlands* project, the North East Catchment Management Authority (NECMA), the Department of Natural Resources and Environment (DNRE) and Charles Sturt University (CSU).

The authors would like to thank Royce Sample for his important contributions as the NECMA project manager.

Particular thanks to Peter Farrell (DNRE) for his contribution to survey design and Peter Ockenden (DNRE) for his assistance with the delineation of Land Management Units (LMU). Matthew Stanway (DNRE) assisted with access and interpretation of DNRE spatial data layers.

Thanks also to staff at the Indigo, Wangaratta and Alpine Shires who assisted with mailing lists.

Surveys were completed by landholders in the Ovens Catchment between May and August 2001.

Greg Wallis, Tony Jones, Tony Ransom, Gary Dawes, John Pianagonda and Frank Russo contributed to the workshop where the draft survey was pre-tested. We thank them for their important contribution to survey development.

The authors would particularly like to thank those landholders that completed the surveys.

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1.0 EXECUTIVE SUMMARY

1.1 Background

This research explored aspects of the important social dimension of natural resource management in the Ovens Catchment of North East Victoria. The stimulus to undertake the project was the realisation by the North East Catchment Management Authority (NECMA) that despite considerable effort, adoption of recommended practices had been slower than required to address priority issues, particularly those related to water quality, habitat rehabilitation, pest plants and animals and dryland salinity.

Poor returns from agriculture, particularly from grazing enterprises, appeared to have limited the ability of many landholders to invest in recommended practices or new enterprises. Even if returns from farming improved it was recognised that landholders might not invest in improved land and water management. Landholders are increasingly aware that they are being asked to undertake work where there is considerable off-site or community benefits. Within commuting distance of larger regional centres such as Albury/Wodonga and Wangaratta there has been considerable conversion and subdivision of existing holdings into lifestyle farming enterprises for retirees and people with off-property work. Recent research suggests that these non-farmers are not strongly motivated by the desire to maximise profits and may not be prepared to invest income earned off-property in improved land and water management. At the same time, Australia has an ageing rural population with life expectancy increasing and younger people relocating to urban centres. It can no longer be assumed that inter-generational transfer of properties will occur within families or that older landholders will move off their properties on retirement. These trends provide challenges and opportunities for those responsible for natural resource management.

1.2 Research objectives

Against this background, the NECMA was able to access Natural Heritage Trust (NHT) funding through the *Heartlands* program to fund social research in the Ovens Catchment. This study built on the authors' earlier experience with a similar study in the Goulburn Broken Dryland (GBD). The GBD is located immediately to the south of the Ovens and therefore provides a useful comparison study. The four key research objectives identified for the Ovens study were:

1. Explore the key factors affecting landholder willingness and capacity to change on-property management in ways likely to deliver improvements in environmental condition at the landscape scale.
2. Identify the capacity of economic incentives to achieve natural resource management objectives (defined as revegetation targets to meet salinity and biodiversity objectives).
3. Identify social factors limiting the uptake of incentives for revegetation and the protection of remnants and ways these constraints can be addressed.
4. Assess the extent a limited range of policy options (other than incentives) could be expected to increase revegetation and the protection of remnants and achieve natural resource management objectives.

1.3 Data collection and analysis

The principal research instrument was a mailed survey during May 2001 to a random selection of landholders in the Ovens Catchment. Surveys were directed to 1,000 of the 8,658 rural land owners with properties larger than 10 hectares as identified on local government ratepayer rolls. With 568 completed surveys, the overall response rate was 67 per cent. This is an excellent response rate and provides considerable confidence for those attempting to extrapolate from the sample to the wider population of landholders in the Ovens.

Considerable effort was expended identifying and operationalising (establishing the format of statements to be used in the survey) current recommended practices (CRP) expected to achieve improvements in land and water management and ultimately, environmental condition. CRP included in the survey included fencing of remnant vegetation, planting of trees/shrubs, perennial pasture establishment, liming to control soil acidity, conservation tillage of crops and work to control weeds and rabbits.

An important aspect of this research was the comparisons of survey data with existing technical data. A Geographical Information System (GIS) was used to combine different data layers.

The Ovens Catchment is considerably smaller in area than the GBD and this may explain why there was a small number of significant differences across the Land Management Units (LMU) in the Ovens. LMU are areas of land delineated by their hydrogeological characteristics.

1.4 Issues of concern

The potential of the farm dams policy to impact on landholder contributions to improved resource management was rated the highest of 16 potential issues. The importance of weeds and pest animals as a high priority issue was reinforced by a number two ranking. The third and fourth highest rating issues were the impact of cutbacks by government and large businesses and the impacts of property subdivision and off-property work.

Very few landholders in the Ovens Catchment are experiencing the effects of salinity and it was no surprise that dryland salinity was not a high priority issue. Higher concern about salinity was linked to higher adoption of CRP.

Soil acidity was rated significantly higher than dryland salinity as an issue affecting respondent's properties and their district. Nevertheless, soil acidity was only ranked fifth of 16 issues listed. It seems that non-farmers are ignoring soil acidity. To the extent that the impacts of soil acidity are quarantined on-property, this lack of concern and subsequent action by non-farmers may not be an issue for natural resource managers. Higher levels of concern about the impacts of soil acidity, weeds and pest animals and habitat decline were all linked to higher adoption of CRP.

Whilst the Ovens survey explored the importance of issues as opposed to values, the finding that at least one social, economic and environmental issue was ranked in the top five issues suggests that appeals to landholders must address the range of values that they attach to natural resources. In a number of instances, respondents were more concerned about the environmental impact of issues than their economic impact. These findings suggest that appeals that focus primarily on dryland salinity or soil acidity and on the production benefits of remedial or preventative action will have limited success.

At the same time, most respondents gave a low rating to the removal of native vegetation as a factor contributing to the decline of native birds and animals in the district. While there are large areas of forested Crown land in the Ovens Catchment, most private land has been extensively cleared. Indeed, many of the ecological vegetation classes (EVC) in the Ovens Catchment have less than 15 per cent of their pre-1750 cover remaining. Importantly, a higher rating for the issue of native vegetation removal was linked to higher adoption of CRP linked to the protection of remnant vegetation. These findings appear to justify further investment in community education to raise awareness of the extent of native vegetation removal/decline.

1.5 Knowledge

Most properties in the Ovens Catchment have high levels of soil acidity, but almost half the respondents said they did not know the soil acidity for any part of their property. Those reporting a salt problem or that they knew the soil acidity level on their property were significantly more likely to undertake ameliorative action. These links were particularly strong for soil acidity.

Most respondents said they had sufficient knowledge to act for three of the seven knowledge topics included in the survey: collecting samples for testing soil fertility or acidity, how to establish introduced perennial pastures, and the production benefits of retaining native vegetation on farms. More than half the respondents indicated they didn't have sufficient knowledge to act for the topics relating to the processes leading to soil acidity and dryland salinity, preparing a farm/property plan or the approximate returns per hectare from farm forestry. In this study there were significant positive relationships between respondent's self-assessed

knowledge and their adoption of CRP. Just over half of all respondents were members of Landcare groups and Landcare participation was linked to higher adoption of CRP, particularly those related to habitat rehabilitation.

These findings appear to confirm the value of community education and suggest there is room for further investment to address shortcomings on important topics, particularly those related to understanding processes leading to dryland salinity. In the case of soil acidity, it seems that it is sufficient for landholders to be convinced that soil acidity is a problem and to know how to collect soil samples as opposed to understanding the processes leading to soil acidification. If this is the case, this finding also highlights the importance of local trials and field days to demonstrate the impact of soil acidity on grass production. Again, to the extent that soil acidity impacts are quarantined on-property, there is less justification for large scale investment in community education on this topic.

Comparisons of landholder identified salinity affected areas and those predicted by expert maps suggested that landholders in the Ovens Catchment had excellent knowledge of the current extent of saline affected areas on their properties. Those who reported saline affected areas had higher adoption of CRP than all of the respondents who said they didn't have saline affected areas. Those who acknowledged they had saline affected areas had adopted CRP for salinity mitigation at significantly higher levels than those who were thought to be unaware of salinity affected areas on their property. These findings suggest that awareness is linked to adoption and that the substantial investment in salinity education in this catchment has been successful in raising salinity awareness and has contributed to the adoption of CRP linked to salinity mitigation.

NRE maps of discharge sites failed to predict more than half of the saline affected areas reported by landholders. It is unlikely that landholders would deliberately overstate the extent of salinity on their property. It is possible that some landholders failed to distinguish between water logged and saline affected areas. It seems there is a need for a substantial investment in updating NRE maps of saline affected areas in the Ovens catchment.

1.6 Attitudes

This study employed the New Environmental Paradigm (NEP) to explore links between attitudes to conservation and adoption of CRP. It seems that most respondents have embraced the constellation of values, attitudes and beliefs that constitute the NEP. There were no significant positive correlations between the NEP index score and adoption of CRP. Most respondents also had positive attitudes towards working together, working with government and accept that landholders have most responsibility for work to address land and water degradation on their property. Again, these attitudes were not linked to the adoption of CRP.

1.7 Ageing rural population

The median age of Ovens survey respondents was 54 years. The common perception of younger age being linked with higher adoption of CRP was not supported by survey findings, suggesting that the ageing of rural landholders was not a major constraint to the adoption of CRP. In an era of declining farm profitability and stagnant property prices, some of the over 65 years group may feel they are locked into living long-term on their property. Given current trends for younger people to abandon farming and to leave rural areas, a sizeable proportion of the properties of the over 65 years group are unlikely to pass to the next generation until after the death or incapacity of the current owners prevents them farming. With increased life expectancy, inter-generational transfer of many of these properties will not occur for some time. There is also anecdotal evidence of a trend for people "retiring" to rural landholdings. This information suggests that resource managers cannot ignore the older landholders and must understand their values, aspirations and needs. Reduced commitment to weed and pest animal control is one of the potential issues that might arise from the trend to lifestyle or amenity farming where there is less emphasis on agricultural production.

1.8 Planning

More than two thirds of all respondents were not involved in property planning, did not use a property budget and had not developed a succession plan. There were some links between involvement in these planning activities and higher adoption of CRP. It seems a case could be made for the inclusion of these activities in community education programs. On the other hand, if there has been a substantial investment in promoting these planning processes then it appears to have had little impact. Any additional investment would need to be carefully targeted. Recent experience suggests that landholders will undertake property planning if it is presented as part of the package delivering assistance with onground work.

1.9 On-property and off-property income

There were significant positive relationships between the level of on-property profits and the adoption of CRP, particularly those linked to the management of pastures and soil acidity. However, forty per cent of landholders did not make any on-property surplus and less than 10 per cent of all respondents reported an on-property income above the $50,000 threshold required to sustain a household and fund investment in a farm's natural and capital resources. At the same time, off-property income was higher than on-property income, but off-property and total household income were not linked to higher adoption of CRP. After combining on and off-property income only 35 per cent of households exceeded the $50,000 threshold. It is possible that landholders earning income off-property are reluctant to invest in unprofitable on-property enterprises. It is also possible that the identity or self-esteem of those working off-property is less tightly linked to the condition of their property. Those working longer hours off-property also have less time to work on their property.

The association between higher on-property profitability and adoption suggests that if economic conditions change, for example, a sustained rise in commodity prices, that there would be increased adoption of CRP. However, in this study there were no links between higher levels of profitability and adoption of CRP for weed and pest management or habitat rehabilitation. This finding suggests there is merit in community education that makes appeals to social and environmental values property owners attach to their land.

1.10 Investing in new enterprises

The small number of respondents and small median areas allocated to the emerging and potentially profitable enterprises, such as farm forestry, wine grapes and other horticulture, suggests that these enterprises will not overcome low on-property profitability in the short-term. Despite generally high levels of equity in their properties, respondents are particularly wary of making substantial new on-property investments. Of 17 listed constraints, the highest ranking topics were the level of new investment required, uncertainty about long-term markets, extent the new enterprise fits existing lifestyle, better returns elsewhere, and access to professional advice. The long list of high rating constraints included a mixture of economic, environmental and social issues that represent a formidable challenge for those attempting to change the enterprise mix in the Ovens Catchment.

1.11 Property size and rural subdivision

Property size is an important element in determining the financial viability of grazing and dryland cropping enterprises. There was a significant positive relationship between increased property size and on-property profitability. The median property size to report an on-property profit in excess of $50,000 was 266 hectares. Larger property size was also linked to significantly higher adoption of CRP associated with commercial agriculture (liming, conservation tillage, perennial pasture) as opposed to those related to habitat rehabilitation. Most land was owned by landholders with properties larger than 150 hectares and by those who were farmers by occupation, suggesting that an effective strategy to improve the adoption of CRP would include a strong focus on farmers. However, subdivision of properties in the Ovens is expected to continue and small property owners are already a majority of landowners and manage a substantial proportion of land, often in critical sites for recharge control or habitat rehabilitation. The reality is therefore, that resource managers will need to work with the owners of both small and large properties.

1.12 Farming and non-farming occupations

The finding that higher levels of off-property work were associated with significantly higher involvement in tree planting suggests that non-farmers can be motivated to adopt CRP, particularly those related to habitat rehabilitation. Again, it needs to be emphasised that non-farmers, including retirees, are less likely to be motivated by appeals to improving agricultural production and profits. Arrangements for separating the ownership and management of land and the establishment of professionally managed teams that undertake onground work are two approaches that may be needed to effect change where there are substantial proportions of landholders working off-property. Natural resource managers should also consider establishing partnerships with state and local governments to ensure that planning schemes help to minimise the potentially negative impacts of the trend for the suburbanisation of rural land.

1.13 Achieving catchment targets

The NECMA has identified 15 per cent of pre-1750 cover as the revegetation target to achieve biodiversity conservation objectives in the North East.

There is a large suite of policy options available to natural resource managers. Our survey examined a small number of the potential approaches. Our intention was to gather information that would stimulate discussion amongst NECMA stakeholders.

Very few landholders in the Ovens catchment are experiencing the effects of salinity and it was no surprise that dryland salinity was not a high priority issue. Most respondents had very low household incomes and higher on-property income was associated with higher adoption of CRP. If salt loads originating in the Oven Catchment are contributing to negative environmental, economic and social impacts downstream, this needs to be acknowledged and addressed. In this study access to government funded programs was linked to higher adoption of CRP related to habitat rehabilitation, suggesting that stronger cost sharing by government would be an effective approach to achieving revegetation targets. Other policy approaches could include supporting landholders to move into more profitable enterprises and strategic land purchases.

Survey respondents were asked to indicate their level of interest in committing to additional revegetation work in exchange for an incentive package that provided for establishment costs, opportunity costs and a fee for active management. About half the respondents said they would take up the incentive proposal and the package would have substantially increased the area revegetated. While this level of support is encouraging, the fact that about half the respondents were not interested suggests that constraints other than financial capacity limit the adoption of CRP. Analyses of survey data indicated that the incentive package offered would increase the area revegetated and accomplish between 19 per cent and 35 per cent (mid estimate of 29 per cent) of the catchment target.

Almost half of the properties in the Ovens Catchment will change hands within the next 10 years. This situation could provide an opportunity for intervention by government or industry, for example, to purchase land for habitat rehabilitation. A revolving fund, such as the program managed by the Trust for Nature Victoria could be established to purchase properties, place covenants that prescribe their future management, and then re-sell them to new owners. These new owners, given the covenant, are more likely to be supportive of and have the capacity to adopt best practice land and water management. In this study, the use of a revolving fund to purchase land in the critical areas may represent one of the most effective (both in terms of cost and land management outcomes) and least divisive policy options. The revolving fund appears to be a more effective strategy than revegetation incentives in that this policy would accomplish between 45 per cent and 50 per cent of the catchment target.

The salinity mitigation revegetation targets for the Ovens Catchment are much more modest than those related to biodiversity conservation, and either the incentive scheme or the revolving fund would have no difficulty meeting them. However, landholders' current revegetation intentions would not meet these catchment targets (60% overall), so some additional policy intervention would be required.

Analyses exploring the effectiveness of two combinations of incentives and land purchases suggested that they would accomplish between 55 per cent and 75 per cent of biodiversity conservation targets. If these policy options were combined with a more sophisticated community education program it seems likely that there would be sufficient revegetation to accomplish the regional biodiversity target for the Ovens Catchment.

1.14 Future research

This research has provided a coherent explanation of landholder adoption of recommended practices in the Ovens and we have indicated some of the resultant policy implications. The survey data also represent baseline information that is not provided by other sources, including the ABS Household and Farm surveys. Additional work is required to evaluate the relative cost-effectiveness of the policy options explored in this research and to investigate ways of implementing a revolving fund.

The real potential of the study will not be realised unless there is a follow-up study in about five years to begin the process of identifying trends over time.

2.0 INTRODUCTION

2.1 Research context

This report presents a summary of key findings from a mailed survey to 1,000 landholders in the Ovens Catchment in 2001. The survey focussed on gathering base-line information about the key social factors affecting landholder decision making about the adoption of practices expected to improve the management of natural resources in the Ovens.

This Ovens project drew heavily on the methodology of a similar project completed in Goulburn Broken Dryland (GBD) in 1999 (Curtis *et al.* 2000). The North East Catchment Management Authority (NECMA) was able to draw on NHT funds for the *Heartlands* project in the Ovens Catchment to undertake this study.

The Department of Natural Resources and Environment (DNRE) was the other principal stakeholder.

2.2 Research objectives

1. Explore the key factors affecting landholder willingness and capacity to change on-property management in ways likely to deliver improvements in environmental condition at the landscape scale.
2. Identify the capacity of economic incentives to achieve natural resource management objectives (defined as revegetation targets to meet salinity and biodiversity objectives).
3. Identify social factors limiting the uptake of incentives for revegetation and the protection of remnants and ways these constraints can be addressed (including by community education).
4. Assess the extent a limited range of policy options (other than incentives) could be expected to increase revegetation and the protection of remnants and achieve natural resource management objectives.

2.3 Report structure

The next chapter provides some background to the Ovens Catchment. The subsequent methodology chapter includes a summary of the literature the research team drew upon to identify the variables included in the survey and brief descriptions of the mail out process and the approach to data analysis.

Research findings are presented in 3 chapters.
1. Key findings for each survey topic.
2. A brief summary of factors affecting landholder adoption of recommended practice. (Objectives 1&3).
3. The potential of economic incentives and land purchases to achieve NRM objectives. (Objectives 2&4).

There is a conclusion and an executive summary.

3.0 BACKGROUND

3.1 The location and character of the Ovens

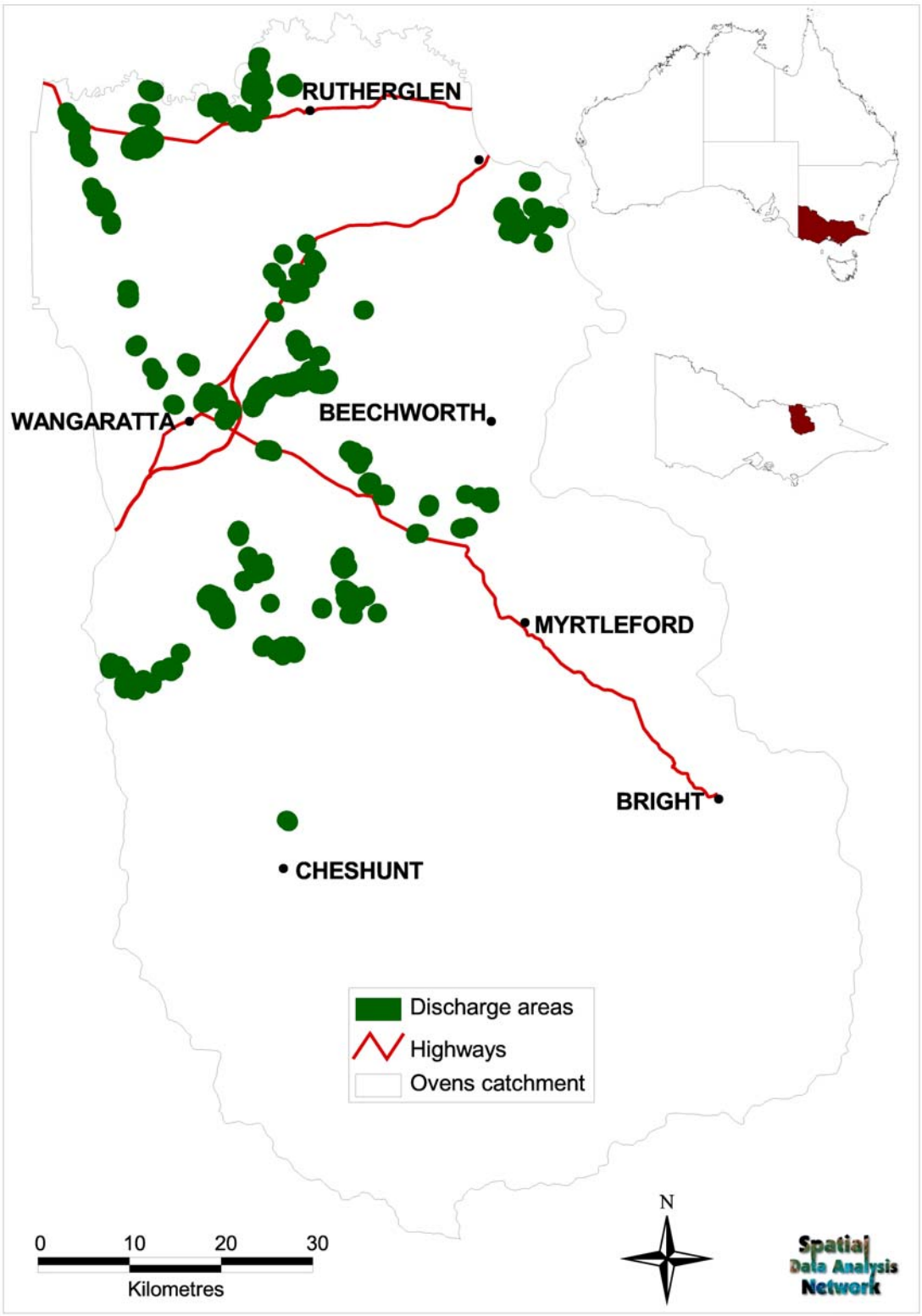
The Ovens Catchment is located in North East Victoria and covers an area of approximately 777,800 hectares [Map 1]. It includes the Black Dog and Indigo creeks as well as the King and Ovens rivers and contributes 14 per cent of the flows to the Murray-Darling Basin (NERCLPB 1997). About half of the Ovens Catchment is public land covered by native vegetation. Major landuses in the Ovens Catchment include broadacre cropping/grazing, pine plantations, intensive horticulture and dairying. Primary production and associated processing industries are the main contributors to economic wealth. Tourism is also an important industry. (NERCLPB 1997).

The population of the Ovens Catchment is about 45,000 (OBWQWG 2000). The Ovens catchment includes the major townships of Wangaratta, Rutherglen, Myrtleford, Bright and Beechworth.

The NECMA Regional Catchment Strategy (RCS) identified the high priority natural resource management issues as being effective communication and coordination of management actions, maintaining high water quality, minimising erosion, controlling pest plants and animals, preventing further habitat decline and managing dryland salinity NERCALPB 1997).

The Ovens river and its tributaries generally have low salinity. Computer modelling suggests that the Ovens Basin contributes between 56,000 and 78,000 tonnes of salt to the Murray River per year (OBWQWG 2000).

Map 1
Location of Ovens Catchment



3.2 Land Management Units

The Ovens Catchment has been divided into 11 land management units (LMU) based upon the geological and hydrological characteristics of the land (CLPR 2000). Some of these LMU are very small in geographic extent and population (LMU 6, 8 & 13 each <1 per cent of total Ovens catchment and <85 properties) [Figure 1]. In response to a request from the research team, DNRE and CMA staff combined a number of LMU on the basis that they had similar geological characteristics and were in close geographic proximity (pers. comm. Ockenden and Sample 2001). These deliberations produced a revised map with seven LMU [Map 2, Figure 1] and it is these LMU that have been used in this report.

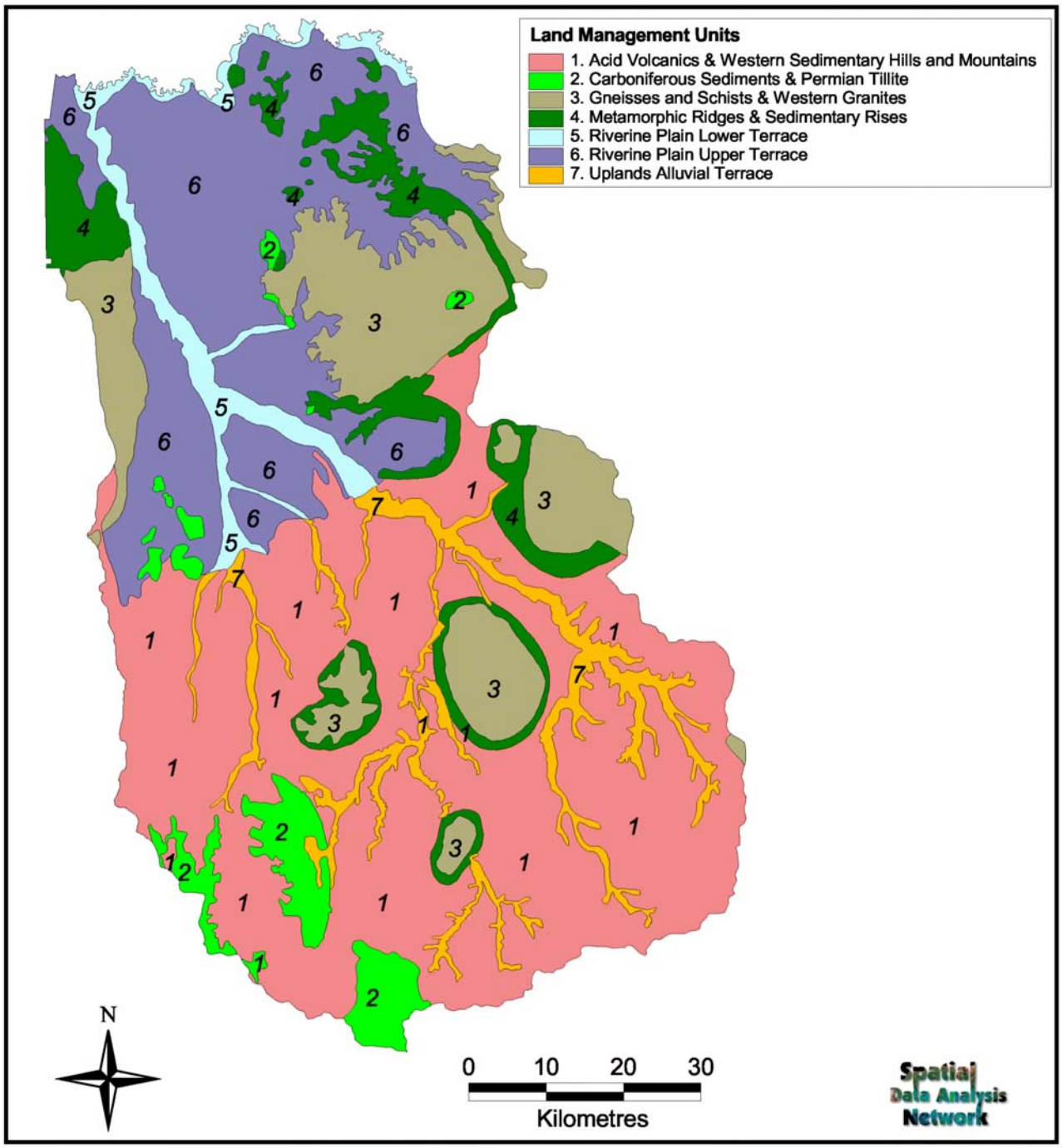
Seven LMU were identified as being key salinity risk areas based upon geology, landscape criteria and ground water trends (NESWG, DNRE; NECMA 2000). Six of the seven revised LMU contain priority salinity risk areas [Figure 1]. Under both the original and the revised LMU categories, most of the Ovens Catchment was/is in designated salinity risk areas. For this reason, we have not distinguished between high priority and other LMU in this report.

Figure 1
Revised Land Management Units
Ovens Catchment, 2001

Original LMU			Revised LMU		
LMU No.	**Original LMU title**	**Landholders in LMU**	**LMU No.**	**Revised LMU title**	**Landholders in LMU**
1	*Riverine plain lower terrace	856	**1**	Riverine plain lower terrace	856
2	*Riverine plain upper terrace	4,044	**2**	Riverine plain upper terrace	4,044
3	Uplands alluvial terrace	556	**3**	Uplands alluvial terrace**	556
4	Acid volcanics	192	**4**	Acid volcanics, Western sedimentary hills and mountains	1,393
11	*Western sedimentary hills and mountains	1,201			
6	Carboniferous sediments	82	**5**	Carboniferous sediments, Permian tilite	150
13	*Permian tilite	68			
8	*Gneisses and schists	59	**6**	Gneisses and schists, Western granites	1,119
5	Western granites	1,060			
7	*Metamorphic ridges	247	**7**	Metamorphic ridges, Sedimentary rises	540
10	*Sedimentary rises	293			
	Total	8,658			8,658

* The 7 original LMU identified as salinity priority areas (NESWG, DNRE; NECMA 2000).
**The 1 revised LMU not identified as a salinity priority area

Map 2
Revised Land Management Units



4.0 METHODOLOGY

4.1 Background to this research

Governments have assumed that, at least in part, poor adoption rates for recommended practices arose because landholders were unaware of important land degradation issues; lacked sufficient knowledge and skills; or had attitudes that emphasised short-term economic returns over maintaining the long-term health of the land (MDBC 1990; ASCC 1991). There has been a large investment of resources over the past decade in awareness raising and education programs, including those carried out by Landcare groups. There is credible evidence that these activities do contribute to increased awareness and understanding and that these changes enhance landholder capacity to adopt recommended practice (Vanclay 1992; Curtis and De Lacy 1996; Curtis *et al.* 2001a). However, though most landholders already have a strong stewardship ethic, such attitudes have not been linked to increased adoption of recommended practices (Curtis and De Lacy 1998).

Some landholders have lifestyles and values that limit their response to approaches that focus on increasing agricultural production and profit maximisation (Barr *et al*. 2000; Curtis *et al.* 2001b). Non-farmers and retirees may respond less quickly to economic signals; be more averse to risking off-property income in on-property enterprises; and will probably have less time for property management (Barr *et al*. 2000). On the other hand, non-farmers may bring new ideas, skills and financial resources that contribute to the renewal of local communities and they may be more likely to respond to appeals for biodiversity conservation (Curtis and De Lacy 1996).

There is now abundant evidence that part of the explanation of low adoption is that many of the current recommended practices or enterprises are either unprofitable and/or unsustainable. Amongst other things, some of the recommended plant-based management systems "leak" water and contribute to ground water flows that mobilise salt (Stirzacker *et al.* 2000; Walker *et al.* 1999). Lack of confidence in recommended practices has been identified as an important constraint affecting adoption (Curtis et al. 2001b).

Low on-property income will constrain the capacity of landholders to respond to new opportunities. Over the past decade, most broad acre farming enterprises in the Murray-Darling Basin (MDB) have been unprofitable using the FM 500 project benchmark of financial sustainability (Barr *et al.* 2000). The FM 500 benchmark assumes that a disposable family income exceeding $50,000 per year is required to sustain a household and fund investment in a farm's natural and capital resources (Rendell *et al.* 1996). There is increasing evidence that many rural landholders, including those in the GBC, have limited on-property incomes and that this is a critical constraint to adoption (Barr *et al*. 2000; Curtis *et al.* 2001a). Poor returns from grazing have meant that landholders could not afford the remedial lime and fertiliser regimes required to maintain pastures and prevent the downward spiral in grass production that effects water uptake and eventually, farm income (Millar and Curtis 1997).

It is also unlikely that many dryland landholders will generate substantial income from new enterprises such as olives, wine grapes and farm forestry (Stirzacker *et al.* 2000; Curtis *et al.* 2000). Landholders are very reluctant to take on new enterprises that will involve them entering long-term agreements with powerful industry partners (Curtis and Race 1996). Problems also arise if recommended practices or new enterprises are complex, are perceived as being risky, do not fit with existing enterprises or conflict with existing social norms (Vanclay 1992; Curtis and Race 1996; Barr and Cary 2000).

It seems that understanding of issues and congruent attitudes are necessary but not sufficient to ensure adoption. Landholders are also increasingly aware that they are being asked to implement work that has community benefits in terms of biodiversity conservation, improved public health and protecting export income (agriculture and tourism) and infrastructure. They also understand that many of the problems that they are being asked to address have resulted from previous government policies. Establishment of the Natural Heritage Trust, with the federal government sharing the costs of large-scale on-ground work on private land, was an acknowledgment of the legitimacy of these arguments (Curtis and Lockwood 2000).

Discontinuity between the source and impact of issues, particularly those related to water degradation, adds a further complication. Many landholders in the upper reaches of catchments are either not experiencing these problems, believe they can live with them or are unaware or unconcerned about contributing to downstream impacts (Curtis *et al.* 2001a).

Australia has an ageing rural population with life expectancy increasing and younger people drifting from rural areas to the more prosperous and attractive lifestyles in urban centres (Haberkorn *et al.* 1999). We can no longer assume that a substantial proportion of the inter-generational transfer of properties will occur within families. Where family succession is unlikely, property owners may be less willing to invest in recommended practices or new enterprises. In an era of reduced farm profitability and lower land prices, particularly where demand for rural subdivisions is not high, some landholders may feel they are locked into living on their properties in retirement. With increasing life expectancy, this trend could delay inter-generational property transfer. These elderly property owners may also be less willing to invest in recommended practice or new enterprises. Guerin (1999) and Curtis *et al.* (2001a) found that there was no clear correlation between landholder age and adoption, and suggested this was an important area for future investigation.

Such pressures were expected to lead to the amalgamation of some smaller grazing properties into larger units. While some amalgamation has occurred, there has not been large-scale consolidation of properties, and the trend has not been uniform across the Murray-Darling Basin (Barr *et al.* 2000). Within commuting distance of larger regional centres, there has been considerable conversion and subdivision of existing holdings into lifestyle farming enterprises for retirees and people with off-farm work. Land prices based on rural residential use will militate against the aggregation of smaller and less viable grazing holdings and closer settlement may impose environmental controls on broad acre farming.

It is increasingly obvious that there are limits to the capacity of landholders to voluntarily effect required change at the landscape scale (Curtis 2000). Effecting behavioural change in private landholders is a complex task and experience suggests that no single instrument will address the underlying reasons for non-adoption (Vanclay 1997; Lockwood *et al.* 2001). As Dovers (1995) and Dovers and Mobbs (1997) emphasised, the challenge is to develop integrated packages that may include:

- legislation or regulations to create the institutional framework for management, set aside areas of land, and enforce standards and prohibitions;
- self regulation;
- research to clarify problems, develop solutions, and monitor environmental conditions;
- education to convince people of the need to change behaviour, gain support for policies, and ensure the ability to apply policy instruments; and
- economic measures such as charges, subsidies, penalties, and tradeable permits to assist efficient allocation of resources and equitable distribution of costs and benefits.

This research also recognised that regional catchments are, increasingly, the scale at which natural resource management occurs in Australia. Understanding and monitoring critical social processes and trends is an important part of the management that regional Catchment Management Committees/Authorities (CMC) and agency staff should do. In turn, regional experience should inform the development of national policies. As our recent research in the GBD (Curtis *et al.* 2000) illustrated, there are also considerable differences at the sub-regional scale. There are differences in the physical settings of the Ovens LMU, the types of rural land use, the extent of rural subdivision and the obvious contrasts in terms of proximity and commuting time to the larger regional centres of Albury/Wodonga and Wangaratta. It seems there will need to be sub-regional differences in the policy mix implemented by the CMC and other organisations (Curtis *et al.* 2001a).

4.2 Need to conduct the survey

Surveying landholders over an area as large as the Ovens catchment is a challenging, time-consuming and expensive task. If there are other data sources available, they should be examined to avoid duplication of research effort. Other organisations, such as the Australian Bureau of Agriculture and Resource Economics (ABARE) and the Australian Bureau of Statistics (ABS), collect data on households and farms. In recent times there have been attempts to interpret these databases and identify important social trends in rural Australia (Barr *et al*. 2000; Haberkorn *et al.* 1999). However, analyses using these data bases have their limitations for those developing policy at the regional scale. Few questions used by ABARE or ABS directly assess factors affecting landholder capacity to change practices or enterprises. Researchers are often forced to infer from the available data and their findings can be misleading in that important variables were not able to be considered. Furthermore, data is only available to the public in aggregated form, the smallest scale being census collector districts that combine data for about 200 households. Aggregation reduces the usefulness of data, particularly when sub-regional or LMU contexts are important, as for the Ovens.

4.3 Topics and variables included in the mail survey

Drawing on the above literature and given the constraints of a mailed survey (mainly space and the type of questions that can be effectively posed), the authors, in collaboration with our industry partners, identified the topics listed below for inclusion in the survey. Whilst a copy of the survey is not included in the report, explanations of survey questions, response options and any additional background information are provided in the relevant section of the report.

- Assessment of issues affecting property and district.
- Self-assessment of knowledge for different topics.
- Awareness of on-property salinity and soil acidity.
- Views about roles and responsibilities for salinity management.
- Views about the importance of factors affecting decision making about new enterprises.
- Attitudes towards conservation.
- Response to stronger cost sharing for revegetation and protecting remnant vegetation.
- Involvement in planning related to family succession, property and business.
- Long-term plans for the property.
- Adoption of recommended practices.
- Other property data, including:
  Property size, number of paddocks, broad enterprise mix, remnant bush, area under specific enterprises (now and in 5 years).
- Background socio-economic data, including:
  Age, gender, education, occupation, on and off-property hours worked (respondent and partner), on and off-property income (respondent and partner), Landcare membership, funding through government programs, time lived in district, level of equity in property.

4.4 Current recommended practices (CRP)

It must be remembered that the 2001 Ovens landholder survey was not intended to contribute to the monitoring of the achievement of the NECMA Regional Catchment Strategy (RCS) targets. The main purpose of collecting survey data was to explore the impact of factors expected to explain variance in the adoption of current recommended practices (CRP). Hence there was no requirement to be comprehensive in the coverage of CRP.

Nevertheless, much energy was expended in identifying and operationalising (establishing the format of statements to be asked in the survey) the CRP to be included in the survey. This process took into account the:

- key NRM issues identified by the RCS;
- targets identified in the more recent salinity (NESWG; DNRE; NECMA 2000) and water quality (NECMA; OBWQWG 2000) strategies;
- views of our industry partners;
- practicalities of a mail survey; and
- the results of pre-testing the survey with peers, agency partners and landholders.

CRP included in the survey were:

1. Area of farm forestry and other tree planting on the property.
2. Number of trees and shrubs planted over the past 3 years.
3. Area limed to control soil acidity at January 2001 and over the past 3 years.
4. Area of native bush or waterway fenced to manage stock access at January 2001 and over the past 3 years.
5. Area sown to introduced perennial pastures, including lucerne at January 2001 and over the past 3 years.
6. Number of paddocks where plants or plant matter covered 70 per cent of the ground this summer.
7. Number of paddocks where there is a record of soil test results.
8. Number of paddocks where stock is usually watered from a trough or tank.
9. Area cropped using conservation tillage practices such as direct drilling and stubble retention.
10. Estimated cost of work to control weeds and rabbits last year (your time at $20 per hour).

Property size can be a major influence on the capacity of property owners to adopt CRP (Curtis *et al.* 2001a). In this study analyses were conducted using both the total area under each CRP and the proportion of the total property under each CRP.

4.5 The mail survey process

A total of 8,658 rural properties were identified in the Ovens Catchment from local government rural property owner lists. Staff from the Indigo, Wangaratta and Alpine Shires provided access to their local government rural property lists. All property listings over 10 hectares were entered into a spreadsheet and a random sample of 500 properties was generated for the Ovens Catchment.

Prior to undertaking the mail out the research team did not have the capacity to locate each property owner on a base map of the catchment. Without this information it was not possible to ensure that there were statistically useful numbers in each of the 11 LMU identified. In an attempt to overcome this problem we increased the sample size from a proposed 500 to 1,000 properties (11.55 per cent of all rural properties). As it turned out, three LMU (the original LMU 6, 8 & 13 in Figure 1) had less than one per cent of all properties and the random sample included very small numbers of properties in these LMU (<11 in each LMU). As explained earlier, DNRE and CMA staff amalgamated some of the LMU covering very small geographic areas and small numbers of rural properties [Map 2, Figure 1]. The number of properties surveyed in each of the revised LMU ranged from 18 to 426 [Table 1]. In the case of LMU 6, although only 18 were surveyed, 15 useable responses were received (83 per cent response rate).

The survey design and mail out processes were undertaken using Dillman's (1979) *Total Design Method*. The survey was pre-tested by academic peers, staff from DNRE and the CMA and by landholders from the Ovens during a three-hour workshop. The first mailout of surveys took place on 23 May 2001. A reminder card was sent out one week later, with a second reminder card mailed on June 7, 2001. Ten weeks after the initial survey mailout, another copy of the survey and a brief letter was sent to landholders that had not responded. The second mailout was followed by another reminder card one week later on August 1, 2001.

Surveys were addressed to property owners identified on the local government rural property owner lists. In the majority of cases only a surname and an initial were provided. It was therefore impossible to tell exactly what proportion of the survey sample were women.

An overall response rate of 67 per cent was achieved. Surveys that were returned to sender or sent back due to the landholder no longer residing at the property, were taken off the original sample along with those where the landholder was too old, ill or deceased or the property had been sold. This left a final sample of 854, with 568 completed surveys returned. The response rate varied from 58 per cent in LMU 3 to 83 per cent in LMU 6 [Table 1].

4.6 Data Analysis

Findings in this report have been presented so they can be interpreted without understanding the statistical methods used. However, for those who are interested to know how we approached the task of data analysis, a brief explanation of the statistical methods used is given below.

Statistical analysis included in this report consists of descriptive statistics, Spearman rank order correlations, Gamma correlations, non-parametric chi-square tests, binary logistic regression, alpha estimation, and the independent samples T test. All statistical analyses used the SPSS software package.

Spearman rank order correlations were used to identify hypothesised relationships between variables. For example, higher on property profitability was hypothesised as being linked to larger property sizes. Spearman rank order correlations rank respondents on each variable from highest to lowest and determine the extent that there is a relationship between ranks on the two variables. For cases exploring the relationship between ordinal variables Gamma correlations were used. A negative correlation coefficient or r_s indicates that a higher score on one variable is linked to a lower score on the other. The value of r_s can range from 1 to –1 with higher values (either negative or positive) indicating a stronger relationship.

Kruskal-Wallis chi-square tests were used to determine the presence of significant differences across continuous variables for two or more independent groups. For example the Kruskal-Wallis chi-square was used to determine if there were any significant differences in property size between those adopting a CRP and non-adopters. The value of the chi-square statistic or χ^2 indicates the strength of the difference between groups on a given variable with a higher value indicating a larger difference. However, the χ^2 value does not indicate the direction of the relationship. The Pearson chi-square test was used to determine the presence of differences across ordinal or binomial data for two or more independent groups. For example, the Pearson chi-square test was used to determine if there were significant differences between Landcare members and non-Landcare members on the adoption of CRP.

The paired samples T-Test was used to identify significant differences in the mean score between related variables. For example this test was used to compare the level of concern about salinity at the property and district level. Higher T values indicate a larger difference.

Binomial logistic regression was used to better determine the extent that a number of independent variables or factors identified by correlation or chi-square tests contributed to the presence or absence of a dependent variable, in this instance adoption of CRP. The Wald statistic provides a measure of the effect of each independent variable on the dependent variable, with higher scores indicating a greater effect. The Exp(B) or odds ratio represents the change in the odds of adoption given a unit increase in the independent variable. Odds ratios above one indicate a positive relationship, while scores below one represent a negative relationship or decreased likelihood of adoption.

Principal components factor analysis was used to reduce a large set of overlapping variables to a smaller set of underlying factors. This analysis was used to assess the uni-dimensionality of the NEP. Statistics computed in this procedure include factor loadings, which are the correlation between individual items and the overall factor score.

Cronbach alpha estimates were used to assess the internal consistency of the NEP scale. This test of reliability measures the extent to which a scale has the ability to produce consistent results. De Vaus (1991) suggested that an alpha value above 0.70 indicates that a scale is reliable.

In all analyses the p statistic represents the significance level were a value below 0.05 is considered to be statistically significant. A p value below 0.05 means there is less than a 5% chance that an observed relationship or difference has occurred purely by chance.

Table 1
Survey response rate by LMU
Ovens Catchment, 2001, N=568

LMU	LMU name	Total landholders in LMU	Per cent of people in Ovens in LMU	Number surveyed	Removed from list (deceased, sold, ill, returned)	Surveys assessed	% of useable surveys by LMU	Response rate (%)
1	Riverine plain lower terrace	856	10%	90	6	51	9%	**61%**
2	Riverine plain upper terrace	4,044	47%	426	75	234	41%	**67%**
3	Uplands alluvial terrace	556	6%	75	8	39	7%	**58%**
4	Acid volcanics, Western sedimentary hills and mountains	1,393	16%	175	26	99	17%	**66%**
5	Gneisses and schists, Western granites	1,119	13%	159	25	95	17%	**71%**
6	Carboniferous sediments, Permian tilite	150	2%	18	0	15	3%	**83%**
7	Metamorphic ridges, Sedimentary rises	540	6%	57	6	35	6%	**68%**
Total		8,658		1000	146	568		**67%**

4.7 Limitations of this research

No single instrument is able to collect data on all possible variables and therefore, some variables were not addressed in this research. One example would be that the survey did not include questions that directly assessed the values that landholders attached to natural resources. However, the issues section did enable some indirect assessment of values. Ultimately, professional judgement was used to determine the variables included in the survey. Every research instrument has its strengths and weaknesses. A mail survey allows researchers to collect information across a large number of respondents and at a much lower cost than would be possible with face-to-face interviews. However, the mail survey does not allow for researchers to use follow-up questions to explore respondent's motivations.

In this research it was not possible to collect information across time. This is an important limitation given the results of Barr *et al.* (2000) that identified important temporal trends across the Murray-Darling Basin. The 2001 Ovens survey should be followed by another, say in five years time. It would then be possible to identify trends over time

The high response rate (>60%) and relatively large sample size (1,000) suggests that survey data should be representative of Ovens Catchment landholders.

5.0 FINDINGS BY SURVEY TOPIC

5.1 Awareness of on-property salinity and soil acidity.

5.1.1 Salinity

5.1.1.1 Awareness of salinity

Landholder awareness of salinity was explored in the mail survey. The key question asked respondents to indicate if there were areas on their property where plants showed signs of the effects of saline water. Respondents were then asked to indicate the total area of land affected on their property [Table 2].

Only eleven per cent of respondents indicated that they had areas where plants showed signs of the effects of saline water [Table 2]. For most respondents, the area affected was relatively small (median two hectares) [Table 2]. The total area of affected land was 509 hectares or less than one per cent of the area surveyed [Table 2].

There were significant differences across the LMU with respect to the proportion of landholders reporting areas where plants showed signs of saline water ranging from 18 per cent in LMU 1 to three per cent in LMU 4 ($\chi^2 = 15.994$, df = 6, p = 0.017) [Table 2].

Table 2
Area of property where plants showed effects of salinity
Ovens Catchment 2001, N=550

LMU	n	% 'yes'	>0-<1 Ha	1-5 Ha	6-10 Ha	11-30 Ha	> 30 Ha	Median	Total Ha
1	9	18%	0%	45%	33%	11%	11%	6	93
2	36	16%	11%	77%	6%	0%	6%	2	337
3	3	8%	0%	100%	0%	0%	0%	1	1
4	3	3%	0%	75%	25%	0%	0%	2	16
5	6	7%	0%	100%	0%	0%	0%	1	12
6	1	7%	0%	100%	0%	0%	0%	5	5
7	4	12%	0%	50%	0%	50%	0%	11	45
Total	**62**	**11%**	**6%**	**74%**	**10%**	**5%**	**5%**	**2**	**509**

Analysis of survey data established a significant positive relationship between respondents reporting plants showing signs of salinity and respondents who indicated they had adopted the CRP planted trees for farm forestry, shelter and shade, habitat, erosion control and recharge control (Wald = 7.396, p = 0.007, Exp(B) = 2.281).

Using binary logistic regression, Ovens Catchment landholders who reported saline affected areas were estimated as being 1.7 times more likely to establish perennial pastures (Wald = 4.063, p = 0.044, Exp(B) = 1.695) and 3.3 times more likely to plant trees (Wald = 20.637, p < 0.001, Exp (B) = 3.346) than those who said they had no saline affected ares.
Respondents who reported that there were signs of salinity on their property were significantly more likely to:

- be concerned about salinity affecting the long-term productive capacity of their property (Wald = 47.697, p < 0.001, Exp(B) = 2.912);
- consider the extent a new enterprise required a large investment of additional funds was an important factor affecting decision making (Wald = 7.093, p = 0.008, Exp(B) = 1.676);
- be further advanced in the preparation of a property plan (Wald = 5.649, p = 0.017, Exp(B) = 1.355);
- have owned their property for a longer period (Wald = 7.374, p = 0.007, Exp(B) = 1.029);
- be a Landcare member (Wald = 5.426, p = 0.020, Exp(B) = 2.283); and
- to report an on-property profit last financial year (Wald = 6.501, p = 0.011, Exp(B) = 2.639).

5.1.1.2 Comparing respondent and expert assessments of salinity

It has been assumed that part of the explanation for limited adoption of recommended practices was that landholders were unaware of the extent of dryland salinity. As part of data analysis we compared respondent's perception of salinity with the maps of saline discharge sites developed by DNRE (Allan *et al.* 1997) and the recently updated DNRE map layer (CLPR 2000). To do this, mail survey data were entered into an Arcview Geographic Information System (GIS) that contained layers for LMU and salinity discharge sites. A one kilometre buffer was adopted to provide some margin of error when comparing the location of discharge sites mapped on a 1:25,000 sheet with landholder perceptions of salinity affected sites that could only be mapped as a property location. We then checked to see if those landholders that said they did not have any areas where plants showed the effects salinity were near a discharge site (using a spatial intersection).

Most respondents said they did not have areas on their property where plants showed the effects of salinity [Map 3]. Only ten per cent (N= 488, n= 47) of those reporting no effects of salinity on vegetation were within one kilometre of a discharge site on DNRE maps [Map 4]. In other words, 90 per cent of the respondent landholders that said they had no areas currently affected by salinity were correct according to the expert maps [Map 4]. By comparison, in our recent study in the Goulburn Broken Dryland, five per cent of respondents (N= 456, n= 18) reporting no effects of salinity on vegetation were within one kilometre of a discharge site on DNRE maps (Curtis *et al*. 2000).

There was also the opportunity to examine the efficacy of the expert maps by assessing their capacity to predict areas affected by salinity as identified by landholders. Eleven per cent (N=550, n= 62) said they had areas on their property where plants showed the effects of salinity. The expert maps correctly predicted areas where salinity was affecting vegetation for 39 per cent (n= 24) of the 62 properties where landholders had identified a salinity problem [Map 5]. Assuming that landholders had correctly diagnosed saline affected areas, this research suggests that the expert maps had failed to predict 61 per cent of the areas affected by salinity. It is unlikely that landholders would deliberately overstate the extent of salinity on their property. However, there is a possibility that some landholders have failed to distinguish between waterlogged and saline affected areas. Some landholders reporting salinity were located well away from known discharge sites as identified by DNRE, suggesting there needs to be additional work to identify discharge sites, particularly in the upper catchment. These findings are consistent with those from our recent study in the Goulburn Broken Dryland where the expert maps failed to predict 50 per cent of the discharge sites identified by respondent landholders (Curtis *et al.* 2001c).

We also explored the extent of differences in adoption of CRP between those who were aware that they had saline affected areas and the "unaware" group (expert maps suggested they were wrong in saying they had no saline affected areas) identified earlier. Using logistic regression, Ovens Catchment landholders who reported saline affected areas were estimated to be 3.4 times more likely to plant trees than those who were "unaware" that they had saline affected areas (Wald = 8.811, p = 0.003, Exp (B) = 3.394).

5.1.1.3 Level of concern about salinity

In another section of the survey, respondents were asked to indicate the importance of dryland salinity as a threat to the quality of river water in their district, the long-term productive capacity of land in their district and the long-term productive capacity of their property. Respondents were asked to select one of five response options from 'very important', 'important', 'some importance', 'minimal importance' and 'not important'. This section also asked about a range of other environmental, social and economic issues, providing the opportunity to assess the relative importance of salinity to respondents [Table 3].

Dryland salinity was not rated highly as an important issue affecting the quality of river water (23 per cent rated very important/important) or the long-term productive capacity of respondent's properties (17 per cent) or their district (29 per cent) [Table 3]. As mentioned earlier, respondents who reported areas showing signs of salinity were significantly more likely to be concerned about impacts on the long-term productive capacity of their property [Table 3].

There were significant differences across LMU for the proportion of respondents who rated dryland salinity as an important issue affecting:

- river water quality in the district ($\chi^2 = 52.890$, df = 24, p = 0.006);
- the long-term productive capacity in the district ($\chi^2 = 39.120$, df = 24, p = 0.027); and
- the long-term productive capacity of their property ($\chi^2 = 46.230$, df = 24, p = 0.004).

Concern about river quality was highest in LMU 1 with 36 per cent indicating this was important/very important compared to 13 per cent in LMU 6. Concern about salinity impacts on the long-term productive capacity of the district was highest in LMU 1 and 7 (37 per cent) and lowest in LMU 3 (18 per cent). Concern about the long-term effects of salinity on-property ranged from 20 per cent in LMU 1 and 7 to six per cent in LMU 6 [Table 3].

In the Ovens Catchment, higher concern about the impacts of dryland salinity (as measured by a scale comprising the three items in Table Three) was also linked to significantly higher adoption of trees planted (Wald = 9.585, p = 0.002, Exp(B) = 1.036).

Table 3
Assessment of issues
Ovens Catchment 2001, N=568

Topic	n	Very Important / Important	Some	Not Important / Minimal	Mean scores
Loss of private property rights due to the farm dams policy will undermine landholder contributions to improved resource management in this district. ***	541	68%	16%	16%	3.91
Introduced weeds and pest animals have contributed to the decline of native plants and animals in this district. *	545	56%	25%	20%	3.60
Cut backs by government or large businesses have reduced the services available and employment opportunities for people in this district. ***	541	65%	23%	22%	3.54
The related trends of property subdivision and off-property work are/will make it more difficult to effectively manage land and water degradation in this district. ***	537	52%	26%	23%	3.45
High soil acidity threatens the long-term productive capacity of land in this district. **	538	49%	22%	27%	3.36
Increased production of wine grapes will lead to controls on spraying that will reduce the ability of landholders to control weeds in this district. ***	539	45%	23%	32%	3.24
The cost of managing weeds and pest animals is undermining the profitability of my on-property enterprises. **	539	42%	22%	37%	3.19
Nutrient runoff from farms and towns is a threat to the quality of river water in this district. *	538	36%	21%	44%	2.93
Dryland salinity threatens the long-term productive capacity of land in this district. **	538	29%	20%	50%	2.75
Increasing soil acidity threatens the long-term productive capacity of my property. **	538	35%	18%	46%	2.86
Removal of native vegetation has contributed to the decline of native birds and animals in this district. *	538	30%	24%	47%	2.78
Changes to river banks and stream-side vegetation has reduced the quality of recreational experiences for people in this district. ***	540	24%	22%	54%	2.55
Dryland salinity is a threat to the quality of river water in this district. *	534	23%	16%	61%	2.48
Removal of native vegetation has reduced the attractiveness of this district as a place to live. ***	542	17%	19%	64%	2.30
Removal of native vegetation has contributed to the decline of native birds and animals on my property. *	528	19%	15%	65%	2.29
Dryland salinity threatens the long-term productive capacity of my property. **	535	17%	13%	72%	2.14

~Mean scores where 1=not important through to 5= very important. *Environmental issue, ** Economic issue, *** Social issue. Items in italics were combined to give an overall index regarding concern salinity impacts.

5.1.1.4 Knowledge about salinity

Respondents were also asked to rate their level of knowledge of a number of topics, including the 'Ability of perennial vegetation to prevent water tables rising' and 'How to establish introduced perennial pastures such as phalaris in this district'. For each statement, respondents were asked to select the best response option from amongst 'no knowledge', 'very little knowledge', 'some knowledge but need more information to act', 'sufficient knowledge to take action if required', 'could provide a detailed explanation to others' [Table 4].

A majority of respondents (57 per cent) said they had sufficient knowledge to take action if required to establish introduced perennial grasses. On the other hand, most respondents (53 per cent) said they would need more information before taking action related to the ability of perennial vegetation to prevent water

tables rising [Table 4]. At the same time, respondents were significantly more confident in their knowledge of processes leading to dryland salinity (47 per cent) than about processes leading to soil acidity (28 per cent) ($t = 12.671$, $p < 0.001$) [Table 4].

There were significant differences across LMU for the proportion of respondents indicating they had knowledge to take action if required to establish introduced perennial grasses ranging from 67 per cent in LMU 6 to 41 per cent in LMU 4 ($\chi^2 = 43.746$, $df = 24$, $p = 0.008$).

Having sufficient knowledge to take action if required to establish introduced perennial grasses was significantly and positively related to the adoption of CRP relating to:

- perennial pasture sown (Wald = 36.120, $p < 0.001$, Exp(B) = 1.872); and
- perennial pasture sown in the last 3 years (Wald = 9.686, $p = 0.002$, Exp(B) = 1.428).

While most respondents indicated that they required more information about the ability of perennial vegetation to prevent water tables rising there was a significant positive relationship between higher knowledge and the adoption of CRP related to:

- trees and shrubs planted (Wald = 6.545, $p = 0.011$, Exp(B) = 1.278);
- native bush and waterways fenced to manage stock access in the last 3 years (Wald = 10.713, $p = 0.001$, Exp(B) = 1.437);
- having a record of soil test results in the last 3 years (Wald = 5.353, $p = 0.021$, Exp(B) = 1.345); and
- planted trees for farm forestry, shelter and shade, habitat, erosion control or recharge control (Wald = 12.727, $p < 0.001$, Exp(B) = 1.547).