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FARMER PERCEPTIONS OF WETLANDS AND WETLAND MANAGEMENT ON THE MURRUMBIDGEE RIVER BETWEEN WAGGA WAGGA AND HAY INCLUDING MIRROOL CREEK

By S.M. Whitten and J.W. Bennett

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Abstract

In recent times, wetland management and conservation has been the focus of much discussion in the media and scientific literature. Relatively little of this attention has focused on the trade-offs faced by land managers when deciding on the use of privately owned wetlands. As a result there is little guidance for the design of wetlands policy and incentive structures with respect to private land. In this research report, the results of a survey of wetland managers in the Murrumbidgee catchment from Wagga Wagga to Hay and including Mirrool Creek are reported. The results are briefly compared to an equivalent survey conducted in the Upper South East Region of South Australia.

The results indicate that farmers obtain considerable non-monetary benefits from their wetlands. Their socio-economic characteristics and the type of wetland owned influence the benefits farmers recognise. Some benefits recognised by land managers are common across the areas surveyed. Wetland managers are able to alter the level and type of benefits derived via selection of wetland management practices. Their decisions are influenced by both monetary and non-monetary characteristics of wetland outputs and differ significantly between the two survey areas. Other factors influencing management decisions are wetland type, physical management constraints and socio-economic characteristics of land managers. When making decisions about wetland management, non-monetary benefits from wetlands are traded-off against monetary opportunity costs. Wetland policy needs to take account of the benefits enjoyed and the costs incurred by wetland owners and managers when evaluating potential incentive schemes. Wetland policy should also take account of the relative strengths of constraints such as manager information and financial viability in particular regions.

1 Introduction

Wetland owners and managers face a range of alternatives when deciding how they use their wetland resources. Some wetland uses increase the monetary benefits available while others increase non-monetary benefits. Benefits and costs of alternative wetland uses are not restricted to individual wetland owners and managers. They may spill over to other members of the community. Hence decisions by private owners and managers alter the available benefits and costs of wetlands to society as a whole. A conflict of interest frequently arises when making decisions about wetland use. A potential conflict at the farm management level arises between the desire for monetary and non-monetary benefits from wetlands and the costs of various management options. At the community level, the potential for conflict lies between net benefits to the community and private net benefits. The conflict of interest has increased with increasing wetland scarcity and with growing community awareness of environmental issues.

The focus of recent conflict between community and private benefits has been on the hydrological and environmental functions of wetlands. In particular, the impact of agricultural systems on the supply of nature conservation values provided by wetlands has been examined (see for example Briggs 1997, 1988, Robertson 1997, Brock, Smith and Jarman 1997 or Crome 1988). Hence wetland managers are now better informed about the biological consequences of decisions about how wetland resources are used. Previous analysis of conflicts over wetland management has focused on the trade-offs faced by the community rather than individual wetland owners and managers although Briggs (1997, 1998) notes the importance of wetland owner and manager motivations (see for example Morrison and Bennett 1997, van Vuuren and Roy 1993). Other analysis has focussed on the ways of achieving community goals using, in part, aspects of individual wetland owner's and manager's values (see for example, Young, Gunningham, Elix, Lambert, Howard, Grabosky and McCrone 1996 and Binning and Young 1997).

Despite the increasing attention devoted to wetland management conflicts and trade-offs within agricultural systems there have been few attempts to analyse the monetary and non-monetary trade-offs faced by individual wetland owners and managers when making decisions about wetland uses. Analysis of the wetland owner's and manager's trade-offs gives an improved understanding of the processes that underpin resource use decisions in wetlands. A better understanding of the processes improves the ability to design policies that will improve resource allocation from a societal perspective.

A survey of farmer wetland management attitudes and practices was undertaken to examine the potential conflicts faced by private wetland owners and managers when trading-off monetary and non-monetary benefits and costs of wetlands. The survey population comprises owners or managers of wetlands in agricultural properties in the Murrumbidgee Catchment between Wagga Wagga and Hay and including Mirrool Creek. Large-areas of wetlands are located in the study area, several of which are listed in the Australian Directory of Important Wetlands (Environment Australia 1998). The wetlands are mainly located on privately owned land and are potentially subject to degradation or destruction via cropping, grazing, impacts of irrigated agriculture and to a lesser extent feral animals, weeds and other impacts of agricultural production. The survey complements and builds on an earlier survey of farmers in the Upper South East (USE) of South Australia (SA).[1] The survey forms part of a larger research project examining the private and social values of wetlands.

Within the Murrumbidgee Catchment study area, wetland owners and managers trade-off a range of monetary and non-monetary consumptive values and non-consumptive values generated by their wetlands when making resource management decisions. These trade-offs are analysed in this paper together with a brief analysis of the policy context. In Section 2, a set of hypotheses is developed to identify the monetary and non-monetary benefits and the trade-offs between these made by wetland owners and managers. Survey design, collection and respondent demographics are described in Chapter 3. In Section 4 the results of the survey analysis are presented. The report concludes with a

[1] Reported in Whitten, S.M. and Bennett, J.W. (1998) Farmer perceptions of wetlands and wetland management in the Upper South East of South Australia, Private and Social Values of Wetlands Research Report No.2, The University of New South Wales.

brief assessment of the implications of the results for future policy generation and a summary of the main conclusions.

2 Hypotheses

The aim, in this report, is to identify the nature of the benefits and costs facing wetland owners and managers and examine the trade-offs they face when making decisions about wetland use. Wetlands can be expected to provide both benefits and costs to wetland owners and managers. The benefits and costs to wetland owners define the nature of the values received by wetland owners and managers. However, a complete array of potential net benefits may not be available to a wetland owner simultaneously. The particular array of benefits available normally depends on the characteristics of the wetland and the management strategies employed. That is, wetland management strategies alter the type of benefits available from wetlands. Hence wetland owners trade-off the benefits available under alternative management strategies when making decisions about wetland use. The hypotheses developed in this section, and tested subsequently in this report, are constructed to afford a structure for the analysis of:

- The range of benefits and costs associated with wetlands;
- The use of alternative management practices; and,
- The trade-offs faced by wetland owners and managers when deciding which strategies to employ.

Wetland values, or the benefits and costs of wetlands, can be divided between use, indirect-use and non-use values (see for example Wills 1997). Use and indirect use values can be further divided into consumption and non-consumption values.[2] Wetland benefits include monetary benefits from grazing or eco-tourism as well as non-monetary benefits from recreation or their scenic beauty. Likewise wetland costs include additional monetary costs associated with feral animals or water management, non-monetary costs associated with odours and opportunity costs due to foregone wetland uses. It is expected a full array of potential wetland uses, and hence values, are available to Murrumbidgee Catchment wetland owners. Wetland uses are summarised in hypotheses 1 to 4.

Hypothesis 1: Wetland owners receive monetary use benefits from their wetlands.

Hypothesis 2: Wetland owners receive non-monetary use benefits from their wetlands.

Hypothesis 3: Wetlands impose monetary costs upon wetland owners and managers.

Hypothesis 4: Wetlands impose non-monetary costs upon wetland owners and managers.

The costs and benefits involved in hypotheses 1 to 4 are all direct use values provided by wetlands. The level of each use is defined by a particular description (for example how often the wetland is

[2] The different types of values are defined as follows:
Direct-use values 'are based on the conscious use of environmental resources in production and/or consumption' of goods and services (Wills 1997, p. 147). Examples of direct-use wetland values in the USE are grazing, tourism, recreation and research.
Indirect-use values 'are based on the contribution of natural resources to human life support' (Wills 1997, p. 147). Examples of indirect-use wetland values in the USE are carbon fixation and nutrient removal and storage. The distinction between direct use and indirect-use is the ability of respondents to directly benefit. For example, use of wetlands for water extraction directly relates to water provision for stock or other purposes. Indirect-use values are less defined because either the benefit is diluted with an unclear distribution (eg. the pest control benefits of birds) or the nature of the benefit received may be unclear (eg. regional tourism benefits).
Non-use values 'involve no tangible current interaction between the environmental asset and those who benefit (value) it' (Wills 1997, p. 147). Examples of non-use wetland values in the USE are bio-diversity and the knowledge they continue to exist.
Consumptive values reduce the conservation value of wetlands in some way. Such uses normally require transformation of the wetland either directly, for example by clearing and draining, or indirectly, for example via over use by recreation.
Non-consumptive values are uses that derive values without reducing the conservation values of wetlands. Examples include scenic values, bio-diversity values and research.

grazed, degree of feral animal problem). Other benefits are more difficult to define, in particular some non-consumptive values (such as scenic value, flora and fauna conservation), indirect-use values and non-use values. Hypothesis 5 involves additional non-consumptive use values and indirect use values. The potential values have both direct and indirect implications for agricultural production.

Hypothesis 5: Wetland owners receive a range of values including non-consumptive and indirect-use benefits from their wetlands.

The array of potential monetary and non-monetary benefits and costs facing all wetland owners and managers has been assumed constant over variable wetland conditions up until this point. A number of external influences change the actual and potential uses of wetlands. Hydrology, geology and climate can interact to produce differing wetland types and hence contrasting potential uses and values. While climatic influences across the study area are reasonably constant, hydrology varies greatly resulting in a number of different wetland types. For example, red gum wetlands require regular flooding and possess a relatively open understorey while lignum wetlands are flooded infrequently and are densely vegetated. Therefore wetland type can influence the benefits and costs of wetlands and hence impacts on wetland owners' and managers' trade-offs. Hypothesis 6 frames an analysis of differences in uses between wetland types.

Hypothesis 6: Wetland type influences wetland values.

Other socio-economic factors such as level of education and income can also influence wetland values. Education can alter the perception of benefits obtained or available from wetlands, both in their current state and under alternative management regimes. Differing levels of income may lead to changing demands for uses available from wetlands. Economic factors can also constrain wetland management options and hence potential uses. Differences in use across variations in respondent's socio-economic factors are considered in Hypothesis 7.

Hypothesis 7: Socio-economic factors influence wetland values.

When making decisions about how to manage their wetlands, owners and managers may be expected to compare the benefits and costs they receive currently (and into the future) and the benefits and costs that they would receive if they changed their management strategy. The net benefits and costs of alternative strategies can be divided between monetary and non-monetary benefits. The monetary returns from wetlands may need to be maintained if farm viability is to be maintained. Hence, one goal of management may be the maintenance of (at least a minimum level of) monetary returns. However, private wetland owners also receive non-monetary benefits directly from wetlands through, for example, recreation, hunting and appreciation of wetland beauty. Hence, another goal of management may be maintenance of non-monetary benefits (or at least a minimum level thereof). Hypotheses 8 and 9 allow an analysis of how the monetary and non-monetary impacts of management changes influence decisions to adopt.

Hypothesis 8: Monetary impacts of management practices influence adoption.

Hypothesis 9: Non-monetary impacts influence adoption of wetland management practices.

Maximisation of monetary benefits may reduce or remove some non-monetary benefits and vice-versa. For example increasing grazing or timber sales from wetlands may reduce surrounding vegetation decreasing the quality of the scenic vista. Hence wetland owners and managers in agricultural systems are subject to two potentially conflicting goals: maximising monetary net benefits and maximising non-monetary net benefits from wetlands. That is, owners and managers trade-off monetary and non-monetary benefits and costs of alternative management strategies when making decisions about wetland resource use. Hypothesis 10 frames an analysis of managers trading off between monetary and non-monetary benefits.

Hypothesis 10: Wetland owners and managers trade-off monetary and non-monetary benefits and costs when making decisions about wetlands.

Hypotheses 6 and 7 afford the analysis of how physical and socio-economic factors affect wetland uses directly. Likewise these factors may affect the adoption of wetland management practices directly or

indirectly. Some wetland practices are more appropriate or yield greater returns when applied to certain wetland types. Education may influence the perceived costs and benefits of applying certain wetland management practices. Economic constraints may restrict adoption, particularly of relatively expensive strategies. In addition, physical management constraints also influence management decisions. Physical constraints likely to vary within the region mainly relate to wetland size, total property productivity, cropping and irrigation opportunities. These issues are considered under hypothesis 11.

Hypothesis 11: Adoption of wetland management practices is influenced by physical and socio-economic factors.

As noted previously, the survey of farmers in the Murrumbidgee Catchment complements an earlier survey of the USE of SA. Wetland uses within agricultural environments are likely to differ between these regions. However there may be some overriding influences on decisions about wetland management. Similarly there may be some similarities in attitudes towards a range of wetland values. Hypotheses 13, 14 and 15 facilitate some comparisons between the two surveys' results. These hypotheses are tested in Appendix 2.

Hypothesis 13: Common attitudes towards wetland values exist for both USE and Murrumbidgee wetlands.

Hypothesis 14: Common socio-economic factors influence wetland values in the USE and Murrumbidgee.

Hypothesis 15: Common influences on the adoption of wetland management practices exist for the USE and Murrumbidgee.

3 Survey methodology

To test these hypotheses data were collected by means of a survey of wetland owners and managers in the study area. The questionnaire used in the survey was composed of five parts. In each part, the questions were designed to gather:

1. Descriptive information relating to the size and production of land managed, size and production of wetlands and wetland type.
2. Descriptive information relating to wetland benefits and costs, a qualitative assessment of the net monetary and non-monetary cost of wetlands and attitudes towards wetlands.
3. Types of wetland management strategies implemented, the type of benefits expected, additional management costs imposed by such strategies and incentives received.
4. Reasons for not adopting wetland management strategies, perceptions regarding the impact of wetland management strategies on farm viability and desired incentives to increase adoption of wetland management strategies.
5. Demographic information about respondents.

The population surveyed consisted of owners or managers of properties containing wetlands, located on the Murrumbidgee Floodplain between Wagga Wagga and Hay and including the Murrumbidgee Irrigation Area, Mirrool Creek and other properties with wetlands in this area. An initial list of names of owners or managers of properties with a wetland present were obtained from a database of wetland owners and managers maintained by the Department of Land and Water Conservation Wetland Officer based at Leeton. This list was supplemented with information provided by Murrumbidgee Irrigation and a Mirrool Creek property owner. 1:25,000 and 1:50,000 topographic maps of the study area were then used to identify wetlands and likely wetland areas where the property owner or manager had not been identified. Department of Land and Water Conservation or Murrumbidgee Irrigation officers or other neighbouring wetland owners then identified the majority of these property owners. A list of one hundred and twenty seven contacts was compiled for the survey. It is estimated that contacts were not obtained for approximately twenty-five properties with wetlands in the study area based on the topographic maps. Hence the total population of owners and managers of properties with a wetland present in the study area is estimated to be approximately 150.

Respondents were telephoned to inform them about the survey, mailed a survey and a reminder call was given to non-respondents approximately three weeks after the mail-out date. One hundred and twenty seven surveys were mailed out but only 120 could be contacted by telephone. Six respondents indicated that no wetlands were present on their properties and 74 useable surveys were returned. This represents a response rate of 64 percent (of those contacted by telephone with a wetland present).

Table 1 summarises respondent demographics. Seventy one percent of respondents lived on the property surveyed. The average time respondents had lived on the property is 24 years. Ninety six percent of respondents had some farming and grazing experience with an average of 30 years.

TABLE 1: SUMMARY OF RESPONDENT DEMOGRAPHICS

	Yes	No
Live full time of property	77%	23%
Own the property	85%	15%
Actively involved in decision making about property	99%	1%
Fully employed as a farmer	75%	25%

	Male	Female	Together
Survey answered by	86%	8%	6%

Age range of respondents		Education	Highest level
20-29	6%	Intermediate or leaving certificate	85%
30-39	14%	Higher School Certificate or Leaving Certificate	56%
40-49	33%	TAFE or other short course (1-2 weeks)	53%
50-59	31%	Other tertiary qualifications	25%
60+	17%	Tertiary qualifications in agriculture	26%

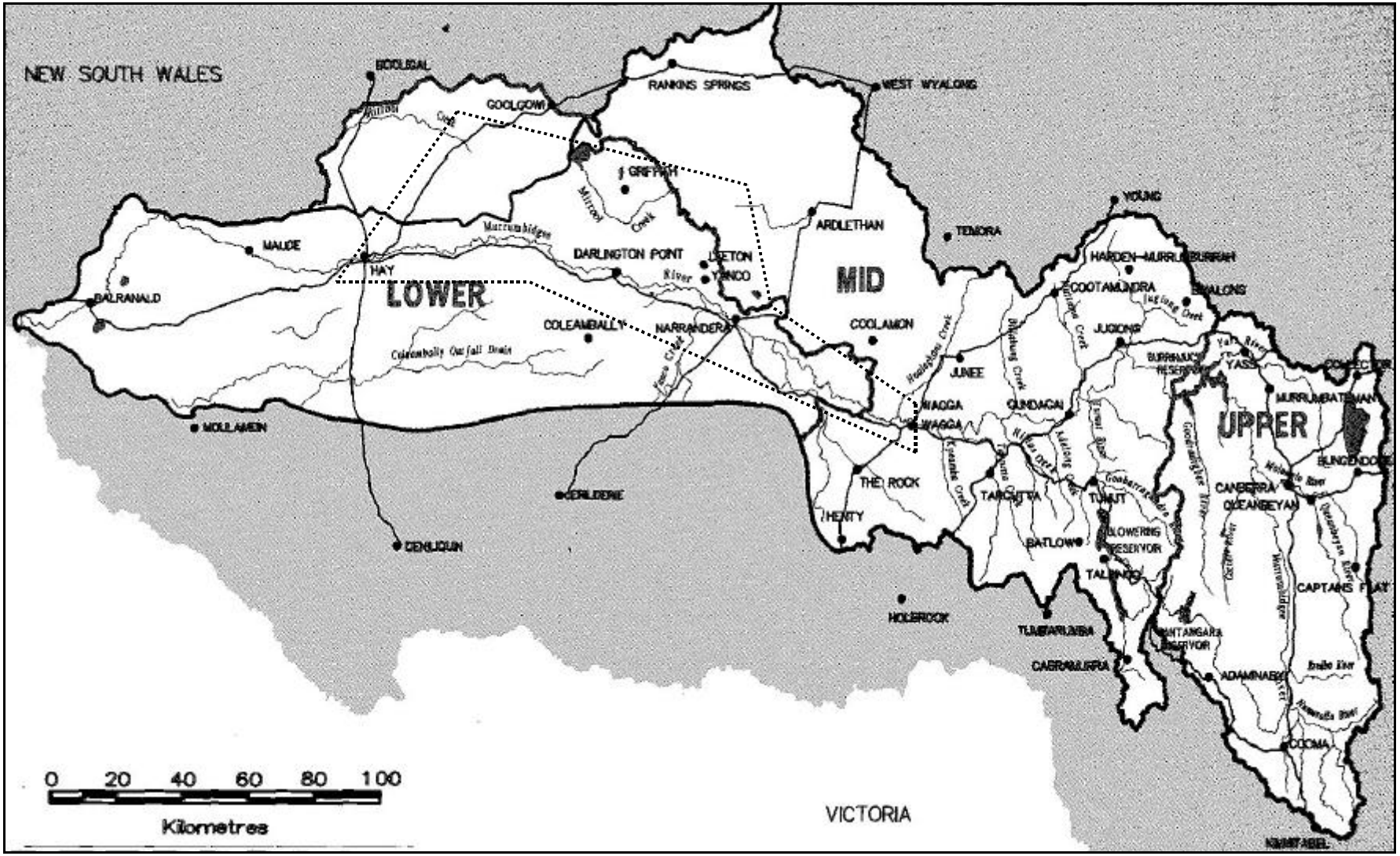
Total wetland area surveyed was 19,893 hectares while the total area of respondents' properties was 201,626 hectares. Wetland areas and types are reported in Table 2. Wetlands comprised a median of seven percent of property area (mean 12 percent). Median property size was 714 hectares (mean 2725 hectares). As an indication of the total agricultural productivity of the properties surveyed, a total of 350,470 dse were grazed on respondents' properties and 33,537 hectares were cropped (of which 16,735 hectares are irrigated). The total area of properties containing wetlands in the study area is unknown.

TABLE 2: RESPONDENT WETLAND TYPES AND AREAS

Wetland type	Wetland Area (ha)*	Percentage of total wetland area	Proportion of respondents
1. Red gum wetlands/billabongs	7520	37.8%	51.4%
2. Shallow open water	4458	22.4%	38.9%
3. Vegetated shallow water	2650	13.3%	25.0%
4. Lignum	2061	10.4%	18.1%
5. Black box depressions	1187	6.0%	30.6%
6. Lignum and black box depressions	329	1.7%	8.3%
7. Cane grass depressions	1383	7.0%	11.1%
8. Bull oak depressions	30	0.2%	2.8%
9. Other	275	1.4%	16.7%
Total	19,893		

* The true total wetland area is somewhat larger as some respondents did not report wetland type.

MAP 1: LOCATION OF SURVEY POPULATION WITHIN MURRUMBIDGEE AND MIRROOL CREEK CATCHMENTS



Area surveyed

4 Results

4.1 Wetland benefits

The range of wetland uses reported by respondents and displayed in Table 3 describes the benefits wetland owners and managers are currently receiving from the direct use of their wetlands. The range of wetland uses gives rise to monetary and non-monetary benefits. Monetary benefits include direct income from grazing, timber sales, reduced stock water supply costs and costs avoided via drainage. Non-monetary benefits include recreation and hunting. The individual uses reported may be in conflict. For example, draining irrigation water into wetlands may conflict with (reduce) recreational benefits (for example if vegetation is killed by waterlogging) but this does not necessarily mean all recreational benefits are destroyed. Hence wetland owners using wetlands for drainage may be trading-off recreational benefits against benefits to production (among other trade-offs).

The proportion of respondents undertaking various activities in their USE wetlands is shown in Table 3. In summary the results indicate:

- 93 percent of respondents graze their wetlands;
- 47 percent of respondents extract timber for use as firewood or farm timber;
- 83 percent alter the hydrological regime either via water extraction from or drainage to their wetlands; and,
- 86 percent of respondents indicate undertaking some form recreational use such as hunting or use for pleasure.

One respondent indicated undertaking no activities in their wetlands.

The results reported in Table 3 clearly indicate the range of benefits wetland owners and managers derive from their wetlands. In total, 99 percent of respondents derive some direct monetary benefit from their wetlands via grazing, sales or use of timber and/or irrigation water supply or storage. Hence Hypothesis 1 can be accepted: *wetland owners receive monetary benefits from their wetlands.*

TABLE 3: WETLAND USES (BENEFITS): PERCENTAGE OF RESPONDENTS USING THE WETLANDS FOR…

		Grazing	
Sheep only		25%	
Cattle only		27%	
Total grazing		93%	
	None	**Family and Friends**	**Commercial**
Hunting pests	39%	60%	1%
Other hunting	67%	29%	4%
Fishing	65%	34%	1%
Pleasure/recreation	27%	72%	1%
Total	14%	86%	
	Sawn or farm timber	**Firewood**	**No harvesting**
Farm use	10%	35%	55%
Commercial	13%	6%	81%
Total timber use	47%		53%
	Whole farm	**Part of farm**	**None**
Water supply	14%	49%	37%
Drainage	47%		53%
Irrigation supply/store	23%		77%
Total	83%		17%

Respondents also nominated the attributes of their wetlands they liked and disliked most. Non-consumptive, non-monetary attributes such as bird-life, aesthetics, flora and fauna were the most

common likes (56 percent of responses). This confirms the result that some form of non-monetary use such as recreation (hunting, fishing or other) in wetlands is undertaken by 86 percent of respondents. Production impacts such as stock feed, shelter or water is the next largest group of likes (24 percent of responses). Hence, Hypothesis 2 is accepted: *wetland owners receive non-monetary benefits from their wetlands*.

4.2 Wetland costs

The existence of wetlands can also impose additional costs upon land managers. Costs may result from undertaking agricultural production in wetlands (such as loss of bogged stock) or from additional costs imposed on non-wetland production by wetlands (such as a source of weeds or access problems). Other wetland costs may not relate to agricultural production (such as odours). A further class of costs relates to the opportunities foregone once a particular management strategy is chosen. This group of costs is called opportunity costs. Respondents' perceptions of a suite of potential costs are reported in Table 4.

In summary, 99 percent of respondents indicated at least one negative impact of their wetlands on agricultural production capacity. Some of the costs indicated were monetary (such as loss of bogged stock and additional weed control requirements) and others non-monetary (such as management complications due to access or bad odours). Respondents were also asked what they disliked most about having wetlands on their properties. The most common dislikes were unproductive land (13 percent), associated management costs (18 percent), flood damage (10 percent) and pests and weeds (18 percent). Interestingly, the majority of dislikes indicated by respondents are related to undertaking agricultural production in wetland areas whereas the majority of likes were related to non-production aspects of wetlands. While it is difficult to distinguish clearly between monetary and non-monetary production costs, most respondents face both as indicated by the risk of disease from mosquitos (86 percent reported at least some risk). Hence Hypotheses 3 and 4 can be accepted: *wetlands impose monetary costs upon wetland owners and managers*, and, *wetlands impose non-monetary costs upon wetland owners and managers*.

TABLE 4: WETLAND COSTS

	Severe or moderate	Minor	No problem
Weed source	37%	40%	23%
Harbours feral animals	28%	43%	29%
Harbours nuisance animals	30%	23%	47%
Waterlogging	8%	52%	39%
Contribute to soil salinity	6%	21%	73%
Access problems	7%	39%	54%
Crop/pasture damage by birds	4%	16%	80%
Loss of bogged Stock	3%	17%	80%
Total production impacts	99%		1%
Noxious odours	14%	20%	66%
Risk of disease from mosquitos	47%	39%	14%

4.3 Other wetland values

Some wetland impacts are not uniformly regarded as costs or benefits. For example, birds attracted to wetlands may be regarded as assisting in pest control by some wetland owners and managers, but as pasture damaging by others (it may also depend on the bird species attracted). Table 5 reports respondent attitudes towards three such potential impacts. In summary, the majority of owners and managers regard wetlands as having no impact on the likelihood of government intervention on their properties or attracting pasture damaging birds (76 percent and 75 percent respectively) and 61 percent regard their wetlands as a fire break.

TABLE 5: OTHER WETLAND IMPACTS

	Negative impact	No impact	Positive impact
Pasture damaging birds	21%	75%	4%
Government intervention	21%	76%	3%
Natural fire break	19%	20%	61%

All the benefits and costs considered up to this point are direct effects on wetland owners and managers. Wetland owners and managers are also hypothesised to receive a range of less easily defined, less direct benefits and costs. The level of these benefits or costs is also more difficult to measure. Respondents were asked about:

- non-consumptive wetland uses such as providing a *place of beauty*;
- production related uses such as *helping control flooding*;
- indirect uses such as *reducing water pollution* and *conservation of native flora and fauna*; and,
- possible wetland uses such as hunting and fishing.

Respondents' attitudes towards each use of their wetlands were recorded using a five point Likert scale plus an additional 'not applicable' category. Responses are reported in Table 6. Non-monetary, non-consumptive uses of wetlands such as *place of beauty*, *conserve flora and fauna* and *beautify the rural landscape* scored very highly. Respondent attitudes were divided over some indirect benefits of wetlands such as *reducing water pollution* and *helping to control floods* (as shown by the similar proportions of respondents that agree compared to those who disagree or returned not applicable). Other indirect values such as *attracting bird life that reduce pests*[3], *trap and recycle nutrients* and *recharge groundwater* had higher proportions of agreement rates. Respondents were also divided over values such as providing native fish habitat, recreational hunting and fishing and tourism and recreation opportunities. From the results in Table 6 it is clear that Hypothesis 5 can be accepted: *wetland owners receive a range of values including non-consumptive and indirect-use benefits from their wetlands*.

TABLE 6: FARMER ATTITUDES TOWARDS THEIR WETLANDS

Statement	Agree	Don't know	Disagree	Not applicable
Non-consumptive use values:				
My wetlands provide a place of beauty	77%	5%	11%	7%
My wetlands beautify the rural landscape	82%	1%	12%	5%
My wetlands conserve native plants and animals	74%	5%	12%	8%
My wetlands help native animal movements	77%	5%	7%	11%
My wetlands provide native fish habitat	39%	1%	19%	40%
Indirect use values:				
My wetlands increase bird life which in turn decreases pests	67%	15%	15%	3%
My wetlands reduce water pollution	31%	33%	9%	27%
My wetlands help to trap and recycle nutrients	51%	28%	14%	7%
My wetlands recharge groundwater	49%	32%	18%	1%
Production impacts of wetlands:				
My wetlands help prevent salting	25%	36%	29%	10%
My wetlands help control floods	51%	8%	23%	18%
My wetlands help prevent soil erosion	27%	24%	13%	36%
Direct use values:				
My wetlands provide for recreational fishing	36%	0%	24%	40%
My wetlands provide for recreational hunting	32%	7%	28%	33%
My wetlands provide tourism/recreation opportunities	42%	7%	15%	36%

4.4 Impact of wetland type on values

Hypotheses One to Five address the alternative benefits and costs that wetland owners and managers are able to extract from their wetlands. As noted above, there are a number of different wetland types present in the Murrumbidgee study area. Each of these differing wetland types is likely to provide an alternative mix of values. For example, red-gum wetlands may provide farm timber. Black box and

[3] This result is in conflict with the proportion of respondents that expected birds to reduce pasture damage. This may be due to respondents recognising that waterbirds provide pest control but not expecting significant benefits. Alternatively farmers may judge that pest control occurs on other farms away from the wetlands.

lignum wetlands may provide some stock shelter for lambing, calving or off-shears. Billabong wetlands may provide a relatively permanent stock water supply.

Four wetland types are owned or managed by greater than 20% of respondents, namely red gum, open water, vegetated water and black box. These types comprise 80% of reported wetland area. Hence tests of significance of wetland type are only reported for these four types. The attributes of the wetland types differ significantly and they cover the majority of wetland areas present within the region. Red gum wetlands range from open woodlands of large trees with a grassy understorey to forests with relatively little understorey. Vegetated wetlands are distinguished from open water wetlands by the presence of emergent vegetation. Open water wetlands may dry back to either a saline pan or grow some fodder. Black box wetlands are open woodlands or scattered trees with a grassy or herbaceous understorey. All wetland types are seasonal (except some deep billabong red gum wetlands) and may not fill every year. Red gum wetlands are filled more regularly than black box while the hydrology of open and vegetated water wetlands across the study area varies significantly.

The results of Chi-square tests of association between the wetland benefits and costs reported in Tables 3, 4 and 5 and wetland type are reported in Table 7. The results indicate that fishing, farm and commercial timber harvesting and recreation are positively associated with red gum wetlands while nuisance animals, risk of disease, bogged stock and government intervention are negatively associated. These associations are expected as red gum woodlands commonly contain billabongs that may have populations of yabbies and/or fish present and large trees that are more useful for both fire-wood and farm timber and provide shade for recreation.

TABLE 7: RELATIONSHIP BETWEEN WETLAND TYPE AND VALUES

Type of wetland	**Red gum**	**Open water**	**Vegetated water**	**Black box**
Wetland benefits:		Chi-square test p-values		
Hunting feral species	0.686	0.055 (+)	0.194	0.039 (+)
Other hunting	0.725	0.036 (+)	0.245	0.026 (+)
Fishing	0.000 (+)	0.667	0.558	0.280
Farm timber harvesting	0.000 (+)	0.565	0.866	0.407
Commercial timber harvesting	0.026 (+)	0.825	0.170	0.204
Pleasure/recreation	0.002 (+)	0.413	0.330	0.341
Stock water supply	0.928	0.143	0.817	0.867
Sink/storage for irrigation drainage	0.143	0.096 (+)	0.295	0.007 (+)
Irrigation water supply/storage	0.710	0.775	0.484	0.483
Wetland costs:				
Harbours feral animals	0.437	0.330	0.295	0.225
Source of weeds	0.527	0.223	0.490	0.281
Harbours nuisance animals	0.044 (+)	0.843	0.525	0.284
Creates noxious odours	1.000	0.367	0.500	0.227
Risk of disease from mosquitos	0.040 (+)	0.920	0.733	0.456
Limits access to parts of property	1.000	0.746	0.038 (+)	0.464
Contributes to waterlogged / impoverished soil	0.173	0.131	0.956	0.361
Contributes to dryland salinity	0.003 (-)	0.010 (+)	0.944	0.177
Loss of bogged stock	0.003 (+)	0.750	0.706	0.162
Other wetland uses:				
Attract pasture damaging birds	0.634	0.173	0.246	0.561
Attracts government intervention	0.093 (+)	0.126	0.067 (+)	0.984
Is a natural fire break	0.312	0.534	0.920	0.243

Note: P-values less than 0.1 are regarded as significant.
+ Indicates wetland type significantly increases probability.
- Indicates wetland type significantly decreases probability.
~ Indicates wetland type significantly increases probability of maximum use *and* minimum use.

Open water wetlands are positively associated with hunting and irrigation drainage. These associations conform to expectations. Open water allows hunters to see the target species relatively easily. One third of the open water wetlands are located in irrigation areas and are the lowest points in the landscape hence often used for drainage and hence may become salinised. While vegetated water is associated with access and government intervention there are no strong theoretical reason for these associations. Black box wetlands are positively associated with hunting and irrigation drainage. These associations are expected as over half are located in irrigation areas and they form a refuge for native and feral animals in a largely agricultural landscape.

The results of the Chi-square tests clearly indicate particular benefits and costs are more strongly associated with particular wetland types. For example open water and black box wetlands are associated with hunting while red gum wetlands are associated with timber and recreation. Hence Hypothesis 6 can be accepted: *wetland type influences wetland values*.

4.5 Other impacts on wetland values

The values available to wetland owners and managers may also result from socio-economic factors. Education can inform wetland owners and managers about current and potential use values, or impacts that are not immediately obvious. For example, education could increase knowledge about native birds and animals living in and around, or making use of wetlands or the impact of wetland birds on pest species in pasture. Economic factors can alter the relative value of wetland uses. For example, individuals with high debt loadings or low cash incomes may place a greater priority on monetary returns from wetlands and may correspondingly value monetary returns more highly. Age may also be an important socio-economic factor.

Regressing level of value against socio-economic explanatory variables tests the impact of socio-economic influences on wetland values. This approach involves estimating a regression of wetland value against age, education and a proxy for income. While levels of wetland value are not directly collected within the survey, a proxy may be developed via estimation of attitudinal factor scores from the data reported in Table 6. Estimation of factor scores is reported in Appendix 1. Higher wetland attitudinal factor scores indicate stronger agreement with wetland use and vice-versa.

Explanatory variables used in trial regressions were age, level of education, full time farmer, live on the property (and how long), wetland type and whether the respondent owned the property. Income variables were not collected within the survey due to difficulties in defining and collecting a consistent income measure from farmers. Variables that were not significant at the ten percent level for any regression were removed prior to final estimation. These variables were full time farmer, vegetated water wetlands, education apart from agriculture and other tertiary education, live on the property and whether the respondent owned the property.

The regression results provide additional evidence that some wetland types are a significant influence on use values obtained by wetland owners and managers. Several socio-economic indicators are significant; age, tertiary education and years lived on the property for non-consumption, other tertiary education for recreation and years on the property for indirect use values. The signs of the significant variables are as expected for significant variables. Hence Hypothesis 7 is accepted: s*ocio-economic factors influence wetland values.* However, it should be noted that the r-squared for indirect use is very low indicating low explanatory power.

TABLE 8: SOCIO-ECONOMIC AND PHYSICAL INFLUENCES ON VALUES REGRESSION RESULTS

Model summary data	**Number of observations**	**R^2 Adjusted**	**Std error of estimate**
Non-consumptive use values	66	0.335	0.739
Recreation values	66	0.340	0.691
Indirect use values	66	0.078	0.761

Model specifications	**Constant**	**Red gum wetlands**	**Black box wetlands**	**Open water wetlands**	**Tertiary Agriculture**	**Other tertiary**	**Years lived on property**	**Aged less than 50**
Non-consumptive use values	1.212*	-0.616*	-0.257	-0.135	-0.649*	-0.519	-0.014*	-0.324
	(0.000)	(0.002)	(0.209)	(0.522)	(0.009)	(0.063)	(0.008)	(0.098)
Recreation values	1.033*	-0.850*	-0.495*	0.372	0.132	-0.481	0.003	-0.237
	(0.000)	(0.000)	(0.011)	(0.063)	(0.557)	(0.065)	(0.575)	(0.193)
Indirect use values	0.538*	-0.326	-0.014	-0.135	-0.352	-0.440	0.010	0.135
	(0.033)	(0.104)	(0.947)	(0.533)	(0.157)	(0.124)	(0.071)	(0.498)

Note: Numbers in brackets are t-test significance levels, * indicates significance at the five-percent level.

4.6 Adoption of wetland management practices

The benefits and costs wetland owners and managers experience can be altered via adoption of alternative management strategies. At one extreme wetland management may be directed towards maintaining benefits or values associated with a natural ecosystem (ie, designed to minimise the impact of consumptive uses on the wetland). Alternatively, at the opposite extreme, management actions may be directed at completely altering the available benefits to a set bearing little resemblance to the initial suite (for example, by clearing and draining wetlands). Wetland management options are constrained by physical limits (for example, saline wetlands will not grow pasture), financial constraints or by outside agencies such as government (for example, native vegetation in wetlands falls under the *Native Vegetation Conservation Act 1997* in NSW).

In Table 9, respondents' adoptions of a range of potential management practices are reported. Sixty three percent of respondents reported implementing at least one management practice. Since many respondents own more than one wetland, management strategies vary from wetland to wetland, especially if different wetland types are owned. For example 97 percent of respondents reported grazing at least some of their wetlands but 18 percent exclude stock from at least one wetland. The most common management practices are *maintenance of native vegetation and revegetation*, *managing grazing access to wetlands*, *control of weeds*, *control of feral animals* and *fire prevention* in wetlands (all undertaken by 50 percent or more of those wetland owners and managers undertaking at least one management practice).

Adoption of management practices reflects benefits from wetlands (maintenance of vegetation) and costs of wetlands (71 percent reported some degree of feral animal problem and 77 percent a weed problem). The least commonly adopted strategies were *seeking and implementing management advice*, *preparing a list of plants and animals seen in or near the wetland* and *restoration of wetland basins or habitat*. The low adoption rate indicates that these practices are perceived as unimportant, relative to the costs, within the Murrumbidgee study area.

TABLE 9: ADOPTION OF WETLAND MANAGEMENT PRACTICES

Wetland management practice	Respondents adopting
Control of weeds in wetland	44%
Manage grazing access to wetland	41%
Maintaining native vegetation around wetland	36%
Fire prevention/control around wetland	34%
Control of feral animals in wetland	33%
Revegetation using local native species	32%
Maintaining a natural wetting / drying regime	25%
Developing a farm management plan incorporating wetland conservation initiatives	23%
Maintaining tree/vegetation filtering strip around wetland	22%
Measures to encourage native wildlife	21%
Restrict grazing to maintain wildlife habitat	19%
Exclude stock from wetland	18%
Directing saline drainage away from wetland	15%
Seeking and implementing management advice on specific problems	10%
Restoring wetland basins/habitat	10%
Preparing a list of plants and animals observed in/near the wetland	8%
Total respondents undertaking wetland management practices	63%

4.7 Perceived costs and benefits of wetland management actions

Management decisions are likely to be based on the type and quantity of expected benefits and costs arising from alternative management strategies. Testing Hypotheses 1 to 4 indicates that wetland benefits and costs are both monetary and non-monetary in nature. The monetary returns from wetland management can either be immediate (via increased cash returns from livestock) or in the future (via

increased property values, future timber sales or avoided land degradation) and can result from highly consumptive uses (timber extraction) or less consumptive uses (eco-tourism).

The types of financial returns expected by respondents are reported in Table 10. In summary, 45 percent of respondents, or almost three-quarters of those adopting management practices (74 percent), expected financial benefits from wetland management activities. Of those respondents expecting financial benefits, most (80 percent) expected increased market value of their properties and approximately one third expected improved pasture growth or health and hence livestock growth and reduced costs from soil salinity. No respondents expected financial benefits from hunting or fishing and less than ten percent expected financial benefits from tourism, eco-tourism or new industries.

From Table 10 it can be concluded that a significant proportion of wetland owners and managers expect financial benefit (either now or in the future) from undertaking wetland management practices. It cannot be directly concluded whether financial benefits directly influence the decision to adopt or whether they are peripheral. That is, to draw a conclusion regarding Hypothesis 9, more information is required regarding farmer decision making.

TABLE 10: EXPECTED BENEFITS OF WETLAND MANAGEMENT ACTIONS

Type of financial benefit expected	**Of all surveys**	**Of respondents undertaking management**	**Of respondents Expecting benefits**
Increased market value of your property	37%	59%	79%
Increased growth rate of cattle/sheep	18%	28%	38%
Increased pasture/crop yield in paddocks adjacent to wetland	15%	24%	32%
Reduced costs from soil salinity	15%	24%	32%
Reduction in the need for insect pest control	12%	20%	27%
Increase in quality/health of pastures/crops	12%	20%	27%
Sales of firewood / farm timber	11%	17%	24%
Reduced need for general pest control	10%	15%	21%
Sales of sawn timber	10%	15%	21%
Guided / unguided eco-tourism	4%	7%	9%
Farm stay tourism	3%	4%	6%
Development of new industries using wetland outputs	3%	4%	6%
Income from hunting / hunters	0%	0%	0%
Income from fishing / fishers	0%	0%	0%
Respondents expecting financial benefits	45%	74%	100%

In Table 11 respondent perceptions regarding the impact of wetland management strategies on farm viability are reported. *Excluding stock from wetlands* is expected to reduce farm viability by 64 percent of respondents while nearly a quarter of respondents believe *facilities to water stock away from wetlands* would result in reduced farm viability. Nearly two thirds of respondents indicated *control of weeds in wetlands* would increase farm viability. Other strategies perceived to lead to increased farm viability included *developing a farm management plan* (37 percent), *control of feral animals* (52 percent), *revegetation* (43 percent) and *drains to manage salinity or saline drainage* (approximately 35 percent). Adoption of management strategies perceived to increase farm viability is generally relatively high with the exception of developing a farm management plan (at only 23 percent).

If monetary impacts influence adoption it would be expected that a perception of farm viability effect and the rate of adoption would be related. That is, respondents who expect an increase in farm viability would adopt the wetland management practice while those who expect a decrease would not adopt. If the practice is not perceived to affect farm viability, adoption may proceed due to non-monetary benefits. Hence for monetary impact to influence adoption strongly, it is expected that both a high proportion of respondents adopting would expect an increase in farm viability and vice-versa.

TABLE 11: MONETARY IMPACT OF ALTERNATIVE WETLAND MANAGEMENT PRACTICES

Management Practice	**Effect on farm viability**		
	Decrease	No change	Increase
Exclude stock from wetland	64%	34%	1%
Manage grazing access to wetland	18%	62%	20%
Facilities to water stock away from wetland	22%	62%	17%
Maintain native vegetation around wetland	14%	57%	29%
Maintaining a tree/vegetation filtering strip around wetland area	15%	52%	32%
Directing saline drainage away from wetland	7%	57%	37%
Facility to restore natural wetting and drying of wetland	12%	54%	33%
Control of feral animals in wetland	2%	46%	52%
Control of weeds in wetland	10%	27%	63%
Revegetation using local native species	5%	52%	43%
Fire prevention/control around wetland	2%	63%	35%
Seeking and implementing management advice on specific problems such as dying trees	3%	66%	31%
Preparing a list of plants and animals observed in/near wetland	2%	92%	6%
Developing a farm management plan which incorporates wetland conservation initiatives	6%	56%	37%
Restoring wetland basins/habitats	11%	61%	27%
Measures to encourage native wildlife	17%	54%	29%
Drains to manage dryland salinity impacts on wetlands	4%	61%	35%

Table 12 shows the proportion of respondents expecting an increase in viability and adopting particular management actions including a chi-square test of association. Significant associations (at the five percent level) were found for *maintaining a filter strip* (p=0.001), *control of feral animals* (p=0.001), *revegetation* (p=0.004) and *fire prevention and/or control* (p=0.000). Neither *maintaining native vegetation* nor *developing a farm management plan* were significant despite a large proportion of those respondents adopting the practice perceiving an increase in profitability. This is due to a relatively low actual adoption rate as a proportion of those expecting an increase.

TABLE 12: FARM VIABILITY INCREASES AND MANAGEMENT PRACTICE ADOPTION

Management Practice	**Percentage expecting an increase in farm viability**	**Proportion (of total) who adopted strategy**	**Chi Square test of association** (p-value)
Exclude stock from wetland	1%	35%	0.561
Manage grazing access to wetland	20%	35%	0.677
Maintain native vegetation around wetland	29%	55%	0.469
Maintaining a tree/vegetation filtering strip around wetland area	32%	29%	0.001
Directing saline drainage away from wetland	37%	16%	0.103
Facility to restore natural wetting and drying of wetland	33%	29%	0.162
Control of feral animals in wetland	52%	47%	0.001
Control of weeds in wetland	63%	47%	0.076
Revegetation using local native species	43%	33%	0.004
Fire prevention/control around wetland	35%	14%	0.000
Seeking and implementing management advice on specific problems such as dying trees	31%	18%	0.042
Preparing a list of plants and animals observed in/near wetland	6%	29%	0.414
Developing a farm management plan which incorporates wetland conservation initiatives	37%	27%	0.998
Restoring wetland basins/habitats	27%	22%	0.070
Measures to encourage native wildlife	29%	35%	0.278

It is clear that *monetary impacts of management practices do influence adoption* and Hypothesis 8 can be accepted. It is equally clear that monetary impacts of adoption do not always influence adoption. For example some strategies commonly adopted include *managing grazing access to wetlands*, *maintaining a natural wetting and drying regime*, and *measures to encourage native wildlife*. As considered under Hypotheses 2 and 4 above, wetland owners and managers receive non-monetary costs and benefits from their wetlands. When owners and managers make management decisions about wetlands they also take into account the non-monetary benefits they obtain. As indicated in section 4.5 (and estimated in Appendix 1) some wetland values can be grouped into non-consumptive, production impacts and indirect impacts. The non-consumptive and indirect impacts are non-monetary and the monetary impact of production impacts is indirect. The 'wetland attitudinal factor scores' are used to represent respondent values for these groups.[4] The association between the wetland attitudinal factor scores and adoption of management practices is examined. Since the factor scores represent the degree and type of non-monetary values received from wetlands the association between non-monetary benefits and wetland management decisions can be tested.

TABLE 13: RELATIONSHIP BETWEEN WETLAND ATTITUDES AND MANAGEMENT PRACTICES

Wetland management practice	**ANOVA F-statistics**		
	Non-con	**Recreation**	**ID-use**
Exclude stock from wetland	1.321	0.287	3.014*
Manage grazing access to wetland	4.810**	0.920	5.249**
Restrict grazing to maintain wildlife habitat	4.222**	0.705	8.973**
Maintaining native vegetation around wetland	5.178**	0.543	2.805*
Maintaining tree/vegetation filtering strip around wetland	1.176	0.033	0.354
Directing saline drainage away from wetland	6.685**	2.452	6.098**
Maintaining a natural wetting / drying regime	4.769**	1.216	2.132
Control of feral animals in wetland	6.454**	0.015	1.766
Control of weeds in wetland	4.503**	1.562	2.786
Revegetation using local native species	2.909*	0.714	0.384
Fire prevention/control around wetland	3.259*	1.877	4.463**
Seeking and implementing management advice on specific problems	0.875	0.951	0.063
Preparing a list of plants and animals observed in/near the wetland	4.359**	0.700	6.249**
Developing a farm management plan incorporating wetland conservation initiatives	3.099*	3.378*	1.250
Restoring wetland basins/habitat	4.913**	6.733**	4.262**
Measures to encourage native wildlife	2.967*	3.858*	6.902**
Total respondents undertaking wetland management practices	11.718**	5.018**	10.911**

** Indicates significance at the 5% level.
* Indicates significance at the 10% level.
Note: Since Table 13 incorporates the results of a previous test (factor analyses) the possibility of a type I error is increased (that is the possibility of rejecting a hypothesis when it is in fact true is increased).

Table 13 reports the results of ANOVAs between the wetland attitudinal factor scores and wetland management practices. All wetland attitudinal factor scores show a significant difference in means for adoption versus non-adoption of any wetland management practice. That is, respondents who expressed positive non-consumptive and/or recreation and/or indirect use attitudes are more likely to adopt wetland management practices. Significant relationships exist between several variables and non-consumptive values (that are also non-monetary) and indirect use values (*manage grazing, maintain native vegetation, maintain natural wetting and drying* and to a lesser extent *measures to encourage native wildlife*). That

[4] The 'wetland attitudinal factor scores' are derived from a factor analysis of the farmer attitudes towards wetlands reported in Table 6. A factor analysis is a statistical method used to reduce the number of variables to the core factors. The core factors will explain most of the variance in the original, larger set of variables. Three factors were extracted from the attitudinal responses and were named according to the type of values they represented. Hence the 13 variables reported in Table 6 are reduced to 3 composite factor score variables. More information on the factor analysis is provided in Appendix 1.

is, respondents with positive attitudes towards the non-consumptive and/or indirect use factors are more likely to adopt these management practices. However recreation is only associated with three wetland management practices (*farm management plan*, *restoring wetland basins and habitat* and *measures to encourage native wildlife*). Hence Hypothesis 10 can also be accepted: *non-monetary impacts influence adoption of wetland management practices*.

The results in Table 13 also indicate that management practices influenced by monetary benefits (Hypothesis 8) may also be influenced by non-monetary impacts. For example, *fire prevention* is related to two (Non-con and ID-use) and *control of feral animals* and *revegetation* to one (Non-con use). Hence non-monetary values are influential in the adoption of some management practices in conjunction with monetary benefits. The joint significance of monetary and non-monetary influences on the adoption of wetland management practices indicates the duality of goals (monetary and non-monetary benefits) faced by farmers when undertaking wetland management decisions.

4.8 Overall impact of wetlands

Wetland owners and managers receive both monetary and non-monetary benefits from their wetlands. Wetland owners and managers implement management strategies to enhance, alter or maintain wetland benefits. The choice of management strategies is influenced by both the expected monetary and non-monetary benefits. Hence wetland owners undertake a variety of management strategies, both influenced by, and receiving monetary and non-monetary benefits. That is, a mixture of monetary and non-monetary goals can influence wetland managers when managing their wetlands. Maximisation of either goal (monetary returns or non-monetary benefits) may require compromising the other goal to some extent. For example, maximising grazing returns is likely to reduce the recreational benefits from wetland areas while maximising timber returns will reduce native flora and fauna and may impair the scenic beauty.

Wetland owners and managers express the conflict between their dual management goals in a variety of ways. For example wetland owners and managers were asked what impact it would have on the long-term profitability of their farm if their wetlands were drained and cleared and/or developed for irrigation:

Profits increase more than 10%	27%
Profits increase 5%	27%
No change in profits	29%
Profits decrease 5%	7%
Profits decrease more than 10%	10%

In total, 54 percent of respondents indicated that if their wetlands were drained, farm profitability (monetary benefits) would increase.

Wetland owners and managers were also asked about the impact on their property values. A smaller proportion (26 percent) of respondents indicated that wetlands have a negative impact:[5]

Property values reduced more than 10%	11%
Property values reduced 5%	15%
No effect on property values	38%
Property values increased	36%

Hence respondents indicated that the presence of wetlands reduced the monetary benefits they were able to obtain from their properties.

When asked to consider all the monetary and non-monetary benefits and costs of their wetlands:

54% Regarded their wetlands as an asset;
31% Regarded their wetlands as neither; and,
15% Regarded their wetlands as a liability.

[5] It may be contended that farmers have an inaccurate perception of wetlands on property values. Irrespective of the accuracy or otherwise of their opinion their perception influences their opinion about whether wetlands are an asset or a liability and their decisions about wetland management.

Some respondents continue to regard their wetlands positively despite recognising that they are foregoing monetary benefits. That is, they are receiving non-monetary benefits in excess of their monetary opportunity costs. These trade-offs are defined in Table 14. Five percent of respondents regard their wetlands as an asset despite recognising they reduce property values. Fourteen percent indicated wetlands reduce property values (reducing monetary returns) but regard their wetlands as neither an asset nor a liability, hence the wetland benefits are sufficient to cancel out. Another six percent regard their wetlands as an asset but suggest no change in property values indicating that the wetland benefits exceed the monetary costs. Hence a total of 25 percent of respondents indicated that their wetland benefits exceed the monetary cost.

Similarly, Table 14 also shows 51 percent of respondents attested that the monetary and non-monetary benefits arising from wetlands exceed the monetary benefits available if their wetlands were drained. Both results are significant at the one- percent level using Chi-square tests of association. Hence we can accept Hypothesis 10: *wetland managers trade-off monetary and non-monetary benefits and costs when making decisions about wetlands.*

TABLE 14: WETLAND TRADE-OFFS

	Net impact of wetlands		
Wetland impact on property values	Asset	Neither	Liability
Reduces property value	5%	6%	15%
No effect on property value	14%	23%	2%
Increases property value	33%	3%	-
Pearson Chi-square 47.766 (p=0.000)			
If wetlands drained:	Asset	Neither	Liability
Profits would increase	25%	16%	13%
No Change	10%	15%	3%
Profits would decrease	16%	2%	-
Pearson Chi-Square 13.245 (p=0.010)			

A cross tabulation between non-monetary uses and net benefits of wetlands, reported in Table 15, reveals additional information about the trade-offs made by wetland owners and managers. Respondents who enjoyed non-monetary benefits from their wetlands indicated their wetlands were an asset or neither an asset nor a liability. For these respondents at least some of the benefits of wetlands relate to non-monetary uses (except one respondent who reported commercial eco-tourism).

TABLE 15: NON-MONETARY USES AND NET BENEFITS OF WETLANDS

	Non-monetary use of wetlands	
Net impact of wetlands	Yes	No
Asset	54%	1%
Neither	24%	7%
Liability	8%	6%
Pearson Chi-square 11.476 (p=0.003)		

The trade-off between monetary and non-monetary benefits of wetlands is also important for owners making decisions about wetland management practices. Management practices are directed at maintaining or altering the costs and benefits arising from wetlands. The management practices discussed are directed at maintaining or conserving wetland areas. Hence, it could be expected that wetland owners who regard the net benefits of wetlands as positive will be more likely to make trade-offs in favour of adopting management practices. Table 16 indicates that this is the case for Murrumbidgee wetland owners and managers. Overall 78 percent of respondents who regard their wetlands as an asset undertake management practices while only 36 percent of those regarding their wetlands as a liability undertake such actions. The chi square test is significant at the five-percent level.

TABLE 16: WETLAND MANAGEMENT ACTIONS AND IMPACT OF WETLANDS

	Wetland management actions	
Net impact of wetlands	Yes	No
Asset	78%	22%
Neither	50%	50%
Liability	36%	64%
Pearson Chi-square 8.552 (p=0.014)		

4.9 Socio-economic influences on adoption of wetland management practices

Decisions about wetland management practices are influenced by monetary and non-monetary benefits. Socio-economic factors may influence the costs and benefits of adoption of wetland management practices. Differences in physical constraints such as wetland type and size or total property production

may also reveal important influences on management decisions. For example, different levels of education may alter perceptions regarding the outcome of restoring a wetland basin. Economic influences may also be revealed indirectly. For example, respondents with large farms and/or wetland areas may be more likely to exclude stock from some wetland areas as they form a relatively small part of total farm production. Likewise, respondents with smaller total production may be less likely to restore wetlands due to the relatively greater impact on farm production. Management practices may not be applied to particular wetland types. This may be because they are unsuitable (for example fire prevention or control on shallow open water wetlands). Alternatively it may be because expected benefits differ (for example the results of fencing a small billabong near the house are easy to enjoy while a fencing a large billabong on a distant part of the property may reduce grazing and rarely be visited).

The potential influence of socio-economic and physical factors on the adoption of management practices was assessed using logit regressions. Use of logit regressions facilitates analysis of dichotomous dependent variables relating to adoption of management strategies. The logit regression performance statistics are reported in Table 17 and the logit regression results in Table 18. Due to the large number of management practices and the identical candidates for explanatory variables the analysis was conducted using stepwise methodology (using forward likelihood ratio selection criteria).

The logit model performance statistics indicate a range of goodness of fit from extremely good to very poor. Hensher and Johnson (1981, p.51) state 'values of [McFadden's] ρ^2 between 0.2 and 0.4 are considered extremely good fits'. Eight of the sixteen logit regressions of management practices possess pseudo ρ^2 (McFadden's ρ^2 adjusted for number of explanatory variables) less than 0.2 and only four less than 0.15. Two of the four management practices with ρ^2 less than 0.15 are among the most commonly adopted and hence likely to be adopted at some level by all respondent groups. One management practice is adopted at a very low level (less than 20 percent) potentially providing insufficient information for discrimination. Key management practices such as excluding stock, farm management plan and revegetation possess good to extremely good fits.

TABLE 17: LOGIT MODEL PERFORMANCE STATISTICS

Dependent variable	Number of observations	Model Log Likelihood	McFadden's ρ^2	Pseudo ρ^2	Overall percent correct
Exclude stock from wetland	68	49.804	0.173	0.239	84%
Manage grazing access to wetland	68	79.266	0.132	0.165	74%
Restrict grazing to maintain wildlife habitat	68	56.974	0.141	0.187	84%
Maintaining native vegetation around wetland	68	66.880	0.231	0.277	82%
Maintaining tree/vegetation filtering strip around wetland	68	71.761	0.000	0.014	78%
Directing saline drainage away from wetland	68	42.469	0.294	0.361	87%
Maintaining a natural wetting / drying regime	68	73.248	0.042	0.068	75%
Control of feral animals in wetland	68	57.338	0.330	0.389	81%
Control of weeds in wetland	68	84.467	0.090	0.122	60%
Revegetation using local native species	68	69.370	0.190	0.225	78%
Fire prevention/control around wetland	68	70.065	0.195	0.252	71%
Seeking and implementing management advice	68	19.577	0.566	0.699	93%
Preparing a list of plants and animals observed in/near the wetland	68	17.055	0.523	0.635	97%
Developing a farm management plan incorporating wetland conservation initiatives	68	59.603	0.138	0.167	79%
Restoring wetland basins/habitat	68	40.587	0.000	0.025	91%
Measures to encourage native wildlife	68	60.454	0.125	0.155	79%
All wetland management practices	68	80.792	0.107	0.140	75%
Expecting benefits from management	68	88.467	0.052	0.073	68%

Explanatory variables used in the regressions were: length of time the respondent had lived on the property; wetland type; large wetland areas; wetlands are a small proportion of total property; tertiary education in agriculture; whether the respondent lived on the property; and, whether any irrigation was undertaken on the property. All variables except length of time on the property were dummy variables. Explanatory variables generally have the expected sign and are significant at the 10 percent level. As expected wetland type influences decisions about many management practices. Many management practices are influenced by the length of time the respondent has lived on the property. This is likely to be partly due to time to recognise and correct problems and due to relatively few new management strategies being undertaken each year. Wetland size influences decisions to exclude stock, manage vegetation, control weeds, compile a list of plants and animals and encourage native wildlife (large wetlands increase probability). A relatively small wetland area as a proportion of total property size reduces the probability of managing grazing, or undertaking fire prevention but increases the probability of feral animal control. Tertiary qualifications in agriculture increase the probability of excluding stock, restricting grazing, managing drainage and developing a list of plants and animals. Respondents who live on the property are less likely to undertake fire prevention measures and to seek management advice. The presence of irrigation indicates respondents are more likely to seek advice about wetland management but less likely to undertake stock management, this is partly because a significant proportion of irrigation farms do not graze livestock. The regression results indicate Hypothesis 11 can be accepted: *adoption of wetland management practices is influenced by physical and socio-economic factors.*

TABLE 18: PARAMETER ESTIMATES FOR REGRESSIONS OF MANAGEMENT PRACTICE

Dependent variable	Constant	Black box wetlands	Red gum wetlands	Large wetland area	Small prop'n wetlands	Irrigation present	Years on property	Live on property	Tertiary education in Ag
Exclude stock from wetland	-1.855			1.661		-1.572			1.336
	(0.003)			(0.038)		(0.046)			(0.074)
Manage grazing access to wetland	-1.091				-1.658		0.043		
	(0.013)				(0.030)		(0.006)		
Restrict grazing to maintain wildlife habitat	-2.031					-1.354	0.050		
	(0.002)					(0.062)	(0.009)		
Maintaining native vegetation around wetland	-2.731			2.067			0.046		1.321
	(0.000)			(0.003)			(0.008)		(0.055)
Maintaining tree/vegetation filtering strip	-1.262								
	(0.000)								
Directing saline drainage away from wetland	-5.064	2.383					0.067		1.443
	(0.000)	(0.007)					(0.008)		(0.109)
Maintaining a natural wetting / drying regime	-1.466	1.061							
	(0.000)	(0.071)							
Control of feral animals in wetland	-3.667	1.356	1.525		1.962		0.079		
	(0.000)	(0.066)	(0.041)		(0.043)		(0.000)		
Control of weeds in wetland	-1.236			1.223			0.027		
	(0.007)			(0.044)			(0.057)		
Revegetation using local native species	-2.387	1.882					0.040		
	(0.000)	(0.003)					(0.013)		
Fire prevention/control around wetland	-1.215		1.556		-2.863		0.052	-1.521	
	(0.046)		(0.026)		(0.017)		(0.014)	(0.090)	
Seeking and implementing management advice	-14.423	2.795		2.014		11.192	0.141	-7.219	
	(0.830)	(0.065)		(0.120)		(0.867)	(0.030)	(0.019)	
Preparing a list of plants and animals observed in/near the wetland	-10.182			4.283			0.108		4.421
	(0.016)			(0.030)			(0.064)		(0.063)
Developing a farm management plan incorporating wetland conservation initiatives	-2.152	1.951							
	(0.000)	(0.003)							
Restoring wetland basins/habitat	-2.335								
	(0.000)								
Measures to encourage native wildlife	-2.010			1.897					
	(0.000)			(0.004)					
Note dependent changes from 0-1 to 1=yes, no=2 hence wetland type is negative									
All wetland management practices	0.537			-1.387			-0.035		
	(0.221)			(0.054)			(0.031)		
Expecting benefits from wetland management practices (as for 8a Y/N)	-0.038				1.424				
	(0.891)				(0.042)				

Notes: Figures in brackets are probabilities for significance levels.
Irrigation present indicates that at least some irrigation is undertaken on the property (but not necessarily in or near wetlands).
Small prop'n wetlands is a dummy covering the quartile of respondents whose wetlands form the smallest proportion of total property area.

5 Policy considerations

5.1 Wetland management incentives

Wetland owners and managers in the case study area receive both monetary and non-monetary benefits from their wetlands. Both monetary and non-monetary impacts of management practices influence adoption. Hence effective incentives can target monetary benefits, non-monetary benefits or a combination. A number of wetland management related incentives are currently available to Murrumbidgee wetland owners and managers. Incentives are provided at three levels; Commonwealth (for example the Landcare income tax rebate); State (for example free management advice); and, local/regional (for example Greening Australia fencing subsidies). Three main incentive questions require answering before any policy conclusions can be drawn, namely:

1. What incentives are currently available?
2. Are these incentives used?
3. Do these incentives influence management decisions?

Incentives available to Murrumbidgee wetland owners and managers are reported in Table 19. Not all the incentives contained in Table 19 are directed specifically at wetland management. For example Landcare income tax rebates are directed towards prevention of land degradation and historically only applied to agricultural land (not land managed for conservation). Landcare incentives aim to decrease the monetary costs to owners and managers and reduce the costs imposed on the community.

Many of the incentives require particular wetland management strategies. For example, local council rate rebates and materials from Greening Australia are often only available for non-agricultural land or to remove land from agricultural production (fence it off). Likewise government grants are often dependent on adoption of specific management strategies. The objective of these incentives is to increase community benefits by reducing the opportunity costs faced by wetland owners and managers (they also increase the non-monetary benefits). Grants of materials by Greening Australia and other organisations are directly targeted towards achieving changed management practices. The aim is to reduce owner and manager monetary costs (hence increasing net benefits) while increasing community benefits.

In Table 19 the proportion of respondents claiming each incentive and the proportion of respondents undertaking wetland management practices claiming each incentive is shown. Twenty-one percent of all respondents and a third of those respondents undertaking wetland management receive at least one incentive. The most commonly claimed incentives are materials/costs from NSW State Government agencies and Greening Australia and free management advice from NSW Stage Government agencies. Only one respondent claimed a rate rebate, two claimed a Landcare tax deduction and no respondents claimed a tax rebate for wetland conservation related initiatives. Landholders must either earn less than a certain amount but still have sufficient cash flow to pay for Landcare works to qualify for a rebate or, alternatively, they must earn beyond the taxable threshold to claim a deduction. Hence the proportion of landholders qualifying for tax rebates or deductions may be small.[6]

It is difficult to assess the impact of incentives on adoption of alternative management strategies. Many of the potential incentives preclude or specify certain management practices. Chi-square tests of association were conducted between adoption of management strategies and whether incentives were claimed. Results indicate an association (at the ten percent level) between incentives and all management strategies except wetland vegetation and hydrological management (except drainage). Importantly the association between excluding stock and incentives is negative indicating that most respondents who receive incentives do not exclude stock. However, the testing process is confounded, as only respondents undertaking management practices are able to receive incentives. Hence the association between particular incentives and adoption of particular practices cannot be tested from these survey data.

[6] In some parts of the region farm profits are low but this is not universal. For example, large volume irrigators received an average farm profit of $135,025 in 1996-97 (ABARE data reported in Whitten and Bennett 1999).

TABLE 19: INCENTIVES RECEIVED FOR WETLAND MANAGEMENT

Type of incentive	**Proportion of all respondents**	**Proportion of wetland managers**
Landcare income tax rebate	0%	0%
Landcare income tax deduction	3%	4%
Local council rate rebate	1%	2%
Materials/costs from Greening Australia	7%	11%
Materials/Costs from NSW State Government agencies	8%	13%
Free management advice from government agencies	6%	9%
Grants from Natural Heritage Trust	4%	7%
Other government grants/ financial assistance	0%	0%
Local Landcare group demonstration project	1%	2%
Total receiving incentives for wetland management	21%	33%

An alternative approach is to examine the constraints to further adoption of wetland management practices, shown in Table 20. If it is assumed that all management strategies increase the benefits to the community from wetlands, the most important constraint to greater adoption of wetland practices appears to be a lack of interest. Lack of interest or non-applicability accounts for between a half and three quarters of respondents who do not adopt specific management practices. The second most important constraint is the financial cost or impact on profits of adopting particular management strategies.

TABLE 20: CONSTRAINTS TO ADOPTION OF WETLAND MANAGEMENT PRACTICES

Management practice	**AA**	**C or P**	**TC**	**KC**	**NA**
Exclude stock from wetland	18%	32%	4%	0%	42%
Manage grazing access to wetland	41%	23%	3%	4%	32%
Facilities to water stock away from wetland	n.a.	19%	0%	0%	41%
Maintain native vegetation around wetland	36%	11%	7%	3%	26%
Maintaining a tree/vegetation filtering strip around wetland area	22%	15%	5%	3%	27%
Directing saline drainage away from wetland	15%	8%	3%	3%	46%
Facility to restore natural wetting and drying of wetland	25%	11%	0%	5%	31%
Control of feral animals in wetland	33%	1%	3%	1%	39%
Control of weeds in wetland	44%	15%	0%	1%	30%
Revegetation using local native species	32%	12%	5%	4%	30%
Fire prevention/control around wetland	34%	3%	3%	1%	32%
Management advice on specific problems such as dying trees	10%	5%	3%	9%	45%
Preparing a list of plants and animals observed in/near wetland	8%	3%	18%	9%	41%
Farm management plan incorporating wetland conservation initiatives	23%	12%	9%	9%	30%
Restoring wetland basins/habitats	10%	15%	5%	8%	34%
Measures to encourage native wildlife	21%	8%	5%	12%	31%

Key:
AA = Already adopted
C or P = Cost or profit constraint
TC = Time constraint
KC = Knowledge constraint
NA = Will not adopt as either not interested or not applicable

Note: Percentages may sum to more or less than 100 as in some cases respondents did not give a reason or gave a reason why the practice had not been adopted in all wetlands.

Additional information regarding adoption constraints is given by respondent requests for particular incentives. Incentive types nominated included:

- Financial assistance (26%);
- Free or low cost water for wetlands (26%);

- Fencing assistance (18%);
- Wetland or property management training/assistance (23%);
- Assistance with feral/nuisance animal control (13%); and ,
- Revegetation Assistance (13%).

Respondents were also asked what additional information they required to manage their wetlands. Information types requested included:

- General wetland management information (32%);
- How to manage wetlands within farming systems (22%);
- Provision of technical advice on request (22%); and,
- Wetland water management (17%).

The majority of incentives requested were either monetary or cost reducing. Hence wetland owners and managers seek to increase the monetary benefits of wetlands as compensation for increasing non-monetary benefits to the community and themselves. The relatively high proportion of respondents desiring fencing and/or revegetation assistance indicates either a lack of knowledge regarding the available incentives from Greening Australia and other groups or difficulty in qualifying.

5.2 Conclusions

Wetland managers in the Murrumbidgee study area receive both monetary and non-monetary benefits and costs from their wetlands. The monetary and non-monetary benefits and costs of their wetlands are traded-off when making decisions about wetland management practices. Wetland type and socio-economic influences affect the benefits and costs of wetlands. Likewise wetland type influences management decisions together with physical operating constraints and socio-economic factors. Alternative wetland management practices change the type and level of benefits and costs available to wetland owners and managers and to the wider community. Hence the community may seek to influence management decisions about wetland use in order to improve the level of overall societal net benefit.

Wetland policies influence the decisions made by wetland owners and managers by altering the trade-offs they face (ie, by changing monetary or non-monetary costs or benefits of particular wetland management practices). For example, fencing subsidies reduce the cost of management practices such as excluding stock, managing grazing access, maintaining fringe vegetation and revegetation. Alternatively, development of tourist infrastructure and promotion of wetland-based farm stays or eco-tourism ventures increases the potential monetary benefits available from wetlands. Hence such policies increase the monetary benefits of management practices such as measures to encourage native wildlife and maintaining a natural wetting and drying regime.

Incentives should be based on achieving resource allocations desired by the community. That is, incentives need to be linked directly, or indirectly, to management practices promoting resource allocations preferred by society. Appropriate incentives differ depending on the aim and scope of wetland policy. For example fencing subsidies are relatively direct, immediate and can be targeted (to specific wetland types, landholder classes etc.). Hence such policies are more suited to a local or regional level. Other policies such as promotion of tourism or development of infrastructure are indirect, longer term and difficult to target towards small regions or groups. Consequently these types of policies are more suited to State or Commonwealth levels. Likewise some socio-economic influences are more generic, for example, education, age and length of time on property and so relate to policies that are also generic, such as support for agricultural education services and rural adjustment programs.

Finally, effective incentives need to be focused on key constraints to the adoption of targeted management practices. Wetland policy that ignores the physical, financial or other constraints experienced by wetland owners and managers will not succeed. In the Murrumbidgee, while wetland owners and managers clearly receive non-monetary wetland benefits, their financial constraints and/or knowledge about wetlands may well be limited. For example, there is little point in providing tourist infrastructure when financial constraints prevent conversion from conventional agriculture to farm-stay or eco-tourism. Similarly there is little point in providing incentives to reduce the impacts of stock grazing on wetlands if there is no perception of a problem and hence no perceived benefits. However, ignoring the substantial non-monetary benefits received by landholders, and traded-off when making decisions about wetland management, could result in the provision of unnecessary incentives and hence a

waste of scarce resources. A key outcome of the survey is to emphasise the importance of finding ways in which wetland owners and managers can convert non-monetary wetland benefits into monetary benefits.

The results of the survey comprise a major input into the bio-economic modelling for the Murrumbidgee study area. Survey results will be used to help define the monetary and non-monetary benefits that wetland owners and managers derive from wetlands. The bio-economic modelling will develop the structure within which the total benefits and costs to society of changing wetland management can be identified and estimated. Constructing a bio-economic model for the Murrumbidgee Case Study area forms the next phase of the 'Private and Social Values of Wetlands' research project.

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Appendix 1 Estimation of wetland attitudinal factor scores

Economists often divide the values arising from eco-system attributes between use, indirect use and non-use values (see for example Wills 1997 and previous Research Reports in this series). When considering the values of wetlands in alternative uses, economists normally combine values into these groups. It is useful to ask whether wetland owners and managers think in terms of similar groupings for ease of communication and to facilitate additional analysis of wetland trade-offs. In order to identify any groupings a factor analysis can be conducted. Factor analysis considers the interrelationships among the variables and explains them in terms of underlying dimensions which are called factors (Hair, Anderson, Tatham and Black 1992). The aim of the factor analysis is to reduce the number of variables reported in Table 6 to groupings based on the type of value represented.

Economic theory suggests that some groupings are likely to be strongly correlated. That is, individuals with high non-consumptive use values may also have high non-use and indirect use values. Direct, consumptive use values (such as grazing) will not necessarily be highly correlated with indirect or non-use values. Hence the factor analysis was conducted using the more flexible methodology offered by 'principle axis factoring' and an oblique rotation (Oblimin with Kaiser Normalisation) (Hair et.al. 1992, Norusis 1993 and Kim and Mueller 1978a,b). The reliability of the factors was assessed using Cronbach's alpha. Alpha values in excess of 0.7 are regarded as a guideline for acceptable reliability (Hair et.al. 1992).

Table A1.1 reports the factor pattern matrix from the factor analysis undertaken on the variables reported in Table 6. The factor pattern matrix contains the rotated factor loadings of each variable. Factor loadings refer to the regression weights of variables to the common factors. Only loadings with an absolute value greater than 0.3 are reported. Variables with high loadings on more than one factor were removed during the analytical process in order to produce 'clean' factors. 'Clean' factors have only one underlying dimension. Cronbach's alphas for each factor are also reported in Table A1.1.

As shown in Table A1.1 three factors have been extracted as opposed to the hypothesised four. The three factors extracted are hypothesised to represent non-consumptive uses of wetlands (Non-con), recreation uses of wetlands (Rec) and indirect uses of wetlands (ID-use). Cronbach's alpha is greater than 0.7 in each case indicating acceptable reliability (Hair et.al. 1992). The fourth hypothesised factor (productivity implications of wetlands) was not extracted – probably due to it being incorporated with indirect use values to some extent. It can be seen that tourism and recreation loads on both the recreation and non-consumptive use factor due to the non-consumptive use values being desirable to stimulate tourism and recreation demand. Other variables removed were native fish habitat, and help prevent soil erosion. These variables exhibited relatively high 'not applicable' and 'disagree' proportions. A high non-applicable and disagree proportion indicates that the value is less likely to be present (or recognised) in Murrumbidgee catchment wetlands and does not contribute to the underlying factors.

The factor scores for each of the factors derived in Table A1.1 are used in some analyses of farmer trade-offs. Factor scores are calculated by multiplying the unrotated factor weights by individual's responses. For each individual, three 'scores' are calculated, one relating to each factor. Hence three new variables (factor scores) are created relating to individuals' composite responses for the three groups of variables. These factor scores are referred to as *wetland attitudinal factor scores*.

TABLE A1.1: PATTERN MATRIX OF ATTITUDINAL QUESTIONS REGARDING WETLANDS.

	Factors		
	Non-con	**Recreation**	**ID-use**
My wetlands provide a place of beauty	0.804		
My wetlands help native animal movements	0.802		
My wetlands beautify the rural landscape	0.752		
My wetlands conserve native plants and animals	0.670		
My wetlands provide for recreational fishing		0.782	
My wetlands provide for recreational hunting		0.576	
My wetlands provide tourism/recreation opportunities	0.496	0.567	
My wetlands increase bird life which in turn decreases pests			0.720
My wetlands help to trap and recycle nutrients			0.558
My wetlands help prevent salting			0.553
My wetlands reduce water pollution			0.507
Eigenvalues	5.277	1.244	1.180
Percent of variance	47.973	11.309	10.727
Cronbach's Alpha	0.899	0.746	0.759

Appendix 2 Comparison of perceptions from the Murrumbidgee (NSW) and USE (SA)

The survey of wetland managers in the Murrumbidgee Catchment study area complements and builds on a survey of wetland managers in the USE of SA (see Whitten and Bennett 1998a,b for details of the USE case study area and survey results). Wetland managers in each study area were asked an almost identical set of questions so facilitating comparison of the results. The conclusions for hypotheses tested in both surveys is identical with the exception of equivalent Hypotheses 7 (Murrumbidgee) and 8 (USE). In the USE, the hypothesis that socio-economic factors influenced wetland values was rejected while it was accepted for the Murrumbidgee study area. As the conclusions drawn from the USE survey are very similar to those drawn from the Murrumbidgee survey it is useful to consider whether the underlying values driving decisions about wetland management are similar in both areas. This process is instructive in terms of assessing the prospects for generalising the results developed in the case studies.

A2.1 Common impacts on wetland values

In both the USE and the Murrumbidgee study areas wetland manager were asked about their attitudes towards a range of uses of their wetlands. Responses were recorded using a five point Likert scale and analysed in Section 4.3. Factor analyses of these results (conducted in Appendix 1) indicated that wetland uses could be grouped according to general ecosystem attributes such as non-consumptive uses and indirect uses. Assuming that the factors driving attitudes towards these uses then similar factors can be estimated from combined USE and Murrumbidgee data. If strong factors can be estimated from combined data the conclusions drawn regarding communication and accounting for wetland trade-offs are strengthened. Common factors are also useful in analysing potential policy impacts (further discussed in Section 5).

In Table A2.1 the pattern matrix resulting from the factor analysis of the combined data sets is reported. The estimation methodology follows that used in Appendix 1 and is not repeated here. As indicated in Appendix 1, theory suggests four potential factors: non-consumptive use; indirect use; productivity impact; and, recreation use. As indicated in Table A2.1 only two factors were extracted, non-consumptive use and a combination of indirect use and productivity impacts. The combination of indirect use and productivity impacts is not surprising given the difficulty in determining whether the benefits of these attributes apply to the property surveyed or outside the property and how direct the benefits might be. No recreation factor was extracted from the pooled results. This was not unexpected as recreational benefits differ significantly between the two regions. In the USE waterfowl hunting is an important recreational use of wetlands however waterfowl hunting is banned with the exception of pest control in NSW. Similarly more than twice as many respondents use their wetlands for fishing in the Murrumbidgee than in the USE. In addition to the common factors extracted largely similar costs and benefits are drawn from wetlands. The largest differences in wetland costs and benefits are a much smaller proportion of wetlands supplying stock water in the USE and a much larger perceived contribution to soil salinity in the USE. Hence Hypothesis 12 is accepted: *Common attitudes towards wetland values exist for both USE and Murrumbidgee wetlands.*

Since two common factors have been extracted it is useful for policy purposes to examine whether common socio-economic factors influence wetland values as was concluded for the Murrumbidgee alone in Section 4.5. The results of a regression of the pooled wetland attitudinal factor scores on wetland type, a dummy variable to identify differing impacts between case studies and several socio-economic explanatory variables are reported in Table A2.2. Significant explanatory variables were wetland type (red gum and tea tree), location, years on property and, for non-consumptive values age (less than fifty) and tertiary education.

TABLE A2.1: PATTERN MATRIX FROM POOLED USE AND MURRUMBIDGEE DATA

	Factors	
	Non-consumptive uses	**Indirect or production uses**
My wetlands provide a place of beauty	0.923	
My wetlands beautify the rural landscape	0.857	
My wetlands help native animal movements	0.735	
My wetlands conserve native plants and animals	0.679	
My wetlands help to trap and recycle nutrients		0.698
My wetlands reduce water pollution		0.656
My wetlands increase bird life which in turn decreases pests		0.629
My wetlands help prevent salting/soil salinity		0.601
My wetlands help prevent soil erosion		0.422
Eigenvalues	4.719	1.039
Percent of variance	52.428	11.546
Cronbach's Alpha	0.893	0.776

TABLE A2.2: SOCIO-ECONOMIC AND PHYSICAL INFLUENCES ON VALUES REGRESSION RESULTS

Model summary data	**Number of observations**	**R^2 Adjusted**	**Std error of estimate**
Non-consumptive use values	113	0.317	0.764
Indirect use and productivity implications values	113	0.268	0.735

Model specifications	**Constant**	**Red gum wetlands**	**Tee tree wetlands**	**Location dummy (1=USE)**	**Tertiary Education**	**Years lived on property**	**Aged less than 50**
Non-consumptive use values	0.852*	-0.642*	-1.265*	0.953*	-0.293	-0.014*	-0.330*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.051)	(0.002)	(0.033)
Indirect use and productivity implications values	0.356	-0.291*	-1.132*	1.218*	-0.217	-0.012*	-0.114
	(0.056)	(0.044)	(0.000)	(0.000)	(0.135)	(0.004)	(0.443)

Note: Numbers in brackets are t-test significance levels. * indicates significance at the five-percent level.

Explanatory variables trialed but not significant were black box and open water wetlands, outside employment and whether respondents lived on the property (co-linear with years on property). Tertiary qualifications in agriculture or other areas were also trialed separately but performed better when combined. Only one of the equations possessed an adjusted R^2 over 0.3 (see Section 4.5 for discussion of performance measures) and signs were as expected. In total four socio-economic explanatory variables are significant including all three for non-consumptive values. Hence Hypothesis 13 is accepted: *Common socio-economic factors influence wetland values in the USE and Murrumbidgee.*

The common significance of socio-economic explanatory variables suggests some possibility for targeting wetland policies at a broad level. However the significance of the location dummy variable in both regressions indicates that significant regional specific drivers of wetland values also exist. That is the relationship is impacted by location as well as socio-economic variables. Hence, while the ability generalise is compromised, there is scope for targeted wetland policy.

A2.2 Common socio-economic influences on adoption of wetland management practices

As common socio-economic variables influence wetland values for both the USE and Murrumbidgee it is useful for policy development to examine whether the adoption of wetland management practices is influenced by common factors. If wetland management practices are influenced by common factors then generic wetland management incentives may be possible. If the factors that influence the adoption of

wetland management practices are specific to the study area then wetland policy needs to be targeted towards particular regional constraints.

In Section 4.9 socio-economic influences on the adoption of particular wetland management practices were estimated. Analysis of pooled data for the USE and Murrumbidgee case study areas followed the methodology outlined in Section 4.9. The results are reported in Tables A2.3 and A2.4. The regression results from the pooled data are substantially inferior to those from either the USE or the Murrumbidgee study areas alone. Only three regression's pseudo ρ^2 exceed 0.2 compared to eleven for the USE and eight for the Murrumbidgee. Furthermore only two explanatory variables are common to all three sets of results (large wetland area and tertiary education for excluding stock from wetlands). The location dummy variable was not significant. However, this is likely to be due to wetland types located in only one study area overriding it. Fourteen explanatory variables are significant in the joint model but not in either of the individual models, while the remaining 25 are significant in the pooled estimates and either the Murrumbidgee or USE models.

On this basis Hypothesis 14 '*common influences on the adoption of wetland management practices exist for the USE and Murrumbidgee'* cannot be accepted for all management practices. Specifically Hypothesis 14 can be accepted for the following management practices: excluding stock; control of feral animals; fire prevention; list of plants and animals; restoring wetland basins; and, encouraging native wildlife. However, despite accepting Hypothesis 14 for these management practices the performance statistics for either the Murrumbidgee or USE are superior. The results suggest that while there is some degree of commonality between the socio-economic influences on adoption of wetland management practices it is unlikely to be sufficient for a generic wetland policy to be successful for any management practice or across all areas.

TABLE A2.3: COMBINED LOGIT MODEL PERFORMANCE STATISTICS

Dependent variable	Number of observations	Model Log Likelihood	McFadden's ρ^2	Pseudo ρ^2	Overall percent correct
Exclude stock from wetland	116	98.571	0.231	0.262	83%
Manage grazing access to wetland	116	147.770	0.046	0.066	65%
Maintaining native vegetation around wetland	116	140.165	0.116	0.141	72%
Maintaining tree/vegetation filtering strip around wetland	116	128.218	0.000	0.008	76%
Directing saline drainage away from wetland	116	89.732	0.104	0.134	85%
Maintaining a natural wetting / drying regime	116	117.34	0.101	0.131	80%
Control of feral animals in wetland	116	130.563	0.157	0.190	72%
Control of weeds in wetland	116	151.954	0.050	0.069	63%
Revegetation using local native species	116	127.928	0.119	0.147	72%
Fire prevention/control around wetland	116	108.589	0.194	0.223	77%
Seeking and implementing management advice	116	80.795	0.096	0.129	87%
Preparing a list of plants and animals observed in/near the wetland	116	62.875	0.350	0.401	89%
Developing a farm management plan incorporating wetland conservation initiatives	116	113.297	0.100	0.132	77%
Restoring wetland basins/habitat	116	76.837	89.337	0.140	87%
Measures to encourage native wildlife	116	111.215	0.148	0.186	80%
All wetland management practices	116	131.275	0.096	0.124	72%
Expecting benefits from management	115	151.920	0.045	0.057	58%

TABLE A2.4: COMBINED MANAGEMENT PRACTICE REGRESSIONS

Dependent variable	Constant	Tea-tree wetlands	Black box wetlands	Red gum wetlands	Large wetland area	Small wetland area	Years on property	Tertiary education
Exclude stock from wetland	-3.221	1.553			1.525			2.003
	(0.000)	(0.003)			(0.006)			(0.000)
Manage grazing access to wetland	-1.134				0.784		0.022	
	(0.001)				(0.081)		(0.054)	
Maintaining native vegetation around wetland	-1.352	1.561			0.861		0.020	
	(0.001)	(0.001)			(0.071)		(0.093)	
Maintaining tree/vegetation filtering strip	-1.145							
	(0.000)							
Directing saline drainage away from wetland	-2.886		1.339				0.035	
	(0.000)		(0.021)				(0.026)	
Maintaining a natural wetting / drying regime	-2.423	1.275	1.319	1.209				
	(0.000)	(0.018)	(0.026)	(0.011)				
Control of feral animals in wetland	-2.579	1.537	0.957	0.844			0.048	
	(0.000)	(0.003)	(0.092)	(0.056)			(0.000)	
Control of weeds in wetland	-0.324			0.753		-1.043		
	(0.243)			(0.053)		(0.053)		
Revegetation using local native species	-2.103		1.265				0.028	0.961
	(0.000)		(0.016)				(0.026)	(0.027)
Fire prevention/control around wetland	-1.338		1.076	0.891		-8.514		
	(0.000)		(0.052)	(0.055)		(0.664)		
Seeking and implementing management advice	-2.996	1.723	1.833					
	(0.000)	(0.018)	(0.019)					
Preparing a list of plants and animals observed	-6.137	2.983		2.184	1.755		0.046	
	(0.000)	(0.000)		(0.006)	(0.011)		(0.022)	
Developing a farm management plan	-2.424	1.297	1.731	0.827				
	(0.000)	(0.020)	(0.004)	(0.083)				
Restoring wetland basins/habitat	-3.385	1.888		1.277				
	(0.000)	(0.002)		(0.044)				
Measures to encourage native wildlife	-2.635	1.490		1.367		-1.258	0.024	
	(0.000)	(0.004)		(0.007)		(0.074)	(0.093)	
All wetland management practices	0.257	-1.564	-1.213				-0.023	
	(0.480)	(0.005)	(0.050)				(0.070)	
Expecting benefits from wetland management practices (as for 8a Y/N)	-0.132					1.286		
	(0.527)					(0.012)		

Notes: Figures in brackets are probabilities for significance levels.

Previous Research Reports in the Series

Whitten, S.M. & Bennett, J.W. (1998). *Wetland Eco Systems and Landuse in the Upper South East of South Australia*, Private and Social Values of Wetlands Research Report No. 1, University College, The University of New South Wales, Canberra.

Whitten, S.M. & Bennett, J.W. (1998). *Farmer Perceptions of wetlands and wetland management in the Upper South East of South Australia*, Private and Social Values of Wetlands Research Report No. 2, University College, The University of New South Wales, Canberra.

Whitten, S.M. & Bennett, J.W. (1998). *Potential Upper South East Regional Wetland Management Strategies*, Private and Social Values of Wetlands Research Report No. 3, University College, The University of New South Wales, Canberra.

Whitten, S.M. & Bennett, J.W. (1998). *Wetland Eco Systems and Landuse in the Murrumbidgee catchment – Wagga Wagga to Hay and including Mirrool Creek*, Private and Social Values of Wetlands Research Report No. 4, University College, The University of New South Wales, Canberra.