FARMER PERCEPTIONS OF WETLANDS AND WETLAND MANAGEMENT IN THE UPPER SOUTH EAST OF SOUTH AUSTRALIA[*]

Stuart Whitten and Jeff Bennett[#]

January 1999

[*] Paper presented at the 43rd Annual Conference of the Australian Agricultural and Resource Economics Society, Christchurch, New Zealand. Funding for the research presented in this paper has been provided under the National Wetlands Research and Development Program by Environment Australia and The Land and Water Resources Research and Development Corporation. A more complete analysis of the results reported in this paper can be found in Whitten and Bennett (1999), copies of which are available from the authors.

[#] School of Economics and Management, University College, The University of New South Wales, Canberra 2600.
Email: whittens@emnw2.arts.adfa.oz.au, j.bennett@adfa.edu.au

Abstract

In recent times much attention has been paid to wetland conservation and management. Relatively little of this attention has been paid to the trade-offs land manager's face when deciding on the use of privately owned wetlands. In this paper the results of a survey of wetland management trade-offs in the Upper South East region of South Australia are reported. Wetland benefits are reflected by farmer attitudes and wetland management behaviour. The results indicate that farmers obtain considerable non-monetary benefits from their wetlands. These non-monetary benefits from wetlands are traded-off against monetary opportunity costs (mainly from restrictions to grazing livestock) and additional management costs. Management constraints faced by land managers are analysed and some potential incentive structures suggested.

Keywords: Wetlands, farmer attitudes, farmer decision making, market and non-market values.

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. In addition, the particular array of benefits and costs also depends on the characteristics of the wetland and the management strategies employed. The 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.

Despite the increasing attention devoted to wetland management 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 trade-offs wetland owners and managers face improves 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. The aim, in this paper, is to provide a better understanding of the processes for one group of wetland owners and managers located in the Upper South East region (USE) of South Australia (SA).

In this paper the results of a survey of wetland management trade-offs in the USE region are reported. Within the USE region, 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. In the next section the survey is placed in the context of related literature. Survey design, collection and respondent demographics are described in part three. In section four the results of the survey analysis are presented. A brief discussion of the implications of the results to incentive structures concludes the paper.

2. Context

The level of knowledge of the biological functions of wetlands within natural ecosystems has increased significantly in recent times. Recent analyses have increasingly focused on the impact of agricultural systems on the supply of nature conservation values provided by wetlands (see for example Robertson 1997 and Briggs 1988). Hence wetland managers are now better informed about the biological trade-offs in wetland decision making.

Where the biological and economic aspects of wetland decision making are examined, analysis has generally focused on the trade-offs faced by the community rather than individual wetland owners and managers (see for example Morrison and Bennett 1997, van Vuuren and Roy 1993). Briggs (1998) notes the importance of wetland owner and manager motivations in landholder decision making. Other analyses of community natural resource

trade-offs have 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). This analysis focuses solely on the trade-offs facing individual wetland owners and managers when making decisions about wetlands.

A relatively large group of wetland owners and managers is located in the USE region of SA. Large-areas of wetlands are located in the region, some of which meet the criteria for 'wetlands of international importance' under the Ramsar convention (White 1997). USE wetlands are mainly located on privately owned land and are potentially subject to degradation via grazing, feral animals and other impacts of agricultural production.[1] No cropping is undertaken in the region except as part of pasture improvement programs. The survey forms part of a larger research project aimed at the examination of the private and social values of wetlands with particular emphasis on potential incentive structures.

3 Survey Methodology

To examine the trade-offs made by wetland owners and managers, a survey was carried out. 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; and,
5. demographic information about respondents.

The population surveyed consisted of both owners and managers of properties containing wetlands, located in the USE region of SA. The total population of owners and managers of properties with a wetland present is 73, of which 51 returned usable responses (70 percent). 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.

The total area of respondents' properties was 223,117 hectares including 30,475 hectares of wetlands. Average property size was 4,462 hectares. The median property size was 1,535 hectares compared to the USE average of 1,500 hectares (Upper South East Dryland Salinity and Flood Management Plan Steering Committee 1993). Average stocking rate on respondents' properties is 4.05 dry sheep equivalents (dse) per hectare compared to the USE average of 4.6 dse per hectare. In total 1.05 million dse were grazed on respondents' properties. The survey covered 33 percent of total agricultural land and 41% of total dse in

1 For a more complete discussion of wetlands ecosystems and landuse in the USE refer to Whitten and Bennett (1998).

the USE region emphasising the significance of wetlands within the region. The total area of properties containing wetlands is not known.

Table 1: Summary of respondent demographics

	Yes	No
Live full time of property	71%	29%
Own the property	83%	17%
Actively involved in decision making about property	98%	2%
Fully employed as a farmer	80%	20%

	Male	Female	Together
Survey answered by	88%	6%	6%

Age range of respondents		Education	Highest level
20-29	2%	Intermediate or leaving certificate	10%
30-39	22%	South Australian Certificate of Education or Matriculation Certificate	2%
40-49	30%	TAFE or other short course (1-2 weeks)	37%
50-59	28%	Other tertiary qualifications	12%
60+	18%	Tertiary qualifications in agriculture	24%

4 Results

4.1 Wetland benefits

The range of wetland uses reported by respondents and displayed in Table 2 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. In total, 88 percent of respondents derive some direct monetary benefit from their wetlands via either grazing, commercial hunting or eco-tourism. Non-monetary benefits include recreation and hunting. In total, 96 percent of respondents obtain non-monetary benefits via recreation, hunting or fishing in wetlands. The individual uses reported may be in conflict. For example, using wetlands as sinks for saline drainage may conflict with (reduce) recreational benefits but this does not necessarily mean all recreational benefits are destroyed. Hence wetland owners using wetlands for saline drainage may be trading-off recreational benefits against benefits to production (among other trade-offs).

4.2 Wetland Costs

Wetlands provide benefits to owners and managers but they may also impose additional costs. 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). In total, 98 percent of respondents indicated at least one negative impact on agricultural production capacity. Other wetland costs may not affect agricultural production (such as odours). In addition opportunity costs are incurred once a particular management strategy is chosen. Respondents' perceptions of a suite of potential costs are reported in Table 3.

Table 2: Wetland uses (benefits)

	Unrestricted	Seasonal	Never or drought
Sheep grazing	22%	49%	29%
Cattle grazing	27%	46%	27%
Total grazing	35%	51%	14%
	None	Family and Friends	Commercial
Hunting pests	24%	74%	2%
Other hunting	61%	35%	4%
Fishing	84%	16%	0%
Pleasure/recreation	12%	86%	2%
Total	4%	96%	
	Farm timber	Firewood	No harvesting
Farm use	4%	32%	64%
Commercial	2%	6%	92%
Total timber use	38%		62%
	Whole farm	Part of farm	None
Water supply	6%	20%	74%
Drainage	52%		48%
Total	62%		38%

Table 3: Wetland costs

	Severe or moderate	Minor	No problem
Weed source	26%	49%	25%
Harbours feral animals	34%	54%	12%
Harbours nuisance animals	38%	30%	32%
Waterlogging	31%	37%	31%
Contributes to soil salinity	33%	43%	24%
Access problems	14%	56%	39%
Loss of bogged Stock	0%	16%	84%
Total production impacts	98%		2%
Noxious odours	22%	6%	73%

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 4 reports respondent attitudes towards three such potential impacts.

Table 4: Other wetland impacts

	Negative impact	No impact	Positive impact
Pasture damaging birds	8%	80%	12%
Government intervention	36%	50%	14%
Natural fire break	30%	8%	62%

Wetland owners and managers also receive a range of less easily defined or less direct benefits and costs. The level of these benefits or costs is also more difficult to measure. Respondents' attitudes towards a range of less direct wetland values were recorded using a five point Likert scale plus an additional 'not applicable' category. Responses are reported in Table 5. Non-monetary, non-consumptive uses of wetlands such as place of beauty, conserve flora and fauna scored very highly. Wetland attributes such as soil erosion and fish habitat / recreational fishing are rarely present within the region or not recognised by respondents (as shown by the high don't know, not applicable and/or disagree proportions). Respondent attitudes were divided over indirect benefits of wetlands such as reducing water pollution and trap and recycle nutrients. Other values such as bird life reducing pests, recreational hunting and to a lesser extent contributing to tourism and recreation opportunities had higher proportions of agreement rates. Respondents were also divided over production impacts such as controlling floods and to a lesser extent preventing salinity.

Table 5: Farmer attitudes towards their wetlands

Statement	Agree	Don't know	Disagree	Not applicable
Non-consumptive use values:				
My wetlands provide a place of beauty	76%	4%	18%	2%
My wetlands beautify the rural landscape	80%	2%	14%	4%
My wetlands conserve native plants and animals	72%	6%	16%	6%
My wetlands help native animal movements	71%	12%	16%	2%
My wetlands provide native fish habitat	20%	6%	28%	47%
Indirect use values:				
My wetlands increase bird life which in turn decreases pests	65%	12%	18%	6%
My wetlands reduce water pollution	20%	22%	30%	27%
My wetlands help to trap and recycle nutrients	35%	24%	36%	6%
Production impacts of wetlands:				
My wetlands help prevent salting	26%	10%	58%	6%
My wetlands help control floods	44%	8%	40%	8%
My wetlands help prevent soil erosion	14%	12%	35%	39%
Direct use values:				
My wetlands provide for recreational fishing	10%	4%	31%	55%
My wetlands provide for recreational hunting	51%	2%	30%	18%
My wetlands provide tourism/recreation opportunities	43%	6%	31%	20%

Respondents were also asked what they liked and disliked most about having wetlands on their properties. Non-consumptive, non-monetary attributes such as scenery, aesthetics, fauna habitat and natural land/ecosystem dominated likes (70 percent of responses). Major dislikes were costs such as unproductive land (26 percent) and associated management costs (52 percent). The majority of dislikes indicated by respondents are related to undertaking agricultural production in wetland areas whereas the majority of likes are related to non-production aspects of wetlands.

4.4 Impact of wetland type on values

Up to this point the range of benefits available to wetland owners and managers from differing wetland types has been assumed constant. However, there are a number of different wetland types present in the USE region of SA. Each of these differing wetland types is likely to provide an alternative mix of values. For example, red-gum wetlands are typically seasonal and comprise an open grassy understorey providing easy productive grazing, tea-tree provides good stock shelter for lambing, calving or off-shears and deep water may provide a relatively permanent stock water supply.

Three wetland types comprise 81% of reported wetland and are each owned or managed by greater than 20% of respondents, namely Red gum, Tea tree and Shallow open water. Hence tests of significance of wetland type are only conducted on these three types. Fortunately the attributes of these wetland types differ significantly and they cover the majority of wetland areas present within the region. Red gum wetlands are open woodlands of large trees with a grassy understorey. Tea tree wetlands are usually an open or closed scrub of *Melaleuca* species with little understorey. Shallow open water wetlands possess little or no emergent vegetation and dry back to either a saline pan or may grow some fodder. Shallow open water wetlands are often fringed by tea tree. All wetland types are seasonal and may not fill every year.

Table 6 reports the results of Chi-square tests of association between the wetland benefits and costs reported in Tables 2, 3 and 4 and wetland type. The results of the Chi-square tests clearly indicate particular benefits and costs are more strongly associated with particular wetland types.

Fishing, farm timber harvesting and recreation are positively associated with red gum wetlands while noxious odours and bogged stock are negatively associated. These associations are expected as red gum woodlands commonly posses yabby populations, large trees that are more useful for both fire-wood and farm timber and provide shade for recreation.[2]

Tea tree wetlands are positively associated with recreation, nuisance animals, and waterlogging, negatively with stock water supply and have a mixed association with grazing. Once again the associations are largely expected. Tea tree wetlands are very salt tolerant and often grow where little else will. Hence they are not suitable for stock water supply and commonly exhibit waterlogging or impoverished soils. Tea tree scrub also provides shelter for native and nuisance species. The mixed grazing result is likely due to some respondents reporting successful grazing use at low intensity or seasonally while other tea tree wetlands are very saline and unsuitable for grazing.

The mixed grazing result for shallow open wetlands is also due to fresh wetlands growing some feed following drying while others are too saline for any significant growth. Shallow open wetlands allow relatively easy hunting when dry, while tea tree fringes provide shelter for feral animals. The development of a salt crust in some saline wetlands may contribute to stock becoming bogged.

[2] Redgum trees are protected under the SA native vegetation act. Only dead timber can be felled or removed although other species less than 150mm in diameter can be felled for firewood or fence posts.

Table 6: Relationship between wetland type and values

Type of wetland	**Red gum**	**Tea-tree**	**Shallow open**
Wetland benefits:	Chi-square test p-values		
All grazing use	0.924	0.078 (~)	0.003 (~)
Hunting feral species	0.651	0.215	0.063 (+)
Other hunting	0.257	0.908	0.257
Fishing	0.001 (+)	0.331	0.428
Farm timber harvesting	0.005 (+)	0.675	0.266
Commercial timber harvesting	0.152	0.355	0.783
Pleasure/recreation	0.073 (+)	0.011 (+)	0.741
Stock water supply	0.749	0.012 (-)	0.585
Outflow area for farm drains	0.368	0.896	0.216
Wetland costs:			
Harbours feral animals	0.103	0.107	0.001 (+)
Source of weeds	0.241	0.394	0.683
Harbours nuisance animals	0.115	0.013 (+)	0.305
Creates noxious odours	0.011 (-)	0.669	0.263
Limits access to parts of property	0.512	0.771	0.257
Contributes to waterlogged / impoverished soil	0.146	0.094 (+)	0.501
Contributes to dryland salinity	0.390	0.126	0.418
Loss of bogged stock	0.009 (-)	0.170	0.048 (+)
Other wetland uses:			
Attract pasture damaging birds	0.598	0.228	0.183
Attracts government intervention	0.212	0.078 (-)	0.412
Is a natural fire break	0.390	0.244	0.899

\+ Indicates wetland type significantly increases probability.
\- Indicates wetland type significantly decreases probability.
~ Indicates wetland type significantly increases probability of maximum use *and* minimum use.

4.5 Adoption of wetland management practices

Wetland owners and managers can alter the benefits and costs they face via adoption of alternative management strategies. Wetland management may be directed towards maintaining benefits or values associated with a natural ecosystem. That is, a wetland may be managed to minimise the impact of consumptive uses on wetlands. Alternatively, 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 constraints (for example saline wetlands will not grow pasture), financial constraints or by outside agencies such as government (for example wetland owners are no longer allowed to clear and drain wetland areas in South Australia).

Adoption of a range of potential management practices by respondents is reported in Table 7. Seventy three percent of respondents report implementing at least one management practice. Since many respondents own more than one wetland, management strategies may vary from wetland to wetland, especially if different wetland types are owned. For example, only 14 percent of respondents never graze any of their wetlands but 35 percent exclude stock from at least one wetland. The most common management practices are maintenance of native

vegetation, control of weeds and control of feral animals in wetlands (all undertaken by approximately 50 percent of wetland owners and managers).

Table 7: Adoption of wetland management practices in the USE region

Wetland management practice	**Respondents adopting**
Exclude stock from wetland	35%
Manage grazing access to wetland	35%
Facilities to water stock away from wetlands	39%
Maintaining native vegetation around wetland	55%
Maintaining tree/vegetation filtering strip around wetland	29%
Directing saline drainage away from wetland	16%
Maintaining a natural wetting / drying regime	29%
Control of feral animals in wetland	47%
Control of weeds in wetland	47%
Revegetation using local native species	33%
Fire prevention/control around wetland	14%
Seeking and implementing management advice on specific problems such as dying trees	18%
Preparing a list of plants and animals observed in/near the wetland	29%
Developing a farm management plan which incorporates wetland conservation initiatives	27%
Restoring wetland basins/habitat	22%
Measures to encourage native wildlife	35%
Drains to manage dryland salinity impacts on wetlands	27%
Total respondents undertaking wetland management practices	73%

Adoption of management practices reflects the trade-offs between benefits from wetlands (maintenance of vegetation) and costs of wetlands (88 percent reported some degree of feral animal problem and 75 percent a weed problem). The least commonly adopted strategies were fire prevention, directing saline drainage away from wetlands and restoration of wetland basins or habitat. The low adoption rate of fire prevention reflects the 62 percent of respondents indicating their wetlands are natural fire breaks. The low protective drainage and restoration adoption rates reflect the current construction of a regional salinity and flood management drainage network. Many respondents are awaiting its completion to either facilitate restoration and/or re-direction of saline drainage.

4.6 Perceived costs and benefits of wetland management practices

Management decisions are likely to be based on trading-off the type and quantity of expected benefits and costs arising from alternative management strategies. Sections 4.1 and 4.2 indicate that monetary and non-monetary wetland benefits and costs are associated with wetlands. The monetary returns from wetland management can either be immediate (via increased cash returns from livestock) or in the future (via increased property values 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 8. In summary, 45 percent of respondents, or over half of those adopting management practices (65 percent),

expected financial benefits from wetland management activities. Of those respondents expecting financial benefits, nearly all (91 percent) expected increased market value of their properties and approximately half expected improved pasture growth or health and hence livestock growth. Less than ten percent of respondents expecting benefits felt that they would receive financial benefits from hunting, fishing, new industries or timber sales.

Table 8: 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	41%	56%	91%
Reduction in the need for insect pest control	14%	19%	32%
Increased growth rate of cattle/sheep	22%	31%	50%
Increased pasture/crop yield in paddocks adjacent to wetland	27%	36%	59%
Reduced need for general pest control	10%	14%	23%
Increase in quality/health of pastures/crops	27%	36%	59%
Income from hunting / hunters	4%	6%	9%
Income from fishing / fishers	2%	3%	5%
Sales of firewood / farm timber	2%	3%	5%
Sales of sawn timber	2%	3%	5%
Farm stay tourism	8%	11%	18%
Guided / unguided eco-tourism	12%	17%	27%
Reduced costs from soil salinity	18%	25%	41%
Development of new industries using wetland outputs	4%	6%	9%
Respondents expecting financial benefits	45%	65%	100%

Table 8 shows a significant proportion of wetland owners and managers expect financial benefits from undertaking wetland management practices. However it cannot be directly concluded whether financial benefits directly influence the decision to adopt or whether they are peripheral.

Respondent perceptions regarding the impact of wetland management strategies on farm viability are reported in Table 9. Excluding stock from wetlands is expected to reduce farm viability by 50 percent of all respondents while around a quarter of respondents believe restoring wetland basins and measures to encourage native wildlife result in reduced farm viability. Approximately 80 percent of respondents indicated management of saline drainage would improve farm viability, however adoption of these strategies is very low (16 percent and 27 percent respectively). This is due to managers awaiting construction of an integrated dryland salinity and flood management drainage scheme (currently under construction) either prior to, or to facilitate, altering management. Additional strategies leading to increased farm viability included developing a farm management plan (42 percent), control of weeds in wetlands (41 percent), control of feral animals (33 percent), vegetation maintenance and revegetation (approximately 30 percent).

If monetary impacts influence adoption, a significant relationship between perception of farm viability effect and the rate of adoption should exist. 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 impacts 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 9: Monetary impact of alternative wetland management practices

Management Practice	**Effect on farm viability**		
	Decrease	No change	Increase
Exclude stock from wetland	49%	40%	11%
Manage grazing access to wetland	13%	77%	10%
Facilities to water stock away from wetland	9%	82%	9%
Maintain native vegetation around wetland	11%	62%	27%
Maintaining a tree/vegetation filtering strip around wetland area	11%	57%	31%
Directing saline drainage away from wetland	8%	14%	78%
Facility to restore natural wetting and drying of wetland	6%	68%	26%
Control of feral animals in wetland	6%	61%	33%
Control of weeds in wetland	6%	53%	41%
Revegetation using local native species	11%	57%	31%
Fire prevention/control around wetland	6%	91%	3%
Seeking and implementing management advice on specific problems such as dying trees	3%	68%	29%
Preparing a list of plants and animals observed in/near wetland	3%	82%	16%
Developing a farm management plan which incorporates wetland conservation initiatives	16%	42%	42%
Restoring wetland basins/habitats	23%	49%	28%
Measures to encourage native wildlife	22%	59%	20%
Drains to manage dryland salinity impacts on wetlands	8%	8%	83%

The proportion of respondents expecting an increase in viability and adopting particular management actions is shown in Table 10. A chi-square test of association was also conducted. Significant associations were found for control of feral animals ($p=0.021$), revegetation ($p=0.012$) and farm management plan ($p=0.006$). Neither of the drainage related management strategies were significant despite a large proportion of those respondents adopting the practice perceiving an increase in profitability. This is due to a low actual adoption rate as a proportion of those expecting an increase for the reasons noted above. It is also surprising that weed control is not significant. This may be due to the smaller proportion reporting a severe or moderate weed problem compared to feral animal problems.

The Chi-square tests of association indicate that monetary impacts of management practices do influence adoption. It is equally clear that monetary impacts of adoption do not always influence adoption. For example some strategies commonly adopted include measures to encourage native wildlife, excluding stock from wetlands and managing grazing access to wetlands. As considered sections 4.1 and 4.2, 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. These remaining practices with high adoption rates are more likely to conserve

natural resource values and hence maintain or increase non-monetary values. The joint importance 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.

Table 10: 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	11%	35%	0.300
Manage grazing access to wetland	10%	35%	0.756
Facilities to water stock away from wetland	9%	39%	0.209
Maintain native vegetation around wetland	27%	55%	0.323
Maintaining a tree/vegetation filtering strip around wetland area	31%	29%	0.128
Directing saline drainage away from wetland	78%	16%	0.726
Facility to restore natural wetting and drying of wetland	26%	29%	0.532
Control of feral animals in wetland	33%	47%	0.021
Control of weeds in wetland	41%	47%	0.734
Revegetation using local native species	31%	33%	0.019
Fire prevention/control around wetland	3%	14%	-
Seeking and implementing management advice on specific problems	29%	18%	0.736
Preparing a list of plants and animals observed in/near wetland	16%	29%	0.814
Develop farm management plan incorporating wetland conservation initiatives	42%	27%	0.006
Restoring wetland basins/habitats	28%	22%	0.258
Measures to encourage native wildlife	20%	35%	0.566
Drains to manage dryland salinity impacts on wetlands	80%	27%	0.389

4.7 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, wetland managers are influenced by a duality of monetary and non-monetary goals 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 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 draining their wetlands would have on the long-term profitability of their farm (illegal in SA):

Profits increase more than 10%	43%
Profits increase 5%	22%
No change in profits	22%
Profits decrease 5%	2%
Profits decrease more than 10%	10%

In total 65 percent of respondents indicated that if their wetlands were drained, farm profitability (monetary benefits) would increase. Similarly respondents indicated wetlands have an impact on their property values:

Property values reduced more than 10%	44%
Property values reduced 5%	14%
No effect on property values	20%
Property values increased	22%

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:

49%	Regarded their wetlands as an asset;
18%	Regarded their wetlands as neither; and,
33%	Regarded their wetlands as a liability.

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 more clearly defined in Table 11.

Table 11: Wetland trade-offs

	Net impact of wetlands		
Wetland impact on property values	Asset	Neither	Liability
Reduces property value	14%	12%	32%
No effect on property value	14%	4%	2%
Increases property value	20%	2%	-
Pearson Chi-square 18.549 (p=0.001)			
If wetlands drained:	Asset	Neither	Liability
Profits would increase	20%	12%	33%
No Change	18%	4%	-
Profits would decrease	10%	2%	-
Pearson Chi-Square 14.433 (p=0.006)			

Fourteen percent of respondents regard their wetlands as an asset despite recognising they reduce property values. Twelve 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 14 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 40 percent of respondents indicate wetland benefits exceed the monetary cost to property values. Similarly, Table 11 also shows 50 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 wetland owners and managers are trading off monetary and non-monetary values when making decisions about their wetlands.

A cross tabulation between grazing use and net benefits of wetlands, reported in Table 12, reveals additional information about the trade-offs made by wetland owners and managers. Respondents who never graze their wetlands indicated their wetlands were an asset or neither an asset nor a liability. These respondents also reported no timber or water extraction (but one respondent used their wetlands as an endpoint of farm drainage). For these respondents the dominant benefits of wetlands relate to non-monetary uses (except one respondent who reported commercial eco-tourism and hunting). Respondents who only graze wetlands when completely dry show the opposite response. For this group, profits increase if their wetlands were drained and the opportunity cost of wetlands exceeds the benefits. Respondents who seasonally or unrestricted graze exhibit a cross section of responses. These respondents are obtaining both monetary and non-monetary benefits from their wetlands. In some cases, their net benefits are positive (overall an asset), and in others negative (overall a liability). Again the chi-square test is significant at 5 percent.

Table 12: Grazing use and net benefits of wetlands

	Net impact of wetlands		
Grazing use of wetlands	Asset	Neither	Liability
Unrestricted	16%	8%	12%
Seasonally grazed	22%	6%	8%
Only grazed when completely dry	2%	-	14%
Never grazed	10%	4%	-
Pearson Chi-square 15.658 (p=0.016)			

4.8 Socio-economic influences on adoption of wetland management practices

Decisions about wetland management practices may not only be influenced by trade-offs between monetary and non-monetary costs and benefits. Other factors, such as socio-economic factors and physical constraints, may also influence adoption of wetland management practices. Socio-economic may influence respondents' views about the benefits of wetland management practices. 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 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. Hence differences in physical constraints such as wetland type and size or total property production may also reveal important influences on management decisions.

The potential influence of socio-economic factors and of physical management factors was assessed using a logit regression of respondents undertaking each management practice. 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 13 and the logit regression results in Table 14.

Table 13: Logit model performance statistics

Dependent variable	**Number of obs.**	**Model Log Likelihood**	**McFadden's ρ^2**	**Pseudo ρ^2**	**Overall percent correct**
Exclude stock from wetland	45	34.627	0.396	0.465	82%
Manage grazing access to wetland	45	48.676	0.169	0.203	71%
Facilities to water stock away from wetland	45	57.111	0.057	0.090	62%
Maintain native vegetation around wetland	45	48.163	0.221	0.270	71%
Maintain tree/vegetation filtering strip around wetland	45	42.135	0.193	0.250	78%
Directing saline drainage away from wetland	45	38.900	0.000	0.026	84%
Maintain a natural wetting /drying regime	45	34.030	0.348	0.425	87%
Control feral animals in wetland	45	62.361	0.000	0.016	51%
Control weeds in wetland	45	62.361	0.000	0.016	51%
Revegetation using local native species	45	40.005	0.283	0.355	78%
Fire prevention / control in wetland	45	33.936	0.128	0.179	84%
Seeking and implementing management advice on specific problems	45	37.173	0.117	0.165	82%
List of plants and animals in wetland	45	38.277	0.267	0.324	80%
Developing a farm management plan incorporating wetland conservation	45	32.046	0.360	0.440	84%
Restoring wetland basins / habitat	45	23.594	0.476	0.587	93%
Measures to encourage native wildlife	45	46.273	0.192	0.245	80%
Drains to manage dryland salinity impacts on wetlands	45	52.192	0.000	0.019	73%
All wetland management practices	45	41.368	0.174	0.233	78%
Expecting benefits from management	44	54.355	0.108	0.157	66%

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'. Ten of the seventeen 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 seven less than 0.15. Three of the seven management practices with ρ^2 less than 0.15 are the most commonly adopted and hence likely to be adopted at some level by all socio-economic classes. A further three management practices are adopted at very low levels (less than 20 percent) potentially providing insufficient information for discrimination. Two management practices (one with a low adoption rate) are complicated by outside influences (construction of a dryland salinity and flood management drainage scheme). Key management practices such as excluding stock, revegetation, farm management plans and restoration of wetland basins all possess good to extremely good fits.

Table 14: Parameter estimates for regressions of management practice

Dependent variable	Constant	Red gum wetlands	Tea-tree wetlands	Shallow open water	Large wetland area	Small wetland area	Large total DSE	Small total DSE	Level of education	Full time farmer
Exclude stock from wetland	-5.361			-1.787	2.801				1.321	
	(0.006)			(0.056)	(0.010)				(0.007)	
Manage grazing access to wetland	1.295			-1.909					-0.389	
	(0.136)			(0.014)					0.104	
Facilities to water stock away from wetland	0.080			-1.179						
	(0.842)			(0.080)						
Maintain native vegetation around wetland	-2.257	1.808	2.526							
	(0.015)	(0.034)	(0.006)							
Maintain tree/vegetation filtering strip around wetland	-3.672	1.838	2.230							
	(0.003)	(0.019)	(0.056)							
Directing saline drainage away from wetland	-1.692									
	(0.000)									
Maintain a natural wetting /drying regime	-4.339	2.530	1.947				1.889			
	(0.001)	(0.007)	(0.110)				(0.062)			
Control feral animals in wetland	-0.045									
	(0.882)									
Control weeds in wetland	-0.045									
	(0.882)									
Revegetation using local native species	-1.224	2.464				-2.190				-0.783
	(0.036)	(0.004)				(0.095)				(0.102)
Fire prevention / control in wetland	-2.367						1.962			
	(0.000)						(0.027)			
Seeking and implementing management advice on specific problems	-2.526	1.833								
	(0.001)	(0.039)								
List of plants and animals in wetland	-3.238	2.628			2.875					
	(0.002)	(0.019)			(0.013)					
Developing a farm management plan incorporating wetland conservation	-5.961		2.196						1.116	-1.731
	(0.016)		(0.091)						(0.042)	(0.011)
Restoring wetland basins / habitat	-9.412		10.649		-3.072			-2.571		-1.123
	(0.818)		(0.795)		(0.021)			(0.051)		(0.088)
Measures to encourage native wildlife	-2.976	2.015	1.784							
	(0.003)	(0.008)	(0.060)							
Drains to manage dryland salinity impacts on wetlands	-1.012									
	(0.003)									
Note dependent changes from 0-1 to 1=yes, no=2 hence wetland type is negative										
All wetland management practices	0.623	-1.772	-1.878							
	(0.389)	(0.062)	(0.172)							
Expecting benefits from wetland management practices (as for 8a Y/N)	0.439	-1.628				1.764				
	(0.278)	(0.032)				(0.090)				

Note: Figures in brackets are probabilities for significance levels.

Explanatory variables used in the regressions were wetland type, dummy variables for small and large wetland areas, small and large total production as measured by carrying capacity in DSE (both approximately the lower and upper quartiles), education and a dummy variable for non full time farming or outside employment. Explanatory variables generally have the expected sign and are significant at the 10 percent level. As expected wetland type influences decisions about most management practices. Wetland size influences decisions to exclude stock, compile a list of plants and animals (large wetlands increase probability), restore wetland basins (large wetland areas negatively influence probability) and revegetate (small wetland areas reduce probability). Total productivity influences decisions to maintain natural wetting and drying (large dse increase probability) and restore wetland basins (small dse reduces probability). Tertiary (higher level) qualifications increase the probability of excluding stock and developing a farm management plan. Non-full time farmers were less likely to revegetate, develop a farm management plan or restore wetlands.

5 Policy considerations

Wetland owners and managers in the USE of SA receive monetary and non-monetary benefits and costs from their wetlands. The non-monetary benefits of wetlands are traded-off against monetary opportunity costs and additional management costs by wetland owners and managers when making decisions about wetlands. However, the decisions made by wetland owners and managers also have implications for the benefits enjoyed by the wider community. Hence the community may wish to influence decisions made by owners and managers of privately owned wetlands. Therefore some direct policy considerations for the USE of SA are discussed in this section.

Wetland policy can alter the structure of benefits and costs within which wetland owners and managers make decisions. In particular wetland policy can change the balance between benefits and costs. At the extreme, wetland policy directly constrains wetland management practices or uses. For example wetland owners and managers in SA are no longer legally allowed to clear and drain wetlands and in NSW it is illegal to hunt ducks (except when declared a pest). Less intrusive policy mechanisms focus on altering wetland owner and manager incentives, and hence the balance of trade-offs, rather than restricting uses. For example grants of materials and/or subsidies for fencing and local government rate rebates. Often incentives are focused on either eliminating or achieving specific management practices. The policy analysis in this paper focuses on less intrusive, incentive based, mechanisms as these are more easily targeted towards specific regional aims.

5.1 Wetland management incentives

USE wetland owners and managers 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. There is a number of wetland management related incentives currently available to USE 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 rate and drainage levy rebates). Incentives available to USE wetland owners and managers are reported in Table 15. Not all the incentives contained in Table 15 are directed specifically at wetland management. For

example Landcare income tax rebates are directed towards prevention of land degradation and historically have not applied to non-agricultural land.

Many of the incentives require particular wetland management strategies. For example local council rate rebates, drainage levy rebates[3] and heritage agreements are only available for non-agricultural land, while government grants are often dependent on adoption of specific management strategies. In practice, only three of the 15 respondents receiving incentives did not exclude stock from their wetlands indicating a strong linkage between management strategies and incentives. The objective of these incentives is to increase community benefits by reducing the opportunity or management costs faced by wetland owners and managers.

Table 15: Incentives received for wetland management

Type of incentive	**Proportion of all respondents**	**Proportion of wetland managers**
Landcare tax rebate or land degradation deduction	2%	3%
Local council rate rebate	12%	16%
Materials under SA Vegetation Heritage Agreements	6%	8%
Free management advice from government agencies	10%	14%
Grants from Natural Heritage Trust	2%	3%
Revegetation grants	2%	3%
Drainage levy rebate	16%	22%
Other government grants/ financial assistance	2%	3%
Local Landcare group demonstration project	4%	5%
Other incentives	4%	5%
Total receiving incentives for wetland management	33%	46%

The total proportion of respondents and, the proportion of respondents undertaking wetland management practices, claiming each incentive are reported in Table 15.[4] A third of all respondents and nearly half of those respondents undertaking wetland management receive at least one incentive. The most commonly claimed incentives are local council rate rebates and drainage levy rebates followed by free management advice. Only one respondent claimed a land degradation tax deduction, no respondents claimed a tax rebate for wetland conservation related incentives. 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. Australian Bureau of Agricultural and Resource Economics (ABARE) data indicates negative 'average farm business profit' for two of the last three available years (ABARE 1997).

5.2 Wetland management constraints

The converse of examining the incentives available to wetland owners and managers is to examine the management constraints. In Table 16, the main constraints to adoption of

[3] A local government rate rebate applies to land covered by a heritage agreement in SA. Drainage levy rebates apply to heritage agreement land, native vegetation areas greater than 40 hectares and wetlands with a management plan that includes fencing out stock and eliminating grazing. Drainage levy rebates refund a levy collected to facilitate construction of a regional dryland salinity and flood management scheme.

[4] The Wetlands Waterlink and Salt to Success programs in the USE region have commenced offering a greater range of incentives for wetlands management since the survey was undertaken.

management practices are reported. If it is assumed that all management strategies increase the net 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 half and three quarters of all respondents not adopting specific management practices. The second most important constraint is the financial cost or the impact on profits of adopting particular management strategies.

Table 16: Constraint to adoption of wetland management practices

Management practice	AA	C or P	TC	KC	NA
Exclude stock from wetland	33%	53%	2%	0%	44%
Manage grazing access to wetland	33%	45%	3%	0%	52%
Facilities to water stock away from wetland	37%	23%	0%	0%	77%
Maintain native vegetation around wetland	53%	44%	4%	8%	44%
Maintaining a tree/vegetation filtering strip around wetland area	27%	38%	7%	10%	45%
Directing saline drainage away from wetland	16%	27%	8%	8%	57%
Facility to restore natural wetting and drying of wetland	27%	19%	6%	10%	65%
Control of feral animals in wetland	45%	13%	13%	4%	71%
Control of weeds in wetland	45%	5%	9%	5%	82%
Revegetation using local native species	31%	32%	15%	0%	54%
Fire prevention/control around wetland	14%	3%	12%	6%	79%
Management advice on specific problems such as dying trees	18%	6%	9%	12%	73%
Preparing a list of plants and animals observed in/near wetland	27%	3%	28%	14%	56%
Farm management plan incorporating wetland conservation initiatives	25%	16%	22%	16%	46%
Restoring wetland basins/habitats	22%	28%	11%	6%	56%
Measures to encourage native wildlife	33%	10%	13%	13%	65%
Drains to manage dryland salinity impacts on wetlands	25%	29%	7%	11%	54%

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

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

- Financial assistance (30%);
- Federal or local tax breaks (28%);
- Fencing assistance (25%);
- Completion of regional dryland salinity and flood management scheme (20%);
- Wetland or property management training/assistance (16%); and ,
- Revegetation Assistance (12%).

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 tax breaks indicates either a lack of knowledge regarding the available rebates and deductions or difficulty in qualifying as noted previously.

5.3 Potential incentive structures

Wetland policy influences the decisions made by wetland owners and managers by altering the trade-offs they face. That is, by altering monetary or non-monetary costs or benefits of particular wetland management practices. Effective incentive structures are targeted in a two stage process. The first stage involves designing effective management strategies designed to achieve the community's aims. The second stage targets incentives towards the main constraints to adoption of the desired management strategies. For example, if reduction in grazing is the desired management strategy effective incentives may focus on reducing the cost of excluding stock via fencing subsidies. Alternatively an effective strategy may be to replace the income farmers currently receive from grazing wetlands, either directly via for example facilitation of eco-tourism, or indirectly via for example improved recreation. Hence effective incentive strategies may focus on reducing adoption costs and hence increasing the net benefits of adoption or on increasing the monetary or non-monetary opportunity costs of not adopting.

Appropriate incentive structures also 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 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 suitable to State or Commonwealth levels.

Examination of the main constraints to adoption reported in Table 16, in conjunction with adoption rates reported in Table 7, and the anticipated effect on farm viability reported in Table 9 suggest several potential incentive strategies:

- Completion of the regional dryland salinity and flood management scheme will remove a major constraint to adoption of hydrological management strategies. The increase in farm viability as a result is likely to result in adoption.
- Incentives for development of farm management plans could be very effective. Farm management plans increase knowledge of the trade-offs of alternative management strategies and hence can facilitate adoption of strategies previously thought non-beneficial. This strategy can also be linked to other incentive strategies to maximise the likelihood of success
- Increased availability of fencing assistance would reduce the costs associated with exclusion of stock or grazing management. This incentive may also indirectly increase the likelihood of adoption of strategies improving flora and fauna habitat or revegetation.
- Incentives that reduce the cost of revegetation, for example cheap trees or hire of equipment.

5.4 Conclusions

USE wetland owners and managers receive both monetary and non-monetary benefits and costs from owning wetlands as indicate in sections 4.1, 4.2 and 4.3. The benefits and costs of wetlands are influenced by wetland type as concluded in section 4.4. Likewise, wetland type influences management decisions together with physical operating constraints and socio-

economic factors as shown in section 4.8. The monetary and non-monetary benefits and costs of their wetlands are traded-off when making decisions about wetland management practices as concluded from sections 4.6 and 4.7. 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 desire to influence management decisions about wetland use in order to improve the level of overall societal net benefit.

Incentive strategies employed by the community should be carefully targeted, firstly in terms of outcomes and secondly towards constraints to adoption. Incentives focus on increasing the net benefits to wetland owners and managers by reducing costs of adoption or increasing the monetary or non-monetary benefits of adoption. Suggested strategies from the survey results focus on reducing the costs of adoption and include fencing assistance, revegetation assistance and development of farm management plans.

References

Australian Bureau of Agricultural and Resource Economics (1997) *Australian Farm Survey's Report 1997*, ABARE, Canberra,

Binning C. and Young, M. (1997) *Motivating People, Using Management Agreements to Conserve Remnant Vegetation*, Final report to LWRRDC and Environment Australia National R&D Program on Rehabilitation, Management and Conservation of Remnant Vegetation, CSIRO Wildlife and Ecology, Lyneham, Australia.

Briggs, S.V. (1988) 'Guidelines for management of inland wetlands in Southern New South Wales', *Wetlands Australia*, Vol. 8(1), pp. 1-2.

Hensher, D.A. and Johnson, L.W. (1981) *Applied Discrete-Choice Modelling*, Croom Helm, London.

Morrison, M.D. and Bennett, J.W. (1997) Water use trade-offs in the Macquarie and Gwydir valleys, *Choice Modelling Research Report* No. 2, The University of New South Wales, Canberra.

Robertson, A.I. (1997) 'Land-water linkages in floodplain river systems: the influence of domestic stock', in *Frontiers in Ecology: Building the Links*, Eds N.Klomp and I. Lunt, Elsevier Science Ltd, Oxford.

Upper South East Dryland Salinity and Flood Management Plan Steering Committee (1993) *Upper South East Dryland Salinity and Flood Management Plan Draft Environmental Impact Statement – for Public Comment*, Natural Resources Council of South Australia, Adelaide.

van Vuuren, W. and Roy, P. (1993) 'Private and social returns from wetland preservation versus those from wetland conversion to agriculture', *Ecological Economics*, Vol. 8, pp. 289-305.

White, J. (1997) *The Ramsar Convention and Wetlands and Wildlife*, Wetlands and Wildlife, Adelaide.

Whitten, S.M. and 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 of New South Wales, Canberra.

Whitten, S.M. and Bennett, J.W. (1999) '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 of New South Wales, Canberra.

Wills, I. (1997) *Economics and the environment, A signalling and incentives approach*, Allen and Unwin, Sydney.

Young, M.D., Gunningham, N., Elix, J., Lambert, J., Howard, B., Grabosky, P. and McCrone, E. (1996) *Reimbursing the Future, An evaluation of motivational, voluntary, price-based, property-right and regulatory incentives for the conservation of bio-diversity*, Biodiversity Series, Paper No. 9, Biodiversity Unit, Department of the Environment, Sport and Territories, Canberra.