Conservation impediments and incentives – progressing the understanding of linkages between the adoption of conservation practices and the motivational orientation of graziers in the tropical savannas

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Abstract

The adoption of conservation practices is a complex matter – rural landholders consider a wide variety of factors and characteristics when deciding whether to adopt a conservation practice. To confound the issue, recent research has suggested that the goals of landholders affect the adoption of conservation practices by creating a subjective consideration of the relative importance of impediments and effectiveness of incentives in the adoption decision. In this research we describe an empirical link between graziers' goals and their perceptions of the relative importance of impediments and the effectiveness of incentives in the adoption of conservation practices. The research was carried out in the tropical savannas region of Australia where pastoral production dominates the landscape and where it is of prime importance to ensure that grazing land is included in the conservation estate. The results suggest that to increase the adoption of conservation practices, schemes will have to be developed with reference to graziers subjective views on impediments and on the effectiveness of incentives.

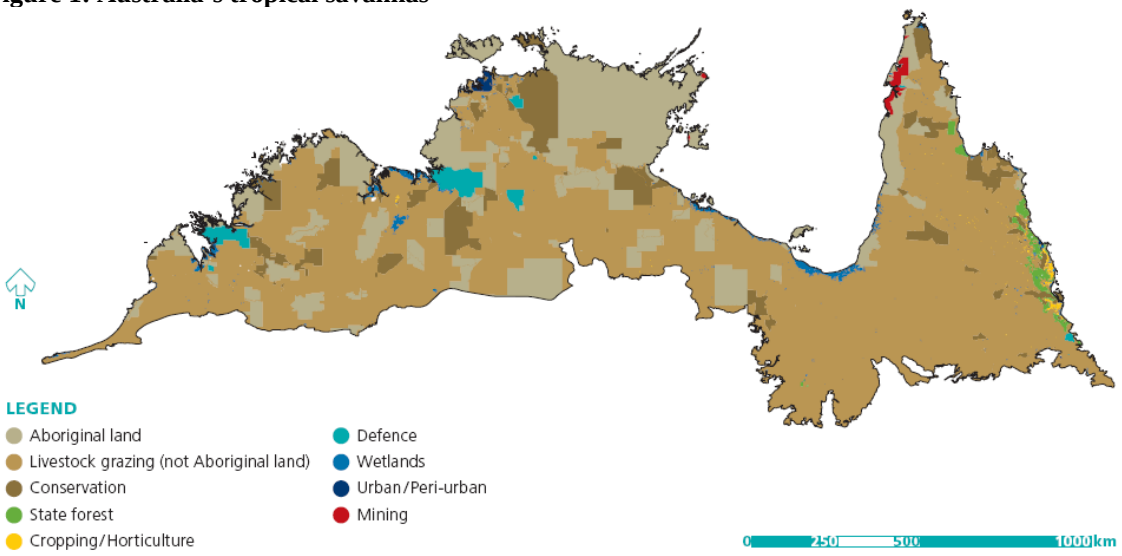
Keyords

Graziers, goals, conservation, tropical savannas, impediments, incentives

Introduction

Australia's tropical savannas are the environments of dense grass and scattered trees that range over the vast majority of the northern part of the continent (TS-CRC, 2008). The tropical savannas are home to a rich variety of plants and animals and, in Australia, substantial portions of these ecosystems are relatively pristine (Woinarski *et al*., 2007). Currently the tropical savannas have a population of approximately 500,000 with more than half living in Townsville and Darwin. The majority of land (65%) is used for grazing purposes (Figure 1); Aboriginal land and the conservation estate are the next largest uses of land representing approximately 11% and 5% of the area respectively (Garnett *et al.*, 2008).

Figure 1: Australia's tropical savannas



Source: (Woinarski *et al.*, 2007) page 25

Australia contains more than 25% of the world's remaining tropical savannas (Woinarski *et al.* 2007). While relatively intact these landscapes are under increasing threat due to a multitude of interacting factors including the introduction of exotic plant and animal species, intensification of pastoral production, and climate change (Woinarski *et al*. 2007). The traditional approach to conservation through the development of reserves and conservation parks is unlikely to succeed in the tropical savannas due to their expansiveness, interconnectedness and the lack of unallocated land – conservation efforts will require the inclusion of land managers to be effective in conserving the natural values of the tropical savannas (Woinarski *et al*. 2007). As the most extensive users of land in the tropical savannas, and in response to the limitations of the conventional approach to conservation (Woinarski *et al*. 2007) graziers are coming under increasing pressure to incorporate the amenity and environmental values of the remainder of the Australian population in their operations (Greiner *et al.* 2008).

In recent decades there has been a shift in the perception of land and landscapes from a primary productivity focus to one that values the intrinsic characteristics of natural ecosystems and their ecosystem services (Greiner *et al.* 2009; Holmes 2002; Wilson 2001). In Australia the shift in focus from a productivity orientation to one including environmental values arguably began in 1989 with the National Landcare Program (NLP) which, at that time, was the single largest stand-alone public investment with conservation objectives in Australia's history (Hajkowicz 2009). The primary success of the NLP was that it raised awareness and engaged communities in conservation activities (Hajkowicz, 2009).

Adoption rates of conservation practices advocated under different conservation schemes have tended to vary widely following the implementation of the NLP (Pannell *et al*., 2006). Recent programs implemented to improve conservation outcomes across Australian catchments (National Heritage Trust 1~ $1.3b; National Heritage Trust 2~ $1.2b; National Action Plan for Salinity and Water Quality ~$1.4b) have generally been unable to demonstrate significant results with respect to their intended outcomes (Hajkowicz 2009). There is a consensus that conservation outcomes will require greater provision of financial incentives to be effective – however there is a danger of public investments crowding out intended private investments in conservation activities (Hajkowicz 2009). The issue of low levels of effectiveness for traditional and more modern conservation schemes such as those described by Hajkowicz (2009) is cause for concern for the tropical savannas where "the contributions of all property-holders and managers are needed to maintain the North's natural values" (Woinarski *et al.* 2007: p88).

A number of papers in the scientific literature suggest that landholder preferences and goals play a significant part in the adoption process of new innovations in agriculture (Greiner *et al.* 2008; Kancans *et al*. 2008; Maybery *et al*. 2005; Pannell *et al*. 2006; Torkamani 2005). For example Greiner *et al.* (2008)

demonstrated that graziers in the Burdekin region with relatively strong conservation and lifestyle motivations were more likely to adopt conservation practices because they were intrinsically motivated to do so. These results suggest that graziers may follow different pathways when considering the adoption of conservation practices depending on their motivational orientation. The questions are then: How do different motivations come to affect the adoption of conservation practices? Are they directly related to the adoption of conservation practices or do they affect adoption through a different perception of the relative importance of impediments and the relative effectiveness of any incentives offered within a conservation scheme?

This paper presents research on the empirical relationships between graziers stated motivations, perceived impediments to undertaking conservation measures and the effectiveness of incentives to facilitate the adoption of conservation measures in the tropical savannas. Three existing datasets from the Northern Territory (Greiner *et al.*2008), the Northern Gulf (Greiner and Miller, 2008), and the Burdekin (Greiner *et al.* 2007) are combined to provide a dataset spanning a large proportion of the Australian tropical savannas. This dataset is used to test the hypothesis that graziers with different goals have different perceptions of the importance of impediments to undertaking conservation measures and of the effectiveness of incentives to alleviate these impediments.

The first section of this paper provides a review of literature on impediments and incentives associated with the adoption of conservation practices by graziers in Australia. This is followed by a description of the methodologies used in collecting and combining the data and in the data analysis. Results from the data analysis are then presented followed, finally, by a discussion of the results and conclusions.

The role of impediments and incentives in the adoption of conservation measures by Australian rangelands graziers

Investments in the environment are, essentially, investments in a good that is inherently public (Hajkowicz 2009; Reeson 2008). Economic theory suggests that private investments in a public good will generally occur below the socially optimal level. Rational actors will invest in public goods only to the point where their marginal private benefits are equal to their marginal private costs for such an investment (Reeson 2008). Fortunately, in the case of supplying environmental services, many people voluntarily contribute far more than would seem to be rational given their marginal private use benefit from such investments (Reeson 2008).

Graziers may be influenced by intrinsic or extrinsic incentives for the adoption of conservation practices. Those with intrinsic motivation may invest in conservation measures at levels beyond what would be rational if they were only considering marginal private benefits whilst those influenced by predominantly extrinsic factors might be described more accurately by the rational actor model (Reeson 2008). Maybery *et al.* (2005) described three categories of goals by which graziers were motivated, namely – economic, conservation, and lifestyle. Similarly Grenier *et al*. (2009) classified the motivational orientation of graziers in the Burdekin into three categories, namely – financial/economic; conservation and lifestyle; and social.

The basis for differences in adoption rates of conservation practices may not lay solely in the motivational arena. A common decision theory framework within economics is the utility maximization hypothesis where decision makers maximize utility subject to some constraints (Cox, 1997). Utility may be derived from predominantly economic, conservation, lifestyle or social factors as implied by the motivational orientation of graziers. However graziers maximize their utility when deciding to adopt conservation practices subject to some constraints. As such we cannot proceed to develop a framework for the design of conservation schemes without understanding these constraints in addition to the motivational orientation of graziers. Factors resulting in differential adoption rates for conservation practices are observed to come from a variety of sources including resource constraints, risk issues and characteristics of the practice itself (Pannell *et al.* 2006). Increasingly there is a realisation that conservation measures must consider the human dimension in addition to the production-conservation trade-off (Vogt 2007).

Economic considerations are key drivers of intensification of grazing systems in Australia (Greiner *et al*. 2007, MacLeod and McIvor 2008) and are generally considered to be extrinsic incentives (Reeson 2008).

The adoption of conservation practices, often involves a de-intensification or restriction of options for future intensifications in conserved areas. This can lead to reduced returns from land and reduction in (use) option values for areas subject to conservation measures. Given their importance in land management decisions economic factors are a logical inclusion in the list of constraints to adoption of conservation practices.

Other factors that play an important part are those of risk and uncertainty and learning (Marra *et al.* 2003). Uncertainty over future market conditions, regulations, climatic conditions and other factors have been shown to play a role in the decision process for landholders considering adoption of agricultural innovations and conservation practices (Greiner *et al*. 2009; Pannell *et al*. 2006; Marra *et al.* 2003). Knowledge and learning are also aspects that impact on the decision process when landholders consider the adoption of conservation practices on their land (Pannell *et al*. 2006).

Social and conservation considerations are also important. Altruism, self-image and fairness aspects can overcome financial motivations (Reeson 2008). The danger of considering only economic aspects in the development and extension of conservation schemes is that the creation of formal institutions providing financial and/or regulatory incentives can crowd out intrinsic motivations to undertake a conservation activity (Reeson 2008). The result of crowding out of intrinsic conservation intentions is a decline in the efficiency of conservation schemes.

This paper seeks to provide empirical evidence to demonstrate that motivations influence graziers' perceptions of the constraints to adoption of conservation measures and the efficacy of incentives in alleviating these constraints. This hypothesis is examined by testing for significant relationships between the goal orientation of graziers, the perceived importance of impediments to the adoption of conservation practices and the perceived effectiveness of incentives in alleviating constraints that these impediments impose.

Method

The research presented in this paper is based on the amalgamation of data from three separate but related surveys of graziers across the tropical savannas region of Australia. All three surveys dealt with matters relating to the adoption of conservation practices by graziers and explored the relationships between graziers goals, the importance of impediments as constraints to adoption of conservation practices and the effectiveness of incentives in alleviating these constraints. Table 1 provides a brief description of the purpose of each survey and some descriptive statistics.

Table 1: Description of the three surveys utilized in this research

Survey region	Year conducted	Sample size	Sample response rate	Percentage of combined dataset	Purpose of survey
Northern Territory	2008	63	33%	28%	Evaluate graziers perspectives on conservation covenants and conservation management agreements
Northern Gulf (Qld)	2007-8	76	35%	34%	Provide a foundation for the development of a grazing code of practice in the Northern Gulf
Burdekin (Qld)	2006-7	85	32%	38%	Evaluate the adoption of Best Management Practices amongst graziers in the Burdekin region

The three surveys contained a set of three questions eliciting graziers motivations, perceptions on the importance of constraints to adoption of conservation measures and the preferred incentives to alleviate these constraints. Respondents were asked to rank a list of items on an ordinal scale. The questions were:

(1) "When you think about being a grazier and managing your operation, how important are the following goals to you?"

(2) "To what extent do the following factors currently prevent you from undertaking conservation measures on your operation?"

(3) "How effective would the following measures be in removing those impediments and helping you to undertake (more) conservation activities on your operation?"

The motivational questions asked respondents to provide an indication of the importance to them of a range of goals related to the grazing lifestyle. These broadly covered economic, lifestyle, environmental and social goals. Respondents in all three surveys were asked to rank items listed on a scale from 1 ("Not at all important") to 10 ("Extremely important"). There were 10 equivalent motivational items present across the three surveys.

The impediments to conservation measures questions asked respondents to provide an indication of the level of constraint a range of factors played in limiting the adoption of conservation measures on-farm. Impediment items covered a range of sources including: financial and resources constraints, knowledge limitations, practicality issues and, risk and uncertainty issues. Burdekin respondents rated these items on a scale from 1 ("Not a constraint") to 10 ("Fundamental constraint"). Northern Territory and northern Gulf respondents rated these items on a scale from 1 ("Not an impediment") to 5 ("Fundamental/Major impediment"). A total of 10 impediment items were equivalent across the three surveys. The difference in rating scales for the impediments question was rectified by halving the scores for Burdekin graziers.

Graziers were asked to rate a range of incentive items in terms of their effectiveness in alleviating constraints to undertaking conservation measures on-farm. The lists included incentives based on: financial incentives, improved information collection and flows, increased public and peer recognition, management plans, and government intervention (regulation). All graziers rated the effectiveness of incentive items on a scale from 1 ("Completely ineffective") to 5 ("Completely effective"). A total of 11 incentive items were equivalent across the three surveys.

The ordinal nature of the data necessitated some adjustments prior to the merging of the dataset. Question lists from each of the surveys included some items that were not common across the three surveys – results from these items were not included in this analysis. Due to the different settings in which the questions were contained (overall survey orientation) and the fact that the presented lists were not identical between the surveys graziers may have responded with different points of reference on which to rate items. The absolute level of rating was not of concern for this research; rather the relative differences between ratings were of primary interest as this alone can show how responses to three questions are related. To ensure that regional/survey reference points did not confound the examination of relationships the distribution of responses to each question and each region were corrected by subtracting mean ratings from individual responses. A mathematical representation is provided below:

$$x_{ijk}^{*} = x_{ijk} - \sum_{i=1}^{n} x_{ijk}$$

Where:

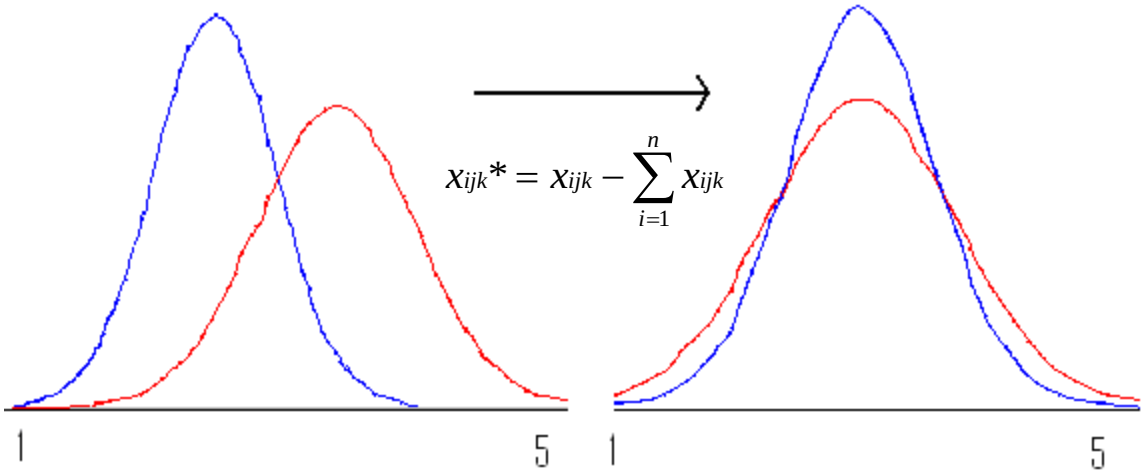
x* = Adjusted response variable

i = Response

j = Survey (i.e. Northern Territory, northern Gulf or Burdekin)

k = Question (i.e. motivations, impediments or incentives)

Figure 2: **Two distributions with different locations and variance (left) and the same distributions re-located over the same point by subtracting the mean from each element (right)**



Factors were derived from the items using Principal components analysis (PCA) to group variables which were highly correlated and represent them as a new single variable (StatSoft, 2001). In doing so, PCA identifies underlying structures or latent variables using combinations of indicator variables. The variance contribution of each factor component was extracted using orthogonal axis rotation. Missing data were deleted from the relevant data analysis matrix in a pair-wise manner. Multiple models were estimated and final models were selected on the basis of parsimony and consistency of factor structure.

Correlation analysis was undertaken using Spearman rank order correlation. The distributions of derived factor variables were significantly non-normal and thus not conducive to the use of the Pearson R correlation coefficient (Diekhoff 1992).

Histograms and non-parametric (Mann-Whitney U) tests for differences in distributions are presented using original data normalised to identical scales but not centred over the same location as in the procedure above (Figure 2). Non-parametric tests were employed because of the non-continuous data obtained from responses using Likert scales and because distributions were significantly non-normal.

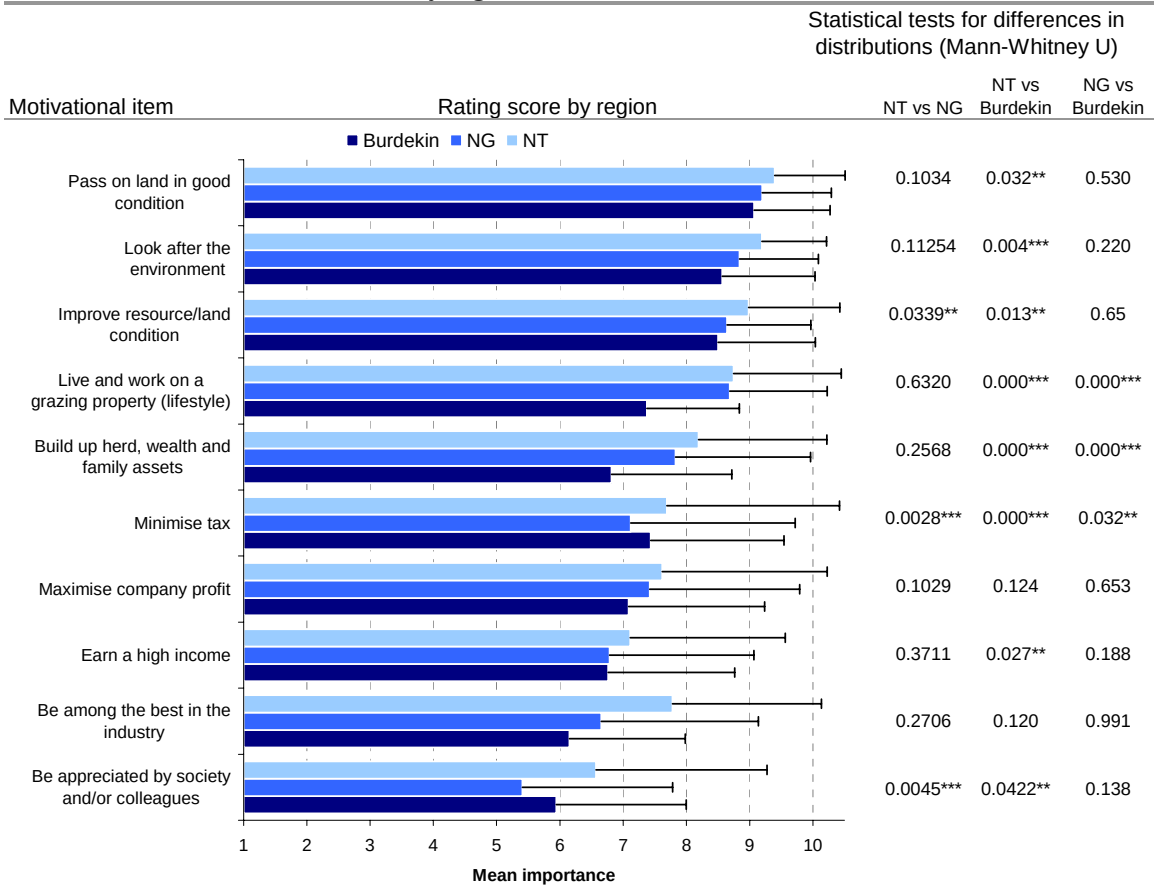
Data analysis was carried out in STATISTICA – a comprehensive, integrated data analysis, graphics, and database management system (StatSoft, 2001). Data management was undertaken in Microsoft Excel™.

Results – Histograms and regional differences

The first set of tests sought to explore whether there were differences in motivational orientation, the perceived impediments to conservation and the preferred incentives amongst the sub-samples (Northern Territory, Northern Gulf, and Burdekin respondents).

Figure 3 shows histograms of the mean and standard deviation for motivational items by region. Results are presented with statistically significant differences – p-values are shown to the right of the histogram for the paired differences tests.

Figure 3: Means, standard deviations and statistical differences of rating scores for motivational items by region

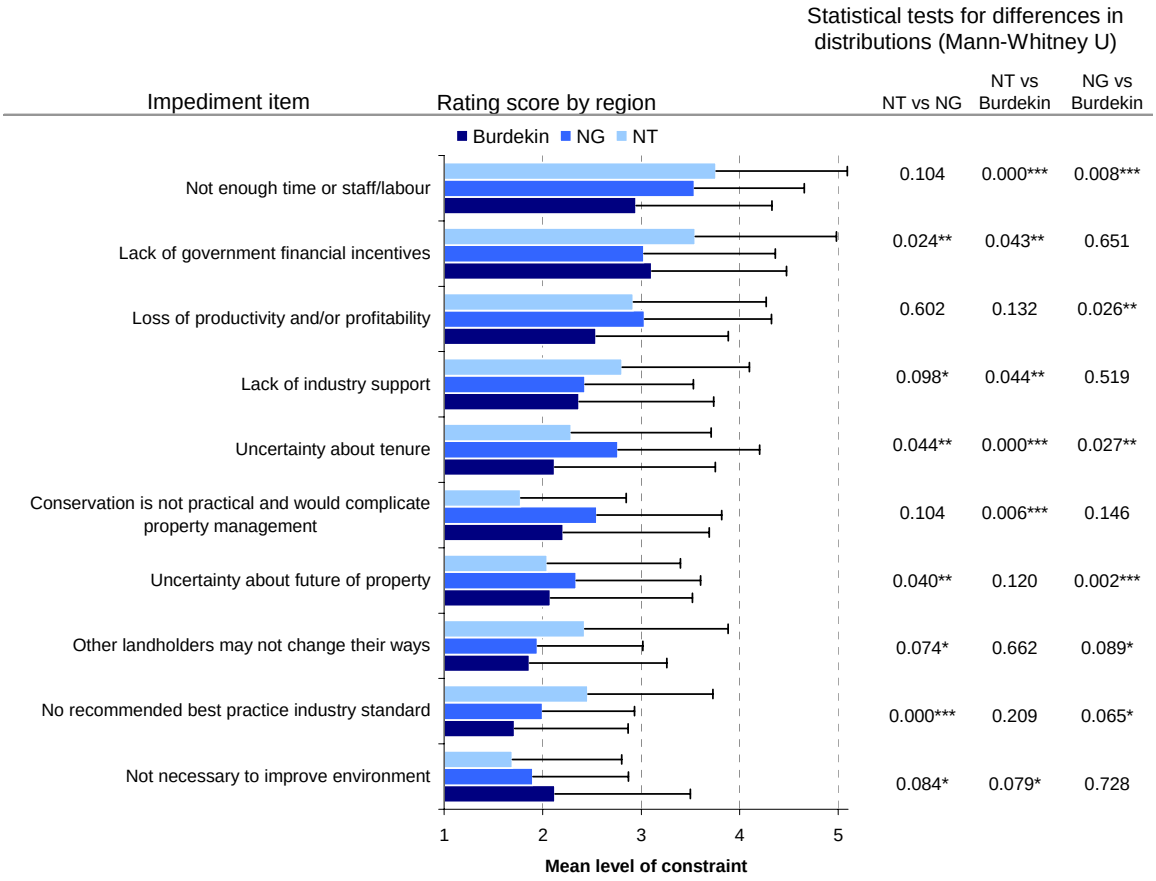


Note: **** = significant at 5% level of significance**
***** = significant at 1% level of significance**
Items sorted by overall mean value.

Graziers from all three regions rated stewardship aspects as the top three items. Lifestyle was also rated highly by Northern Territory and Northern Gulf graziers but somewhat less by Burdekin graziers. The motivational item "Be appreciated by society and/or colleagues" was consistently rated as the item of least importance. The majority of ties in ranks (where two regions ranked an item in the same place) occurred between the Burdekin and Northern Gulf group (six ties). The Burdekin and Northern Territory groups had four ties and the Northern Gulf and Northern Territory groups had five ties. There were a total of three ties when comparing all three groups of graziers.

Results of the regional analysis for the importance of impediments are shown in Figure 4.

Figure 4: Means, standard deviations and statistical differences of rating scores for impediment items by region



Note: **** = significant at 5% level of significance**
***** = significant at 1% level of significance**
Items sorted by overall mean value.

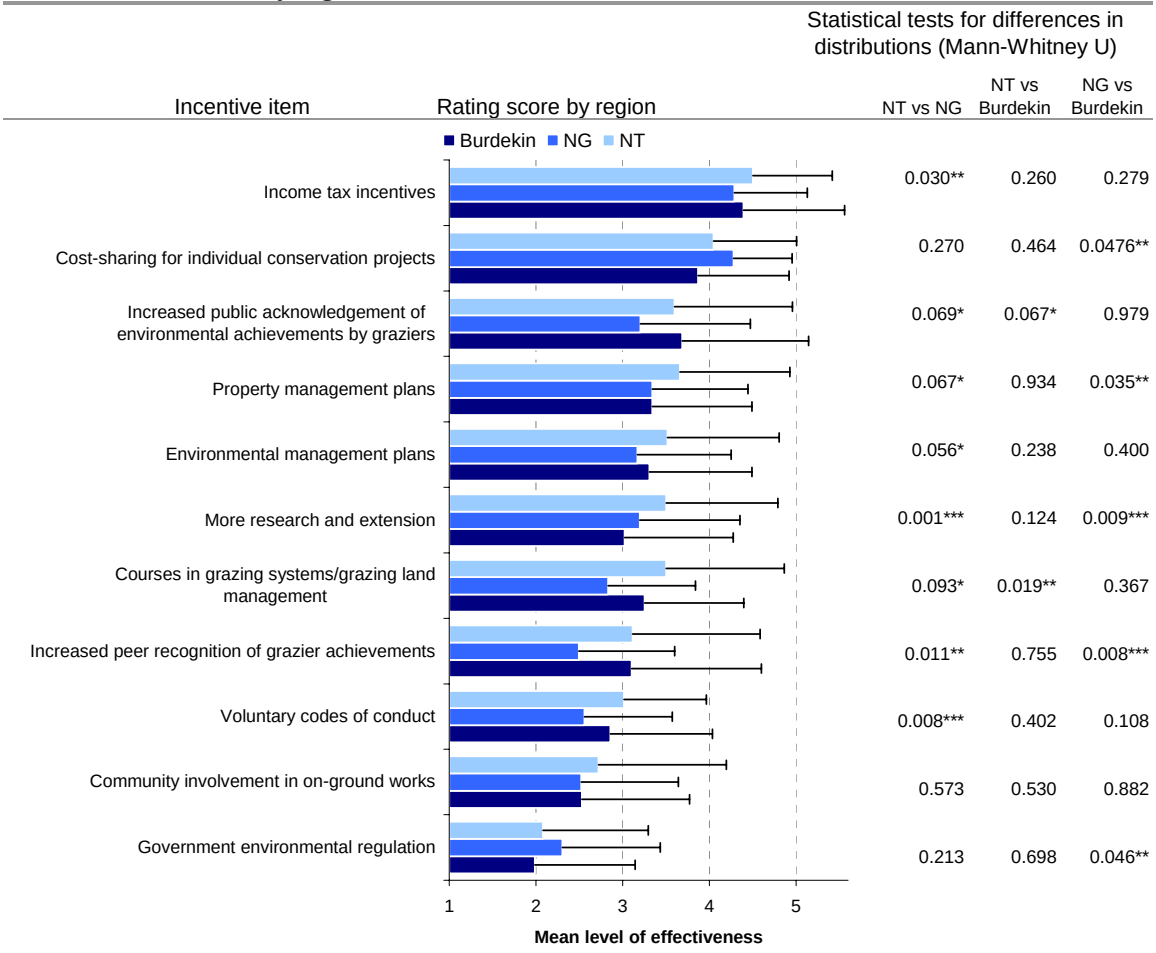
The top three rated impediment items were the same across the three regions and broadly reflected productivity concerns and a lack of resources. Burdekin graziers rated the assertion that conservation practices were "not necessary to improve the environment" as the sixth most important impediment to conservation practices – this compares with Northern Territory and Northern gulf graziers who considered it the least important (10th most important). Burdekin and Northern Gulf graziers considered the practicality of conservation measures and uncertainty over tenure as relatively more important than Northern Territory graziers. Northern Territory graziers, on the other hand, considered the lack of a best practice industry standard and the fact that other landholders may not change their ways as relatively more important than the Northern Gulf and Burdekin graziers.

Four ties in ranking location were observed for the Burdekin and Northern Territory graziers. One tie in item ranking was observed for the Burdekin and Northern Gulf comparison and two were observed for the Northern Gulf and Northern Territory comparison.

The range of ratings from each group varied widely with at least five significant differences in the location of distributions when using paired tests for differences.

Figure 5 presents the regional analysis of effectiveness ratings for incentives.

Figure 5: Means, standard deviations and statistical differences of rating scores for incentive items by region



Note: **** = significant at 5% level of significance**
**** = significant at 1% level of significance**
Items sorted by overall mean value.

Graziers from all three regions considered financially oriented incentives to be the most effective in alleviating constraints to the adoption of conservation practices on-farm. There were no major differences in the rankings between regions with the relative rankings of incentive items differing by one ranking position at most.

There was a high level of agreement on the ranking of incentive items for the three graziers groups. The most similarities were observed for the Burdekin and Northern Territory groups for which seven ties were observed for item rankings. The least similar were the Burdekin and Northern Gulf groups with three ties in item ranking observed. For Northern Gulf and Northern Territory graziers, ties in ranking were observed for six incentive items.

Results – Factor model estimation and correlation analysis

The following section presents the results of PCA derived factors for the motivational orientation of graziers and their perceived impediments and preferred incentives with regards to conservation measures.

PCA on motivational items produced a three factor model shown in Table 2 explaining a total of 70% of the variance within the dataset for this question. There was no incidence of items loading on multiple factors for goal orientation and the factors derived were internally consistent.

Table 2: Factor loading matrix of Goals: three factor model (valid n = 213)

Motivation items	Factor 1	Factor 2	Factor 3
Be appreciated by society and/or colleagues	0.186	0.157	**0.808**
Be among the best in the industry	0.156	0.108	**0.848**
Build up herd, wealth and family assets	**0.818**	0.106	0.177
Earn a high income	**0.855**	0.060	0.141
Improve resource/land condition	0.068	**0.860**	0.218
Live and work on a grazing property (lifestyle)	0.299	**0.549**	0.013
Look after the environment	0.020	**0.897**	0.108
Maximise company profit	**0.879**	0.119	0.146
Minimise tax	**0.649**	0.233	0.065
Pass on land in good condition	0.191	**0.882**	0.084
Variance explained	2.786	2.743	1.516
Proportion of variance	0.279	0.274	0.152

Goal 1: Financial and economic
Goal 2: Conservation and Lifestyle
Goal 3: Social and peer group

The motivations factor model explains a high proportion of the variance within the dataset and is consistent with Greiner *et al*. (2009) who estimated a Principal Components Model on the Burdekin data only.

Financial and economic goals primarily reflect a production and profit orientation with goals including wealth and asset accumulation and profit and tax minimization. Conservation and lifestyle goals reflect concerns oriented around sustainability, conservation, and lifestyle considerations. Social and peer group goals reflects desires to be appreciated by society/colleagues and to be among the best graziers in the industry.

PCA on impediment items produced a four factor model which is shown below in Table 3 which explained 65% of the variance within responses to this question.

The impediment factor “opportunity costs” represents constraints to the adoption of conservation measures based on a view that they are not practical, not necessary and have adverse impacts on productivity/profitability. The factor “financial and resources constraints” represents capacity constraints – in terms of labour, capital and time resources, and lack of industry support. Issues with uncertainty over the future of the property and tenure are described by the factor “uncertainty”. The fourth factor, “no best practice and lack of integrated action”, represents a perceived lack of industry position on the matter, absence of recommended best practice standards and free-rider/effectiveness issues due to neighbouring landholders failing to adopt the conservation practices.

Table 3: Factor loading matrix of Impediments: four factor model (valid n = 178)

Impediment items	Factor 1	Factor 2	Factor 3	Factor 4
Conservation is not practical	**0.799**	0.049	0.149	0.182
Lack of government financial incentives	0.049	**0.712**	0.175	0.166
Lack of industry support	0.024	**0.733**	0.099	0.392
Loss of productivity and/or profitability	**0.695**	0.262	0.110	-0.032
Not enough time or staff/labour	0.166	**0.706**	-0.094	-0.099
Not necessary to improve environment	**0.623**	-0.069	0.012	0.478
No recommended best practice industry standard	0.061	0.172	0.101	**0.801**
Other landholders may not change their ways	0.199	0.100	0.102	**0.760**
Uncertainty about future of property	0.230	0.046	**0.818**	0.036
Uncertainty about tenure	0.016	0.074	**0.858**	0.156
Variance explained	1.637	1.666	1.509	1.699
Proportion of variance	0.164	0.167	0.151	0.170

Impediment factor 1: Opportunity costs
Impediment factor 2: Financial and resources constraints
Impediment factor 3: Uncertainty
Impediment factor 4: No best practice and lack of integrated action

Table 4 shows the five-factor incentives model resulting from PCA which explained 66% of the total variance within the data.

Table 4: Factor loading matrix of Preferred Incentives: five factor model (valid n = 192)

Incentive items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Cost-sharing for individual conservation projects	0.146	-0.110	**0.852**	0.215	0.080
More research and extension	0.152	0.020	0.045	0.108	**0.854**
Courses in grazing systems/grazing land management	0.307	0.139	0.064	0.013	**0.748**
Voluntary codes of conduct	**0.645**	-0.081	0.150	0.058	0.181
Community involvement in on-ground works	0.398	-0.063	0.161	**0.533**	0.150
Property management plans	**0.863**	0.178	0.062	0.068	0.178
Environmental management plans	**0.833**	0.235	-0.007	0.158	0.159
Increased public acknowledgement of environmental achievements	0.209	**0.847**	0.151	-0.113	0.045
Increased peer recognition of grazier achievements	0.013	**0.899**	-0.010	0.160	0.101
Income tax incentives	0.050	0.350	**0.774**	-0.197	0.035
Government environmental regulation	0.049	0.078	-0.045	**0.903**	0.030
Variance explained	2.202	1.785	1.408	1.267	1.422
Proportion of variance	0.200	0.162	0.128	0.115	0.129

Incentive factor 1: Guidelines and management plans
Incentive factor 2: Peer and public recognition
Incentive factor 3: Financial incentives
Incentive factor 4: Community involvement and regulation
Incentive factor 5: Research, extension and education

The first incentive factor ("guidelines and management plans") represents the application of guidelines and planning tools to alleviate constraints to conservation. The incentive factor "peer and public recognition" describes improvements in public and peer recognition as facilitating the adoption of conservation measures. Incentive factor 3 ("financial incentives") represents items such as cost-sharing and income tax incentives. The fourth incentive factor ("community involvement and regulation") represents the involvement of local community in farm work and the application of government environmental regulation. The last factor ("research, extension and education") describes research, extension and education efforts as alleviating constraints to conservation.

Correlation analysis (Spearman rank order correlation) was undertaken to enable a description of how graziers' goals related to perceived impediments to conservation activities and the preferred incentives to alleviate these impediments. Correlation coefficients were calculated between all three factor model combinations. Missing data were deleted in a case-wise manner. Table 5 shows the correlation between

factors derived from graziers' goals and impediment and incentive factors for respondents across the three survey regions.

Table 5: Correlations between factors for graziers' goals and impediment and incentive factors (Spearman rank order correlation)

	Motivation factors		
Impediment factors	Financial and economic	Conservation and lifestyle	Social and peer group
Opportunity costs	**0.19****	**-0.17****	-0.05
Financial and resource constraints	**0.21*****	0.03	0.10
Uncertainty	-0.07	-0.08	0.09
No best practice and lack of integrated action	0.14	-0.04	**0.26*****
Incentive factors			
Guidelines and management plans	**0.24*****	**0.22*****	**0.19*****
Peer and public recognition	**0.24*****	**0.15****	**0.40*****
Financial incentives	**0.15****	**0.17*****	-0.02
Community involvement and regulation	**0.15****	0.12	**0.21*****
Research, extension and education	**0.18****	**0.16*****	**0.17****

Note: ** = significant at 5% level of significance
***** = significant at 1% level of significance**

Graziers with strong *Financial and economic* goals considered a range of impediment types to be more important in terms of the level of constraint they placed on the adoption of conservation practices than graziers with strong *Conservation and lifestyl*e or *Social and peer group* goals. Specifically, graziers with strong *Financial and economic* goals were significantly positively correlated with rating *Opportunity costs* and *Financial and resources* constraints highly in terms of their importance as impediments to the adoption of conservation practices. Graziers with strong *Social and peer group* goals were significantly positively correlated with rating the impediment factor *No best practice and lack of integrated action* highly as a constraint to adoption of conservation measures. Graziers with strong *Conservation and lifestyle* goals were less likely to rate *Opportunity costs* as significant impediments to the adoption of conservation measures on farm.

The examination of relationships between graziers goals and incentive factors showed that graziers with strong *Financial and economic* goals were significantly positively correlated with the whole range of incentive types. Graziers with strong *Social and peer group* goals were also significantly correlated with a wide range of incentive types but not *Financial incentives*. Those graziers with strong *Conservation and lifestyle* goals were positively associated with all types of incentives other than *Community involvement and regulation* type incentives. The positive correlation between *Conservation and lifestyle* goals and *Financial incentives* was greater than that between *Financial and economic* goals and *Financial incentives*. The strongest correlation between incentive factors and graziers goals is that between *Social and peer group* goals and the incentive factor *Peer and public recognition*.

Discussion

This research utilised a combination of three sets of data obtained from graziers across the tropical savannas of Australia. Previous research (e.g. Greiner *et al.* 2009) was limited by sample size and was thus considered to be exploratory in nature. The research builds on that of Greiner *et al.* (2009) who examined one of the three datasets (Burdekin) included in this paper.

The opportunity to combine three datasets was the result of three similar surveys in the Burdekin (Greiner *et al*. 2007), Northern Gulf (Greiner and Miller 2008) and the Northern Territory (Greiner *et al.* 2008). The surveys contained identical questions on the importance of motivations to graziers, the perceived importance of a range of impediments acting as constraints to the adoption of conservation practices, and the perceived effectiveness of incentives in alleviating constraints. The total sample size available for analysis in this paper was 224.

Two issues were identified with combining the datasets. Firstly the rating scales were not identical for one of the questions (perceived importance of impediments). This issue was dealt with by halving the scores obtained for Burdekin respondents to ensure all responses were on a scale from 1 ("Not an impediment") to 5 ("Fundamental/major impediment"). Secondly, responses were provided on an ordinal scale which could have been influenced differentially by survey scope, positioning of questions with the surveys and inclusion of different items within each question. This was dealt with by applying a correction factor that centered the distributions of responses over the same location.

Statistical analysis of the dataset initially involved testing for significant differences between the regions in responses to questions using non-parametric (Mann-Whitney U) tests. This was followed by the application of PCA to all responses for the questions to derive factors of strongly correlated groups of items. The factors for each question (motivations, impediments and incentives) were then tested for statistically significant correlations using Spearman's rank order coefficient, a non-parametric alternative to Pearson's R.

The key drivers for land management decisions have been identified alternatively as economic considerations (e.g. MacLeod and McIvor 2008) or a combination of personal and economic considerations (e.g. Greiner *et al*. 2009, Reeson 2008). Personal considerations have been modeled as graziers goals in a number of studies (Greiner *et al.* 2009; Greiner and Miller 2008; Maybery *et al*. 2005). Factors describing goals of graziers which were identified in this research are entirely consistent with those identified by Greiner *et al*. (2009) and are broadly consistent with those identified by Maybery *et al*. (2005).

In two of the studies which have described the goals of graziers (Greiner *et al.* 2009; Greiner and Miller 2008) correlations between motivation factors (graziers goals) and impediments and incentives to conservation were estimated to observe relationships between these variables and their relevance to the adoption of conservation practices. Greiner *et al*. (2009) showed that graziers with strong conservation and lifestyle goals were more likely to adopt a range of conservation practices than graziers with strong financial and economic or social goals. In these previous studies (Greiner *et al* 2009; Greiner and Miller 2008) sample sizes limited the interpretability of results. This research builds on these previous works to provide a more detailed examination of the linkages between graziers goals, the impediments to conservation and incentives to alleviate impediments.

Economic considerations are important in graziers' decisions on whether to adopt a conservation practice (Reeson 2008; Pannell *et al*. 2006; Greiner and Miller 2008). However it has been shown that these extrinsic constraints can be balanced and even overwhelmed by intrinsic motivations or incentives such as a desire to carry out environmental investments (Reeson 2008). This can result in private investments in environmentally beneficial practices beyond a level that would be considered normal for a public good (Reeson 2008). The results from this and previous research (e.g. Austin *et al.*1998, Greiner *et al*. 2009) show that farmers attach great importance to the conservation and lifestyle aspects of livestock production – i.e. there likely exists intrinsic motivations to manage productive land in an environmentally sustainable manner amongst the graziers of the tropical savannas.

We can now propose a decision framework that is utilized by graziers with diverse motivations. It suggests that the impediments to conservation are judged subjectively and thus viewed through a lens coloured by the motivational orientation of a particular decision maker. That is, the extrinsic constraints to adoption described by Reeson (2008) are not independent of the intrinsic motivations of graziers. Their importance

in terms of adoption of conservation practices is a function of the motivational orientation of the decision maker/s and thus beliefs surrounding the characteristics of a particular conservation scheme are subjective. Pannell *et al.* (2006) describe subjectivity with respect to a farmers perspective on the characteristics of a conservation scheme is due to a lack of knowledge, learning or uncertainty and also to farmers goal orientation.

The results of this research support those derived in previous research by Greiner *et al*. (2009) and Greiner and Miller (2008). Specifically:

- Graziers with financial and economic goals were more likely to consider a wide range of impediments to be important constraints to the adoption of conservation measures relative to graziers with either conservation and lifestyle or social and peer group goals
- Graziers with financial and economic goals were positively associated with ranking the entire range of incentives as effective.
- Graziers with conservation and lifestyle goals were not correlated with the rating of impediment items in terms of their importance as constraints to the adoption of conservation practices at any standard level of statistical significance
- Graziers with conservation and lifestyle goals considered guidelines and management plans and research, extension and education to be effective incentives.

Examination of the regional differences showed that, in general, the motivational orientation and perception of impediments/incentives with regard to conservation practices is consistent across the tropical savannas. One curious result however is the relatively high importance that Burdekin graziers gave to the comment "[conservation measures are] not necessary to improve the environment" compared with Northern Territory and Northern Gulf graziers who rated it as the least important impediment consideration. Using information from the National Land and Water Resources Audit (online at http://www.anra.gov.au/_mapmaker; accessed 18/02/2009) it can be seen that the environmental condition of the Burdekin catchment is consistently worse than that of the Northern Territory and the Northern Gulf. This would suggest that conservation measures *are* important to improve the environment in the Burdekin catchment but that many Burdekin landholders are unable to recognize degradation.

Pannell *et al*. (2006) describe the importance of learning and knowledge in the adoption of conservation practices by rural landholders. The results from this research provide support for the importance of learning and knowledge in the adoption process as it is a highly rated incentive, in terms of effectiveness, for graziers motivated by any of the goals described above.

Beyond the role of individual factors in the adoption of conservation practices, this research shows that a diversity of impediments constrains adoption decisions and that the provision of a range of incentives may alleviate these constraints. However these factors cannot be viewed as characteristics of a conservation scheme or region that are independent of the relevant actors within it – they are affected by subjective perceptions on their relative importance (for impediments) or relative effectiveness (for incentives). Hajkowicz (2009) described community landcare groups as suffering from "burnout" – this may be explained as farmers with *Conservation and lifestyle goals* not being provided with sufficient guidance, knowledge or learning experiences which this research shows to be important incentive factors for this group. Even graziers with *Financial and economic goals* may require more than mere financial assistance – they were more strongly associated with rating *Guidelines and management plans* and *Peer and public recognition* as effective incentives than *Financial incentives*. Additionally, graziers with *Social and peer group* goals may require more efforts to promote a favourable public opinion of graziers conservation efforts in the media to undertake increased levels of conservation activity. Of all of the types of incentive types available to graziers, those with strong motivations of any type were significantly positively correlated with rating *Guidelines and management plans*, *Peer and public recognition*, and *Research, extension and education* as effective incentives.

Conclusions

This paper presents empirical research from the combination of datasets from three separate surveys of graziers within the tropical savannas in Australia. The surveys had broadly different objectives but all were carried out with an intention of examining the relationships between graziers goals, the importance of impediments and the effectiveness of incentives with reference to the adoption of conservation practices.

The research set out to test the hypothesis that graziers goals affected the adoption of conservation practices through creating different, subjective views on:

1. the importance of impediments as constraints to adopting conservation practices on farm
2. the effectiveness of incentives in alleviating constraints to the adoption of conservation practices

The results from this research suggest that future conservation schemes should be designed with consideration to the different goals of graziers and the way these goals affect the perception on the importance of impediments to conservation and the effectiveness of incentives.

Of particular note from these results is that graziers with financial and economic goals did not explicitly prefer financial incentives – rather they considered the whole range of incentives to be effective in facilitating the adoption of conservation practices. All respondents to these surveys were highly motivated graziers – irrespective of their predominant type of motivation. Graziers of any motivation were significantly positively correlated with rating *Guidelines and management plans*, *Peer and public recognition*, and *Research, extension and education* as effective incentives to alleviate constraints in the adoption of conservation practices.

This research shows that graziers are not a homogenous group with a purely objective understanding of the constraints they face to adoption of conservation measures on-farm. Graziers across Australia likely have heterogeneous motivations which influence their perception of the constraints to adoption of conservation measures and the effectiveness of incentives to alleviate constraints. The significance of these motivations in influencing subjective judgements on the influence of constraints and incentives suggests conservation schemes should be developed with a high level of input from the target grazier population. Grazier input should facilitate the elicitation of subjective views of constraints to adoption of conservation practices and the preferred incentives to alleviate these constraints.

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