

Pre-print

Heterogeneity in preferences for non-financial incentives to engage landholders in native vegetation management

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This document represents the initial draft of the article prior to peer review and is not the final version accepted for publication by *Land Economics*. While the pre-print and published article are not substantially different, readers should refer to the published article when it is available, as it further clarifies aspects of the methodology, interpretation, and conclusions drawn from the results.

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Abstract

Most of Australia's native-forest vegetation is located on private land, and conservation success often depends on farmers' participation in bush management programmes. 251 landholders within the Brigalow Belt bioregion of southeast Queensland were asked to make pairwise comparisons of 10 non-financial incentives and one financial compensation scheme. Based on a latent class analysis we identify three distinct landholder classes. We discuss the implication of our results for the future design of native vegetation management and conservation policies.

Introduction

Australia has a long and tumultuous history with native vegetation management dating back to colonisation by European settlers in the early 19th century (Bradshaw 2012). Demand for agricultural products has led to largescale changes in the landscape, as farmers have cleared native forests and bushland to make way for pasture and cropland. This historical trend is particularly evident in the northern Australian state of Queensland. Over the last 20 years, land clearing rates in Queensland have fluctuated dramatically, largely due to a politically charged environment (Bradley, et al. 2010; Seabrook, et al. 2006; Simmons, et al. 2018a). Currently, many ecosystems are severely threatened or overexploited. Furthermore, relationships and trust between Queensland farmers and the Queensland state government have deteriorated (Dale 2018). Generally, there is pressure on policy makers to restrain budgetary expenses. Hence, policy mechanisms that have been heavily utilised in the past—involving direct payments to farmers to compensate them for changes in regulation or as part of environmental extension programmes—are now seen as unaffordable, even as pressure to regulate increases. In Australia and globally, these pressures have led to growing interest in how policies and environmental schemes can be designed to increase conservation outcomes without relying on financial incentives. This interest has led to a need to better understand the potential effectiveness of non-financial incentives in terms of increasing participation in agri-environmental schemes. Despite some research efforts reported in the literature, the effectiveness of non-financial incentive mechanisms remains poorly understood relative to financial incentive mechanisms, which have been the focus on much of the conservation-related economic research to-date.

We contribute to this knowledge gap by evaluating the preferences of landholders in Queensland, Australia for financial and non-financial incentives to participate in bush management schemes. The main aim of this study was to investigate how landholders rank non-financial incentives compared to financial incentives. We designed and implemented a survey to identify the relative importance of these financial and non-financial attributes and their relevance for designing more effective bush management schemes. We further examined whether a link can be established between key socio-demographic characteristics of landholders and their preferences for non-financial incentives. Finally, we discuss implications of our findings for future design and targeting of bush management programmes with the aim of increasing their conservation effectiveness.

Background

Designing agri-environmental schemes

Agri-environmental schemes are used in many countries to encourage landholders to protect biodiversity or environmental assets on their private lands. A common feature of these programmes is their reliance on financial payment mechanisms to compensate landholders for undertaking conservation activities (Uthes and Matzdorf 2013). The rate of payment is often a pre-determined fixed payment or dynamically determined through a competitive bidding process (e.g. a conservation tender scheme). While designing these programmes, it is generally expected that higher financial payments would encourage more landholders to participate in such programmes (de Vries and Hanley 2016; Shogren, et al. 1999). However, evidence suggests that agri-environmental schemes relying on financial instruments often fail to attract sufficient numbers of participants to make such programmes effective. For example, a review by Rolfe, et al. (2018) found that participation rates in conservation tenders varied from 1% to 50% in developed countries, with most cases obtaining less than 20%. This begs the question of how to design such programmes to make them more attractive to landholders and ultimately more efficient in terms of environmental protection.

While it has been demonstrated that financial motivations are the major driver of landholder decisions regarding environmental protection, a number of studies have shown that landholders also engage for non-financial reasons (Knowler and Bradshaw 2007). Further, there is a considerable grey area between purely financial and purely non-financial incentives. Examples of incentives in this grey area include certification or regulation (H. Raedeke 2001). Both imply a potential impact on the farmer's economic circumstances, though this impact occurs indirectly through market mechanisms, rebates, taxes, or management options. Landholders may have key values and beliefs about the conditions and threats that affect what they individually value. These key values and beliefs may motivate their sense of moral obligation (Stern 1999) to undertake appropriate action to preserve values on their land. Values and beliefs may be influenced by landholders' fundamental beliefs, their attitudes and the decision context (Guagnano et al. 1995). In the absence of ongoing financial incentives, non-monetary reinforcement with social approval or personal commitments may encourage behaviour maintenance and long-term durability of the conservation scheme (Cook and Berrenberg 1981). Asking participants to make visible, personal commitments, such as signing a pledge, has appeared to create longer-lasting behaviour change in some circumstances (Jacquemet et al. 2016).

Understanding preferences for financial and non-financial incentives

Research into incentive mechanisms within agri-environmental schemes is not new (Morris and Potter 1995). The studies on participation in these schemes may be grouped into two approaches. The first applies information about landholders' actual participation (revealed behaviour) in existing environmental programmes. This typically involves investigating the link between participation choice and landholder characteristics (e.g., Knowler and Bradshaw 2007; Rolfe, et al. 2009). Participation in

agri-environmental schemes has been found to correlate with farmer and farm-household characteristics, farm biophysical characteristics, farm financial and management characteristics, and exogenous factors (Knowler and Bradshaw 2007). The second approach relies on stated participation (stated behaviour) in hypothetical programmes. This approach often employs stated choice experiments designed to assess the importance of financial compensation and other non-financial aspects of contract design (e.g. duration, flexibility, monitoring, feedback) on landholders' decision to enter into voluntary environmental-payment contracts (Broch, et al. 2013; Langpap 2004; Layton and Siikamäki 2009; Matta, et al. 2009; Nagubadi, et al. 1996; Vedel, et al. 2015).

Despite substantial research efforts to understand sociodemographic drivers of heterogeneity in farmers' participation decisions, there is limited consensus within the literature regarding directions or magnitudes of impacts related to specific farmer and farm household characteristics. Although some studies have found positive or no influence of age, most studies concluded age to be negatively correlated with agri-environmental scheme uptake (Duke, et al. 2012; Lehtonen, et al. 2003). Other studies have found female owners are more likely to be concerned about the environment (van Ingrid, et al. 2011). Higher education levels (Duke, et al. 2012) and increased habitat availability (Nielsen, et al. 2018) have also been found to increase the probability of selecting a preservation contract. Farm size may play a role in how important an area is for generating financial outcomes. Small-scale farms may be relatively more motivated to own and manage land for non-pecuniary benefits such as aesthetics, nature protection, bequest, and privacy (Creighton, et al. 2002; Maes, et al. 2012; Petucco, et al. 2015; Urquhart and Courtney 2011), compared to large-scale owners. Further, bio-physical factors such as soil fertility and terrain may be correlated with potential opportunity cost of conservation and therefore may reduce the likelihood of participation in conservation (Mohebalian and Aguilar 2016). Contract characteristics such as increased flexibility, reduced monitoring and reduced contract length have been found to increase participation (Christensen, et al. 2011; Greiner 2016; Kaczan and Swallow 2013). Several studies have also found improved communication and feedback to correlate positively with participation (Bernedo, et al. 2014; Braga and Starmer 2005; Cary and Webb 2001; Gsottbauer and Van den Bergh 2011). Psychosocial characteristics may also play an important role. For instance, some farmers might choose to participate in conservation schemes either to conform to their self-image, if they believe others expect them to participate, if other farmers also participate (conditional participation), or if they trust management authorities (Christensen, et al. 2011; Comerford 2014; Tesfaye and Brouwer 2012; Thøgersen 1994; Valbuena, et al. 2010). Finally, large uncertainty regarding future income and cost flows as well as governmental uncertainty regarding schemes and policies have been found to deter participation (Page and Bellotti 2015). Notwithstanding all this, the findings are often case-specific and the cumulative literature is inconclusive in terms of identifying generally valid drivers of participation in agri-environmental schemes.

Study area and land clearing context

Queensland represents the most ecologically diverse state in Australia, encompassing 2.04 M km² of tropical, temperate, and desert bioregions (Fig. 1). Despite only 2.8% of the population being employed in the agricultural industry (Queensland Government

Statistician's Office 2019), 82% of the state is managed as pasture for livestock grazing (ABARES 2016). Consequently, historic land clearing for pasture development has reduced native vegetation cover by at least 50% over the last 200 years and accounts for more than 60% of total clearing in Australia in the last 40 years (Evans 2016). To combat high clearing rates, the Queensland Government enacted the *Vegetation Management Act (VMA) 1999*, which protected remnant (i.e. old-growth) vegetation on private lands throughout the state (Simmons, et al. 2018a). However, policy-uncertainty caused by subsequent regulatory changes—which either strengthened, weakened or removed protection for remnant vegetation—led to ‘panic clearing’ by landholders. Panic clearing describes clearing undertaken in anticipation of changes (usually a strengthening) to regulatory protection for remnant vegetation. This clearing has undermined the effectiveness of the VMA and of a subsequent ban on broad-scale clearing that was implemented in 2007 (Simmons, et al. 2018b; Simmons, et al. 2018c). Remnant vegetation management has remained a debated topic in Parliament, as landholders continue to protest further land clearing restrictions on their property and environmental advocates argue for stronger protection of Queensland's natural resources.

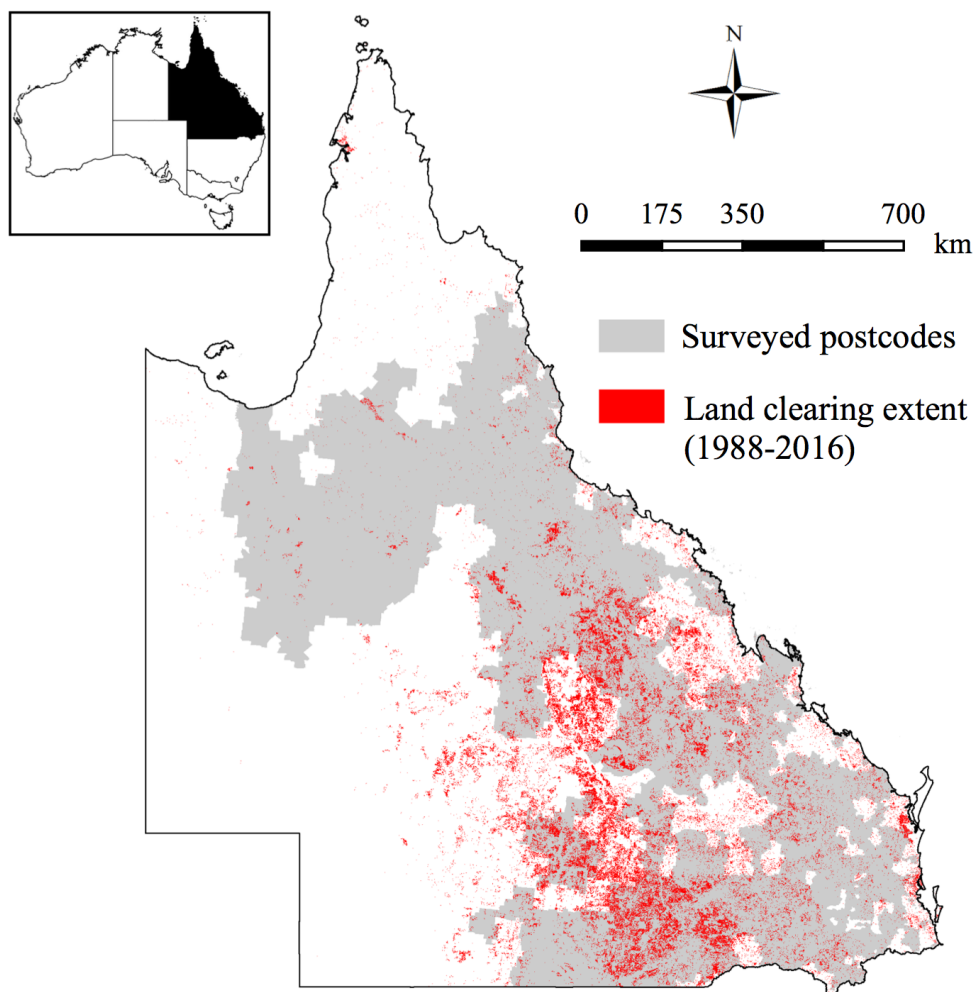


Figure 1

Location of surveyed landholders' primary postcode of residence in relation to recent land clearing extent in Queensland, Australia.

Methods

To assess the preferences for financial and non-financial incentives to participate in bush management schemes in the study area, we use a quantitative survey-based approach involving surveys with relevant stakeholders, i.e. farmers/graziers, landholders, and members of farming families who live in Queensland.

Data collection

Survey participants were recruited by a social research company to complete an anonymous survey over the telephone or online during May 2018. Initially, participants within historical clearing hotspots were targeted for recruitment, and once participant telephone numbers were exhausted in these postcodes, recruitment was expanded into more moderate clearing postcodes throughout the state (Fig. 1). In total, 251 participants completed the relevant survey questions for this study. The majority of participants were male (71%), currently managed a production property (82%), and were the primary decision-maker in the family (72%). The average age was 61 years old, and there was relatively equal representation of all education and income levels (Supplementary Table 1). Most participants only managed one production property and had been managing this land for 34 years, on average. All aspects of data collection, use, and analysis received ethical clearance prior to commencement (Approval #2017001054).

Survey construction

Incentives

Based on a literature review, four anonymous interviews with social scientists and experts in land management behaviour, and one focus group interview with Queensland stakeholders, we identified a total of ten incentives of particular relevance for the decision to engage in bush management contracts (Table 1). These included a direct financial incentive (*financial*), two indirect financial incentives (*certify* and *funding*), and seven non-financial incentives—chosen to represent a variety of potential characteristics of bush management contracts.

We used a paired comparisons approach for eliciting incentive preferences (David 1988), resulting in 45 unique pairwise comparisons. As noted by Louviere, et al. (2015), this approach to ‘object based’ choice has largely been superseded by balanced incomplete block designs that generate sets of k (>2) objects where participants select both “best” and “worst” items. A constraint on our adoption of this approach was the reliance on telephone interviews: it was perceived as too difficult for participants to compare more than two objects if they were not presented on paper. To reduce the time and cognitive demands on participants, each participant received a random subsample of ten of the pairwise comparisons. For each pair of incentives, participants were asked, “Which option is most important to you when considering bush management schemes?” and they could select only one option. Due to the

random presentation of incentive pairs, some incentives may have been presented more than once to a participant or not at all.

Table 1

Incentives of the hypothetical bush management scheme presented to participants.

Description	Abbreviation
Option to certify produce as ‘bush friendly’	<i>certify</i>
Most farmers in the region being involved	<i>popular</i>
Extra public funding for community-based projects	<i>funding</i>
Regular updates on the scheme’s outcomes	<i>updates</i>
Training in best management practices	<i>training</i>
Flexibility to choose the length of the program	<i>duration</i>
Flexibility to choose the areas of land to be included	<i>land area</i>
Low compliance monitoring	<i>monitor</i>
Low paperwork	<i>paperwork</i>
Financial compensation per hectare	<i>financial</i>

Descriptive variables

For an in-depth description of all variables included in the survey and their measurement see Supplementary Table 1 and Simmons, et al. (2020). The following demographic variables were recorded: age, gender, income, education, land manager status, primary decision-maker status, number of years managing their current property, and the postcode(s) of their main place of residence and their property (if applicable). Participants identifying as a current land manager were asked about their clearing behaviours, including if they have trees on their property, how often they have cleared for relevant (i.e. permitted) and non-relevant (i.e. not permitted) purposes in the last five years (as defined by the 2018 version of the *Vegetation Management Act 1999*), the amount of trees cleared in the last five years, their clearing amount relative to other landholders in their community, factors influencing their clearing decisions, and their intentions to clear in the next six months.

The following psychosocial variables were measured for land managers only: values (economic, lifestyle, and conservation values), place attachment, farmer self-identity, loss aversion, and social capital. The remaining psychosocial variables were measured for all survey participants: sense of security, attitudes (anti-clearing and anti-regulation), ‘good farmer’ definition, perceived threat of regulation, trust in the government, emotions to regulation, perceived behavioural control, social norms (tree clearing and regulatory disobedience), awareness of norms, financial strain, life satisfaction, and perceived barriers and incentives for participating in extension-based land management programs (e.g. conservation covenants). Using an explorative

approach, we tested the explanatory power of each of these descriptive variables on the participants' choices in the pairwise comparisons.

Econometric model

We analysed survey data using a logit specification with Stata 15. Following this specification, we assume a latent utility function v for person n described over the ten incentive items J such that

$$v_{jn}^* = \beta_j X_j + \varepsilon_{jn} \quad (1)$$

where X_j is a vector of dummy variables, describing the presence of an item, and β_j is a vector of the associated utility weights. For identification, one item must be selected as the 'base' and assigned zero utility. Since the true utility of a person cannot be perfectly observed by the analyst, a random error term ε is added to capture the unobservable part of the utility function. Assuming this error process is described as Type II extreme value, the probability that individual n selects incentive j as the preferred option compared to incentive k is given by:

$$P_n(Y = j) = \frac{\exp(\lambda \beta_j X_j)}{\exp(\lambda \beta_j X_j) + \exp(\lambda \beta_k X_k)} \quad (2)$$

where λ is the scale coefficient, conventionally normalised to 1 for identification. This can be conceived of as a conditional logit model with only 2 alternatives. Equation (2) assumes that preferences are homogeneous within the sample. Heterogeneity in preferences can be dealt with in a number of ways: 1) by modelling the utility weights as a function of observable characteristics; 2) by assuming that they are drawn from some random distribution and estimating the moments of that distribution; or 3) by assuming that participants are drawn from a number of (latent) classes, each of which can have different preferences or combinations of all 3. Here we employ a latent class approach and assume that preferences are homogeneous within a class. We restrict the role of observable characteristics of the participant to explaining class membership.

In the latent class model the probability of selecting incentive j as best compared to k when there are M possible latent classes becomes (Train 2009):

$$P_n(Y = j) = \sum_{m=1}^M s_m \left(\frac{\exp(\lambda \beta_{jm} X_j)}{\exp(\lambda \beta_{jm} X_j) + \exp(\lambda \beta_{km} X_k)} \right) \quad (3)$$

where s_m is the probability that the respondent belongs in class m . These shares can be parameterised, and made a function of individual characteristics, using a multinomial logit model:

$$s_l = \frac{\exp(\alpha_l Z_n)}{\sum_{m=1}^M \exp(\alpha_m Z_n)} \quad (4)$$

where \mathbf{Z} is a vector of individual specific characteristics. For identification, some restriction has to be imposed: we employ $\sum_{m=1}^M \alpha_m = 0$. The marginal effect of an attribute on the probability of being in class l is given by:

$$s_l \left(\alpha_l - \sum_{m=1}^M s_m \alpha_m \right) \quad (5)$$

Although the estimated utility parameters give an estimate of the relative weight and hence ranking of the items, they can be difficult to interpret. A proposed representation of the relative weights is to calculate relative-scaled probability scores (Sawtooth Software 2013) that range from 0 to 100. We define the ratio-scaled probability score for incentive j , for class m as:

$$R_{jm} = \frac{\exp(\bar{\beta}_{jm})}{\exp(\bar{\beta}_{jm}) + 1} \quad (6)$$

where $(\bar{\beta}_{jm})$ are the zero centred raw logit parameter estimates for incentive j in class m . This can be interpreted as the probability that incentive j will be selected as best when compared to an incentive that has the average weight. For convenience, the probability scores for the set of incentives within a class are rescaled so they sum to 100. Note that these scores are not independent of error scale: if a class has a very high level of random noise in their choice process, these probability scores will tend towards $1/J$. It is useful to get some idea of the precision of the estimates of the ratio scores. We do this by simulation, conditional upon class membership. We take the variance covariance matrix of the vector of estimated utility weights β_{jm} , and draw a sample of 2,000 observations from a multivariate normal distribution using this matrix, for all parameters. We then calculate the simulated probability scores and calculate the 95% confidence intervals.

Results

Most land managers scored highly in lifestyle and conservation values and moderately high in economic values (Table 2). There was large variation in perceived social norms, but the majority believed most farmers in their community are obeying the regulations and refraining from clearing trees. Overall, landholders held weak anti-clearing attitudes and strong anti-regulation attitudes. Their sense of trust in the government and sense of control were very low, and their sense of security was moderately low, despite a low degree of reported financial strain. Past participation rates in various voluntary conservation programs were typically low, with most landholders citing lack of knowledge and perceived losses of autonomy and income/market value of land as the main reasons for not participating in the programs. Those that had participated in one or more of the programs primarily cited environmental benefits, threat mitigation, and intrinsic values of nature as the main reasons for participating. Additional characteristics of landholders can be found in Supplementary Table 1.

Table 2

Average responses from landholders for select variables (see Supplementary Table 1 for responses to all items included in survey).

Variables	Items	Scale	Mean (SD)	n
<i>Values</i>				
Economic*	When planning future farming activities I only focus on how profitable they will be A maximum annual return from my property is my most important aim	[1, 6]	4.00 (1.30)	206
Lifestyle*	The lifestyle that comes with being on the farm is very important to me We do not make a fortune from farming but the lifestyle is great	[1, 6]	5.10 (1.05)	206
Conservation*	The most important thing is leaving my property in better shape than I found it Managing environmental problems on my farm is a very high priority	[1, 6]	5.53 (0.79)	206
<i>Attitudes</i>				
Anti-clearing*	I am concerned about the rate of tree clearing in Queensland Tree clearing should be stopped People are clearing too many trees People who clear trees from their property do not care about the environment	[1, 6]	2.42 (1.27)	251
Anti-VMA*	In my opinion, vegetation management regulations... Are a burden to me Are fair to farmers [†] Are necessary [†] Should be more strict [†]	[1, 6]	4.57 (1.11)	251
Trust in the government*	The Queensland Government has my best interests in mind I can trust the Queensland Government to always do what is right	[1, 6]	1.49 (0.93)	251
Sense of security*	I am confident that I can still enjoy a comfortable lifestyle while following vegetation management regulations Vegetation management regulations are a threat to my business or livelihood [†]	[1, 6]	3.05 (1.44)	248
Perceived behavioural control*	How much personal control do you feel you have over tree clearing decisions on your property? Following the vegetation management regulations set forth by the Queensland Government is... [difficult to easy]	[1, 6]	2.42 (1.26)	251
<i>Social norms</i>				
Tree clearing	Most of the farmers in my community clear trees	[1, 6]	3.05 (1.74)	242
Obedying regulations	Most of the farmers in my community follow the vegetation management regulations	[1, 6]	4.78 (1.27)	225
Financial strain*	Within the last four weeks, how often have you... Had serious financial worries? Not been able to do the things you like to do because of shortages of money? Not been able to do the things you need to do because of shortages of money?	[1, 5]	2.53 (1.19)	251
Voluntary program participation*	Have you participated in any of these programs? Landcare grants for private land conservation (e.g. sustainable agriculture, restoration) Land management agreements (e.g. Land for Wildlife) Conservation covenants (e.g. The Nature Refuges Program) Other projects or programs	[1, 5]	2.27 (0.75)	251

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Table 2 *continued*

Variables	Items	Scale	Mean (SD)	n
<i>Incentives for participation (% yes)</i>	Which of the following factors are the main reasons why you have participated in one or more of these programs?			
Importance	The intrinsic value or importance of nature	Yes/No	71.3%	101
Environmental	The environmental benefits for my property or community	Yes/No	91.1%	101
Risk-aversion	To minimise environmental threats or risks to my property or family	Yes/No	80.2%	101
Community influence	My neighbours or other farmers in my community have benefited from them	Yes/No	53.5%	101
Financial	The financial benefits for my property or my community	Yes/No	58.4%	101
<i>Barriers to participation (% yes)</i>	Which of the following factors are the main reasons why you have not participated in one or more of these programs?			
Exposure	Lack of exposure or knowledge of the programs	Yes/No	50.5%	214
Loss-aversion	Loss of autonomy or control over my property	Yes/No	39.7%	214
Financial	Loss of income or market value of my land	Yes/No	32.7%	214
Community influence	My neighbours or other farmers in my community regret participating in them	Yes/No	14.0%	214
Importance	I do not think nature needs to be protected on my property	Yes/No	22.9%	214

* Scores for individual items averaged for a single score

† Scores reversed for analysis

Table 3 reports the results from a search over the number of classes to include in the latent class model. Conventionally, model choice is determined through an appropriate statistical information criteria—here we report BICs and CAIC (Scarpa and Thiene 2005)—although some additional judgement on interpretability of coefficients can be required (Ruto, et al. 2008; Scarpa and Thiene 2011). All results here are for the model with *security* as the single explanatory variable for class membership since this was the only descriptive variable that was significant in the class membership function (Table 4). Wald test p-values for other variables included in the model are reported in Supplementary Table 2. The security variable was constructed from two items capturing participants' sense of security regarding the perceived threat of the VMA to their lifestyle and livelihood, scored on a six-point scale (1 = 'strongly disagree' to 6 = 'strongly agree'): "*I am confident that I can enjoy a comfortable lifestyle following vegetation management regulations*" and "*Vegetation management regulations are a threat to my business or livelihood*," the latter of which was reverse scored to align with the former during analysis. Responses to both items were averaged to form a single measure of security, where 1 = 'very low sense of security' and 6 = 'very high sense of security.' The sample size drops to 248 participants as a result of a few missing values for the security variable. The total number of choice occasions is 2426, due to some respondents not completing all question. The CAIC measure suggests two classes, while the BIC suggests three. In the results that follow, we report the three-class model, as the number of classes in either case is not large.

Table 3

Measures of model fit as number of classes changes. Bold values represent the optimal choice for each measure of fit.

	LL	BIC(LL)	CAIC(LL)	No. parameters
1-Class Choice	-1589.1243	3227.87	3236.87	9
2-Class Choice	-1531.7155	3173.70	3193.70	20
3-Class Choice	-1498.7407	3168.40	3199.40	31
4-Class Choice	-1477.8664	3187.30	3229.30	42
5-Class Choice	-1455.6135	3203.44	3256.44	53

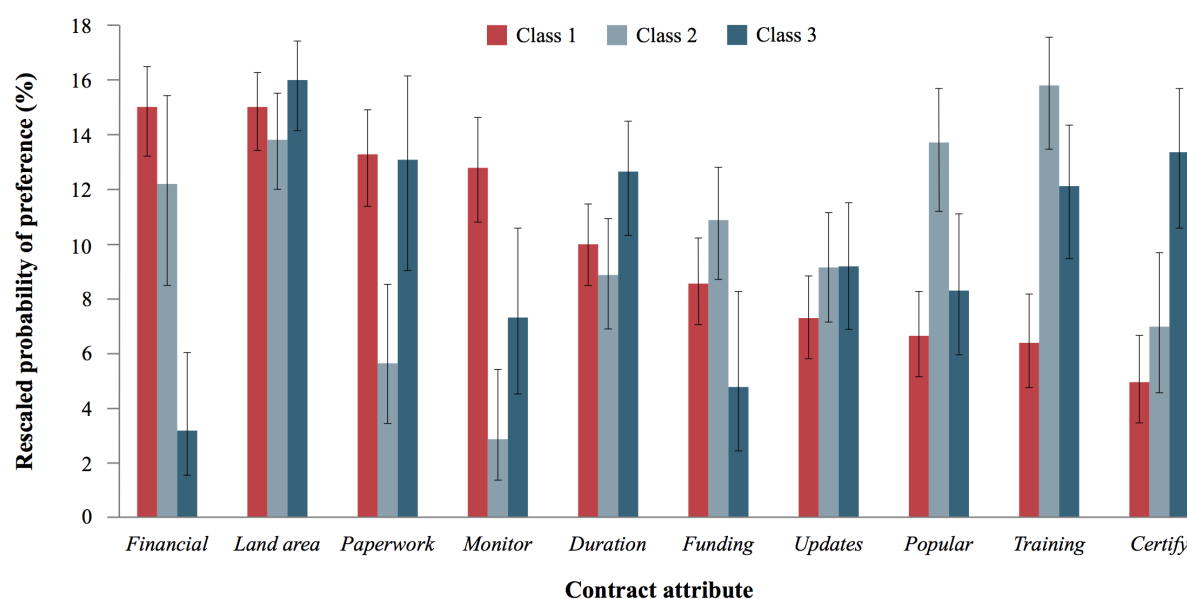
Table 4 reports the estimation results for the three-class model. Note that both the preference parameters and the class membership model are estimated simultaneously. The categorical variable representing the set of 10 incentives is effects coded (i.e. reported coefficients represent deviations from the mean of all effects). Although for identification one variable must be dropped in estimation (in this case *financial*), it is possible to retrieve the coefficient by re-estimating the model dropping a different attribute. Hence, we report all 10 coefficients for each class. Although some key results can be identified from the primary estimates, comparisons across classes is complicated by the conflation with error variance/scale. Instead we report the probability score results (see equation [6]) for each class, with 95% confidence intervals (Fig. 2).

Table 4

Results from latent class discrete choice model preferences for land clearing contracts.

	Class 1	SE	Class 2	SE	Class 3	SE
Model for preferences						
<i>certify</i>	-1.11 ***	0.22	-0.61 **	0.30	0.72 **	0.42
<i>popular</i>	-0.70 ***	0.18	0.81 ***	0.28	-0.33	0.40
<i>funding</i>	-0.29 *	0.17	0.19	0.22	-1.14 ***	0.32
<i>updates</i>	-0.56 ***	0.16	-0.16	0.22	-0.15	0.27
<i>training</i>	-0.76 ***	0.20	1.37 ***	0.32	0.45	0.39
<i>duration</i>	-0.01	0.15	-0.21	0.22	0.56 **	0.25
<i>land area</i>	1.09 ***	0.18	0.83 ***	0.21	1.43 ***	0.27
<i>monitor</i>	0.57 ***	0.22	-1.77 ***	0.40	-0.54	0.24
<i>paperwork</i>	0.68 ***	0.20	-0.93 ***	0.33	0.65	0.26
<i>financial</i>	1.09 ***	0.21	0.47	0.38	-1.65 ***	0.35
Model for classes						
Intercept	1.00 ***	0.28	-0.36	0.38	-0.64	0.39
<i>security</i>	-0.25 ***	0.08	0.11	0.09	0.14	0.09
Class size	0.4254		0.3112		0.2633	
LL = -1498.74 N = 248 R ² _{entropy} = 0.63 R ² _{standard} = 0.65						

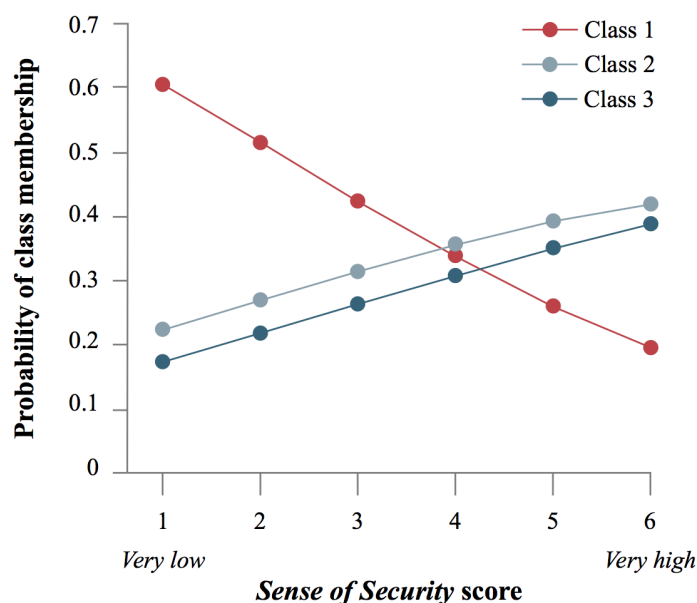
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

**Figure 2**

Rescaled probability score representation of preferences by class with simulated 95% confidence interval.

In estimation of the models, only *security* is found to be significant in explaining class membership. Interpretation of marginal effects in multinomial logit models is complex (Greene 2003), with the signs of marginal effects not necessarily the same as the estimated coefficients. With only one variable, a more transparent way of indicating the impact of the variable on class membership is to plot the probabilities as *security* changes (Fig. 3). The proportions of Class 2 and 3 are very similar, and they increase together as *security* increases. Probability of being in Class 1 falls as *security* increases, with a relatively large marginal effect—the probability ranging from 0.6 to 0.2 across the range of *security*.

Given that landholders' sense of security is the primary driver of class membership, where two groups are distinguished (Class 1, Classes 2 & 3), we can assume that *security* has a greater effect on the key contrasts in preferences between these two groups and negligible effects on any similarities between them. Overall, there are some consistent preferences for all landholders. All classes ranked *flexibility to choose the areas of land to be included* highly. There were also similar rankings for *flexibility to choose the length of the program* and *regular updates on the scheme's outcomes*, which were moderately preferred. The greatest difference between the classes is their ranking of non-financial incentives relative to the financial incentive. Where the two groups contrast the most, and where increasing landholders' sense of security may have greatest impact, is in landholder's preference for *training in best management practices* and *low compliance monitoring*.

**Figure 3**

Evolution of class membership probabilities as security changes.

For Class 1, no non-financial incentives were preferred over the financial incentive, with *option to certify produce as 'bush friendly'* and *training in best management practices* ranking the lowest. The only non-financial incentives to be ranked relatively equal to the financial incentive were *flexibility to choose the areas of land to be included*, *low paperwork*, and *low compliance monitoring*. These roughly equivalent preferences highlight Class 1 landholders' low sense of security, as all of these incentives enhance their level of autonomy and control, and diminish the level of bureaucracy and government/top-down influence on their property. This is in stark contrast to landholders in Class 3, who rank the financial incentive lowest of all incentives presented to them. While they also rank *flexibility to choose the areas of land to be included* highly, they differ most from Class 1 in their high ranking of *option to certify produce as 'bush friendly'* and *training in best management practices*. The only non-financial incentive to be ranked nearly on-par with the financial incentive was the indirect financial incentive, *extra public funding for community-based projects*.

Landholders in Class 2 are more moderate in their overall ranking of non-financial incentives relative to the financial incentive. Their preference for financial incentives did not differ from the average landholder in the surveyed sample, likely due to the high level of variation in its ranking. While the expansive confidence interval of financial preference makes it difficult to distinguish strong deviations in ranking of non-financial incentives, some notable rankings can be identified. *Low compliance monitoring* and *low paperwork* were ranked the lowest of all incentives, which may be a product of these landholders' enhanced sense of security. Class 2 landholders differed most from Class 3 landholders in their greater preference for *most farmers in the region being involved* and lesser preference for *option to certify produce as 'bush friendly'*, though they had similarly high rankings for *training in best management practices* and *flexibility to choose the areas of land to be included*.

Discussion

The importance of programme flexibility and communication

In this study, we investigate landholders' preferences for financial and non-financial incentives to enrol in bush management programmes. Given the generally low capacity of governments to enforce clearing legislation or provide financial incentives to prevent land clearing around the world, our aim was to identify whether non-financial incentives could be sufficient to change landholder behaviour. After surveying 251 landholders across Queensland, Australia, we found that landholders have heterogeneous preferences for financial versus non-financial incentives. This heterogeneity was identified using latent class methods, which specified three landholder classes. Membership of the three classes was primarily driven by landholders' sense of security. This has important implications for state vegetation management policy, as incentivising landholders to conserve remnant vegetation will be more costly if regulatory controls continue to be perceived as a threat to landholders' lifestyle and livelihood.

Among the three latent classes, there was some agreement in the incentives that farmers preferred, as well as some notable differences. Three incentives were highly ranked across all classes: (1) flexibility to choose the areas of land to be included, (2) flexibility to choose the length of programme, and (3) regular updates on the scheme's outcomes. This reflects landholders' historical complaints regarding autonomy, controllability, trust, and transparency of policy instruments (Productivity Commission 2004; Senate Inquiry 2010). Throughout the survey, most farmers expressed a feeling of injustice. This was believed, by both the farmers and the industry representatives, to be one of the largest roadblocks to any engagement between regulating bodies and farmers. Several participants commented on a perceived indecisiveness by regulating bodies with respect to clearing regulation, and ultimately, feelings of betrayal. Thus, incorporating more of these non-financial incentives that place a greater amount of control in the hands of landholders and provide regular and transparent updates on the instrument's effects would be an advantageous approach for private land management initiatives (Sorice, et al. 2013).

The greatest difference amongst the classes was in how they ranked financial versus non-financial incentives. The preferred options of Class 1 were all financial, with training in best management practices ranking last. This could reflect more conservative values towards land management on their property and a reluctance to change their traditional on-farm practices. By contrast, Class 3 exclusively preferred non-financial incentives. Given their greater sense of security, Class 3 landholders may place greater value on enhancing the sustainability of their own land management practices and are more open to outside influences, provided they have their say in where this influence occurs on their property. This reflects important heterogeneities in the types of farmers that exist in agricultural landscapes, where landholders with inherently different styles, motivations, and approaches to land management will also differ in their likelihood of implementing pro-environmental practices on their farm (Burton and Wilson 2006; Darnhofer, et al. 2005; Guillem, et al. 2012).

Class 2 appears to represent an important nuance in the potential effects of sense of security on preferences for financial incentives. Landholders can still have a moderate preference for financial incentives even with a greater sense of security, but this preference can be influenced with the right non-financial incentives to encourage normative behaviours. For instance, if more secure landholders believe there is a wider social shift in land management behaviours in their region, provoked by greater community involvement in bush preservation schemes and the emphasis these schemes place on the adoption of new land management practices, this could be more effective in garnering their participation than the use of financial incentives alone (Michel-Guillou and Moser 2006; Selinske, et al. 2016). Without these particular programme attributes, however, Class 2 landholders may defer to financial incentives, even if they do not see vegetation management regulations as a threat to their livelihood.

These mixed (and relatively high) preferences for financial payments and several non-financial incentives, such as flexibility in land management and regular updates on programme outcomes, are consistent with the literature. For example, using a discrete choice model of responses from farmers in Northern Italy, Defrancesco, et al. (2008) found that the expectation of income (compensation) from a scheme and the flexibility of implementing the scheme are major influencing factors in participation decisions. The importance of financial compensation is often ascribed to the 'missing market' hypothesis, which suggests that it might be necessary to compensate for the gap in expected income from participation in a scheme (Hanley, et al. 2012). Financial incentives, however, should be implemented with caution. Despite the importance of using monetary incentives to increase uptake for some of the most resistant types of farmers (Kabii and Horwitz 2006; Kusmanoff, et al. 2016), the interactions of multiple financial incentives can affect environmental outcomes (Bryan and Crossman 2013) and may crowd out the intrinsic, environmental motivations for conservation (Agrawal, et al. 2015). This may be especially true considering Class 2 landholders in this study, who are likely to be more susceptible to crowding out effects than Class 3 landholders.

Non-financial incentives pertaining to flexibility in implementing bush management schemes are strongly preferred by the participants. Similar findings were made by Blackmore and Doole (2013) in their survey of participants in Victorian conservation tenders. They suggested that higher flexibility reduces the transaction costs of participation and implementation of the schemes, which attracts more landholders. A number of studies have also highlighted the importance of providing information on the programmes and opportunities available to landholders as a key factor influencing participation rates (Blackmore and Doole 2013; Schenk, et al. 2007). However, regular updating of the programme outcomes has not previously been identified as a major factor. This highlights a potential large gap in the implementation of such programmes. Conservation programmes are rarely monitored, and if they are, the results are often not publicly available. Australia, in particular, suffers from a lack of long-term monitoring of impacts from voluntary and incentive-based programmes; what little evidence does exist of these various natural resource management programs indicates that they may build community support and social capital, yet fail to deliver real conservation benefits (Curtis, et al. 1998; Hajkowicz 2009; Lockie and Higgins 2007).

Limitations and recommendations

The difficulty of reaching landholders in remote agricultural areas, like in rural Queensland, imposes some limitations on any studies ability to infer preferences that are representative state-wide. Despite exhaustive telephone recruitment efforts, the final sample size is small relative to the spatial distribution of landholders surveyed across the state. This sample also has a relatively high median age (62 years) compared to the 2017 census data of the greater Darling Downs area (41 years, ABS 2018). This may have been influenced by the higher likelihood that older landholders would be home to answer the phone and have the time to answer the questions. Some bias in the sample may exist due to our preferential targeting of postcodes where clearing has been highest in the state, but these regions are the most relevant to identifying incentive preferences for habitat conservation. While some correlation between class membership and clearing hotspots/coldspots might exist, we expect much of this interaction is captured by the measures of past clearing behaviours and clearing norms—of which we found no significant effect on preferences. The survey was implemented shortly after new amendments to the controversial vegetation management policy were passed in Parliament, and thus it is possible that some degree of participation bias may exist, where landholders who were strongly pro- or anti-regulation would be most inclined to express their opinions. Similarly, responses to some survey questions may also be biased due to the heated political environment at the time, potentially provoking more reactionary responses (Proudfoot and Kay 2014). Finally, a number of factors that were not included in the survey may also significantly affect landholders' incentive preferences, such as assets or capital (Arriagada, et al. 2015), property size (Seabrook, et al. 2008), income reliance on farming (Comerford 2013), career goals or motivations (Farrar-Bowers and Lane 2009), and political or occupational identity (Groth, et al. 2014; Unsworth and Fielding 2014).

It will be important for future research to consider the potential drivers of participation in a number of policy instruments available to landholders, like direct payment schemes for conservation (Hajkowicz 2009), conservation covenants (Fitzsimons 2015), and heritage agreements (Leaman and Nicolson 2014), as well as their potential usefulness for curbing rising deforestation rates. This could come from a series of full choice experiments, where preferences for these different instrument options would be measured under various social, political, and economic contexts. Similar strategies have been employed to understand 1) the effects of regulatory crowding-out on optimal economic decision-making (Cardenas, et al. 2000), 2) what types of motivations drive willingness to participate in conservation programs (Greiner 2015), and 3) how attitudes affect landholders' willingness to pay for conservation benefits (Hoyos, et al. 2015). This would also present more opportunities to investigate how landholders perceive and cope with varying levels of risk (Levin, et al. 1998; Mase, et al. 2015), which could provide a more direct measure of the effects of (e.g.) policy uncertainty, droughts, and message-framing on regulatory compliance, landholders' interaction with different policy instruments, and overall tree clearing decision-making.

Land clearing is a highly contentious political and cultural issue, and the primary reliance on command-and-control instruments to curb rising clearing rates is viewed unfavourably by landholders (Cocklin, et al. 2007). While voluntary price-based or

community-based programmes are viewed more favourably, and the uptake of conservation covenants has experienced dramatic increases in the last decade (Fitzsimons 2015), these instruments often lack the political ‘teeth’ to achieve significant land clearing changes in practice, largely due to issues stemming from poor communication (Morrison, et al. 2015), a property-centric focus of land management (Cooke and Moon 2015), and strengthening resistance to top-down interventions (Lockie and Higgins 2007). Our results provide a more nuanced understanding of how land clearing behaviour could be managed and of how policy design/implementation could be approached. This understanding is centred on heterogeneous preferences towards financial and non-financial incentives, which are driven by landholders’ sense of security. Designing policy that can address and capture this heterogeneity remains a major challenge to improving land clearing outcomes. If intervention efforts continue with a business-as-usual approach, creating large-scale changes in clearing behaviours will require large financial incentives to persuade participation in private land conservation from the landholders feeling most threatened by regulation; still, perverse outcomes may arise if more financial incentives crowd out the intrinsic preferences of other landholders for non-financial incentives for private land conservation. The most promising alternative, however, could involve targeted communication strategies that reinforce landholders’ sense of security during ongoing top-down regulation, potentially through message framing (Crompton 2010), disseminating information via local champions (Torabi, et al. 2016) and strengthening relationships between landholders and extension officers (Blackmore and Doole 2013).

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Appendix

Supplementary Table 1

Landholder responses to all survey items.

Variables	Items	Scale	Mean (SD)	n
<i>Values</i>				
Economic*	When planning future farming activities I only focus on how profitable they will be A maximum annual return from my property is my most important aim	[1, 6]	4.00 (1.30)	206
Lifestyle*	The lifestyle that comes with being on the farm is very important to me We do not make a fortune from farming but the lifestyle is great	[1, 6]	5.10 (1.05)	206
Conservation*	The most important thing is leaving my property in better shape than I found it Managing environmental problems on my farm is a very high priority	[1, 6]	5.53 (0.79)	206
Place attachment*	I am happiest when I'm on my farm I feel my farm is a part of me	[1, 6]	5.31 (0.89)	206
<i>Attitudes</i>				
Anti-clearing*	I am concerned about the rate of tree clearing in Queensland Tree clearing should be stopped People are clearing too many trees People who clear trees from their property do not care about the environment	[1, 6]	2.42 (1.27)	251
Anti-VMA*	In my opinion, vegetation management regulations... Are a burden to me Are fair to farmers [†] Are necessary [†] Should be more strict [†]	[1, 6]	4.57 (1.11)	251
Trust in the government*	The Queensland Government has my best interests in mind I can trust the Queensland Government to always do what is right	[1, 6]	1.49 (0.93)	251
Sense of security*	I am confident that I can still enjoy a comfortable lifestyle while following vegetation management regulations Vegetation management regulations are a threat to my business or livelihood [†]	[1, 6]	3.05 (1.44)	248
Perceived behavioural control*	How much personal control do you feel you have over tree clearing decisions on your property? Following the vegetation management regulations set forth by the Queensland Government is... [difficult to easy]	[1, 6]	2.42 (1.26)	251
<i>Social norms</i>				
Tree clearing	Most of the farmers in my community clear trees	[1, 6]	3.05 (1.74)	242
Obedying regulations	Most of the farmers in my community follow the vegetation management regulations	[1, 6]	4.78 (1.27)	225
Financial strain*	Within the last four weeks, how often have you... Had serious financial worries? Not been able to do the things you like to do because of shortages of money? Not been able to do the things you need to do because of shortages of money?	[1, 5]	2.53 (1.19)	251
Voluntary program participation*	Have you participated in any of these programs? Landcare grants for private land conservation (e.g. sustainable agriculture, restoration) Land management agreements (e.g. Land for Wildlife) Conservation covenants (e.g. The Nature Refuges Program) Other projects or programs	[1, 5]	2.27 (0.75)	251

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Supplementary Table 1 *continued*

Variables	Items	Scale	Mean (SD)	n
<i>Good farmer definition</i>	A 'good farmer'...			
Profit-maximising	Always finds a way to maximise their profits	[1, 6]	4.81 (1.20)	249
Altruistic	Puts the needs of the community before his/her own needs	[1, 6]	3.94 (1.18)	246
Law-abiding	Obeys laws that restrict what can and can't be done on his/her farm	[1, 6]	4.72 (1.28)	246
Productivity-maximising	Always finds a way to maximise the productivity of their land	[1, 6]	5.10 (1.08)	248
Lifestyle-focused	Enjoys the farming lifestyle even if profits are low	[1, 6]	4.76 (1.29)	250
<i>Good farmer identity*</i>	I think of myself as a 'good farmer'	[1, 6]	4.64 (0.85)	206
	I am a 'better farmer' than most people in my community			
<i>Relative threat of the VMA</i>	To what degree do the following pose a threat to the property you manage?	[-5, 5] [‡]	0.46 (1.47)	250
	Drought and extreme weather	[1, 6]		
	Pest species (e.g. feral cats, pigs, foxes, rabbits)	[1, 6]		
	Mining activities	[1, 6]		
	Your personal health and well-being	[1, 6]		
	Escalating costs of running the business	[1, 6]		
	Changing prices for agricultural products	[1, 6]		
	Vegetation management regulations	[1, 6]		
	Chemical and pesticide use regulations	[1, 6]		
<i>Loss aversion*</i>	I get easily attached to material things (e.g. my car, my furniture)	[1, 5]	2.93 (1.08)	206
	If profits become very high, I wouldn't want to return to previous profit levels			
<i>Emotions to regulations</i>	When you think about vegetation management regulations in Queensland, do you feel...			
Negative*	Angry?	[1, 6]	3.76 (1.48)	249
	Depressed?			
	Anxious?			
	Exhausted?			
Positive*	Relieved?	[1, 6]	2.11 (1.29)	249
	Hopeful?			
<i>Awareness of norms*</i>	I know how most farmers in my area manage their land	[1, 6]	4.75 (1.14)	239
	Most farmers in my area know how I manage my land			
<i>Life satisfaction</i>	Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?	[0, 10]	8.57 (1.89)	251
<i>Social capital*</i>	Are you an active member of the following?	[0, 3]	1.43 (0.96)	206
	An agricultural organisation (e.g. AgForce, Queensland Farmers' Federation)			
	A local community group, organisation, or club (e.g. sport, craft, social club)			
<i>Trees present (% yes)</i>	Are there any trees (including tree regrowth) currently on your property that are not grown or harvested for production purposes?	Yes/No	76.7%	206
<i>Clearing purposes</i>	In the last 5 years, how often have you cleared trees from your property for the following purposes?			
Relevant	Restorative purposes (e.g. thinning)	[1, 5]	2.31 (1.21)	177
	Necessary maintenance (e.g. regrowth or weed removal)	[1, 5]	3.15 (1.16)	177
	Infrastructure (e.g. fences, barns or sheds)	[1, 5]	2.60 (1.22)	177
	Fodder development or expansion	[1, 5]	1.75 (1.08)	177
Not relevant	High-value agriculture development or expansion	[1, 5]	1.97 (1.08)	177
	Pasture development or expansion	[1, 5]	2.18 (1.26)	177
<i>Clearing amount relative to others</i>	Compared to other farmers/graziers in your community, do you think you clear trees more or less than they do?	[1, 5]	2.32 (0.88)	177
<i>Clearing intentions (next 6 months)</i>	"I intend to engage in tree clearing on my property during the next 6 months."	[1, 6]	2.84 (1.89)	177

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Supplementary Table 1 *continued*

Variables	Items	Scale	Mean (SD)	n
<i>Clearing amount</i>	In the last 5 years, how often have you cleared the following amount of trees from your property?			
	Single trees	[1, 5]	2.51 (1.14)	177
	Less than 1 hectare (ha)	[1, 5]	1.78 (0.98)	177
	1 – 5 ha	[1, 5]	1.54 (0.91)	177
	5 – 10 ha	[1, 5]	1.42 (0.82)	177
	More than 10 ha	[1, 5]	1.47 (0.95)	177
<i>Clearing influences</i>	To what extent do the following influence how you make tree clearing decisions on your property?			
Agricultural prices	Agricultural or livestock prices	[1, 6]	2.37 (1.79)	177
Droughts	Recent droughts	[1, 6]	2.19 (1.69)	177
Regulations	Vegetation management regulations	[1, 6]	3.03 (2.04)	177
Profitability	Potential profitability of the land	[1, 6]	3.27 (1.90)	177
Aesthetics	Aesthetic or attractive value of trees	[1, 6]	2.65 (1.80)	176
Policy uncertainty	Talks of new clearing regulations in Parliament	[1, 6]	2.53 (1.90)	176
Costs	Feasibility or costs associated with clearing	[1, 6]	2.91 (1.94)	175
<i>Incentives for participation (% yes)</i>	Which of the following factors are the main reasons why you have participated in one or more of these programs?			
Importance	The intrinsic value or importance of nature	Yes/No	71.3%	101
Environmental	The environmental benefits for my property or community	Yes/No	91.1%	101
Risk-aversion	To minimise environmental threats or risks to my property or family	Yes/No	80.2%	101
Community influence	My neighbours or other farmers in my community have benefited from them	Yes/No	53.5%	101
Financial	The financial benefits for my property or my community	Yes/No	58.4%	101
<i>Barriers to participation (% yes)</i>	Which of the following factors are the main reasons why you have not participated in one or more of these programs?			
Exposure	Lack of exposure or knowledge of the programs	Yes/No	50.5%	214
Loss-aversion	Loss of autonomy or control over my property	Yes/No	39.7%	214
Financial	Loss of income or market value of my land	Yes/No	32.7%	214
Community influence	My neighbours or other farmers in my community regret participating in them	Yes/No	14.0%	214
Importance	I do not think nature needs to be protected on my property	Yes/No	22.9%	214
<i>Demographics</i>				
Age			61.6 (13.7)	245
Gender (% male)			70.9%	251
Manager status	Which of the following best describes you?			251
Manager	I manage a farm or other grazing or production property		82.1%	
Non-manager	I have a family member who manages a farm or other grazing or production property		17.9%	
	I interact with farmers or graziers for my work			
Properties	How many grazing or production properties do you manage?		1.81 (1.64)	251
Years managing	Approximately how many years have you managed your current farm or other grazing or production properties?		34.1 (20.1)	251
Decision-maker	Are you primarily responsible for making management decisions on this property?	Yes/No	72.3%	206
Education	What is the highest level of education you have completed?			250
	Did not complete high school		21.6%	
	High school		32.0%	
	Diploma or TAFE/Technical Certificate		27.6%	
	Bachelor degree		12.4%	
	Post-graduate degree		6.4%	
Income	The average person in Queensland has a total personal income of \$40,000 to \$50,000 per year. Is your personal income above, below or roughly equal to this average?			249
	Below this average		28.9%	
	Equal to this average		31.3%	
	Above this average		39.8%	

* Scores for individual items averaged for a single score, † Scores reversed for analysis

‡ Scale of the generated single score differs from items' scales; see Simmons et al. (2020) for description

Supplementary Table 2

P-values for Wald test of the inclusion of sociodemographic variables in 3 class membership model. Each variable included individually, with *security* included.

Variable	<i>p</i> -value
<i>Values</i>	
Economic	0.95
Lifestyle	0.77
Conservation	0.80
<i>Attitudes</i>	
Anti-clearing	0.34
Anti-VMA	0.07
<i>Trust in the government</i>	0.28
<i>Perceived behavioural control</i>	0.13
<i>Social norms</i>	
Tree clearing	0.88
Obeying regulations	0.36
<i>Financial strain</i>	0.52
<i>Education</i>	0.67
<i>Gender</i>	0.70
<i>Income</i>	0.15
<i>Years of residence</i>	0.77