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PRACTICAL ARTICLE

Concern about threatened species and ecosystem disservices underpin public willingness to pay for ecological restoration

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Public preferences for ecological restoration can be revealed through environmental valuation studies that aim to measure willingness to pay. However, respondents' environmental views will often influence the conclusions drawn from such studies. We conducted a national survey of perceptions of the benefits and perverse outcomes arising from ecological restoration using a dichotomous choice payment card. Using interval regression to estimate willingness to pay, we find that there are respondents who will perceive mostly biodiversity benefits from restoration, with a particular interest in threatened species recovery. We find that this eco-centric view of the benefits of restoration also increases the dollar amount that respondents are willing to pay to support restoration activities. A proportion of respondents also perceive restoration as having negative impacts, with concerns orientated towards increased fire, decreased farmland productivity, and groundwater availability. Perceptions of the potential effects of restoration on land productivity had a significant negative influence on the amount of money respondents were willing to pay. These findings are useful for targeting outreach in order to garner public support for ecological restoration.

Key words: Australia, biodiversity, contingent valuation, ecosystem services, preferences, revegetation

Implications for Practice

- Consideration of both benefits and disservices that might arise from ecosystem restoration can inform the design of restoration projects.
- Preferences for benefits and concern for disservices can be used to target outreach to enhance support for restoration.

Introduction

The value of ecosystem services is notoriously difficult to quantify (Conte 2010; Ninan & Inoue 2013), and is particularly so in a habitat restoration context where outcomes are not known with certainty. Stated preference methods can be used to gain an understanding of the social benefit that ecosystem services provide to society, with a commonly employed method being contingent valuation (CV; Spash 2008*a*). CV is able to capture often difficult to quantify cultural and nonuse values by estimating people's willingness to pay (WTP) for an environmental entity or outcome (Loomis et al. 2000; Zhongmin et al. 2003). For example, CV was used to estimate WTP for forest restoration in Chile (Schiappacasse et al. 2012), and to estimate public benefits of landscape restoration in France (Bonnieux & Le Goff 1997). CV has, however, been questioned with regards to its ability to put a "true" and monetarily comparable value on environmental resources (Spash 2008*b*). Kahneman et al. (1999) suggested that instead of using WTP estimates as an actual valuation of environmental entities, the method may be better understood as an attitudinal appraisal of individuals or for measuring collective public support. Alam (2013) employed measures of WTP in such a way to better understand public support for restoration.

Different individuals will have different perceptions of benefits from ecological restoration, and this may be reflected in respondents' relative WTP (Mitchell & Carson 1989). For example, Connelly et al. (2002) observed that WTP was strongly aligned with respondents' general support for ecosystem restoration actions, Biénabe and Hearne (2006) found that WTP was higher for biodiversity conservation than for scenic beauty, and Garcia-Llorente et al. (2011) observed that people responded differently when asked to value use (e.g.

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ecosystem services) or nonuse (e.g. biodiversity) goods. Some restoration activities could also have potential downsides, generating ecosystem "disservices." Ecosystem disservices are functions of ecosystems that are perceived as harmful, unpleasant, or unwanted and negatively impacting human well-being (Lyytimäki & Sipilä 2009). For example, disservices from restoration may include impacting agricultural production. Landholders have also been found to show concern that restoration projects could lead to increased prevalence of pests, establishment of endangered species on their land, and the loss of productive farmland, with the associated loss of revenue a common concern (Buckley & Haddad 2006; Zhang et al. 2007). Consideration of both benefits and disservices that might arise from ecological restoration is needed to inform objective decision-making (Shackleton et al. 2016; Vaz et al. 2017), but they are rarely considered in unison.

This study does not attempt to place objective value upon ecosystem services, but rather aims to analyze public preferences revealed through WTP amounts in survey responses. Specifically, we seek to (1) estimate how the WTP for restoration activities varies with socio-demographic characteristics and with perceptions about the benefits and disservices from restoration and (2) identify opportunities for targeting outreach in order to garner broader public support for restoration activities.

Methods

The data for this study were collected through a nation-wide online survey. The survey collected information about respondents' willingness to donate funds for ecological restoration, the amount they would be willing to pay for restoration, and people's perceptions of benefits and disservices arising from restoration.

Survey Administration

Respondents were recruited by an experienced market research firm. Their research panel received a link to the online survey, which remained open until the target number of respondents was reached. As typical in this sort of research, survey participants received cash or cash equivalents valued at AUS$2–$2.50 for completing the survey. To ensure that the sample was representative of the Australian adult population (Australian Bureau of Statistics 2013*a*, 2013*b*), we used respondents' quotas based on 2011–2012 Australian census data for age, gender, income, and state of residence.

Restoration Scenario

The survey presented respondents with details of a hypothetical regionally specific restoration project. The project description was tailored to the region in which the respondent lived through reference to local species and habitats that would benefit from the proposed restoration, but the ecosystem services remained the same between regions (see Appendix S1, Supporting Information, for examples). After having read the scenario, respondents were shown a list of ecosystem service benefits that could be provided by restoration and were asked to identify the benefit they preferred most. Respondents could select their preferred benefit from the following:

1. Protection for threatened species;
2. Bigger or better habitat for native plants and animals;
3. Carbon storage;
4. Increases to amount of water supply;
5. Soil improvements;
6. Improvements to water quality;
7. Harvest of forest products;
8. Public access for recreation;
9. Jobs, training, or environmental education;
10. Farm benefits.

These ecosystem service benefits were categorized as biodiversity-focused (1–2) or environmental-focused (3–10) and the order of benefits was randomized in the survey.

Willingness to Pay

The observation that people may be willing to pay for restoration is based on economic utility theory, which states that people derive utility (also understood as "welfare" or "value") from the goods and services they use. This "use" need not be direct consumptive use, but includes indirect use and nonconsumptive use (Champ et al. 2003). In our research context, the theoretical framework assumes that respondent i derives utility V_i from the restoration project x described in the survey and other goods and services q with vector of prices P, and individual income y_i: $V_i(P,x,y_i)$. A person's maximum WTP_i for restoration project x will satisfy:

$$V_{i,0}\ \left(P_q, x, y_i; Z_i\right) = V_{i,1}\ \left(P_q, x, y_i - WTP_i; Z_i\right) \qquad (1)$$

where $V_{i,0}$ is indirect utility before, and $V_{i,1}$ indirect utility after, the project. Here, utility is allowed to depend on a vector of individual characteristics Z_i (see, e.g. Carson & Hanemann 2005; Hoyos & Mariel 2011; Mitchell & Carson 1989).

After seeing the scenario, respondents were told that private funds would be needed for the restoration and asked if they would be willing to donate funds to a nonprofit agency that would accomplish the restoration. Respondents were told that the management objective of the restoration would be to prioritize the respondent's preferred benefit. Those who answered that they would be willing to donate money were then shown a payment card with one-time donations ordered from AUS$1 to AUS$500. Respondents were asked to choose the amount closest to their WTP from the options provided (including an "I don't know" option). This two-staged approach (donation then WTP) follows existing literature (Champ et al. 1997; Foster et al. 1997). For example, Kotchen and Reiling (2000) used a similar two-stage set-up, where respondent's first vote yes/no on their support for a fund, and are then asked the

WTP question. Furthermore, donating to charitable organizations is not uncommon as a way for people to support restoration and conservation work. The protest options we presented (see below) specified ways in which people might object to this mechanism.

Those who had answered that they were not willing to donate any money were asked to explain their main reason for doing so. This follow-up question was used to distinguish "true zeroes" (people who stated that the benefits provided were not worth paying for, or who were unable to afford the expense), from "protest noes" (people who objected to some aspect of the survey rather than expressing a genuine preference for or against restoration). Respondents classified as protesters were those who (1) were "not confident that the restoration project would actually provide the benefits"; (2) "don't give to charitable or not-for-profit organizations"; (3) "don't trust that their money would actually go to the restoration project"; (4) thought that "government money should support the whole project, without need for private donations"; or (5) other reasons (extracted from open answers). These protesters were not included in the regression models presented here. Results that include protest responses are available upon request from the authors.

True zeroes were coded as having a $0 WTP value. People who answered "yes" to the donation question, and subsequently chose "I don't know" on the payment card were coded as being willing to donate but recorded as a missing value for the dollar amount of WTP.

The analysis of WTP answers relies on random utility maximization (RUM; Carson & Hanemann 2005). In a RUM model, it is assumed that an individual's WTP cannot be directly observed, but is described by a latent variable Y_i that is a function of the restoration project (x_i), a set of individual socio-demographic characteristics and preferences for restoration benefits and disservices ($\mathbf{Z_i}$), and an independent and identically distributed error term $\boldsymbol{\varepsilon_i}$ (Train 2009):

$$Y_i = \beta_x' x_i + \beta_z' \mathbf{Z_i} + \varepsilon_i \quad (2)$$

Using a payment card elicitation question, the probability that an individual chose a bid in the interval $[y_{1i}, y_{2i}]$ is modeled as $\Pr(y_{1i} \le Y_i \le y_{i2})$ (Cameron & Trivedi 2010). This is analyzed using interval regression models in STATA 14 (StataCorp 2015).

Disservices

After the WTP questions, we gauged respondents' (dis)agreement with a series of statements about potential downsides to restoration projects. The five potential downsides (disservices) presented to respondents were:

1. Restored forests will get overgrown and cause bushfires (*bushfires*);
2. Restored forests will take away farmland and hurt the economy (*farmland*);
3. Restored forests will be uglier than the scenic countryside we have now (*aesthetics*);
4. Restored forests will use up too much groundwater (*groundwater*); and
5. Restored forests will attract pests (*pests*).

Categorical responses to these statements were collected on a 5-point Likert scale. These ratings were used to create a "disservices index" that took a value of −3 if the respondent "strongly disagreed" with all disservice statements; −1 if the respondent "strongly disagreed" or "disagreed"; 1 if the respondent "agreed" or "strongly agreed", and 3 if the respondent "strongly agreed" with all disservice statements. The index took a value of 0 otherwise.

Results

Survey Sample

The nation-wide survey was sent to 3,959 prospective participants. Of these, 1,909 panel members were ineligible based on our quotas; declined to give informed consent; or failed to complete all the survey questions. We estimated that respondents would need at least 5 minutes to read and complete all the survey questions, and removed a priori any survey completed faster than that. We further eliminated survey responses where respondents had clearly not made an effort (for example by giving the same answer for all rating questions) or were recorded as having an international IP address. This filtering process left a final sample of 1,869 valid responses, or a response rate of 47%.

Response Categories

Of the 1,869 responses, 822 respondents (44.0%) were willing to donate funds to the restoration scenario. Of those who said they were unwilling to donate, 369 respondents (19.7%) were classed as "true zero WTP". About 36% of respondents (678) were classed as "protest noes" (Table 1). The sample consisted of slightly more women than men, with an average age of 46 years, an average income of just under 78,000 $/year, and about 15 years of education. Nearly 40% of the sample had a university degree. The majority of respondents were from New South Wales (NSW), Victoria (VIC), and Queensland (QLD) (Table 1). We observed a significantly higher proportion of males and a significantly lower proportion of respondents with a university education in the protest group ($p < 0.005$), compared to respondents who were willing to donate money for restoration (Table 1).

Preferred Benefits From Restoration

Respondents strongly preferred restoration outcomes that focused on biodiversity. Protecting threatened species in the region was most preferred (Table 2), followed by providing habitat for native plants and animals. More human-centered environmental benefits like farm benefits, access for recreation, or the harvest of forest products were (on average) least preferred by respondents. Preferences for biodiversity benefits are significantly lower among protesters compared to nonprotest respondents ($p < 0.05$), while preferences for jobs, training

Table 1. The socio-demographic characteristics of the survey sample.

	All Respondents		*Nonprotesters*		*Protesters*	
Demographic Variables	*Mean*	*%/SD (Range)*	*Mean*	*%/SD (Range)*	*Mean*	*%/SD (Range)*
Total responses (#)	1,869		1,191		678	
Gender (#)						
Male	901	48.2%	536	45.0%	365	53.4%
Female	968	51.8%	655	55.0%	313	46.2%
Age (years)	46.2	15.9 (24–75)	45.9	15.9 (24–75)	46.8	16.0 (24–75)
Income ('000 $/year)	77.7	54.3 (9.75–200)	78.2	53.6 (9.75–200)	76.8	55.4 (9.75–200)
Education (years)	15.4	2.1 (8–19)	15.4	2.1 (8–19)	15.3	2.1 (8–19)
Have a university degree (#)	737	39.4%	497	41.7%	240	35.4%
State (#)						
New South Wales	553	29.6%	347	29.1%	206	30.4%
Victoria	473	25.3%	303	25.4%	170	25.1%
Queensland	390	20.9%	241	20.2%	149	22.0%
South Australia	174	9.3%	114	9.6%	60	8.9%
Western Australia	177	9.5%	115	9.7%	62	9.1%
Other (Australian Capital Territory, Northern Territory, Tasmania)	102	5.5%	71	6.0%	31	4.56%

Table 2. Respondents' preferred benefits for ecological restoration.

	All Respondents		*Nonprotesters*		*Protesters*	
Preferred Restoration Benefit	*Number of Respondents*	*%*	*Number of Respondents*	*%*	*Number of Respondents*	*%*
Protection for threatened species	654	35%	473	40%	181	27%
Bigger or better habitat for native plants and animals	459	25%	315	27%	144	21%
Jobs, training, or environmental education	209	11%	111	9%	98	14%
Improvements to water quality	175	9%	112	9%	63	9%
Increases to amount of water supply	123	7%	56	5%	67	10%
Carbon storage	74	4%	40	3%	34	5%
Farm benefits	51	3%	27	2%	24	4%
Soil improvements	50	3%	29	2%	21	3%
Public access for recreation	50	4%	17	1%	33	5%
Harvest of forest products	24	1%	11	1%	13	2%
Total sample	1,869		1,191		678	

or education, water supply, and recreational access are also significantly different between the two groups ($p < 0.001$).

Perceived Disservices of Restoration

We assessed respondents' (dis)agreement with potential disservices of restoration (Fig. 1). Bushfire risk was ranked the greatest perceived disservice, while scenic concerns were ranked the lowest. Respondents who protested against the WTP question perceived greater downsides from restoration due to bushfires and pests than nonprotest respondents, while nonprotesters disagreed significantly more with farmland or groundwater being affected by restoration compared to protesters ($p < 0.001$) (data not shown).

Determinants of WTP Amount

In the interval regression models, we investigated what characteristics $\boldsymbol{Z_i}$ could predict the amount someone was willing to pay (in $). After testing numerous model specifications, the model that best fit the data specifies WTP as:

$$Y_i = \beta_0 + \beta_1\, age_i + \beta_2\, income_i + \beta_3\, uni_i + \beta_4\, male_i + \beta_5\, NSW_i + \beta_6\, preferred\ benefits_i + \beta_7\, perceived\ disservices_i + \varepsilon_i \quad (3)$$

where β_0 reflects the average sample WTP to obtain the restoration project, β_{1-5} capture the change in average WTP due to an individual's socio-demographic characteristics, and β_{6-7} capture the difference in average WTP for respondents who prefer different benefits or perceive different disservices from restoration. Age and income were recoded to "diff-age" and "diff-income," which are the respondent's age/income minus the sample average age/income. This way, β_1 and β_2 can be interpreted as the difference in WTP between the average respondent and older/younger or higher/lower income respondents. Protesters were not included in the WTP models because

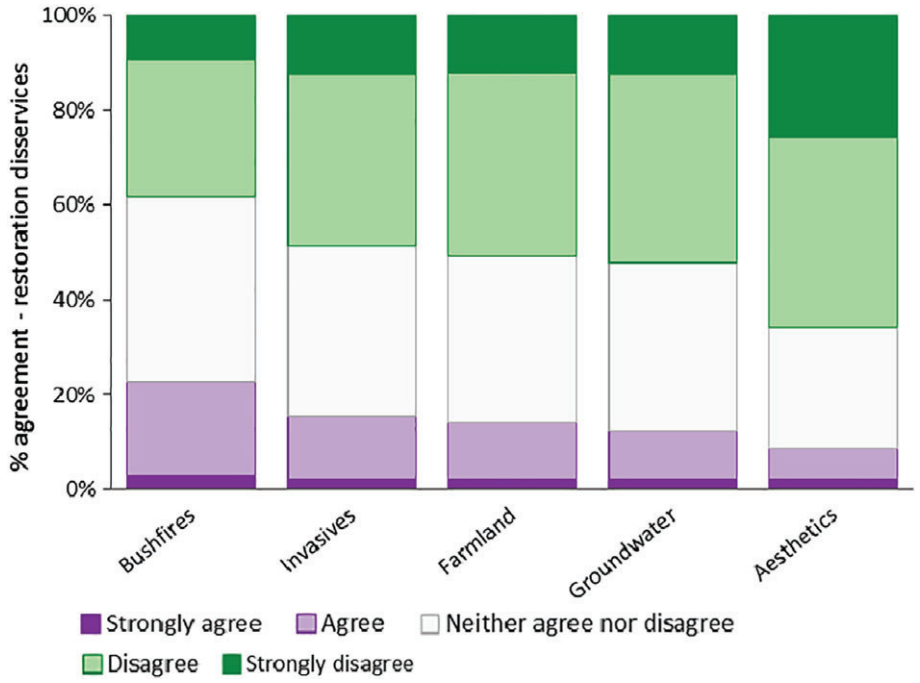

Figure 1. Agreement with potential disservices from restoration (% of respondents).

Table 3. Payment card responses. Respondents' willingness to pay, as a one-time donation, for the restoration project to provide the respondent's preferred benefit ($n = 990$).

Bid Amount	*Number of Respondents*	*% of Respondents*
$0	346	34.95
$1	9	0.91
$2	3	0.3
$3	3	0.3
$5	112	11.31
$8	9	0.91
$12	33	3.33
$20	254	25.66
$30	61	6.16
$45	54	5.45
$65	26	2.63
$100	69	6.97
$150	5	0.51
$225	2	0.2
$350	1	0.1
$500	3	0.3
Total	990	100

they do not express a true value. There were also missing values for the WTP amount (121) and income (80), resulting in 990 observations for the WTP models (Table 3).

We estimated two models (see Table S1). Model 1 includes a binary variable "biodiversity-focus" for respondents who preferred a biodiversity benefit (out of the 10 presented ecosystem services). Model 1 also includes the disservices index as an explanatory variable. In the second model, we disentangle the biodiversity preference and disservices index to investigate *which* benefit and *which* disservice are most significant. In both models the constant gives us the sample average WTP for a female respondent of average age, with average income, no university degree, and not from NSW. The other variables are dummy or effect coded. Hence, their coefficients can be interpreted as the change in WTP if that respondent (1) has a university degree; (2) is male; (3) is from NSW; (4) chose a biodiversity (Model 1)/threatened species (Model 2) focused benefit as their preferred service; or (5) disagrees with the disservices statements (Model 1)/"farmland" disservice (Model 2). Any other variables collected in the survey were not significant in the WTP models.

For Model 1 the average WTP was $8.54. Age, income, education level, and gender influenced WTP for restoration, as theory and previous findings would predict (Wiser 2007). Older respondents ($p = 0.007$), respondents with a higher annual income ($p < 0.001$), and having a university degree ($p = 0.003$) were associated with a higher WTP for restoration. For example, respondents with a university degree were willing to pay $7.19 more for restoration than those without a university degree (Table S1). Respondents from NSW were willing to pay significantly more than respondents from other states ($p = 0.011$), but there were no statistical differences in the socio-demographic characteristics of NSW respondents and respondents from other states. Finally, respondents who had chosen a biodiversity-focused benefit as their preferred service had a higher WTP than respondents who preferred environmental-focused services ($p = 0.091$). Respondents who scored higher on the disservices index (i.e. those who agreed that ecological restoration projects would generate disservices) had a lower WTP ($p = 0.036$).

These last two results are unpacked further in Model 2 (Table S1). Closer inspection of the data showed that preferring "Protection for threatened species" drives the higher WTP; respondents who chose that benefit as their preferred service are WTP \$5.73 more for the restoration project than the sample average ($p = 0.016$). WTP is \$5.13 lower for respondents who agreed or strongly agreed that restored forests will take away farmland and hurt the economy, compared to other respondents ($p = 0.002$; Table S1).

Discussion

Our results indicate that respondents more often prefer the biodiversity benefits of ecological restoration projects and that holding this eco-centric view of benefits also increases the dollar amount that respondents are willing to pay. Our study echoes that of Connelly et al. (2002), who found that respondents had greater WTP for restoration activities that focused on broad ecological criteria (protection, conservation) versus public-use criteria (e.g., human access).

Importantly, our findings can inform communication approaches for restoration projects and for targeting environmental education and outreach efforts. If a population consists of more people who care deeply about threatened species, support for restoration will be higher, in a context where all other possible co-benefits are explicit. Conversely, if a population consists of people that are concerned about farmland loss and the environmental hazards that might arise from restoration, then public support will be low regardless. We also reveal that state-specific campaigns about the benefits of ecological restoration are unlikely to add much value. Ignoring preferences among different groups of people may seriously undermine support for ecological restoration (Byg et al. 2017).

Our study reveals that the way in which individuals perceive ecological restoration differs according to their socio-demographic characteristics such as age, income, and education (Escobedo et al. 2011). Income was the most significant variable, with respondents who have higher incomes being willing to pay more. This "income effect" is typical and consistent with the theoretical construct validity of the CV method (Mitchell & Carson 1989; Whitehead & Hoban 1999), with similar observations observed in other CV surveys concerning various environmental goods and services (Singh et al. 1993; Connelly et al. 2002; Shang et al. 2012). A study on public support for wetland restoration suggested that raising awareness can be a useful strategy to foster public support but that a targeted approach is necessary because different groups of people may require different kinds of information (Scholte et al. 2016). Garcia-Llorente et al. (2011) suggested that environmental education programs regarding biodiversity conservation should target older people with lower education levels and men. Our results also indicate that awareness raising campaigns of the benefits of ecological restoration may wish to target people with lower education levels.

We uniquely accounted for both benefits and disservices in the determination of public support under different restoration scenarios. Schaubroeck (2017) argued that for any nature valuation study, it is crucial to explicitly state which benefits and disservices will be delivered and place these under a common assessment framework. Shackleton et al. (2016) also noted that by only focusing on benefits we may fail to consider potential perverse outcomes. As a result there is a possibility that management alternatives that will minimize negative impacts will not be considered (Vaz et al. 2017). A better understanding of the reasons for resistance to restoration can also lead to more cooperation and ultimately promote favorable ecological and social conditions for successful restoration outcomes (Buckley & Crone 2008; Schaubroeck 2017).

Of the respondents to our survey who believe that restoration has negative impacts, concerns were oriented towards increased bushfire risk, decreased farmland productivity, and groundwater availability. Though the tendency to perceive disservices from restoration is associated with a lower WTP, not all disservices had this effect. Only the potential effects of restoration on land productivity had a significant negative influence on the amount of money respondents were willing to pay. Clear communication and clarification of possible impacts is important due to the influence on welfare economics, as shown by the results of this study. In particular, our study provides support for resolving dissonance between peoples' perceptions of impacts and realized impacts. Such education may improve strategies for private fundraising and community support for restoration activities.

This study contributes to the debate about the importance of communicating the ecosystem services arising from restoration. Our results provide evidence that environmental education and stakeholder engagement should include nonuse benefits such as threatened species benefits, and also clarify potential disservices arising from ecological restoration. These measures will more comprehensively accommodate the broader interests and concerns of community members and the influence this diversity has on the public perceptions of and support for restoration.

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Supporting Information

The following information may be found in the online version of this article:

Appendix S1. Examples of hypothetical regionally specific restoration project presented in the on-line survey.

Table S1. Interval regression models on respondents' stated WTP amount for restoration (in $) ($n = 990$).

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