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Social preferences for adaptation measures to conserve Australian birds threatened by climate change

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Abstract

Debate about climate change adaptation for biodiversity, particularly the ethics and consequences of assisted colonization, has polarized professional opinion but the views of the wider community are unknown. We tested four hypotheses about the acceptability of adaptation strategies among a sample of the Australian general public using a combination of direct questions and a choice experiment. We found that (i) among the 80% who wanted extinction avoided, increased *in situ* management of wild populations was preferred to captive breeding or assisted colonization; (ii) preferences for adaptation strategies were not explained by gender, income, education or knowledge about birds; (iii) genetically distinctive taxa were not actively preferred; (iv) over 60% of respondents were content for conservation managers to make decisions about strategies rather than local communities or the general public. The results provide Australian policymakers with a mandate to bolster efforts to retain existing populations but suggest that assisted colonization and captive breeding might be accepted if essential.

Keywords: assisted colonization; biodiversity; captive breeding; climate change; choice experiment; threatened species

1. Introduction

Many potential approaches to helping biodiversity adapt to climate change are controversial (Tam & Daniels, 2013) with solutions as much values-based as technical (Hewitt et al., 2011) and with pros and cons evident in all options. Assisted colonization (also called assisted migration; Hewitt et al., 2011), where climate-challenged taxa are moved to places where the climate is predicted to be more suitable, may also provide opportunities for invasive species (Ricciardi & Simberloff, 2009). Adaptive introgression, where new genes that could aid adaptation are introduced to climate-affected populations (Hamilton & Miller, 2015), can compromise species integrity (Gómez et al., 2015). Captive breeding will inevitably cause loss of genetic variability (Araki et al., 2007) even if current capacity constraints (Alroy, 2015) can be overcome. Less intrusive approaches, such as intensified in-situ management of sensitive species, are potentially only short-term investments given the inevitability of climate change (West et al., 2009). Landscape corridors can aid the spread of invasive species (Resasco et al., 2014).

This uncertainty about outcomes means policy-makers have little clear direction on how best to allocate adaptation investment, or whether to invest at all. This is because it is unclear which, if any, potential adaptation action has the strongest social license to proceed (Klenk & Larson, 2013). As is evident from the broader climate change debate, technical disagreements potentially create space for opponents of potential adaptation actions to delay changes by increasing political risk (Ceccarelli, 2011). Thus actions lacking a social license are unlikely to receive either authorization from the State or the public funding that will in most cases be required to put them into effect (Burbidge et al., 2011). While social responses to climate change adaptation are both culturally contingent and malleable (Adger et al., 2013), establishing the strength of public opinion before any actions are decided can both inform policy and enhance political confidence in the face of potential opposition.

Some studies have gauged the opinion of conservation scientists on climate change adaptation (Hagerman et al., 2010; Hancock & Gallagher, 2014; Hagerman & Satterfield 2015). Scientific knowledge is certainly essential to understanding the technical feasibility of management. However, in a democracy, the opinions of scientists about public policy have no more legitimacy than those of lay members of the public.

There are many examples of environmental legislation that protects even obscure species - about which the public knows very little, including some with substantial economic, social and political consequences. Thus, policy makers need to understand public opinion even where there is likely to be little understanding of the positions held by conservation scientists or of the technical matters relating to those positions.

Our main aim is to reveal the current level of acceptance by the Australian public of proposed conservation actions that would help birds adapt to climate change. These are based on realistic scenarios and associated actions that emerged from an analysis of the effects of climate on all Australian birds which showed that, for about 100 bird taxa, the climate where they currently live will be quite different in 50 years' time (Garnett et al., 2014). The proposed conservation management actions were increased *in situ* conservation, assisted colonization and the establishment of captive populations (e.g. in zoos). While experts favour greater investment in reducing threats *in situ* over assisted colonization (Hancock & Gallagher, 2014), to date no survey has been conducted among the general public in Australia or elsewhere to see if they know or care about proposed actions at this stage in the debate.

Also, because choices about which birds to conserve are likely to be compounded by the attractiveness of the taxa concerned, we tried to choose birds with a relatively low public profile. We also chose a mixture of species and subspecies with different levels of taxonomic distinctiveness, i.e. the level of genetic relatedness to other bird taxa. While taxonomic distinctiveness was first suggested as the basis for prioritising threatened bird conservation over 20 years ago (Faith, 1992,2002; Garnett, 1992; Weitzman, 1998), and has been used to choose between species for investment in New Zealand (Joseph et al., 2009), no distinction is made in legislation designed to conserve species in any nation examined (Garnett & Christidis, 2007). There is also no information on whether taxonomic distinctiveness is understood or used by the public in choosing among taxa to conserve.

This paper is therefore designed to understand the current preferences of the Australian public in three states where actions that might help species adapt to climate change may occur with the object of informing policy makers about which might be socially acceptable.

2. Methods

2.1. Case study birds and survey instrument

To test preferences for management actions we sampled 1,119 members of the Australian public living within the ranges of four bird taxa. Previous modelling (Garnett et al., 2014) has suggested that much of their habitat would be climatically unsuitable by 2085 (Fig. 1).

[Fig. 1 here]

The first section of the questionnaire described the four case study birds and potential adaptation strategies for securing their future (see Supplementary Material 1). The bird taxa were the Rufous Scrub-bird *Atrichornis rufescens*, one of just two members of an ancient Australian passerine bird family, the Atrichornithidae, the Scrub-tit *Acanthornis magna*, one of two endemic monotypic Tasmanian species but a member of a widespread family, the Acanthizidae, and two subspecies of another member of the Acantizidae, the relatively common and widespread Brown Thornbill *Acanthiza pusilla*, one from mainland Australia *A. p. pusilla*, one from Tasmania *A. p. tasmanicus*. By 2080 the scrub-bird and mainland subspecies of thornbill will potentially gain areas in Tasmania with climatic characteristics similar to where they currently occur, to which they could be moved. The scrub-bird has no close relatives in Tasmania. The mainland subspecies of Brown Thornbill will probably interbreed with individuals of the Tasmanian subspecies, meaning neither population would be the 'pure' form. The scrubtit and the Tasmanian thornbill subspecies have no prospective climate space in Australia but adaptation options offered for all four taxa included both intensive management within their current range to help birds cope with climate change and keeping populations in a zoo indefinitely. The status quo was to do nothing with the most likely consequence being eventual extinction.

The background information was written in a way that would avoid bias. For example, because we aimed to establish general principles for conservation preferences, rather than specific advice on the case study birds, we described the four taxa in bland descriptive language to reduce the chances of charisma bias (Brambilla et al., 2013) with enough information for respondents to understand the likely consequences of climate change but with no attempt to emphasise their conservation merit. This meant that we only noted that two of the bird taxa were subspecies from the same species, even though, as noted, the scub-bird and scrubtit were far more distinct than the two thornbill subspecies. We felt that such differences could influence the preferences of respondents with existing knowledge but that we could not have provided that knowledge as part of the questionnaire without implying higher levels of distinctiveness had greater value.

To understand which, if any, management actions are preferred as a means of assisting species cope with climate change we reviewed those recommended by Garnett et al. (2014) and chose the following: 1) increased *in situ* support for wild populations in their current locations ("in situ" described as helping a species stay where it is), 2) assisted colonization ("assisted colonization" described as moving a taxon to Tasmania) and 3) the establishment of captive populations ("captivity" described as keeping in a zoo). Respondents were asked to choose the most preferred management option out of three options in a choice set (see below). In this way they consider the importance to them of both the bird type which they wanted to see conserved and the action which they thought should be pursued. The acceptability of other adaptation options, such as the creation of habitat corridors, could not be tested because Tasmania is separated from the mainland by a substantial water body. This also prevented testing acceptability of natural climate refugees (Lundhede et al., 2014) since none of the case study taxa naturally cross marine barriers. Accounts of the alternative adaptation actions were described in plain language that tried to avoid potentially value-laden words or phrases, again to avoid bias as much as possible. We assumed all approaches are technically feasible and that the costs would be met from government tax revenue, which is usually the case for conservation in Australia, rather than from direct personal donation.

2.2. Design of the choice experiment

In an online survey, respondents were presented with a choice experiment, which systematically manipulates a set of attributes within each choice; such choice or preference elicitations are widely used to reveal preferences through requested trade-offs that may not be evident from more direct questions (Hensher et al., 2015). This means that, on the basis of a combination of prior knowledge and the information provided in the questionnaire, respondents chose between options that involved trade-offs among a mix of desirable and undesirable outcomes. The strength of feelings about the different options is then revealed through analysis of responses to a series of choice sets, in each of which the costs and outcomes attributes are varied. In this case respondents were asked to choose the conservation option in which they think the Australian Government should invest. Each involves a set of hypothetical conservation actions, one of which was the status quo in which birds would be left to cope with climate change without external assistance. The remaining two offered alternative trade-offs between birds and management actions (Fig. 2).

We used a Bayesian approach to obtain the experimental design underlying the choice experiment. Each bird taxon represented an attribute that could take two or three levels in addition to the status quo option “Leave it to cope”. The levels were “Help it stay where it is” and “Keep it in a zoo” for all taxa. The management action “Move it to Tasmania” was possible for the two mainland taxa. To allocate attribute levels to alternative choice sets a Bayesian d-efficient design was optimized for a conditional logit model (Rose & Bliemer, 2014) in a two-step procedure. Firstly, we created a design using uniform priors for which the interval boundaries were taken from previous studies. This design was used for the first 200 respondents. Secondly, after obtaining the data, conditional logit models were estimated and the results used to update the design. This updated design was then used for the remaining respondents. In both waves each respondent was presented with four different choice sets presented in a randomized order.

[Fig. 2 here]

We deliberately avoided asking respondents to make a private monetary contribution to bird conservation, as is usually done in environmental valuation when the aim is to quantify the values of non-market or public goods (Adamowicz et al., 1998). In such studies the cost is one of the attributes to be traded off, allowing calculation of the marginal willingness-to-pay for each of the attributes (here birds). In this case we had no interest in the willingness-to-pay for each attribute but were interested in the trade-off between attributes regardless of cost. Also the most realistic scenario is one in which the Australian Governmental would invest in the conservation of the birds using taxes imposed on society rather than individuals paying. An experimental design without a cost attribute was consistent with our aim to reveal peoples' acceptance of conservation actions for the different bird taxa rather than people's willingness-to-pay for these actions. Adding a cost attribute would probably have shifted the choice behaviour away from peoples' ethical and emotional reactions to proposed conservation actions towards considerations of cost (Carlsson et al., 2007; Pedersen et al., 2011).

The choice experiment was followed by questions on the respondents' demographic background, their attitudes towards and knowledge about birds and their understanding of climate change and its causes (see Supplementary Material 2). A four point rating scale was used where appropriate, but avoided use of 'no opinion' to eliminate social acceptability bias (Garland, 1991) and force deeper psychological engagement with the question (Smyth et al., 2006).

2.3. Sampling and data

Data were collected through a commissioned online survey in September/October 2014. The study was approved by the Charles Darwin University Human Research Ethics Committee (H13115). The sample was recruited from an online panel recruited by MyOpinions PermissionCorp. MyOpinions has an active panel of about 300,000 verified respondents and has developed, and continues to maintain, an actively managed panel which adheres to a strict "research only" policy governed by industry bodies such as ESOMAR, AMSRS and AMSRO. MyOpinions is also accredited to ISO 20252 and ISO 26362 professional standards and guidelines. Approximately half of the panel has been recruited from offline sources. MyOpinions offered a small incentive of AU$2 for completion of the survey.

A random sample of adults (>18 years) was drawn from the panel in three Australian states (Tasmania, Victoria, Queensland), aligning with the distribution of the birds. A total of 7816 people were sampled and invited to take the survey. When invited, panel members do not know the topic of the survey. We received 1421 responses (response rate: 18.2%) of which a further 307 (21.6%) dropped out without completing all the questions. In total there were 1119 completions, 78.4% of those knowing the survey content.

2.4. Econometric approach

For the analysis we used a random utility model (McFadden, 1974) as point of departure. Assuming that the researcher does not possess complete information regarding individual decision maker *n,* individual preferences are the sum of a systematic (V) and a random (ε) component:

$$U_{ni} = V_{ni}(x_{ni}\beta) + \varepsilon_{ni}\ , \qquad (1)$$

where U_{ni} is the true but unobservable utility associated with alternative *i* out of a set of available alternatives *j*, V_{ni} is the deterministic part that is a function of the attributes (x_{ni}), β is a vector of coefficients reflecting the desirability of the attributes, and ε_{ni} is unknown and treated as random. Selection of one alternative over another implies that the utility (U_{ni}) of that alternative is greater than the utility of the other alternatives:

$$P(i) = \Pr ob(V_i + \varepsilon_i > V_j + \varepsilon_j) \quad \forall\, j \in C, j \neq i \qquad (2)$$

Assuming that the error components are distributed independently and identically (IID) following a type 1 extreme value distribution, one gets the conditional logit (CL). In this model the probability of individual *n* choosing alternative *i* is:

$$P_{ni} = \frac{\exp(\mu V_{ni})}{\sum_{j \in C} \exp(\mu' V_{nj})} \qquad (3)$$

The scale parameter *μ* is normalised to 1 as it cannot be identified separately from the vector of parameters in a single data set. One of the shortcomings of the CL is that it erroneously assumes that all respondents have identical preferences. Thus, we additionally use a latent class approach to identify a number of *a priori* unknown subgroups that might exist in a population (Swait, 2007); each of the subgroups is characterised by a distinct preference structure. Every individual is assumed to belong probabilistically to one of the subgroups. The probability that a respondent chooses alternative *i*, conditional on belonging to a given segment *s*, in the latent class framework is:

$$P_{(ni|s)} = \frac{exp(\beta_s X_{in})}{\sum_{j=1}^{J} exp(\beta_s X_{jn})}\ . \qquad (4)$$

Application of the latent class model requires external determination of the number of classes separate from the maximization procedure. Thus, we sequentially estimated models with an increasing number of segments S (S = 1, 2, 3, 4, …). We used the Bayesian Information Criteria (BIC) to select the number of classes (Greene & Hensher, 2003). All models were estimated using the software Latent Gold Choice 5.0 (Vermunt & Magidson, 2014).

We conducted likelihood-ratio tests to investigate the relative attribute impact (Lancsar et al., 2007) as the parameter values cannot be interpreted directly in nonlinear models and additionally the parameter values are confounded with scale. For the latent class model we run this test separately for each class (see 'Development of the latent class model' in Supplementary Material 3).

3. Results

The most parsimonious classification of respondent preferences for either actions or bird taxa identified three classes using latent class analysis of the choice modelling results (Table 1). These were characterised as 'Wild preferred' for people who consistently favoured the option of helping species stay where they currently occur over other options, 'No extinction' for people who demonstrated little preference for any action provided taxa did not go extinct and 'Status quo' for people who were most likely to agree that taxa be left to cope with climate change without intervention of conservation managers. While classes were statistically indistinguishable in terms of income (AU$44,700 p.a.), education (80% had completed secondary school), gender and knowledge of birds, the small 'Status quo' class (21%) respondents were older, less likely to attribute human agency in climate change or to agree that decisions about adaptation should be made by experts. They were also less likely to enjoy seeing new birds. Two thirds of this class chose the status quo in all the four choice sets they were offered and the remainder chose it twice (18%) or three times (17%). Reasons for a lack of support for adaptation support being relatively evenly split among a belief that climate will have no effect (29%), meaning that no adaptation investment would be needed, disapproval of conservation investment generally (27%), not feeling that they knew enough (22%) and a belief that money would not be spent appropriately (18%). The other two classes differed only in their attitude to the adaptation actions proposed, with one class (29% of respondents) favouring protection in the wild ('Wild preferred') more strongly than the other (50%; 'No extinction').

[Table 1 here]

While the basis of the latent class analysis was to discover which classes supported conservation, particularly of wild birds, preferences were not immediately evident from direct questions about which actions they found acceptable. More than 65% of all classes agreed or strongly agreed that all three options – retention in the wild, assisted colonization or captivity – were acceptable (Fig. 3a). However, over 60% of respondents varied in the extent of their preferences (Fig. 3b), with the Status quo' respondents less likely to express a preference than the others (breadth of preferences measured as standard deviation across four values for three variables; χ^2=33.33; P<0.001). When we calculated the difference between proportion of people listing one of the three options as less acceptable than the other two and the proportion listing the same option as more acceptable than the others, the contrast was markedly in favour of investment in the wild and against the other options (Fig. 3b).

Although 'Status quo' respondents were less likely to consider expenditure on any of the birds acceptable (Fig. 3a), over 86% of all respondents gave the same level of importance for all bird taxa (Fig. 3b) and the preferences of the 6% who favoured one taxon above the others almost cancelled out the preferences of the 4% who gave a lower importance to one taxon than all the others (Fig. 3c). The choice model analysis, however, revealed that respondents in the 'Wild preferred' class also favoured assisted colonization of the Rufous Scrub-bird should the climate change.

[Fig. 3 here]

Respondents from Tasmania (n=249), the place to which scrub-birds or mainland Brown Thornbills would be moved if required, were as likely to be in any of the classes as people from the mainland states (Table A4 in Supplementary Material 3). While more Tasmanian respondents preferred decision-making by local communities (30% compared to 24% on the mainland) than by the general public (10% and 14%), the proportion believing conservation managers should make the decision was 60% in both cases (Supplementary Material 4).

4. Discussion

Four points emerge from these data.

First there was a high level of desire to avoid extinctions across all respondents (79% of respondents). This proportion is comparable to Europe and the USA: in Europe 93% of respondents thought that the decline and loss of animal and plant species was ‘very serious’ (59%) or ‘fairly serious’ (14%) (European Union, 2013); in the USA an average of 66% of respondents (range 61-78%) worried ‘a great deal’ or ‘a fair amount’ about the extinction of plant and animal species in annual surveys conducted 2000-2015 (Jones & Saad, 2015). That the figure obtained in the current study is higher than the 63% of Australians willing to pay into a fund to prevent the extinction of threatened species (Zander et al., 2014) was expected: in the current study it was assumed that government would allocate taxes rather than payments being direct from the respondents, which is the situation with most threatened species conservation in Australia. It follows that there remains strong support for legislation and policy that prevents the extinction of species, despite the simultaneous promulgation of legislation and policies that undermine democratic principles by permitting developments that lead to extinction (Ellis, 2010).

Second is that nearly 30% of respondents expressed a strong preference for maintaining species where they currently occur in the wild. These respondents, however, do not rule out moving taxa like the Rufous Scrub-bird should that prove essential. Indeed most respondents were relatively comfortable with options such as assisted colonization or retaining in a zoo in perpetuity that many scientists have until recently considered taboo (Hagerman & Satterfield, 2014), even if these were not actively favoured. This is in contrast with 53 Australian conservation professionals sampled by Hancock & Gallagher (2014) of whom 21% felt that, in the foreseeable future, plants should not be moved to places where they are likely to have occurred before anthropogenic change, let alone to sites beyond their former range. Some 89% of this group also felt that increased *in situ* action was the most urgent activity. The strength of opinion among those favouring wild conservation suggests that this option needs to be investigated thoroughly before other options are adopted, but that the more contentious ideas should not be rejected as being unacceptable to the general public, whatever private views are held by conservation professionals.

Thus, the low level of support for retaining birds in zoos in perpetuity suggests that this option would need the strongest justification before it is adopted. These results resemble those of conservation biologists (Hagerman et al., 2010) and self-selected panels (Tam & Daniels, 2013) in Canada and the USA, both of which favoured strategies with low risk but provide qualified support for other options. The relatively small 'Status quo' class expressed too few preferences on actions to influence the debate. Overall the level of climate scepticism (17% scam or only natural change) was within the range reported from Australia-wide surveys (15-19%; Greenhill et al., 2014) but that of the 'Status quo' class (33%) was much closer to that of recent surveys in the USA (35%; Yale Project on Climate Change Communication, 2014).

Third, while various authors have insisted on the importance of local ownership of the governance processes of assisted colonization (e.g. Hewitt et al., 2011), with the 53 Australian conservation professionals sampled by Hancock & Gallagher (2014) believing that "full approval from all stakeholders at the source and recipient sites" to be the most important influence on successful assisted colonization of flora. In the case examined here, respondents demonstrated a high level of trust in conservation professionals with over 60% of the respondents content that conservation professionals have the major say in the decision about the adaptation option most suitable for conserving a species in the face of climate change. That a higher proportion of Tasmanian respondents preferred that decisions about adaptation approaches be made by local communities rather than the general public may reflect an anti-mainland sentiment among those who did not want conservation professionals to make the decision. However, the proportion of Tasmanian respondents willing to accept the direction of experts on appropriate adaptation strategies did not differ from the mainland. This result may reflect ignorance or lack of interest, especially while the question remains hypothetical, but does behove the conservation professionals to act in the best interest of the taxa being conserved and recognise that this may be influenced by their own value system.

Lastly, none of the classes expressed preferences for the different bird taxa, even though they were informed that two were species and two were subspecies. Studies of a range of taxa have shown that the threat of extinction is the most powerful driver of how people value species, regardless of charisma or other confounding factors such as distinctiveness (Tisdell, 2014). In this case charisma was avoided as much as possible by confining the choice to four small brown birds. Also, as noted, genetic distinctiveness was deliberately not emphasised, even though the Rufous Scrub-bird has a genetic distinctiveness double that of the Scrub-tit and five times that of the Brown Thornbill as a species (Garnett et al., 2015). Subspecies of Brown Thornbill, of which there are five, are even less distinct. However, we were as careful as we could be not to change respondents' level of understanding in our questions as they would then not have been typical of the wider population. Thus the lack of preference for species over subspecies or of the scrub-bird over the others suggests that prioritization based on genetic distinctiveness, which has been favoured by some scientists and economists (Faith, 1992, 2002; Garnett, 1992; Weitzman, 1998; Joseph et al., 2009), is a characteristic that is either not well understood by the general public or is understood but does not affect their preferences. The acceptance of top-down direction on management of bird conservation in the face of climate change found here might suggest that the public is happy for their views about genetic distinctiveness in setting priorities to be over-ridden by conservation managers. On the other hand the legislation of most countries, including Australia, gives equal value to all levels of genetic distinctiveness (Garnett & Christidis, 2007). In Australia, even a taxon like the Norfolk Island Owl *Ninox novaeseelandiae undulata*, of which the last female was mated with a New Zealand male to retain its genetic potential (Garnett et al. 2011), has been given the highest priority in the Australian Government's latest policy documents (Australian Government, 2015). Also Tasmania has explicitly given equal value to species and subspecies in a recent prioritization exercise (Tasmanian Government, 2010). The results from this survey corroborate the approach taken in Tasmania. Whatever the private views of conservation professionals, there is currently no legitimacy in using genetic distinctiveness to prioritise taxa for conservation action in Australia.

5. Conclusions

Overall the results suggest that 80% of the Australian public wishes to avoid extinction, preferably by helping climate-stressed populations adapt where they currently occur. However people are relatively sanguine about other approaches if deemed necessary, and are willing to follow the advice of experts. The findings should allow Australian conservation managers to proceed with climate change adaptation with appropriate caution as conditions change. It provides evidence that the public generally supports the more strongly expressed views of conservation advocates that the highest priority should be support for existing wild populations (Lundhede et al., 2014), even in the face of climate stress on those populations, but there is acceptance that more drastic interventions may eventually be needed.

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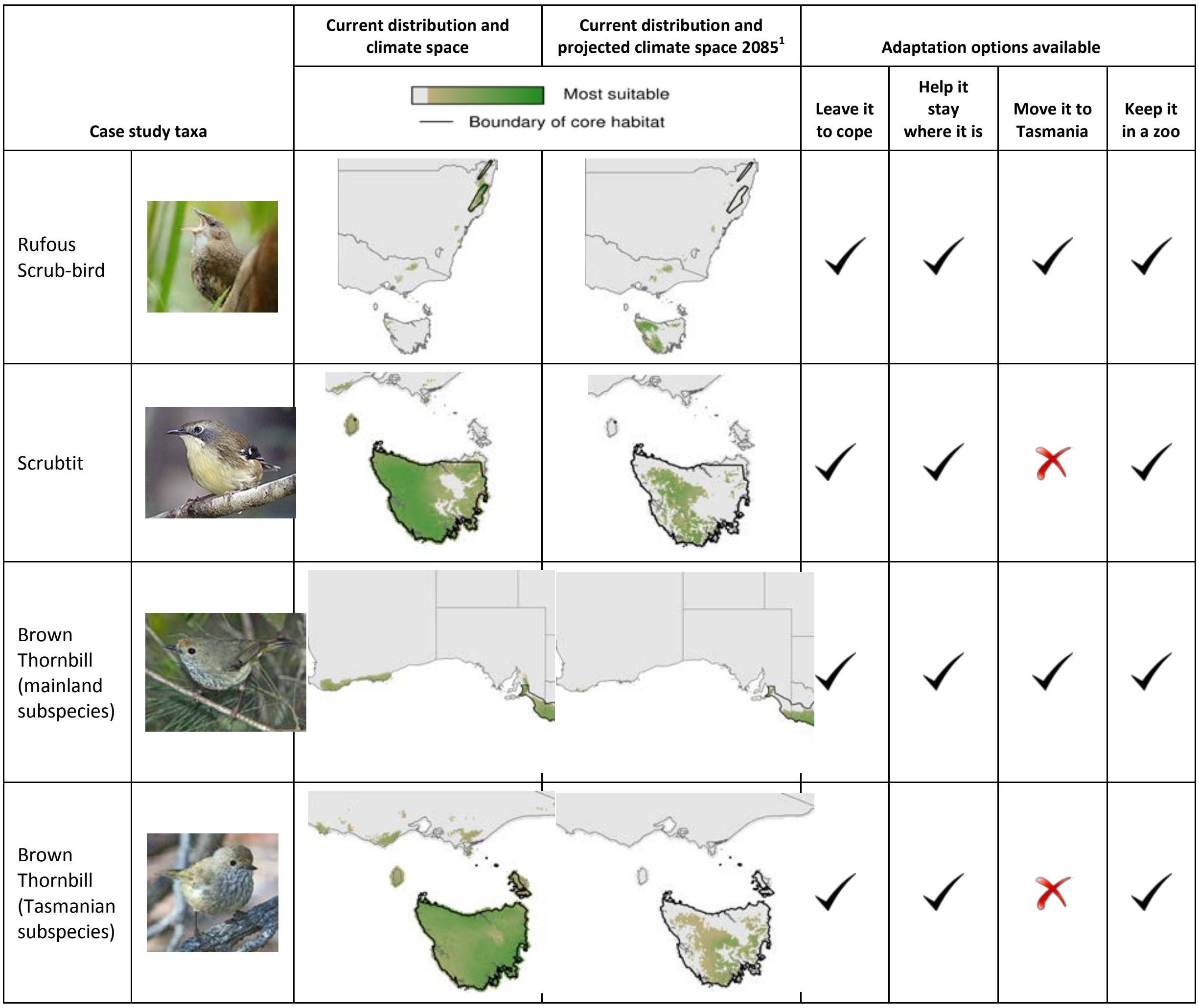
Tables

Table 1. Characteristics of three Australian respondent classes identified through latent class analysis of choices made about strategies that could be used to help bird taxa threatened by climate change.

Characteristic	All	Status quo	Wild preferred	No extinctions	Statistics
N	1,119	240	345	534	
Income (AU$)	44,700 (±31,800)	44,700 (±31,300)	44,000 (±29,700)	44,200 (±33,300)	F=0.14 P=0.871
Female (%)	50	47	54	49	χ^2=3.98 P=0.137
Post-secondary education (%)	66	67	68	65	F=0.26 P=0.773
Age (years)	49 (16)	52[a] (15)	49[b] (16)	48[b] (16)	F=6.24 P=0.002
Cause of climate change					
Human	31	16	38	34	χ^2=74.88 P=0.001
Natural + Human	52	51	52	52	
Natural	12	21	7	11	
Scam	5	12	3	4	
Primary locus of decision making authority					
Local people	25	39	20	23	χ^2=74.69 P<0.001
General public	15	28	11	11	
Conservation scientist	60	33	68	66	
Self-reported ability to identify birds					
Few	31	35	27	32	χ^2=10.91 P=0.091
Common	62	58	68	60	
Most/All	7	7	5	8	
Reaction to encountering a bird species for the first time					
Take no notice	19	30	16	16	χ^2=26.13 P<0.001
Enjoy	66	54	69	69	
Identify/List	16	17	14	16	

Figures

Fig 1. Characteristics of four Australian bird taxa likely to be affected deleteriously by climate change, their current distributions in comparison to modelled habitat suitability in 2014 and 2085 and the options available for climate change adaptation. “Leave it to cope” is to do nothing; “Help it stay where it is” is to assist birds to survive *in situ*; ”Move it to Tasmania” is to move birds to places with a more suitable climate; “Keep it in a zoo” is to establish a permanent captive population.



[1] Projected distribution in 2085 of areas with a climate resembling that currently occupied by the taxon (from Garnett et al. 2014)

Fig 2. Example of a choice set and accompanying text as presented to respondents in an online survey.

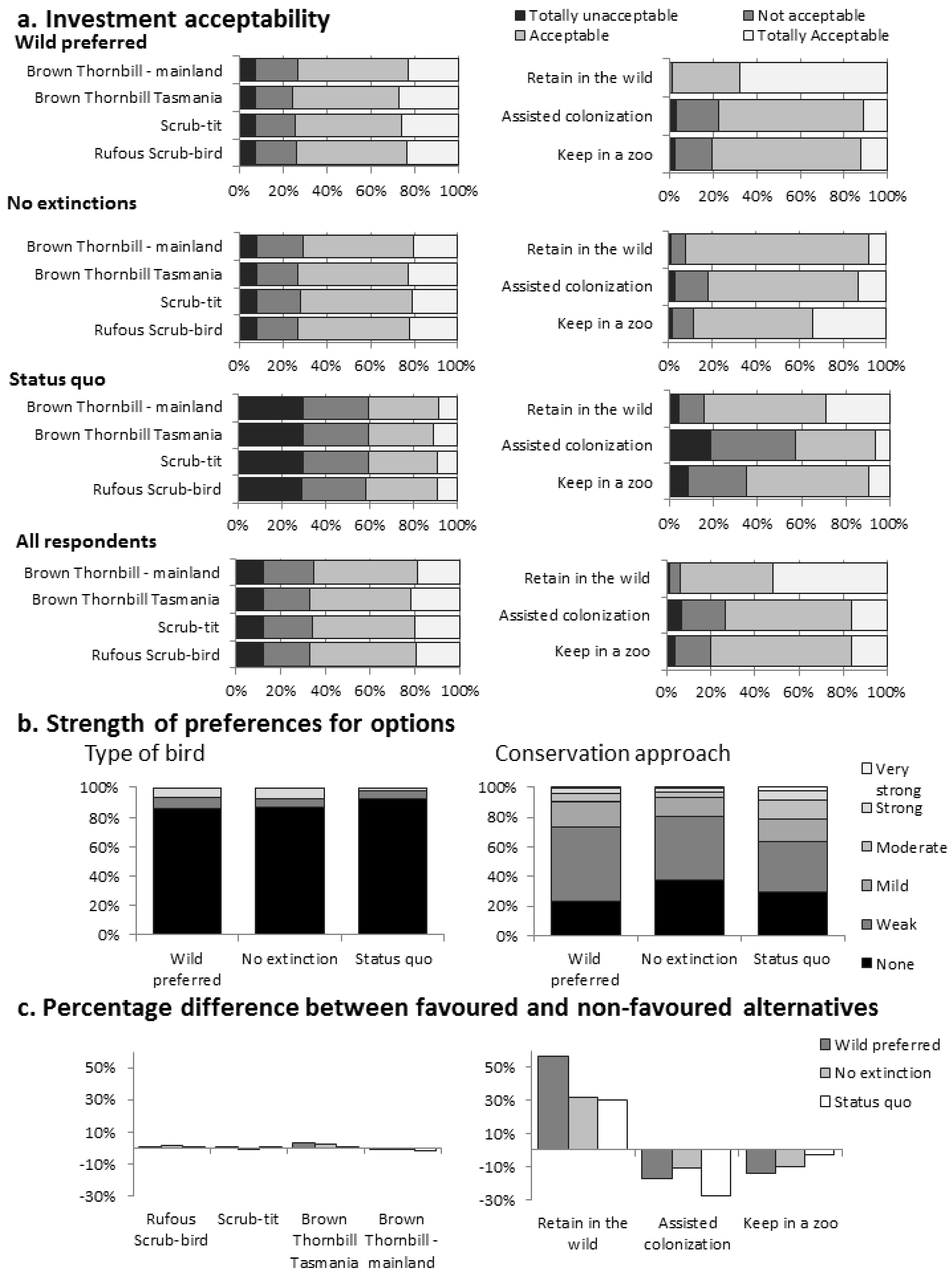
In this set of three options there are two ("Management options A and B") for which the Government would pay to manage birds threatened by climate change, and one option in which no money would be spent ("No special management").

If only these three options were available, which one would you prefer? (A reminder about which bird is which is at the bottom of the page)

	Management option A	Management option B	No special management
Rufous Scrub-bird	Leave it to cope	Move it to Tasmania	Leave it to cope
Scrub-tit	Keep it in a zoo	Keep it in a zoo	Leave it to cope
Brown Thornbill – mainland form	Keep it in a zoo	Leave it to cope	Leave it to cope
Brown Thornbill – Tasmanian form	Help it stay where it is	Keep it in a zoo	Leave it to cope

Reminder:
Rufous Scrub-bird: Occurs in mountain forests in south-east Queensland and north-east New South Wales but in the future the best climate for it may be in Tasmania.
Scrub-tit: Occurs only in the wet forests of Tasmania but the climate there may change completely.
Brown Thornbill - mainland form: Occurs in the forests and woodlands of south-east Australia. Could be moved to Tasmania to follow suitable climate but would mix with the form of Brown Thornbill already there.
Brown Thornbill - Tasmanian form: Occurs in the forests and woodlands of Tasmania. The climate there may become unsuitable but the Tasmanian form could be replaced by the mainland form.

Fig 3. Stated preferences among three respondent classes for climate change adaptation measures for four Australian bird taxa: a. acceptability of government investment in either conservation of birds or different types of adaptation measure; b. extent of variation in preferences across four bird taxa or three adaptation measures on a four point scale; c. percentage difference between those with a clear preference for a bird or adaptation measure and those with a clear disapproval.



Supplementary Material

Supplementary Material 1: The choice experiment setting

1. Introductory text to choice experiment for respondents
2. Description of case study birds in survey

Supplementary Material 2: Questions supplementary to the choice model

Supplementary Material 3: Development of the latent class model

Supplementary Material 4: Comparison of Tasmanian and mainland results