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

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9 **Abstract**

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

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

23

24 **1. Introduction**

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

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

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

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

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

63 Also, because choices about which birds to conserve are likely to be compounded by the
64 attractiveness of the taxa concerned, we tried to choose birds with a relatively low public profile. We also
65 chose a mixture of species and subspecies with different levels of taxonomic distinctiveness, i.e. the level of
66 genetic relatedness to other bird taxa. While taxonomic distinctiveness was first suggested as the basis for
67 prioritising threatened bird conservation over 20 years ago (Faith, 1992,2002; Garnett, 1992; Weitzman,
68 1998), and has been used to choose between species for investment in New Zealand (Joseph et al., 2009),
69 no distinction is made in legislation designed to conserve species in any nation examined (Garnett &
70 Christidis, 2007). There is also no information on whether taxonomic distinctiveness is understood or used
71 by the public in choosing among taxa to conserve.

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

75 **2. Methods**

76 **2.1. Case study birds and survey instrument**

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

80 [Fig. 1 here]

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

96 The background information was written in a way that would avoid bias. For example, because we
97 aimed to establish general principles for conservation preferences, rather than specific advice on the case
98 study birds, we described the four taxa in bland descriptive language to reduce the chances of charisma
99 bias (Brambilla et al., 2013) with enough information for respondents to understand the likely

100 consequences of climate change but with no attempt to emphasise their conservation merit. This meant
101 that we only noted that two of the bird taxa were subspecies from the same species, even though, as
102 noted, the scub-bird and scrubtit were far more distinct than the two thornbill subspecies. We felt that
103 such differences could influence the preferences of respondents with existing knowledge but that we could
104 not have provided that knowledge as part of the questionnaire without implying higher levels of
105 distinctiveness had greater value.

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

121 **2.2. Design of the choice experiment**

122 In an online survey, respondents were presented with a choice experiment, which systematically
123 manipulates a set of attributes within each choice; such choice or preference elicitation are widely used to
124 reveal preferences through requested trade-offs that may not be evident from more direct questions
125 (Hensher et al., 2015). This means that, on the basis of a combination of prior knowledge and the

126 information provided in the questionnaire, respondents chose between options that involved trade-offs
127 among a mix of desirable and undesirable outcomes. The strength of feelings about the different options is
128 then revealed through analysis of responses to a series of choice sets, in each of which the costs and
129 outcomes attributes are varied. In this case respondents were asked to choose the conservation option in
130 which they think the Australian Government should invest. Each involves a set of hypothetical conservation
131 actions, one of which was the status quo in which birds would be left to cope with climate change without
132 external assistance. The remaining two offered alternative trade-offs between birds and management
133 actions (Fig. 2).

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

144 [Fig. 2 here]

145 We deliberately avoided asking respondents to make a private monetary contribution to bird
146 conservation, as is usually done in environmental valuation when the aim is to quantify the values of non-
147 market or public goods (Adamowicz et al., 1998). In such studies the cost is one of the attributes to be
148 traded off, allowing calculation of the marginal willingness-to-pay for each of the attributes (here birds). In
149 this case we had no interest in the willingness-to-pay for each attribute but were interested in the trade-off
150 between attributes regardless of cost. Also the most realistic scenario is one in which the Australian
151 Governmental would invest in the conservation of the birds using taxes imposed on society rather than

152 individuals paying. An experimental design without a cost attribute was consistent with our aim to reveal
153 peoples' acceptance of conservation actions for the different bird taxa rather than people's willingness-to-
154 pay for these actions. Adding a cost attribute would probably have shifted the choice behaviour away from
155 peoples' ethical and emotional reactions to proposed conservation actions towards considerations of cost
156 (Carlsson et al., 2007; Pedersen et al., 2011).

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

162 **2.3. Sampling and data**

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

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

177 **2.4. Econometric approach**

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

181
$$U_{ni} = V_{ni}(x_{ni}, \beta) + \varepsilon_{ni}, \quad (1)$$

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

187
$$P(i) = \text{Pr ob}(V_i + \varepsilon_i > V_j + \varepsilon_j) \quad \forall j \in C, j \neq i \quad (2)$$

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

191
$$P_{ni} = \frac{\exp(\mu V_{ni})}{\sum_{j \in C} \exp(\mu V_{nj})} \quad (3)$$

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

199
$$P_{(ni|s)} = \frac{\exp(\beta_s X_{in})}{\sum_{j=1}^J \exp(\beta_s X_{jn})}. \quad (4)$$

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

205 We conducted likelihood-ratio tests to investigate the relative attribute impact (Lancsar et al.,
206 2007) as the parameter values cannot be interpreted directly in nonlinear models and additionally the
207 parameter values are confounded with scale. For the latent class model we run this test separately for each
208 class (see 'Development of the latent class model' in Supplementary Material 3).

209 **3. Results**

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

225 attitude to the adaptation actions proposed, with one class (29% of respondents) favouring protection in
226 the wild ('Wild preferred') more strongly than the other (50%; 'No extinction').

227 [Table 1 here]

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

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

244 [Fig. 3 here]

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

249 proportion believing conservation managers should make the decision was 60% in both cases
250 (Supplementary Material 4).

251 **4. Discussion**

252 Four points emerge from these data.

253 First there was a high level of desire to avoid extinctions across all respondents (79% of
254 respondents). This proportion is comparable to Europe and the USA: in Europe 93% of respondents thought
255 that the decline and loss of animal and plant species was 'very serious' (59%) or 'fairly serious' (14%)
256 (European Union, 2013); in the USA an average of 66% of respondents (range 61-78%) worried 'a great
257 deal' or 'a fair amount' about the extinction of plant and animal species in annual surveys conducted 2000-
258 2015 (Jones & Saad, 2015). That the figure obtained in the current study is higher than the 63% of
259 Australians willing to pay into a fund to prevent the extinction of threatened species (Zander et al., 2014)
260 was expected: in the current study it was assumed that government would allocate taxes rather than
261 payments being direct from the respondents, which is the situation with most threatened species
262 conservation in Australia. It follows that there remains strong support for legislation and policy that
263 prevents the extinction of species, despite the simultaneous promulgation of legislation and policies that
264 undermine democratic principles by permitting developments that lead to extinction (Ellis, 2010).

265 Second is that nearly 30% of respondents expressed a strong preference for maintaining species
266 where they currently occur in the wild. These respondents, however, do not rule out moving taxa like the
267 Rufous Scrub-bird should that prove essential. Indeed most respondents were relatively comfortable with
268 options such as assisted colonization or retaining in a zoo in perpetuity that many scientists have until
269 recently considered taboo (Hagerman & Satterfield, 2014), even if these were not actively favoured. This is
270 in contrast with 53 Australian conservation professionals sampled by Hancock & Gallagher (2014) of whom
271 21% felt that, in the foreseeable future, plants should not be moved to places where they are likely to have
272 occurred before anthropogenic change, let alone to sites beyond their former range. Some 89% of this
273 group also felt that increased *in situ* action was the most urgent activity. The strength of opinion among

274 those favouring wild conservation suggests that this option needs to be investigated thoroughly before
275 other options are adopted, but that the more contentious ideas should not be rejected as being
276 unacceptable to the general public, whatever private views are held by conservation professionals.

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

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

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

324 **5. Conclusions**

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

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339

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365 [The_Extinction_Crisis_and_Democratic_Theory-110.pdf](http://www.diss.fu-berlin.de/docs/servlets/MCRFileNodeServlet/FUDOCS_derivate_000000001327/Ellis-The_Extinction_Crisis_and_Democratic_Theory-110.pdf) [accessed 13 May 2016].
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451 **Tables**

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



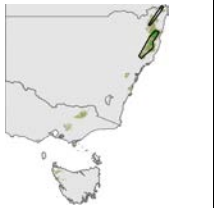
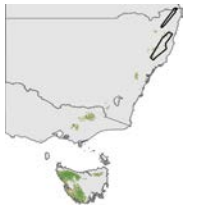


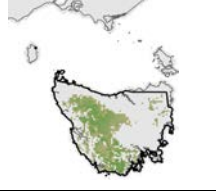



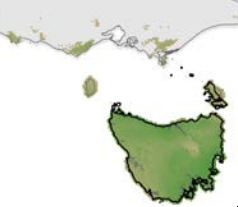
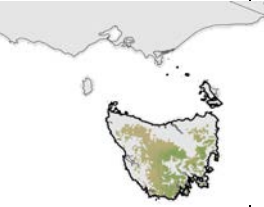
Characteristic	All	Status quo	Wild preferred	No extinctions	Statistics
N	1,119	240	345	534	
Income (AU\$)	44,700 (±31,800)	44,700 (±31,300)	44,000 (±29,700)	44,200 (±33,300)	F=0.14 P=0.871
Female (%)	50	47	54	49	$\chi^2=3.98$ P=0.137
Post-secondary education (%)	66	67	68	65	F=0.26 P=0.773
Age (years)	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	$\chi^2=74.88$ 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	$\chi^2=74.69$ 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	$\chi^2=10.91$ 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	$\chi^2=26.13$ P<0.001
Enjoy	66	54	69	69	
Identify/List	16	17	14	16	

455

456

457 **Figures**

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

Case study taxa		Current distribution and climate space	Current distribution and projected climate space 2085 ¹	Adaptation options available			
				Leave it to cope	Help it stay where it is	Move it to Tasmania	Keep it in a zoo
Rufous Scrub-bird				✓	✓	✓	✓
Scrubtit				✓	✓	✗	✓
Brown Thornbill (mainland subspecies)				✓	✓	✓	✓
Brown Thornbill (Tasmanian subspecies)				✓	✓	✗	✓

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

466

467 **Fig 2.** Example of a choice set and accompanying text as presented to respondents in an online
 468 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.

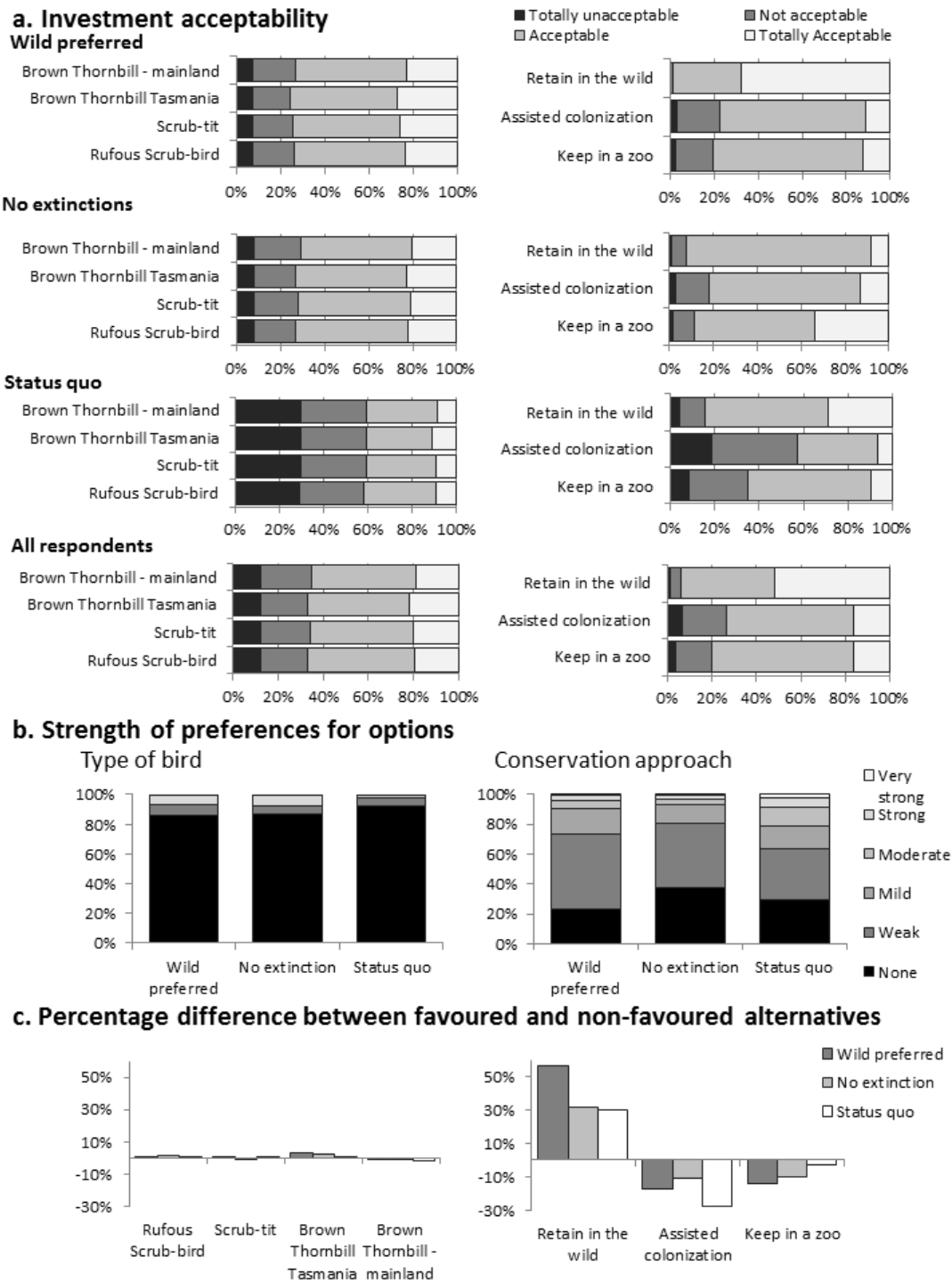
Scrub-tit: Occurs only in the wet forests of Tasmania but the climate there may change completely.

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.

469

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



475

476

477 **Supplementary Material**

478 **Supplementary Material 1:** The choice experiment setting

479 1. Introductory text to choice experiment for respondents

480 2. Description of case study birds in survey

481 **Supplementary Material 2:** Questions supplementary to the choice model

482 **Supplementary Material 3:** Development of the latent class model

483 **Supplementary Material 4:** Comparison of Tasmanian and mainland results