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Biodiversity conservation as a promising frontier for behavioural science

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1 **Biodiversity conservation as a promising frontier for behavioural science**

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42

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44

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51 **Abstract**

52 Human activities are degrading ecosystems worldwide, posing existential threats for
53 biodiversity and humankind. Slowing and reversing this degradation requires profound and
54 widespread changes to human behaviour. Behavioural scientists are therefore well placed to
55 contribute intellectual leadership in this area. This Perspective aims to stimulate a marked
56 increase in the amount and breadth of behavioural research addressing this challenge. First,
57 we describe the significance of the biodiversity crisis for human and non-human prosperity
58 and the central role of human behaviour in reversing this decline. Next, we discuss key gaps
59 in our understanding of how to achieve behaviour change for conservation and suggest how to
60 identify key behaviour changes and actors capable of improving biodiversity outcomes.
61 Finally, we outline the core components for building a robust evidence base and suggest
62 priority research questions for behavioural scientists to explore in opening a new frontier of
63 behavioural science for the benefit of nature and human wellbeing.

64 **The problem**

65 A recent global synthesis estimates that 75% of Earth's land surface has been significantly
66 altered by human activities, 66% of the ocean has been negatively affected, and 85% of
67 wetland areas have been lost¹. The combined effects of land-use change and habitat
68 fragmentation, overharvesting, invasive species, and pollution and climate change have
69 resulted in an average decline in monitored populations of vertebrates of nearly 70% since
70 1970 as well as extinction rates which are orders of magnitude higher than the average seen in
71 the geological record²⁻⁴. The threats to species are so severe that there is growing scientific
72 consensus that we are entering the sixth mass extinction – the fifth being the Cretaceous-
73 Paleogene extinction event 66 million years ago that killed all non-avian dinosaurs⁵.

74 The rapid degradation of ecosystems and associated loss of species is of profound
75 importance, for at least three reasons. First, there are powerful moral arguments that people
76 should not cause the avoidable extinction of perhaps one million or more species⁶. Second,
77 human prosperity depends on wild habitats and species for a host of essential benefits, from
78 climate regulation, biogeochemical and flood regulation to food production and the
79 maintenance of mental wellbeing^{7,8}. Their deterioration thus presents an existential
80 challenge¹. Third, evidence suggests that pandemics resulting from greater disease
81 transmission between humans and wild animals^{9,10} will become more regular features of the
82 future unless our interactions with wild species changes fundamentally^{9,11-14}. The COVID-19
83 pandemic – with devastating effects on societies and economies worldwide – illustrates the
84 consequences of deteriorating wild habitats and biodiversity exploitation.

85 Humanity's impacts on biodiversity are the result of our actions, from unsustainable
86 wildlife harvesting through to the rising demand for environmentally damaging foods^{1,15-18}.
87 Importantly, these actions are undertaken by actors in myriad roles – including consumers,
88 producers, and policymakers – who directly or indirectly impact ecosystems and wild

89 species¹⁹. For example, the rapid clearance of the Amazon is driven by the actions of
90 consumers across the globe who eat beef, policymakers who undervalue forest retention, and
91 ultimately local ranchers who are incentivized to convert forest to pasture^{20,21}. Similarly, the
92 illegal trade of wildlife (e.g., rhino horn, pangolin scales, tiger bones, or elephant ivory)
93 involves suppliers who hunt the animals, intermediaries who facilitate trade and transport the
94 products to market, and domestic and international consumers^{17,22–24}. The direct impacts on
95 biodiversity are, however, not only centred in less developed countries. For example, the
96 continued illegal persecution of birds of prey in UK uplands is the result of choices by some
97 gamekeepers to shoot and poison raptors to limit their predation of red grouse, by some
98 hunters to pay exceptionally high prices for large daily “bags” of grouse, and by policymakers
99 to resist attempts at tighter regulation of the shooting industry²⁵.

100 Because human activities are responsible for driving ecosystem decline, reversing
101 current trends will require profound and persistent changes to human behaviour, across actors
102 and scales²⁶. Despite its critical importance, the science of behaviour change and its
103 application has not been a principal focus of research in conservation science^{26–31}.
104 Conservation scientists have been slow to incorporate behavioural science evidence into their
105 theories and interventions^{26,29,32–34}. Likewise, biodiversity conservation has not been a strong
106 focus of study for behavioural scientists. One exception is research on common-pool resource
107 management and commons dilemmas, which has a long history tracing back to the 1970s^{35–38}.
108 This research tradition has tackled issues closely linked to biodiversity conservation and
109 foreshadows many contemporary and interdisciplinary analyses. More recently, social-
110 marketing techniques have been used to tackle a variety of biodiversity problems and their
111 potential is increasingly recognized^{39,40}. For example, a recent study in the Philippines,
112 Indonesia, and Brazil used locally tailored social marketing campaigns to shift social norms
113 and increase sustainable fishing among communities of small-scale fisheries⁴¹. Yet, while the

114 number of successful applications of behavioural science to biodiversity conservation is
115 increasing, they remain rare and often suffer from methodological limitations⁴². The
116 conservation evidence base is consequently patchy and generally poorly informed by
117 behavioural science^{29,43}.

118 Meanwhile, behavioural science has made gains in understanding how to encourage
119 prosocial behaviour, including actions that ultimately affect biodiversity outcomes. A growing
120 body of research related to climate change suggests the importance of social norms, risk
121 communication, emotion, and choice architecture in changing behaviour^{44–48}. Behavioural
122 science has been incorporated into some public efforts to encourage sustainable land
123 management in the United States and the European Union^{49,50}. Nevertheless, there are still
124 few applications of behavioural science to explicitly address the most important proximate
125 causes of biodiversity loss (overharvesting, invasive species, habitat loss and degradation).
126 Behavioural insights from research related to climate change, land management, consumer
127 behaviour, voting, and program enrolment can inform the multi-scale approach needed to
128 deliver effective biodiversity conservation, but this research has not been systematically
129 linked to address conservation challenges. Moreover, the literature is heavily focused on
130 households and not well-developed for other important actors^{48,51}. We therefore see
131 unrealized potential for behavioural science to address a snowballing biodiversity crisis.

132

133 **Increasing scientific engagement**

134 Behavioural scientists might be motivated to become engaged in biodiversity conservation
135 research for at least three reasons. First, biodiversity conservation is essential for the long-
136 term prosperity of people and nature, with unique challenges that offer a new arena for
137 exploring critically important research questions and for testing behaviour change

138 interventions. Such research can contribute to the mitigation of a global and existential threat,
139 as well as to direct improvements to the livelihoods of often vulnerable communities.

140 Second, engaging in biodiversity conservation research offers behavioural scientists a
141 chance to investigate theories and interventions in new contexts and populations^{52–54}. A key
142 requirement for increasing the generalisability of behavioural science is to ramp up research
143 activities outside North America, Australia, and Europe^{55,56}. Due to the importance of the
144 tropics for biodiversity, the focus of many conservation interventions is in Africa, Latin
145 America and Asia, providing opportunities to test theory in contexts which are less WEIRD
146 (Western, Educated, Industrialized, Rich, and Democratic). A related challenge is the need to
147 shift behaviours of many actors (see below). Behaviour-change interventions in other sectors
148 have been criticised for being too narrowly focused on end-users^{57,58}: Conservation problems
149 provide opportunities for targeting the behaviours of a far broader array of stakeholders.

150 Finally, conservation scientists and practitioners are keen to collaborate more with
151 behavioural scientists^{59,60}. An increasing number of conservation scientists and practitioners
152 recognise the need for stronger integration of behavioural science in order to design
153 interventions which are grounded in greater understanding of their research the social,
154 motivational, and behavioural drivers of people's actions^{26,33,61,62}. Naturally, as with all
155 interdisciplinary collaborations, these collaborations will have their challenges⁶². However,
156 recent examples show that effective collaborations can produce novel and mutually beneficial
157 research that suggests practical routes to achieving behaviour change for biodiversity
158 conservation^{41,63–66}.

159 The remainder of this Perspective seeks to encourage greater engagement of
160 behavioural scientists in conservation-targeted research. We first highlight the diversity of
161 actors involved in threats to biodiversity and the scope of behaviour changes required. In
162 doing so, we propose routes to identifying key behaviour changes and prioritising among

163 them, based on their potential for improving biodiversity outcomes. We suggest research
164 questions for better understanding how to influence different actors' behaviours and for
165 improving conservation interventions, and close by making recommendations for how to
166 expand the conservation evidence base systematically.

167

168 **Identifying key actors and behaviour changes**

169 Threats to biodiversity are rarely caused by a single action of a single actor. Rather, they
170 typically result from multiple behaviours by multiple actors over large spatial and temporal
171 scales²⁹. It can thus be very challenging to identify those behaviour changes with the greatest
172 promise of being achieved and of positively impacting biodiversity. Doing so requires
173 systematically considering the proximate causes and underlying drivers of threats to
174 conservation targets (e.g., specific populations or ecosystems), the actors involved (e.g.,
175 producers and consumers), and the harmful behaviours performed by those actors^{19,33,38,67}.

176 The proximate threats to wild species and the places they live can be categorised into
177 four main groups: habitat loss and degradation, overharvesting, invasive species, and climate
178 change and pollution^{68–70}. These threats also interact, with species or ecosystems commonly
179 impacted by multiple threats, sometimes with amplifying effects. For example, the spread of
180 some invasive plants is thought to be exacerbated by elevated nitrogen deposition and
181 atmospheric CO₂ concentrations^{71,72}. Proximate threats are driven by broader societal
182 processes, including rising demand for food and consumer goods, weak local, national, and
183 international institutions that struggle to ensure the protection of public goods, population
184 growth, and the growing disconnect of people from nature due to increasing urbanisation and
185 indoor recreation⁷³. The interventions conservationists often deploy to tackle proximate
186 threats, including removing invasive species, restoring wetlands, or propagating threatened
187 species in captivity, are not primarily about changing people's behaviour (although even in

188 these examples those carrying out the management actions must be trained and incentivised,
189 and behaviours must change if these threats are not to recur). However, given the pervasive
190 importance of human activities in conservation problems, many interventions do involve
191 attempts to alter behaviour. If behavioural science is to improve the effectiveness of these
192 efforts, an important first step is to identify the main actors responsible for a given threat and
193 the changes in their behaviour that might be required to alleviate it.

194 One tool for mapping the actors and behaviours impacting a conservation target is to
195 build a threat chain³¹. This is a simplified summary of knowledge of the reasons for the
196 unfavourable status of a species or ecosystem, from changes in ecological dynamics through
197 to the socioeconomic mechanisms thought to be responsible, and their underlying drivers.
198 Once this putative causal chain has been constructed, the main actors in the chain can be
199 identified, along with changes in their behaviour that might potentially reduce the particular
200 threat. Where conservation targets are impacted by multiple threats this process can be
201 repeated, with the likely impact of different behaviour changes compared across threats in
202 order to identify the most promising interventions for delivering those changes.

203 Using Amazon deforestation (as an example of habitat loss) for illustration (Fig. 1; red
204 boxes)^{20,21}, the extirpation of forest-dependent species and ecosystem processes resulting
205 from conversion to pasture has been caused (*inter alia*) by a combination of rising global
206 demand for beef, poor pasture and livestock management, the absence of incentives for forest
207 retention, and the practice of establishing *de facto* land tenure via forest clearance. Underlying
208 drivers include weak governance at multiple levels and rising per capita demand for beef
209 among a growing population in Brazil and beyond. Potential behaviour changes that might be
210 targeted to reduce deforestation (blue boxes) include increased enforcement of forest
211 protection legislation by government agencies, improved pasture and stock management by
212 ranchers, a reduction in per capita demand for beef among domestic and international

213 consumers, and an accelerated decline in human population growth in high-consumption
214 countries.

215 As a heuristic, we conducted this threat-mapping exercise for 12 examples chosen to
216 represent different threatening processes and the diversity of ecological and socioeconomic
217 contexts in which they arise (see ref.³¹). We identified nine main clusters of actors (rows in
218 Fig. 2), classified by how their behaviour impacts conservation targets. Producers and
219 extractors of natural resources, conservation managers, and consumers are commonly
220 identified as targets for behaviour change interventions in conservation and other sectors.
221 However, we also identified other actor groupings, including manufacturers and sellers,
222 financiers, policymakers, voters, communicators, and lobbyists, all of whom may have
223 considerable, usually indirect, influences on conservation outcomes, yet are commonly
224 overlooked when it comes to behaviour change interventions. Because our clusters of actors
225 are operationally defined, they align well with the diversity of behaviour changes we
226 identified (Fig. 2, right-hand column) – reducing consumers’ purchases of high-footprint
227 items, directing financiers’ investments towards less damaging production technologies, and
228 so on. Our clusters can also be mapped onto more conventional, organisational groups (such
229 as citizens or businesses, intermediate columns in Fig. 2), but because such organisational
230 groups impact conservation targets in heterogenous ways, their correspondence with
231 behaviour changes is much weaker than for our typology.

232

233 **Prioritising behaviour changes**

234 After examining all major threats to a given conservation target and identifying promising
235 behaviour changes involving specified actors, the next step is to prioritise behaviour changes
236 and in turn the interventions potentially capable of achieving them. We suggest this should
237 focus on two main characteristics that together determine the impact of behaviour change

238 interventions^{48,74}. The first is the target behaviour's potential, if changed, to improve the state
239 of the conservation objective (by analogy with the climate change literature, its *technical*
240 *potential*). In the Amazon (Fig. 1), both enforcing forest protection laws and providing herd
241 management support that is conditional on ranchers stopping clearance, for example, might be
242 considered to have greater technical potential than slowing population growth in beef-
243 consuming countries (which may have only limited effect if per capita demand continues to
244 rise). Prioritising behaviours for research and intervention on the basis of their technical
245 potential – considered an omission in behavioural science contributions to climate change
246 mitigation^{48,75,76} – ensures that resources and efforts are allocated toward the behaviours with
247 the greatest potential to effectively mitigate biodiversity threats.

248 The second aspect to consider in prioritisation is the behaviour's *plasticity*, referring to
249 the degree to which a target behaviour can be changed by a specified intervention⁴⁸. For
250 example, to what extent can behaviour change interventions increase the share of plant-based
251 food in overseas or Brazilian diets, or improve the cattle and pasture management of
252 Amazonian farmers? Due to the current paucity of conservation-focused behaviour change
253 interventions, good estimates of behavioural plasticity will often be lacking. Instead, evidence
254 from interventions targeting comparable behaviours relating to other actors, contexts, or
255 domains may serve as useful proxy indicators until more direct evidence becomes available⁷⁴.
256 Although considerations of technical potential and behavioural plasticity should guide which
257 behaviours to study and intervene against, we note that additional considerations may become
258 pertinent when selecting interventions for implementation (e.g., feasibility, stakeholder
259 support, and costs)^{77,78}.

260 Given the range of actors involved in causing ecosystem change and the complexity of
261 their behaviour, standalone behaviour change interventions are unlikely to effectively mitigate
262 a biodiversity threat (as illustrated in Fig. 1). Thus, while individual-level interventions – for

263 example, targeting specific farmers, manufacturers, or investors – may well form an important
264 part of the solution, they will usually be insufficient on their own. For example, successfully
265 incentivising ranchers in one Amazonian municipality to retain their remaining forests will be
266 of little benefit to biodiversity if prevailing market failure or weak institutions continue to
267 incentivise forest clearance elsewhere. Tackling more systemic drivers, such as
268 environmentally damaging subsidy regimes, corporate interests, poor governance, and
269 persistent norms, also necessitates population-level interventions that can alter economic
270 systems, institutional systems, and physical infrastructure. Importantly, the intent here is not
271 to undermine the legitimacy of individual-level interventions – quite the contrary. Systemic
272 changes also cannot be achieved without individual-level behaviour changes and
273 support^{48,79,80}. Different levels of intervention must work in concert, which requires a holistic
274 understanding of the determinants of human behaviour.

275

276 **Building a robust evidence base**

277 Generating evidence on behaviour change interventions for biodiversity conservation
278 demands a mix of methods, including experimental and observational studies using
279 quantitative and qualitative techniques^{81–83}. Critically, to build an evidence base, these studies
280 must be based on mapping or scoping of the existing literature or reviewing it with a view
281 toward synthesising it⁸⁴. They also need to be embedded in relevant conceptual or theoretical
282 frameworks, coupled with a theory of change, and designed with the statistical power to
283 answer the study questions. This might include, for example, taking a systems perspective⁸³,
284 as well as using a taxonomy or typology of interventions^{85,86}.

285 Behavioural responses and the effectiveness of interventions are likely to vary between
286 social and cultural contexts. Assessing the effect size of interventions in different settings will
287 be key to building a robust evidence base that has global application. Improving the cross-

288 cultural profile of behavioural science evidence is thus imperative, and particularly so for
289 biodiversity conservation where many problems are centred outside Europe and North
290 America. Achieving this will, however, be challenging given that the research capacity in
291 behavioural science remains low in high-income countries and even lower elsewhere.
292 International partnerships will therefore be one important strand of building capacity across
293 regions.

294

295 **Emergent research questions**

296 Given that behavioural science research into conservation-related problems is still in its
297 infancy, many important questions remain unanswered. In this final section, we outline four
298 higher-order questions we believe could impact the effectiveness of interventions aimed at
299 reducing people's negative impacts on biodiversity, natural habitats, and the services provided
300 by ecosystems. All necessitate close collaboration between behavioural scientists and
301 conservation researchers and practitioners.

302 The first research question deals with prioritisation. As with climate change
303 interventions, there is a clear need for a more systematic understanding of the technical
304 potential of different behaviour changes: which ones, if delivered, would be most likely to
305 reduce a threat and thereby enhance the status of the conservation target, taking into account
306 other threats it faces? Given the focus of many recent environmental interventions on
307 appealing, tractable but relatively low-impact behaviour changes (e.g., eating more locally
308 grown food or avoiding plastic drinking straws), such prioritisation is badly needed. A further
309 consideration here is how far such a behaviour change might reduce (or indeed increase)
310 threats to other conservation targets.

311 Our other suggested research questions are aimed at improving our understanding of the
312 plasticity of priority behaviours: which interventions work best to alter them, and how does

313 this vary across contexts? One key aspect is exploring how the suitability of behaviour change
314 interventions changes as a function of the level of deliberation and perceived importance of
315 the decision being made. Consider contrasting interventions aimed at increasing how often
316 consumers buy sustainably (rather than unsustainably) sourced fish. For someone making a
317 weekly shopping trip such a choice may be performed with limited deliberation, which means
318 that interventions targeting automatic decision-making processes may be effective⁸⁷.
319 However, for other actors, such as supply-chain managers making bulk purchases for
320 supermarkets, different interventions – perhaps motivated by limiting reputational risk – will
321 probably be required. At the level of decision-makers, designing national or international
322 fisheries policy other sorts of interventions⁸⁸ – potentially linked to cessation or realignment
323 of taxpayer subsidies – might need to be considered.

324 This example also illustrates our next research question: how the effectiveness of
325 behaviour change interventions varies with the financial and psychological costs of the
326 change for the target actor. In some instances, actors may benefit directly from pro-
327 conservation behaviour (e.g., because eating more sustainably sourced fish aligns with other
328 values). But sometimes those choices may carry costs (e.g., sustainable seafood may be more
329 expensive or difficult to source). In the case of the supermarket chains, there may be financial
330 and administrative costs to switching suppliers, at least over the short term. Policymakers will
331 also face strong lobbying pressure to continue to support the status quo policies. Clearly,
332 different interventions will be needed across such diverse circumstances.

333 Lastly, how can practitioners design interventions to ensure that behaviour changes
334 persist over the long term? Although many intervention studies do not evaluate persistence
335 over time, those that do commonly observe that effectiveness wanes^{89–91}. In some contexts, it
336 might be possible to design one-off interventions with long-lasting effects, but in others,
337 delivering lasting change may necessitate recurring rounds of intervention, or the repeated

338 introduction of novel interventions. Better understanding the persistence of intervention
339 effects will be key to sustaining beneficial behaviour change.

340 Many more questions will emerge as this field develops. Addressing them will require
341 fresh partnerships and continued commitment to work across disciplines and in unfamiliar
342 circumstances. Nevertheless, we submit that there are few other opportunities where
343 behavioural scientists have such potential to tackle one of the great challenges of our age. We
344 hope this Perspective can help inspire this critical work.

345

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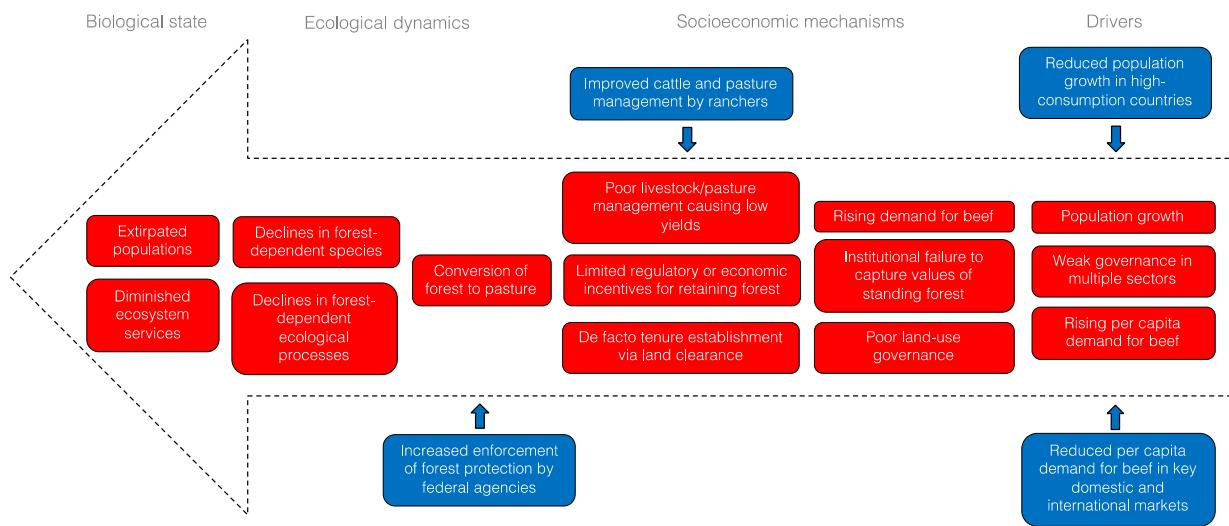
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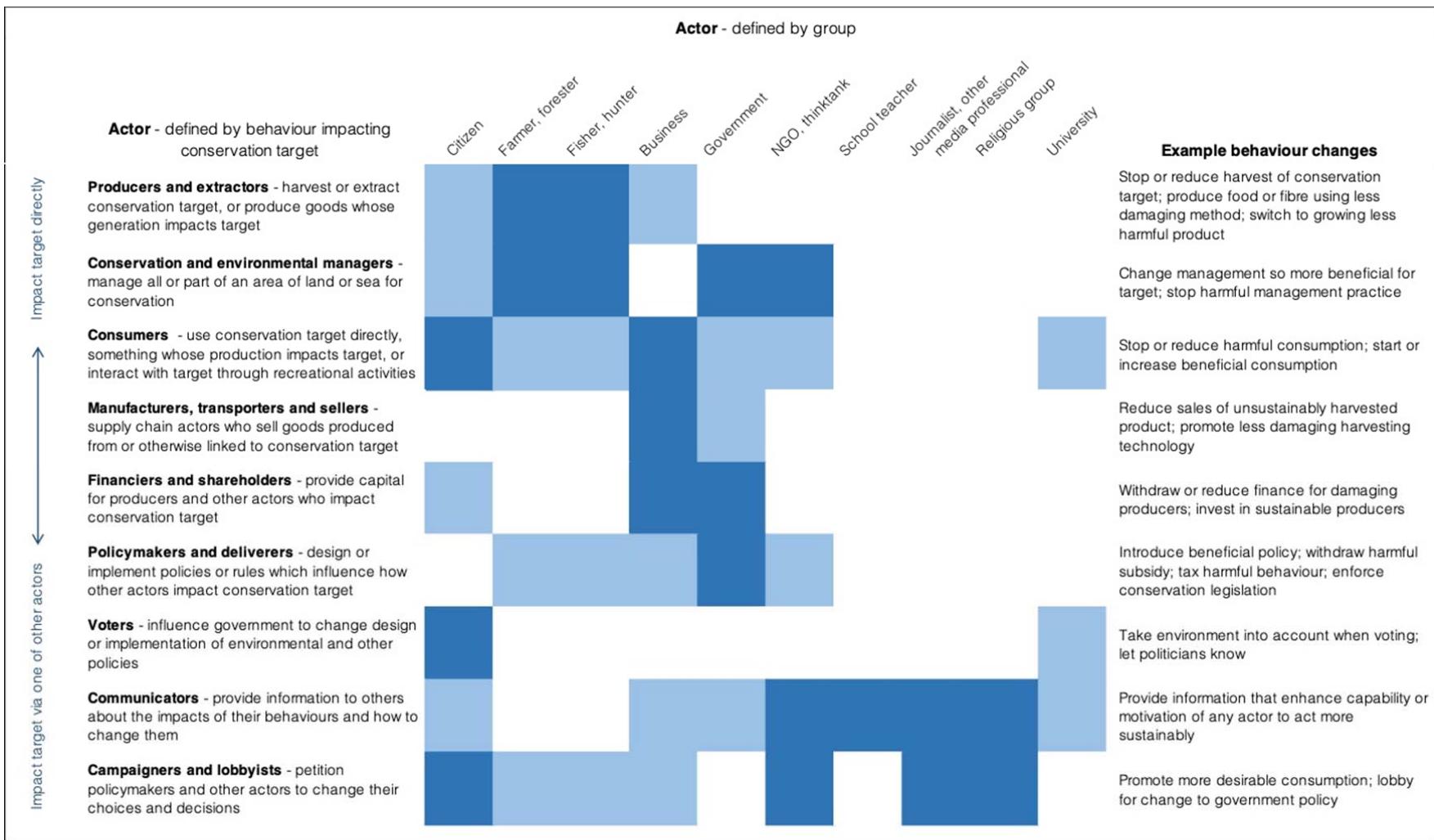
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Fig. 1. Conversion of Amazon forest to cattle pasture in Brazil. This example characterises (in red boxes) the threat to the Amazon forest from conversion to cattle pasture. Potentially beneficial changes in the behaviours are in blue boxes. This threat chain addresses only one of several interacting threats impacting the conservation target. The threat chain model is adapted from Balmford et al.¹⁹



567

568 **Fig. 2. Classification of actors according to their behavioural impacts on conservation targets (rows) and by their organisational
569 affiliation.**