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1 **What we know about Privately Protected Areas and their outcomes**

2

3 **Abstract**

4 Government administered protected areas (PAs) have dominated conservation strategies,
5 discourse and research, yet private actors are increasingly managing land for conservation.
6 Little is known about the social and environmental outcomes of these privately protected areas
7 (PPAs). We review the global literature on PPAs and their environmental and social outcomes.
8 We find that research on PPAs is geographically skewed. There is evidence of mostly positive
9 environmental outcomes, but social outcomes of PPAs are more mixed. Few PPA owners
10 report negative social and environmental outcomes and receive improved social capital,
11 property value and a reduction in taxes. Local communities benefit from increased
12 employment, training and community wide developments (e.g. building of schools) but they
13 report reduced social capital and no significant difference to household income. The causal
14 mechanisms through which PPAs influence social and environmental outcomes remain
15 unclear, or how political, economic and social contexts shape these. Further research would
16 benefit from widening the geographical focus and diversifying the types of PPA being studied.
17 Future research should also put greater emphasis on evaluating how PPAs operate as
18 institutions and the environmental and social outcomes of PPAs in varying contexts,
19 determining their casual mechanisms and how PPA benefits (if any) are shared. Lastly, we
20 propose an initial framework for how PPAs can be assessed to better inform PPA conservation
21 policy and practice.

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26 **Introduction**

27 Biodiversity is in crisis, with extinction rates 1,000 times higher than expected background
28 rates (Diaz et al., 2019). In response, the international community has explicitly included
29 biodiversity protection and the expansion of PAs in multiple international agendas, including
30 the Aichi Biodiversity Targets and Sustainable Development Goals. Government
31 administered PAs have dominated conservation strategies, discourses and research for
32 decades (Adams, 2004; Watson et al., 2014). However, a variety of private actors including
33 individuals, non-governmental organisations (NGOs) and businesses are increasingly
34 purchasing and managing significant tracts of land for conservation. These areas are
35 collectively known as privately protected areas (PPAs). PPAs are highly diverse in their
36 form, ownership, size and location. There are numerous definitions of PPA (Holmes, 2013)
37 but Stolton et al., (2014) provide a comprehensive and widely accepted definition that we use
38 in this review. They define a PPA as: *“a protected area, as defined by IUCN, under private
39 governance (i.e. individuals and groups of individuals; non-governmental organizations;
40 corporations – both existing commercial companies and sometimes corporations set up by
41 groups of private owners to manage groups of PPAs; for-profit owners; research entities
42 (e.g. universities, field stations) or religious entities)”*.

43

44 In contrast to other forms of PAs, PPAs have received relatively little scholarly attention
45 (Cortes Capano et al., 2019). This is despite being an old conservation approach, with some
46 countries (e.g. the UK) having established PPAs decades before state governed PAs (Hodge
47 and Adams 2012). PPAs deserve greater attention because they may be increasing in number
48 due to rising trends in neoliberal conservation approaches that facilitate a role for private
49 actors (Büscher and Whande, 2007; Hardy et al., 2017), and because there is a pressing need

50 for conservation on private land to help achieve global conservation goals (Kamal et al.,
51 2015). The World Database on Protected Areas (WDPA) currently reports 13,103 privately
52 governed PAs (UNEP-WCMC, IUCN & NGS, 2020). Yet, this may be a substantial
53 underestimate as only a small proportion of countries report PPAs to the WDPA and these
54 may also only report a subset of existing PPAs (Fitzsimons, 2001; Bingham et al. 2017).
55
56 PPAs can potentially make significant contributions to conservation in some countries
57 (Holmes, 2013), and may operate differently to other forms of PAs due to different owner
58 motivations and incentives, access to financial resources, and levels of accountability
59 (Langholz and Lassoie, 2001). Existing global reviews of PPAs have focused on PPA
60 typologies (Langholz and Lassoie, 2001; Carter et al., 2008; Kamal et al., 2015), their
61 differences to other effective conservation measures (OECMs) (Mitchell et al., 2018), their
62 geographical distribution (Stolton et al., 2014; Bingham et al., 2017), and PPA reporting
63 (Clements et al., 2019) and management guidelines (Pasquini et al., 2011; Mitchell et al.,
64 2018). Recent studies focusing specifically on outcomes have been region specific; exploring
65 the outcomes of private land acquisitions for forest conservation in the United States (Nolte,
66 2018), contributions of PPAs to the regional persistence of large and medium sized mammals
67 in South Africa (Clements et al., 2019) and Brazil (Laurindo et al., 2017), how PPAs
68 contribute to ecosystem representativeness in Victoria, Australia (Fitzsimons, & Wescott,
69 2001), and the outcomes of conservation concessions in South America (Schleicher, 2018).
70 Yet, we currently lack a global understanding of PPA outcomes for people and nature.
71 We address this gap by synthesizing the published literature on PPAs to (i) describe the
72 distribution of peer reviewed PPA literature, (ii) summarize PPA environmental and social
73 outcomes and how these have been measured (see table 3 and 4 for how we categorise these
74 outcomes), (iii) if outcomes are positive or negative and for whom, and (iv) discuss the

75 challenges of measuring PPA outcomes and future research needs. We assess ecological
76 outcomes to see to what extent PPAs contribute to global biodiversity conservation goals. We
77 assess social outcomes of PPAs because it is now accepted in conservation that PAs should
78 “do no harm” to local communities. Moreover, the social outcomes of PAs can determine
79 their legitimacy and level of support they receive from local communities and therefore their
80 long-term persistence and effectiveness in achieving their biodiversity conservation goals.

81

82 **Compiling the Literature**

83 We conducted extensive literature searches in Web of Science, SCOPUS and the first 500
84 papers from Google Scholar in October 2019 using the PRISMA method (Moher et al.,
85 2009). We focused on PPAs in peer review journals in English. We also assessed the grey
86 literature on PPAs but decided to exclude it because of its current limited scope. We assessed
87 the grey literature through searches on google scholar, snowballing and from searching NGO
88 and Land Trust websites who work with PPAs (e.g. The Nature Conservancy, World Land
89 Trust). Much of the grey literature in English focuses on defining PPAs (e.g., Stolton et al.,
90 2014), how they should be managed (e.g. Mitchell et al., 2018), and where they can be found
91 (e.g., American Bird Conservancy, 2013.) Very few reports focus on environmental outcomes
92 (n = 2), and social outcomes centre on changes in land value following the establishment of
93 conservation easements (n = 7). The grey literature is also difficult to systematically collate
94 and poses challenges over research quality and potential duplication of information (Oldekop
95 et al., 2016; Hajjar et al., 2016). Although we exclude grey literature from our review, we
96 believe our results nonetheless reflect important PPA trends and gaps and the way key issues
97 are currently covered in the peer-reviewed literature. Using the comprehensive IUCN report:
98 The Future of Privately Protected Areas (Stolton et al., 2014), we compiled search terms to

99 cover the diversity of forms of PPAs, which are widely reported and accepted (See
100 supplementary information for our complete search string).
101 We screened all results in a three-stage process based on: (i) titles, (ii) abstracts, and (iii) full
102 texts, according to our study inclusion criteria. To be included in our study, studies needed to
103 first meet our definition of PPA. Confusion still exists as to what exactly classifies as a PPA,
104 and the boundaries between what constitutes a PPA versus PAs under other forms of
105 governance or an OECM can be ambiguous. We base our definition upon that of the IUCN
106 (Stolton et al (2014)) and define PPAs as areas that (i) are under private forms of governance,
107 (ii) are primarily engaged in biodiversity conservation activities, (iii) have long term intent
108 and (iv) have legal or other effective means of protection. Like Capano et al., (2019), we
109 discarded articles reporting ecological surveys inside PPAs areas without relating the results
110 to PPA management or governance (n = 15). We coded PPAs by landowner type, governance
111 entity and protection mechanism. We coded environmental and social outcomes according to
112 main research asked in the literature and to increase clarity, further categorised social
113 outcomes using the five livelihoods assets within the sustainable livelihoods framework
114 (DFID, 2000). We coded outcomes as positive (+), negative (-), or no discernible effect (~),
115 and to whom the outcomes accrued too.

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117 Our initial search returned 1,325 articles, which we reduced to 373 following title and
118 abstract screening. We selected a further 54 papers from references lists, resulting in a final
119 sample of 409 articles. A full overview of our methods is available as Supplementary
120 Information.

121

122 **Results**

123 Our results show an increasing trend in the number of published peer-reviewed articles in
124 English focusing on PPAs, but the overall number of articles continues to be small -
125 compared with the total number of PPAs currently reported (n = 409, Fig 1), relative to the
126 number of PPAs known to exist (n =13,103). Other studies (e.g. Oldekop et al., 2016) found
127 that the literature on PAs is dominated by studies of state governed areas”. The
128 environmental and social outcomes of PPAs have only recently received scholarly attention
129 (Fig 1). We find the literature is substantially skewed in: (i) geographical focus (in part due to
130 a sampling bias of conducting the literature search only in English) (Fig 2); (ii) the types of
131 PPAs studied (Table 1); (iii) the types of questions asked of PPAs (Table 2); and (iv) the
132 spatial scale at which research is conducted. Most studies are conducted at a subnational
133 (n=261) or national scale (n=78). In contrast, landscape-level studies are uncommon (n=21).
134 Most studies were conducted in only five countries (USA n = 226, Brazil n = 31, Australia n
135 =31, South Africa n = 30 and Chile n = 19), and studies on conservation easements in the
136 USA dominate the literature (Fig 2, Table 1). Marine PPAs, which receives less attention
137 than terrestrial PPAs in the broader conservation literature (Oldekop et al. 2016), are largely
138 absent (n=6). This may be because there are so little marine waters that are privately owned
139 to enable the establishment of a PPA (Stolton et al., 2014; Fitzsimons, 2015).

140 To date, studies have largely focused on what drives PPA establishment, their
141 geographical locations, and PPA definitions (Table 2). In contrast, relatively less attention
142 has been given to environmental and social outcomes of PPAs (Table 3, Fig 1).
143 Environmental outcomes were considered in 79 studies and focused mainly on species
144 coverage (n=37) and ecosystem representativeness (n = 20). Social outcomes were discussed
145 in 48 studies, with the majority of these focusing on financial outcomes (n = 35).

146 Overall PPAs have overwhelmingly positive ecological outcomes, particularly for
147 species conservation (+, n = 35, -/~, n = 3) (Table 3). Social outcomes of PPAs are more

148 mixed. Local communities benefit from skills training (n=6), infrastructural development
 149 within the local area (n=4), improvements to the regional economy (n=5) and increased
 150 employment opportunities (+, n=9, -/~, n = 3) however, there is little improvement in
 151 household income (+, n= 2, -/~, n = 5). Local communities report feeling a loss of power and
 152 cultural identity (n = 9). More broadly, the general public loss out on tax revenue (n = 4) and
 153 access to open space (n=4) and landownership inequality is increased (n = 3). Whereas
 154 landowners benefit from increased land value (n = 8), reduction in tax payments (n=4) and
 155 strengthened community involvement, relations and networking (n = 6). Very few PPA
 156 owners report any negative impacts (n = 6).

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158 **Table 1: Types of PPA studied**

PPA Characteristic	No. of Articles (n=409)
Landowner Type	
Individual	251
Multiple Undefined*	89
Non Governmental Organisation (NGO)	38
Unspecified**	18
Corporate	8
Informal Community Group	5
Governance Entity	
Convenant (Unspecified**)	126
Multiple Undefined	93
Individual -NGO Partnership (<i>e.g. landowner and The Nature Conservancy</i>)	54
Individual	52
Non Governmental Organisation (NGO)	29
Individual -State Partnership	28
Unspecified	17
Corporate	8
Informal Community Group	2
Protection Mechanism	
Conservation Easement / Convenant	246
Multiple Undefined	56
Landholder agreement in perpetuity (<i>e.g RPPN in Brazil</i>)	44

Unspecified	29
NGO Freehold	26
Long-term landholder agreement	8

159 **Notes:** *Multiple undefined refers to studies where PPAs are reviewed or generalisations are
160 made across PPAs but certain specific characteristics are not given. ** Unspecified refers to
161 studies where a case study has been undertaken on a certain subset of PPAs in a specific
162 region (e.g. conservation easements in Wyoming) but specific details are not provided
163

164 **Table 2: Focus of papers on PPAs**

Focus of paper	No. of Articles (n=409)
Ownership characteristics, incentives or motivations	83
Coverage (e.g. Spatial distribution, representativeness, connectivity)	69
Opportunities, Challenges and Constraints	51
Defining PPAs (e.g. typologies, classifications, history)	42
Management Actions	38
Ecological Effectiveness & Impacts (e.g. reduce deforestation or prevent development)	31
Permanence	26
Financial analysis (e.g. how establishment effect land prices)	25
Governance (e.g. participation of local communities, collaborative governance)	17
Social Impacts	16
Political economy (e.g. neoliberalism, land grabbing, resource nationalism)	11

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179 **Table 3: Assessments of the environmental outcomes of PPAs**

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Study Focus	No. of Articles	Methods	Impact	Studies
Species Conservation	36			
<i>Increase species abundance</i>	8	Biodiversity surveys	+	Burgi et al., (2011), Higgins et al., (1999), Tapp et al., (2015), Benson et al., (2018)
		Spatial Analysis	+	Herzog & Vaughan (1998), Pegas et al., (2016), Child et al., (2013)
		Spatial Analysis	-	Olmstead et al., (2013)
<i>Projected estimates of PPAs to conserve species in future scenarios</i>	19	Analysis of secondary data / Modelling	+	Cox & Engstrom, (2001), Stralberg et al., (2011), Copeland et al., (2013) Smith et al., (2016), Lewis et al., (2019)
		Biodiversity Surveys	+	Cabral et al., (2017) Dos Santos & Da Costa, (2008), Falcão et al., (2012), Gatti et al. (2017), Laurindo et al., (2017), Porfirio et al., (2014), Posso et al., (2013), Ruiz-Esparza et al., (2016), Sánchez-Lalinde et al., (2019), Talamoni et al., (2014), Zortéa et al., (2008), Jones & Jiménez-Saa, (2017), Clements et al., (2019)
		Spatial analysis	~	Sandker et al., (2011)
<i>Compliment species protection in other PAs</i>	9	Biodiversity surveys	+	Rambadli et al., (2005), Colletta et al., (2016), Shanee et al., (2017), Negroes et al., (2011), Lovett-Doust & Kuntz (2001)
		Spatial Analysis	+	Pegas et al., (2016), Munks et al., (2004), Alarcón & Cavieres, (2015), Maslo et al., (2015)
<i>Protect species of conservation concern</i>	1	Biodiversity Surveys	+	Ortiz-Lozada et al., (2017)
Ecosystem representativeness	20			

<i>Increase ecosystem representativeness</i>	18	Analysis of ecoregions, plant species diversity or ecosystems contained within PPA boundaries compared with other PA types	+	Squeo et al., (2011), Martinez-Tilleria et al., (2017), Pliscoff & Fuentes-Castillo (2011), Lemeanger et al., (2014), Baldwin et al., (2015), Gallo et al., (2009), Von Hase et al., (2010), Shanee et al., (2017), Graves et al., (2019) De Vos & Cumming (2019), Yuan-Farrell et al., (2005), Fitzsimons & Wescott, (2001)
		Analysis of ecoregions, plant species diversity or ecosystems contained within PPA boundaries compared with other PA types	~	Jackson & Gaston (2008), Larrea-Alcazar et al., (2010), Schutz (2017), Yuan et al., (2015), Lacher et al., (2019)
		Analysis of ecosystems protected in future PPA scenarios	+	Chomitz et al., (2006)
<i>Protect / restore conservation priorities and human values</i>	2	Spatial analysis of overlap of ecosystems protected and desirable human values	+	Fisher et al., (2012), Cronan et al., (2010)
Connectivity and adjacency	15	Spatial analysis of PPA locations assessing contiguity and connectivity of PAs.	+	Crouzeilles et al., (2013), Chomitz et al., (2006), Gatti et al. (2017) Langholz and Lassoie (2001), Rissman & Merenlender (2008), Meyer et al., (2015), Graves et al., (2019), Tack et al., (2019), Lawley et al., (2015), De Vos and Cumming (2019), Lovett-Doust & Kuntz (2001), Pegas et al., (2016)
		As above	~	Rissman (2013), Cronan et al., (2010), Lacher et al., (2019)
Land restoration	8	Field surveys to determine reduction in pollutants, increases in ecosystem function	+	Benson et al., (2018), Burgi et al., (2011), Forshay et al., (2005), Bunnell-Young et al., (2017), Sonnier et al., (2018), Tang et al., (2016), Tapp et al., (2018)
Deforestation and Degradation	5	Spatial analysis of reforested area	+	Zambrano et al. (2008)
		Biodiversity surveys	+	Turyahabwe & Tweheyo (2010)

		Matched similar areas under different PA gov types to determine deforestation rates	+	Scheicher et al., (2017), Vuohelainen et al., (2012), Song et al., (2014)	181
					182
		As above	~	Noone et al., (2012)	183
					184
Land cover change (non-forests)	3	Matched similar areas under different PA gov types to determine land cover change	+	Braza (2017), Wu (2000)	185
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		Spatial analysis	~	Gonzalez-Roglich et al., (2012)	189
Development Prevention	4	Modelled projection of development with or without PPAs	~	Byrd et al., (2009),	190
					191
		As above	+	Smith et al., (2016)	192
		Analysis of degree of naturalness of protected land under diff. gov types	~	Fouch et al., (2019)	193
		Inside PPA – outside PPA comparison of road densities	+	Pocewicz (2011)	194
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Table 4: Assessment of the social outcomes of PPAs

Impact	Methods	Positive / Negative	For Whom?	Studies
Financial				
Employment opportunities	Questionnaires and Interviews	+	Local community	Hora (2018), Hora (2017), Zambrano et al., (2010), Sims-Castley et al., (2005), Barany et al., (2010)**, Langholz (1996)
		+ / -		Serenari et al., (2017b)
		~		Serenari et al., (2017)
Household income	Case Study	-		Louder & Bosak (2019)
		+	Local Community	Dodds (2012)
		-		Buergin (2016)
Household income	Quasi-experimental design	+	Local Community	Sims et al., (2019)
		+	Local Community	Hora (2017), Sims-Castley et al., (2005)
	Questionnaires and Interviews	~	Local Community	Hora (2018), Spenceley & Goodwin (2007), Zafra-Calvo & Moreno-Penaranda, (2017)
		+	PPA owners	Rissman & Sayre (2012), Maynard et al., (1998)
	Financial analysis	+	PPA Owners	Farinha et al., (2019)
		-	Local community	Sandker et al., (2011)
Land / Property value	Quasi-experimental design	~	Local Community	Sims et al., (2019)
		+	Local community	Hora (2018)
Land / Property value	Questionnaires and Interviews	+	Local community	Hora (2018)
		+	Landowners of PPAs	Farinha et al., (2019)
	Modelling using secondary data	+	PPA owners	Schilling et al., (2013)
		+	Land owners surrounding PPAs	Zhang et al., (2018), Reeves et al., (2018), Yoo & Ready, (2016), Chamblee et al., (2012), Armsworth et al., (2006), Farja (2017)
		-	PPA owners	Lawley et al., (2014), Anderson & Weinhold, (2008)
	Financial analysis	-	Non land owners (renters)	Farja (2017)
		+	PPA Owners	Sandre-Drake (1999), Crompton (2009), Jurinski & Goveia, (2000), Forshay et al., (2005)
Tax	Financial Analysis	~	General public (tax payers)	King & Anderson (2004)
		-		Varcammen (2017), Crompton (2009), Anderson & King (2004)

Regional economy	Interviews & Questionnaires	+	Local Community	Zambrano et al., (2010), Child et al., (2013), Sims-Castley et al (2005), Barany et al., (2010)**
Ability to access grants / funding	Interviews	+ / - +	Local Community PPA owners	Serenari et al., (2017b) Horton et al., (2017)
Physical Capital				
Development in the area (e.g. road improvements, building schools)	Interviews and Questionnaires	+	Local Community	Hora (2017), Serenari et al., (2017b), Zambrano et al., (2010)
	Case Study	~ +	Local Community	Hora (2018) Buergin (2016)
Social Capital				
Strength Community involvement, relations and networking	Interviews and Questionnaires	~	Local community	Hora (2018),
	Case Study	+	PPA owners	Rissman & Sayre (2012), Horton et al., (2017)
	Questionnaires	+ / -		Maciejewski et al., (2016), Selinske et al., (2015), Pasquini et al., (2010)
	Interviews	+ / ~		Harrington et al., (2006)
Strength / Maintain cultural identify	Interviews and Questionnaires	+	Local community	Hora (2018)
		-		Louder & Bosak (2019)
		+	PPA owners	Maynard (1998)
Strength power relations / ability to make decisions	Interviews	-	Local Community	Louder & Bosak (2019), Serenari et al., (2017b)
		+ / -	PPA owners	Horton et al., (2017)
Land ownership inequality	Interviews	-	Local community	Langholz et al., (2000)***, Serenari et al., (2017b)
	Case Study	-	Local community	Quintana & Morse (2005)***
Human Capital				
Improve environmental education	Questionnaires and Interviews	~	Local community	Hora (2018)
	Interviews	+	Local Community	Serenari et al., (2017), Serenari et al., (2017b)
	Case Study	+	Local Community	Dodds (2012)
New skills (e.g. diving, tour guiding, baking, cooking)	Case Study	+	Local Community	Dodds (2012)
	Interviews	+	Local Community	Hora, (2017), Serenari et al., (2017b)**
Natural Capital				

Access to open space / cultural heritage / recreation (cultural services)	Interviews & Questionnaires	-	General public	Crompton (2009), Owley (2015), Rissman & Merenlender (2008), lieberknecht (2009)
		+	PPA visitors	Clements & Cumming (2017), Langholz (1996)
	Modelling	+	PPA visitors	Nahuelhual et al., (2013)
Regulating services (e.g. erosion control, surface water regulation)	Modelling	+	Everyone (but PPA owners benefit more)	Villamagna et al., (2015),
Access to forest resources (provisioning services)	Interviews	-	Local Community	Serenari et al., (2017b)

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211 *We define local community as a group of individuals who live in the area immediately surrounding a PPA

212 **Outcomes especially for women

213 *** Outcomes felt most by Non-wealthy community members

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Discussion

Characterising the literature on PPAs

PPA research is geographically and ecologically limited, reflecting global skews in conservation research (Fazey et al., 2005; Oldekop et al., 2016; Capano et al., 2019). There is a marked overlap between the country and PPA type studied, perhaps because certain types of PPA management may be unique to, or more dominant in specific countries (e.g. Private Natural Heritage Reserves - Reservas Particulares do Patrimônio Natural (RPPNs) in Brazil). The bulk of the PPA literature focuses on conservation easements in the USA (n= 274, 64% of all studies), perhaps due to their prominence and large numbers (Nolte, 2018; IUCN and UNEP-WCMC, April 2020). Conservation easements and covenants are contractually binding agreements between landowners and a third party (e.g. Land Trusts or governments) that dictate how properties should be managed alongside conservation goals (Merenlender et al., 2004). Mexico, Canada, Colombia, Namibia, Spain and Finland have growing PPA networks (Stolton et al., 2014; Mitchell et al., 2018) and receive limited scholarly attention. Studies commissioned by NGOs in these countries are not being written up into the peer review literature. Countries with a higher number of PPAs internationally reported receive greater scholarly attention. The UK is an exception: it has a large number of PPAs reported to the WDPA (n=690) yet remains understudied (n=2). Limited questions have been asked of PPAs, with 38% of articles (n=161) investigating the location of PPAs, or ownership characteristics, incentives and motivations for PPA establishment (Table 2). These research questions reflect an exploratory research agenda but also demonstrate a trend of research heavily dominated by factors shaping PPA establishment and aims (inputs), rather than results (outputs) (Table 3 & Table 4).

239 **Environmental outcomes of PPAs**

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241 *Additionality, complementarity and connectivity*

242 PPAs may make unique and significant spatial contributions to achieving some global
243 conservation targets and overwhelmingly have positive ecological outcomes (89%, n = 70).
244 PPAs can increase i) the total area of the world's surface under protection (additionality), ii)
245 the number or extent of different ecosystems, ecoregions or species covered by PAs
246 (representativeness), and iii) connectivity of existing PA networks. We find that although
247 PPAs seem to add little to the total protected land area, they are more likely to be in areas that
248 are either not represented or underrepresented by other PA governance types (Gallo et al.,
249 2009), and that they may increase PA network connectivity(De Vos and Cumming, 2019).

250 The extent of PPA coverage is much smaller than that of State PAs (Langholz &
251 Lassoie, 2001; Pegas et al., 2016). Globally, State PAs account for 82% of total PA coverage
252 whereas PPAs account for ~7% (UNEP-WCMC, IUCN & NGS, 2020). 72% of papers (n =
253 13) discussing ecosystem representativeness suggest PPAs add complementarity to the PA
254 matrix by existing in ecoregions not represented and/or under-represented by state PAs, or in
255 less remote areas that are more suitable for agricultural or urban development (Rissman &
256 Merenlender, 2008; Gallo et al., 2009; Pegas et al., 2016; Graves et al., 2019; De Vos &
257 Cumming, 2019). PPAs have been reported to protect species not recorded in state PAs
258 (Shanne et al., 2017). 80% of papers (n=12) discussing connectivity found PPAs increase the
259 contiguity and connectivity of PAs by being adjacent to other PAs (Rissman & Merenlender,
260 2008) or by forming parts of wildlife corridors increasing connectivity between PAs of other
261 governance types (Fitzsimons & Carr, 2014; Gatti et al., 2017; De Vos and Cumming, 2019).
262 The remaining 20% (n=3) exclusively studied conservation easements in the USA and found
263 they add little to PA network connectivity as they are often small and do not border other PAs
264 (Graves et a., 2019; Lacher et al., 2019).

265 Overall, different countries have unique spatial configurations of PPAs leading to
266 varied conservation outcomes, potentially because within each country, PPAs establishment
267 is shaped by different factors (Nolte, 2018).

268

269 *PPA ecological effectiveness*

270 Few studies have monitored or evaluated the ecological effectiveness of PPAs. Those
271 that do define effectiveness as the degree to which a PPA achieves a successful outcome for
272 biodiversity conservation as defined by their own unique study criteria. 80% (n=5) of papers
273 analysing deforestation rates report that PPAs are more effective at reducing deforestation
274 and degradation than PAs under other governance types (Vuohelainen et al., 2012; Schleicher
275 et al., 2017; Nolte et al., 2019). 66% of studies examining landcover change (n=2) found
276 PPAs are effective at reducing land cover change in non-forest habitats. All studies assessing
277 ecological restoration (n =8) found that PPAs have positive outcomes for restoring degraded
278 lands. Most of these studies focus on wetlands in the USA and show PPAs can increase
279 wetland functionality, reduce pollution, increase flora and fauna diversity and contribute to
280 recovery of species in greatest conservation need (Tang et al., 2016; Bunnell Young et al.,
281 2017; Benson et al., 2018). Four studies empirically assess the impacts of PPAs on
282 development prevention with half (n=2) reporting reductions in development and the other
283 reporting no discernible changes in development.

284 95% (n=34) of papers examining species conservation found that PPAs achieve
285 positive outcomes. Empirical exploration of PPAs' ability to protect or increase specific
286 species' populations show that PPAs can significantly increase numbers of wetland bird
287 species compared with unprotected sites (Tapp et al., 2018; Sonnier et al., 2018), and that
288 they may play a substantial role in the long term conservation of large and medium sized
289 mammals (Cabral et al., 2017; Laurindo et al., 2017; Clements et al., 2018; Sanchez-Lalinde

290 et al., 2019) - although the ability of PPAs to conserve Rhinos in South Africa has been
291 questioned (but this has not yet been empirically tested) (Child et al., 2012; Rubino &
292 Pienaar, 2017). Model-based studies to predict future PPA impacts suggested they may
293 contribute to the conservation of key species (Cox & Engstrom, 2001; Stralberg et al, 2011;
294 Copeland et al., 2013). Only one study explores the spillage effects of PPAs (Wu, 2000).

295

296 **Social outcomes of PPAs**

297 Social outcomes of PAs take different forms, including economic, livelihood and cultural
298 outcomes (Oldekop et al., 2016). We find PPA outcomes echo the common outcomes of
299 other types of PAs however, private entities may have different levels of accountability than
300 non-private equivalents.

301 We find studies on the social outcomes of PPAs have predominantly focused on
302 financial outcomes (n = 35, 73%). 82% of studies (n=9) discussing employment report that
303 PPAs increase employment opportunities for local communities and Sims et al., (2019)
304 suggests PPAs may have greater positive impacts for employment than state PAs. However,
305 only 29% of studies (n=2) commenting on household income report that PPAs increase the
306 household income of local communities and Sims et al., (2019) find no difference in median
307 household income between state and private PA governance types. Moreover, some studies
308 report that PPAs could also increase inequalities within communities with poorer households,
309 those less able to capitalize on tourism opportunities, or those living further from reserves
310 boundaries benefiting less than others (Spenceley & Goodwin, 2007; Zambrano et al., 2010;
311 Dodds, 2012; Serenari et al., 2016; Hora et al., 2017).

312 Eight studies (80%) quantifying changes in land value, find landowners benefit from
313 increased land value after designating a PPA. However Farja, (2017), reports this can have
314 detrimental effects for non-land owners facilitating a concentration of land ownership and

315 exacerbated inequalities. Lastly, where PPAs are used in tourism studies in Costa Rica,
316 Nicaragua, Chile and South Africa report PPAs can have a positive impact for regional
317 economies however in the USA (where easements are not used in tourism and more likely to
318 be family ranches), studies report PPAs reduce regional tax revenue (Anderson & King,
319 2004; Cropton, 2009; Varcammen, 2017).

320 The broader social costs and consequences of livelihood shifts linked to PPAs have
321 not been systematically studied (Spierenburg & Brookes, 2014). Trade-offs may exist
322 between financial gains, and social and cultural costs. Two studies reporting on cultural
323 identity (66%) report that local community sense a loss of cultural identity and values and
324 community cohesion. This may be because non-locals move into the area introducing new
325 cultures and ideas and as opportunities for greater financial income increase it can generate
326 competition within communities (Serenari et al., 2017; Buscher et al., 2018; Louder & Bosak,
327 2019).

328 PPAs can redistribute political resources, particularly control over land. They have
329 sometimes been perceived as ‘land grabs’, illegitimate and harmful land acquisitions by
330 foreign and local elites with negative outcomes for local communities (e.g. Langholz et al.,
331 2000; Holmes, 2014, Serenari et al., 2017; Busscher et al., 2018). 100% of studies (n=3) in
332 our review commenting on landownership inequality report an increase in land ownership
333 inequality and negative outcomes for non-wealthy community members in areas where PPAs
334 are established. In contrast, 6 studies (80%) report that individuals who own, create and
335 govern PPAs (e.g. through conservation easements) may obtain greater social benefits (e.g.
336 building social networks), political empowerment (e.g. being able to have greater influence
337 over development decisions (Rissman & Sayre, 2011) and are able to maintain their cultural
338 identity (Maynard et al., 1998).

339 We found 9 studies discuss PPA outcomes on natural capital. Villamagna et al.,
340 (2017) review the distribution of ecosystem service benefits from PAs and find they offer
341 benefits for all however the benefits disproportionately benefit households with greater
342 income, and that ecosystem services beneficiaries from PPAs in particular, have a
343 significantly greater household income than all other governance types. Crompton (2011)
344 finds that public benefits of conservation easements emerge serendipitously to the public, and
345 that most benefits accrue to landowners. These findings are important because enhancing the
346 equity of benefit delivery from PPAs will build public and private support for them as a long-
347 term conservation strategy and increase conservation efficacy. We found no empirical studies
348 on the magnitude of impacts that PPAs have on sequestering carbon or improving water
349 quality, although, Kreuter et al. (2010) do find private nature reserves exhibit some of the
350 critical conditions for the sustainability of common-pool resources. These studies are needed
351 because PPA creation may be driven by REDD+ incentives which claim to provide
352 ecosystem services such as carbon sequestration (Schleicher, 2018). 100% of studies
353 investigating cultural services (n=5) find PPA have negative impacts for local communities
354 (e.g. access to open space and forest resources) (e.g. Seranari et al., 2017b) however they
355 have positive impacts for paying PPA visitors (Clements & Cumming, 2017). It is unclear the
356 extent to which people had access to land before being established as a PPA as the land may
357 have been privately owned with limited public access.

358 A small number of articles (n=7) briefly mention PPA outcomes on physical and
359 human capital. Some PPAs may encourage infrastructure developments for local
360 communities (e.g. roads and building of schools) (Barany et al., 2001; Zambrano et al., 2010;
361 Serenari et al., 2016) and PPAs involved in tourism may offer training or facilitate access to
362 education for local staff (Dodds, 2012; Hora, 2017).

363

364 **Current approaches to determine PPA outcomes**

365 Research approaches vary in the scale and rigor of analysis (Table 3 & Table 4). Quasi-
366 experimental designs to measure PPA effects on deforestation and forest degradation reflect
367 broader trends in the use of such methods to assess outcomes of natural resource management
368 and conservation interventions (Ferraro & Hanauer, 2014). We are aware of only one study
369 which applies these methods to assess PPA outcomes for land restoration (Sims et al., 2019).
370 Current methods to assess PPA outcomes for species of conservation interest either use
371 model projected future outcomes (e.g. Copeland et al., 2013) or focus on individual case
372 studies using primary data (e.g. Negroes et al., 2011). Methods to assess the social outcomes
373 of PPAs have almost exclusively focused on semi-structured interviews and mailed
374 questionnaires. Most studies have interviewed a variety of stakeholders (e.g. government
375 officials, PPA owners, local communities) and use large sample size of respondents relative
376 to the total population size. Only three (Langholz et al., 2000; Hora et al., 2017; Serenari et
377 al., 2017) out of 14 studies combine methods and data sources to triangulate results, raising
378 questions about the strength of many conclusions regarding the social outcomes of PPAs.
379 Only one study (Sims et al., 2019), uses quasi-experimental techniques to assess the social
380 outcomes of PPAs.

381

382 **Challenges to assessing PPA outcomes**

383 The global number of reported PPAs is believed to be a significant underestimation of
384 total number in existence (Stolton et al., 2014; Bingham et al., 2017). While we acknowledge
385 some countries have good national level spatial data for PPAs (e.g. South Africa) (de Vos &
386 Cumming, 2019) others do not (e.g. Canada (Stolton et al., 2014; Wilkinson, 2014)), or it may
387 not be publicly available (e.g. Australia (Wilkinson, 2014)). Moreover, the quality of spatial
388 point and polygon data on the location of PPAs is highly variable, depending on the original

389 data source (Milam et al., 2016). For example, there may be mismatches in the reported area
390 and actual area of the PPA, and PPA locations may be given as points (with a written area
391 attached) which do not convey the actual shape of the PPA and the area it covers on the
392 ground (Bingham et al., 2017). There is rarely data that would allow a detailed assessment on
393 the contribution of PPAs to landscape scale conservation, beyond presence or absence of a
394 PPA, making any assessment of their additionality, complementarity or connectivity a “best
395 guess”. For example, in some area such as South Africa, PPAs are often fenced and thus
396 impermeable to animal movements, limiting their effective contiguity, yet such data is rarely
397 reported.”Quasi-experimental approaches are increasingly being used to address limitations
398 of before-after, and inside reserve to outside reserve methods to determine PPA
399 environmental and social outcomes (Schleicher, 2018). Yet these studies rely on good quality
400 spatial data, which may be scarce for PPA in some regions.

401

402 **Future Research needs**

403 Our study offers a comprehensive review of PPA literature but suggest this could be
404 expanded by including non-English literature which will minimise any regional bias within
405 our results and NGO literature which may further support our initial findings. Our study
406 shows there is a need to measure and report the diverse outcomes of PPAs as well as examine
407 the underlying factors that make PPAs effective, which is currently absent within the
408 literature. These insights could help maximise potential PPA benefits and minimise negative
409 outcomes. We propose an assessment framework that could be adopted to facilitate this
410 process. Firstly this framework should include the extent to which PPAs achieve their desired
411 environmental and social outcomes (e.g. extent to which landscape restored or poverty
412 alleviated) ii) how PPA operate as institutions (e.g. who are PPAs stakeholders, what are the
413 distributions of power and agency between different stakeholders and to whom are the

414 stakeholders accountable to) and iii) how the positive outcomes of PPAs (if any) are shared
415 among stakeholders and the local communities surroundings PPAs. We envisage this
416 framework could be used both by PPA owners to self report, but also by academics and
417 government bodies to objectively assess PPA outcomes. This will require strengthening data
418 collection efforts on the distribution of PPAs and their environmental and social impacts (e.g.
419 deforestation rates with PPAs boundaries or changes in multi-dimensional poverty
420 surrounding PPAs) to accompany the rise in quasi-experimental approaches, as well as
421 qualitative research initiatives to assess more intangible social impacts of PPA interventions.

422

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744 **Figure Legends**

745 **Fig 1. Cumulative number of peer reviewed articles discussing private protected areas**

746 **Fig 2. Geographical distribution of articles discussing private protected areas**

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