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1 **The many meanings of No Net Loss in environmental policy**

2

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18 **Preface**

19 ‘No net loss’ is a buzz phrase in environmental policy. Applied to a multitude of
20 environmental targets, like biodiversity, wetlands, and land productive capacity, no net loss
21 (NNL) and related goals have been adopted by multiple countries and organisations, but these
22 goals often lack clear reference scenarios: no net loss *compared to what?* Here, we examine
23 policies with NNL and related goals, and identify three main forms of reference scenario. We
24 categorise NNL policies as relating either to overarching policy goals, or to responses to
25 specific impacts. We explore how to resolve conflicts between overarching and impact-
26 specific NNL policies, and improve transparency about what NNL-type policies are actually
27 designed to achieve.

28 **Keywords:** baselines, environmental offsets, compensatory conservation, conservation
29 policy, counterfactuals, land degradation neutrality, mitigation, no net loss, reference
30 scenarios

31

32 As humanity struggles and fails to stay within a safe operating space ^{1,2}, an increasingly
33 influential principle in environmental management and policy is that of ‘no net loss’ (NNL)
34 (of biodiversity, carbon stocks, water quality, etc.), along with a family of related terms and
35 concepts, such as Net Positive Impact, Zero Net Deforestation, and Net Gain (NG). The
36 reference to net outcomes implies an assumption that natural resources, environmental quality
37 or biodiversity will continue to be lost due to economic development and our increasing
38 human footprint, and that residual losses should be counterbalanced in some way by
39 equivalent gains elsewhere. If they live up to their stated goal, NNL and NG policies should
40 help keep us or move us back to within planetary boundaries.

41 No net loss and related goals have emerged for a broadening range of natural targets, from
42 forest cover, biodiversity and fisheries, to land productive capacity and carbon. Since the
43 term ‘no net loss’ was first popularized during the 1988 United States presidential election
44 campaign of George H.W. Bush ^{3,4}, such goals increasingly have become embedded within
45 international pledges ^{5,6}, national and regional government policies ⁷, voluntary corporate
46 sustainability policy ⁸, and lending requirements for major financial institutions ⁹. For
47 example, the European Commission is exploring policy options for a European Union-wide
48 No Net Loss Initiative, and countries including France, Colombia and Peru have recently
49 introduced legislation that includes such goals ^{10,11}. Biodiversity offset policies which require
50 NNL of biodiversity are now in place or enabled in over eighty countries⁷.

51 No net loss of biodiversity or ecosystem services sounds like an appealing goal. However, the
52 phrase is meaningless in isolation: that is, the goal is NNL *compared to what?* ¹²⁻¹⁴. Policy
53 goals like NNL must be specified relative to an alternative possible scenario: i.e., the
54 *reference scenarios* for the aspect of the environment targeted by the policy, over time and
55 space. Different reference scenarios against which NNL is to be achieved make for entirely

56 different intended outcomes for the environment. The question is, then: relative to what
57 biophysical reference scenario is the NNL outcome sought ^{12,14}?

58 A given reference scenario against which one aims to achieve NNL is, in effect, the target
59 outcome – and so the goal of policies that do not specify a reference scenario is unclear ⁴. In
60 practice, such reference scenarios are rarely articulated ^{13,15}. Thus, appropriate
61 implementation of policies striving for NNL outcomes is undermined by an inability to
62 account robustly for net outcomes, as this depends entirely on knowing the intended reference
63 scenario ¹⁵.

64 Further, NNL and related terms are being used indiscriminately to describe what are actually
65 two distinct policy goals: 1) an *overarching* goal with a broad scope, applying to all impacts
66 (anthropogenic and natural, large and small) on the environmental target across a
67 jurisdiction, such as a commitment to achieve NNL of biodiversity by 2020 ¹⁶ or zero net
68 deforestation by 2015 ¹⁷; and 2) an *impact-specific* policy goal based on a narrower scope
69 such as counterbalancing losses from a particular category of development impacts using
70 offsets¹⁸. Such impact-specific policies may be, but are not always, considered a way to help
71 achieve overarching policy goals.

72 Although the term ‘no net loss’ is used in both cases, the reference scenario against which
73 this is to be achieved can be very different. For example, biodiversity offset policies that have
74 a goal of NNL tend to relate only to the component of loss caused by the particular impact in
75 question (e.g. the removal of habitat to make way for an infrastructure project). Therefore, a
76 successful NNL outcome in that instance can still mean that less biodiversity exists compared
77 to before the impact, if we accept that biodiversity declines caused by factors other than the
78 particular impact in question would have occurred ¹³. However, overarching policy goals

79 seem to imply a different scenario; for example, that declines in the targeted biodiversity will
80 be halted, regardless of what is causing them.

81 The indiscriminate and unqualified use of NNL to describe these very different (but
82 interlinked) outcomes obscures policy debate and the capacity for evaluation. Further, the
83 opacity about reference scenarios for such goals contributes to poor practice in estimating
84 losses and gains ¹⁵ at both the level of particular impacts, and across landscapes or
85 jurisdictions.

86 In this contribution, we review and distinguish among the reference scenarios implied by
87 NNL-type policies at overarching and impact-specific levels. We critically evaluate these
88 reference scenarios in the context of different policy goals, and demonstrate the widely
89 different outcomes that they imply for the environmental features they target (e.g.,
90 biodiversity). Finally, we examine the interaction between overarching NNL-type policies
91 and impact-specific NNL policies, with practical guidance on how to ensure the two work in
92 harmony, rather than conflict.

93

94 **Reference scenarios for no net loss**

95 A range of environmental features can form the target of NNL and related goals, including
96 renewable natural resources, living nature and biodiversity, and measures of soil, air and
97 water quality. For the sake of brevity throughout this paper, we collectively refer to these
98 biophysical targets of NNL policies as “natural capital”, though we recognise the diversity of
99 terms adopted across different jurisdictions and policy domains. Because framing goals in net
100 terms implies exchanging losses and gains of the target natural capital, a central issue is the
101 definition and measurement of what is to be traded. Determining an appropriate unit of

102 exchange is often a non-trivial challenge, especially for approaches that address features such
103 as biodiversity or ecosystems that defy precise measurement and vary along a continuum in
104 both space and time⁷.

105 There are various reference scenarios that might feasibly apply in relation to NNL policy
106 goals. Each scenario captures a different biophysical trend against which NNL is to be
107 achieved—and therefore, achieving NNL relative to each would mean a different outcome for
108 the targeted natural capital. The reference scenario could be either fixed: for example,
109 describing a present or future state of biodiversity; or dynamic: for example, representing a
110 biodiversity trend over time¹³.

111 We consider three broad types of reference scenario implied by NNL policies and goals, both
112 overarching and impact-specific (Figure 1). In this analysis, we focus on the conceptual basis
113 behind the approaches, to reveal what they are *designed* to achieve if they work perfectly,
114 notwithstanding the many practical challenges to policy effectiveness.

115

116 A. *No net loss relative to a fixed reference scenario*

117 Achieving NNL compared to the current state of natural capital or to some future state sets a
118 cap on the amount of natural capital to be retained (e.g., a desired amount of forest retained).
119 This means that the losses from development and gains from offset activities together result
120 in natural capital being maintained at the level defined by the fixed reference scenario. For
121 example, cap and trade systems have also been developed to address nutrient loads, which
122 incentivize reductions in non-point contamination²⁰ or investments in increasing the
123 assimilation capacity of ecosystems²¹. Using a fixed state as a goal can improve certainty
124 about the end-point of environmental decline²². However, some goals are based on an

125 undefined state at a future point in time (e.g., achieving zero net deforestation by 2020 ⁶)
126 instead of a quantified fixed baseline in units of the target natural capital (e.g 100,000
127 hectares of forest retained by 2020 and maintained thereafter). In such cases, the goal state
128 remains uncertain, because it is not known how much loss will have occurred by the time the
129 cap kicks in.

130 Given the risks associated with over- or under-estimating future scenarios ^{13,15}, some authors
131 have argued that using a reference scenario fixed at an explicit, known state such as ‘now’ or
132 ‘prior to the impact’ carries less risk, and has the added advantage of simplicity ²³. Indeed,
133 most non-specialists including public stakeholders likely presume this meaning of NNL (i.e.,
134 no further loss of biodiversity compared to what currently exists, whatever the cause of
135 losses). For example, the goal of ‘land degradation neutrality’ is to be achieved relative to
136 2015, the year the approach was developed ⁵. Nevertheless, even the current state of natural
137 capital is usually imperfectly known.

138 Fixed reference scenarios could also, in effect, be aligned with desired ‘targets’ that are
139 higher or lower than the current state. For example, in South Africa, biodiversity offsets for
140 the loss of vegetation types involve protection at a ratio of hectares protected to hectares lost
141 such that, if all remaining vegetation was either lost to development or protected as an offset,
142 the retention targets for each vegetation type will have been met²². Nevertheless, setting a
143 reference scenario that reflects a further drawing-down of natural capital introduces
144 challenges and risks, especially for the most vulnerable components of biodiversity or where
145 thresholds have been crossed. The persistence of some biota—for example, of threatened
146 species already precariously depleted—may depend on improvements to current habitat
147 availability or quality ²⁴; conversely, in other circumstances further decreases of biodiversity
148 or forest may be possible without risking socially-unacceptable consequences. Therefore,
149 designing tailored trading schemes that aim to achieve a future desired state for the target

150 biota is perhaps the most transparent and defensible approach to balancing biodiversity and
151 development from a conservation perspective. Yet such an approach bears little resemblance
152 to most current schemes intended to achieve NNL.

153 A goal framed as ‘no net loss compared to what we want to achieve’ is an awkward and
154 arguably redundant formulation of the concept of more traditional conservation planning. It is
155 often, however, a motivation for ‘net gain’ goals for projects with impacts on particularly
156 threatened species or habitats (e.g. under Performance Standard 6 of the International Finance
157 Corporation).

158 *B. No net loss relative to a dynamic reference scenario excluding development*

159 Rather than placing a cap on the total amount of natural capital to be maintained, a reference
160 scenario that changes through time may be specified, rather than a fixed state. For example,
161 the IUCN policy on biodiversity offsets suggests they should be designed so as to achieve a
162 NNL or net gain outcome relative to a reference scenario of what is likely to have occurred in
163 the absence of the project and the offset²⁵ (Figure 1). Such a reference scenario is called a
164 *counterfactual*: what would have happened in the absence of some intervention/s⁷. This
165 counterfactual scenario will therefore depend on the broader policy context in the jurisdiction
166 where the offset approach is being implemented.

167 The use of such dynamic reference scenarios has obvious challenges: first, desired outcomes
168 in terms of e.g. biodiversity conservation or land productive capacity often relate to states
169 (e.g. 17% protected by 2020, halt population decline, maintain land productive capacity
170 above 2015 levels), but policies with a dynamic reference scenario are obviously not
171 designed to achieve a fixed state. Second, selecting what the reference scenario should be
172 requires developing plausible and relatively detailed projections of future change—a process
173 challenging enough in itself, but which is made more difficult by the high risk of being

174 gamed given the stakes at play^{4,26,27}. Third, the appropriate rate of change might vary
175 considerably spatially, among different biota, and over time, and so the challenge of ensuring
176 the reference scenario remains plausible is ongoing.

177 Similar challenges are common to any dynamic reference scenario^{28,29}, but the unique feature
178 of a defensible reference scenario for NNL is that it must exclude any impacts that are the
179 target of the policy itself, as well as any benefits that occur only because the policy itself
180 requires them (e.g., benefits from offset actions). Only processes that are independent of the
181 policy should be reflected in the reference scenario³⁰. So, this type of reference scenario is: a
182 plausible pattern of change over time, but one that excludes the impact and any
183 counterbalancing interventions. As such, this type of reference scenario is well suited to
184 impact-specific policies, in which the objective is to achieve no net loss from the particular
185 impacts covered by the policy.

186 *C. No net loss relative to a dynamic reference scenario including development*

187 Occasionally it is suggested that a suitable reference scenario may be what would have
188 occurred if no NNL policy were introduced and economic development continued – a
189 business as usual scenario. For example, South Australia’s Significant Environmental Benefit
190 (SEB) policy states that offsets under the policy must achieve “... *an overall environmental*
191 *gain ... The gain in vegetation is considered against what would likely have occurred to the*
192 *vegetation in the absence of the SEB being established...*”³¹. Further, the REDD+ discussion
193 is framed against achieving reductions in emissions compared to a business as usual scenario
194 in which emissions continue to grow^{28,32}. However, such a reference scenario is nonsensical
195 in the context of a NNL goal. Under this approach, a NNL policy becomes a non-policy: it
196 endorses the same outcomes that would have occurred without the policy. It may be argued
197 that a ‘net gain’ goal (instead of NNL) could validly generate a benefit by pledging its

198 achievement against this baseline (à la REDD+), but this would mean *any* positive outcomes
199 for biodiversity relative to business as usual—however minute—would meet this low
200 standard. Such a reference scenario allows one to claim that a net gain is achieved because 99
201 hectares of forest was removed, rather than 100 hectares had there been no policy.

202 Because of the nature of a NNL commitment, the reference scenario chosen is particularly
203 crucial: it is the scenario that the policy is designed to achieve. As such, the outcome for
204 biodiversity from a NNL policy with each of these types of reference scenario can be vastly
205 different (Fig. 1). In the next section, we discuss the types of reference scenarios (and thus,
206 outcomes) that are implied by both overarching and impact-specific policy goals, and argue
207 for the use of particular types of reference scenarios in each case.

208

209 **NNL policies and their reference scenarios**

210 To explore the range of reference scenarios implied by existing NNL and related policies, we
211 reviewed a series of prominent examples of policies (organisational, governmental) that
212 reference no net loss, net gain, net positive impact, net neutrality, zero net deforestation, and
213 related concepts. Policies were identified for review based on a search of the literature and
214 the authors' familiarity with NNL policies globally; the review was not intended to be
215 exhaustive, but illustrative. We classified each policy as primarily overarching or impact-
216 specific (Table 1). For each, we identified the statement of the NNL goal, the target natural
217 capital, and any explicit statement of the reference scenario for the policy goal in policy
218 documentation. Where possible, we also explored published materials documenting the
219 design implementation of the policy to infer implied reference scenarios. For example,
220 regardless of any policy claims to the contrary, NNL biodiversity offset policies that allow
221 losses to be exchanged for protection of existing biodiversity assume that protection provides

222 avoided losses, which implies an effective reference scenario of decline¹³. Finally, we
223 classified the type of reference scenarios against which each policy aims to achieve its NNL
224 goal (Figure 2).

225 Table 1 summarises those policies for which we could confidently conclude a no net loss goal
226 or similar was intended. We exclude those where this was unclear. For example, we have not
227 included the example of US Species Conservation Banking as a NNL policy. It includes no
228 explicit statement of intended net outcomes, although its guidance states that the goal is to
229 “offset adverse impacts to [endangered] species”, and offsetting is defined in global best-
230 practice guidance as achieving as at least a no net loss outcome^{25,33,34}. Nevertheless, an
231 overall net loss in habitat extent is the most likely outcome of conservation banking, although
232 banks themselves may be higher in quality than the habitat lost^{35,36}.

233 From this analysis, it is clear that there can be mismatches between the stated reference
234 scenario against which overarching NNL policies seeks to achieve their goals, and the way
235 impact-specific policies operate. In some cases, the two conflict within the same jurisdiction
236 (Figure 2). Although the Australian Native Vegetation Framework aims to increase the
237 national extent and connectivity of native vegetation³⁷, the NNL offset policies employ
238 reference scenarios of decline (in some cases, steep decline¹³) (Figure 2; Table 1). The US no
239 net loss of wetlands policy includes both an overarching goal and programs for
240 implementation (including trading losses of wetlands for credits purchased from wetland
241 ‘banks’). The overarching goal implies a reference scenario of no further declines in the
242 function and values of wetlands. However, in some US states, it is possible to allocate credits
243 for protection of existing wetlands, though usually fewer per unit area than for wetland
244 creation or restoration. So, while overarching policies tend to aim towards a fixed target, the
245 impact-specific policies that form part of how they are implemented tend not to (Figure 2).

246 **Reference scenarios for overarching and impact-specific NNL policies**

247 Given that there are different types of reference scenarios for NNL, broadly classifiable into
248 fixed and dynamic (Figure 1), what type of reference scenario is suitable for different types of
249 policies? We argue that because the intention and scope of overarching and impact-specific
250 policies differ, different reference scenarios can be appropriate—at least initially.

251 Impact-specific NNL policies, such as those that include offsetting, are usually intended only
252 to deal with the component of loss caused by the particular impact in question. Therefore, if it
253 is likely that the state of target natural capital would be changing even in the absence of the
254 impact and linked offsets (for example, due to unregulated impacts, climate change, invasive
255 species, and unrelated conservation actions), then it is reasonable for the policy to be
256 designed to achieve NNL relative to a dynamic reference scenario set to reflect that
257 ‘background’ rate of change. On the other hand, such a reference scenario makes little sense
258 when applied in the context of an overarching policy (Figure 2). Overarching policies would
259 normally be understood to be about a fixed, overall state of natural capital, encompassing all
260 drivers of change, both positive and negative. This should be a desired state—in effect, a
261 target state.

262 *Reference scenario guides loss-gain accounting*

263 In the case of an impact-specific NNL policy, site-level reference scenarios are required to
264 identify both the amount of loss from an impact, and the amount of gain from an offset.
265 These losses and gains need to be measured relative to counterfactual scenarios—that is, what
266 would happen to the target natural capital without the impact and the offset (also known as
267 ‘debiting baselines’ and ‘crediting baselines’; *sensu*¹³). These counterfactual scenarios must
268 be logically consistent with the reference scenario for the overall policy goal.

269 In any given situation, multiple counterfactual scenarios are possible. By definition, these
270 scenarios can never be ‘correct’, and can only be an estimate of what the future would look
271 like in the absence of some particular intervention. However, it can be consistent or
272 inconsistent with the policy’s reference scenario, and be plausible or implausible—e.g.,
273 informed by recent trends that occurred under comparable circumstances, coupled with
274 explicit assumptions about relevant physical, social, economic and institutional drivers^{15,29,38}.
275 Therefore, some counterfactual scenarios are more appropriate than others.

276 When developing counterfactual scenarios for use in calculating losses and gains, it is
277 important to distinguish between impacts that are regulated by the relevant impact-specific
278 NNL policy (‘Type 1’ impacts), and impacts that are not regulated (‘Type 2’ impacts)³⁰ (See
279 Box 1).

280 Type 1 impacts: These are negative impacts which will trigger the application of the NNL
281 policy, such as a requirement for an offset, or positive impacts from activities associated with
282 such an offset.

283 Type 2 impacts: These impacts are not subject to the NNL policy and thus neither trigger a
284 requirement for an offset, nor are contingent upon an offset being required.

285 All factors that affect the target natural capital in the region in which the NNL policy is
286 operating can therefore be classified as either Type 1 or Type 2 impacts. The importance of
287 this distinction is that *only Type 2 impacts should be included in the reference scenario for*
288 *the given policy* (and therefore be used in estimating offset gains resulting from avoiding
289 losses) (Box 1). Type 1 impacts should not be included, as any negative Type 1 impacts
290 would themselves generate offsets to achieve impact-specific NNL, so averting them would
291 not result in biodiversity gains. For example, if a region is under pressure from extractive
292 industries, and offsets would be required for these industry impacts, then protecting habitat

293 that would otherwise have been lost due to extractive industry impacts should not count as a
294 gain: each and every impact of extraction would require an offset, resulting in NNL and thus
295 nothing to avert³⁹. The imperfect operation of offset policies, of course, means this may not
296 be the case in practice—but including Type 1 impacts in the counterfactual would further
297 undermine the effectiveness of the policy³⁰.

298

299 **Overarching and impact-specific NNL policy goals interact**

300 For jurisdictions that have both impact-specific and overarching NNL policies (e.g., the
301 European Union, Australia, the USA), there is often an implementation gap. An impact-
302 specific NNL policy, like biodiversity offsetting, cannot achieve an overarching goal of NNL
303 when impacts other than those captured within the impact-specific policy persist. This is
304 especially problematic when the impact-specific policy has a narrow scope, or allows the
305 protection of existing habitat to generate offset credit (e.g., avoided loss offsets in Colombia;
306 Figure 2). The net outcome from offset policies that allow avoided loss to count as a benefit
307 in exchange for a loss is a decline in the target natural capital. Therefore, a jurisdiction with
308 an overarching NNL goal as well as offset mechanisms that result in decline (i.e., have a
309 reference scenario of decline) needs to address the gap between this rate of decline and the
310 overarching NNL goal.

311 The net outcomes of an impact-specific NNL policy contribute to the overall natural capital
312 outcomes for the jurisdiction where the policy operates. The more types of impacts that the
313 impact-specific NNL policy covers, the more influence its reference scenario will have on
314 outcomes for the jurisdiction. Therefore, it is important that where a jurisdiction has an
315 overarching policy goal of NNL as well as impact-specific NNL policies, the reference
316 scenarios for the two are compatible.

317 If the reference scenario for an impact-specific NNL policy is one of decline, but the
318 jurisdiction also has an overarching NNL policy that uses a fixed baseline (desired state) as a
319 goal, then the cost of achieving that overarching goal shifts progressively from those
320 responsible for the impacts, to society (Figure 3). This is because offsets for specific impacts
321 would need only to counterbalance enough loss to maintain the declining reference scenario,
322 but achieving the overarching goal of ceasing or reversing decline necessitates filling the gap
323 through public investment. In such situations, traditional publicly-funded conservation
324 policies will continue to be core to stemming environmental decline ⁴⁰.

325 Ideally, the counterfactuals used in impact-offset exchanges should distinguish between Type
326 2 impacts (those that do not trigger an offset requirement) and Type 1 impacts (those that do).
327 It is reasonable for public investment to be used to redress Type 2 impacts in pursuing the
328 overarching NNL goal. However, as public investment starts to address background declines,
329 then this more favourable trend must be built into the reference scenarios used for impact-
330 specific policies. Otherwise, the public will pay more than their fair share (Figure 3).

331 Other approaches for achieving the convergence of overarching and impact-specific policies
332 are to expand the scope of impacts that require an offset as widely as possible, and explicitly
333 reflect in the reference scenarios for such policies all independent activities that generate
334 gains in natural capital ²⁶. This in turn reduces the benefits able to be claimed from
335 protection of existing natural capital—that is, the avoided loss⁴¹—because very few Type 2
336 impacts remain. This would mean the reference scenario used for impact-specific NNL goals
337 would converge on the overarching, fixed, reference scenario, and avoided loss would be
338 possible in very limited circumstances ^{30,41,42}. There are costs, however, to introducing such a
339 comprehensive scope for an impact-specific NNL policy. Taxpayer-funded conservation
340 policies may be more cost-effective at achieving an overarching NNL goal than requiring
341 many small negative impacts to be offset individually, as this typically comes with high

342 transaction costs. For example, green taxes based on adequate proxies of biodiversity loss
343 (e.g. on area, with rates that vary across localities as a function of biodiversity features) could
344 be used to bridge the funding gap between impact-specific and overarching NNL policies⁴³.

345

346 **A way forward**

347 Clearly specifying reference scenarios is important for all NNL policies, including those that
348 guide offsetting. Without them, the NNL goal is meaningless. Recognition of this need is
349 increasingly urgent as the NNL concept continues to expand to areas beyond biodiversity
350 outcomes, such as the concept of ‘Land Degradation Neutrality’⁵. We found little evidence
351 that detailed reference scenarios are explicitly specified in a range of prominent NNL
352 policies, and that the implementation of these policies can be inconsistent with their stated or
353 implied intent.

354 Apart from clarifying the intended goal and outcome of a NNL policy, a clearly stated
355 reference scenario is required so that the design and implementation of the policy is
356 consistent with achieving that outcome. In the case of an impact-offset exchange, consistency
357 is required between site-level reference scenarios and the reference scenario for the overall
358 policy goal. Otherwise, the net outcome from the exchange will not achieve the policy’s
359 stated goal. When not all impacts are covered by impact-specific NNL policies, overarching
360 NNL policies in the same jurisdiction need to specify how the gaps between the two NNL
361 policies are to be filled to achieve intended outcomes, for example, through traditional
362 publicly-funded conservation policies.

363 Promoting a no net loss policy without explicit reference scenarios introduces the risk that
364 pressure from economic and political interests can influence how the policy is implemented,

365 whilst appearing to maintain a clear standard⁴. Policymakers may therefore be reluctant or
366 unable to clearly specify counterfactual reference scenarios for NNL policies. Policies
367 designed to achieve NNL should ensure: (i) clarity about how they interact with other goals
368 and targets; (ii) transparency about the reference scenario at the overarching policy level; (iii)
369 identification of the scope of impacts to which an impact-specific policy applies, so that Type
370 1 and 2 impacts can be identified; and (iv) specification of how counterfactuals at the impact-
371 specific level should be calculated, such as excluding Type 1 impacts.

372 At least in principle, NNL policies could have an important role to play in keeping humanity
373 within a safe operating space^{1,2}. However, this depends upon many elements of policy design
374 and implementation, starting with clearly defined and appropriate reference scenarios.

375 Current NNL policies interpret the ‘no net loss’ concept in vastly different—and, we argue,
376 often inappropriate—ways, and so in many cases it is not clear what the outcome of these
377 policies is intended to be.

378 This complexity and confusion highlights the need for the compensatory component that is
379 intrinsic to NNL policies to be the option of last resort, with avoidance of impacts the first
380 priority (for example, as per the mitigation hierarchy^{25,34}). In the meantime, NNL policies are
381 increasingly adopted and implemented without clarity on what, how much and where natural
382 capital is being lost in exchange for compensation that cannot easily be evaluated against
383 intended outcomes. NNL policies, especially those that involve trading biodiversity and its
384 components, are facing strident opposition from individuals and organisations on the basis of
385 ethical, social, technical and governance concerns^{7,44,45}. Creating clarity about what such
386 policies are intended to achieve will not satisfy most of these concerns, but it does set the
387 yardstick by which policy performance can be judged.

388 **Author contributions**

389 All authors contributed to the conceptual development and writing of the paper. MM
390 developed the original concept and analysed the policies. AG led the sections on Type 1/2
391 impacts.

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542 Colombia, 2012).
- 543

544 **Author Contributions:**

545 All authors developed the concepts. MM developed the initial idea and led the writing. All
546 authors contributed experience and perspectives on reference scenarios, drawing from their
547 familiarity with many offsets and NNL-type policies. AG led the section on Type 1 and 2
548 impacts.

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553 **Figure Legends**

554 **Figure 1.** Examples of potential trends in focal natural capital resulting from the
555 implementation of ‘no net loss’ policies (either overarching or impact-specific). The different
556 types of reference scenarios shown include three fixed states (A) and two dynamic reference
557 scenarios (B and C). Note that line ‘B’ is parallel to the grey line depicting the ‘background’
558 trend, which depicts the expected change in stocks of natural capital caused by various
559 factors, including only impacts not targeted by the NNL policy. The background trend is not
560 necessarily one of decline. Assuming perfect implementation of the relevant NNL policy, the
561 net outcome would match the reference scenario set for the policy.

562 **Figure 2.** Reviewed overarching and impact-specific policies with stated NNL or similar
563 goals mapped against their specified or effective reference scenario. Where a mismatch
564 occurs between a policy’s stated reference scenario and its outcome based on the policy’s
565 design, or there is uncertainty, the box overlaps both regions.

566 **Figure 3.** Components of the cost of achieving an overarching reference scenario that
567 constitutes a favourable target. In this case, the impact-specific reference scenario is in
568 conflict with the overarching, desired reference scenario, and only part of the impacts of
569 development (relative to the overarching reference scenario) are the responsibility of the
570 proponent of the development.

571

572 **Table 1.** Overarching and impact-specific policies that seek to achieve NNL, net gain, net positive impact, net neutrality, zero net deforestation,
 573 and related goals.

| Policy name | Jurisdiction/ location | Status | Stated/paraphrased NNL goal and target | Stated/paraphrased reference scenario | Effective reference scenario (based on policy design/implementation guidelines) | Sources |
|---------------------------------------|-----------------------------------|----------------------------|---|---|---|---------------------|
| <i>Overarching policies</i> | | | | | | |
| No Net Loss initiative | European Union | In development | No net loss of biodiversity | Current or desirable future state | | ¹⁶ |
| Zero Net Deforestation | Global | In development/ adopted | Zero net deforestation or decline in forest condition | Fixed at 2020 forest cover and condition | | ⁶ |
| Land Degradation Neutrality | Global | Adopted | No net loss of land productive capacity | Fixed at 2016 state | | ⁵ |
| Zero Net Deforestation Act | British Columbia, Canada | Adopted, not in force | No net reduction in forest land | Fixed at 2015 forest area | | ¹⁷ |
| No net loss of Wetlands | USA | Adopted | No overall net losses of wetland functions and values | Current fixed state | Fixed or declining scenario (in the few cases where protection of existing wetlands generates some credits) | ^{19,46,47} |
| <i>Impact-specific policies</i> | | | | | | |
| EPBC Act Environmental Offsets Policy | Australia | Adopted | Improve or maintain the viability of matters of national environmental significance | Dynamic scenario of business as usual if neither the impact nor the offset occurred | Dynamic scenario, usually declining | ¹⁸ |
| Birds and Habitats | European | Adopted | No net loss of species and | Fixed state of favourable | In practice, fixed at current state | ⁴⁸⁻⁵¹ |

| | | | | | | |
|--|-------------------------|------------------------------------|---|---|--|-------|
| Directive; Environmental Liability Directive | Union | | habitat types that justify Natura 2000 status | conservation status (which can be current or desired state depending on species or habitat types, and location) | and implemented mainly through response to development | |
| Biodiversity impact mitigation and offsetting | France | Adopted | No net loss/net gain of nationally and sub- nationally protected species and particular habitats | Fixed state of favourable conservation/ecological status | Fixed at current state | 11,52 |
| Biodiversity offsetting (as part of the mitigation hierarchy) | South Africa | In draft | No Net Loss of biodiversity up to specified limits of acceptable change | Fixed minimum at desired future state (“ <i>remedy residual negative impacts to ensure that national biodiversity targets can be reached.</i> ”) | | 53 |
| Fish Habitat (productive capacity) | Canada | Adopted (1985, revised 2012) | Maintaining or improving fishery productivity | Not specified | Fixed current state – restoration only | 54-56 |
| Environmental Offsets Policy | Queensland Australia | Adopted | Improve or maintain the viability of matters of State Environmental Significance | Dynamic scenario of business as usual if neither the impact nor the offset occurred | Dynamic declining scenario (focus is on protection of existing habitat at 4:1 ratio) | 57 |
| Biodiversity offsetting guidelines | Ghana | In draft | Compensate for biodiversity losses resulting from development projects | Not specified | Fixed current state – restoration only | 58 |
| Guide for the Compensation of Biodiversity in the System of Environmental Impact Assessment | Chile | Adopted | No net loss or net gain of biodiversity | Not specified | Dynamic declining scenario | 59 |
| Offsets for Loss of | Colombia | Adopted | No net loss of biodiversity | Not specified “ <i>when compared to</i> ” | Dynamic declining scenario | 60 |

| | | | | | | |
|-----------------------------------|-----------------|---------|---|---|---|----|
| Biodiversity | | | | <i>the base line</i> ” | (protection and maintenance of existing biodiversity generates gain) | |
| Significant Environmental Benefit | South Australia | Adopted | An overall environmental gain | Dynamic scenario of what would likely have occurred to the vegetation with development but without the policy | Dynamic declining scenario (protection and maintenance of existing biodiversity generates gain) | 31 |
| IUCN Biodiversity Offsets Policy | Global | Adopted | No net loss or net gain of biodiversity | Dynamic scenario of business as usual if neither the impact nor offset occurred, declining permitted | | 25 |

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Box 1. The problem with including Type 1 impacts in counterfactuals

Type 1 impacts are those impacts that trigger an impact-specific NNL policy; **Type 2 impacts** are those that do not. In a hypothetical landscape, a threatened plant population is declining due to two factors: impacts from mining, and livestock grazing. A NNL policy that aims to counterbalance impacts on threatened species applies to all new impacts from mining, but not to the ongoing impacts of grazing.

Company X submits plans for a new mine that will **impact 500 of the remaining threatened plants**. It has two options to offset this impact. Option 1 involves protecting another part of the mining lease, which supports 700 individuals of the same plant, but might otherwise be mined in the future, resulting in the plants being lost. Option 2 is to purchase an adjoining property which has 600 of the threatened plants, but is subject to livestock grazing. Company X would remove the grazing in the hope that this will increase the plant population.

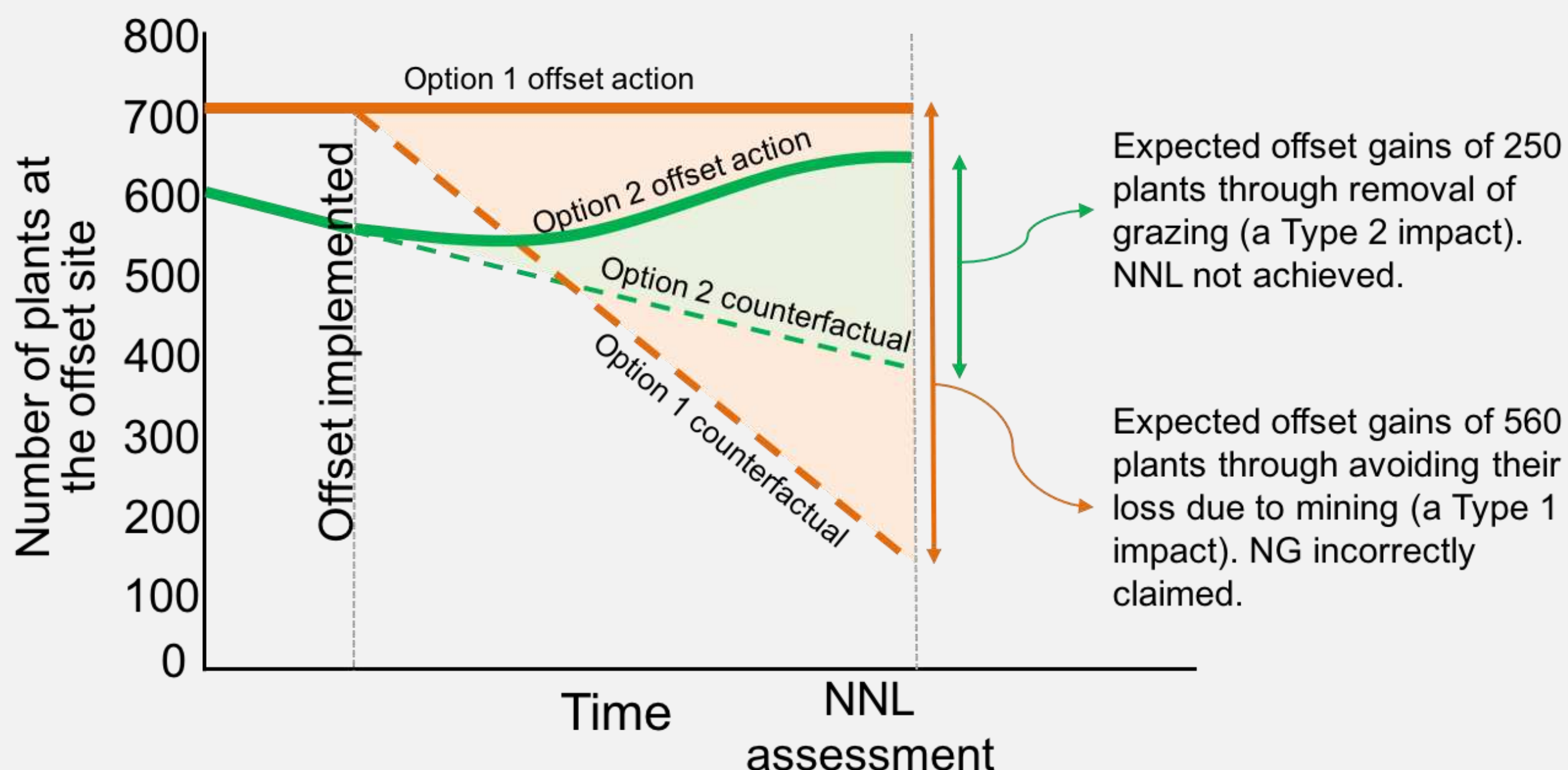
Company X proposes that **Option 1** would achieve a net gain outcome under the NNL policy. Their calculation relies on a counterfactual scenario for the site: how many plants there would be if the site did not become an offset. They state that if they were not to protect this part of their lease through an offset, there is a high chance – estimated at 80% – that the site would be lost to mining (a Type 1 impact), resulting in loss of all the threatened plants. The expected loss of plants without the offset is therefore 0.8×700 plants. By protecting the site from mining, however, all 700 plants would remain – so Company X concludes that the offset benefit of avoiding the loss of 560 plants more than counterbalances the original impact (loss of 500 plants) and achieves NNL.

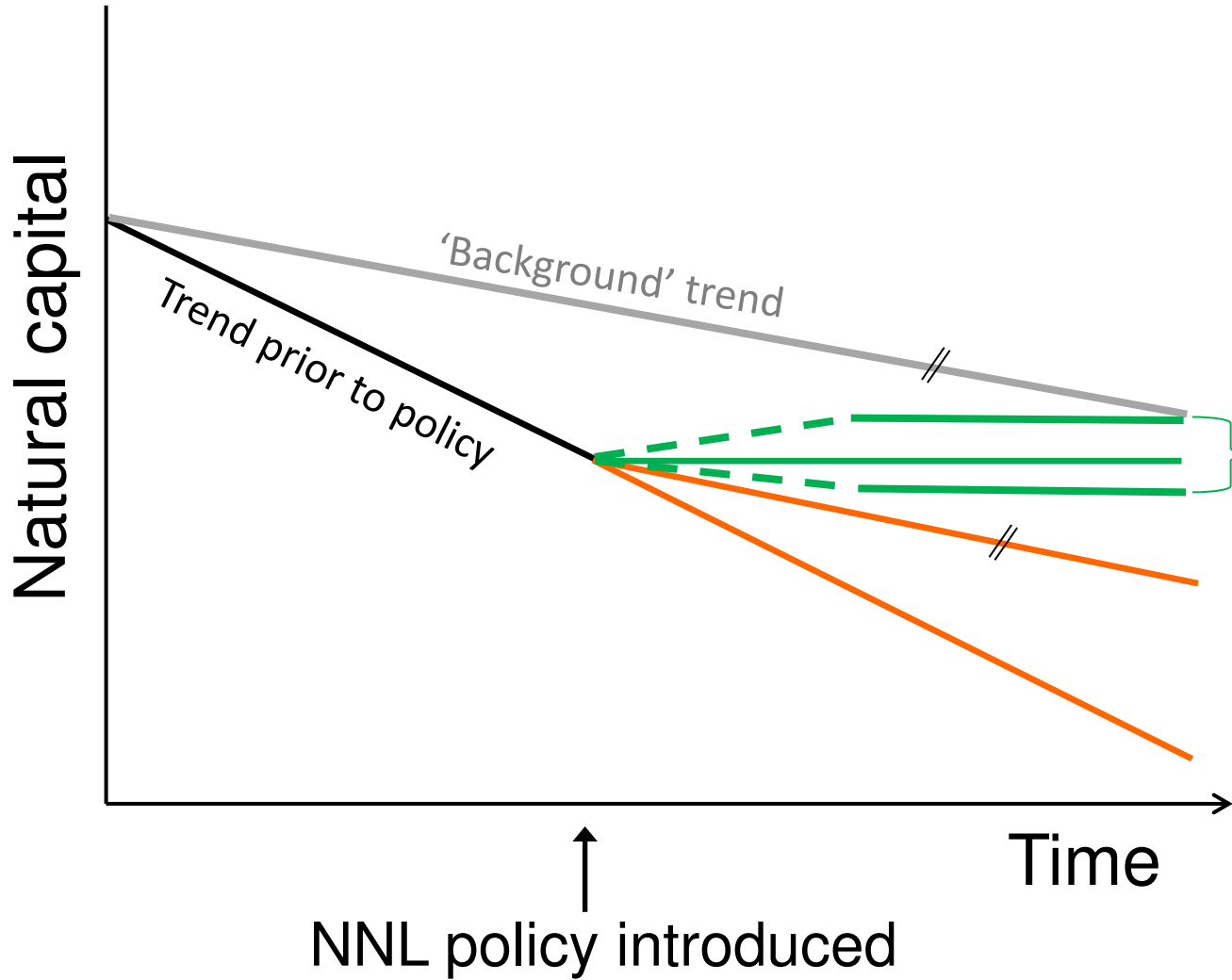
It is not valid for Company X to claim the benefit from the avoided loss of the offset site to mining (a Type 1 impact) because, according to the policy, **any future mining at the site would also have been subject to a NNL requirement, and thus its own offset**. The loss of the site would have to be counterbalanced elsewhere, with a gain of 700 plants required. Thus, the actual benefit of Option 1 is zero.

Option 2, however, is a different story. The continuation of livestock grazing (a Type 2 impact) will cause the loss of 200 of the threatened plants, and its removal is expected to increase the population to 650. So, the benefit of Option 2 is avoidance of the loss of 200 plants, plus the increase of 50 plants – a total benefit of 250 plants that would not otherwise exist. Option 2 provides only half the benefit required for a NNL outcome, meaning that Company X would need to implement additional offsets – but it is a much more beneficial offset than Option 1, which incorrectly included the avoidance of Type 1 impacts in their calculation of benefit.



An hypothetical plant species threatened by both Type 1 and Type 2 impacts





Fixed reference scenarios

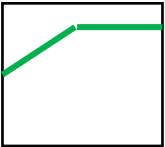
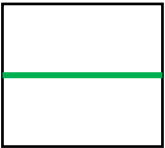
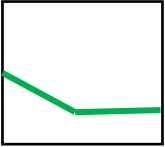
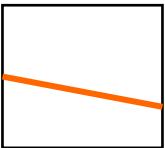
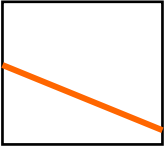
A. NNL compared to a fixed value

Dynamic reference scenarios

B. NNL compared to without impacts targeted by the policy (background trajectory)

C. NNL compared to without the policy (but with development impacts)

// Denotes parallel lines

| | Form of reference scenario | Overarching policies | Impact-specific policies |
|---|----------------------------|--|---|
|    | Fixed (A) | Better than current state | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed black; padding: 5px;">Canada fish habitat</div> <div style="border: 1px dashed black; padding: 5px;">Ghana offsets</div> </div> |
| | | Same as current state | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed black; padding: 5px;">EU NNL initiative</div> <div style="border: 1px dashed black; padding: 5px;">UNCCD LDN</div> <div style="border: 1px dashed black; padding: 5px;">EU Directives</div> <div style="border: 1px dashed black; padding: 5px;">France offsets</div> </div> |
| | | Worse than current state | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed black; padding: 5px;">BC, Canada ZND Act</div> <div style="border: 1px dashed black; padding: 5px;">USA NNL of wetlands</div> </div> |
|   | Dynamic | (B) Excluding both impacts targeted by the NNL policy and linked actions | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed black; padding: 5px;">Zero Net Deforestation</div> <div style="border: 1px dashed black; padding: 5px;">S. Africa offsets</div> </div> |
| | | (C) Without NNL policy and including impacts | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed black; padding: 5px;">IUCN offsets</div> <div style="border: 1px dashed black; padding: 5px;">Qld, Australia offsets</div> <div style="border: 1px dashed black; padding: 5px;">Chile offsets</div> <div style="border: 1px dashed black; padding: 5px;">Colombia offsets</div> </div> |
| | | | <div style="border: 1px dashed black; padding: 5px; margin-left: auto; margin-right: auto;">Australia EPBC Act offsets</div> |
| | | | <div style="border: 1px dashed black; padding: 5px; margin-left: auto; margin-right: auto;">S. Australia SEB offsets</div> |

