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

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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 countries[7].

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   offsets[18]. 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 time[7].

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 time [13].

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 contamination [20] or investments in increasing the

123   assimilation capacity of ecosystems [21]. Using a fixed state as a goal can improve certainty

124   about the end-point of environmental decline [22]. 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 met[22]. 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 offset[25] (Figure 1). Such a reference scenario is called a

164 *counterfactual*: what would have happened in the absence of some intervention/s [7]. 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 scenario [30]. 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 decline[13]. 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 vegetation [37], the NNL offset policies employ

238   reference scenarios of decline (in some cases, steep decline[13]) (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).

Reference scenarios for overarching and impact-specific NNL policies

246

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   <u>Type 1 impacts</u>: 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   <u>Type 2 impacts</u>: These impacts are not subject to the NNL policy and thus neither trigger a

284   requirement for an offset, nor are contingent upon on 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 avert [39]. 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 policy [30].

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 loss[41]—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 policies [43].

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 standard [4]. 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.

Author contributions

All authors contributed to the conceptual development and writing of the paper. MM

developed the original concept and analysed the policies. AG led the sections on Type 1/2

impacts.

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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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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

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

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
Overarching policies						
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]
Impact-specific policies						
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 ("*remedy residual negative impacts to ensure that national biodiversity targets can be reached.*")		[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 "*when compared to*	Dynamic declining scenario	[60]

Biodiversity				*the base line*"	(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.

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

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.
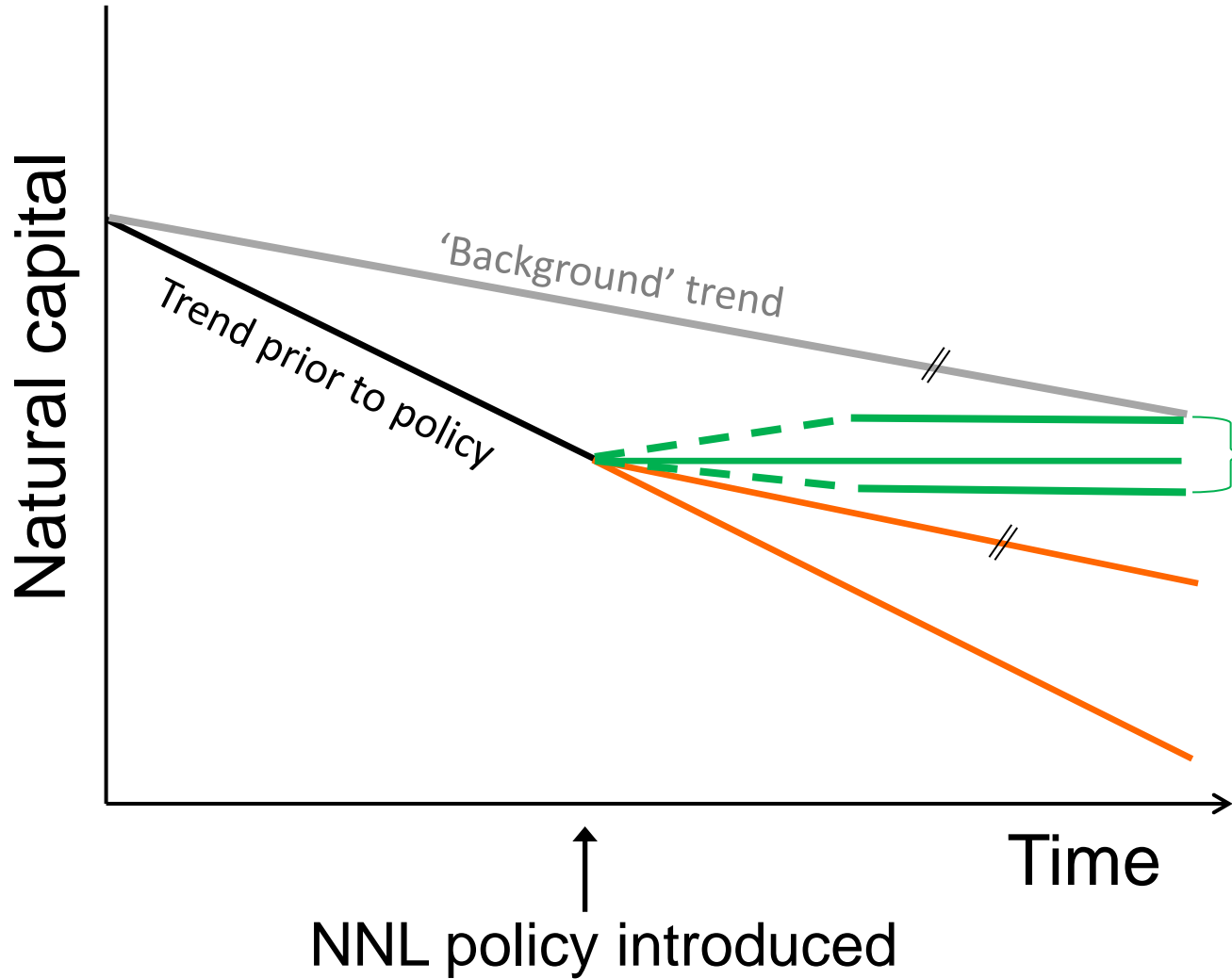
Option 2, however, is a different story. The continuation of livestock grazing (a Type 2 impact) will cause the loss of 200 of the threatened plants, and its removal is expected to increase the population to 650. So, the benefit of Option 2 is avoidance of the loss of 200 plants, plus the increase of 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.

Expected offset gains of 250 plants through removal of grazing (a Type 2 impact). NNL not achieved.

Expected offset gains of 560 plants through avoiding their loss due to mining (a Type 1 impact). NG incorrectly claimed.

	Form of reference scenario	Overarching policies	Impact-specific policies
Fixed (A)	Better than current state		Canada fish habitat; Ghana offsets
		EU NNL initiative; UNCCD LDN	EU Directives; France offsets
	Same as current state	BC, Canada ZND Act; USA NNL of wetlands	
	Worse than current state	Zero Net Deforestation	S. Africa offsets
Dynamic	(B) Excluding both impacts targeted by the NNL policy and linked actions		IUCN offsets; Qld, Australia offsets; Chile offsets; Colombia offsets; Australia EPBC Act offsets
	(C) Without NNL policy and including impacts		S. Australia SEB offsets

Axis labels: Target natural capital (vertical), Time (horizontal)

Overarching reference scenario (=target trend)

Impact-specific reference scenario

Public cost

Private cost