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RESEARCH ARTICLE

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'Should' and 'can' active restoration be used in biodiversity offsets? Stakeholder perspectives from New South Wales, Australia

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Abstract

1. Despite their controversial nature, biodiversity offsets are often used as a regulatory tool to counterbalance the impacts of land clearing on biodiversity. Offsets usually aim to achieve no net loss (NNL) of biodiversity through protection and/or restoration of habitat.
2. In the scientific literature, it is generally acknowledged that ecological restoration can improve biodiversity, subject to an understanding of how and under what circumstances it can be harnessed effectively.
3. The perspectives of practitioners on the use of restoration, notably in the context of offsetting, remain understudied. We address this knowledge gap by providing insights into the views of stakeholders involved (directly or indirectly) in the New South Wales Biodiversity Offsets Scheme on the use of active restoration in the context of offsetting. Using a survey and semi-structured interviews, we developed a rich picture of stakeholder perspectives on whether active restoration 'should' and 'can' be used in this context.
4. We found divergent perspectives on whether it 'should' be used, with some stakeholders arguing that protection of good-condition habitats has to be prioritised, while others argued that NNL can only be achieved through restoration on lower-condition sites. Regarding whether active restoration 'can' be used, stakeholders pointed out potential contradictions between active restoration and the functioning of offsetting. First, although the outcomes of active restoration are uncertain, offsetting requires accurate predictions of biodiversity improvements. Second, active restoration requires flexibility and creativity. This contrasts with the method used to calculate biodiversity gains in the NSW scheme, which was thought to be rigid and prescriptive.
5. Within the context of offsets, our results suggest that active restoration is likely to be considered appropriate and feasible only if: (i) it is used on sites where less 'intensive' practices do not succeed, (ii) good-condition and irreplaceable habitats are adequately protected, and active restoration is not used

to justify or enable the clearing of good-condition habitats; (iii) it is likely to succeed within reasonable margins of uncertainty and (iv) ample room is created for intelligent tinkering and experimentation (separately from generating gains) to help reduce scientific and operational uncertainties related to active restoration in the longer term.

KEYWORDS
active restoration, Australia, biodiversity offsets, ecological restoration, stakeholder perspective

1 | INTRODUCTION

Biodiversity offsets are a regulatory tool often aiming for no net loss (NNL) or a net gain of biodiversity by means of compensating the loss of biodiversity at one site by generating measurable and equivalent biodiversity gains at another site (BBOP, 2018; IUCN, 2016). Offsets are intended as a last resort in the mitigation hierarchy[1] to manage residual impacts of land clearing after avoidance, minimisation and on-site restoration (remediation) have been considered (IUCN, 2016). Compensation of environmental impacts emerged as a policy requirement in various parts of the world in the 1970s (Maron et al., 2025), while biodiversity offsets more specifically took hold in the early 2000s (Hrabanski, 2015). Despite widespread concern over their effectiveness, they have progressively become a widely utilised mechanism (Maron et al., 2025).

Biodiversity gains at offset sites can be achieved through protection or restoration of habitats (Moilanen & Kotiaho, 2018; Moreno-Mateos et al., 2015). Protection of habitat threatened by land clearing or other forms of land degradation is argued to generate biodiversity gains by avoiding future losses. Gains are calculated against a counterfactual scenario of the loss that would have occurred without offsets (Sonter et al., 2017). With the ecological restoration approach—the 'process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed' (Gann et al., 2019, p. 7)—gains in biodiversity are calculated based on the habitat improvements generated by the restoration activities undertaken. Such gains can be obtained through passive forms of restoration, which mainly focus on managing factors leading to ecosystem degradation; or active forms of restoration, which involve a higher level of intervention in order to replace missing biotic and abiotic components of ecosystems (Atkinson & Bonser, 2020).

A significant limitation of avoided loss offsets resides in the difficulty of developing counterfactual clearing scenarios (Sonter et al., 2017), due to the many inter-related factors that influence clearing (Heagney et al., 2021; Hernandez, Duce, et al., 2024). If clearing rates are overestimated, avoided losses will also be overestimated, leading to an inadequate compensation of biodiversity loss (Maron et al., 2015). Even when estimates of biodiversity loss are plausible, avoided loss has been argued to be equivalent to 'defin[ing] a level of acceptable loss (in terms of area)' (Quétier & Lavorel, 2011, p. 2997), as it protects existing habitat rather than adding to it. In view of those limitations, ecological restoration is often thought to be more likely to compensate for biodiversity impacts (Guillet & Semal, 2018; Moilanen & Kotiaho, 2018; Weissgerber et al., 2019). However, restoration also has uncertainties (Curran et al., 2014; Maron et al., 2012), in part due to the complexity of ecosystems and the challenges of reconstructing them (Moreno-Mateos et al., 2015). While there are examples of successful outcomes (e.g. Florentine et al., 2023), they can be difficult to predict (Brudvig et al., 2017; Sinclair et al., 2018). In cases where recovery is measured against pre-disturbance reference states, 'full recovery' may take many decades or even centuries, if at all (Atkinson et al., 2022; Parkhurst et al., 2022). Furthermore, the effectiveness of different approaches to restoration is still debated. Some studies find that passive restoration consistently performs better than active restoration and that passive restoration should be prioritised when possible (Crouzeilles et al., 2017; Di Sacco et al., 2021; Jones et al., 2018). Others argue that these results are often confounded by prior degradation state (active restoration tends to be used in more highly degraded contexts) (Gerwing et al., 2023; Reid et al., 2018), and that passive and active restoration are *complementary* and should be selected based on context (e.g. ecosystem type, ecological condition, project objectives, funding) (Díaz-García et al., 2020; Trujillo-Miranda et al., 2018) (Figure 1). These uncertainties pose difficulties in the context of offsets where losses are certain, but the timescale and effectiveness of restoration gains are not (Maron et al., 2012).

As illustrated above, the role of passive and active restoration has been discussed in the scientific literature. Yet there is a dearth of research on the perspectives of stakeholders involved in offset design and implementation on the matter. With an expected shift towards Net Positive Impact (Bull et al., 2020; Moilanen & Kotiaho, 2021), active restoration may have an increasing role to play in meeting biodiversity objectives in the context of offsetting worldwide. While NNL aims to neutralise the biodiversity impacts of land clearing, Net Positive impact aims to provide biodiversity outcomes that generate additional benefits (Alama et al., 2015). In this context, the emphasis of offsets is likely to move towards

[1]Assisted (natural) regeneration is the facilitation of 'recovery at sites of intermediate (or even high) degradation [using] both the removal of causes of degradation and further active interventions to correct biotic or abiotic damage' (Standards Reference Group SERA, 2017, p. 8). Biotic interventions can include for example invasive species control. Abiotic interventions can include, for example, fire management.

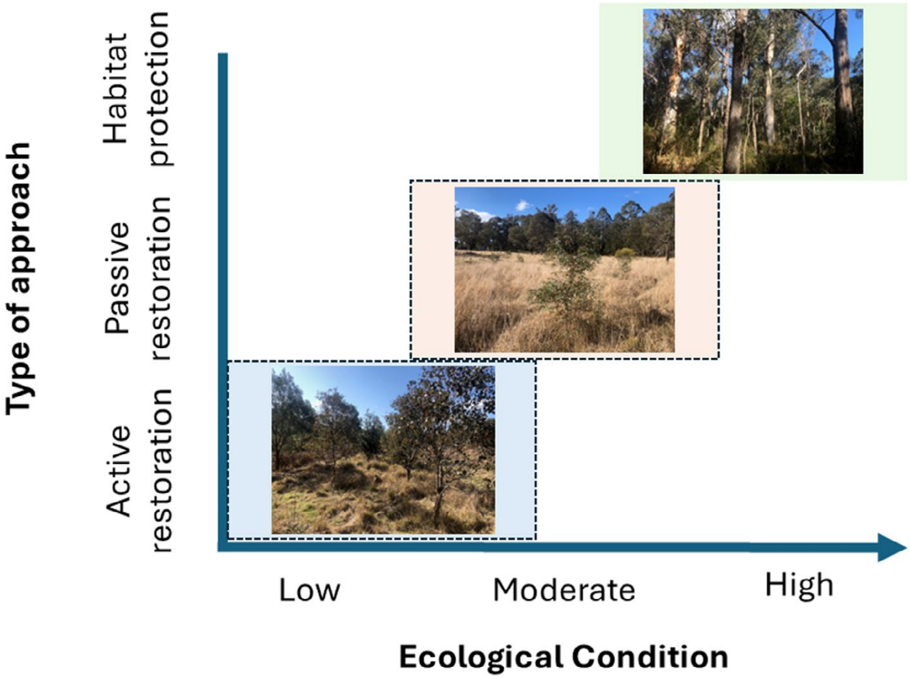

FIGURE 1 Conceptual representation of the types of approach (from protection to active restoration) and their application to sites of varying (low to high) ecological condition. The dashed rectangles represent the focus of our current study.

restoration, as avoided loss cannot provide additional biodiversity benefits.

Understanding these wider perspectives could inform policy to proactively support acceptable and more effective use of active restoration in biodiversity offsetting. It is often assumed that actors operating in a market-based system are primarily behaving in response to price signals (Pirard, 2012). We adopt the premise that actions are situated in rules and norms which are, in part, socially conditioned (Plant & Ruoso, 2023). Understanding values, perspectives and experiences—as proxies of these rules and norms—allows contextualisation of stakeholder actions beyond their responses to price signals and can provide valuable insights on broader aspects of the governance of offsetting.

We present a case study of stakeholder perspectives on active restoration in the New South Wales Biodiversity Offsets Scheme (NSW BOS). The NSW BOS, established in 2008, provides a relevant case study because it is a mature scheme that aims to encourage active restoration management actions, but has, so far, experienced low uptake. By 2022, only 19.3% of the total area under offsets proposed to adopt active restoration (Hernandez, Dorrough, et al., 2024). Understanding stakeholder perspectives on active restoration in the context of offsetting may shed light on some of the reasons behind the low uptake and provide broader perspectives on the role of active restoration within biodiversity offsets schemes.

Our study is two-tiered. First, we focus on whether active restoration 'should' be used. Here, we examine the circumstances under which active restoration is considered a justified approach to address residual biodiversity loss. Second, we look at whether active restoration 'can' be used, that is, whether it is practically feasible to restore land set aside as an offset. For each question ('should' and 'can') we look at interviewees' perspectives on the use of active restoration in general and in the context of the NSW BOS, so as to compare and contrast the considerations or challenges that relate to active restoration in general, with the ones that relate more specifically to active restoration in the context of the NSW BOS.

While our focus is on active restoration, the practice of restoration (both passive and active) presents itself on a continuum (Figure 1). This makes it difficult to discuss a specific approach in isolation. Additionally, restoration is often juxtaposed against the protection of existing vegetation. As a result, when expressing views on active restoration, interviewees also talked about ecological restoration more generally (including passive restoration) and habitat protection. As such, broader perspectives on restoration and habitat protection are also presented and put in perspective with active restoration.

2 | METHODS

2.1 | Case study: The NSW BOS

In this section, we briefly describe the functioning of the NSW BOS along with the restoration approaches approved under the scheme.

2.1.1 | The functioning of the NSW BOS

Under the NSW BOS, losses and gains in biodiversity are calculated using the Biodiversity Assessment Method (BAM) (DPIE, 2020a). On the development side (offsets demand side), if the development triggers the NSW BOS, then the developer is required to provide a biodiversity development assessment report. This report is developed by a consultant with accreditation to operate under the BAM (an accredited assessor). The report quantifies the environmental impacts of development (e.g. land clearing) and forms part of the application to the consent authority for development approval. In approving the application, the consent authority requires the developer to compensate for their residual impacts by securing offsets, which creates demand for offsets.

On the offset supply side, landholders willing to participate in the NSW BOS express interest in establishing an offset site. Once they have done so, they hire an accredited assessor to assess the biodiversity values on the land they are proposing as an offset. This is documented in a site assessment report. As part of this report, the accredited assessor develops a proposal to manage and improve the biodiversity values of the site, within the rules, policies and guidelines set by the NSW government. From this, a management plan is developed. It details the actions—and associated costs—that will be carried out on an offset site to generate gains in biodiversity and manage the site in perpetuity (further information on the types of actions that can be conducted are provided in the section below). The assessment report and management plan (including associated costs) are reviewed by the NSW government—the decision-maker for establishing the offset site—for practicality, feasibility and risk. The anticipated biodiversity gains are then converted into transactable 'credits' available on the offsetting market (BCT, 2022). Those credits are purchased by developers (directly or via government on their behalf) to acquit their offset obligations. Utilising funds allocated from the sale of the credits, annual payments are disbursed to the landholder in perpetuity to undertake actions in accordance with the prescribed management plan (DCCEEW, 2024). The landholder can self-manage the site or contract a qualified third party (i.e. a restoration practitioner) to do the work.

2.1.2 | Restoration approaches under the NSW BOS

The NSW BOS identifies two ecosystem restoration approaches: 'required management actions' and 'active restoration management actions' (DPIE, 2020b). This distinction broadly aligns with the terms 'active' and 'passive' restoration (see Table 1). While the categorisation of ecological restoration approaches is the subject of ongoing debate (Atkinson & Bonser, 2020; Chazdon et al., 2021), our study adheres to the policy definition of the NSW BOS to define active and passive restoration. Accordingly, required management actions are

TABLE 1 Key definitions of ecological restoration approaches.

Active and passive restoration (based on Atkinson & Bonser, 2020, p. 1034)	NSW BOS (DPIE, 2020a, pp. 53–55)
Passive restoration: Ending degradation by removing threats (e.g. inappropriate fire regimes, grazing or logging) [with the following aspects of *assisted regeneration*: weed management, pest management, fire management]	*Required management actions*: Removal of threats and pressures including: • Fire management • Grazing management • Native vegetation management • Threatened species habitat management (e.g. protecting breeding habitat features) • Integrated pest animal control • Integrated weed management to limit or reduce spread of high-threat weeds • Management of human disturbance (e.g. clearing)
Active Restoration: Ending degradation, abiotic (e.g. habitat creation) and biotic interventions (e.g. invasive species management) and reintroduction of major proportion of biota	*Active restoration management actions*: • Habitat enhancement (e.g. nesting boxes or constructed hollows), • Native vegetation and habitat augmentation (e.g. targeted supplementary planting) • Integrated weed management and control or elimination of high-threat exotic vegetation (e.g. removal of high-threat exotic vegetation through appropriate method—e.g. scalping—and replacement with native vegetation through natural regeneration and/or targeted supplementary planting). Weed management aimed at reducing the spread of high-threat weeds is considered a passive or required management action. However, when it aims to eliminate or significantly reduce the spread of high-threat weeds, it is considered to be active restoration. • Hydrology management (e.g. creating artificial frog ponds or wetlands, manage drainage and hydrological flows)

TABLE 2 Stakeholder categories as per their 'primary role' at the time of the survey/interview.

Stakeholder	Characteristics	Survey (*n*)	Interviews (*n*)
Accredited assessors (AA)	Individuals accredited in the application of the BAM by the NSW government. Accredited assessors can be ecological consultants who assess sites under the NSW BOS. They apply the BAM to calculate losses and gains in biodiversity and develop the management plans to generate gains in biodiversity on offset sites. Government employees who review and assess development impacts and BSA applications may also hold accreditation The interview participants who are categorised as accredited assessors in this table held roles as ecological consultants with accreditation at the time of the interview. Government employees who hold accreditation (some of whom may also have been ecological consultants in the past) are categorised as 'government employees.' It is worth noting that government employees cannot be concurrently ecological consultants as this would constitute a conflict of interest	35	10
Government employees (GE)	Individuals working for government agencies who play a direct or indirect role in the NSW BOS *Direct roles* include government staff who develop the rules/methods of the scheme (e.g. developing the BAM), review and assess development impacts (developer side), review and assess BSA applications, support landholders with existing BSAs and identify offset sites for developments funded and delivered by government agencies or government-owned corporations *Indirect roles* include government staff (local government, Local Land Services, etc.) who provide advice and support to landholders (regardless of whether they are part of the NSW BOS) on biodiversity and other land management matters	21	15
Restoration practitioners (RP)	Individuals involved in restoration activities, through the development of management plans and the implementation of restoration practices. Some of the practitioners interviewed had direct involvement in the NSW BOS, while others did not	8	10
Total number of participants		64	35

similar to those of passive restoration focusing on the reduction or removal of threatening processes. They also include interventions similar to 'assisted (natural) regeneration',[2] notably native vegetation management or fire management. Active restoration management actions 'aim to substantially alter the characteristics or processes of the environment to support the return of native vegetation and/or habitat features' (DPIE, 2020a, p. 10) and align more closely with active restoration (Table 1). As the NSW BOS terminology is not widely used beyond the NSW context, we will adopt the passive/active restoration terminology for the remainder of this paper, noting that passive restoration, in our context, may include certain weed, fire and pest management activities.

2.2 | Stakeholder selection

We engaged with stakeholders involved directly or indirectly in the assessment and management tasks described above. We identified three categories of stakeholders: accredited assessors, government employees and restoration practitioners. In Table 2, we placed stakeholders in the category they primarily belonged to at the time of the interview. However, stakeholders often sit across several categories. As such, our objective is not to describe three distinct groups of stakeholders, but to ensure that we have adequate representation among these categories, acknowledging that they are somewhat artificial. Further information on stakeholder categorisation is provided in Data S1. In the findings section, quotes are attributed based on whether they come from the survey ('SR' for survey respondent) or the interviews ('IP' for interview participant), as well as using the primary category of the interview participant or survey respondent ('AA' for accredited assessor, 'GE' for government employee and 'RP' for restoration practitioner).

The decision to establish an offset site and, ultimately, undertake active restoration resides with the landholder. Consequently, the stakeholders that our study concerns itself with could be considered as secondary to landholders. However, the perspectives of our identified stakeholders are deemed relevant for several reasons:

- Many stakeholders interviewed play a *direct role* in setting the context for the adoption or non-adoption of active restoration under the NSW BOS. This includes accredited assessors who undertake site assessments and develop offset management plans, and government staff who review management plans, or determine the rules under which the NSW BOS operates. They are therefore likely to influence the types of management actions recommended to and undertaken by landholders (acknowledging that many other factors—including financial incentives—are likely

[2]Assisted (natural) regeneration is the facilitation of 'recovery at sites of intermediate (or even high) degradation [using] both the removal of causes of degradation and further active interventions to correct biotic or abiotic damage' (Standards Reference Group SERA, 2017, p. 8). Biotic interventions can include for example invasive species control. Abiotic interventions can include, for example, fire management.

play a role in landholders' decision-making process. However, those fall outside the scope of this study).

- Other stakeholders play an *indirect role* in active restoration in the context of the NSW BOS. These were identified as meaningful participants due to their expertise more broadly in the NSW BOS, land management and/or the restoration industry. Understanding their views on the circumstances under which the use of active restoration in the NSW BOS is considered effective and practical yields insights concerning broader acceptability and legitimacy.

2.3 | Data collection and analysis

We used a survey and semi-structured interviews to develop an understanding of restoration and offset practitioners' perspectives on the use of active restoration in the context of the NSW BOS.

2.3.1 | Survey

An online survey was developed to obtain an initial understanding of practitioners' attitudes towards biodiversity offsets, active restoration and active restoration in the context of the NSW BOS, as well as insights on the forms of capitals—physical, natural, human, social, financial, information (Ellis, 2000; Odero, 2006)—that may hinder or facilitate the adoption of active restoration in general and in the context of the NSW BOS (see Data S2 and S3 for a definition of attitudes and forms of capitals). At the end of the survey, respondents were invited to provide a free-text comment on their perspective on active restoration and offsets. While the answers to the survey questions have been analysed elsewhere (Hernandez, Dorrough, et al., 2024), qualitative free-text responses were included in the current analysis.

The survey was administered online in March and April 2022. As presented above, our cohort of interest consisted of accredited assessors, government employees and restoration practitioners involved in the NSW BOS and/or the restoration industry. Participants were recruited via direct invitations using professional email list services, professional group membership and snowball sampling (respondents could forward the link to others). Participants were first sent a pre-notification email with information about the survey, followed by an invitation to participate in the survey, along with two email reminders. About 111 individuals responded to the survey, out of which 64 provided a free-text comment (Table 2).

2.3.2 | Semi-structured interviews

Drawing on the survey findings, semi-structured interviews were conducted to gain further insights on attitudes and forms of capital that hinder/facilitate the use of active restoration in general and within the NSW BOS. An interview guide was developed focusing on eliciting: (i) attitudes towards active restoration and the reasons that can explain them, (ii) current use/recommendation of active restoration, (iii) perspective on the current uptake of active restoration within and beyond the NSW BOS and (iv) main barriers and enablers to the uptake of active restoration within and beyond the NSW BOS (see Data S4 for the full interview guide).

Interviews were conducted online between June and September 2022. Participants were recruited using three strategies: self-nomination from the online survey (this means that a degree of overlap exists between participants in the online survey and participants in the interviews), snowball sampling from interview participants and existing professional network of the research team. Thirty-five individuals took part in the interviews (Table 2), until we reached a priori thematic saturation (Saunder et al., 2018).

Data collection, storage and analysis comply with the University of Technology Sydney's human ethics policies and principles (reference number ETH24—10021, project number 21169). Consent was obtained from participants prior to the survey and semi-structured interviews. For the survey, project information was provided on the landing page of the survey. To access the survey, participants ticked the following statement: 'I agree to participate in this survey and agree to the use of information I provide as described above'. For the interviews, verbal consent was obtained at the beginning of the interview. Verbal consent was preferred to written consent as interviews were conducted online. Consent was audio-recorded, as well as manually recorded by the interviewer on a verbal consent sheet.

2.3.3 | Coding

The interviews and the survey's free-text comments were transcribed and then coded using Dedoose v. 9.0.54. The codes used reflect:

- Positive/negative attitudes towards active restoration, offsetting in general, the NSW BOS or the use of active restoration under the NSW BOS.
- Presence/absence of certain forms of capitals that would facilitate/hinder the adoption of active restoration in general and within the NSW BOS.

Our study aims to better understand participants' attitudes towards whether active restoration 'should' and 'can' be used in general and within the NSW BOS. As a result, the analysis focused on the codes that described stakeholders' attitudes towards active restoration in general and under the NSW BOS specifically. However, in some interviews, participants closely linked the expression of their attitudes (notably around whether active restoration 'can' be successful) to the presence/absence of certain forms of capitals, notably information ((un)availability of scientific and technical knowledge) and natural ((un)favourable site conditions and climatic context) capitals. As a result, those forms of capital will be presented in the findings. Other forms of capital, such as human and physical capitals, are not presented in the findings, the reason being that, while they may result in practical implementation barriers, they did not appear to play a direct role in determining stakeholders' attitudes towards whether active restoration ‘can’ be successful.

3 | FINDINGS

3.1 | ‘Should we actively restore?’

3.1.1 | Perspectives on ecological restoration and habitat protection

When asked whether active restoration was an effective strategy for enhancing, managing, and conserving biodiversity, interviewees responded with broader considerations on ecological restoration (in general) and habitat protection. Many interviewees argued that the priority should be to protect and retain existing vegetation before considering ecological restoration:

> It [ecological restoration] is probably not the preferred option because you're not starting with a lot of biodiversity. [...] A much more effective way is to protect what we have rather than try and restore something that isn't there now.
>
> (GE.IP5)

Ecological restoration was often viewed as a ‘supplementary tool’ (AA.IP2), ‘sitting in parallel’ (RP.IP12) with protection. Because of past and ongoing ecosystem loss and degradation, habitat protection—while essential—was sometimes thought to be insufficient on its own. And ecological restoration was considered a necessary complementary approach to address vegetation loss:

> We continue to see biodiversity loss as the key thing. And I think that taking the more conservative approach of fencing off good patches is just not going to be enough into the future. [...] We have to move to a more proactive way of managing biodiversity.
>
> (RP.IP13)

3.1.2 | Perspectives on the role of active restoration

When considering the role of active restoration more specifically, several interviewees agreed that active restoration was needed to enhance biodiversity in low-ecological condition areas where passive restoration may not be effective:

> Restoration is kind of part of what's needed in a lot of places. If you're not doing a kind of active—those active management actions—then you're not going to overcome ecological thresholds or really address some of the underlying issues of a site that prevent it from improving.
>
> (GE.IP23)

However, while some found that active restoration was necessary in ‘a lot of places’ (GE.IP23) others were of the opinion that ‘most of the sites I've looked at have some soil resilience, and assisted natural regeneration would be beneficial and more cost effective’ (AA.SR60). Several respondents stressed the importance of first considering whether a site may benefit from passive restoration before moving to active restoration, notably tree and shrub planting. Those interviewees believed tree and shrub planting was often adopted in circumstances where passive restoration would have been preferrable. As such, while interviewees agreed that active restoration may be needed for areas of lower ecological condition, opinions varied on how often that was the case.

Moving beyond the site level and focusing on the ecological community scale, several interviewees suggested that active restoration could be particularly useful in ecological communities that, owing to past and ongoing disturbance, are now mostly in low-ecological condition and where opportunities to use passive restoration are scarce or non-existent (e.g. Cumberland Plain woodland in Western Sydney (GE.IP29), riverine systems throughout NSW (GE.IP23) or inland Grey Box (*Eucalyptus microcarpa*) communities (GE.IP16)).

As a side note, we would like to mention that participants used various formal and informal terms to refer to habitat condition, such as ‘heavily degraded’, ‘good nick’. As ecological condition presents itself on a continuum, such terms may be interpreted differently by different individuals. As such, we refrain from using very specific language that could be misleading. Instead, we use ‘low-condition habitat’ or ‘lower-condition habitat’ to broadly refer to sites that have been degraded, modified and transformed and where the use of active restoration may be beneficial.

3.1.3 | Perspectives on (active) restoration in the context of the NSW BOS

Stakeholder perspectives on protection and restoration within the NSW BOS appear to be more polarised than when discussed in general terms. Some argued that offsets should protect good-condition sites, while others believed that ecological restoration (active or otherwise) of lower-condition areas should be the focus.

The protection of good-condition sites would achieve gains mostly through avoided loss, with some potential for passive restoration. For some, this approach was preferable as it maintained existing biodiversity values, in contrast to restoring ecosystems which may or may not provide those values in the future. Additionally, the protection of good-condition sites could be seen to protect good-condition habitat that could otherwise be cleared:

> If that land [containing existing forest] has no protection, [...] it can be subject to clearing under the LLS Act.[3] [...] To restore cleared land obviously is great, if that works, it is conserved and it gets to maturity, you are adding to it. We also need that protection on that existing forest, which is providing services right now. [...] I'd prefer retaining that [existing forest] if the option was that was not under protection.
>
> (AA.IP18)

For others, the prioritisation of avoided loss through the protection of good-condition sites was seen as leading to the acceptance of some degree of habitat loss. They argued instead that priority should be given to ecological restoration:

> The offsets scheme, unless you actually do active restoration, or some sort of restoration work, it's a negotiated loss system. For every hectare of land you develop, you are offsetting it by finding five hectares somewhere else. So, it is a 5:1 loss ratio, there is no gain. I think the gain is artificial. It is in the metric, it is in the formulas, but I do not think the gain is actually happening.
>
> (AA.IP15)

> The benefits of the offsets scheme should be to increase the area of native vegetation cover, not protect the cover that's already there.
>
> (GE.IP27)

The above quotes are not prescriptive on the type of restoration (i.e. passive or active) that should be used to encourage an increase in native vegetation cover. However, we can assume that, depending on their degree of degradation, sites may require either passive restoration, active restoration or a combination of both.

While restoration was considered by some to be necessary to generate biodiversity gains, two concerns were raised about restoration, particularly active restoration: (i) entrenching a 'false narrative' (AA.SR16) that habitats can be destroyed and restored, making habitat destruction 'acceptable'; (ii) offsetting the loss of good-condition, potentially irreplaceable, habitat with the restoration of lower-condition habitat.

The first concern was articulated by an interviewee in the following way: '[w]e have to be concerned about [...] individuals, politicians, [...] bureaucrats as well, putting forward the idea that we can fix everything with active restoration. That it doesn't matter what we develop or how we develop, we can always bring it back with active restoration. That's a fallacy. It is just impossible' (GE.IP8). Interviewees expressed divergent opinions on whether the NSW BOS discouraged or facilitated vegetation clearing—that is, whether it indirectly promoted the idea that any development could be offset. One interviewee explained that 'there is certainly a feel[ing], with a lot of practitioners, that any development can go ahead, if you offset it' (GE.IP5). Another argued that, putting a price on biodiversity influenced developers' decisions: 'the ability to put a price tag on it, to say that's a 40 mil[lion] option, that's a 4 mil[lion] dollar option, that's sharper. That's making it really clear to people that the choices have consequences in terms of their budget' (GE.IP29). Prior to putting a 'price tag', impact studies, (conducted by developers to assess the impacts of various development options), often showed that 'a lot of different choices used to be that they all affected the bush [...] they all neutralised each other' (GE.IP29). For this participant, the NSW BOS encourages developers to consider biodiversity in their decision-making. However, they acknowledged that the 'price tag' did not influence decisions around large developments where the 'differential[s] between different options are so small that just putting a price doesn't drive an outcome' (GE.IP29). This discussion relates to whether offsets (in general) reduce the impacts of developments on biodiversity. However, participants did not provide specific insights on whether active restoration (as opposed to habitat protection or passive restoration) could bolster a false narrative that vegetation clearing may proceed as it can be actively restored through offsets.

The second concern centred on the possibility of offsetting good-condition, potentially irreplaceable habitat, with the restoration of lower-condition habitat. Participants' views about whether restoration is appropriate were dependent on the biodiversity values of the impact site, and the degree to which they believed these can be replaced. While restoration to offset good-condition habitat would be permissible under the NSW BOS, it would require the restoration of a larger area than the impact area. Still, this approach was considered unsatisfactory as there was no guarantee that the restoration outcomes would be realised and that the larger area of restoration would ever compensate for the lost biodiversity:

> If you're pulling down a higher condition area of PCT [Plant Community Type[4]] × and you are offsetting that with a lower condition PCT then that will increase the number of hectares that you have to offset with the lower condition. There are obviously potential problems there because [...] no area of the offset is going to potentially meet the level of biodiversity that was lost in the area that was destroyed.
>
> (GE.IP9)

[3]Local Land Services Act.

[4]The finest level of vegetation classification in NSW and describe assemblages of native plant species as vegetation communities NSW (DPE, 2022).

Some of those concerns could potentially be alleviated if restoration activities preceded impacts (i.e. advance offsets, Pope et al. (2021)). However, the current operational frameworks for the NSW BOS do not explicitly support this and, in practice, funding for restoration activities only becomes available once the development impacts have occurred.

3.2 | 'Can we actively restore?'

3.2.1 | Perspectives on the feasibility of ecological restoration

Interviewees often characterised ecological restoration as lacking in evidence: 'The science of ecological restoration, and particularly reconstruction [i.e. active restoration] is in its infancy. Significant ongoing research is required in all fields of soil, water, microbial, flora and fauna before we can confidently achieve a naturally occurring plant community type through this process' (AA.SR42). This contributed to uncertainty regarding restoration practices and their likely outcomes: ecological restoration projects were described as reproducing, at best, an 'approximation of what it used to be' (GE.IP27). The quality of this approximation was thought to depend on a range of factors described in Table 3 below. While some of those factors (i.e. timescale, ecosystem complexity, knowledge on ecosystems and proximity to remnant vegetation) appear to apply to ecological restoration in general, others (i.e. degradation, species propagation, climate impacts and climatic constraints) seem to focus on challenges related to active restoration activities, notably the reintroduction of plant species.

The factors outlined in Table 3 illustrate that restoration is a complex and highly context-dependent practice, conducted without full knowledge of the processes that underpin ecosystem functioning. This led one interviewee to characterise restoration as 'as much art as it is science', based on 'trial and error' and 'local knowledge [...] and experience in the industry' (GE.IP11).

3.2.2 | Implications for the NSW BOS

Characteristics of ecological restoration, including active restoration, were seen by some stakeholders as potentially conflicting with the functioning of the NSW BOS. First, active restoration can be a risky and uncertain activity, while the standard of NNL[5] requires guaranteed biodiversity outcomes. Second, active restoration requires a creative and flexible approach, which may not be fully aligned with what some interviewees see as the prescriptive nature of the method used to assess gains and develop management plans.

Uncertainties and predicted gains

Several interviewees explained that predicting gains was particularly difficult for active restoration activities:

> I just think that long term—ending up with what you expect—so with any planting, you put it in, you don't know what's going to survive, what won't [...]. So, it might actually change over time from what you expect it to be. That's not necessarily a bad thing [...]. It may change but, in the scheme [...] you may not reach a performance measure, but ecologically it doesn't matter because the timescales are different to our agenda.
>
> (AA.IP18)

This shows a perceived misalignment between the requirements of the NSW BOS and the reality of active restoration:

> The response of a site is uncertain, but the scheme [NSW BOS] and the purchase price, the assessor and the metrics they use are sort of stuck. There is a bit of a mismatch.
>
> (RP.IP32)

Consequently, several interviewees raised concerns over the use of active restoration under the NSW BOS, due to the inherent uncertainties of active restoration ('I think those sites that are that heavily degraded don't really represent true viable options for active restoration [...] in terms of a stewardship site [...] there is too much uncertainty to do that'—GE.IP8) and the risks of over-incentivising active restoration, leading to poor biodiversity outcomes ('The risk is like if you incentivise people too much [...] [they] over promise and under deliver'—GE.IP6).

To account for these uncertainties, the NSW BOS applies a risk weighting to gains achieved through active restoration. It also requires annual reporting and monitoring and allows for the management plan (and actions) to be updated every 5 years in accordance with the site conditions and progress towards benchmark. However, it is unknown whether these measures are considered sufficient by stakeholders. Additionally, while the management plan can be reviewed and modified, the amount of money the landholder receives to conduct restoration activities is pre-negotiated. Where restoration outcomes are poor or unsuccessful, there may not be finances available to support a change to the site management.

Flexibility and the BAM

Interviewees also perceived a misalignment between the prescriptive nature of the methods used to assess biodiversity gains and determine management activities on the one hand, and the

[5]At the time the research was undertaken, the NNL standard was not explicitly present in the legislation governing the NSW BOS. However, it is reflected in the NSW Biodiversity Assessment Method (BAM), which is a legal and regulatory document. Indeed, the BAM aims to 'set a standard that will result in no net loss of biodiversity values in NSW' (DPIE, 2020a, p. 46).

TABLE 3 Participants' perspectives on the barriers to successful restoration outcomes.

Factor	Description	Illustrative quote
Timescale	The restoration time of some ecosystems (e.g. rainforests or semi-arid landscapes) is too long to know whether expected outcomes will be achieved	'When you are trying to restore a forest, or rainforest, or whatever it is, the timescale is just so great that it is hard to know at the start whether you are going to achieve the outcome that you are hoping you are going to achieve' (AA.IP15)
Ecosystem complexity	Structurally complex ecosystems are thought to be more difficult to restore than simpler ones	'I did a saltmarsh restoration project years and years ago on the Parramatta River—and saltmarsh is an interesting one because it's really influenced by soils and tides, and if you get the inundation right, and you control weeds, it is quite easy, it just colonises bare landscape. So, it is [...] simple, but you are not talking about a structurally complex ecosystem, you are talking about a community that might have 10 or 20 species in it, and it's only got one structure to it, it is a low shrubland' (AA.IP15)
Knowledge on ecosystem type	Knowledge on re-establishing self-sustaining ecological functioning varies by ecosystem. While some have been the subject of restoration projects, others remain understudied	'For things like wet sclerophyll forest and subtropical coastal flood plain for all these particular freshwater wetlands, there'd be relatively very few long-term restoration projects that you could point your finger at and say that's what it looks like, at the end of the day. So, there's that level of uncertainty. Not saying it hasn't been done, but I'm saying that [...] you [are] only talking handful of particular veg[etation] types or communities where you can demonstrate that it has been done' (GE.IP8)
Connectivity	Ecological restoration was thought to be more likely to be effective when conducted in proximity to remnant vegetation	'I suppose the point would be do it [active restoration] wherever you could and as much as you could. But from an observational point, as somebody who has managed restoration projects, you always get the best outcomes when you do have remnants [...] So it would be about trying to build upon them and link them with other remnants and connectivity, but also really building on what is there, rather than just blank slate projects. They do work but I don't think they work as well' (GE.IP11)
Degradation	Restoration outcomes are more uncertain for degraded ecosystems. Several factors influencing restoration outcomes were identified, including the presence/absence of native ground cover, disturbed water or nutrient cycles, absence of seedbank	For example, native ground cover: 'I think the greatest gains and benefit would come from where you might have a derived native grassland, or a grassland derived from a forest or woodland community where the ground cover is intact but the overstory and midstory, the tree and shrub species layers, will be missing. So, they will be the ones that are easiest to restore in some ways because they won't have in theory as high a weed burden. If we have an exotic cleared paddock then obviously it has a high exotic ground cover. That's a really hard burden to overcome' (GE.IP34)
Species propagation	Many species cannot be propagated, hindering the re-creation of a diverse habitat through active restoration activities, more specifically sowing seeds	'There is a suite [of] species missing that we can't click save. Or they don't germinate from seed or [they] have other associations, or whatever, that are missing. So yes, restoration is fairly poor in recreating complex, rich, diverse habitat' (RP.IP31)
Climate change-related species shifts	Active restoration activities, more specifically planting, may not be adequate as the composition of species changes due to climate change	'Climate change is rapidly changing species composition in my region and destroying areas of active regeneration that were planted to offset the loss of mature forests and woodlands' (AA.SR46)
Climate change-related extreme events	Extreme climate events can destroy areas where active restoration (i.e. planting) has been conducted	
Climatic constraints	The use of active restoration, specifically planting, was perceived as unlikely to be successful in habitats with specific bioclimatic constraints	'I also think that there is probably some landscapes [...] [where] restoration probably isn't going to be viable ever. [...] I think they are the ones where natural regeneration and proper grazing might work in the longer term. But trying to [...] plant [...] trees into semi-arid landscapes, it's just, I think, a waste of time. One dry year and it will fall over' (GE.IP6)

creativity and flexibility required by active restoration on the other hand. While having a standardised method is necessary to develop a transparent, consistent and systematic assessment of potential gains, its 'prescriptive' aspect may not always provide room to experiment. This contradiction was described as follows by a survey respondent:

> Active regeneration is, in essence, an application of science that engenders a need for flexibility and circumstantial creativity. [...] The [NSW] BOS is very prescribed and often inflexible as it does not incentivise the use of creative solutions to remedy problems that are biologically meaningful.
>
> (AA.SR13)

4 | DISCUSSION

Building on the findings from our case study, we identify four thematic areas of concern regarding the use of active restoration in offsetting and provide a range of strategies that may alleviate them. Drawing on the findings of our case study, we highlight broader lessons for offset policy, especially where jurisdictions are shifting towards Net Gain. We do so by identifying four general conditions under which active restoration is likely to be considered appropriate and feasible by stakeholders involved in offsetting and restoration. We also identify two meta-themes, which are likely to have broader relevance for the design, implementation and management of offsetting elsewhere.

4.1 | 'Should' we and 'can' we actively restore?

4.1.1 | Encouraging the use of active restoration where and when it is 'fit-for-purpose'

Several stakeholders were of the view that active restoration should be used when passive restoration is unlikely to succeed (e.g. on lower-condition sites). They expressed concerns around the use of active restoration in cases where they did not deem it 'fit-for-purpose'. Those concerns are echoed in the literature, with Chazdon et al. (2021) and McDonald (2021) arguing that active restoration are sometimes adopted in cases where they may be unnecessary or even damaging.

Adopting a strategic approach to distinguishing between areas that would benefit from active restoration and those that are likely to benefit from passive restoration could encourage the 'fit-for-purpose' use of active restoration (e.g. interviewees identified ecological communities that were in low-condition and may benefit from a degree of active restoration). This approach would consider a range of ecological, practical and economic factors in space and time to complement—not replace—the need for site-by-site decisions on active restoration. It would provide general direction regarding the sites likely to require active restoration.

Additionally, ensuring that site management plans encourage flexibility regarding the mix of active restoration and passive restoration could minimise the likelihood of misapplication. For example, landholders could adopt passive restoration practices in the first instance and move to active restoration (notably planting) at a later stage. Such a staged approach has been adopted in some offset management plans under the NSW BOS.

4.1.2 | Avoiding the trading of quality for quantity

Several stakeholders, in agreement with the literature (e.g. Weissgerber et al. (2019)), stressed that real biodiversity gains can only be achieved using ecological restoration, as opposed to avoiding losses through the protection of good-condition habitat. However, other stakeholders voiced concerns that biodiversity values could be lost if threatened, good-condition and/or irreplaceable habitats were cleared and then offset with active restoration of lower-condition habitats, albeit of larger area (trading quality for quantity). Good-condition habitats provide biodiversity values in the present and due to uncertainties associated with restoration, there is a risk that future biodiversity values may not be realised (Maron et al., 2012). The NSW BOS applies mechanisms designed to reduce impacts to good-condition habitats[6]; however, the degree to which threatened, good-condition and/or irreplaceable habitats are impacted and then offset through active restoration in areas of lower condition remains to be established.[7]

Several strategies could be considered to create the conditions that would minimise this concern. First, implementing transparent registers of development impacts and their matching offset sites (i.e. Kujala et al., 2022) may help to address whether this is a real or perceived risk. Second, ensuring that offset schemes direct development to low-condition sites could minimise the risk of good-condition habitat being offset with active restoration on low-condition habitat. [Correction added on 5 July 2025 after first online publication: The word 'condition-condition' has been corrected to 'good-condition']. While one respondent observed that the NSW BOS encourages avoidance of good-condition or high conservation value habitats through 'putting a price tag on it' (P29), the extent to which this occurs has not been evaluated. Third, avoidance mechanisms for good-condition, threatened and/or irreplaceable habitats may need to be strengthened through establishing 'no-go zones' and increasing multipliers. Finally, for good-condition habitats, one interviewee recommended requiring offsets to be of a comparable habitat condition to the impact site, with gains primarily from 'avoided loss'. However, this would not maintain, let alone

[6]The first—which focuses specifically on threatened species and ecological communities—is to identify and avoid impacts if they are likely to significantly increase a threatened species, population or ecological communities at risk of extinction. Although there are lists of threatened species and ecological communities that must be assessed via these additional provisions, the decision to allow the impact is discretionary. The second mechanism applies multipliers as part of the credit obligations when high-condition habitats, threatened ecological communities or species are impacted. The multipliers are designed to encourage avoidance.

[7]While the BAM would technically allow for it in some circumstances, whether it would be economically feasible to generate enough credits through active restoration on low-condition habitat to offset such losses remains uncertain and may vary.

increase, the area of habitat. It would require either very large offset ratios to appropriately account for background counterfactual rates of loss or necessitate long offset accounting timeframes (Gibbons et al., 2018).

4.1.3 | Advancing the state of restoration science

Several interviewees voiced concern about the risk of biodiversity offsets, and more specifically active restoration, being used to support an overly optimistic narrative ('*false narrative*' (AA.SR16)) that habitat destruction can be fully offset through restoration. Similar concerns have been raised in the literature, notably around a 'techno-optimist' approach to restoration when 'modesty and precaution' may be required instead (Moreno-Mateos et al., 2015, p. 557). Deeper ethical questions are emerging here—as technology, and indeed techno-optimism, advances—that habitat substitution and virtualisation may become the new normal. While such questions are beyond the scope of this work, better documenting scientific uncertainty and associated likelihood of active restoration success is an immediate way forward.

Maron et al. (2012) recommended that active restoration be adopted under an offset scheme only if there is adequate scientific evidence. Development of a scientific and practical restoration evidence-base for different ecosystems and practices could form the basis for a risk management framework to assess restoration proposals. Ecosystems or practices for which knowledge is poor or outcomes are highly uncertain, could receive a higher risk weighting and/or a proportion of the expected credits could be withheld until active restoration outcomes are demonstrated. A higher risk weighting would discourage the use of active restoration where it is considered risky. Withholding credits would mean that a proportion of the payments made to landholders would only occur once the progress towards ecological benefits on habitats are realised. However, the acceptability of such a measure by landholders participating in offsetting remains to be explored.

4.1.4 | Accommodating innovative approaches

The relatively unpredictable nature of active restoration and the need to apply '*circumstantial creativity*' (AA.SR13) to its practice were highlighted by stakeholders. In contrast, the regulatory nature of the scheme requires the use of a transparent, consistent and systematic approach to assess potential gains and determine management activities. As a result, many of our interviewees saw active restoration as 'risky business' in the context of offsets. While there is literature documenting those risks (Curran et al., 2014; Maron et al., 2012), there is also literature documenting success, even with 'risky' innovative practices (Florentine et al., 2023). The challenge is to determine how and when to encourage the application of innovative active restoration practices while minimising risk and maintaining the need for transparent, systematic and fair assessment. The condition of accommodating innovative approaches would have to be balanced with rigorous review and evaluation. Such processes could emphasise the merits of 'intelligent tinkering' (sensu Murcia & Aronson, 2014) and experimentation (Kantorovich, 1993). While a regulatory scheme may not be the natural home of highly innovative practices, room could be found to facilitate restoration innovation, while reducing concerns around the riskiness of active restoration. This could be done by implementing an additional restoration levy paid by developers, which would be calculated based on the magnitude of the impact. The levy would be allocated towards a 'restoration innovation fund'. Experimentation failures would be kept separate from failure to obtain gains, yet successful innovations could be adopted in offsets.

Based on the four conditions identified above, our provisional answer to whether active restoration 'should' and 'can' be used in offsetting is as follows: active restoration is likely to be considered as appropriate ('should') and feasible ('can') if:

- it is used on sites where less 'intensive' practices (e.g. passive restoration) do not succeed;
- good-condition and irreplaceable habitats are adequately protected, and active restoration (along with passive restoration and avoided loss) is not being used to justify or enable the clearing of good-condition and irreplaceable habitats;
- it is likely to succeed within reasonable margins of uncertainty; and
- ample room is created for intelligent tinkering and experimentation (separately from generating gains) to help reduce scientific and operational uncertainties related to active restoration in the longer term.

To this we could add that appropriate strategies should be in place to minimise the risk of failure—that is an appropriate framework and structure to support realistic goal setting, resourcing, management, planning, monitoring, evaluation and enforcement of adaptive management. Even if the other conditions are all met—if none of these framework components are present—even active restoration applied in the best possible situation may well fail.

4.2 | Broader considerations

From our synthesis above, two meta-themes emerge, with generic significance and bearing on offsetting in NSW, in Australia and in jurisdictions elsewhere in the world.

4.2.1 | The mitigation hierarchy and its application

Our results indicate that support for the use of active restoration in the context of biodiversity offsets may partially depend on whether stakeholders are confident that threatened and/or good-condition habitat will not be cleared (and substituted by to-be-restored low-condition habitat). Making documented evidence of the application of the mitigation hierarchy publicly available, may provide further certainty to stakeholders (Arlidge et al., 2018). Avoidance is the first, and arguably the most important step of the hierarchy. However, in comparison to offsetting, it appears to have attracted little attention in the academic literature (e.g. Phalan et al., 2018). In practice, few offsets' schemes document and report on application of the mitigation hierarchy, for example by means of providing a register of those areas that have been avoided, impacted and offset (Kujala et al., 2022). Transparent reporting of avoidance will be essential for understanding the extent to which offsetting and, by extension, active restoration is appropriate. However, it is important to note that avoidance may happen in very early stages of the development decision-making process and may therefore be difficult to document. Additionally, offsets schemes often sit within broader regulatory frameworks, which include other mechanisms for the management of biodiversity or, on the other hand, regulations or policies that facilitate or encourage habitat loss. As such, any understanding of the implementation of the mitigation hierarchy should take account of the broader regulatory framework and other mechanisms.

4.2.2 | Tightening the rules versus market efficiency

The four necessary 'conditions' identified require devising additional rules and processes to create the circumstances under which active restoration is more likely to be acceptable and successful. Tension exists between the need for rules and processes to ensure active restoration is used appropriately and the market-based context underpinning offsets schemes. This tension has been discussed in the broader context of biodiversity offsets by Walker et al. (2009), who argue that there is a fundamental incompatibility between trading mechanisms, which require 'simple, measurable and interchangeable commodities' (p. 149), and biodiversity which is inherently complex, incommensurable and not interchangeable. For this contradiction to be minimised, these authors argue, strict trading rules are required for biodiversity to be protected. However, the authors also suggest that when tighter rules hinder trading, governments are likely to loosen them, to enable trading and ensure market stability. While this leads Walker et al. (2009) to consider biodiversity offsets as 'administratively improbable and technically unrealistic' (p. 149), Damiens et al. (2021) provide a different analysis. They argue that, initially, biodiversity offsets were integrated into 'reformist' agendas, which encouraged development at the expense of nature. More recently, 'transformative' agendas have reframed offsets as a tool to create 'sustainable economies' by tightening offset rules (e.g. enforcement of strict no-go zones) (Damiens et al., 2021, p. 170). As such, for Damiens et al. (2021), biodiversity offsets could be integrated into a more 'transformative' approach to sustainability. However, they point out that it would require the implementation of structural changes, notably with regard to governance. A similar view is adopted by Swinfield et al. (2024), who argue that a strict regulatory framework could support the uptake of high-integrity biodiversity offsets by private stakeholders, in order to meet regulatory requirements.

This discussion illustrates the tensions between, on the one hand, operating a shift in the way development occurs by implementing more restrictive processes and on the other hand, facilitating trading through relaxed rules that may be incompatible with the overall ecological objectives of offsetting.

5 | LIMITATIONS AND FUTURE RESEARCH

We have shown how a range of 'intermediate' stakeholders (i.e. government employees, accredited assessors, restoration practitioners) perceive the use of active restoration in the context of offsetting. While they represent an essential stakeholder group, the perspective of other stakeholders should also be considered, notably landholders. Landholders are the supplier of biodiversity offset sites. As such understanding their perspectives on and willingness to use active restoration is essential.

Our research explores stakeholder attitudes towards whether we 'should' and 'can' use active restoration in the context of offsets, but did not address the question of 'what' is restored. Ecosystems are dynamic and change through time, with changes becoming more extreme and more rapid as the Anthropocene unfolds. As a result, the question of whether restoration should focus on reverting to a historical reference state or foster novel ecosystems, and the implications of such considerations for offset schemes also constitute a necessary line of inquiry.

Another area for future research relates to the practical and governance barriers and enablers to the implementation of active restoration in various contexts. Indeed, while some practical aspects of the implementation of active restoration were discussed in so far as they influenced stakeholder attitudes towards whether active restoration 'can' be successful (i.e. Table 3 summarises the 'practical' constraints that may hinder active restoration), a broader exploration of the full suite of practical barriers and enablers would be needed (e.g. availability of seeds, presence of trained professionals). Additionally, a study of the governance dimension of active restoration in the context of offsets is also warranted. As mentioned above, appropriate resources need to be allocated in order to manage, plan, monitor, evaluate and enforce active restoration. The resourcing of offsets schemes may vary across jurisdictions and understanding how this may affect the uptake and success of active restoration is of importance. This is particularly relevant considering that jurisdictions around the world will likely be shifting their focus towards Net Gain outcomes, and away from NNL. With this shift, the avoided loss baseline becomes untenable and (active) restoration is likely to become a necessity.

AUTHOR CONTRIBUTIONS

Josh Dorrough, Stephanie Hernandez, Roel Plant and Laure-Elise Ruoso jointly designed the research; Stephanie Hernandez and Laure-Elise Ruoso collected and analysed the data; Laure-Elise Ruoso drafted the first version of the manuscript; all authors contributed to the further development of the manuscript, with Laure-Elise Ruoso

and Roel Plant leading the writing. Josh Dorrough acquired funding and administered the research.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

This study presents findings from 64 qualitative free-text responses and 35 semi-structured interviews. While we provide detailed information on the methods used to collect and analyse the data, the transcripts of the free-text responses and the semi-structured interviews have not been archived as our ethics approval stipulates that the raw data will only be accessible to the research team.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Data S1: Stakeholder categorisation.

Data S2: Thematic coding framework.

Data S3: Thematic categories.

Data S4: Interview guide.

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