SUPERB
Upscaling Forest Restoration

Deliverable 8.1
Annex 3

Upscaling Route Map – NRW Germany demonstration area

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DISCLAIMER

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Executive Summery

Since 2018, 133,000 ha of former spruce stands in North Rhine-Westphalia (NRW) have been destroyed due to the combined effects of drought, storm, and bark beetle infestations, resulting in severe consequences for the region's forests, forest owners, and residents. This widespread damage has led to significant ecological and economic challenges, including the disruption of critical ecosystem services. Urgent reforestation of these calamity areas is essential to restore ecosystem functions, mitigate soil erosion, and secure the long-term resilience of NRW's forests.

The overarching goal of the reforestation efforts implemented in the NRW demo region is to restore resilient forests that continue to provide vital ecosystem services such as timber, clean water, and recreational spaces, while addressing the challenges posed by climate change. The adopted restoration approach emphasizes the establishment of mixed-species forests to enhance resilience against climate change and future biotic and abiotic threats. The implemented reforestation approach aligns with the reforestation and silviculture concepts developed by NRW's Ministry of Agriculture and Consumer Protection and the State Forest Service. The demonstration sites established through the SUPERB project serve as practical models for forest owners and managers, supported by government funding schemes, thereby laying the foundation for scaling up reforestation efforts across the region.

This document, the "Upscaling Route Map" for the demonstration region North Rhine-Westphalia (NRW), provides a reflection and analysis of barriers and enablers to the reforestation of bark beetle calamity areas in NRW. Barriers are identified across political, economic, social, technical, and environmental dimensions, drawing on insights gained from the establishment of approx. 34 hectares of demonstration sites in collaboration with seven associate partners across various forest ownership types.

While not exhaustive, the report highlights key factors to consider when planning and scaling reforestation efforts of calamity areas in NRW. Among the key barriers identified are high restoration costs, a lack of certified seed sources, and conflicting approaches to reforestation from governmental nature conservation and forest management authorities. A key enabler is the ongoing establishment of a network of demonstration sites in NRW, which serve as practical examples for forest owners on how existing knowledge and funding schemes can be leveraged to reforest calamity areas with site-adapted species mixtures.

Keywords

Up-scaling, forest restoration, forest ecosystem services

1. Introduction

This document presents an analysis and reflection on potential barriers and enablers to the reforestation of bark beetle calamity areas in North Rhine-Westphalia (NRW) and as such forms a part of deliverable 8.1. It specifically draws on insights gained and lessons learned from the establishment of approximately 34 hectares of demonstration sites on bark beetle calamity areas, spanning various ownership structures. While the reflections presented are not exhaustive, they offer valuable contributions to the ongoing development of effective reforestation strategies for impacted regions throughout NRW. The document identifies key factors and conditions that should be considered when planning and scaling up reforestation efforts. This document aims to inform relevant stakeholder involved in or planning forest restoration initiatives following bark beetle infestations within NRW.

This report does not provide a detailed description of the regulations surrounding reforestation in NRW. For further information, please refer to the reforestation and the silviculture concept of NRW, published by the state's Ministry of Agriculture and Consumer Protection (MLV). The concepts were developed by the Forest State Service (LBWH) with input from other environmental agencies, associations of private and communal forest owners, and nature conservation organizations. As such, these concepts constitute the foundation of the SUPERB demonstration sites in NRW. For a broader context on the governance framework on forest restoration in Europe please refer to the Good Practice Model/ Guideline for the development of upscaling route-maps (Deliverable 8.1) as well as Fleckenstein & Sotirov (2024, Deliverable 5.1).

1.1 Background

The federal state of North Rhine-Westphalia (NRW) is the most populous state of Germany and contains the largest urban network in Germany, the Rhine-Ruhr metropolitan area. The region grew significantly since the mid-19th century due to industrialization and was characterized by heavy industry, especially coal and iron mining. The switch from charcoal to black coal as the main source of energy changed the demands on the forest. The need for pit timber increased. As a result, mainly coniferous stands consisting of Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) were established in NRW's forests, which used to be mainly deciduous with beech (*Fagus sylvatica*) and oak (*Quercus spp.*) as main tree species.

Forest ownership in NRW is fragmented. The majority of forests is privately owned (63%) by about 152,000 forest owners (MLV, 2024). The majority of owners owns a relatively small area. About 90% of forest owners own less than 5 ha of forest (SDW, n.d.). Municipal forests make up 21%, state forest 13% and federal forest approximately 3% (Wald und Holz NRW, n.d.). The fragmentation comes with challenges and opportunities especially in providing consultative and support services. Close collaboration between State Forest Services and forest owners is essential (Feil et al., 2018; MLV, 2023).

Forests in NRW are increasingly exposed to the consequences of a changing climate. A prolonged dry period from 2018 to 2020, characterized by high temperatures and a significant precipitation deficit, weakened many local forest ecosystems. Particularly the region's formerly extensive spruce monocultures were affected, while pure beech stands also suffered under these conditions. Drought stress compromised the natural defence mechanisms of spruce trees, rendering them more susceptible to secondary pest damage. As a result, the reduced physiological resistance of the spruce combined with their concentration in monocultures, facilitated rapid colonization by European spruce bark beetle (*Ips typographus*), leading to widespread infestations and mortality of spruce stands. As of late August/early September

2024, the estimated calamity area in NRW is approximately 133,000 ha (MLV, 2024), with more than half (around 53%) of this area still requiring reforestation.

Reforestation is mandated by law (specifically §11 BWaldG and §44 LFoG). However, there are no specific legal provisions regarding the structure of future forests. Guidance is provided through concepts developed by the State Forest Service of NRW in collaboration with key stakeholders in the fields of forestry and nature conservation. Additionally, the state offers funding to support reforestation efforts aimed at establishing resilient mixed forest stands. To further promote reforestation with climate-resilient mixed forests, demonstration areas are established, offering examples that may inform and guide forest owners and managers towards developing resilient, mixed-species forests.

Figure 1: Spruce dieback observed around the Lörmecke Tower in Warstein, NRW (approx. 580 m a.s.l.). At lower elevations, spruce populations have been nearly eradicated. While spruce stands at higher elevations have shown comparatively better resilience, they have still suffered considerable damage by bark beetle infestations as evidenced in the image. Photo: Dietmar Figura, 2024.

2. Restoration needs and barriers

2.1 Building a case for upscaling

Overarching Restoration Goal: *Reforestation of resilient forests that provide use, protective, and recreational functions.*

The forests in NRW provide critical ecosystem services, such as timber, clean water, biodiversity, and recreational spaces. Remarkably, NRW is characterized by a relatively low amount of forest per capita, with only about 528m² of forest for each resident that has to provide all essential ecosystem services (Wald und Holz NRW, n.d.). That is 62% less than the national average of 1400 m² (SDW, n.d.). This makes the forests in NRW not only a key resource but also a vital element for maintaining ecological values and human well-being.

The recent spruce dieback exacerbates the situation by reducing forested areas, thereby compromising the provision of essential ecosystem services. Moreover, the extensive damage to forests has created large areas of exposed land. Particularly on slopes soil erosion has become a growing concern. This erosion threatens the stability of the land, posing risks to

both infrastructure and human lives. Timely reforestation is imperative not only to restore the provision of ecosystem services but also to mitigate the risk of long-term degradation of forest ecosystems and risk to human life.

Figure 2: Calamity area along a slope (Großes Sonnenstück, approx. 580 m a.s.l.). The onset of soil erosion on the slope is clearly visible and occurs above a well-frequented hiking trail. While natural regeneration tries to colonize the slope, its progress is likely insufficient to effectively prevent further soil erosion without active restoration. Photo: Dietmar Figura, 2024.

Given the critical role of forests in NRW, the restoration efforts in the SUPERB demonstration region (demo region) NRW aim to restore forest ecosystems to ensure the sustainable provision of ecosystem services and enhance forest resilience against the adverse impacts of climate change. This goal is pursued through the restoration of bark beetle calamity areas by establishing mixed-species forests that offer greater resilience to climate change. This approach diversifies forests stands, helping to mitigate risks of future large-scale calamities, such as the extensive spruce dieback since 2018. The restoration measures also ensure that the forest continues to fulfil its use, protective, and recreational functions.

The climate-adapted restoration approach implemented in the demo region follows the reforestation concept of NRW, which was developed from the silviculture concept of NRW (MLV, 2023, 2024). Based on the site conditions (water and nutrient balance, growth period), the expected impact of climate change to current site conditions (Representative Concentration Pathway (RCP) 4.5/8.5), and the interest of the forest owners/managers as well as potential legal requirements, recommended species mixes (so-called forest development types or WET) were selected for the respective restoration sites. Each WET consists of at least four different site-adapted tree species either planted and/or where appropriate derived from natural regeneration.

The selected restoration approach follows the recommendations and guidelines of the state's Ministry of Agriculture and Consumer Protection (MLV) and the State Forest Service (LBWH). Additionally, the main government funding schemes for forest restoration after calamities resulting from extreme weather events ("Extremwetterfolgenförderung") supports the restoration of those demo sites fulfilling the respective funding requirements. As such the demonstration sites established within SUPERB constitute practical restoration examples for bark beetle calamity sites that would largely be supported under existing government funding schemes. They thus serve as concrete examples to help guide forest owners and managers in their own efforts to restore and manage their forest areas and provide a valuable foundation for the upscaling of urgently needed restoration of bark beetle calamity areas in NRW.

2.1.1 Defining the possible scope for upscaling

2.1.1.1 Geographic upscaling potential

With 18 million inhabitants, North Rhine-Westphalia is the most populous state in Germany. Due to the high population pressure and the diverse demands on the forest, it is particularly important to create a forest landscape that can provide all essential ecosystem services in the long term. According to the latest report on the forest condition in NRW there are 133,000 ha calamity area in NRW with the majority of it (approx. 53%) in need of restoration (MLV, 2024).

2.1.1.2 Upscaling beyond current restoration needs

According to the data of the most recent national forest inventory from 2022 about 13.3% or 126,343 ha of forest in NRW are pure conifer stands mainly located in higher elevations in the Eifel and the Sauerland. To increase their resilience and prevent future calamities a timely conversion into mixed-forest stands is a relevant measure to consider. The framework used for restoring calamity areas with the focus on soil mapping, climate modelling, and tree species mixtures can also be applied to the gradual conversion of older stands and thus constitutes an upscaling potential beyond the restoration of calamity areas.

2.1.1.3 Temporal upscaling need

Further treatment of restored forest stands is important in order to maintain a site-adapted mixed-species forest that can provide all essential ecosystem services. Therefore, the continuous management of the restored stands over time is necessary. In order to achieve the desired species mixtures, maintenance measures are applied in accordance with the silviculture concept of North Rhine-Westphalia, such as mixed growth regulation and thinning. Corresponding maintenance recommendations for each forest development type are provided in the concept.

2.2 Situational analysis

The following section outlines and discusses barriers encountered during the realization of the SUPERB demo sites in NRW, as well as those that may pose challenges to the further upscaling of reforestation efforts. These barriers are first presented in a PESTEL analysis (section 2.1.1), which includes an assessment of their urgency and importance. Following the PESTEL analysis, selected barriers are examined in greater detail, focusing particularly on those faced during the planning or implementation of the SUPERB demo sites. Section 2.2.2.6 will address a potential barrier for future upscaling that has not yet been encountered, given the early stages of the reforestation efforts but may be anticipated as forest management shifts towards more species-rich forests.

2.2.1 PESTEL analysis

Table 1 outlines potential barriers to further upscaling of restoration efforts that were encountered during the project planning and/or implementation or that may be expected in different contexts. The table does not constitute an exhaustive list of barriers. Additional barriers might be encountered in different contexts. Furthermore, barriers might not be applicable to all contexts. Section 2.2.2 outlines selected barriers with greater detail.

The list of barriers was so far largely established without direct input from local stakeholders involved in the project planning and implementation. Instead, the PESTEL analysis is based on the reflection of the planning and implementation process of the NRW demo region, though insight from conversations with some demo stakeholders are included as well. This report therefore constitutes a preliminary upscaling route map. It is planned to receive further feedback to the upscaling route map for the NRW demo during future stakeholder meetings.

Table 1: Overview of barriers encountered or anticipated in later stages of the restoration process or different contexts. For each barrier, a brief description is provided, along with its underlying causes and potential enablers. The urgency and importance of each barrier are also assessed. This overview is not exhaustive but provides a broad perspective on potential challenges. The list is not exhaustive and additional barriers may exist in different contexts while not all listed barriers may apply universally.

Dimension	Possible Barriers	Basis/ Documentation	Possible Enablers	Urgency	Importance
Political	**Conflicting restoration approaches of nature conservation and forest management**	• Implementation of demo area in Natura 2000 area	• Joint taskforce between ministries (nature conservation and forestry)	Moderate	High
Economic	**High costs of initiating restoration and long-term maintenance**	• Cost calculations of SUPERB demo sites • Conversation with colleagues	• Public funding schemes (Extremwetterfolgenförderung, partially PKW Richtlinie)	High	High
	Alignment of government funding with societal and ecological objectives as well as forest owners' needs	• Communication with colleagues (research, foresters, funding office) • Extremwetterfolgenförderung	• Guidance by funding department of state forest services (*support through regional forestry offices and district foresters; support website for forest owners*)	Moderate	High
Social	**Public resistance to restoration measures**	• Conversation with colleagues; • Waldzustandsbericht 2024 Barrier not experienced in SUPERB but could be relevant in different, particularly urban, contexts.	• Separate workshops and guided tours geared towards the general public • Informative signage about reforestation measures	Low	Moderate
	Resignation of forest owners	• Conversation with colleagues (research, foresters) Barrier not directly experienced in SUPERB but could be relevant in different contexts.	• Information material offering low-barrier possibilities for restoration (*silviculture concept, reforestation concept*); • Guidance from regional forestry offices and district foresters • Public funding schemes	Moderate	High

Technical	**Lack of experience in mixed-species forest management**	• Conversations with colleagues and project partners Possibly an emergent barrier: As sites grow older different interventions are required than in pure conifer stands, necessitating training for mixed-species forest management.	• Forest development types consultants in district forestry offices • Published resources (silviculture concept, reforestation concept) • Guidance by local forest managers • Website: Waldbauernlotse	Moderate	High
	Lacking market adaptation and industry collaboration	• Conversations with colleagues Barrier not experienced within SUPERB but a relevant topic with mixed-species forest restoration in the future.	• Birch project with Zentrum Holz	Moderate	High
	Adequate seed supply for climate-resilient reforestation	• Supply shortage during demo restoration • Conversation with colleagues (research, forester)	• Timely communication of reforestation plans to local nursery • Planning stage well ahead of implementation to allow for production of desired planting material • Registration and establishment of additional seed stands and plantations	High	High
	Communication with and retainment of qualified subcontractors	• Misunderstandings with contractors regarding adherence to outlined planting scheme in some demo sites. • Conversation with foresters responsible for demo sites	• Clear planning including graphics • Retention of contractors throughout the project	Moderate	Moderate

Environmental	**Suppressive growth of understory vegetation**	• Observation from demo sites.	• Funding for treatment of restoration sites (Extremwetter-folgenförderung)	High	Moderate
	Herbivory	• Game-forest-conflict; need for protection of restoration site in demo areas • Conversation with project partner	• Workshop on the game-forest-conflict with local hunters	High	High
	Concept of potentially natural vegetation (PNV): PNV is not always the site adapted species mixture when considering modelled climate change scenarios in nature conservation areas.	• Implementation of demo area in Natura 2000 area	• Digital tools such as WaldInfo.NRW • Silviculture concept NRW	High	High
	Climate change	• Climate science • Experience from large-scale calamity and observations of developments of forest vitality General barrier for most projects dealing with any ecosystem type.	• Scientifically informed adaptation to expected future site conditions as utilized by the silviculture concept of NRW	High	High
Legal	**Fragmentation of forest governance**	• Conversations with colleagues • Examples of laws, regulations and international agreements addressing or referring to forests in some way A general barrier for most projects dealing with forests		Low	Moderate

2.2.2 Reflections on barriers to reforestation encountered in the NRW demo region

The following section further reflects on selected barriers listed in table 1. Section 2.2.2.1 to 2.2.2.5 reflect on barriers that were encountered during the planning or implementation of the demonstration sites that form the demonstration region NRW within the SUPERB project. Section 2.2.2.6 reflects on a potential barrier for future upscaling that has not yet been encountered, given the early stages of the reforestation efforts. However, it is anticipated that this aspect will need increasing attention as reforestation scales up and forest management shift towards more species-rich forests.

2.2.2.1 Political dimension: Conflicting interpretations of policy schemes and approaches to reforestation

Barrier for: policy makers, forest owners, forest managers

Could be addressed by: policy makers

Conflicting focal points between nature conservation and proactive, climate-adapted forest management became evident during the planning phase of the project. In the following a brief summary of the issue, which highlighted the respective barrier:

> A municipal associate partner to the project intended to reforest calamity sites within its municipal forest, specifically in areas designated as Luzulo-Fagetum (habitat type 9110) under the Habitat Directive (Council Directive 92/43/EEC). In an effort to ensure transparency, the city proactively consulted with the regional nature conservation authority (HNB). A formal approval of the HNB was not required. The proposed plan represented an ecological improvement by transforming a former spruce monoculture into an oak-beech mixed forest, thus adhering to the directive's prohibition on deterioration. An analysis of site conditions and experience from prior restoration efforts indicated that beech, usually a dominant species in Luzulo-Fagetum areas, was not well-suited as dominant tree species to the identified and expected site conditions of the respective restoration site. Furthermore, past restoration attempts with beech on a similar site resulted in a 60% seedling loss rate, leading the municipal partner and the State Forest Service to refrain from investing in a project with such high risks. The HNB, on the other hand, did not accept a higher proportion of alternative tree species, regardless of them still being compliant with the provisions set out in the Habitat Directive and the state's guidelines on the 9110 habitat type. Despite extensive negotiations, no mutually agreeable solution was reached, and the site was not restored within the project.

It remains to be explored further whether the challenges stem from differing interests or divergent interpretations of policy guidelines. The latter could potentially be addressed through enhanced cross-departmental collaboration, while the former may present more complex challenges. In any case, the observed extent of the division between nature conservation and forest management as well as the lack of opportunity for compromise is not conducive to resolving the issue.

The apparent division between nature conservation and adaptive forest management presents considerable barriers for further upscaling of reforestation efforts towards more resilient mixed-species forests particularly in Natura 2000 and nature conservation areas. Current land-use planning and static close-to-nature-concepts like potentially natural vegetation (PNV), as often referred to by nature conservation authorities, do not fully consider the potential impacts of climate change on site conditions, which could make species that have been or are currently suitable less viable in the future. Therefore, the attempted

implementation of demonstration sites in a Natura 2000 area highlights the need for improved collaboration and communication among government agencies as well as possibly a revision of official land-use planning to address the evolving challenges from climate change in Natura 2000 areas.

Furthermore, different government agencies appear to apply different interpretations for policies and regulations. While the State Forest Service argued that the prohibition on the deterioration of areas as outlined in §2 Art. 6 of the Habitat Directive (Council Directive 92/43/EEC) was complied with in the outlined case, the HNB argued that public actors have to adhere to an improvement requirement of the respective habitat type. However, this requirement is not specifically mentioned or outlined in the Habitat Directive. Regardless of formal requirements, any reforestation measure that does not lead to a coniferous monoculture would constitute an improvement to past and current site conditions.

Moreover, in the second stakeholder workshop a representative from a local nature conservation authority seemed surprised about the strict stance of the HNB commenting that his office is not as stringent. This fragmentation of policy interpretation and application constitutes a significant barrier to the upscaling of restoration efforts that needs to be addressed as it reduces government credibility as well as planning security for forest owners, forest managers, and government agencies themselves.

Overall, the municipal partner's proactive approach appears to have led to unintended negative consequences. Rather than fostering a stronger relationship and building trust for future projects through transparent communication, the HNB's involvement resulted in conflict that stalled restoration efforts. If other forest owners encounter similar circumstances, they may be inclined to bypass nature conservation authorities altogether. In the worst-case scenario, this could lead to forest owners taking measures to ensure that their forests fall outside the scope of regulatory oversight to avoid engagement with the authorities, thereby undermining efforts to promote the establishment of more resilient mixed-species forests.

These circumstances highlight several issues that have to be considered in and addressed for the upscaling of reforestation efforts:

- Reduced planning security due to diverging interpretation of policy schemes by different government authorities → need for improved reliability and credibility of policy interpretation and application across government agencies
- Potentially, lack of trust in government authorities due to a seemingly inconsistent application and/or interpretation of nature conservation regulations by different government agencies → need for improved reliability and credibility of policy interpretation and application across government agencies
- High risk associated with reforestation using tree species not adapted to current and future site conditions → incorporation of considerations of climate change dynamics in official area planning of nature conservation areas and conservation targets of habitat types that are so far based on static close-to-nature-concepts

2.2.2.2 Political dimension: Alignment of government funding with societal, ecological, and forest owners' needs

Barrier for: policy makers, forest managers, forest owners

Could be addressed by: policy makers

In North Rhine-Westphalia, a comprehensive government funding scheme is in place to support the recovery from calamity-related damage and to facilitate necessary reforestation efforts. The "Extremwetterfolgenförderung" (EX-RL) supports different measures in the

context of calamity recovery such as forest road construction or the planning, establishment, and treatment (for up to five years) of mixed-species forests according to the silviculture concept of NRW with up to 12,700 €/ha depending on the selected species mixtures (MULNV, 2018, updated in 2023). The funding is paid out as a reimbursement while in November and December an early disbursement of funds for eligible activities can be applied for.

Double-funding is prohibited in the government funding scheme which makes it difficult to combine public funding with alternative funding sources. The restriction can act as a potential barrier for forest owners deterring their utilization of government funding, especially when the funding does not sufficiently meet their needs. Additionally, the EX-RL places certain limitations on forest management choices that can differ depending on the funding scheme that is utilized. For example, funding for initial plantings of at least 400 trees per ha offers greater flexibility but provides less financial support than the more comprehensive reforestation funding. Latter is based on selected forest development types including specific guidelines such as a minimum share of 50% deciduous tree species on the restoration site, which in practice excludes conifer-dominated forest development types from funding eligibility. These stricter conditions in the more comprehensive funding scheme do deter a share of forest owners from utilizing this type of funding.

Despite its complexity and several revisions over time, the funding scheme has generally been well utilized by forest owners. Species choices have become more restrictive (the minimum share of deciduous trees increased over time) while the above-mentioned more flexible funding scheme, the so-called reforestation premium ("Wiederbewaldungsprämie"), was added to the EX-RL. Moreover, the alignment of the government funding with the silviculture concept of NRW is complex because much flexibility is provided for the utilization of the silviculture concept. This space for modification of the silviculture concept makes it difficult to plan appropriate species-mixes if experience in mixed-species forest management is lacking and also complicates the verification process of eligible activities by the funding office, possibly delaying the disbursement of funds. The EX-RL has therefore been criticized by forest owners for its complexity often requiring greater resources in terms of time and expertise as well as extensive guidance and consultation for understanding the requirements, planning reforestation efforts and thus utilizing the funding.

So far, government funding has largely aligned with demand, with sufficient funds available to support forest owners who applied for funds. However, in 2025, the available funds under the RL-EX were fully depleted by April that year. This early exhaustion of funding is expected to delay further reforestation efforts in 2025 and has significantly reduced planning certainty for forest owners for the coming year.

Public funding schemes need to strike a fine balance between ecological and societal objectives and the practical needs of forest owners. While the EX-RL scheme in NRW has provided important support for calamity recovery, its complexity and imposed management restrictions can pose challenges for uptake. Flexibility is important to address diverse needs, but it is equally vital to set clear and verifiable obligations to ensure the intended goals of the funding scheme are met.

Therefore, several issues should be taken into consideration when supporting forest owners and developing funding schemes targeting reforestation:

- Lack of knowledge about the available funding schemes → provision of low-barrier consultative services through local foresters
- Lack of resources or willingness of forest owners to engage with the funding schemes available → provision of low-barrier consultative services through local foresters

- Mistrust towards funding schemes → ensuring reliability and credibility of funding schemes (predictability through stability to promote trust in the funding scheme e.g., no sudden significant changes to the scheme); ensuring a reliable and timely compensation of forest owners for implemented measures
- Lack of resources to pay reforestation costs in advance → need for flexible financing options and funding models
- Unwillingness to accept forest management restrictions associated with the funding schemes → need for sufficient flexibility for forest owners while clearly communicating and maintaining the goals of reforestation
- Lack of acceptance of funding scheme by local foresters → need to purposely engage with local foresters (training and feedback)

2.2.2.3 Social dimension: Willingness and capacity of forest owners to reforest their lands

Barrier for: policy makers, forest managers, forest owners

Could be addressed by: policy makers, forest managers, forest owners

The scale of the bark beetle calamity led to a drastic decrease in wood prices as the market was flooded with salvaged timber. In consequence, forest owners struggled to generate any profit from their sales, which still limits their capacity to reforest calamity areas. Historically, spruce used to be a reliable choice for forest owners in NRW, offering predictable revenue within a relatively short timeframe. The management of spruce monocultures is well-understood and straightforward, which made it an attractive investment for many forest owners. The risks associated with spruce monocultures only became apparent upon the extensive calamity following the drought period from 2018 to 2020. The combination of the calamity's scale, financial losses, and persisting uncertainty about the future led to a sense of resignation among many forest owners, reducing their willingness to engage in active reforestation efforts.

Reforestation of bark beetle calamity areas is associated with certain risks, particularly as they provide breeding grounds for pests such as the large pine weevil (*Hylobius abietis*) (MLV, 2023; Wald und Holz NRW, 2021). The development time from egg to fully developed beetle takes 1 to 2 years, and a resilient beetle lives for 2 to 3 years. To mitigate the risk of infestation, it is recommended to wait 3 to 4 years before replanting, provided there are no nearby breeding sites, such as dead conifer trees or fresh stumps (Wald und Holz NRW, 2021). This is a particularly relevant measure when replanting with conifer-dominated mixtures, which are often favoured by forest owners who focus on generating profits from their land. Additionally, a certain fallow period allows for the regeneration of soil tilth. During this time, however, extensive groundcover frequently emerges, which complicates site preparation for future plantings and increases the costs and need for additional treatments to ensure successful reforestation.

Given the risks, uncertainties, time, and costs associated with reforestation in general and climate-adapted reforestation in particular, forest owners in some regions are increasingly turning to alternative land uses, such as Christmas tree plantations, in search of more secure and timely sources of revenue.

The observations may be attributed to various factors that highlight several potential issues for the upscaling of reforestation efforts:

- High costs of restoration meet limited funds of forest owners → need for targeted funding

- Unfamiliarity with mixed-species forest management of forest owners → need for education through practical examples
- Potentially high opportunity costs associated with reforestation investments → need for attractive funding support to mitigate opportunity costs
- Feeling of resignation of forest owners, reducing their willingness to invest time and money into their forest → need for accessible consultation and reforestation options

Figure 3: View across a mechanically planted Christmas tree plantation at the Hellefelder Höhe (approx. 350 m a.s.l.). These plantations constitute attractive investment options, offering substantial economic potential due to their relatively quick returns and income stability. Photo: Dietmar Figura, 2025.

2.2.2.4 Technical dimension: Seed supply for climate-resilient reforestation

Barrier for: forest owners, forest managers, nurseries

Could be addressed by: policy makers, forest owners, forest managers

During the implementation of the demonstration sites, compromises were necessary regarding the desired provenances, particularly for sessile oak (*Quercus petrea*), due to supply limitations. Oak-dominated mixtures constitute half of the SUPERB demonstration sites in NRW, primarily because of oak's drought tolerance, its high wood value as well as the funding opportunities provided by the project and existing funding schemes. Besides their limited seed storage capabilities of acorns, oak species, being mast-fruiting species, have had several years without significant mast production, which reduced the seed supply nurseries could use to cultivate seedlings for reforestation.

To mitigate this barrier, new certified seed sources (seed stands and plantations) must be designated and established from which high-quality seedlings can be cultivated and marketed by nurseries. Moreover, nurseries require sufficient time to produce seedlings for reforestation. Therefore, it is essential that planning of reforestation efforts is communicated well in advance to nurseries to better align their product portfolio with the anticipated demand. The combination of limited seed storage capabilities, challenges in sourcing ideal provenances, and the growing time required by nurseries to produce quality seedlings suggests that the supply of certain tree species may face increasing difficulties in the future especially when upscaling reforestation.

The following issues can be discerned from this barrier:

- Lack of certified seed stands and plantations → certification of additional seed stands and establishment of plantations with adequate provenances
- Plannability of product stock for nurseries → communication of reforestation plans well-before planting phase

2.2.2.5 Environmental dimension: Flora and fauna as inhibitors to climate-adapted reforestation

Barrier for: forest owners, forest managers

Could be addressed by: hunters, forest owners, forest managers

As mentioned in section 2.2.2.3 reforestation of bark beetle calamity areas might require an extended period without intervention to mitigate the risk of pest damages, particularly from the great pine weevil. This fallow period allows for the development of natural regeneration and suppressive undergrowth which can significantly impede planting efforts by necessitating intensive site preparation. After planting, suppressive undergrowth continues to pose challenges. Extensive undergrowth, such as bracken fern and blackberry, required intensive management on all demo sites to support plantings. While undergrowth can be beneficial for certain tree species, it poses a threat to the survival of others, highlighting the complexity of managing mixed-species forests, where each species requires tailored treatment strategies.

In addition to suppressive undergrowth, many demo sites are subject to strong herbivory pressures, which is one of the reasons that all demo sites are fenced or protected with growth shelters. However, neither growth shelters nor fences are viable options for many forest owners due to the high costs associated with installation, maintenance, and removal. Consequently, effective game management is crucial in many regions to protect plantings and increase the chances of successful reforestation.

The environmental dimension highlights particularly the following issues:

- Unbalanced ungulate populations → need for close collaboration with local hunters
- Suppressive undergrowth → development of strategies to better manage or counteract suppressive undergrowth e.g., through purposely sown “competing” vegetation that is grazed, thus managed, by ungulates (e.g., project: ReForm-RegioWald)

2.2.2.6 Potential barrier to upscaling: The wood supply chain and reforestation

Barrier for: policy makers, forest owners, forest managers, nurseries (due to plannability of product stock)

Could be addressed by: policy makers, forest owners, forest managers, wood industry (saw mills and subsequent producers)

A potential barrier to scaling up reforestation efforts particularly those focusing on the establishment of mixed-species forests as implemented in the NRW demonstration, is the lack of integration between the wood supply chain and reforestation initiatives. While this issue was not directly encountered yet, it could become relevant for the upscaling of climate-adapted reforestation efforts.

As reforestation efforts are scaled up, the supply of conifers might be reduced in favour of deciduous trees, which have longer rotations and different wood qualities. While conifers will still constitute a significant portion of the supply to the wood industry, it is essential to consider the commercial viability of tree species that are not yet widely utilized or recognized by the industry. A disconnect between forest management and market demand can create

challenges for forest owners, who may be reluctant to invest in reforestation without a clear economic return. It will therefore be crucial to strengthen collaboration between the forestry sector and industry stakeholders to ensure that species used in reforestation can be integrated into the wood supply chain and gain market acceptance. Without such alignment, the full potential of reforestation projects may be limited, particularly for less commercially recognized species.

3. Addressing the barriers to upscaling

This section presents suggestions for the mitigation of certain barriers encountered in the demonstration region NRW and/or that can affect restoration initiatives in other contexts. It is acknowledged that the project implementation in the demonstration region NRW may not have comprehensively identified all barriers or possessed the full range of expertise required to address them. Additional tools and resources that can inform forest restoration efforts and the mitigation of barriers are available through the SUPERB Gateway.

3.1 Stakeholder engagement

3.1.1 Description of the stakeholder engagement in the NRW demo

During the stakeholder mapping process 175 stakeholders were identified in the demonstration region NRW. These include the following stakeholder groups: landowners and forest managers participating in the demo area, other landowners and forest managers in NRW, hunters, policymakers and regulating actors, nature conservation organisations, tree nurseries, forest visitors, financing actors and churches. The NRW demo region of SUPERB comprises of a network of demonstration areas, established in close collaboration with local landowners and forest managers, which showcase best practices for reforestation of bark beetle calamity areas. This engagement has been expanded to other landowners, forest managers, and the broader community through workshops, excursions, and discussions on the implemented forest restoration approach.

The demo's engagement strategy includes tailored activities for different stakeholder groups. During the demo implementation process forest managers were engaged in the co-creation of site-specific restoration plans, ensuring the integration of considerations on climate change and appropriate species selection. Landowners actively participated in workshops and excursions, where they were encouraged to share their restoration goals and receive guidance on establishing resilient mixed-species forest stands.

Other landowners and forest managers in NRW were also kept informed through excursions and workshops, offering training on climate-resilient mixed forest establishment or other pressing topics such as herbivory or Natura2000 regulations and reforestation. Collaboration with hunters and public agencies was focused on balancing forest restoration goals with wildlife management and nature conservation regulation, while tree nurseries support the demo by providing suitable planting materials. Forest visitors were educated about the restoration process to foster a sense of engagement during workshops and guided tours. All engagement strategies for the respective stakeholders are ongoing activities throughout the demo planning and implementation process. It is recommended and intended to proceed with stakeholder engagement activities beyond the project lifetime.

3.1.2 Stakeholder engagement for upscaling of reforestation efforts

As outlined in section 1.1, forest ownership in NRW is fragmented, with the majority of forests being owned privately or by municipal actors. Forest managers, along with forest owners,

including churches and municipalities, are therefore key stakeholders in the upscaling of reforestation efforts, as they own or manage the land that needs to be reforested. Additionally, to enable the upscaling, it is important to facilitate collaboration with supporting stakeholders such as nurseries, hunters, policymakers, financing actors, nature conservation organisations, and wood industry representatives. Ultimately, the success of reforestation efforts depends on the ability of these diverse stakeholders to work together towards shared objectives.

Scaling up reforestation efforts is complex due to the diverse barriers faced by stakeholders, many of which can only be addressed through collaboration with other parties. During the demonstration project, it became evident that effective communication is essential for the successful implementation of demo sites. As such, communication plays a central role in the broader upscaling of reforestation efforts. It is crucial to approach stakeholder engagement as a continuous process that creates accessible platforms for achieving long-term success and scalability of reforestation efforts toward mixed-species forests. This engagement should extend beyond the implementation of reforestation efforts.

In terms of stakeholder engagement beyond restoration implementation, it is relevant to strengthen the collaboration between forestry management and the wood processing industries. These industries play a key role in transforming the raw materials produced from forest restoration activities into marketable products, and their involvement ensures the economic viability of mixed-species forest management. Small forest owners, however, might face challenges in directly engaging with these industries due to factors such as limited resources, lack of infrastructure, or logistical barriers. To facilitate greater integration and enhance the commercial value of underutilized tree species, it is therefore essential for government agencies, financing actors, and forest owner associations to take a leading role in developing targeted initiatives that focus on researching and creating markets for tree species that have not traditionally been in demand, thereby unlocking new economic opportunities for forest restoration projects. By supporting the development of such initiatives, these stakeholders can help bridge the gap between small forest owners and wood industry, making the restoration of mixed-species forests more economically attractive. This could, in turn, help to offset the opportunity costs currently associated with reforestation efforts aimed at establishing climate-adapted mixed-species stands.

3.1.3 Supporting forest managers and forest owners in reforestation efforts

To support forest owners in implementing reforestation actions on their lands it is important to continuously monitor, improve and potentially adjust the alignment between public funding, societal and ecological objectives as well as forest owners' needs in regards to reforestation efforts. While forest owners are key stakeholders targeted by public funding, local foresters also play a pivotal role in advocating for existing and future funding schemes. Given their direct relationship with forest owners whose lands they manage, foresters serve as crucial multipliers in promoting funding initiatives. Engaging with both foresters and forest owners to gather feedback on their perspective and needs in respect to funding for reforestation could be a way to further develop existing funding mechanisms.

The integration of flexibility to funding schemes should not make them unnecessarily complex in their utilization. The addition of the more flexible reforestation premium (Wiederbewaldungsprämie) to the "Extremwetterfolgenförderung" is for instance a funding possibility that has been received more positively by forest owners. This could be due to the lack of strong restrictions on their forest management choices yet could also reflect its reduced complexity, easing its utilization.

The demonstrative function of the demonstration sites proved to be highly influential throughout the project. During site excursions forest owners were educated on the implementation of these areas and how existing funding schemes were utilized in the efforts. The exposure to practical examples enables forest owners to implement similar approaches in their own forests. For instance, following an excursion to the demo site of the FBG Calle with members of the association, many participating forest owners were inspired to reforest their forest with a similar approach like the demo site presented during the excursion. Over the course of the project approximately 142.80 ha have been reforested by members of the FBG following the silviculture concept of NRW, indicating that a lack of exposure to viable examples, rather than issues related to regulatory flexibility or resignation, was a key barrier to overcome in this case.

The role of the established demo sites as enablers should not to be underestimated. Forest owners and managers should not be required to travel extensively to see practical reforestation examples. Consequently, the State Forestry Service of NRW works on developing a comprehensive network of demonstration areas across the region. In the future, a majority of the regional forestry office will maintain two to three demo sites to ensure a broad access to practical examples of climate-adapted mixed-species reforestation for interested stakeholders. The demonstrative function of demo sites extends beyond the duration of most projects. Therefore, it is recommended to maintain demo sites as ongoing excursion spots to support the continued upscaling of reforestation efforts.

3.2 Governance and legal considerations

The successful upscaling of reforestation efforts hinges on effective governance and clear legal frameworks. A key challenge for reforestation efforts is the divergence in policy interpretation and application between nature conservation and forest management authorities. Fragmented interpretations create uncertainty for forest owners and hinder a smooth project implementation. To address this, it is essential to foster better communication and coordination between the respective government agencies, ensuring that policies are applied consistently and reflect a shared understanding of objectives.

During the demo planning process for the municipal demonstration site outlined in section 2.2.2.1, an attempt was made to discuss the issue through a stakeholder meeting, which included representatives from the affected stakeholder groups. Unfortunately, this dialogue did not lead to a resolution of the conflict. It may be advisable to involve a neutral mediator in future discussions of a similar nature. Ideally, however, any divergent interpretations to nature conservation regulations should be addressed at a higher administrative level to reduce ambiguities and ensure greater clarity for future restoration efforts, particularly in Natura 2000 areas.

An effective way to address discrepancies between nature conservation and forest management authorities, as has been suggested within the project, could be to formalize collaboration on the reforestation issue through a joint working group comprising representatives of the Ministry of Agriculture and Consumer Protection (forestry) and the Ministry of Environment, Nature Conservation, and Transport (nature conservation). The joint working group should meet regularly to discuss and align policy interpretations, ensuring that all relevant agencies are working toward a unified set of objectives. Building platforms for open dialogue and dissolving existing barriers between ministries could help achieve more cohesive and effective governance in reforestation efforts.

The collaboration between nature conservation and forest management authorities becomes even more important in light of the EU Nature Restoration Law (NRL), for which national

restoration plans have to be drafted until September 2026. It remains to be seen how the NRL will impact forest management in NRW. In any case, the issue concerning climate change-induced changes to site conditions remains for Natura 2000 areas, as the NRL mainly refers to Council Directive 92/43/EEC, which does not address climate change impacts on designated Natura 2000 sites. Thus, proactive climate change adaptation, in particular of Natura 2000 habitat types, seems to not be sufficiently considered within the NRL.

Furthermore, Art. 4.14b and Art. 12.4b of the NRL state that the non-fulfilment of obligations for habitat types outside of Natura 2000 sites (Art. 4) and forest ecosystems (Art. 12) are justified in case of “unavoidable habitat transformations which are directly caused by climate change” (European Union, 2024). In the worst case, the exemptions can leave the deterioration of these habitats to go unaddressed, which could ultimately undermine efforts in protecting biodiversity and inhibit the upscaling of restoration efforts, as set out in the SUPERB demo region NRW. The most recent SUPERB policy brief (Chakraborty et al., 2024) also commented on this issue.

3.3 Financing

Financing will remain a key challenge for upscaling of reforestation projects, given the high initial costs and the delayed returns from the reforested areas. Additionally, mixed-species forest management requires a different and more intensive treatment beyond the implementation of sites. Therefore, the availability of targeted funding schemes, particularly for small forest owners, is essential. Local forest managers play a vital role in this context as they maintain direct contact to forest owners and are familiar with their needs and preferences. They can provide valuable guidance on available funding opportunities and offer direct support in the planning and application processes. These low-barrier consultative and supportive services by the State Forest Services, including support through local foresters and information websites such as Waldbauernlotse, are crucial elements in the scaling of reforestation efforts. Additionally, as mentioned in several sections so far, practical examples demonstrating how funding schemes can be utilized for reforestation initiatives, even on small areas, are key to helping forest owners understand their options.

An additional enabler for forest owners who may not wish to utilize public funding schemes would be to diversify funding sources for reforestation, including private and philanthropic funding possibilities. In the demo implementation process alternative funding sources besides government funding were not utilized and cannot easily be utilized due to the prohibition of double-funding. However, SUPERB provides guidance on sustainable financing for restoration projects in its Restoration Gateway platform and through the work completed by WP4.

3.4 Technical

Management of mixed species forest stands is a new task for many forest owners that used to own and/or manage coniferous monocultures. Thus, targeted education and training programmes for forest owners and forestry professionals, including local foresters, are needed to support the establishment of expertise in mixed-species silviculture. Programmes should focus on silvicultural practices tailored to mixed-species stands. Practical training, such as on-site workshops at demonstration areas, can provide hands-on experience to build the necessary skills to alter familiar forest management regimes. The newly gained knowledge can increase the support for and trust in reforestation of mixed-species forests. Training in silvicultural treatment of mixed-species stands is planned to be conducted on demonstration areas established through SUPERB as well as the ongoing efforts by the State Forest Service.

Alongside practical training of forest owners and managers, continued investment in research on species suitability under climate change scenarios is needed. Pilot projects, such as SUPERB, can serve as living laboratories to test and refine new restoration approaches, such as planting of species mixtures adapted to current and future site conditions. In this regard, monitoring of restoration sites is a relevant step to document the success of the restoration action and enable long-term learning. However, significant barriers to long-term monitoring are sufficient funding and expertise. Therefore, monitoring activities cannot be demanded to be completed by forest owners. The most feasible way to monitor restoration sites might be to include their monitoring in the federal or national forest inventory efforts.

In any case, the knowledge gained from the implementation and monitoring of restoration sites should inform policy-making, helping to better align strategies and funding mechanisms with the goal of fostering resilient mixed-species forests. The insights can also guide tree nurseries by identifying species best suited to changing climate conditions, ensuring a reliable supply of appropriate seedlings for reforestation. Additionally, the findings can support the robust development of education and training programmes, enhancing their credibility and effectiveness.

Furthermore, many sites are impacted by unbalanced game populations, which hinder regeneration and reforestation without protective measures such as fences or growth shelters. For most demo areas, a significant portion of costs for reforestation is attributed to protection measures. Between 22% to 52% of reforestation costs in the demo areas were allocated to site protection measures. Therefore, a cost-effective strategy for restoration would be to foster close collaboration with local hunters so that game populations are managed in a way that supports natural regeneration and growth of plantings. Unfortunately, many forest owners are not able to directly influence the hunting regime in their areas. Thus, key stakeholders to engage in the scaling of reforestation efforts are national and local hunting associations.

4. Recommendations

To briefly summarize this report, the implementation of the SUPERB demo sites in NRW underscored the need for clear and transparent communication and collaboration with many stakeholder groups throughout the project. Given the diverse barriers and interests of the parties involved in reforestation, successful upscaling of forest restoration efforts requires the establishment of mutual trust amongst stakeholders, as well as confidence in the underlying concepts and funding mechanisms that support these initiatives.

Providing concrete recommendations for reforestation projects and their upscaling efforts is difficult due to the unique social and ecological circumstances of each forest area in need of reforestation. However, there are certain general recommendations that could benefit a majority of reforestation efforts:

Recommendation 1: Establishment of an inter-agency workgroup on forest restoration in nature conservation and Natura 2000 areas.

- **Actors**: Government agencies in nature conversation and forest management
- **Feasibility**: Moderate
- **Comment**: The feasibility depends on agencies willingness to collaborate. The issue is of high importance as governance ambiguity can create uncertainty for key stakeholders in the upscaling process, thus hindering their participation in reforestation efforts.

Recommendation 2: Consideration of climate change impacts in conservation objectives of Natura 2000 habitat types and the official area-planning of Natura 2000 sites.

- **Actors**: Government agencies in nature conservation and forest management
- **Feasibility**: Moderate
- **Comment**: See comment of recommendation 1. This topic could for example be dealt with by an inter-agency workgroup.

Recommendation 3: Designation of new seed stands and establishment of new seed plantations of appropriate origins and species.

- **Actors**: Government agencies, nurseries
- **Feasibility**: High
- **Comment**: This is a necessary measure without which significant upscaling is likely impossible. Seed stands provide less high-quality material but are quicker in their designation process. Plantations require more time for their establishment but provide certified high-quality seed material with a better vitality.

Recommendation 4: Maintenance and continuous development of supportive, consultative, and educational services provided by government agencies to forest owners and forest managers.

- **Actors**: Forest State Service and other government agencies
- **Feasibility**: High
- **Comment**: Many important services are already in place. They should be developed and updated continuously in line with the latest knowledge. Funding schemes must be reliable in both their structure and disbursement.

Recommendation 5: Continuous research on species suitability under climate change scenarios and development of mixed-species forest stands established in demo areas.

- **Actors**: Policymakers, researchers, universities
- **Feasibility**: Moderate (highly dependent on funding possibilities)

Recommendation 6: Initiation of collaborative projects between the forestry sector and the wood industry.

- **Actors**: Forest owner associations, government agencies, wood industry representatives
- **Feasibility**: High (exemplary project already established)
- **Comment**: An exemplary project is a collaboration between the State Forest Services with the Zentrum HOLZ as well as several universities exploring the potential uses of birch wood (Zentrum HOLZ, n.d.). While birch is not yet widely utilized commercially, the project demonstrated its advantages over laminated spruce timber e.g., its higher density. This allows for the use of slimmer structural beams and walls without compromising strength, resulting in both a reduction in volume and material savings in construction. As a result, the project opens up new market opportunities for this pioneer tree species, providing forest owners with additional options for managing their stands.

Recommendation 7: Inclusion of silvicultural targets in lease agreements with hunters.

- **Actors**: Policy makers, forest owners, forest managers, hunters
- **Feasibility**: High
- **Comment**: Rather than defining hunting targets in lease agreements as hunting quotas they should include silvicultural targets such as realized natural regeneration without a fence until a specified point in time in the future. This can be monitored

through reports on browsing damage and a quantification of natural regeneration found in a fenced sample area compared to a sample area that is not fenced. If targets are not met sanctions should be formulated and enforced.

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