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Ecological and social barriers to nature restoration within a land degradation neutrality framework in Nordre Follo, Norway

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Preface

This thesis represents the final product of my MSc in natural resource management at the Norwegian University of Life Science (NMBU). I have learned an incredible amount along the way, and I never thought that writing a master's thesis would be so challenging. But here I am, finally, with a complete thesis of my own research project.

First and foremost, I would like to thank my main supervisor, Erik Trond Aschehoug, for all the time and advice, and always knowing when I needed support and when I needed a push. I would also like to thank my co-supervisor, Knut Bjørn Stokke, for guidance and insightful conversations on the social aspects of my thesis. Thanks to Siri Lie Olsen for assisting me with deciding NNT species, as well as Maria Rørvik Haver for all the help in the field. Furthermore, I thank Nordre Follo municipality for their positive attitude toward my thesis and for answering questions throughout the process.

Finally, many thanks go to my friends and family. To Tora and Jarle, for sitting with me day in and day out in the study hall. To Signe and Linnea, for listening to my frustrations and enthusiasm underway. To my mother and sister, for academic guidance and reading through my thesis. And last but not least, my boyfriend, Ottar, who always believes in me.

Ås, May 15th 2025

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Abstract

Anthropogenic land-use change is a major driver of ecosystem degradation and global biodiversity loss. Simultaneously, humans depend on fully functioning ecosystems for survival and well-being. As a result, land degradation neutrality (LDN) has emerged as a policy framework to promote more sustainable land-use practices. LDN requires ecological compensation in the form of restoration or financial contribution to restoration initiatives when nature is degraded in development projects. The first ecological restoration project used as compensation under the LDN framework in Norway is being implemented in Nordre Follo municipality, linked to the construction of the Skotbu elevated water reservoir. This thesis evaluates the Skotbu project as a case study to explore how ecological restoration decisions are made within a Norwegian LDN context.

A mixed methods approach was applied to assess both ecological and social dimensions of the site selection in the Skotbu project. Three proposed restoration sites (a deciduous forest, a pine forest, and a semi-natural grassland) were evaluated for ecological and social barriers, as well as potential trade-offs. Vegetation analyses revealed ecological barriers including invasive species, grazing maintenance, and informal road networks. Stakeholder interviews identified limited public participation as a significant social barrier. Although stakeholders expressed strong ambitions for biodiversity conservation, the final site selection was primarily driven by socio-economic interests of feasibility, costs, and access to private land. This trade-off underscores the need for increased support from government agencies in LDN restoration projects administered at the municipal level. Municipalities are the primary land-use authority in Norway and have a key role in restoration efforts required to safeguard biodiversity and reach the global goal of restoring 30% of degraded land by 2030. As Norway's first LDN restoration case, the Skotbu project provides important insights into how the LDN framework should be developed and implemented in Norway in the future.

Sammendrag

Menneskeskapte arealendringer er en hovedårsak til ødeleggelse av økosystemer og globalt tap av naturmangfold. Samtidig er mennesker avhengig av fult fungerende økosystemer for overlevelse og velstand. Som svar på dette, har arealnøytralitet dukket opp som et politisk rammeverk for å fremme mer bærekraftige arealbrukspraksiser. Arealnøytralitet krever økologisk kompensasjon i form av naturrestaurering eller økonomiske bidrag til restaureringsinitiativer når natur ødelegges som følge av utbyggingsprosjekter. Utbyggingen av Skotbu høydebasseng i Nordre Follo kommune representerer Norges første naturrestaurering etter arealnøytralitetsprinsippet, og er allerede i gang. Denne masteravhandlingen tar for seg dette prosjektet som en case-studie for å øke forståelsen for valg som blir tatt under naturrestaureringsprosessen i et norsk rammeverk for arealnøytralitet.

Blandede metoder ble brukt for å undersøke både økologiske og sosiale dimensjoner i valget av restaureringsområde i Skotbu-prosjektet. Tre allerede foreslåtte restaureringsområder (en edelløvsskog, en furuskog og en naturbeitemark) ble evaluert for økologiske og sosiale barrierer, samt avveiinger mellom disse. Vegetasjonsanalyser viste til økologiske barrierer i form av fremmedarter, beiteskjøtsel og små veinettverk. Intervjuer med interessenter i saken avdekket begrenset medvirkning som en avgjørende sosial barriere. Til tross for at interessentene hadde sterke ambisjoner om bevaring av naturmangfold, ble avgjørelsen av restaureringsområde hovedsakelig bestemt av de sosio-økonomiske faktorene gjennomførbarhet, økonomiske kostnader og tilgang til private områder. Denne avveiningen understreker behovet for økt støtte fra statlige nivå i kommune-drevne arealnøytralitets-prosjekter. Kommunene er den primære arealbruksmyndigheten i Norge, og har derfor en nøkkelrolle i restaureringsarbeidet som kreves for å ta vare på naturmangfoldet og for å nå det globale målet om 30% restaurering av forringet natur innen 2030. Som Norges første restaureringsprosjekt under arealnøytralitetsprinsippet, gir Skotbu-prosjektet viktige innsikter for hvordan arealnøytralitet bør utvikles og iverksettes i Norge framover.

Contents

1 Introduction

1.1 Background and research questions

Human activities, particularly anthropogenic land-use change, have significantly altered 75% of the Earth's land surface (IPBES, 2019). This has led to widespread ecosystem degradation through habitat loss and fragmentation, resulting in a rapid decline of biodiversity within species, communities, and ecosystems worldwide (IPBES, 2019). At the same time, humans depend on fully functioning ecosystems to provide the food, shelter, pollination services, and cultural identity that are essential for survival and well-being (Gann et al., 2019). Thus, there is an urgent need to safeguard biodiversity and ecosystem services to ensure a sustainable future for both nature and humans.

Ecological restoration seeks to repair human-induced ecosystem degradation by facilitating natural recovery processes through active measures (Gann et al., 2019). As such, restoration is a socio-ecological process linking ecology to various cultural, economic, and political factors (Tedesco et al., 2023). In addition to increasing biodiversity and improving ecosystem functioning, successful restoration can foster community engagement, employment opportunities, and health benefits (Gann et al., 2019). This makes ecological restoration an important tool for improving both ecological conditions and social well-being.

Norwegian nature is facing an increasing pressure from housing and cabin construction, industrial development, and renewable energy production (Simensen et al., 2023). Between 2017-2022, NRK reported a total of 44,000 nature encroachments across the country, equivalent to the loss of 79 square meters of Norwegian nature every minute (Støstad et al., 2024). At the same time, Norway has limited experience with ecological restoration (Hagen et al., 2013; Stange et al., 2021). Due to a low population density and a general perception of having an abundance of wilderness areas, neither money nor much attention has been allocated to ecological restoration (Hagen et al., 2013). Restoration efforts to date have mainly consisted of individual projects aimed at supporting threatened species or nature types, often in semi-natural ecosystems, on state-owned or common property (Hagen et al., 2013).

However, growing international obligations and increasing media attention on biodiversity loss are pushing restoration higher on the political agenda. By signing the Kunming-Montreal Global Biodiversity Framework in 2022, Norway has committed to restoring 30% of all degraded nature by 2030 (UNEP, 2022). Although a nature accounting system is being

developed to assess Norwegian ecosystem condition, no overarching national strategy for terrestrial-based ecological restoration has been established (Meld. St. 35 (2023-2024)).

The primary land-use planning authority in Norway is the municipality. Municipalities thus play a key role in both designing and approving restoration projects (Hagen et al., 2013). In recent years, land degradation neutrality (LDN) has emerged as an approach to combat nature degradation through local area planning in Norway. As of 2025, a total of 87 municipalities were actively working with the LDN approach (Vikse, u.å.). The concept of LDN aims to raise the threshold for when natural areas can be developed for social purposes. In cases where this is inevitable, the loss of natural values must be offset with restored nature elsewhere to neutralise the degradation (Cowie et al., 2018). As such, LDN is rooted in a response hierarchy: 1) avoid land degradation through sustainable land management practices, 2) reduce inflicted degradations as much as possible, and 3) restore the degraded biotic integrity. If implemented accordingly, LDN can be a powerful tool for Norwegian municipalities to limit land-use change and increase restoration efforts.

Among the Norwegian municipalities working with LDN, Nordre Follo has emerged as a pioneer. In addition to making the principles of LDN legally binding, Nordre Follo is the only municipality with a plan for LDN based ecological compensation (Nordre Follo municipality, 2023b). According to the plan, the project owner must provide ecological compensation either in form of ecological restoration, or as financial contributions to restoration projects.

In 2023, the first project to trigger the requirement for ecological compensation under LDN was approved (Nordre Follo municipality, 2023c). The project will build an elevated water reservoir in the community of Skotbu, Nordre Follo, which requires the removal of nearly 3,500 m^2 of plantation spruce forest. As the project owner, the municipality is therefore obligated to offset the loss of nature through ecological compensation. A consultant report from 2024 recommended that this compensation should take the form of ecological restoration at one of three assessed sites: a deciduous forest, a pine forest, and a semi-natural grassland (Liebel et al., 2024). This thesis aims to use the Skotbu water reservoir project as a case study to better understand how ecological restoration decisions are made within a Norwegian land degradation neutrality framework. As such, I sought to answer the following questions:

1. Which, if any, ecological barriers to restoration success can be found within the proposed restoration sites?

2. Which, if any, social barriers to restoration success can be found within the decision-making process of selecting a restoration site?
3. How are ecological interests weighed against other key interests in the selection of a restoration site?

To answer these questions, I employed an interdisciplinary approach in order to consider both the ecological and social contexts. The first research question is addressed using field collected, plant community data from the three restoration sites, while the second question is explored through interviews with stakeholders. The final question integrates these two knowledge domains, examining socio-ecological interactions and linkages in the Skotbu restoration project. As the first LDN case in Norway, the restoration project in Skotbu lays important foundations for how the principles of LDN will be practiced in the municipality in the future. It also has the potential to inspire and guide LDN methods throughout Norway, thereby strengthening restoration efforts and reducing ecosystem degradation.

1.2 Dictionary

English	**Norwegian**
Ecological restoration	Naturrestaurering
Land degradation neutrality (LDN)	Arealnøytralitet
Land use plan	Kommuneplanens arealdel
Planning and Building Act	Plan- og bygningsloven
Skotbu elevated water reservoir	Skotbu høydebasseng
White paper	Stortingsmelding
Zoning plan	Reguleringsplan

2 Context

2.1 Land degradation neutrality in a Norwegian context

In Norway, the concept of LDN was introduced by the environmental organisation Sabima in 2013 (Vikse, u.å.). Sabima argues that implementing LDN is the most effective way to reverse biodiversity loss in Norway and has advocated for a national LDN target that would require the framework to be applied in all development projects across all municipalities. Interest in LDN is growing, and in 2025, 87 Norwegian municipalities reported they are working to incorporate the concept into policies and planning (Vikse, u.å.).

Despite increasing interest, there are currently no national guidelines or decisions regarding LDN in Norway. Principles on ecological restoration was approved by the government in 2019, however these are indicative and only counts for what is defined as "valuable nature" (Hagen et al., 2022). In the latest government report on sustainable use and conservation of Norwegian nature, most measures to reduce loss of nature involved strengthening and improving already existing land-use frameworks (Meld. St. 35 (2023-2024)). Some new measures included finalising a national nature and land-use accounting system that also can be used at the local level by municipalities. Also, the government aims at facilitating more ecological restoration in municipalities through subsidy schemes like "natursats", which prioritizes municipalities that have decided to adopt the LDN principles. However, with the White Paper introducing few national goals and measures, most of the responsibility for sustainable land-use and ecological restoration falls on the municipalities. In this context, Nordre Follo municipality represents a flagship by testing out and integrating the new framework of LDN.

2.2 Land degradation neutrality in Nordre Follo

Nordre Follo was the first to adopt legally binding provisions on area neutrality and ecological compensation in the area section of the municipal plan (Nordre Follo municipality, n.d.-a). The provisions were defined as follows:

"***§ 16.6 Land Degradation Neutrality***

The principle of land degradation neutrality applies to the entire municipality. Land degradation neutrality means reusing and densifying areas that are already developed, rather than developing agricultural land and natural areas.

By 'nature,' we mean the main ecosystems: forests, wetlands, waterways, naturally open areas in lowlands, and semi-natural land, along with their underlying natural types. Degraded

nature, such as drained marshes, is also considered nature. The same applies to nature-like recreational and green areas, such as parks, small urban forests, and urban green corridors." (Nordre Follo municipality, 2023b, p. 27)

"***§ 18.4 Ecological Compensation***

If a zoning plan permits the loss of nature or an area's ecological function in violation of the principle in § 16.6 Land Degradation Neutrality, the developer must provide ecological compensation for the loss caused by the project. Ecological compensation is determined by the municipality and can be provided either as compensatory area or as a financial contribution to restoration projects."
(Nordre Follo municipality, 2023b, p. 30)

Currently, the first practical test of the requirement for ecological compensation is underway. This case involves the development of an elevated water reservoir in the community of Skotbu. The new reservoir is deemed necessary to ensure a sufficient and stable water supply for the residents of Skotbu and must be situated on a natural elevation to provide the required pressure. Following the LDN response hierarchy, the reservoir was placed in a production forest to minimize damage to valuable and diverse natural areas. Despite these efforts, approximately 3,500 km² of nature will be permanently degraded, necessitating ecological compensation. As the municipality is the project manager, it is responsible for implementing the compensatory restoration.

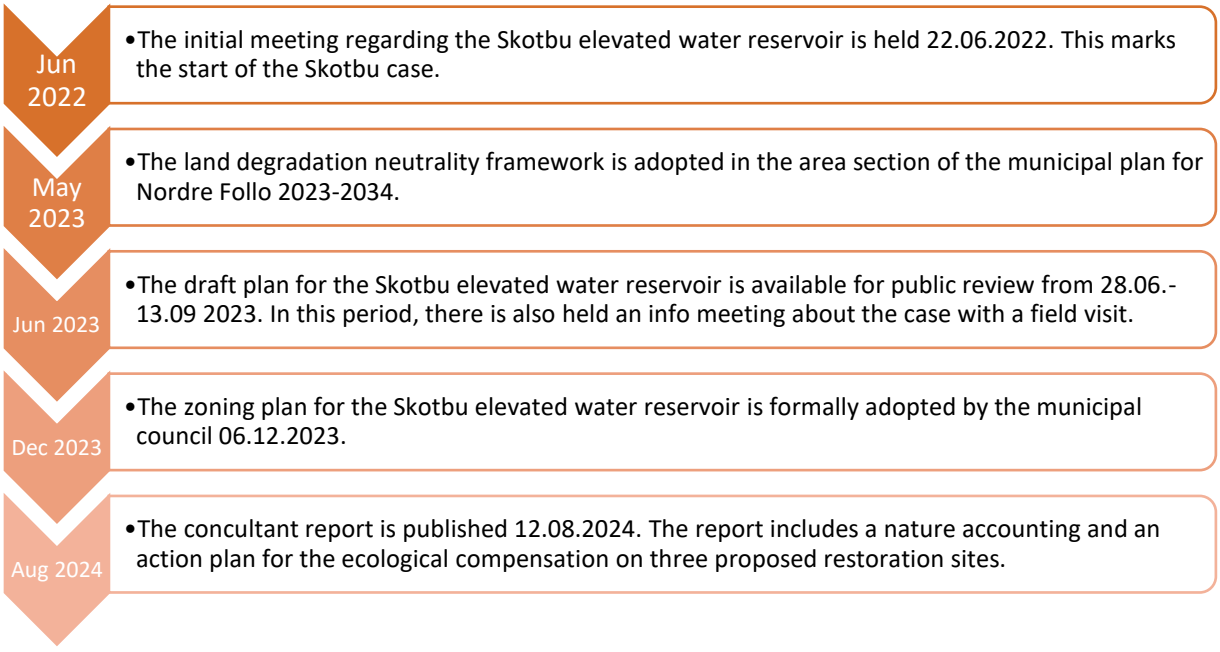

Figure 1: The timeline of the planning process of Skotbu elevadted water reservoir. The timeline is inspired by Nordre Follo's own timeline (Nordre Follo municipality, n.d.-b).

The Skotbu elevated water reservoir project started in June 2022, nearly one year prior to the adoption of the LDN framework by Nordre Follo municipality (Fig. 1). Consequently, it was already anticipated that the Skotbu project would be the first to trigger the requirement for ecological compensation when the municipality committed to LDN. As a result, the requirement for ecological compensation was incorporated into the planning documents as a sequence requirement. The general public was invited to express their opinions on the project during the public hearing period from June to September 2023. No comments on the case from the public were received (Nordre Follo municipality, 2023a). The municipality also held an information meeting in Skotbu with a following field visit during the hearing period, as additional participation measures to encourage public participation. The information meeting was well attended by Skotbu residents. Finally, the Skotbu zoning plan was formally approved by the municipality council in December 2023.

Subsequently, the process of ecological compensation for the degradation imposed by the Skotbu elevated water reservoir started. First, the municipality issued a tender, and the selected consulting firm was hired to make a project-based nature accounting and an action plan for the restoration. Three potential restoration sites were identified based on existing mapping data and a field visit together with the municipality administration. The final report, which compared the ecological compensation potential of the three sites, was submitted in August 2024. Next, it was up to the municipality to decide which site would represent the first instance of ecological compensation under the LDN framework in Norway.

3 Theory

3.1 International principles on ecosystem restoration

To ensure ecological restoration achieves its full potential, the Society for Ecological Restoration (SER) developed the International Principles and Standards for the Practice of Ecological Restoration (Gann et al., 2019). These widely recognized Standards provide a robust framework for communities, scientists, policymakers, and land managers, supporting all stages of restoration: planning, implementation, and monitoring. Through a broad consultative process, eight principles were formulated with inputs from experts, practitioners, international partners, stakeholders, members, and supporters. Altogether, these principles serve as measurable indicators for successful ecological restoration, ensuring benefits to both nature and society. The Standards have already guided numerous projects worldwide, demonstrating their practical value in achieving restoration goals in various ecosystems (Gann et al., 2019). Therefore, it is also relevant to assess how the Skotbu project aligns with these standards to determine whether the project is reaching its full potential.

The first principle of the Standards emphasizes the importance of engaging stakeholders in every ecological restoration project. Stakeholders include all those directly and indirectly affected by the restoration measures, ranging from government politicians to local neighbours. Inclusion and active engagement measures should be implemented from the early conceptual phase onwards. This way, stakeholders can contribute with key insights regarding prioritization of restoration sites, setting achievable goals, and participatory monitoring. Successful engagement fosters respect, interest and commitment among and across stakeholder groups, contributing to wider political and financial support. In return, stakeholders benefit from ecological restoration through for example pleasing recreation sites, improved air or water quality, subsistence fishing and hunting, and nature-based employment opportunities. Therefore, engaging stakeholders links communities and nature, ensuring mutual benefits for both.

The second SER principle explains how ecological restoration builds on many types of knowledge. Successful restoration requires a combination of knowledge from many fields such as agronomy, forestry, landscape design, and engineering. Such ecological knowledge can derive from practitioner experiences, traditional ecological knowledge (TEK), local ecological knowledge (LEK), and scientific discovery. All types represent formal or informal knowledge based on trial and error, facilitating adaptive management. Members of local communities often hold extensive and detailed information about sites and ecosystems, making TEK and LEK

experts key to identifying native reference systems and teaching cultural management practices. Hence, learning from various ecological knowledges improves restoration efficiency and effectiveness.

The third principle of ecological restoration involves identifying the native ecosystem and developing a reference model that represents the desired condition of the restoration area, assuming no degradation had occurred. This model should not rely solely on historical states, as they may overlook the dynamic nature of ecosystems. Reference models can be constructed using diverse sources, including local similar sites, historical data, and successional models. Engaging stakeholders, such as those contributing with TEK and LEK, is beneficial. Additionally, descriptions of reference models should include the six key ecosystem attributes for ecosystem integrity: Absence of threats, physical conditions, species composition, structural diversity, ecosystem function, and external exchanges. For semi-natural areas, the model must consider human utilization, as degradation often results from inadequate management.

The fourth principle acknowledges nature's ability to self-organise. Ecological restoration should aim at assisting an ecosystem until it can support itself. Accordingly, the first step in ecological restoration is to remove the degrading factors, and the next step is to reinstate missing biotic and abiotic components to support self-organisation. The desired state is a self-organising nature system that is resilient to future stressors, and several follow-up interventions may be necessary.

The fifth SER principle conveys that reaching a restored ecosystem requires well-defined goals and objectives. The goals should be realistic and use measurable indicators. To record progress, each objective should include indicators from the six key ecosystem attributes of the reference site, as well as desired outcome and time frame. Both ecological and social attributes must be addressed in the goals. Furthermore, goals and objectives should be developed already in the planning phase, but they can also be adjusted over time following the adaptive management approach. Following this, the sixth principle of the Standards highlight that these goals should reflect the highest level of recovery possible for the ecosystem. Consequently, ecological restoration is a time-demanding process that requires sound monitoring as evidence of restoration progress.

The seventh principle of successful restoration entails that for ecological processes functioning on a regional or landscape scale, restoration projects must be conducted at a larger scale to deliver desired outcomes and benefits. This could for example be securing water streams that

are affected by upstream conditions, or conserving reindeer (*Rangifer tarandus*) that is a species with large minimum habitat requirements. Large-scale restoration is also essential to avoid degradation practices moving to other places instead of being terminated. One way of fulfilling principle seven is to integrate small projects within larger restoration programmes. A broad perspective on restoration is also reflected in the eighth and last principle: ecological restoration as part of a continuum of restorative activities. Direct or indirect actions to support the recovery of ecosystem attributes are conducted continuously, leading to cumulative benefits. Such activities can support nature in form of reducing societal impacts, remediation, rehabilitation, or ecological restoration. Practitioners should select the activity best suited to its context, but in general, ecological restoration should be prioritized when feasible, as it promotes the highest possible recovery level of an ecosystem.

3.2 Ethical aspects of ecological restoration

When conducting ecological restoration, several ethical questions arise. Can humans recreate nature, or would that be "fake" nature? Should humans really intervene more in nature after degrading so much of it? What are the justifications behind restoration? Several critical and supportive perspectives have been arisen in the philosophical debate around ecological restoration. These perspectives are interesting to acknowledge in any restoration project, as they provide insights into the underlying motivations for intervening in nature, thereby shaping the decision-making processes involved. Since this thesis aims to answer how different interests are weighed and decisions are made, exploring ethical motivations to restoration will also help clarify the Skotbu restoration project. This section will first present five general motivations to restore ecosystems, before taking a deep dive into some supportive and some opposing ethical perspectives on ecological restoration.

3.2.1 Five motivations to restore nature

The restoration movement is a popular and rising movement, receiving substantial funding and engaging public as well as volunteer actors. Yet, project descriptions rarely explain *why* the restoration is worthwhile the efforts put in (Clewell & Aronson, 2006). The justifications behind ecological restoration are thus left understated and unappreciated. In an attempt to counter this research gap, Clewell and Aronson (2006) has synthesized five broad yet widespread reasons for conducting restoration projects.

The technocratic rationale behind restoration aims to recover social values provided by ecosystems, such as water quality, erosion control, wildlife habitat, and endangered species. It is typically implemented by governmental agencies or large institutions and performed on

public land. Therefore, technocratic restoration encompasses the capability to carry out large projects requiring coordination and legal assessments, however more practical tasks are often outsourced to smaller firms or NGOs. Restoration under this rationale is mandated as compensation for environmental impacts, and the projects are commonly integrated into public frameworks to fulfil goals, performance standards or strategies. Challenges with the technocratic rational is its top-down structure and the tendance of treating restoration as engineering tasks with finite endpoints. Consequently, restoration processes are simplified and often exclude the public from the ability to participate due to limited time, budget or control resources.

The biotic rationale is informed by ecological principles and knowledge, and the main goal is to support biodiversity. This approach is often held by biologists, environmentalists and the general public. Restoration projects are typically performed with a local perspective, trying to benefit rare and endangered species or ecosystems. European projects motivated by the biotic rationale have also emphasized restoration of the biodiversity on the landscape level.

A third rationale is the heuristic approach. Here, the aim is to provide useful insights into ecological processes and principles that can contribute to ecological science and pedagogic environments. As such, restoration under the heuristic approach is often grounded in hypotheses trying to test different strategies and methods. Nevertheless, conducting ecological restoration as scientific projects presents significant challenges. It is difficult to ensure controlled conditions, isolate specific effects, and find replicate plots with similar characteristics. This has led to the heuristic rationale rarely being the primary motivation behind restoration projects. Instead, it often emerges as a supplementary method during the implementation of these projects.

Within the idealistic rationale, restoration is understood as a process that reconciles the human-nature relationship. The underlaying assumption is that people develop attachments to natural areas around them, serving as a motivation to preserve and protect this nature. Resultingly, restoration under the idealistic approach is typically performed by local volunteers and communities. Restoration is offering a way to make up for anthropogenic damage of nature and aims at bringing nature and culture closer through restoration measures serving as recreation and meditation. Idealistic restoration has great freedom in choosing what to restore and how, however measures based on volunteerism is limited by scale and resources.

The last of Clewell and Aronson's (2006) motivations behind restoration is the pragmatic rationale. This approach justifies restoration by its ability to satisfy human values, either by providing natural capital, or by mitigating human-induces climate change. As ecosystems of higher biodiversity and functionality can better provide ecosystem services like timber, seafood or flood water control, restoration of nature will ultimately sustain human wellbeing. The pragmatic rationale supports large-scale governmental and international restoration programs, as these are seen as the only viable solution to ensure the necessary stocks of natural capital to sustain global economies. Consequently, the pragmatic rationale behind restoration involves an instrumental valuation of nature.

However, a notable challenge when navigating through restoration rationales can be the contrasting paradigms regarding the nature-human relationship. In the dualistic paradigm, nature and human is perceived as separate units, and restoration is seen as a human-induced technical task on nature to sustain societal values. In the opposing paradigm, human and nature are interdependent, and ecological restoration will thus benefit both nature and people. Both perspectives can be used in any of the restoration rationales, bringing tension within and between rationales on whether nature possesses instrumental or intrinsic value. Still, the dualistic paradigm is typical for the pragmatic rational, and the non-dualistic paradigm is well-grounded in the biotic rationale. The other rationales can be found on both sides if the paradigm spectrum.

Finally, Clewell and Aronson (2006) conclude that no rationale is adequate on its own, as each approach has its weaknesses. To ensure ecological restoration that succeeds in benefitting both nature and people, a combination of different rationales should form the basis for restoration projects. The authors argue that the most important rationales for well-conceived and effectively executed projects are the technocratic and the idealistic approaches. This way, ecological restoration can be beneficially coordinated and large-scale, and at the same time get support and participation from the public. Simultaneously, other attributes from the remaining rationales can be included along the way. The project's goals may be based on the social benefits from the pragmatic rationale, while assisting vulnerable species and ecosystems, adhering to the biotic rational, can be objectives integrated within these goals. Lastly, during the implementation phase, the project managers can make the restoration field an educational platform for schools and universities, ensuring support of the heuristic rationale.

3.2.2 Restored nature is not real nature

Katz (1996) represents the critical side of the ecological restoration philosophical debate. For Katz, restoring nature is to create an inauthentic nature deviant from the undisturbed and naturally evolved nature. As such, intervening in nature through restoration is to deny nature's autonomy and freedom, and in this way serves as yet another measure for humans to control or dominate nature. According to Katz, ecological restoration entails a mentality that technology and science can repair and improve the nature. However, restored nature differs from natural nature, as it is created to meet human interests and criteria for satisfaction. Hence, ecological restoration embraces a moral hazard: restoration is a means to justify continued degradation of nature. Instead of using restoration as a supplement to preserve nature, Katz argues that restoration is used to substitute pristine nature. Consequently, ecological restoration holds a negative value, and the only way to support nature's naturalness is to exclude human actions from it. In this way, Katz supports a dualistic worldview where nature and naturalness is separated from humans and cultural societies. Humans are not seen as part of nature and any intervention by them would reduce nature's integrity.

3.3.3 Restoration fosters the human-nature relationship

In contrast, Light (2003) and Tanasescu (2017) perceive ecological restoration as a positive activity with potential at reinstating the human-nature relationship. Light emphasizes the process of restoration rather than its end product, viewing it as a means to actively engage people while respecting nature's autonomy This engagement encourages cooperative and humble attitudes towards nature and serves as a way to repair moral damage from past human-driven degradation. Tanasescu goes even further by framing restoration as a moral obligation. He argues that humanity's capacity to destroy nature through continuous technological advancements does not separate humans from nature; rather, it increases our responsibility to ensure its continued existence.

By rejecting the dualist tradition, Light dismisses most of Katz's arguments. For example, restoration includes removing degrading impacts on the ecosystem, allowing nature to resume its evolution course rather than imposing human domination on it. Light also recognizes than humans cannot recreate naturally evolved ecosystems, however he points out, that does not mean restoration cannot benefit nature or people. The negative viewpoint on ecological restoration as encouraging a moral hazard held by Katz, is what Light defines as "malicious restoration". Alternatively, Light offers a positivistic restoration approach where humans and nature work together for mutual benefits, described as "benevolent restoration".

Another supporter of restoration is Cronon (1995). Cronon also strongly criticizes the dualistic worldview, blaming it for alienating humans from the natural world. This worldview conceptualizes wilderness as pristine and untouched, the ultimate form of nature. Wilderness is often romanticized as a place of sublime beauty and spiritual renewal, yet it excludes humans. This is problematic to advocators of responsible environmentalism, such as restoration practitioners, because any interfering with nature equals degradation or disturbing its natural beauty. As so, Cronon calls for the need to emphasize conservation models that move beyond the dualistic wilderness approach. He suggests that ecological restoration can serve as a model creating sustainable, harmonious relationships between human and nature. However, this can only be achieved if wilderness is recognized into everyday environments, embracing a continuum of natural landscapes including cities, suburbs, and wild areas. The focus should be on restoring nature in areas where people work and live, as this will promote sustainable practices that integrate human and nature. In summary, Cronon acknowledges a need for restoration in everyday-nature, asserting that this is the only way to reinstate a human-nature relationship where responsible use and conservation of nature can coexist.

4 Methods

4.1 Mixed methods case study

Ecological restoration requires an interdisciplinary approach that integrates both ecology and sociology throughout its process and outcomes. Restoration projects tend to put most emphasis on the ecological aspects, despite the fact that successful restoration depends heavily on social context (Tedesco et al., 2023). For example, ecological restoration requires active measures, and therefore relies on social dimensions like political will, public support, economic resources, access to land, and agents to perform and monitor the area. This is also reflected in SER's Standards for successful ecological restoration, where social and ecological factors are treated as interdependent throughout the eight principles (Gann et al., 2019). Hence, restoration should be understood as a socio-ecological process that combines a range of different practices, knowledges and values across stakeholder groups.

Since my thesis aims to explain municipal decision-making in ecological restoration, a more holistic study is achieved by understanding both the ecological and social contexts. This is possible through a mixed methods approach, which integrates quantitative and qualitative components within a single research design (Clark et al., 2021). Creswell and Plano Clark's (2011) convergent design with a parallel-databases variant is particularly suitable when different but complementary data enhance understanding of a phenomenon. In this design, quantitative and qualitative strands remain independent, with separate research questions, data collection, and analysis. Both data types are given equal priority and collected concurrently. Integration occurs only at the final stage, interpretation.(Creswell & Plano Clark, 2011). Applying the convergent design on my study unlocks the ability to examine ecological barriers to restoration through quantitative field methods, while stakeholders' experiences and interests regarding restoration can be explored through qualitative interviews.

To be able to explore a municipality-driven decision-making process on ecological restoration under the LDN framework, a case study design was appropriate. Case studies provide detailed and intensive analyses of contemporary events, for example decision-making processes (Clark et al., 2021). Furthermore, cases are well-fitted to answer "how" or "why" the event works and often entails both quantitative and qualitative research (Yin, 2018). By studying the Skotbu project, a combination of quantitative and qualitative research methods can provide an in-depth description of the context (research question 1 and 2) *and* elucidate how decisions were made (research question 3). As the first municipality-led restoration under the LDN framework in Norway, the Skotbu restoration project was selected as an extreme case (Yin, 2018). This makes

it a valuable case for exploring insights that may inform future LDN restoration efforts in Norway.

4.2 Study area

The study area consists of three sites near Skotbu in Nordre Follo municipality, Eastern Norway (Fig. 2). The three sites were chosen during a field trip conducted by the consultant firm and the municipality administration of Nordre Follo (Liebel et al., 2024). All three sites are located within a 1 km radius of the reservoir. The study area is within the boreonemoral vegetation zone where both nemoral deciduous forests and boreal coniferous forests are common and the O1 weak oceanic bioclimatic section (Moen, 1998). The three sites are under private ownership.

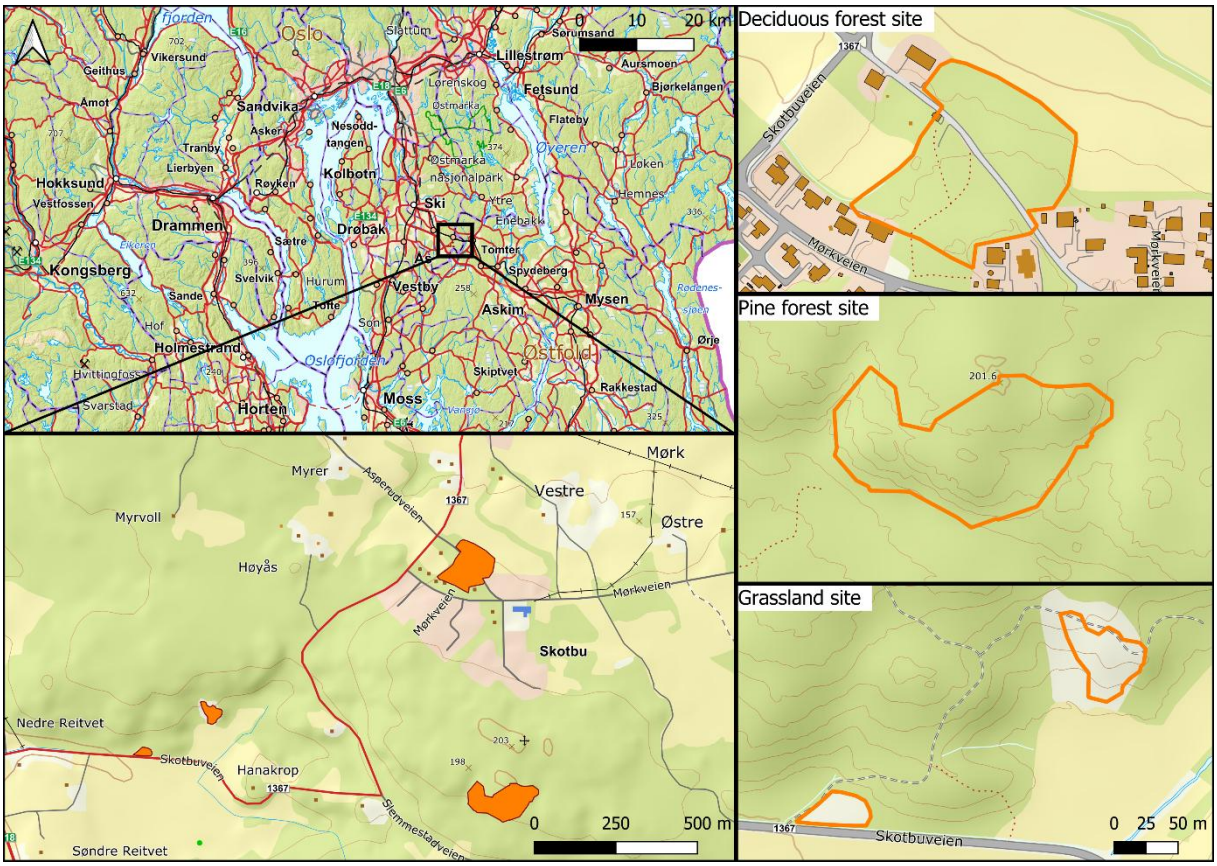

Figure 2: Map of the three study sites in Skotbu. Made in QGIS 3.40.6 LTR (QGIS.org, 2025) with the layer Topografisk Norgeskart (Kartverket, 2017).

4.2.1 Site 1: Deciduous forest

The first site is an isolated rich deciduous forest patch bordered by housing to the south, a farm to the north, and fields to the east and west (59°39'36.0"N 10°56'46.5"E; Fig. 3). In total, the forest is 15,600 m^2, divided by a gravel road for walking and biking. The site lies approximately 160 meters above sea level.

Figure 3: Aerial photograph with the author's own outlining of the deciduous forest site in Skotbu. The map is retrieved from norgeskart.no (Kartverket, 2024).

The forest is dominated by deciduous trees like *Fraxinus excelsior* (EN, ash), *Acer platanoides* (maple), and *Populus tremula* (aspen). The area is influenced by planted *Picea abies* (spruce), although most of the spruce trees have now been removed (Liebel et al., 2024). Some logging waste remains on the site, and the forest bears signs of human-induced fertilization (Miljødirektoratet, 2005). Patches of the forest are dominated by raspberry tickets (*Rubus idaeus*) and the invasive species *Sambucus racemosa* has been registered (Liebel et al., 2024). West of the gravel road, the forest is densely vegetated, with a small path leading to a clearing used for wood storage. This area has been identified as an important biotope under the MiS-livsmiljø system due to rich-barked trees like Fraxinus (NIBIO, n.d.). In contrast, the eastern part is more open, with scattered deadwood and typical deciduous flora like wood anemone (Anemone nemorosa). In 2010, this section was classified in harvest class 5 with high growth potential (NIBIO, n.d.). While the forest was registered as a locally important nature type in 2005, more recent nature mapping (NiN) in 2020 by Norconsult did not confirm this classification (Miljødirektoratet, 2005; Miljødirektoratet, 2020c).

4.2.2 Site 2: Pine forest

The second site consists of a natural, old pine forest within a larger continuous forestry area (59°39'13.3"N 10°56'49.9"E; Fig. 4). Bordering forest areas east and northwest of the site were clear-cut in ca. 2020. As such, the pine forest site is the only remaining natural, old forest of high or very high quality at Hanakropåsen (Liebel et al., 2024). The forest is situated around 195 meters above sea level and has a total area of 16,318 m^2.

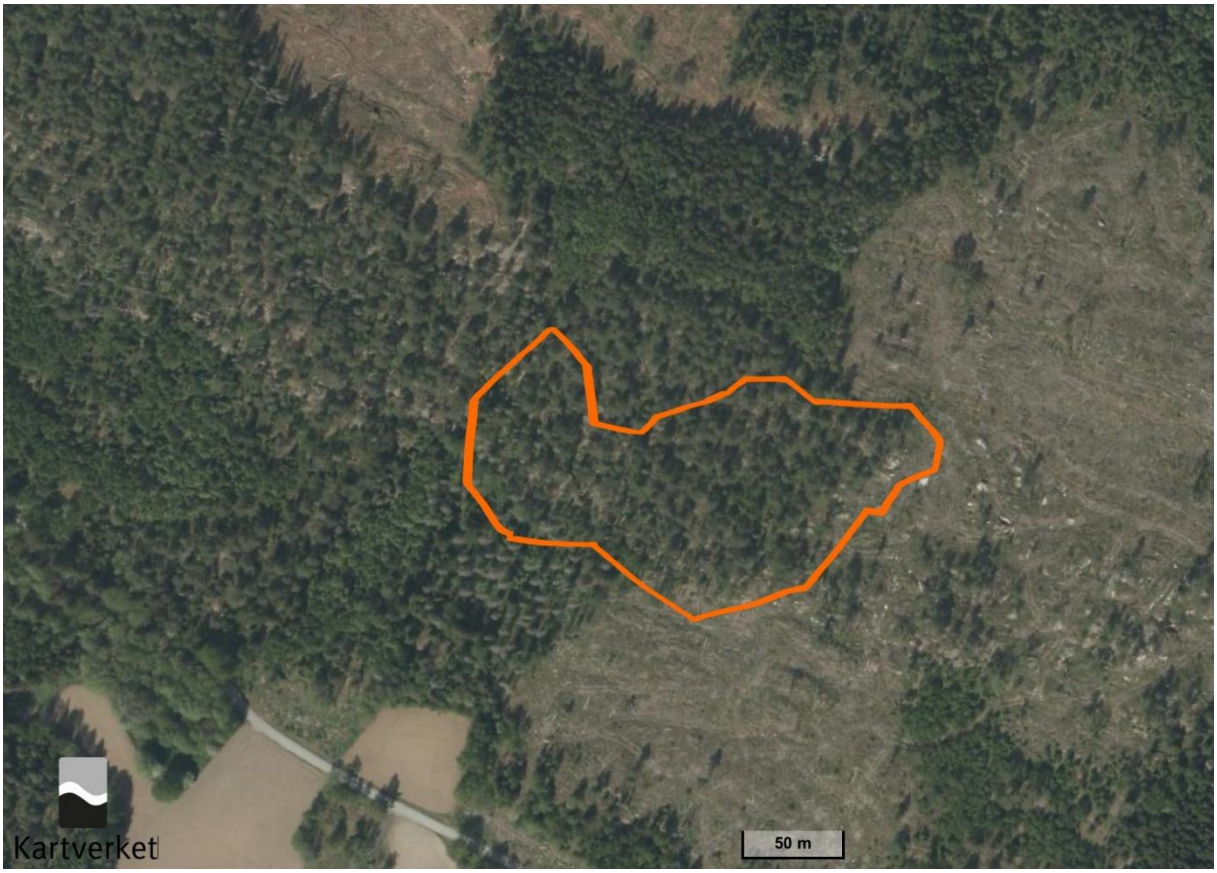

Figure 4: Aerial photograph showing the pine forest site related to the Skotbu restoration project. The map is retrieved from norgeskart.no (Kartverket, 2024).

Although dominated by naturally regenerated *Pinus sylvestris* (pine), the southern section of the site is influenced by spruce (2020b). The forest holds trees up to 400 years old (based on tree structure), however there is little dead wood (Miljødirektoratet, 2020b). The northern parts of the site are registered as harvest class 5 and with a low tree growth potential of 6 (NIBIO, n.d.). Norconsult evaluated the condition to be good and the biodiversity level moderate in the latest nature mapping of the area (Miljødirektoratet, 2020b). No red-listed nor invasive species were identified.

4.2.3 Site 3: Grassland

The third site is a semi-natural grassland (VU) situated south-west to Skotbu (59°39'22.0"N 10°55'54.8"E). The area was originally one continuous grassland, but cessation of grazing maintenance led to regrowth of forest between the eastern and western part (Fig. 5; Liebel et al., 2024). Both grassland parts are surrounded by forest in the north and agricultural fields in the south. The southern grassland area also borders a public roadway on the southern side and a private, dirt road along the western side. The total area of the two grassland sections is 3,701 m², situated between 100 and 120 meters above sea level.

Figure 5: The third study site, two grassland areas south-west of Skotbu. The aerial photograph is retrieved from norgeskart.no.

The vegetation at the grassland site is in a fallow phase, with few grassland-associated species present and no red-listed species identified (Miljødirektoratet, 2020a). Due to no grazing and light fertilization, Norconsult (2020) has registered the quality of the nature type to be low. The southern area is characterized with tall graminoids and patches with logging waste.

4.3 Study design

4.3.1 Vegetation analysis

I conducted a vegetation analysis during August 2024. Four 50 meter transects were established in each site, starting from an edge point and extending into the area (Fig. 6). Along each transect, a 1×1 meter quadrat was placed every second meter, making up a total of 25 quadrats per transect and 100 quadrats per site (Fig. 7). The southern section of the grassland area was too small for a 50 meter transect, so one of the transects was split into two 25 meter transects.

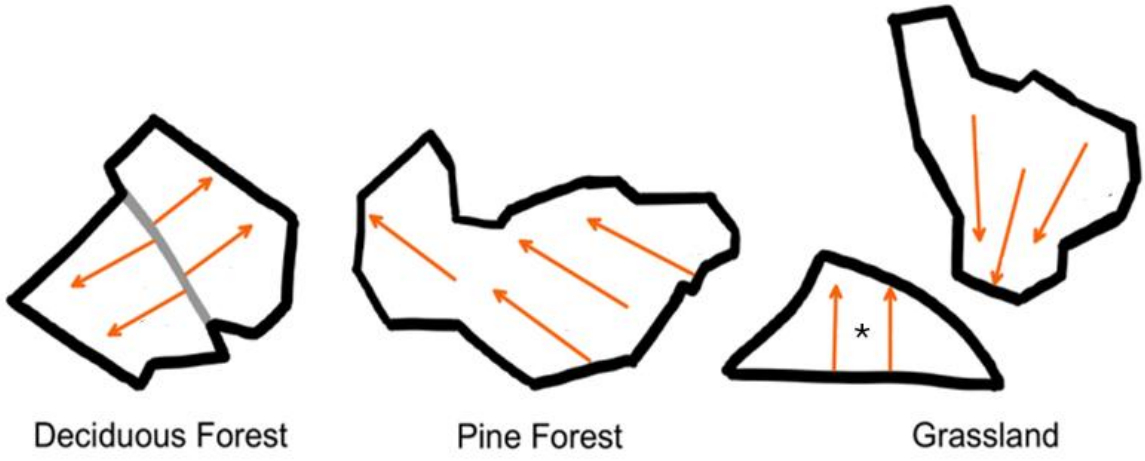

Figure 6: Transect design across the three study sites. The grassland site comprised two sections; the southern section included two 25 m transects, marked with an asterisk (*).

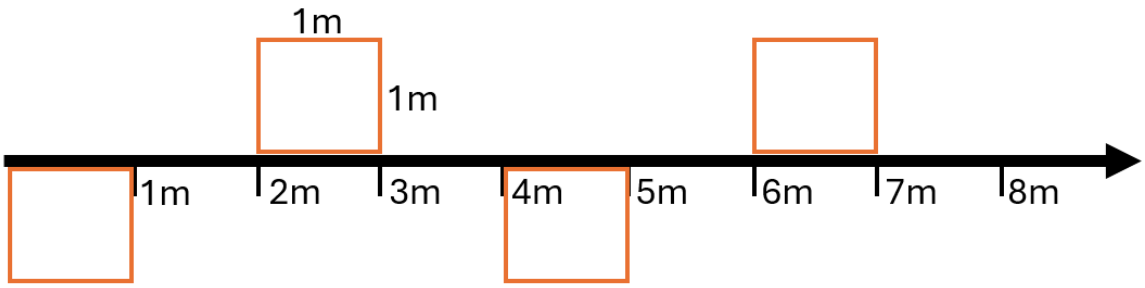

Figure 7: Quadrat design in each of vegetation analysis transects. The quadrat measured 1 × 1 meter and were placed every second meter of the transect.

A vegetation cover analysis was carried out by estimating the percent cover of plant functional groups in each quadrat. These groups included grasses, forbs, shrubs, vines, trees, mosses, lichens, and ferns. The analysis also accounted for non-living categories such as rocks, bare ground, dead wood, and litter. Percent cover of species of interest, such as invasive species, red-listed species, adult trees, or native species that are not normally found in the given nature type (native non-target species; NNTs), was also registered. One red-listed species was found,

Fraxinus excelsior, which is evaluated as endangered in the Norwegian red list due to the fungal disease *Hymenoscyphus fraxineus* (Solstad et al., 2021).

4.3.2 Interviews

In qualitative scientific interviews, it is the interactions between the interviewer and the interviewee that produces knowledge, and one-to-one interviews under this method serve well to reach into people's own experiences, perspectives, and choices in their daily lives (Kvale & Brinkmann, 2015). Since the purpose of this thesis is to understand stakeholders' participation experiences and decisions within the municipality-driven Skotbu restoration under LDN, qualitative scientific interviewing is an ideal method. A semi-structural interview approach was chosen to ensure flexibility at the same time as focusing on themes relevant to the research questions (Clark et al., 2021). Interview guides were made to ensure the same topics of ecological restoration and land degradation neutrality were covered in all interviews (Appendix 1). The guides were adapted to the different stakeholder groups, and all were tested on a friend before used in the research. By asking open questions, the interviewees had flexibility to lead the direction of the answer and come with elaborations and digressions, which sometimes were followed up by the researcher. A total of eight semi-structured interviews were conducted with eight stakeholders in the Skotbu restoration project. These interviews took place between November 2024 and February 2025, each lasting between one and two hours. All interviews were conducted in Norwegian, and quotations cited in the thesis were translated into English.

Interviewees were selected by purposive sampling, a method allowing the researcher to sample strategically to answer the research questions (Clark et al., 2021). As this research focused a specific case, purposive sampling was useful to ensure the inclusion of a diverse range of stakeholder, each of whom was information-rich on the Skotbu restoration project. Hence, interviewees were selected on the criteria of attachment to the Skotbu case, as well as adhering to one of the following stakeholder groups: interest organisation, local politician, municipality administration worker, consultant, or landowner. First, a generic purposive sampling was conducted to find appropriate stakeholders by searching on Retriever, a newspaper archive system. The search word "Nordre Follo" was used together with "ecological restoration", "land degradation neutrality" or "Skotbu". Some stakeholders were identified by looking up information about the case on the municipalities' own webpages and from watching recorded municipality council meetings. The potential interviewees were then contacted by mail, and as the participants approved, they came up with suggestions for other relevant interview participants. Resultingly, three of the interviewees were identified by snowball sampling. The

total sample size consisted of one interest organisation member, two local politicians, two municipality administration workers, two consultants, and one landowner.

Before the interviews, all participants received a letter detailing which personal data would be collected and their rights regarding this information. A self-declaration agreeing to these terms had to be signed prior to the interviews, and the interviewees had the possibility to withdraw from the project at any time without any consequences. Additionally, the interviews were recorded both with a traditional Dictaphone and the Dictaphone application by Nettskjema, with all participants consenting to the recordings beforehand. Both sets of recording files were securely stored. The Nettskjema recordings were stored in a password-protected user account, accessible only to the researcher. The interviewees were also given the opportunity to read through their own quotes if cited directly in the thesis.

The interview transcripts were analysed according to Braun and Clarke's reflexive thematic analysis, offering a robust and transparent, yet flexible framework (Braun & Clarke, 2021). As this type of analysis aims at understanding underlying patterns and meanings across the interview dataset, it was effective in giving an in-depth examination of the Skotbu restoration. The reflexive thematic analysis comprises six phases, however the method is iterative, as the researcher continuously moves back and forth between steps to enhance understanding. The first phase was data familiarisation. Here, the transcribed interviews were corrected and cross-checked while listening to the audio, as well as anonymized. Further on, all interviewees were only referred to in terms of their stakeholder group. Then, each transcript was read through one time to get a general understanding of the content, without taking notes or focusing on specific themes. Next, the texts were read again, and a few notes summarizing each page were taken. The second step in the analysis process was coding. All transcripts where uploaded to the analysing programme Nvivo where the coding was conducted. Small fragments of text were given code names trying to capture every meaning of relevance. The first coding round resulted in 148 codes. In the third phase, initial themes were generated by connecting codes across the dataset into mind maps. The candidate themes had to both represent the data and address the research questions. The fourth phase was theme revision, which consisted of a process going back and forth between the full dataset, coding and developing themes. Initial codes were split up or merged, creating new themes to investigate. The final code count was 117. Phase five of the thematic analysis was wrapping up final themes that best created meaningful insights to answer the research questions. The final three themes were: "participation with limits", "restoring for nature's own sake", and "ecological goals, human priorities". The sixth and last

phase consisted of formal writing. This phase was continuous and started as early as the interview process by writing memos of first impressions of each interview. Furthermore, memos gathering thoughts and ideas about the results and the discussion were produced along the analysis process. These notes together with the analysis themes made the foundation for the final writing of the thesis, using the themes to structure the narrative and answer the research questions.

Smaller deviations to the thematic analysis steps occurred. One of the interviews was not conducted one-on-one but involved both municipal administration workers simultaneously, as this felt more natural in the interview setting. However, an additional interview was conducted afterwards with only one of the administrators. Also, the interview with the landowner was only read through once in phase one of the thematic analysis, since the interview was conducted concurrently with the analysis process.

4.4 Statistical analyses

All analyses and general descriptive statistics (e.g. means +/- SE) were calculated using R-studio version 4.4.2 (R Core Team, 2024; RStudio Team, 2024).

Statistical significance in the odds ratio plot was calculated manually by dividing the mean log-odds by their corresponding standard errors to obtain z-scores. Two-tailed p-values were then derived from the standard normal distribution. In the NNT bar plot, the car package was used to check the assumption of homoscedasticity before performing a t-test (Fox & Weisberg, 2019).

To understand the relationship between road proximity and the presence of unwanted species, I conducted a beta regression analysis on the grassland site using the betareg and glmmTMB packages (Brooks et al., 2017; Cribari-Neto & Zeileis, 2010). A beta regression was chosen since the response variable consisted of continuous data in the form of proportions, and the model involved only two categorical predictors (Douma & Weedon, 2019). Model selection was guided by the Akaike Information Criterion (AIC) and Likelihood Ratio Tests with the lmtest package (Zeileis & Hothorn, 2002). The best-fitting model included a variable precision parameter (ϕ) that allows dispersion to vary with predictors, which was applied to the transects bordering to a road. Post-hoc pairwise comparisons between distance groups within these transects were performed with the emmeans package (Lenth, 2025).

All graphic presentations for the vegetation analysis were performed using the R package ggplot2 (Wickham, 2016).

4.5 Use of artificial intelligence

All tasks related to this thesis were made in accordance with NMBU's guidelines on usage of artificial intelligence (AI). AI was primarily used as a sparring partner throughout the thesis, much in the same way that a colleague or a supervisor would assist: proofreading, helping with linguistic structure and translations, and formulating code designs for R. As such, AI was used as a writing support tool and not as a source of knowledge.

Microsoft Copilot (version GPT-4) via NMBU subscription served as the main AI tool. In addition to writing support, Copilot was periodically used to make synopses of provided texts or scientific articles to get an overview of the specific source. In these cases, the original text was always manually checked up before used as a reference in the thesis.

Some other AI tools were occasionally used. Whisper V3 from OpenAI was an in-built transcriber of interviews uploaded to the Nettskjema application. All transcripts were thoroughly proofread and corrected manually. OpenAI's Chat GPT (Mar 14, 2023 version) served as a crosschecker in codes formulated by Copilot. Furthermore, the AI literature searching tool Keenious was used to search for relevant journal articles, and Google's NotebookLM (Gemini 2.0, Dec 13, 2024 version) was used as a tool to understand and compare scientific papers. The two latter AI programmes were never used as the only source for finding literature, but as a supplement to conventional literature search.

A common practice when conducting interviews for research purposes, is to involve more than one researcher in the process to crosscheck the interview perceptions. This is useful to improve the reliability and validity of the research, and to avoid that personal biases impact the analyses. As including another researcher into this thesis' interview process was infeasible, AI tools were used to imitate such validation. After conducting the reflexive thematic analysis myself, the same anonymized interview transcripts were uploaded to NotebookLM. This language model can only generate answers based on the provided sources, making it as bias free as possible for analysing the transcript. The AI tool was first given the research questions and then asked to create themes to answer these based on the transcripts. The purpose of this activity was to uncover possible biases inhabited by the thesis' author and then take these into consideration in the further analyses of the results.

The themes and summaries from the cross-checking did not reveal any new or overlooked insights beyond those identified through manual coding. Overall, the understandings matched my own analysis, however the AI highlighted some aspects of the interviews I chose not to

focus on. On the other hand, NotebookLM provided valuable insights on how to connect the different perspectives and themes within the interviews. It is worth noting that the AI tool also included some misleading information due to new data provided by stakeholders after the interviews. The cross-checking exercise proved beneficial in comparing my findings with an alternative interpretation of the data, provoking me to reconsider what was relevant to the research questions. This process facilitated new reflections on the interview results, which were subsequently integrated into the discussion.

4.6 Reflexivity and limitations

Reflexivity refers to the researcher's critical examination of their actions, motivations, and their influence on the research, serving as a tool to identify potential bias (Braun & Clarke, 2021). Furthermore, reflexive thematic analysis is inherently subjective as the knowledge production is shaped by the researcher's personal identity and values, as well as disciplinary and academic background (Braun & Clarke, 2021). To strengthen this thesis' reliability and validity, my positionality as a researcher and decisions on the method is described here, as well as routinely reflected upon throughout the whole research process. To strengthen the reliability and validity of this thesis, my positionality as a researcher and reflections on method choices are described here and was considered throughout the research process.

My academic background is interdisciplinary, encompassing a bachelor's degree in international environmental and development studies followed by a master's degree in natural resource management. This foundation has promoted my valuing of understanding phenomena through the integration of diverse perspectives, which has influenced the methodological choices in this thesis. Moreover, as this is my first independent research project, my inexperience as a researcher may have impacted various decisions throughout the thesis development.

Personally, I have been actively involved in environmental organisations advocating for nature and climate for many years. This engagement, along with my academic background, has shaped my critical thinking and assumptions about the world. In this research, critical assumptions regarding authorities and large systems may have influenced the formulation of interview questions and the interpretation of stakeholder responses. Furthermore, this background may have fostered an inherently positive attitude towards ecological restoration. I have therefore tried to reduce this positioning from affecting my research reliability by acting as a neutral interviewer, remaining open and understanding to all stakeholder perspectives.

The research may also have included some limitations related to the interviewee selection. Interview participants were purposively sampled based on their presumed connection to and knowledge of the Skotbu restoration project. Also, due to one-to-one interviews being a resource-intensive method, the number of interviews was limited to eight. As a result, certain stakeholder perspectives may not be represented in the data.

While the vegetation analysis has provided several useful insights regarding ecological barriers to restoration success, some weaknesses need to be addressed. The vegetation and species dataset had a strong zero-bias, which may have included false and structural zeros (Blasco-Moreno et al., 2019). False zeros could derive from the vegetation analysis being conducted in late August when many plants have stopped flowering, making them hard to identify. Some zeros could also come from limited botany knowledge of the observer, leading to some species being overlooked. Furthermore, the strong zero bias may also be a result of ecological restrictions of the system, such as looking for species that cannot grow in the area anymore due to the changes in the ecosystem. Similar future research could minimize these weaknesses by going out in the field earlier in the season and registering all vegetation at species level.

While investigating the Skotbu restoration project with a mixed methods approach has provided useful insights, it also included some challenges. Collecting and analysing two distinct data types from different sources required much time and effort, which may have reduced the data quality in either type. It also imposed a challenge to combine the data in a meaningful way and at the same time give equal consideration to both. That being said, understanding restoration cases must include both the ecological and social sphere, and future research could address the mentioned challenges by including more researchers from both the ecological and social science domain or making single-method studies part of a bigger interdisciplinary research project.

5 Results

5.1 Vegetation analyses

5.1.1 The deciduous forest

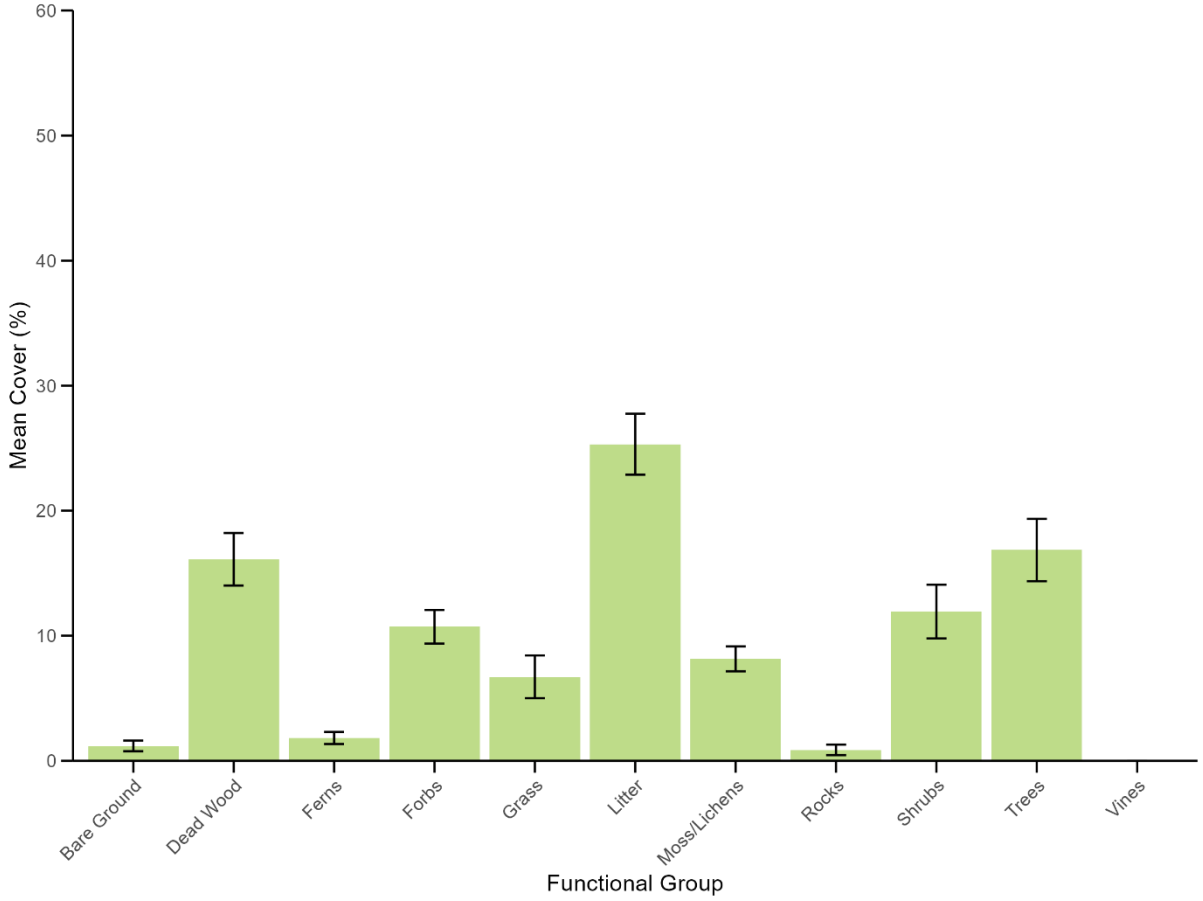

Figure 8: Average percent cover of functional groups in the deciduous forest site. Tree cover did not include canopy layer. Human-induced litter including roof tiles, metal mesh, and corrugated metal sheet was observed in seven quadrats covering between 5-85%, however not included as a functional group. Error bars indicate +/- SE.

Vegetation litter was the group with highest cover in the deciduous forest, accounting for one fourth of the total vegetation cover (Fig. 8). This vegetation group was partly found as fallen leaves from the deciduous trees, partly in relation to logging residues found along the transects. Much of the dead wood (16%) was found as logging residues, but also as naturally fallen trees. Mean tree cover only stood for 17 % of the total, however it was the second biggest vegetation group. Low tree cover numbers can be anticipated as vegetation analyses at ground level only record tree trunks and young trees up to one meter, excluding canopy cover. The shrub cover (12 %) consisted primarily of raspberry.

5.1.2 The pine forest

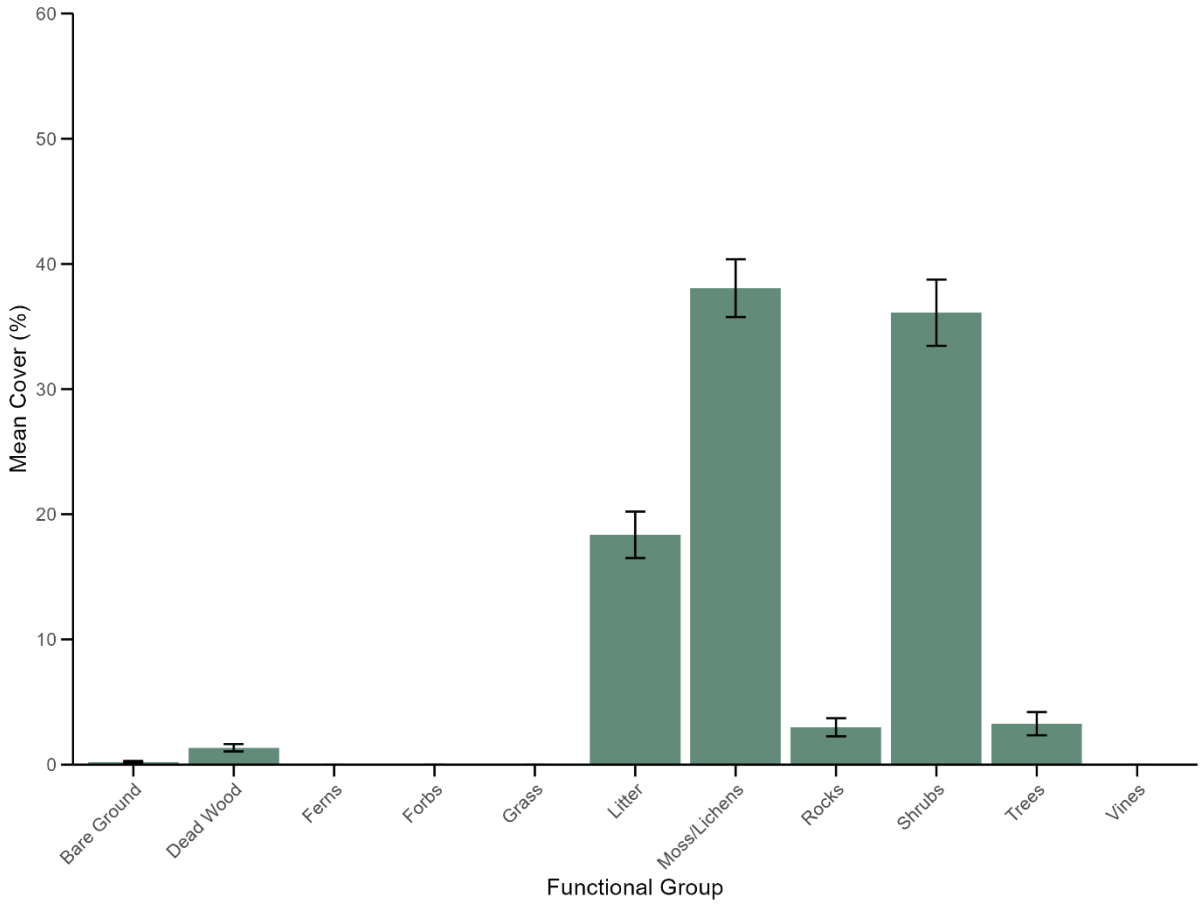

Figure 9: Average percent cover of functional groups in the pine forest site. Tree cover did not include canopy layer. Error bars indicate +/- SE.

The most abundant vegetation groups found in the pine forest were mosses and lichens (38 % cover) and shrubs (36 % cover; Fig. 9). Berry heather made up most of the shrub category. There was also a substantial amount of litter (18 %), mostly consisting of dead plants and fallen pine needles. As with the deciduous forest, the tree category has a low mean value (3 %) because only tree trunks and seedlings are captured in the vegetation analysis.

5.1.3 The grassland

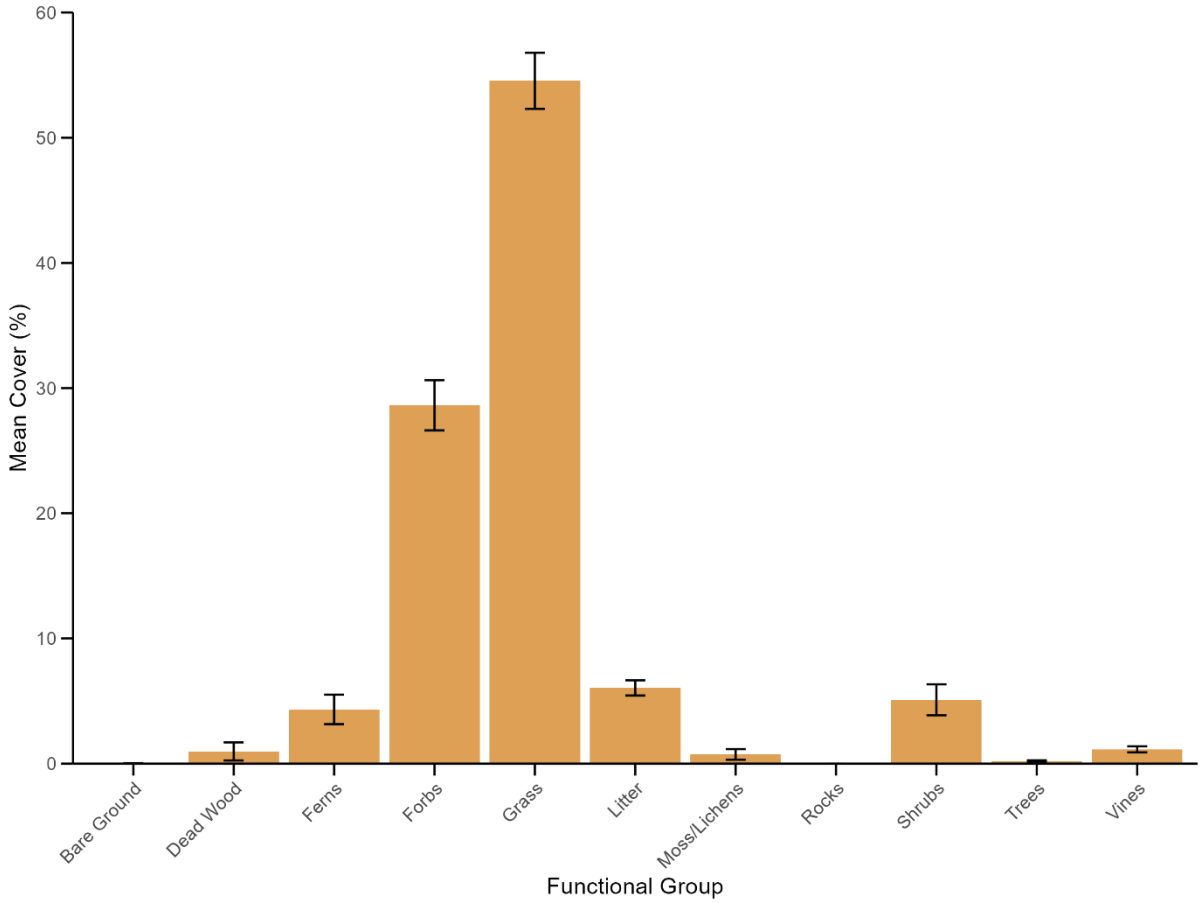

Figure 10: Average percent cover of functional groups in the semi-natural grassland site. Error bars indicate +/- SE.

Grasses constituted the largest vegetation group with 55 % cover, almost double the second largest group, forbs (29 %; Fig. 10). Litter (6 %), raspberry shrubs (5 %) and bracken ferns (*Pteridium aquilinum,* 4 %) were present in low amounts.

5.1.4 Invasive species

Three invasive species were registered during the vegetation analyses. While no invasive species were found in the pine forest, red elderberry (*Sambucus racemosa*) was prevalent in the deciduous forest and there were instances of both creeping cinquefoil (*Potentilla reptans*) and Canada goldenrod (*Solidago canadensis*) in the grassland. Canada goldenrod was observed at the west edge of the northern grassland area and is thus not directly part of the vegetation analysis, but is noteworthy because it is in the highest risk category of non-native species and has a high invasion rate (Skarpaas et al., 2023b).

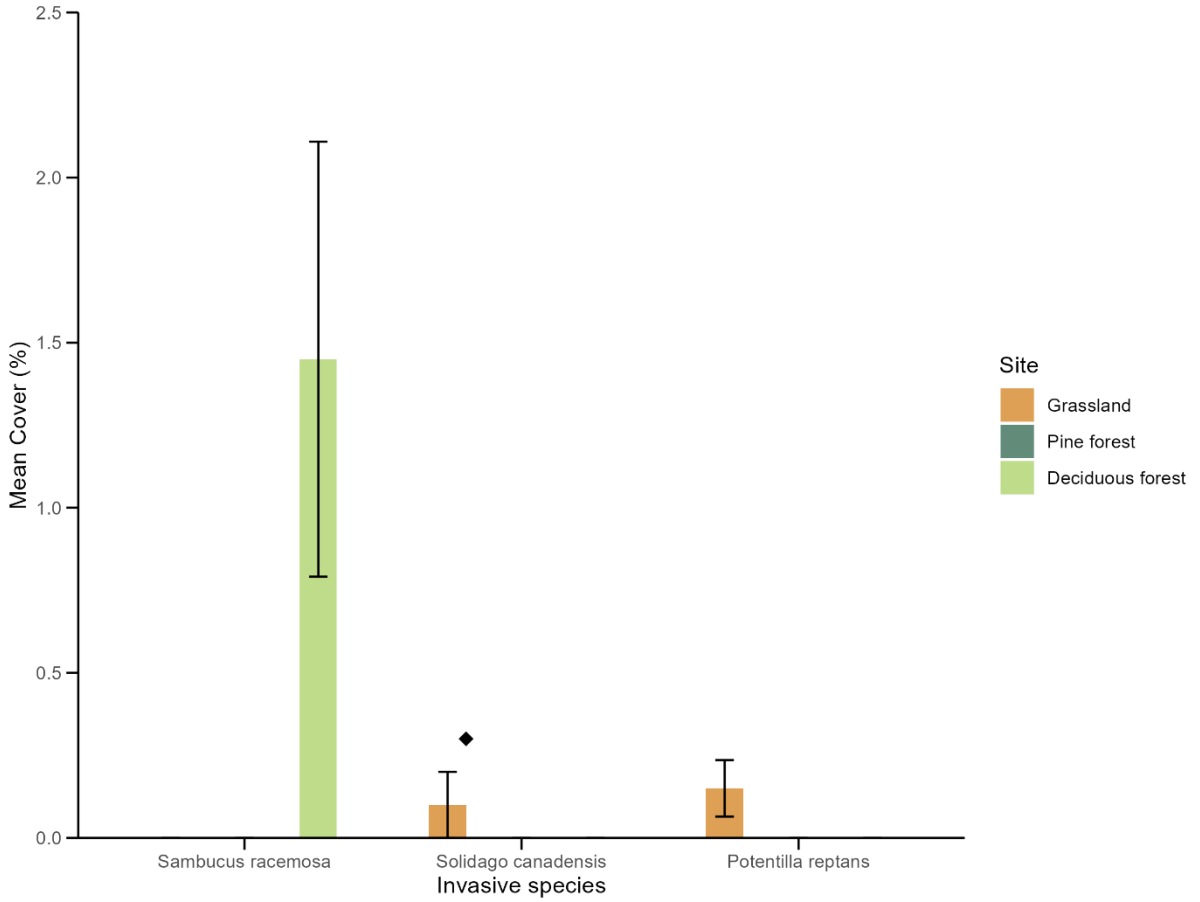

Figure 11: Average cover of invasive species in each site. No invasive species were found in the pine forest. The black diamond indicates observations found outside the transects. Error bars indicate +/- SE.

In general, the cover of invasive species was low, however red elderberry had a notably wider distribution compared to the other two species (Fig. 11). *Sambucus* had a mean site cover of 1.45%. In contrast, both *Solidago* and *Potentilla* accounted for less than 0.2% of the grassland cover. While the red elderberry was observed in 14 quadrats with up to 60 % coverage, the two other invasive species together only occurred in four quadrats with a maximum coverage of 10 %.

5.1.5 Native non-target species

Eleven NNTs species were observed: two in the deciduous forest and eleven out of the eleven in the grassland (Table 1). No NNT species were found in the pine forest.

Table 1: Overview of all native non-target species (NNTs) and in which of the three site(s) they were found.

Species	**Common name**	**Site**		
		Deciduous forest	Pine forest	Grassland
Juncus effusus	Common rush			X
Rumex longifolius	Northern dock			X

Juncus conglomeratus	Compact rush		X
Stachys palustris	Marsh woundwort		X
Cirsium arvense	Creeping thistle		X
Artemisia vulgaris	Mugwort		X
Filipendula ulmaria	Meadowsweet		X
Anthriscus sylvestris	Cow parsley		X
Pteridium aquilinum	Bracken fern		X
Urtica dioica	Stinging Nettle	X	X
Rubus idaeus	Raspberry	X	X

NNTs covered more than 10% of the total vegetation in the grassland and the deciduous forest (Fig. 12). Raspberry dominated in the deciduous forest, counting for 96 % of this cover. Although *Rubus* also counted for the majority in the grassland, other considerable species were bracken fern, creeping thistle (*Cirsium arvense*) and cow parsley (*Anthriscus sylvestris)*.

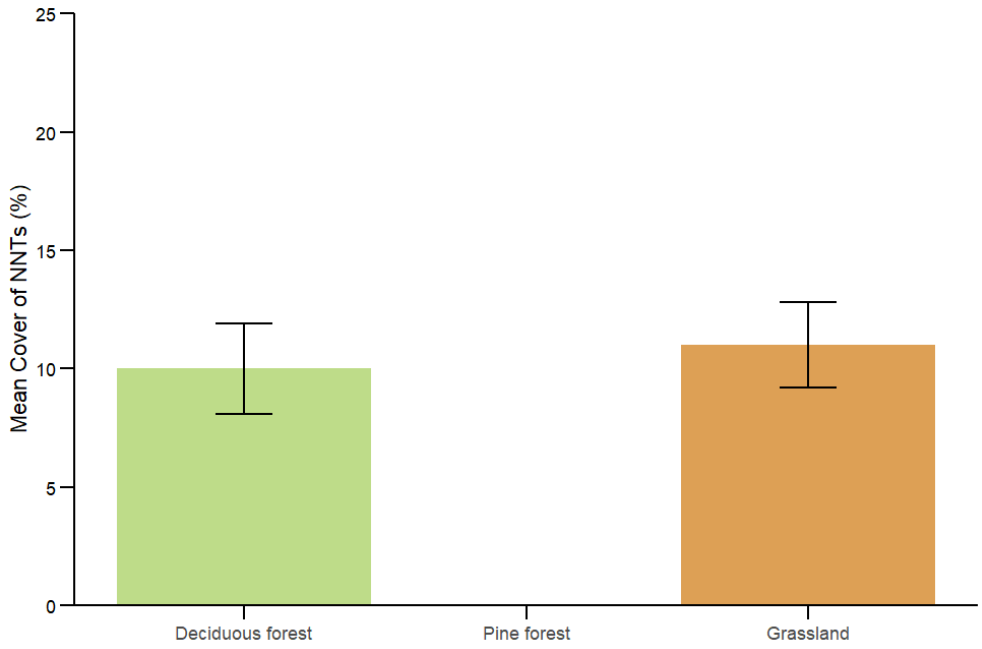

Figure 12: Mean cover of native, non-target species (NNTs) at each site. No NNTs were recorded in the pine forest. A t-test revealed no significant difference between the sites (p = 0.70). Error bars indicate +/- SE.

5.1.6 Vegetation cover

There was significantly more vegetation than non-vegetation (stones, bare ground, dead wood, and litter) covering the grassland and the deciduous forest (Fig. 13). In contrast, no clear dominance was found in the deciduous forest (p = 0.117), where the standard error overlapped zero, indicating uncertainty.

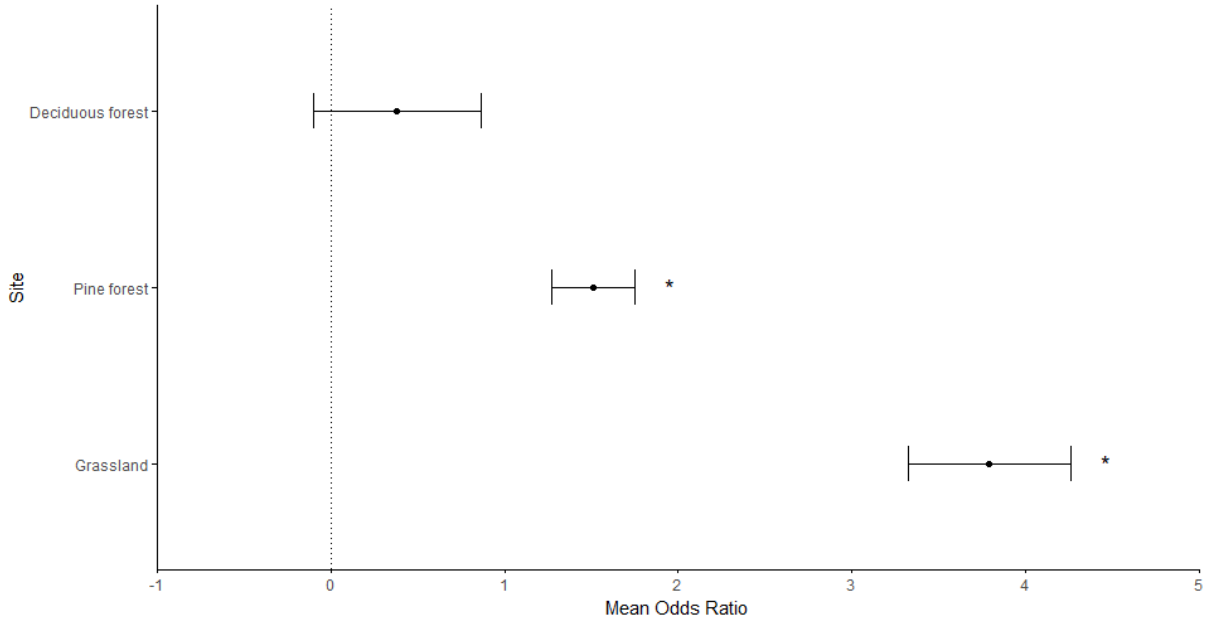

Figure 13: Odds ratio plot comparing the ratio of vegetation and non-vegetation in the three sites. The dashed line at x = 0 represent a fifty-fifty vegetation and non-vegetation cover. Values above 0 indicate more vegetation than non-vegetation, and the opposite for values under 0. The scale is logarithmic, and the error bars represent +/- SE.

5.1.7 Possible edge effects and dispersion corridors

A beta regression was conducted to look at roads as a possible dispersion route for unwanted species. The grassland was the only suitable site for this regression, as the other two sites had too few unwanted species. Two separate regressions were performed: one on the transects in the southern grassland area bordering to a road, and one on the remaining transects in the northern grassland area which does not border a road (control site). For both cases, the regression investigated the relationship between coverage of unwanted species and distance from road. Unwanted species represents invasive species and NNTs combined. Distance from road was deducted from the quadrat position on the transects and grouped for every ten meters from the road. The regression in the road bordering area only included three distance groups since the transects consisted of two 25-meter transects.

There were significant differences between the quadrats closest to the road (0-10) and the quadrats furthest away (20-30; Fig. 14). The vegetation 0-10 meters from the road was slightly negatively correlated with coverage of unwanted species (β = -1.87). The vegetation 20-30 meters from the road, however, had a positive correlation with coverage of unwanted species (β = 2.31) and the proportion of unwanted species was ten times higher than vegetation within the first 20 m from the road.

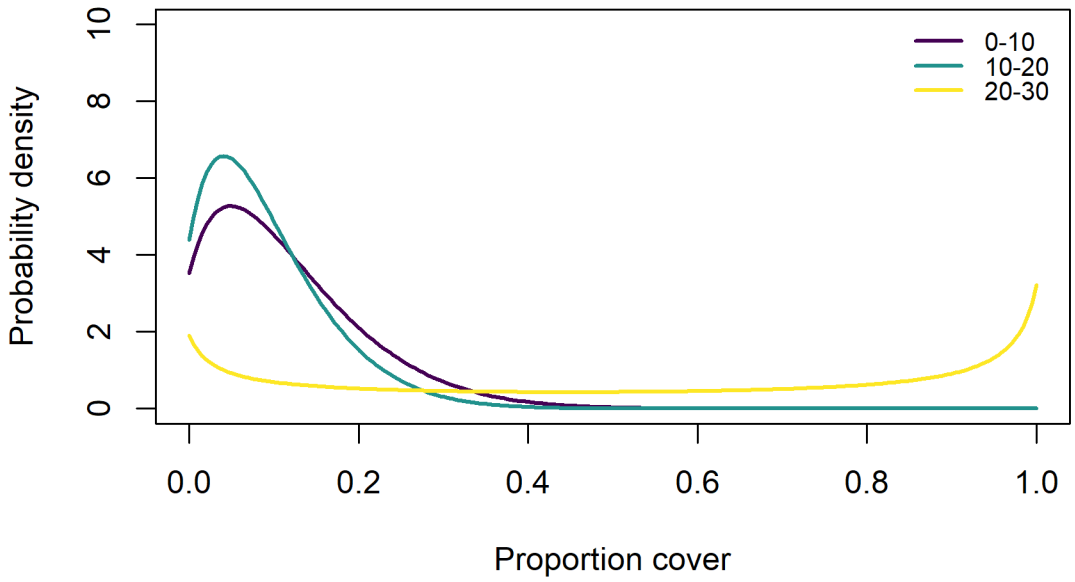

Figure 14: Beta regression testing the correlation between presence of unwanted species (invasive species + NNTs) and distance from road (m) on the southern grassland site. The distance data was first grouped into three categories for every 10 meters from the road, then all groups were tested for significance compared to the first group (0-10). While 0-10 meters from the road indicated a negative effect on presence of unwanted species (β = -1.87, $p < 0.000$), 20-30 meters from the road showed a positive correlation with presence of unwanted species (β = 2.31, $p = 0.001$).

The beta regression on the northern grassland transects revealed significance only for the 0-10 group (Fig. 15). The 0-10 group showed a slightly negative effect (β =-1.87) on coverage of unwanted species, and a similar pattern of unwanted species can be found along the entire transects.

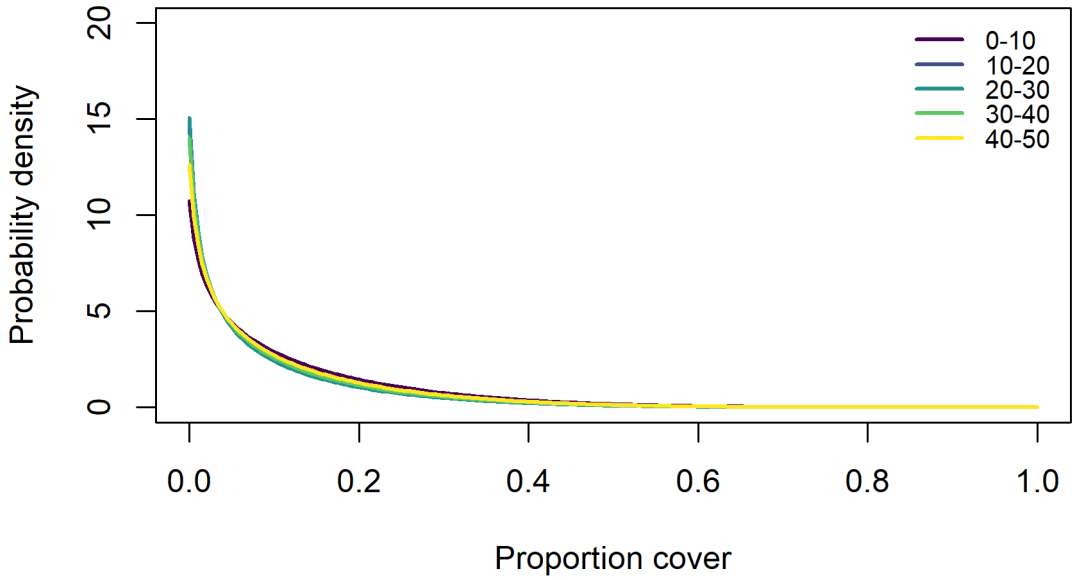

Figure 15: Beta regression testing the correlation between presence of unwanted species (invasive species + NNTs) and distance from road (m) on the northern grassland site (control). The distance data was first grouped into five categories for every 10th meter from the road, then all groups were tested for significance compared to the first group (0-10). No other group than 0-10 showed a statistically significant effect ($p < 0.000$).

5.2 Thematic analysis

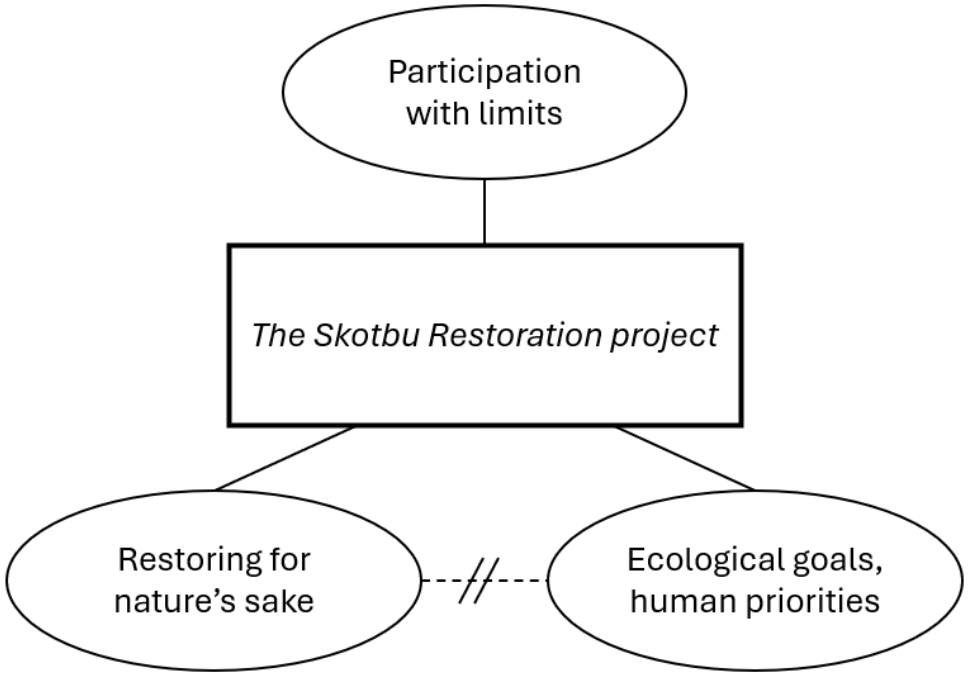

Figure 16: A mind map showing the themes developed through the thematic analysis. The dotted line with intersecting lines indicates contradictions.

From the eight interviews with different stakeholders related to the restoration regarding the Skotbu elevated water reservoir, I developed three themes through my thematic analysis (Fig.

16). “Participation with limits” reports how direct stakeholders was involved within the restoration project decision-making, while indirect stakeholders had limited participation access. The theme “Restoring for nature’s sake” encompasses the stakeholders’ desire to conserve biodiversity and their view of ecological restoration as a means to repair human-caused damage to nature, as well as to create new nature. Lastly, “ecological goals, human priorities”, on the other hand, conveys that in the real decision-making, anthropocentric values prevailed over biocentric values.

5.2.1 Participation with limits

Throughout the interviews, it became evident that the participation process among direct restoration stakeholders differed from participation related to indirect stakeholders. While the zoning plan regarding the water reservoir went through a participation process according to the Planning and Building Act, the restoration part of the project was treated as a purely administrative matter. Direct stakeholders, that is the administration, politicians, consultants and landowners, were included in the actual restoration decision-making process. Indirect stakeholders on the other hand, including interest organisations and general inhabitants, did not get the chance to participate in the restoration decisions. Public participation measures were required for planning processes of development projects like zoning plan and the overarching municipal land-use plan, however not for restoration processes. One of the politicians explained how the restoration worked as a democratic process:

“the residents, well, they don’t get to participate in this type of case. That’s why they have elected us to make those decisions on behalf of the residents. However, they had a great degree of participation when we created the plan for land use. And it’s the big documents and the big hearings- yes, the big documents and the important documents that we adopt, that’s where the residents get very concrete participation. But otherwise, they have to talk to us, right, they have to contact us politicians and share their opinions.”
(Politician 2)

Regarding the zoning plan for the Skotbu water reservoir, the administration elaborated on the specific participation measures that were implemented for indirect stakeholders. In addition to sending information letters to the neighbourhood, the municipality administration actually exceeded the formal requirements in the law by holding an open information meeting with subsequent field inspection in Skotbu. However, when asked about communication about the restoration specifically, the municipality administration clarified:

"I can say that we have communicated with residents at a general level. This includes discussions related to zoning work and other necessary matters. However, to be honest, we did not go into much detail regarding land degradation neutrality and restoration compensation. Regarding land restoration, we have been in contact with the affected landowner, but not in such detail with communication with others."
(Administration worker 2)

The administrators also emphasized the importance of having an open and transparent process. The Skotbu water reservoir project had its own page on the municipality's website, where the consultant report was published, and the progress of the project was updated regularly. Yet, one of the politicians and the landowner questioned how much information on this medium actually reached out.

"*the information in this area has been available and accessible, but for most people, it feels completely out of reach. However, it also depends on interest. It's very difficult to disseminate good information about a lot of things, when some people haven't necessarily sought it out*"
(Politician 1)

The landowner explicitly remarked how broader communication about LDN could benefit restoration projects. Before being contacted by the municipality, the landowner had neither heard about the restoration in Skotbu, nor the principle of LDN.

"*Yes, but I think people could have taken the initiative themselves as well, if they knew about it. I hadn't heard about this at all before the municipality mentioned it, really.* [...] *But when it becomes a bit more known, I think maybe people will take the initiative themselves as well, and might want to do it*"
(Landowner)

Moreover, Politician 1 described how ensuring adequate participation in general was experienced as challenging. Even in cases where the rules on participation had been followed, as with the Skotbu project planning process, it could be difficult to inform the general public about *when* they could influence decision-making:

"*It is a democratic challenge, participation in general, and it has been the case here* [land degradation neutrality] *as well. Not that we as politicians haven't been able to participate, but in terms of involvement and understanding among residents. And one thing is, in a way... the concepts here, but the other is the consequences for society. It is very typical that when a new*

central plan is made that involves very big changes, there is very little engagement. But when those changes start to be implemented, the attention becomes very large, and then everyone responds 'yes, but now it's too late, you should have said something in 2017.' So, it is a huge challenge, and something we must never be satisfied with, in terms of how much participation we manage at the right time."
(Politician 1)

A consultant pointed at another challenge in securing participation. Development projects often contain a wide range of stakeholders, and the interviewee expressed that especially indirect stakeholders could be hard to detect. Consequently, such groups could easily fall through when it comes to facilitation for participation by the municipality. The consultant also highlighted that indirect stakeholders should be given extra consideration as they can contribute to the project with, for example, local knowledge.

"*It can easily be users of a natural area, for example, right? Which one might easily forget. It can be important to include associations, it can be schools and kindergartens. They often use the natural area. Yes, one should make sure to include such users. And neighbours. Because it might be hardest to catch those* [groups] *who are more informal. But it can be the orienteering club... They often have a lot of local knowledge.*"
(Consultant 2)

The concerns regarding participation were somewhat reflected in the Skotbu restoration, as direct and indirect stakeholders had different experiences towards involvement. For the direct stakeholders, seven out of the seven interviewed (two administration workers, two politicians, two consultants, one landowner) described the process as of being efficient in its information flow, with good communication and without any conflicts.

Despite being contacted *after* the municipality had selected the restoration site, the landowner felt heard, and that the municipality was available for questions at any time. The landowner believed they could not have contributed much earlier in the process and therefore did not feel the need to be included earlier either. Nevertheless, the interviewee felt that grounding among landowners would be essential for any restoration on private land: "*I think it's important that as a landowner, you're at least heard. As a landowner, it is essentially you who should perhaps have the right to say what should be done*" (Landowner).

In contrast, the indirect stakeholder interviewee from the interest organisation did not know about the restoration in Skotbu. This was despite ecological restoration being a popular subject

in the organisation, and that they worked with several other restoration projects in the municipality. When asked specifically about the Skotbu restoration, the only thing the member recalled thinking about the project was "*okay, great, the elevated reservoir will be beneficial for many people*" (Organisation member). In the end of the interview, the informant reflected over the case again, and came with some remarks on how the information about the restoration could have reached out: "*No, that's a shame. Yes, it should be a point in every zoning plan, addressing what should be restored and what the end state of the project is*" (Organisation member). As zoning plans are publicly available, the interviewee believed that more people would be engaged in LDN projects if restoration measures were explicitly mentioned in the papers. In the previous case of implementing LDN in the municipality, the organisation member had not experienced any additional efforts to enhance participation. Indeed, the interviewee felt that the local politicians clung to their party's agenda, regardless of who was included or not during planning processes.

Although the interviewees felt that national attention to restoration was increasing, there was a perception that this issue was only relevant to those with special interests. Regarding Skotbu, the interviewees believed there was more interest in the water reservoir than in the restoration efforts, and that people caring about LDN were more interested in the concept in general than the specific case of Skotbu. One recurring theme was that only those politically engaged in the nature and climate debate would follow the Skotbu case. As one politician put it, these were the "hardcore conservationists". Since 2019, both the administration and the politicians had noticed a shift in focus among the residents. Internationally impacting factors like Trump being re-elected, wars and economic recession came up during the interviews. The municipality saw it as political trends moving away from environmentalism:

"In 2019, climate issues, Greta Thunberg, and the UN's climate and nature panel were hot stuff. Now, it's different. So, we're left with... And 2019 was somewhat unique. If you talk to environmentalists from the 80s, 90s, or 2000s, they felt like a very small minority, facing little understanding. But in 2019, it was something people cared about, not just those who voted for traditional environmental parties, but almost regardless of who you voted for, you'd say climate and nature were super important. Now, it feels like we've somewhat returned to it being perceived as a narrow interest again."
(Politician 1)

Furthermore, three interviewees stated that local affairs always take precedence over interest in nature. In other words, residents tend to think that personal economy and development of the

local community is more important than whether a forest is conserved or cut down, at least according to the member of the interest organisation:

"If you come to areas where you have personal interests in local surroundings, urban forests, playgrounds for children, and such things, then there may be local engagement. But no one thinks about area neutrality. And I believe the main reason for that is that it costs money. We always end up focusing on the economy, and people are busy with daily life and the high cost of living and such things. So, it's like... Wow, should we dig up that peatland? What's the point of spending money on that when we have youth crime and need more daycare places? So, these issues are set against each other."
(Organisation member)

Politician 1 pointed at a missing link between the general interest in nature, and the specific interest in the Skotbu restoration or LDN. People feeling nature is important would not automatically vote for LDN. Reducing this gap could lead to greater public engagement in restoration initiatives, as illustrated by the following quotation:

"So, the local nature means a lot to many voters, across many, many parties. But the transition from that to understanding that the principles behind area neutrality and ecological compensation are the best way to secure local nature for people, the enthusiasm that I personally feel... I don't get the impression that voters initially perceive it as very important."
(Politician 1)

5.2.2 Restoring for nature's sake

When the interviewees were asked about what type of nature should be restored, a common theme was the need to prioritize diverse and vulnerable nature. The interest organization member and one politician highlighted biodiversity, for example in relation to insect death, while one consultant pointed at the redlist for nature types as a good guide for restoration. Four out of eight interviewees (landowner, consultant, organization member and politician) mentioned that rare nature must be conserved, no matter what nature type it was. The emphasis was on the local scale, and what was seen as rare did not have to comply with national red lists.

There was a particular interest in the nature types of natural forest and peatland. All stakeholder groups, except the administration, stressed the importance of conserving natural forests. One reason for this was that there are few natural forests left and that they contain a rich species diversity in all life stages. Another frequent reason was the experiential value of being in a bright and open forest, compared to plantation forests. One consultant and one politician wanted

first and foremost to restore peatlands. In addition to recovering the native fauna and flora in the peatlands, the two interviewees highlighted the climate benefits of increased carbon storage as well as the peatlands' ability to regulate water.

The stakeholder groups did not only talk about how restoration preserves the nature, but also how restoration creates nature. They advocated for an understanding of ecological restoration going beyond conservation alone, that restoration also encompasses transforming already developed areas, so-called grey areas, into nature. In these cases, restoration did not have to mean "bringing back what was there before", but could simply be to create any desired form of nature.

Also, most of the stakeholders felt an ethical responsibility to restore nature. The responsibility did not only come from the fact that humanity has impacted or degraded most of nature, but also because humans depend on nature. In this regard, humans were seen as part of nature, making the two mutually interdependent on each other. Restoration was in a long-term perspective seen as more than saving wild species, it was ultimately an action to save ourselves, the human species:

"*The goal is to improve the condition of ecosystems again. We have destroyed a lot, even historically. Industrialization, the fact that we are becoming more and more numerous and need to use more and more land to produce food, intensify and use a lot of chemicals, sprays, pesticides, and everything else. So we have a huge impact on nature, as seen in all the red lists, in all countries, that it is getting worse and worse. And we are completely dependent on nature, even though in the society we live in, even though we have little contact with nature ourselves, many at least, it is so important that ecosystems are strengthened, and that we get the ecosystem services that we depend on, but also because species and nature have an intrinsic value... which is difficult to quantify, but is very important, I think.*"
(Consultant 1)

Alongside Consultant 1, the organisation member emphasized nature's intrinsic value, advocating ecological restoration for nature's own sake. The organisation member argued that this value should guide all restoration decisions, even when it conflicts with human interests. At the same time, the interest organisation member proposed an alternative ethical perspective: humanity's extensive destruction of nature imposed an ethical responsibility to interfere less. Instead of further tinkering with nature, we should let it be and evolve by itself.

5.2.3 Ecological goals, human priorities

The process of choosing a site to restore regarding the Skotbu elevated water reservoir started at the consultants. The consultant explained that in their project-based nature accounting method, the restoration site had to comply with the three principles of similarity, additionality, and closeness. The principle of similarity implied that the nature being restored should be as similar as possible to the nature being degraded. However, in the case of Skotbu, this principle had to be adjusted since the area designated for the water reservoir mainly consisted of a spruce plantation. Consultant 1 explained: "*Here, it's only everyday nature or quite heavily modified areas that are impacted, and of course, one wouldn't establish a new spruce plantation if one takes down a spruce plantation*". Due to its low biodiversity values, tree plantations were not desired nature types for restoration. As the consultants explained, the idea behind the nature accounting was to ensure the restoration would increase the biodiversity or ecosystem functioning of an area. Thus, in cases where "modified areas" of nature were degraded, the nature account method required compensation through restoration of higher-valued nature. Preferably, this would be restoration of "valuable nature", referring to red-listed nature types or nature with key ecosystem functions. Alternatively, it could be restoration of "everyday-nature", meaning natural areas with less biodiversity than valuable nature, often impacted by human use, like natural forests close to housing areas. Hence, for the principle of similarity to be fulfilled in the Skotbu case, the restoration area had to consist of either everyday-nature or valuable nature. The second principle, additionality, indicated that more nature must be restored than what is degraded, adding some criteria to restoration area size. The third principle of closeness favoured restoration sites near the water reservoir site, ensuring degradation of nature in Norway cannot be offset by restoration in other parts of the world.

With these principles in mind, the consultants delineated three potential restoration sites. By using existing mapping data of the areas and the NINA report on potential restoration areas in Nordre Follo (Skrindo et al., 2023), Consultant 1 found the deciduous forest, the pine forest and the grassland. All sites were within a one-kilometre radius of the development site. The deciduous forest was chosen because the municipality had already established contact with the landowner and was aware they had carried out some previous restoration efforts in the area. The forest was defined as everyday-nature. Regarding the pine forest, the consultants discussed whether this site would truly fulfil the principle of additionality, as restoration would primarily involve leaving the area undisturbed without expanding the extent of valuable nature. In the end, the site was included because there were few old pine forests in the area, and these forests

were at great risk of being cut down. Similarly, the grassland was selected due to the scarcity of intact localities of this nature type in the municipality and its classification as vulnerable on the Norwegian red list. Both the pine forest and the grassland were labelled as valuable nature.

The project-based nature accounting method resulted in the pine forest receiving the highest restoration score. The consultants had compared the three sites regarding quality improvement potential, management interest, degree of difficulty, time perspective, distance from the development area, and total area of the restoration site. Despite this, the consultants recommended prioritizing the other sites over the pine forest due to its failure to fully meet the principle of additionality. Following the pine forest, the grassland was ranked second. Restoring the grassland would provide a higher ecological benefit than the deciduous forest; however, restoring the deciduous forest would be cheaper and easier. Consequently, the grassland became the recommended site for restoration. Ultimately, restoring any of the three areas would offset the nature degradation caused by the water reservoir site, adhering to the principle of area neutrality.

The consultants were content about the nature account method they had developed and believed that their decision regarding restoration in Skotbu was based on an adequate knowledge base. Nevertheless, Consultant 1 emphasized how the method was a pilot in need of further development:

"*Well, because the method* […] *is just one part of a comprehensive nature accounting. According to the UN definition, a natural accounting should consist of an area accounting, an ecological condition accounting, including natural goods, ecosystem services, and natural capital. But what we do with this nature points method is to only look at an area accounting plus a condition accounting, when assessing the health status of nature. But we do not include ecosystem services and the monetary value of nature. And that's simply because we find it very difficult at the present time, and there is so much that can go into ecosystem functions. It can range from timber value to pollination or water purification, so it is very... very vague and difficult to include it in an account now, at least for us. So we focused only on biodiversity*."
(Consultant 1)

Furthermore, the consultant and the organisation member expressed the need of increased detailed mapping of valuable nature types and species. The member pointed out how the mapping was on a too big scale not able to capture important details, and that it was only a

snapshot of the given area, as the mappings usually are conducted in just one day. One of the municipality administrators also mentioned local knowledge as an important part of the knowledge base. In contrast, Consultant 1 argued there was no need for this type of knowledge in the Skotbu case, as the restoration areas did not include any mobile species of interest. Local knowledge was thus not collected.

After submitting the report with the evaluated restoration sites, it was up to the municipality to make a decision. As the politicians had approved the zoning plan, the decisions on how and where to restore was up to the administration. At the time the interviews were conducted, the administration had selected which site they wanted to proceed with. However, they were in the process of making a deal with the landowner, so the outcome could quickly change. Although the administration was satisfied with the consultants' report and had great confidence in their professional assessment, the bureaucrats decided to go ahead with another site than the recommended grassland:

"*well, we would have liked to choose this old pasture, given that there are so few left in the municipality, making it somewhat rare. But again, one has to think practically and consider how feasible it was, so that takes precedence. Feasibility is an important principle, yes.*"
(Administration worker 1)

Due to its feasibility, the administration opted for the deciduous forest site. Firstly, the administration worker emphasized how the most decisive factor was to achieve a voluntary and long-term agreement with the private landowner. The consultants and the politicians also underlined this aspect. As the municipality did not own any areas nearby Skotbu, the project depended on a private landowner's agreement to fulfil the principle of closeness. Regarding the deciduous forest site, the municipality already knew the landowner and were left with the impression that they were positive to restoration, also in a long-term perspective.

"*it seems like the grandfather* [of the landowner] *has already removed quite a few large spruce trees here, which is a kind of management advice for a rich deciduous forest. So, they have already done some things that are correct in relation to the nature type. So it seems to me that there is an understanding that this forest area is a different type of forest than the rest of the spruce forest at least. So that also maybe helps with, yes, that one might be able to reach this agreement. But we'll see how it goes, we are not sure how it will go.*"
(Administration worker 1)

Secondly, the administration believed that it would be more resource-intensive to restore the grassland. Annual grazing would be required, and there were no nearby farms with animals to perform this maintenance. Additionally, the area was isolated and quite small, making it insufficient as a standalone grazing resource.

Since the deal with the private landowner had not yet been signed, it was hard for the administration to tell what timeframe would apply for the restoration in Skotbu. Although the administration workers would gladly have a 100 year-long deal, they had looked to other government restoration projects as a reference and thought that a 30-year perspective was more achievable. The landowner, on the other hand, had not considered any specific timeframe; they simply wanted a thriving forest for a long time, provided the trees were not in danger of falling over and causing harm.

The interviews revealed that the municipality clearly had financial limitations. The administration was tied to budgets for each development project, and the budgets were decided by the elected politicians. One of the politicians stressed that economic factors were decisive in limiting which restoration sites at Skotbu were realistically available:

"*They* [the consultants] *have said which area is most suitable, but we also have to consider the economics of it. For example, if we were to protect that pine forest, and the landowner demands disproportionately high compensation for it, then that is not an option.*"
(Politician 2)

The administration, the politicians and the organisation member indicated how economic restrictions forced the municipality to choose between nature or growth:

"*And what perhaps didn't come up clearly in the matter* [restoration in Skotbu] *was precisely this about the economy. And we do have a responsibility towards our citizens, right? But should we count money, or should we think that you get good natural areas? This is a conflict, we are constantly in a dilemma.*"
(Politician 2)

Another factor in choosing a restoration site was its communication potential. Stakeholders widely agreed that creating enjoyable nature experiences for the general public was an important aspect of ecological restoration. Both the landowner and the consultants stressed the need to consider public outreach when selecting a site. Effective communication was seen as crucial to inform people about the restoration activities and their purposes.

"*But, at least as a start, I think it's important, or of course, you can do it in a forest that no one uses too, to try to showcase it, but it's at least important that people see it, in a way. Because if people just read that a certain amount of money is being spent to fix an area and that's all they know, then I think for many it becomes like, yeah, what's the point of it, in a way*"
(Landowner)

By showcasing the restoration process, the Skotbu project could enhance public understanding of restoration and land degradation neutrality, while also attracting more supporters. Compared to the other sites, the deciduous forest had an advantage regarding communication as it was situated in the town of Skotbu. The landowner described how the gravel road crossing the forest was heavily used by pedestrians and bikers on their way to and from the train station.

In addition to being able to see the restored nature, many interviewees thought it would be beneficial if people could access it and use it. One consultant, one politician, the organisation member and the landowner highlighted the importance of having nature close and accessible, also referred to as everyday-nature. This could be flower meadows, a cluster of trees, or open streams, generally nature near densely populated areas. Both consultants thought that the everyday-nature had received less attention and appreciation than it deserved. More important than the ecological values of this nature type, was how everyday-nature could build and strengthen relations between human and nature. Thus, restoring more everyday-nature would have the potential to increase the appreciation and support for nature in general. Although the deciduous forest site was much seen, the landowner clarified that it was not much in use. The interviewee only recalled childhood memories of people walking in the forest when it was previously maintained. Still, this suggested that the area could see increased use in the future if restored.

For the landowner, having access to use the site was a decisive factor when agreeing to restoration. The interviewee was initially opposed to forest restoration if it meant strict protection. However, when the municipality explained that restoration involved active measures and allowed the landowner some flexibility in using the land, their attitude towards restoration and LDN became positive. "*Yes, there will be no restrictions in any way, and that has been somewhat important for us. For example, if we want to have goats there, it is important that it can still be used for that*" (Landowner). The interviewee further emphasized that the ambiguity between protection and restoration could be an obstacle to more landowners supporting LND and offering their properties.

After working with the Skotbu restoration, the stakeholders had noted several factors that were crucial for a successful project. Firstly, having a long-term perspective. According to all interviewees, successful restoration both depended on long-term plans for restoration measures and monitoring, but also long-term access to areas. As with the Skotbu case, restoration on private land required a watertight agreement with the landowner. Secondly, making the best decision on which area to restore required a thorough knowledge base. According to the interviewees, the knowledge base would need to include a comprehensive understanding of the local ecology and potential impacts from different restoration measures, as well as a detailed nature mapping of the areas.

Furthermore, the Skotbu project had highlighted essential factors for restoration and the concept of LDN to be implemented overall. According to the interviewees, there needed to be political will, budgetary space, and administrative capacity to work with restoration. Since restoration and LDN was not mandated by the state, the municipality relied on political will to prioritize time and funding to these initiatives. Next, municipal restoration depended on cooperation across stakeholders. As explained by one of the politicians, Nordre Follo did not have the best economic conditions to implement LDN, however a strong political will as well as a remarkable cooperation between the administrations and the politicians led to adoption of the principles:

"*I believe that two important factors have been a very strong political will and an understanding that this is brilliant, and a professional environment in the municipality that has the ability to turn good visions into practical, feasible community development. So, the collaboration between politics and administration has been extremely important*"
(Politician 1)

In order to continue and improve restoration practices, all but one politician missed more assistance from the state. One recurring issue was the need for a national and standardized method on nature accounting. As nature accounting had been an important tool for Nordre Follo to perform the first LDN restoration at Skotbu, designing and developing an appropriate method had been time consuming and costly. Therefore, many also mentioned the necessity for more earmarked funds for restoration driven by municipalities. Lastly, the administration and the politicians wished for more help with legal affairs related to LDN and restoration. Since the concept of LDN was new to Norway, the municipality had several questions regarding securing areas for restoration according to the law.

6 Discussion

This thesis examined ecological restoration decision-making under the LDN framework in Nordre Follo, using the Skotbu Water Reservoir Project as a case study. The following chapter revisits the research questions in light of the findings. The first research question explored ecological barriers to restoration across three proposed sites. Vegetation analysis identified invasive species, grazing maintenance in the grassland, and informal roads as key obstacles. The absence of reference sites further complicated ecological assessment and long-term monitoring. To enhance ecological evaluations, the applied nature accounting method should be expanded to include species- and community-level indicators. The second question investigated stakeholder involvement in restoration decisions. The process primarily included municipal administrators, consultants, and the landowner, while interest organisations and the public were excluded. Although public participation is a core principle in zoning plan processes, it was not considered integral to restoration, which was treated as a technical matter. Future LDN restoration projects should require public participation to ensure benefits from stakeholder involvement and knowledge exchange. The final question addressed trade-offs between ecological and socio-economic interests. While ecological goals framed the project, socio-economic constraints ultimately shaped the site selection. The decision-making process reflected a technocratic approach, emphasizing instrumental over intrinsic ecological values. Future projects should prioritize the restoration process itself to better integrate ecological considerations.

6.1 Ecological barriers to restoration success

The overview of functional vegetation groups across the three sites showed unexpected patterns for the deciduous forest (Fig 8). The high levels of litter and dead wood reflect previous logging activities in the area, such as the removal of conifer trees. This disturbance may explain the relatively high abundance of NNTs, as forest management practices often result in twig piles that release nitrogen, favouring nitrogen-loving species such as raspberry and stinging nettle (Larsson & Søgnen, 2003). However, given that small-scale disturbances are natural in deciduous forest ecosystems, the presence of litter, dead wood, and NNTs is not expected to hinder restoration (Larsson & Søgnen, 2003). Additionally, anthropogenic litter consisting of roof tiles and metal mesh was observed. Such non-organic litter needs to be removed as part of the restoration measures.

Invasive species, however, can act as direct barriers to restoration success as they obstruct establishment and growth of native species (D'Antonio et al., 2016). In addition, invasive species are able to alter key ecosystem properties like soil cover, nutrient cycling and hydrology (Weidlich et al., 2020). Consequently, IPBES has reported dispersion of invasive species as the fifth biggest driver of biodiversity loss (IPBES, 2019). At the same time, removing invasive species can be tricky, often requiring expensive and long-lasting treatments with uncertain results (Weidlich et al., 2020). Among the three invasive species identified at the restoration sites (Fig. 11), *Potentilla* carries a low risk of damage (LO), whereas *Sambucus* and *Solidago* are ranked as having the highest risk possible (SE) (Skarpaas et al., 2023a; Skarpaas et al., 2023b; Skarpaas et al., 2023c). Although only one individual of *Solidago* was observed in the grassland, the high invasion potential imposes a risk of rapid spread and displacement of native vegetation. In the deciduous forest, Sambucus was registered in 14 quadrats with a cover up to 60%, constituting a risk of disturbing the forest species composition. In order to promote successful restoration in the grassland and deciduous forest sites, restoration measures must address the traits of each invasive species, their impact on community structure, as well as the feasibility of these measures in terms of resources and costs (D'Antonio et al., 2016; Hulme, 2006; Weidlich et al., 2020).

Two native non-target species were identified in the deciduous forest, whereas eleven species were observed in the grassland (Table 1). In contrast to invasive species, NNTs are not foreign; instead, they are unwanted because they are not characteristic of the specific nature type. As such, NNTs are typically weedy species, and a high distribution indicates poor condition of the nature type (Kuester et al., 2014). In the deciduous forest, *Rubus* and *Urtica*, which are very common species, are classified as NNTs due to their high abundance. These species exploit conditions of high disturbance but are not stress-tolerant, thus representing typical ruderal species (Grime, 2006). The recent selective logging of spruce trees in the forest may have facilitated the proliferation of these NNTs. As ruderal species are not competitive, *Rubus* and *Urtica* are likely to be outcompeted during the natural secondary succession of the logged forest areas (Grime, 2006; Larsson & Søgnen, 2003). Consequently, they are unlikely to pose a long-term barrier to restoration success.

The eleven NNTs in the grassland site reflects that the site is in a fallow phase. As a semi-natural habitat, the grassland requires regular maintenance, such as grazing or mowing, to prevent overgrowth (Pitkänen et al., 2014). Historically, the northern and southern parts of the grassland at Skotbu were connected, but forest planting in the middle section during the 1960s disrupted

this continuity (Liebel et al., 2024). It is likely that grazing ceased during this period, allowing more competitive species like *Juncus* and *Rumex* to expand. Resuming low-pressure grazing in the area is expected to reduce the abundance of NNTs, and additional mechanical weeding methods can be employed to manage particularly aggressive species (Pitkänen et al., 2014). The NNTs also include more nutrient-dependent species like *Stachys palustris*, suggesting that the area has been cultivated or fertilized at some point (Olsen, 2025). Light fertilization characteristics are noted in the NiN mapping, but not to a degree that eliminates nitrogen-sensitive grassland species (Miljødirektoratet, 2020a). To promote species characteristic of grasslands, it is thus crucial to avoid further fertilization to reduce competition. Semi-natural grassland is ared-listed habitat type (VU), and 29% of all threatened species in Norway depend on semi-natural habitats (Artsdatabanken, 2018; Artsdatabanken, 2021). Therefore, restoring the grassland, including reducing the abundance of NNTs, has great potential to enhance biodiversity and support red-listed grassland species such as *Dracocephalum ruyschiana*.

Most grassland restoration projects rely on a viable seedbank containing previous present species (Pitkänen et al., 2014). When such a seed bank exists, characteristic grassland species may reestablish themselves once appropriate management measures are implemented, aligning with Principle 4 of the SER Standards, which emphasizes supporting self-organizing ecosystem recovery. However, field studies in both Norway and Sweden have found that seed banks in grasslands do not correspond to the vegetation above ground (Milberg, 1995; Rosef, 2008). Few species make up most of the seed bank, and often these are weeds like *Juncus*. Milberg (1995) reported that seeds of weedy species remain viable for decades, whereas those of characteristic grassland species have considerably shorter viability. Assuming the grazing management of the Skotbu site ceased up to 60 years ago, the grassland species soil bank may be deprived. Hence, depending on the seed bank as primary source for biodiversity restoration may be insufficient, and additional measures like hay application and manual sowing should be considered. To ensure successful restoration, soil seed data should be collected to inform appropriate measures for a management plan.

The need for regular management itself can be an ecological barrier to successful restoration. Common management methods for grasslands are mowing and grazing, however grazing is favoured in temperate grasslands due to its efficiency (Rosef, 2004). Optimal grazing pressure can benefit both the economy and biodiversity, but the right grazing level varies according to biotic and abiotic conditions, as well as the specific grazing species (Rosef, 2004). Additionally, the grazing will be affected by the length of the grazing, whether it is continuous or rotational,

and species composition, their traits and abundance in the vegetation. Consequently, successful restoration by grazing requires careful consideration and a management plan adapted to the specific site. Restoring the grassland in Skotbu may be more resource-intensive, but the outcome could be beneficial for biodiversity, the farmer, and aesthetically pleasing for nearby residents. Finding the optimal grazing method often depends on trial and error, which stimulates adaptive management according to principle five of the Standards. Additionally, since grazing is often a previously used method, many restoration projects like Skotbu may benefit from TEK, promoting principle two on incorporating different types of knowledge.

The odds ratio plot for vegetation cover indicates a higher proportion of vegetation compared to non-vegetation elements (litter, bare ground, rocks, and dead wood) within the grassland and pine forest sites (Fig. 13). The pine forest exhibits a lower vegetation cover than the grassland, which is expected because of the accumulation of conifer needles reducing light availability and lowering soil pH (Alriksson & Olsson, 1995; Janišová et al., 2007). Conversely, the mean odds ratio for the deciduous forest was not statistically significant, suggesting an approximately equal distribution of vegetation and non-vegetation cover. In other words, half of the ground cover in the deciduous forest site consisted of dead vegetation, bare ground, and rocks. Understory vegetation constitutes a crucial layer within forests, contributing significantly to ecosystem biodiversity through the presence of seedlings, shrubs, herbs, bryophytes, and lianas (Deng et al., 2023). This vegetation also supports many mobile animal species through being a source of food, shelter, and habitat. Additionally, the forest understory plays a vital role in ecosystem services, including nutrient cycling, decomposition, water conservation, and carbon sequestration (Deng et al., 2023). Therefore, the understory plant community may be a key indicator of the overall productivity and quality a forest (Deng et al., 2023; Wulf, 1997). However, it is important to note that deciduous forests typically exhibit high litter abundance due to seasonal defoliation, and the understory vegetation is influenced by factors such as overstory species, climate, and environmental conditions (Landuyt et al., 2019). These results suggest that a restoration plan for the deciduous forest in Skotbu should include facilitation of a diverse understory vegetation.

Previous research has shown that invasive species thrive along roadsides, making human infrastructure favourable corridors for their dispersion (Flory & Clay, 2009; Mortensen et al., 2009; Von Der Lippe & Kowarik, 2007). Similarly, native weeds are defined as stress-tolerant plant species benefitting from disturbances, making roadsides suitable habitats (Sharma et al., 2021). Thus, a beta regression was performed on the grassland transects to investigate any

relationship between NNTs and invasive species combined as unwanted species, and distance to road (Fig. 14: Fig. 15). The two separate grassland areas made it possible to test the relationship on one site, while the other served as a control. The regression revealed that the chance of finding unwanted species in the control site was equally high throughout the transect, indicating no dispersal corridor at the edges of the northern grassland site. Furthermore, when unwanted species were observed in quadrats, they constituted only minor percentages. Thus, in the interior grassland area, unwanted species had a very low abundance and were evenly distributed. The southern grassland area bordering the car road showed a different distribution pattern: the vegetation furthest away from the road included areas with unwanted species covering between 80-100 % of the quadrat. Compared to the trend of unwanted species dispersing along roadsides, this result reveals a completely reversed situation in Skotbu, where the unwanted species seem to emerge from the interior edge. However, this is probably a consequence of the logging waste found furthest away from the road. There is a narrow, unimproved, private road bordering the western edge of the southern grassland site, which facilitated the dumping of logging waste. Accordingly, the results suggest that informal roads may also act as strong dispersal corridors for unwanted species because they facilitate human access to the area and increase ecosystem disturbance. As such, informal roads can be an ecological barrier to restoration success, highlighting the need to assess their potential effects at restoration sites.

The Skotbu restoration project in some ways deviates from other expected future cases of ecological restoration under LDN in Nordre Follo. An important guiding principle within the applied nature point method was the principle of similarity, however this was not applicable for the restoration in Skotbu. The area to be degraded due to the construction of the water reservoir primarily consisted of production spruce forest, which is considered an undesirable nature type for restoration because of its low biodiversity and aesthetic value. By placing the project in this area, Nordre Follo municipality adhered to the LDN response hierarchy of minimizing the inflicted degradation. Nevertheless, this decision also meant there was no preferred nature type to be restored. Consequently, the three potential restoration sites represented three different nature types. Although restoring any of the sites would make up for the degradation in the production spruce forest according to the nature points, the decision-making process became more complicated. As the sites consisted of different nature types, it was not possible to compare the sites to each other regarding degrading factors. Furthermore, no reference sites were provided nor mentioned in the interviews, resulting in a limited ability to measure potential

restoration benefits. Without such references, it is challenging to establish clear and measurable goals and to monitor restoration success. Consequently, the Skotbu restoration fails to meet principle 3 and 5 of the SER Standards, thereby risking an inadequate restoration outcome (Gann et al., 2019). Therefore, the lack of a reference site can be considered a significant ecological barrier to achieving restoration success.

The project-based and newly developed nature point methods provided a systematic evaluation without reference ecosystems. Still, some of the scorings depended on personal knowledge and experience, and several researchers have warned that reducing nature into one metric value cannot capture its complexity, dynamics, diversity nor intrinsic value (Gómez-Baggethun & Ruiz-Pérez, 2011; Maechler & Boisvert, 2024). Given that the Skotbu case was influenced by the LDN response hierarchy, future restoration projects may encounter similar circumstances. Future initiatives would benefit from selecting potential sites that consist of the same nature type and from identifying reference sites early in the process. This approach would facilitate the decision-making process regarding restoration sites and enhance the project's chances of success.

Several ecological barriers to restoration success have been identified in the three proposed restoration sites in Skotbu. Invasive species like *Sambucus* and *Solidago* act as ecological barriers because of the risk of altering the native plant community composition and require immediate intervention to prevent their impact from increasing. Necessary grazing measures in the grassland site constitutes a barrier due to the complexity of implementation. Lastly, informal roads in the grassland as well as the deciduous forest have the potential to facilitate human-induced ecosystem disturbance and represents a barrier that should be confronted in restoration plans. That being said, ecological barriers to restoration success does not imply that areas are unsuitable for restoration. Indeed, the presence of ecological barriers suggests that the overall net positive outcome from successful restoration efforts will be greater. However, this demands more restoration resources and efforts to ensure success. Research on species-level community structure and dynamics, as well as broader-scale ecosystem services is necessary to provide a more comprehensive assessment of ecological barriers within the three sites. Investigations into abiotic factors such as soil quality and moisture would further improve this evaluation. Finally, reference sites must be provided to allow for quantifiable restoration success. These recommendations should be implemented in the nature point system for future restoration projects under LDN in Nordre Follo.

6.2 Broader participation potential

The municipality administration emphasized the importance of the Skotbu project to be an open and transparent process with Skotbu residents. All stakeholders knew about the development of the elevated water reservoir, and the municipality implemented several measures to ensure participation, such as open meetings, field visits to the reservoir area, and a public web page detailing the project's development. However, little information was provided about the restoration. The environmental organisation member did not know about the restoration part of the project when being interviewed, and the landowner had not heard about LDN or the Skotbu restoration before directly consulted by the administration. These findings point to inadequate communication about the restoration part of the project from the municipality, indicating that the first two principles of successful ecological restoration have not been met.

Principle 1 of the SER Standards about engaging stakeholders affirms the responsibility of restoration project managers to "genuinely and actively engage with those who live or work within or near restoration sites" (Gann et al., 2019, S10). The principle emphasizes that stakeholder engagement should begin in the early conceptual phase and continue throughout the project, ensuring contributions at every stage (Gann et al., 2019). Acting as a bridge between the ecological and social spheres, stakeholder engagement is essential for delivering local community benefits to Skotbu. Neither the landowner nor the interest organisation member experienced such engagement, pointing to the exclusion of the public.

Furthermore, local community members are an important source of local and traditional ecological knowledge. As such, the exclusion of the public in the Skotbu restoration project fails principle 2 of successful restoration, which seeks to fill gaps regarding detailed site information, historical use, and feasibility of implementation via local knowledge (Gann et al., 2019). Despite acknowledging the importance of local knowledge in restoration projects, the consultants felt no need for using this type of knowledge in their nature accounting assessment. As the landowner held valuable information about the area's usage and users, this showcases one example of how local ecological knowledge could have benefitted the Skotbu restoration project.

Working on integrating the LDN framework into existing laws was challenging for the municipality administration. They thought the optimal approach would be to incorporate the LDN framework within the planning processes governed by the Planning and Building Act, so that a completed restoration plan would be evaluated as part of the zoning plan. Knowing the

negative impacts on nature and the corresponding restoration measures required for compensation beforehand would enable politicians to make informed decisions on development projects. Yet, there was no focus on public participation within the restoration process. For both the politicians and the administration, it seemed natural to treat the restoration as a purely technical matter. As a result, public participation was not considered an integral part of the restoration process, unlike established planning procedures such as zoning plans and municipal plans.

Since the zoning plan for the Skotbu water reservoir had already undergone initial reviews prior to the adoption of the LDN framework, the ecological compensation had to be established as a sequence requirement (Nordre Follo municipality, 2023c). Consequently, neither plans nor descriptions of restoration measures were included in the zoning plan during the public participation phase or upon its approval. This explains how the municipality could meet the participation requirements in the Planning and Building Act while simultaneously providing the general public with minimal information regarding the restoration efforts. The municipality administration explained that as Skotbu served as a pilot project for LDN, they expected some trial and error before determining the optimal method for incorporating ecological compensation into legislation.

In the Skotbu restoration project, the decision-making process regarding the restoration site primarily involved the municipal administration, external consultants, and the potential landowner. The consultants proposed three restoration sites, the administration assessed the practicalities, and the landowner agreed to the restoration of their land. Municipal politicians played a more general role in approving the Skotbu zoning plan, while interest organizations and local residents were excluded from the restoration aspect of the project. Consequently, the Skotbu restoration project has demonstrated that, in the absence of clear rules for participation in ecological restoration, indirect stakeholders are not included in the decision-making processes. Given that exclusion of social considerations in restorations is a well-documented pitfall, the Skotbu case has highlighted a lack of measures to □ulfil SER principles 1 and 2 within Nordre Follo's LDN framework (Gornish et al., 2024; Löfqvist et al., 2022; Tedesco et al., 2023). As a result, limited participation constitutes a social barrier to restoration success. As Nordre Follo is currently in the process of integrating the LDN framework into legislation, this presents an opportunity to include public participation as a requirement in restoration projects under LDN. Further research is needed to explore the integration of participation regulations

for restoration within the Norwegian context and to identify effective measures for communicating and engaging the public in restoration efforts.

6.3 Trade-offs between ecological and socio-economic interests

The key interests identified in the decision-making process for the restoration site were divided between ecological (biodiversity, proximity, additionality) and social (feasibility, economy, communication, accessibility, and timeframe. The first four are considered ecological interests, which formed both the basis and the goal of the Skotbu restoration project. The municipality allocated substantial resources for the consultant's report, which served as the ecological basis for the selection of a restoration site. By evaluating potential restoration sites through a nature accounting method, the report sought to ensure complete ecological compensation for the degraded nature. In the selection of potential restoration sites, biodiversity interests were weighted to prioritize areas of rare or threatened nature types. The accounting method also placed special emphasis on proximity and additionality (area size). Sites located near the reservoir received more points to promote functional ecosystems in the vicinity of development projects. Larger sites were awarded more points to ensure additionality, meaning that more natural areas were restored than degraded. As the alternative of conserving the pine forest would not increase the area of valuable nature, this site did not meet the additionality principle and was dismissed early in the process. Hence, the nature accounting method highlighted ecological interests by emphasising rare nature, additionality, and closeness.

The interest of biodiversity also constituted the main goal of the Skotbu restoration project. Interviews revealed that stakeholders viewed supporting vulnerable and endangered species and ecosystems at the local scale as the main goal of the project. It was perceived as important to repair what had been damaged, making up for human-imposed nature degradation. Restoring of natural forests and peatlands were especially emphasized due to biodiversity richness and climate change mitigation.

Ecological barriers to restoration success, with the exception of grazing, received limited attention. These barriers were perceived more as opportunities for restoration rather than actual impediments. For example, invasive species were frequently mentioned during the interviews, but only as a justification for the necessity of restoration, and never as a potential constraint to restoration success. However, grazing in grasslands was considered a barrier, primarily due to its resource demands rather than its ecological complexity.

The Skotbu restoration site selection process also depended on the socio-economic sphere. Practical aspects of the restoration were especially important for the municipality administration responsible for implementing the measures. Since the restoration had to be conducted on private property, securing a voluntary, long-term agreement with a private landowner was seen as one of the most decisive factors for success. The feasibility criterion also suggested a preference for sites that required less resource-intensive restoration measures. Since grazing in the grassland would necessitate annual livestock management, this site was deemed less feasible for restoration.

Another interest influencing the decision-making was economy. Politicians and the administration saw the Skotbu restoration as expensive, and the willingness to pay for restoration had to be evaluated against other social priorities, such as supporting schools and elderly care. Since the municipality managed the Skotbu elevated water reservoir project, all associated costs would eventually indirectly affect the citizens. Although politicians were not directly involved in selecting the restoration site, they impacted the decision from the outset by establishing budgets.

The potential to communicate about the restoration and access the restoration site emerged as important factors in the interviews. Since emphasis was on reaching out to the general public, sites that were frequently visited by people or located near residential areas were preferred. This interest favoured what the interviewees referred to as “everyday nature” for restoration: natural areas used for recreational purposes that did not contain vulnerable or valuable species.

Lastly, the timeframe for restoration was a concern for the Skotbu restoration stakeholders. While the development of the water reservoir was projected to take up to two years, the compensatory restoration was anticipated to require considerably more time, potentially extending to a hundred years, according to the interviewees. Consequently, it would be impossible to demonstrate satisfactory results of the required compensation before the approval of the development project. Moreover, since the Skotbu restoration had to be conducted on private land, securing the area for long-term restoration posed another challenge. The solution was a voluntary binding agreement with the landowner, albeit limited to a 40-year timeframe. Given that the municipal council operates on a four-year term, securing land for restoration, as well as continuous maintenance and monitoring could not be guaranteed in the long term, thus presenting a barrier to successful restoration.

As a result, the decision-making process for selecting the restoration site in the Skotbu project involved trade-offs between ecological and socio-economic interests. Initially, the consultants evaluated the proposed restoration sites based on their ecological values. The action plan in the report also included an assessment of costs and the level of difficulty associated with the restoration. Here, the grassland ended up as the recommended site due to the weighting of its ecological benefits. Subsequently, the municipality administration conducted an interdisciplinary evaluation of the three sites, where resource demand and securing a voluntary agreement with the landowner were the most decisive factors. Consequently, the final decision was to restore the deciduous forest, representing a compromise between ecological potential and feasibility. This prioritization indicates that socio-economic considerations, or limitations, outweighed ecological interests in the Skotbu restoration.

However, several ecological interests were not included in the nature accounting method. For instance, species-level information was not assessed, resulting in only one of three invasive species being identified in the report. Species-level assessments should be conducted in future restoration projects, as invasive species may significantly alter the restoration situation, both by changing the ecological conditions and increase the budget due to required controlling measure(Weidlich et al., 2020). Connectivity and ecosystem services were also overlooked in the nature accounting. The omission of ecosystem services was attributed to the novelty of the method and acknowledged by the consultants. Future restoration projects within the LDN framework should incorporate ecosystem services to bridge the ecological and social dimensions of restoration, thereby enhancing the success rate in alignment with SER principles (Gann et al., 2019).

The Skotbu restoration fits under Clewell and Aronson's (2006) technocratic rationale since it was undertaken by the municipality representing the local governmental level. Furthermore, the restoration was a method of compensating environmental impacts and served to fulfil the LDN requirements as well as the international restoration obligation of Norway to restore 30% of degraded land areas before 2030. The project also required careful integration into the legislation. Lastly, the restoration in Skotbu shared some of the technocratic challenges like having a top-down approach, and that there was a lack of public participation measures. Additionally, the pragmatic rationale was somehow supported as three stakeholders recognized restoration's function to mitigate climate change, and four stakeholders mentioned human survival as part of the motivation behind ecological restoration.

At the same time, the biotic rational significantly shone through the Skotbu restoration. The selection of restoration site was informed by ecological principles and knowledge, and the main goal of the restoration measures was to assist the locally rare nature type of deciduous forest. The latter aspect was confirmed both in the nature accounting report and the stakeholder interviews. There were also some hints of the idealistic rationale in the decision-making. Both politicians and both consultants felt an ethical responsibility to restore due to all human-induced degradation over the times, and the restoration thus symbolised an atonement for environmental damage. Furthermore, the emphasis on communication and accessibility showcased how stakeholders perceived the restoration holding potential to reconcile people with nature.

Having a technocratic or pragmatic motivation can increase the instrumental value of restoration, viewing it as a means to achieve goals and fulfil obligations, and to ultimately benefit humans. This perspective prioritizes the end goal of restoration over the process. In contrast, biotic and idealistic motivations perceive restoration as having intrinsic value, thereby emphasizing the process itself. Consequently, there may have been conflicting motivations behind the restoration efforts in Skotbu. Since all proposed sites met the required compensation in nature accounting, an instrumental view of restoration would imply that any of the sites could satisfy the restoration goal. Thus, selecting the most convenient or feasible site would be a natural choice. This appears to have been the case for Skotbu, suggesting that the instrumental approach within technocratic and pragmatic motivations prevailed. Conversely, if the value of restoration lies in the process, choosing the site with the highest potential for restoration would be preferred. Additionally, focusing on the process would encourage public participation, thereby enhancing the success of restoration efforts. This underscores the importance of supporting biotic and idealistic motivations in future LDN restoration projects in Nordre Follo.

One politician, one consultant and the landowner recognised the value of restoring everyday-nature, aligning with Cronon's (1995) understanding of restoration. They emphasized the importance of restoring nature where people live and work, particularly for the initial restoration projects under LDN, to foster greater public understanding and support. This approach also aligned with the perspectives emphasizing communication, accessibility, and experiential value of nature for humans. Cronon's approach on restoration implies a prioritization of socio-economic interests over ecological ones by favouring less vulnerable and diverse nature. Still, restoring nature closer to where people live has a higher potential to engage the general public and thereby fulfil principles 1 and 2 for restoration success.

The dualistic paradigm of Katz (1996) was predominantly rejected by the stakeholders as all but one never questioned humans' role in ecological restoration. The interest organisation member hinted to the risk of moral hazard once, fearing that local politicians would benefit from the LDN framework by the ability to justify degrading development projects. Also, the same stakeholder mentioned that humans should interfere less with nature, especially within protected areas. Nevertheless, all stakeholders, also the organisation member, had a positive impression of ecological restoration. They regarded it as a way for people to positively impact nature, reflecting the ethical perspectives of Light (2003) and Tanasescu (2017). Consistent with Tanasescu's viewpoint, both consultants and politicians even felt a moral responsibility to engage in restoration efforts. In contrast to the organisation member, most stakeholders perceived the requirement for ecological compensation as hindering development projects by making them more expensive. Lastly, although some stakeholders mentioned that ecological restoration benefits humans, this was considered supplementary to its primary purpose of serving nature, thereby recognizing restoration as beneficial to both nature and people. These additional perspectives show how motivations are complex and rarely only fitting into one of Clewell and Aronson's (2006) five motivations.

6.4 Insights for future restoration under municipality-driven LDN

The development of LDN practices in Nordre Follo, where the Skotbu restoration project serves as a pilot, has made the municipality a driver of restoration in Norway. As the lack of integrated land-use planning is the fourth biggest barrier to restoration in Europe, municipality LDN frameworks, like in Nordre Follo, have great potential to increase restoration efforts (Cortina-Segarra et al., 2021). Restoration integrated into land-use planning is valuable for two reasons: first, a massive upscaling of restoration is necessary to reach the 30 % goal to which Norway has committed (Hagen et al., 2022). Second, new land-use practices are required to alter the current pattern of continuous human-induced degradation of nature (IPBES, 2019). Since municipalities are the primary land-use planning authority in Norway, a successful outcome of the Skotbu restoration may inspire and guide other municipalities and government authorities to implement and support LDN practices.

At the same time, investigating the Skotbu project has demonstrated how municipality-driven restoration in an LDN framework can be a fragile system. Before introducing ecological compensation as a legal requirement, several prerequisites had to be met: strong political will and engagement within the municipal council, sufficient economic resources and capacity, and a concrete definition of the LDN concept. Additionally, the municipality bears numerous

responsibilities in the implementation phase of the restoration, such as ensuring a robust knowledge base for decision-making, comprehensive mapping of nature sites, maintaining a long-term project perspective, and conducting adequate monitoring. Consequently, the Skotbu restoration constitutes a municipality "surplus project". As the LDN framework is implemented on a voluntary basis, its legal enforceability is limited and may be subject to reversal by the municipal council, particularly if political commitment weakens or resource availability declines.

Therefore, to achieve increased and successful restoration at the national level, the Norwegian government must increase its support to the local level. The most recent governmental report on the sustainable use and conservation of Norwegian nature has addressed some of Nordre Follo's concerns by promising a national nature accounting framework and introducing the subsidy scheme "natursats" (Meld. St. 35 (2023-2024)). However, the Skotbu restoration project has uncovered the need for legislative measures that not only facilitate the implementation of LDN, but also explicitly incorporate provisions for inclusive stakeholder participation throughout the restoration process and secure access to restoration areas. Such a solution could increase the focus on achieving ecological outcomes as well as valuing the restoration process itself. This shift aligns more closely with the SER principles, enhancing the potential for restoration efforts to deliver benefits to both nature and people (Gann et al., 2019). Furthermore, a process-oriented approach may strengthen idealistic motivations, leading to a better balance between the administrative advantages of technocratic restoration and the bottom-up engagement of idealistic restoration (Clewell & Aronson, 2006). Finally, the Skotbu case underscores the necessity of reliable state funding to ensure that ecological priorities are not compromised by the socio-economic capacities of individual municipalities.

7 Conclusion

Land degradation neutrality provides a strategic framework to address unsustainable anthropogenic land-use practices within Norwegian municipalities. By mandating ecological compensation for environmental degradation in development projects, LDN promotes restoration initiatives. To fully realize the potential of restoration that benefits both people and ecosystems, however, projects must effectively integrate ecological and social dimensions (Gann et al., 2019). The LDN mandated Skotbu restoration project in Nordre Follo, includes several ecological and social barriers to successful restoration. While stakeholders expressed ambitious biodiversity and conservation goals, the selection of restoration site was ultimately decided by the municipality's socio-economic capacity and access to private land. The nature accounting methodology employed by the consultants lacked on-the-ground assessments and reference site comparisons. Consequently, critical ecological factors such as ecosystem services, invasive species, and anthropogenic road networks were not adequately considered in site selection. As the restoration project was excluded from formal planning legislation, there was also a lack of public participation measures. To meet the SER international standards on successful restoration, future LDN restoration projects must include field-based assessments at the species and community levels, as well as engage a broader spectrum of stakeholders throughout the restoration process (Gann et al., 2019). Restoration should be approached not as a fixed endpoint but as a dynamic, iterative process that evolves over time.

The success of future municipal LDN restoration project depends on increased support from the state. To ensure that ecological interests are not overruled by local socio-economic issues, the state must provide guaranteed LDN funding, establish a rigorous national standard for nature accounting, and implement a legal framework that ensures public participation and land access. As LDN projects expand from single sites to regional initiatives, strengthening the LDN framework will be essential to support Norway's efforts in achieving the global target of restoring 30% of degraded land by 2030.

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Appendix 1: General interview guide

**Spørsmål til spesifikke utvalgsgrupper er markert med rød skrift.*

Introduksjon

Presentasjon

Jeg heter Mari Vold Hansen og jeg tar en master i naturforvaltning på NMBU i Ås. Oppgaven min tar for seg valg og avveiinger rundt naturrestaurering på kommunenivå. Forventet prosjektslutt er juni 2025.

Om prosjektet

Prosjektet mitt følger en case i Nordre Follo kommune. Nordre Follo er helt i spissen når det kommer til arealnøytralitet, og har vedtatt dette i sin kommuneplans arealdel. Arealnøytralitet betyr at natur så langt som mulig skal unngås å bygges ned, men i de tilfellene der dette er uunngåelig, må kommunen sikre økologisk kompensasjon. Denne kompensasjonen skal helst være i form av naturrestaurering. Nå befinner kommunen seg i startfasen for det første prosjektet hvor en slik økologisk kompensasjon skal gjennomføres, nemlig i utbyggingen av Skotbu høydebasseng. Det er her jeg kommer inn, og ser på hvordan de ulike aktørene som er involvert tar valg underveis i prosessen. Med dette ønsker jeg å øke forståelsen for de avveiingene og valgene som tas.

Formål med intervjuet

Formålet med intervjuet er å få innsyn i erfaringene og synspunktene til de ulike aktørene tilknyttet naturrestaureringen i Skotbu eller prinsippet om arealnøytralitet. Du får spørsmål om å delta fordi du er tilknyttet saken gjennom:

- din arbeidsstilling
- ditt politiske engasjement
- sitt engasjement i en lokal miljøorganisasjon
- din eiendom

og derfor har verdifull innsikt i prosessen rundt naturrestaurering i henhold til Skotbu høydebasseng.

Behandling av data

Dersom du tillater det, vil jeg gjerne ta opp intervjuet. Opptak vil kun brukes til egen forskning. Det vil ikke distribueres eller brukes av andre som ikke er tilknyttet prosjektet. Du skal ha mottatt en samtykkeerklæring med viktig informasjon om hvordan dine personopplysninger behandles. Kan du bekrefte å ha lest og samtykket til dette?

Anonymitet

Du kommer ikke til å bli sitert med navn, alder, kjønn, stilling eller andre identitetsmarkører. Det vil imidlertid refereres til kategorier for de ulike utvalgene, for eksempel «politiker / kommuneadministrasjon / interesseorganisasjon / grunneier uttaler at…». Du vil få anledning til å lese gjennom sitater dersom du blir sitert direkte. Du har krav på innsyn i egne opplysninger og en kopi av disse opplysningene. Dersom du ønsker dette, kan du ta kontakt med meg etter intervjuet.

Frivillig deltakelse

Å delta i intervjuet er frivillig. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Dette gjelder også etter at samtykkeerklæringen er signert. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Har du noen spørsmål før vi begynner intervjuet?

Intervjuguide

Først ønsker jeg å takke deg for at du stiller opp til intervju. Intervjuet vil hovedsakelig dreie seg om prosessen rundt naturrestaurering i forhold til utbygging av Skotbu høydebasseng, men det vil også være noen spørsmål rundt dine meninger om naturrestaurering generelt.

Stryk eventuelle spørsmål som ikke er relevant for dette intervjuet.

a) Kan du fortelle litt om din rolle i naturrestaureringsprosjektet Skotbu høydebasseng?
b) Kan du ta meg gjennom prosessen så langt med naturrestaureringen i Skotbu høydebasseng-prosjektet?
c) Kan du fortelle litt om eiendommen din som blitt valgt ut til én av de tre områdene som vurderes til restaureringen? (grunneier)
d) Kan du fortelle litt om prosessen rundt utvelgelsen av de tre områdene som vurderes til restaureringen?

Hvem og hvilke interesser blir hørt i prosessen?

e) Hvordan ble du involvert i prosessen?
f) Hvordan opplever du at dine meninger og vurdering blir ivaretatt?
g) Hvor stor grad av medvirkning mener du det er i prosessen?
h) Hvilke andre interessenter/aktører er involvert?
i) Hvilke, hvis noen, grep har blitt gjort for å sikre medvirkning underveis i prosessen?
j) Opplever du at dette er en sak som opptar lokalbefolkningen? Kan du si litt mer om det?
k) Har du vært noen uenigheter rundt arealnøytralitet? Er det noen konflikter i kommunestyret eller mellom andre interessenter?
l) Hvordan har informasjonstilgangen vært i dette prosjektet?
    - Har det vært mye tilgjengelig informasjon fra kommunen? Har det vært mye omtalt i media?
m) På hvilken måte har dere benyttet dere av ekstern kompetanse underveis i prosjektet? (politikere og administrasjon)
n) Har dere på noen måte benyttet dere av eller innhentet lokalkunnskap om områdene som behandles i Skotbu-prosjektet? (konsulenter)
o) Hvordan har dere vektlagt den eksterne kompetansen? (politikere og administrasjon)
p) Er det noe du vil legge til?
q) Er det andre du vet om som jeg burde snakke med om denne saken?

Hva er de fremtredende økologiske faktorene ved valg av areal for naturrestaurering?

r) Hvilken informasjon ble/blir samlet inn (fra din eiendom - grunneier) før valg av restaureringsareal tas?
    - Kan du si litt om denne prosessen? (konsulenter)
    - Hvordan spiller graden av forringelse inn?
s) Vet du hvorfor akkurat din eiendom ble vurdert som egnet til restaurering? (grunneier)
t) Hvilken informasjon mener du bør ligge til grunn før man kan velge areal?
u) Vet du om det har vært satt noen økologiske kriterier for valg av potensielle restaureringsareal? Hvilke?
v) Er det noen spesifikke naturverdier som du synes er viktig for valg av restaureringsareal?
w) Er det noe du vil legge til?

x) Er det andre du vet om som jeg burde snakke med om denne saken?

Hvordan blir de forskjellige økologiske, sosio-økonomiske og politiske interessene avveid i prosessen med å velge areal for naturrestaurering?

y) Hvordan vil du definere naturrestaurering?

z) Hva mener du er målet med naturrestaurering?

- Gjøres naturrestaurering for noen/noe?

æ) Er det noen typer natur som heller bør restaureres enn andre? Hvorfor?

ø) Hvor lenge er du villig til å binde deg til restaureringen? Hvilket tidsperspektiv har du? (grunneier)

å) Finnes det noen begrensende faktorer ved naturrestaurering?

aa) Etter din mening, er det noen utfordringer / vanskelige hensyn å ivareta i beslutningen om areal for naturrestaurering i Skotbu?

bb) Hva er avgjørende for at prosjektet med naturrestaurering i Skotbu skal bli vellykket?

cc) Har grunneierforhold noe å si for restaurering av et område?

dd) På hvilken måte spiller øvre politiske mål og bestemmelser inn på naturrestaurering i kommuner?

ee) Hvordan påvirker lovverket naturrestaurering i kommunene?

ff) Hvilken rolle bør kommunen ha i naturrestaurering?

gg) Er det noe som burde ha blitt gjort annerledes i prosessen?

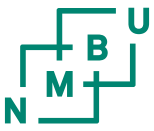
hh) Hvordan ser du for deg at naturrestaurering i kommuner vil utvikle seg framover?

- Hva med arealnøytralitet?

ii) Er det noe du vil legge til?

jj) Er det andre du vet om som jeg burde snakke med om denne saken?

Takk for intervjuet!



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